ROCKAWAY RIVER AND DEN BROOK
DENVILLE TOWNSHIP
MORRIS COUNTY, NEW JERSEY
CAP SECTION 205
FLOOD RISK MANAGEMENT STUDY

DRAFT FEASIBILITY REPORT & ENVIRONMENTAL ASSESSMENT

September 2023

U.S. Army Corps of Engineers
North Atlantic Division - New York and Baltimore Districts
In partnership with the New Jersey Department of Environmental Protection

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the actual cost will be lower than $19.0 million and fall within the statutory limit of the CAP 205 program authority. Net benefits are maximized for the Recommended Plan with annualized net benefits of $481,000 and a benefit cost ratio (BCR) of 1.72 in October 2022 (FY 2023) price levels and use a discount rate of 2.5 percent. The NJDEP and the Township of Denville have indicated support for this plan. The Township of Denville submitted a letter on March 3, 2023 stating that they will be willing to serve as the non-Federal sponsor for design and implementation of this project.

Table ES-1: Number of Structures in Recommended Plan*

Mitigation Measure	Total # of Structures Impacted	Residential	Non-residential
RECOMMENDED PLAN – NORTH, NORTH RIVERSIDE & SOUTHWEST CLUSTERS			
Elevation	30	28	2
Wet Floodproofing	2	2	0
Dry Floodproofing	6	0	6
RECOMMENDED PLAN TOTAL	**38**	**30**	**8**

**The number of structures in the Recommended Plan may change as USACE guidance for nonstructural FRM evolves. Therefore, the number of eligible structures and proposed measures may be revised as additional analysis is completed during the design and implementation of this project, particularly if assumptions regarding participation rates are revised. See additional information provided below.*

Currently, the total project cost in this IFR/EA includes easement agreement costs to allow for the installation, construction, maintenance, and operation of the various voluntary nonstructural treatments in buildings within the Recommended Plan in compliance with existing USACE policy. This IFR/EA also relied on general assumptions related to participation rates, implementation strategy, contracting approach, and requirements related to the terms of conditions for participation in USACE nonstructural plans. Easement agreements will be required in order to implement nonstructural measures. USACE policy for nonstructural plans is evolving. It is anticipated that the policy under development will require that, as a condition of participation in a nonstructural floodproofing or elevation project, the property owner must agree to provide an easement to the non-Federal sponsor without additional compensation for that property interest. These easement agreements will allow for installation of the nonstructural measures and provide rights for inspection and maintenance by the non-Federal sponsor. The easements are also expected to include future use restrictions that will prohibit human habitation below the target elevation, prohibit new structures, additions, or renovations to existing structures below the target elevation, prohibit installation of mechanical systems below the target elevation, and prohibit alterations of the topography that may change the flow patterns or flood retention characteristics of the property. Therefore, the Recommended Plan may be revised as a result of additional analysis required by USACE policy that will result in changes in total project costs, participation rates, eligibility requirements, the total number of structures being recommended, contracting approach, and the overall implementation strategy. Even with these anticipated changes, the Recommended Plan is estimated to be$19.0 million or less.

The changes to total costs and participation rates will have broader implications for selection of individual buildings and clusters for nonstructural measures in the Recommended Plan. This Draft IFR/EA details five clusters in the Denville Study with positive net benefits (Section 5) and are therefore economically justified

for federal participation as part of this project: North, North Riverside, Southwest, Center, and Southeast. These five clusters consist of a total of 54 buildings with recommendations for nonstructural measures in the Township of Denville– 40 for elevation and 14 for floodproofing. The Final IFR/EA will reflect changes to the total number of structures and clusters in the Recommended Plan that may include consideration of measures for all 54 buildings within these five clusters. While there may be overall changes to the Recommended Plan in the Final IFR/EA as a result of public comment or additional analysis, these changes are not anticipated to substantively impact the environmental evaluation and conclusions in the National Environmental Policy Act (NEPA) documentation included in the Draft IFR/EA being released for public comment as the Draft IFR/EA has already considered and evaluated potential impacts to all 54 structures being considered for implementation in the Denville Study.

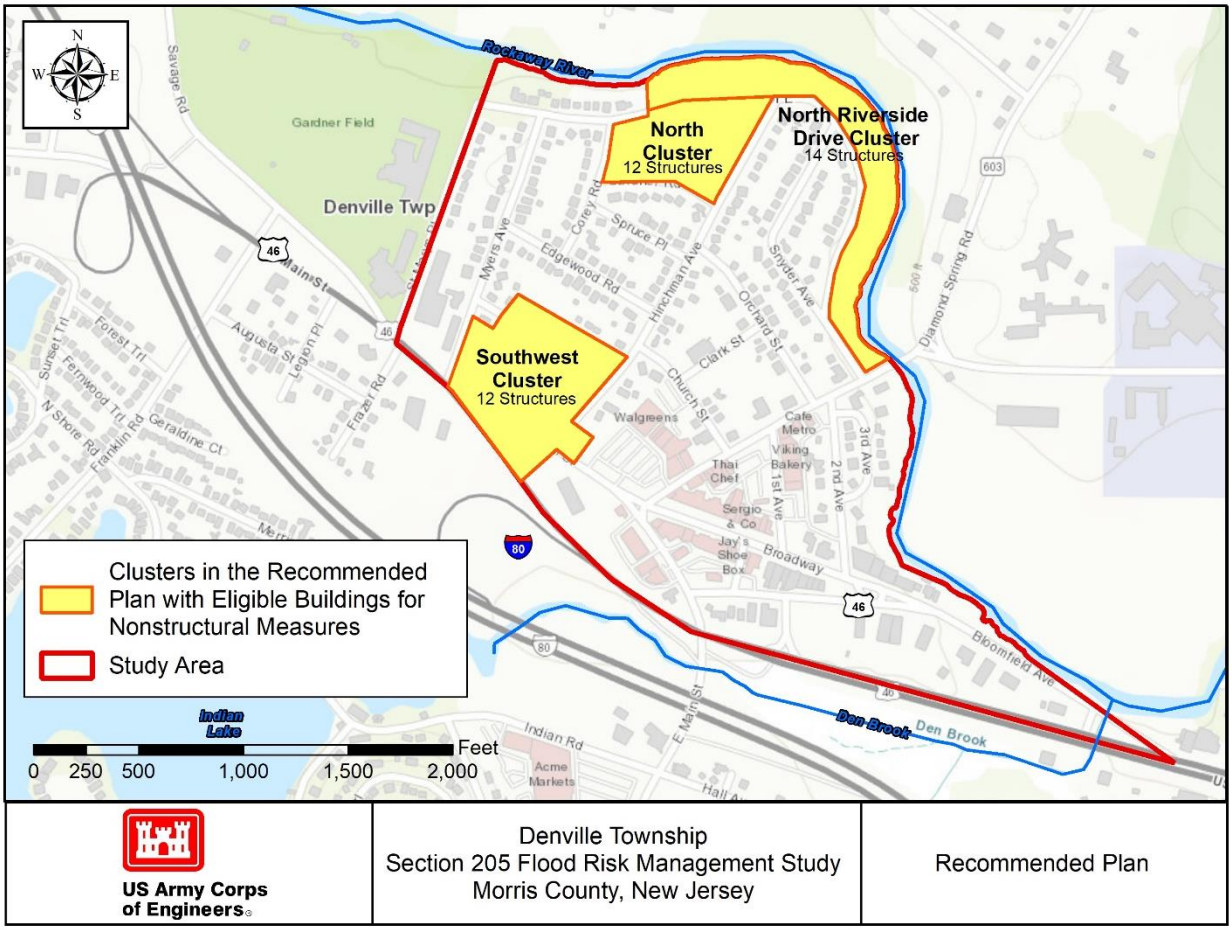

Figure ES-1: Recommended Plan Map

Neither dry nor wet floodproofing would increase the structure footprint nor cause an increase in water surface elevations during flood events. Following implementation of nonstructural measures, residual risk would remain; therefore, it is critical that local residents evacuate promptly during significant storm events. The Township of Denville has existing procedures for mandatory evacuation of residents living in flood prone areas to the Townships' Emergency Shelter at Lakeview Elementary School. The egress route from the

township's flood prone areas and shelter location are not impacted by FRM measures proposed in this study's Recommended Plan.

The project will require the approval of a non-standard estate by USACE Headquarters (USACE HQ) to allow for the installation, construction, maintenance, and operation of the various voluntary nonstructural treatments that will be incorporated into an easement agreement, signed by the non-Federal Sponsor and property owner(s), and recorded in the land records of Morris County, New Jersey. The Recommended Plan includes only voluntary nonstructural FRM measures. If a property owner wants to participate, they must, among other things, be willing to sign an easement agreement that will allow for installation of the nonstructural measures and provide rights for inspection and maintenance by the non-Federal sponsor. The easements are also expected to include future use restrictions prohibiting human habitation in an enclosed structure below the base target elevation, prohibiting new structures, additions, or renovations to existing structures below the target elevation, prohibiting installation of mechanical systems below the target elevation, and prohibiting alterations of the topography that may change the flow patterns or flood retention characteristics of the property. If the owner elects to not participate or does not complete the necessary preliminary steps to start the work, eminent domain will not be pursued. The nonstructural measures in the Recommended Plan are voluntary and available on a first come, first serve basis to eligible homeowners until the funding available in the CAP Section 205 authority is expended.

The Recommended Plan is in compliance with environmental protection statutes and other environmental requirements including, but not limited to, the NEPA, Clean Air Act (CAA), Clean Water Act (CWA), Endangered Species Act (ESA), Fish and Wildlife Coordination Act (FWCA), and National Historic Preservation Act (NHPA). No substantial environmental or social concerns were identified. All practicable and appropriate means to avoid or minimize adverse environmental effects were analyzed and incorporated into the Recommended Plan. Best management practices (BMPs) will be implemented, if appropriate, to minimize impacts.

The District Engineer recommends that the Recommended Plan be constructed under the authority of Section 205 of the Flood Control Act of 1948, as amended. Construction is anticipated to take two years from execution of the Project Partnership Agreement.

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Abbreviations

AAB	Average Annual Benefits
AAC	Average Annual Costs
AAD	Average Annual Damages
ACE	Annual Chance Exceedance
ACM	Asbestos-Containing Material
AEP	Annual Exceedance Probability
APE	Area of Potential Effect
AMNET	Ambient Biological Monitoring Network
AQCRs	Air Quality Control Regions
BCR	Benefit-to-Cost-Ratio
BCE	Before Common Era
BFE	Base Flood Elevation
BMP	Best Management Practices
CAA	Clean Air Act
CAP	Continuing Authorities Program
CM	Construction Management
CHAT	Climate Hydrology Assessment Tool
CO	Carbon Monoxide
CWA	Clean Water Act
CZMA	Coastal Zone Management Act
D&I	Design and Implementation
DMA	Disaster Mitigation Act
DRV	Depreciated Replacement Value
EA	Environmental Assessment
ECB	Engineering and Construction Bulletin
EAD	Equivalent Annual Damages
EGM	Economic Guidance Memorandum
EO	Executive Order

ER	Engineering Regulation
ESA	Endangered Species Act of 1973
F	Fahrenheit
FCCM	Facility Capital Cost of Money
FCSA	Feasibility Cost-Sharing Agreement
FEMA	Federal Emergency Management Agency
FID	Federal Interest Determination
FIRM	Flood Insurance Rate Map
FIS	Flood Insurance Study
FRM	Flood Risk Management
FWCA	Fish and Wildlife Coordination Act
FWOP	Future Without Project
FY	Fiscal Year
GCM	Global Climate Model
GIS	Geographic Information System
HEC-FDA	Hydrologic Engineering Center-Flood Damage Analysis
HEC-HMS	Hydraulic Engineering Center-Hydrologic Modeling System
HEC-RAS	Hydraulic Engineering Center-River Analysis System
HTRW	Hazardous, Toxic and Radioactive Waste
IDC	Interest During Construction
IFR/EA	Integrated Feasibility Report and Environmental Assessment
IPAC	Information, Planning, and Consultation
KCSL	Known Contaminated Sites List
JCP&L	Jersey Central Power & Light
LBP	Lead-Based Paint
LER	Land, Easements, and Rights-of-Way
LERRDS	Land, Easements, Rights-Of-Way, Relocation, and Disposal Areas
LOP	Level of Performance
MUA	Municipal Utilities Authority

NAAQS	National Ambient Air Quality Standards
NAVD88	North American Vertical Datum of 1988
NED	National Economic Development
NEPA	National Environmental Policy Act of 1969
NFIP	National Flood Insurance Program
NHPA	National Historic Preservation Act
NJ	New Jersey
NJCRGIS	New Jersey Cultural Resources Geographical Information System
NJDEP	New Jersey Department of Environmental Protection
NJDEP FIBI	New Jersey Department of Environment Protection Finfish Index of Biotic Integrity
NJDOT	New Jersey Department of Transportation
NJ SHPO	New Jersey State Historic Preservation Office
NJNG	New Jersey Natural Gas
NNBF	Natural and Nature-Based Feature
NOAA	National Oceanic and Atmospheric Administration
NO2	Nitrogen dioxide
NRCS	Natural Resource Conservation Service
NRHP	National Register of Historic Places
NTP	Notice to Proceed
NWI	National Wetlands Inventory
O3	Ozone
O&M	Operation & Maintenance
Pb	Lead
PDT	Project Delivery Team
PM	Particulate Matter
PPA	Project Partnership Agreement
RCRA	Resources Conservation and Recovery Act
RED	Regional Economic Development
RONA	Record of Non-applicability

SF	Square Feet
SIP	State Implementation Plan
SHPO	State Historic Preservation Office
SMART	Specific, Measurable, Attainable, Risk Informed, and Timely
TPCS	Total Project Cost Summary
TMDL	Total Maximum Daily Load
TSP	Tentatively Selected Plan
UCC	Uniform Construction Code
USACE	United States Army Corps of Engineers
USACE HQ	United States Army Corps of Engineers Headquarters
USDA	United States Department of Agriculture
USEPA	United States Environmental Protection Agency
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
VOC	Volatile Organic Compound
WMA	Watershed Management Area

1. Introduction

1.1. Background

The New Jersey Department of Environmental Protection (NJDEP) requested a study for the Township of Denville under the authority of Section 205 of the Flood Control Act of 1948, as amended. The feasibility study has been completed by the United States Army Corps of Engineers (USACE) – Baltimore District and New York District. NJDEP is the non-Federal sponsor and provided 50 percent of the funding for the study.

1.2. Study Area

The Rockaway River flows through the Township of Denville, Morris County, New Jersey (Figure 1-1). Denville is located about 25 miles northwest of Newark, New Jersey, in the north central part of the state. The Township is mostly developed, with the densest development being a mix of residential and commercial land uses located south of Rockaway River. As of the 2010 census, it had a population of 17,107 people (US Census, 2020). Denville is highly vulnerable to fluvial flooding from Rockaway River and Den Brook.

The study area is approximately 130 acres and consists of residential and commercial areas. It is bounded on the North by the Rockaway River, on the South by U.S. Route 46, on the east by Rockaway River, and on the West by St. Mary's Place. Most of the site is gradual in rise and fall of elevation with altitude ranging from approximately 500 feet above sea level at its lowest point, on the south side near Den Brook, to its highest point of approximately 520 feet above sea level south of Riverside Drive and west of Myers Avenue. Most of the study area consists of urban development and associated non-impervious surfaces; however, the north side of the site consists of thick woody vegetation and trees near the Rockaway River stream banks. The major roadways running in the north and south direction are Myers Avenue, Hinchman Avenue, and Diamond Spring Road. Major roadways running in the east and west direction are Orchard Street, Church Street, West Main Street and Broadway.

The Rockaway River's headwaters are known as the Upper Rockaway River, which drains approximately 116 square miles above the Boonton Reservoir Dam. Steep hills in the northwestern portion and low-lying floodplain areas in the eastern portion characterize the Upper Rockaway River Basin. There are numerous small lakes within the basin and several tributaries of importance drain into the river. Russia Brook originates in Sparta Township, Sussex County, and drains into the river in Jefferson Township, Morris County. Green Pond Brook originates in Green Pond, Rockaway Township, and flows into the river at the Rockaway Township/Dover/Wharton borders. Beaver Brook also originates in Rockaway Township and flows into the river at the Denville/Rockaway Borough border. Den Brook originates in Randolph Township and enters the river in Denville. Other tributaries include Jackson Brook, McKeel Brook, Mill Brook, and Tanglewood Brook. The Lower Rockaway River is not part of the study area.

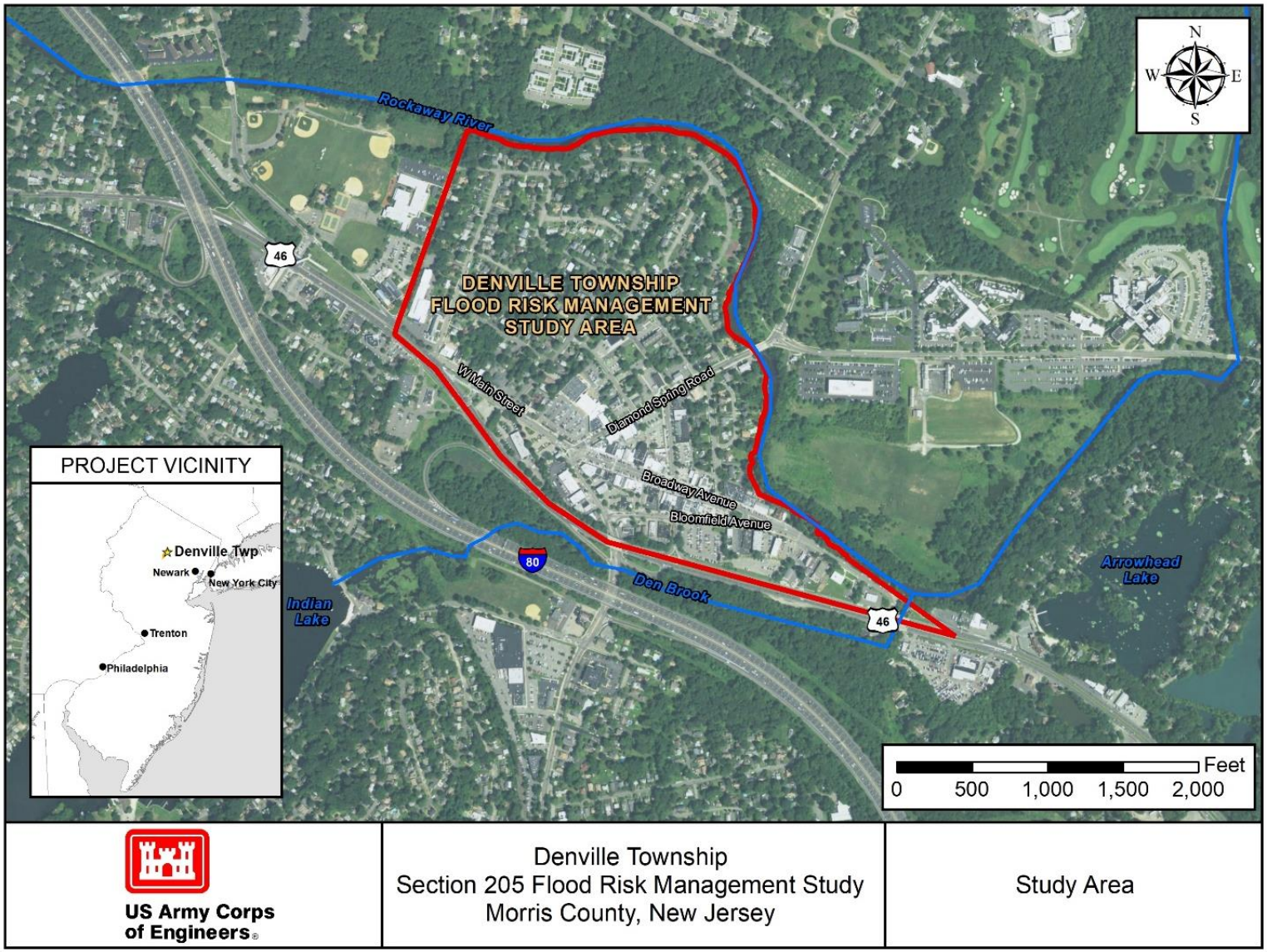

Figure 1-1: Study Area, Township of Denville, Morris County, New Jersey

1.3. Purpose and Need for the Proposed Action

The feasibility study is the first phase of the two-phased USACE Continuing Authorities Program (CAP) planning process. The purpose is to evaluate all reasonable alternatives to reduce flood risk identified in the study area. The Township of Denville has experienced significant damage to property and risk to human life and safety because of riverine flooding, exacerbated by development throughout the watershed, dense development in urban areas, and human alterations to natural flood storage areas. The Township of Denville requested the USACE New York District to evaluate structural and nonstructural measures that could be implemented as a part of a federal project to reduce the flood risk in the portion of the downtown business district. The area is subject to flooding from intense rainfall and storm events, and there is a history of flood damage within the Township, with the most severe damage occurring during Hurricane Irene (August 27-28, 2011).

Many structures within the Township of Denville are identified as repetitive loss or severe repetitive loss. Although the Federal Emergency Management Agency (FEMA) does not share specific locations for the properties, there are a total of 57 structures identified as repetitive loss and 32 structures identified as severe repetitive loss within the Township. FEMA defines the two below:

- A Repetitive Loss property is any insurable building for which two or more claims of more than $1,000 were paid by the National Flood Insurance Program (NFIP) within any rolling ten-year period, since 1978.
- A Severe Repetitive Loss Building is any building that is covered under the NFIP and has incurred flood losses that resulted in either:
    - Four or more flood insurance claims payments that each exceeded $5,000, with at least two of those payments occurring in a 10-year period, and with the total claims paid exceeding $20,000; or
    - Two or more flood insurance claims payments that together exceeded the value of the property.

The purpose of this draft integrated feasibility report and environmental assessment (IFR/EA) is to present the problem, initial alternative solutions, an evaluation of the alternatives and finally, a Recommended Plan. The IFR/EA provides the basis for federal interest in project construction. The proposed plan will help the Township of Denville to meet their goals of reducing flood risk, decreasing health and safety risk and financial burden to its residents and the Township.

1.4. Project Authority

The authority for this project is Section 205 of the Flood Control Act of 1948 (Public Law 80-858), as amended. Under this authority, the USACE is authorized to plan, design, and construct small flood control projects. A Feasibility Cost Sharing Agreement (FCSA) for this study was executed between USACE New York District and NJDEP on September 24, 2018. In the current implementation guidance, each project is limited to a federal cost share of not more than $10 million, including all project related costs for feasibility studies, planning, engineering, design, and construction.

1.5. Township of Denville Storm and Flood Damage History

The Township of Denville faces safety, health, and economic risks from flooding. Within the study area, there has been a history of significant flooding and damage, with flooding occurring along Rockaway River throughout the township.

1.5.1. Historic Storms

Morris County and the Township of Denville region have a history of flooding impacts from severe, tropical, and winter storms as well as hurricanes, several of which have resulted in FEMA emergency or disaster declarations. Major floods occurred in 1903, 1936, 1968, 1971, 1973, 1977, 1979, 1984, 1996, 1999, 2007, 2011, and 2014. A list of recent major storms, the corresponding maximum water level, stream flow, rainfall, and economic impacts (county-wide) are shown in Table 1-1 and Figure 1-2 below. Tropical Storm Irene, in 2011, caused severe flooding and damage to the Township of Denville. The pump and sewer station were damaged by floodwaters and power outages, and approximately one dozen private properties reported damaged in the Township.

Table 1-1: Historical Storms and FEMA Flood Claims

Event FEMA Designation	Date	Stream Height (ft)[1]	Stream Flow (ft^3/s)[2]	Rainfall (inches)[3]	County Costs[4]	Impact Summary[4]
Heavy Rains and Flooding DR-310	Aug 28-Sep 4, 1971	6.28	3,550		$621,000 (Denville only)	Flooding in Denville homes, and severe damage to Riverside Drive.
Winter Storm and Flooding NA	Jan 25, 1979	7.063	5,430	8	$5 million	Flooding in Denville with roadway and bridge closures, blocked access to St. Clare's Hospital, and forced evacuations.
Coastal Storms and Flooding DR-701	Mar 28-Apr 8, 1984	7.23	5,590	3.87	$57,400 (Denville only)	Snowmelt with 2-day rain event inundated 8 streets, flooded several homes, and forced evacuations in Denville.
Tropical Storm Floyd DR-1295 EM-3148	Sep 17, 1999	6.26	4,270	7.2	$30 million	Severe inland flooding, 6 deaths in Morris County; this was the largest hurricane death toll In the USA since 1972.
Severe Storms and Flooding DR-1337	Aug 12-21, 2000	5.023	2,750	3.9	$12 million	Flood peaks on Rockway River, washed out dams, bridges, and roads, and damaged over 2,700 homes and businesses. Much of downtown Denville was flooded.
Severe Storms and Flooding DR 1588	Apr 1-3, 2005	6.333	3,640	Not Available (N/A)	$1 million	N/A
Severe Storms, Inland and Coastal Flooding DR 1694	Apr 14-20, 2007	6.693	4,170	N/A	$26 million	N/A
Thunderstorms, High Wind, and Flooding NA	Mar 8-9, 2008	5.41	2,450	3.91	$100,000	Flooding of the Rockaway and Passaic Rivers.
Thunderstorms and High Wind NA	Aug 2, 2009	3.98	1,100	N/A	$20,000	N/A
Severe Storms and Flooding DR-1897	Mar 12 – Apr 15, 2010	6.813	4,350	5.72	$15 million	The Rockaway, Pompton, and Passaic Rivers were above their flood stages. In Denville, minor damage to facilities. FEMA Project Worksheets were submitted.

Event FEMA Designation	Date	Stream Height (ft)[1]	Stream Flow (ft^3/s)[2]	Rainfall (inches)[3]	County Costs[4]	Impact Summary[4]
Thunderstorms and High Wind **NA**	Nov 17, 2010	4.3	291	N/A	$50,000	N/A
Severe Winter Storm and Snowstorm **DR-1954**	Dec 26-27, 2010	2.58	134	N/A	$1,000	In Denville, utilities were out of service and businesses were closed. FEMA Worksheets were submitted.
Flooding **NA**	Mar 7, 2011	6.31	3,540	2.98	$10.6 million	In Morris County, sections of the Pompton and Passaic Rivers were over their flood stages.
Heavy Rain and Flooding **NA**	Mar 11, 2011	7.01	4,320	4.86	N/A	N/A
Heavy Rain and Flooding **NA**	April 16-22, 2011	6.23	3,250	3.82	$250,000	The Passaic, Pompton, Pequannock and Rockaway Rivers were above their flood stages.
Hurricane Irene **EM-3332** **DR-4021**	Aug 26-Sep 5, 2011	9.313	95,002	10.52	$200 million	The Rockaway, Pequannock and Passaic Rivers, along with Whippany Creek, all experienced major flooding. In Denville, FEMA Project Worksheets were submitted.
Remnants of Tropical Storm Lee **DR-4039**	Sep 6-14, 2011	5.47	N/A	8.70	$1 million	Major flooding along the Passaic and Pompton Rivers. The Rockaway River flooded in Denville.
Severe Storm **DR-4048**	Oct 29, 2011	N/A	N/A	17.00	N/A	In Denville, FEMA Project Worksheets were submitted.
Severe Thunderstorm **NA**	Jun 10, 2012	2.28	1,060	N/A	$20,000	N/A
Severe Thunderstorm **NA**	Jul 26, 2012	1.5	210	N/A	$25,000	N/A

Event FEMA Designation	Date	Stream Height (ft)[1]	Stream Flow (ft^3/s)[2]	Rainfall (inches)[3]	County Costs[4]	Impact Summary[4]
Hurricane Sandy **EM-3354** **DR-4086**	Oct 26-Nov 8, 2012	1.65	495	N/A	$50,000	Morris County had three deaths attributed to the storm. In Denville, FEMA Project Worksheets were submitted.
Flash Flood **NA**	Jun 18 2013	1.87	674	1.87	$10,000	
Heavy Rain and Flooding **NA**	Apr 30 – May 2, 2014	3.7	2,900	4.89	$1.25 million	Minor to moderate flooding in the Passaic Basin.
Severe Thunderstorm, Funnel Cloud **NA**	Aug 4, 2018	2.27	1,030	N/A	N/A	Township of Denville experienced power loss and downed trees.

[1] Peak stream height of Rockaway River Gage (United States Geological Survey [USGS] 01380500 Rockaway River above Reservoir at Boonton NJ for data prior to 9/30/2011, USGS 01380450 Rockaway River at Main Street at Boonton NJ for after 9/30/2011)

[2] Peak stream flow from Rockaway River Gage (USGS 01380500 Rockaway River above Reservoir at Boonton NJ for data prior to 9/30/2011, USGS 01380450 Rockaway River at Main Street at Boonton NJ for data after 9/30/2011)

[3] Maximum rainfall amounts across Morris County

[4] From *2015 Morris County, New Jersey, Multi-Jurisdictional Hazard Mitigation Plan*, and *DRAFT 2020 Morris County, New Jersey, Multi-Jurisdictional Hazard Mitigation Plan*

Not Available (N/A) – Data not available

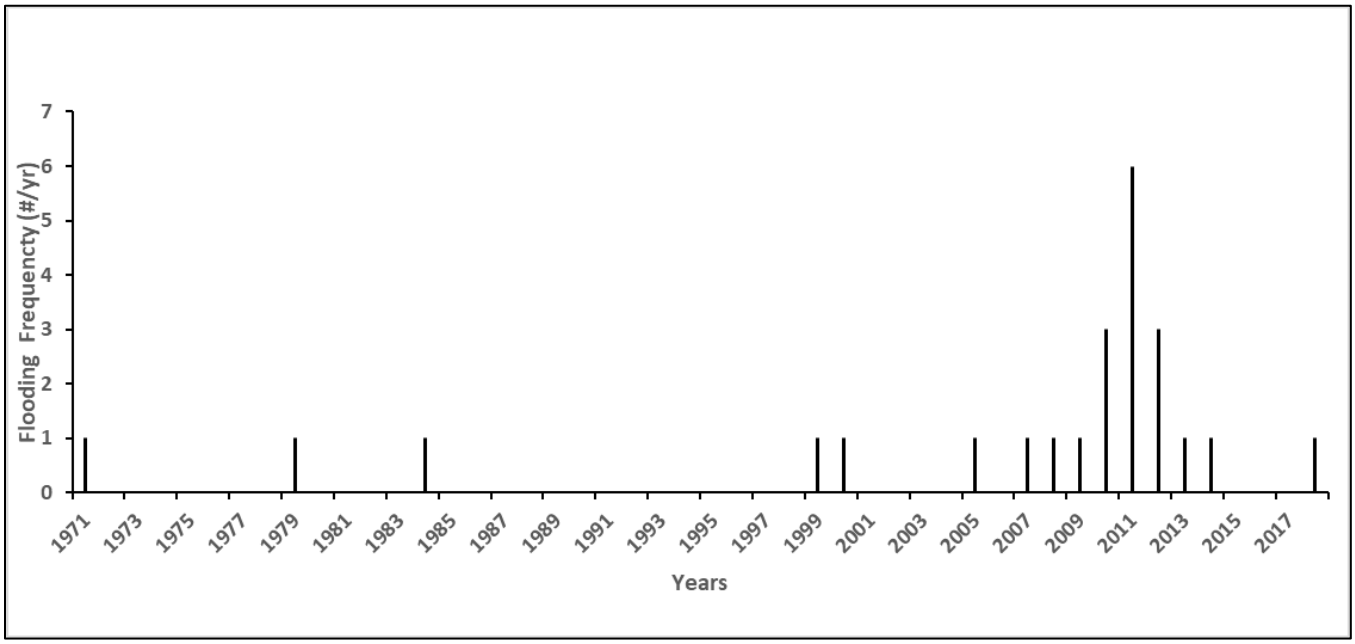

Figure 1-2 Timeline of Flooding Events

1.6. Prior Studies, Reports and Existing Projects

The Township of Denville and the surrounding region has a history of flooding and flood-related damages. There have been many studies conducted in the region starting in 1948. Table 1-2 includes a list of the relevant studies.

Table 1-2: List of Prior Studies

Date	Study Title	Organization	Area Affected
Oct-1948	Survey Report for the Passaic River Watershed	USACE	Passaic River Watershed and Upper Rockaway River Basin
Jun-1962	Survey Report for the Passaic River Watershed	USACE	Passaic River Watershed and Upper Rockaway River Basin
1970	Reconnaissance Report for Tanglewood Brook	USACE	Dover Town and Rockaway Borough
Jun-1972	Survey Report for the Passaic River Watershed	USACE	Passaic River Watershed, Upper Rockaway River, Denville, NJ
Mar-1980	Technical Report for the Longwood Valley Hydroelectric Pumped Storage Project	USACE	Upper Rockaway River, Jefferson Township
May-1987	Flood Control Feasibility	USACE	Upper Rockaway River
May-1989	Technical Report for the Longwood Valley Pumped-Storage Project	USACE	Longwood Valley
Jan-1990	Phase I General Design Memorandum Passaic River Basin, New Jersey and New York, Final Report on Flood Protection Feasibility Remaining Tributaries	USACE	Passaic River Basin and Tributaries, Upper Rockaway River, Boonton, Denville, Rockaway Borough, Rockaway, Randolph, Victory Gardens, Dover, Wharton, Jefferson
Jan-1990	Upper Rockaway River Watershed Study	Morris County, NJ	Upper Rockaway River Watershed
Apr-1998	Visions & Strategies Report for the Rockaway River	Friends of the Rockaway River	Upper Rockaway River
Mar-2004	Highlands Task Force – Action Plan	State of New Jersey/Highlands Task Force	Reading Prong Highlands
Jun-2008	Upper Rockaway River, New Jersey, Flood Damage Reduction and Ecosystem Restoration: Alternative Plan Formulation Report	USACE/NJDEP	Upper Rockaway River
Dec-2012	Hydrologic & Hydraulic Analysis Technical Support Data Notebook, Task Order HSFE02-09-J-0001	FEMA	Passaic River Watershed, NJ

Date	Study Title	Organization	Area Affected
Apr-2014	Flood Risk Reduction Program: Alternative Action Plan	Township of Denville/HMM	Denville, NJ
Dec-2015	Federal Interest Determination Flood Risk Management Study	USACE	Rockaway River and Den Brook, Denville, NJ
Sep-2016	Flood Mitigation Report	Township of Denville/HMM	Denville, NJ

Previous studies of the Rockaway River by USACE were conducted between 1948 and 1990. These studies did not result in any final comprehensive plan or study recommendations, as alternatives were rejected due to high cost, lack of economic justification, major environmental impacts, or lack of public acceptability. The 2008 USACE Upper Rockaway River Report identified a plan with a benefit cost ratio above unity and was, therefore, economically justified based on federal criteria. Further development and environmental assessments were halted due to significant public concern and the subsequent withdrawal of non-Federal sponsor support by the NJDEP.

The April 2014 Flood Risk Reduction Program Alternative Action Plan commissioned by the Township of Denville recommended a combination of nonstructural, structural, and long-range planning approaches, including improved flood warning and public education, acquisition or elevation of existing structures, channel and bridge maintenance, local mitigation measures, hydraulic improvements to Powerville Dam, and regional stormwater detention planning in cooperation with Morris County. Information from this report was used to inform the development of initial alternatives during the scoping phase of this study.

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2. Existing Conditions

2.1. Location

The area of interest for this feasibility study was defined by a focus on flooding problems and flood risk management (FRM) opportunities in the downtown business district of the Township of Denville. The area of interest also includes a wider geographic area that is substantially affected by conditions and processes occurring outside the downtown business district.

The Township of Denville lies in the center of Morris County and is bordered by multiple municipalities. The borough of Mountain Lakes and township of Parsippany-Troy Hills (Parsippany) lie to the east, Randolph Township lies to the south and west, Rockaway Borough lies to the west, Rockaway Township lies to the north and west and Boonton Township lies to the north. Denville is known as the "Hub of Morris County" for its location along major transportation routes at the center of the county (see Figure 2-1).

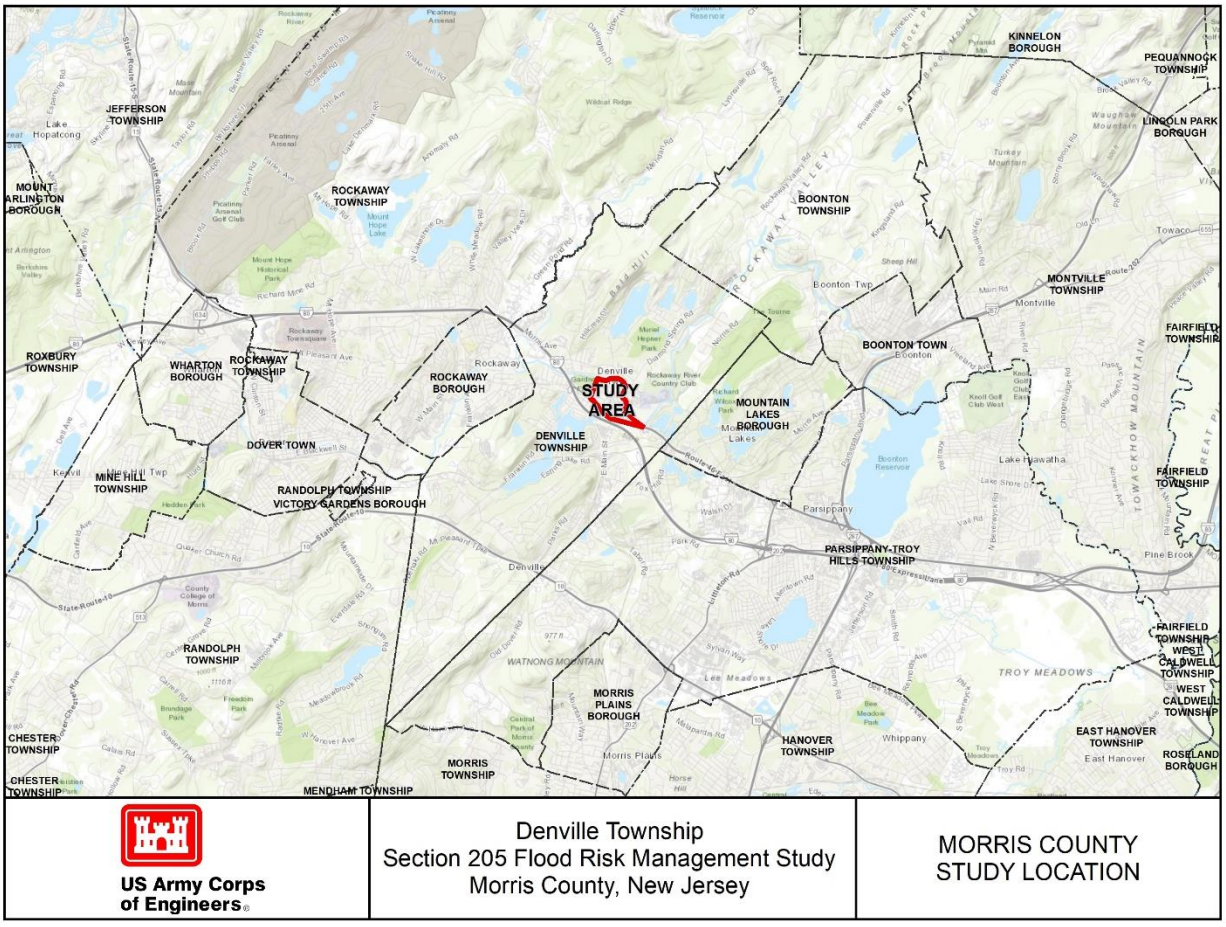

Figure 2-1: Study area location in Morris County, New Jersey

2.2. Physical Environment

2.2.1. Land Use and Land Cover

The Township of Denville (including lands outside the study area) contains a mix of suburban development, older lake communities, highway commercial development, and traditional core downtown (Denville, 2014). The study area is explicitly identified on the Township of Denville zoning map as "downtown business district." The downtown business district includes land zones "highway business," "central business," "general business," "neighborhood shopping center," "office building," as well as "residential." The downtown business district portion of Denville is a designated smart growth "Metropolitan Planning Area" by the State of New Jersey (NJ).

Denville, including lands outside the study area, experienced significant residential development following World War II (Trails Master Plan). Denville began controlling development within the floodplain in 1980 (Township of Denville, 1980). In recent decades, increased open space has been produced locally by removing structures vulnerable to repetitive flooding in the floodplain (Denville, 2018).

2.2.2. Geology, Topography and Soils

The Township of Denville is located in the Highlands Physiographic Province, which is underlain by metamorphic and igneous hard rocks at depth, although these rocks are only locally exposed at the surface. The downtown business district area is underlain by gneiss and granite hard rock. The Denville area was covered by multiple glaciers over geologic time, and surface geologic materials differ from the rock underneath in that the surface geologic material consists of rock debris and soil deposited in the area from updrift and upstream sources to the north and west. The downtown business district contains surficial geologic materials consisting of glacial stream deposits, as well as floodplain sediment deposits from the Rockaway River (Township of Denville, 2014).

The Rockaway River valley and the river's floodplain are major geographic features of the Township of Denville. The downtown business district lies within the Rockaway River floodplain, with the Rockaway River bounding the north side of the downtown business district and Den Brook bounding the south side. The downtown business district is generally flat, with maximum slopes of less than 15 percent. Along the north and south sides of the Rockaway River Valley, slopes of greater than 35 percent occur locally (Denville, 2014). Elevations in the downtown business district range from about 500 to 520 feet above sea level (USGS, 2019).

Based on lack of sinuosity, the Rockaway River appears to be historically channelized and straightened over a substantial portion of its length, including downstream of Diamond Springs Road along the downtown business district. The streambank has been altered, to an extent, by bank stabilization and sediment removal activities, such as in McCarter Park where the outer banks are stabilized with stone, although appearing natural to the untrained eye (Photos at Google Maps for the park). NJDEP issued a permit in 2014 for removal of accumulated sediment in the Rockaway River from the Diamond Spring Road bridge and for 200 ft upstream, plus 30 ft upstream and 70 ft downstream of the Pocono Road bridge (Figure 2-10 for street references).

The US Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) Soil Mapper was consulted to obtain information on soils of the study area (Table 2-1). Most of the soils in the downtown business district are mapped as urban land soils (USROCC). Urban soil types are characteristic of urban areas with long histories of cut and fill, wherein the soils include substantial human artifacts. The USROCC soil surface is substantially covered by pavement, concrete, buildings, and other structures underlain by disturbed and natural soil material. The natural soil material is derived from coarse-loamy till. Several soils classified by NRCS as prime farmland are mapped to occur in the study area. However, none of these are actively farmed.

Table 2-1: Mapped Soils of Downtown Business Area Vicinity

Map Unit Code	Map Unit Name	Farmland Classification	Hydric Soil Rating
USROCC	Urban land-Rockaway Complex with 3 to 15 percent slopes	None	No
HcuAt	Hatboro-Codorus complex, 0 to 3 percent slopes, frequently flooded	Not Prime Farmland	Hatboro Yes; Codorus No
RksB	Riverhead gravelly sandy loam, 3 to 8 percent slopes	Prime Farmland	No
NerB	Netcong gravelly sandy loam, 3 to 8 percent slopes	Prime Farmland	No
PohB	Pompton sandy loam, 3 to 8 percent slopes	Prime Farmland	No
PrkAt	Preakness sandy loam, 0 to 3 percent slopes, frequently flooded	Not Prime Farmland	Yes

2.2.3. Hydrologic Setting

The Township is entirely within the Passaic River basin. Most of the Township drains to the Rockaway River, a major tributary of the Passaic River. Den Brook is a small tributary, which flows into the Rockaway River in the Denville downtown business district. A small portion of the southeastern corner of the Township drains to the Whippany River, also a Passaic River tributary (Figure 2-2).

Historically, human activities substantially altered natural flow in the Denville area, as well as created manmade water bodies. The Morris Canal, constructed in the 1820s and 1830s, provided a water route between the Delaware River and the Hudson River. The canal followed the Rockaway River in the study area and then crossed the Rockaway River downstream of, what is today, the downtown business district. The Canal crossing of the river required construction of a dam (the Powerville Dam) on the Rockaway River downstream of the downtown Denville business district. Beginning in the 1800s and continuing into the 1900s, development of manmade lakes occurred in the Denville area in association with development of summer communities (Township of Denville, 1980).

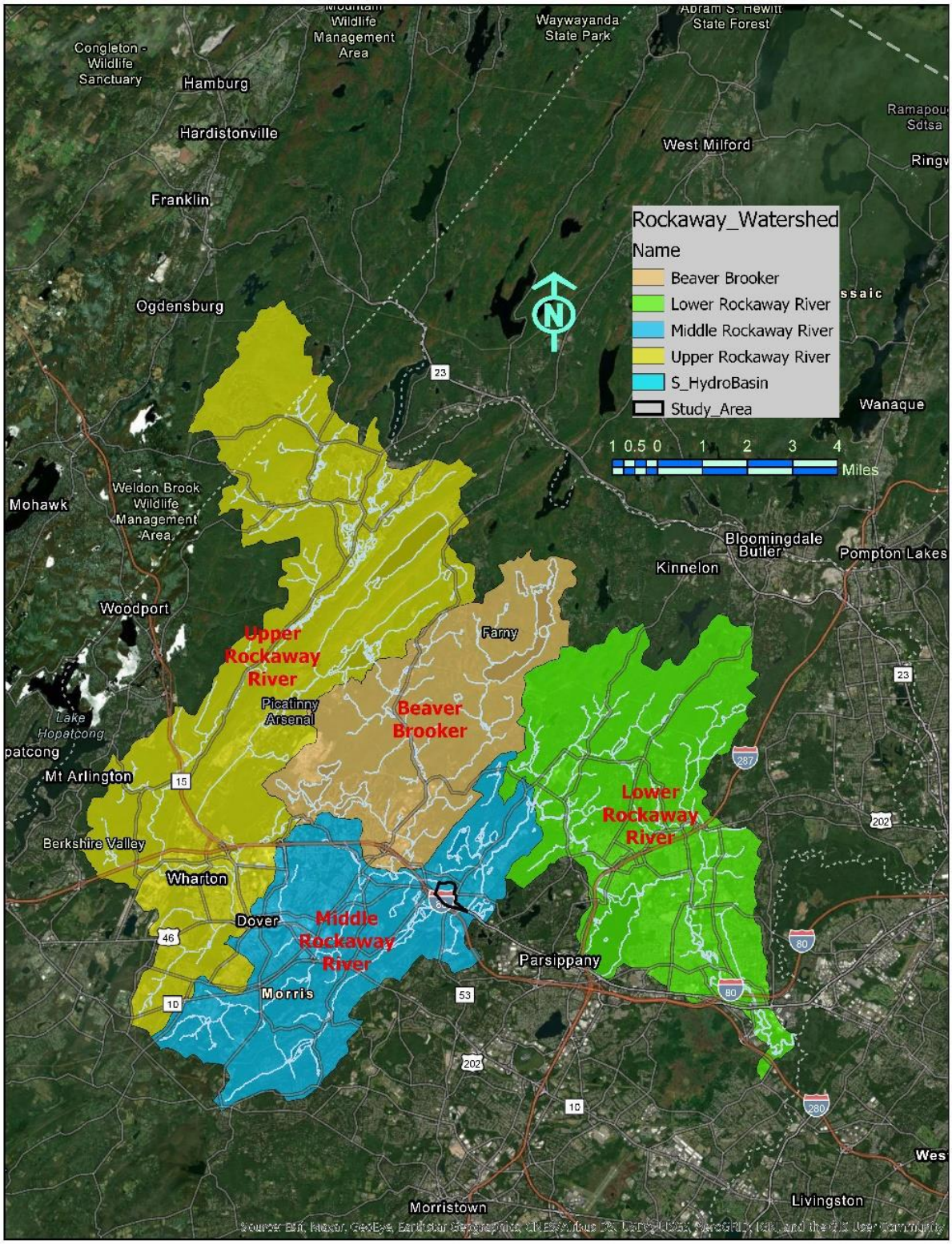

Figure 2-2: Watershed Boundary Map

The section of Denville adjacent to the Rockaway River has flooded repeatedly. Particularly severe floods affecting people in the floodplain occurred in 1903 and in 2011 (Hurricane Irene) (Township of Denville, 2014). Inundation extents were generated using the HEC-River Analysis System (HEC-RAS) model developed for this feasibility study. Figures 2-3, 2-4, 2-5, and 2-6 show the 4 percent (25-year), 2 percent (50-year), 1 percent (100-year),and 0.2 percent (500-year) annual exceedance probability (AEP) inundation extents, respectively, for the downtown business district. Additionally, the majority of the downtown business district of Denville lies within the FEMA 1 percent AEP inundation extent, according to the effective and preliminary FEMA Flood Insurance Rate Map (FIRM) and Flood Insurance Study (FIS) dated October 17, 1984, and August 22, 2017, respectively. These neighborhoods consist of high-density residential and non-residential structures and critical infrastructure, with dense and vulnerable populations. In the effective and preliminary FIRM, significant areas along Rockaway River were identified as high-risk flood zones.

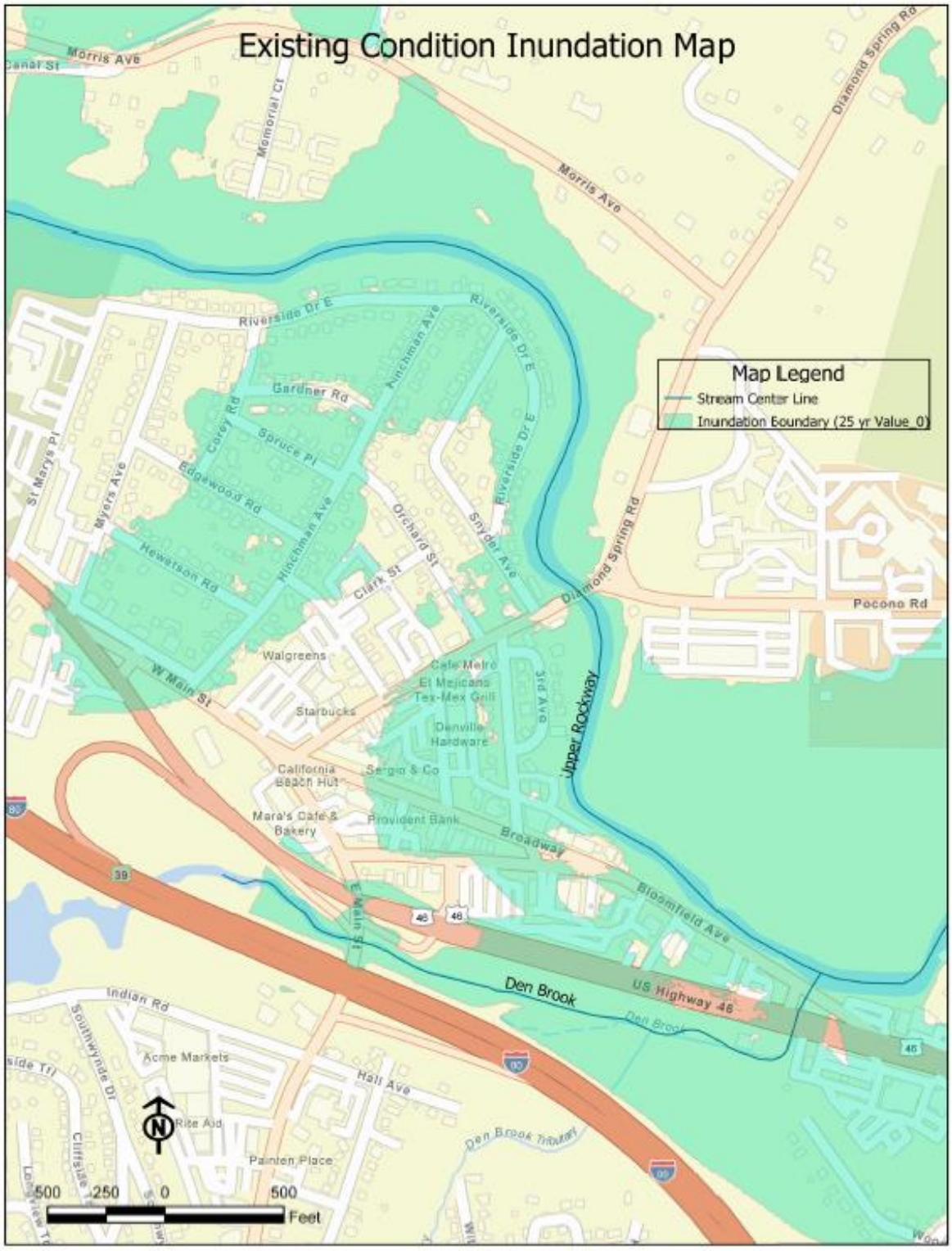

Figure 2-3: Township of Denville, 4% (25 year) AEP Inundation Extent

Figure 2-4: Township of Denville, 2% AEP (50 year) Inundation Extent

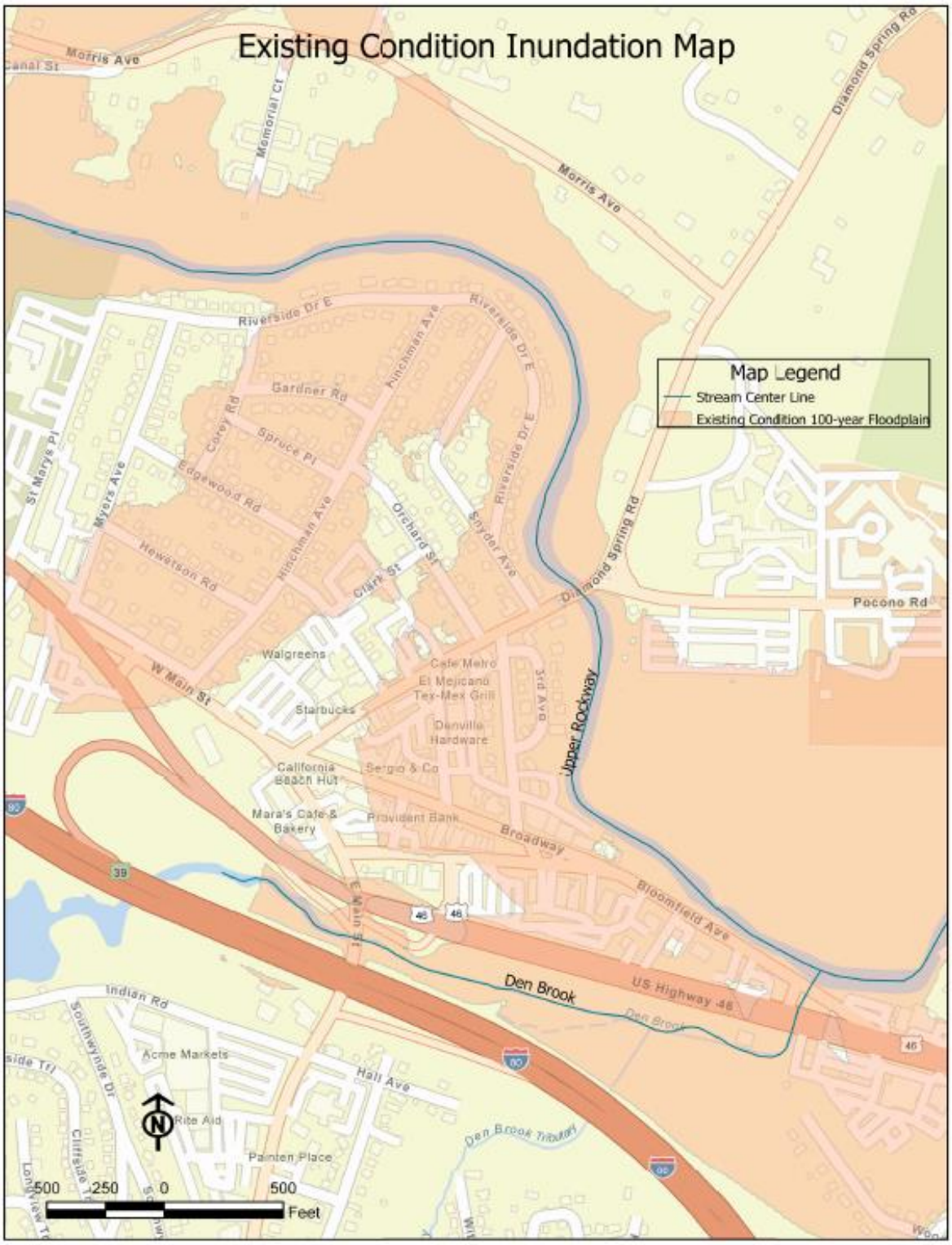

Figure 2-5: Township of Denville, 1% AEP (100-year) Inundation Extent

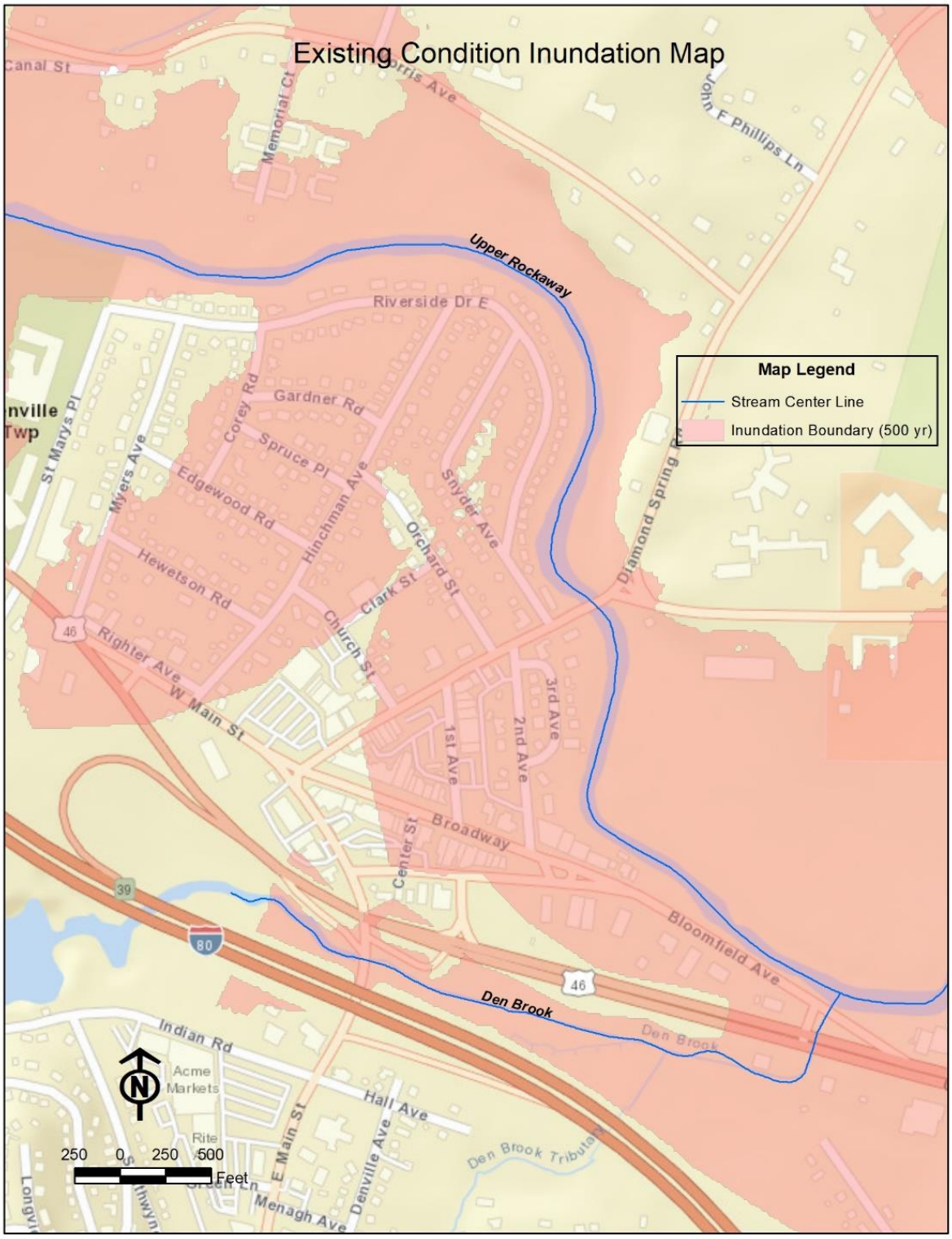

Figure 2-6: Township of Denville, 0.2% AEP (500-year) Inundation Extent

2.2.4. Climate and Air Quality

The Township of Denville Environmental Resources Inventory (2014) provides a summary of climate conditions for Denville derived from the Office of the New Jersey State Climatologist. The Denville area is classified as having a humid subtropical climate according to the Koppen climate classification scheme. Air circulation is dominated by undulating air masses moving generally from west to east. Boonton Reservoir, about 3 miles east of the Denville downtown business district, produced a long-term local weather record over the period 1893-1998. The warmest month is July, with average high temperatures of 84˚Fahrenheit (F). The coldest month is January, with average minimum temperatures of 19˚F. Median annual precipitation at Boonton is 46 inches. Precipitation occurs fairly evenly by month through the year, although February was the driest with median precipitation of 3 inches while May had a median precipitation of 4 inches. Median annual snowfall is 25 inches.

New Jersey has shown a trend of increased temperature of 1.2˚F over the decade of 2001-2010 compared to the baseline period 1971-2000. In northern New Jersey, annual precipitation was 5 inches per year greater over the period 1971-2000 versus 1895-1970. The last three decades have shown a small, but not statistically significant, trend towards more extreme precipitation events (above 1 inch per day) in the New York City region (Sustainable Jersey, 2019).

Climate projections have been made for New Jersey based on the averages from 16 global climate models (GCMs) and 3 emissions scenarios utilizing the middle 67 percent of values from model-based probabilities. By the late 2020s, mean annual temperature in New Jersey is forecast to increase to 1.5 to 3˚F above the baseline period 1971-2000. By the 2050s, mean annual New Jersey temperature is forecast to increase by 3 to 5˚F above the baseline period 1971-2000. Average annual precipitation is forecast to increase by up to 5 percent by the 2020s and up to 10 percent by the 2050s. This increased precipitation is more likely to fall during extreme events. Analyses performed for New York City indicate a 10 to 25 percent increase in the frequency of intense precipitation events by the 2080s (Sustainable Jersey, 2019).

Morris County is located in the New York–Northern New Jersey–Long Island, NY-NJ-CT Air Quality Control Region (U.S. Environmental Protection Agency [USEPA], 2019). Similar to most urban industrial areas, emissions from automobiles, manufacturing processes, and utility plants have affected air quality in the study area. Levels of some pollutants are largely affected by emissions from regional upwind sources outside of New Jersey. Air quality in New Jersey has generally improved over the last 40 years (Denville, 2014).

USEPA has promulgated National Ambient Air Quality Standards (NAAQS) to protect the public health and welfare for six criteria pollutants: carbon monoxide (CO), sulfur dioxide (SO_2), particulate matter (particles with a diameter less than or equal to a nominal 10 micrometers [PM10] and particles with a diameter less than or equal to nominal 2.5 micrometers [PM2.5]), ozone (O_3), nitrogen dioxide (NO_2), and lead (Pb). Federal regulations designate Air Quality Control Regions (AQCRs) in violation of the NAAQS as nonattainment areas. According to the severity of the pollution problem, nonattainment areas can be categorized as marginal, moderate, serious, severe, or extreme. Severity categories have not yet been applied to PM2.5 nonattainment areas. Maintenance areas have recently met NAAQS but are considered to be at risk of not remaining in attainment if efforts are not continued to maintain better air quality. The

New York–Northern New Jersey–Long Island, NY-NJ-CT Air Quality Control Region is also in the Ozone Transport Region. The Ozone Transport Region includes states in the northeast United States that must adhere to stricter conformity thresholds for nitrogen oxides (NOx) and volatile organic compounds (VOCs), which are precursors for O_3.

Morris County is designated as a moderate nonattainment area for ground-level ozone (8-hour Ozone 2008 and 2015 standards). Morris County is designated in maintenance for carbon monoxide and PM2.5 (USEPA, 2019).

2.2.5. Water Quality

NJDEP classifies the Rockaway River and Den Brook as Category One (C1) waterways. C1 waterways are high quality waters protected by regulation from measurable degradation in water quality characteristics and is the highest level of protection for a stream in New Jersey. Although high quality, neither waterway is classified as a trout stream. Non-trout waterways do not support trout, either because of their physical nature or because of their biological or chemical characteristics (Township of Denville, 2014). Although, trout do not spawn in natural populations, they are stocked for recreational purposes. No long-term water quality data for the Rockaway River in the Denville area were used in preparation of this this study. However, data for multiple tributaries of the Passaic River and its tributaries downstream of Denville show a long-term decline in nutrient pollution loads over the period 1971-2011, indicating a trend of generally improving water quality with respect to nutrient pollutants (USGS, 2017).

The Rockaway River is located within NJDEP Watershed Management Area (WMA) 6, which also includes the Upper and Middle Passaic and Whippany Rivers. Multiple total maximum daily loads (TMDL) have been developed for the Rockaway River and some of its major tributaries. TMDLs applicable to the Township of Denville focus on addressing excess fecal coliform bacteria, mercury (in fish tissue), and total phosphorus (NJDEP, 2019).

2.2.6. Riparian Vegetation

Wetlands mapped by the National Wetlands Inventory (NWI) are nearly absent from the downtown business district (Figure 2-7). A minor parcel of scrub-shrub wetlands is located at the northwestern edge of the downtown business district along the Rockaway River. The NWI maps indicate vegetated wetlands are also located in multiple parcels along the north bank of the Rockaway River, opposite the downtown business district. The largest mapped parcels on the north bank occur at the upstream end of the downtown business district, with a large parcel located in Cynthia Park owned by the Passaic River Coalition. Mapped wetlands are located immediately along the Rockaway River on the north bank opposite the downtown business district in McCarter Park. Multiple parcels of emergent, scrub-shrub, and forested wetlands are located between Route 46 and Interstate 80 south of the downtown business district. Mapped wetlands are located northeast of the downtown business district along the historic Morris Canal.

The Denville study area is urban in character, and so possesses shade trees and landscaped lawns typical of small-town urban areas of New Jersey. Forest parcels are in parks and areas poorly suited for development (too steep, too wet, or too vulnerable to flooding). No areas containing unique natural

ecosystems (as mapped by the NJDEP) are in the study area vicinity (Township of Denville, 2014). Historic U.S. Geological Survey (USGS) maps from 1888 (Morristown Sheet) depict portions of what is today the downtown business district were at that time wetlands. The area mapped as wetlands in 1888 was depicted as developed on the 1954 USGS Boonton, New Jersey, topographic map, with no wetlands remaining by that time.

Multiple species of mature trees in natural and urban settings are undergoing decline in the area due to encroachment of non-native species, changing climate, and perhaps other factors. Tree species in decline include ash (Fraxinus) and oak (Quercus). Ash trees have been known in the area to been impacted by Emerald Ash Borer, while oaks are impacted by several diseases. These dead and dying trees constitute local safety hazards including falling branches and debris (Denville Trail Master Plan, 2018).

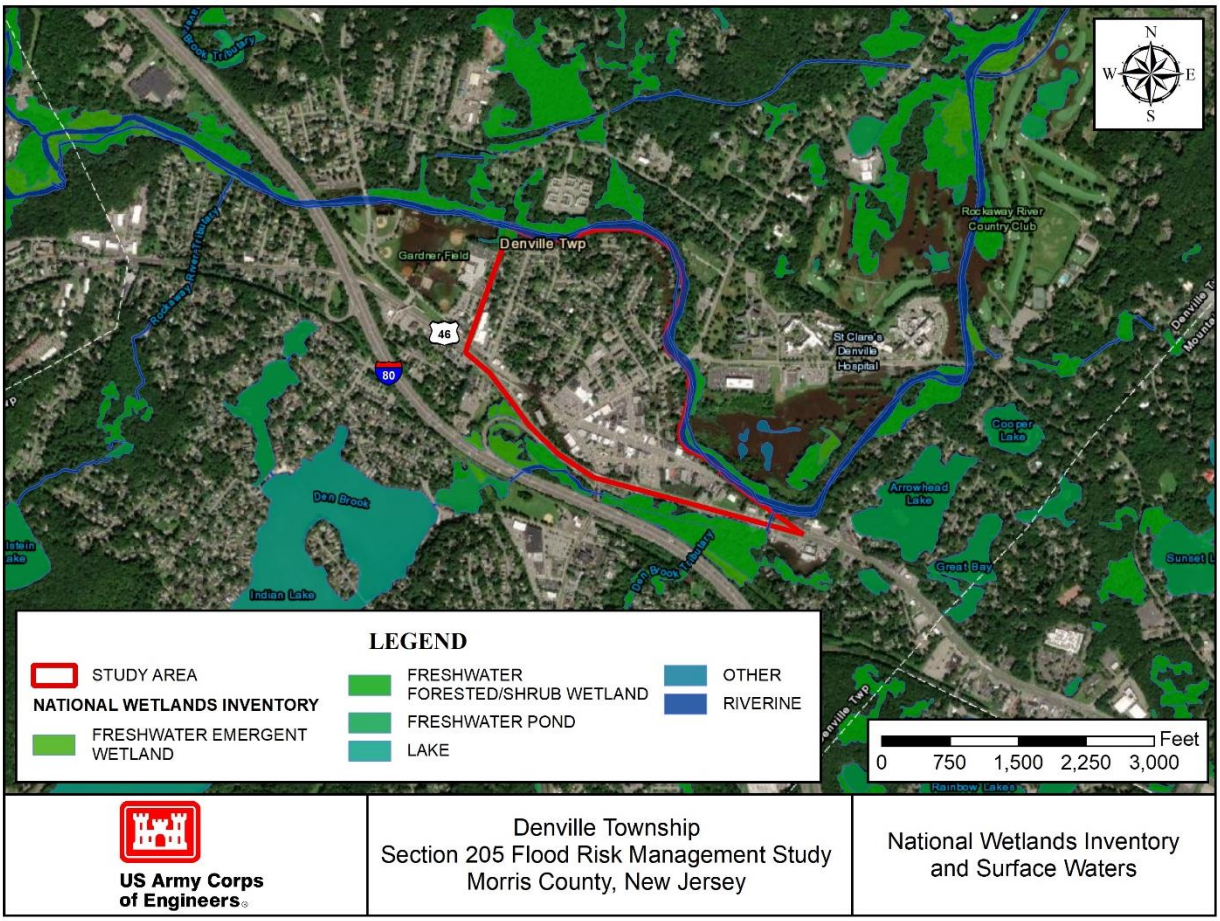

Figure 2-7: Mapped Waters and Wetlands

2.2.7. Fish and Wildlife

Aquatic life of streams includes a variety of animals without backbones (invertebrates) and with backbones (vertebrates). Common aquatic invertebrates include mollusks and insects, while vertebrate species include finfish. These species are commonly monitored and sampled to characterize the water

quality of water body. Over the last two decades, efforts have been undertaken to monitor stream health by sampling stream macroinvertebrates and finfish.

Macroinvertebrates were sampled at NJDEP "Ambient Biological Monitoring Network" (AMNET) station AN0248 over a 10-year period (Table 2-2). This station is located on the Rockaway River immediately downstream of the Den Brook confluence. Particularly abundant macroinvertebrates include amphipod crustaceans (*Gammarus*) and riffle beetles (*Optioservus*), and the score is listed as fair in 2008 (NJDEP, 2012; Study Library.Net, 2011).

Table 2-2: Macroinvertebrate Scores at AMNET Station AN0248

Rating Period	Macroinvertebrate Score
1998-99	Good
2003-04	Fair
2008	Fair

Fish have been sampled at one station on the Rockaway River by the NJDEP Finfish Index of Biotic Integrity (FIBI) network in 2004 at the Pocono Road bridge (station FIBI083). This site is approximately ½ mile downstream of the downtown business district. Ten species of fish were sampled, with tessellated darter (*Etheostoma olmstedi*) and redbreast sunfish (*Lepomis auritus*) being most abundant. The station was found to have a Fair FIBI Rating. One migratory fish species, sea lamprey (*Petromyzon marinus*), was collected in the 2004 sampling.

The Rockaway River does not support anadromous migratory fish. Natural and manmade fish blockages prevent upstream migration of most aquatic life from tidal waters downstream. The 77-foot height of the Great Falls of the Passaic River, located in Paterson, is a major natural blockage. Boonton Reservoir Dam on the Rockaway River downstream of Denville is a notable manmade fish blockage. Interestingly, American eel have been sampled in the Rockaway River downstream of Boonton Reservoir, as recorded in NJDEP FIBI data.

NJDEP, in its 2018 State Wildlife Action Plan, includes Morris County within the "Skylands Landscape Region." However, the Denville downtown business district does not lie within a mapped conservation focal area, indicating that it is a low priority area for wildlife conservation efforts. Wildlife occurring in Denville's downtown business district would include species that are tolerant of, and/or dependent upon, people.

The U.S. Fish and Wildlife Service (USFWS) *Information, Planning, and Consultation* (IpaC) System website was consulted multiple times during the study to identify USFWS trust-species potentially occurring in the project area, most recently in October 2022. IpaC identifies Bald Eagle and nine other migratory bird species of conservation concern potentially occurring in the area (Appendix B). However, because of the urban nature of the downtown business district, it is unlikely that these species would be present other

than as transients, with brief occurrences likely limited to the remnant forest parcels along the Rockaway River.

2.2.8. Rare, Threatened, and Endangered Species

According to the NJDEP "Landscape Project", which maps occurrences of rare species throughout the state, the Denville downtown business district does not contain federal or state listed species of concern. However, remnant forest parcels along the Rockaway River within the Denville downtown business district are identified as meeting habitat suitability requirements for endangered, threatened, or priority wildlife species.

The USFWS IpaC System website was consulted to identify federally listed species potentially occurring in the Township of Denville multiple times over the course of the study. IpaC was consulted most recently in May 2023 for the study area as presented in Appendix B of this report. The IpaC system in May 2023 identified three federally listed endangered or threatened species that could potentially be in the vicinity: the endangered Indiana bat (*Myotis sodalis*), threatened northern long-eared bat (*Myotis septentrionalis*), and threatened bog turtle (*Glyptemys muhlenbergii*). Per USFWS correspondence dated January 26, 2023, the northern long-eared bat is scheduled for reclassification from threatened to endangered on March 31, 2023 (Appendix B). The IpaC system identifies no formal critical habitats for any of these species in the study area. Nature Serve (2022) characterizes important habitats for both bat species as mature forest habitats, although caves are also of importance for Indiana bat. A concurrence letter from USFWS was received on May 22, 2023, confirming in agreeance with USACE, stating no effect determination for northern long-eared bat (Appendix B). Bog turtle is associated with herbaceous wetlands. Given the urban character of the downtown business district and absence of these habitats, it is unlikely that individuals of these federally listed species would be present there. These species could perhaps occur as transients within the limited remnant forest parcels along the Rockaway River.

The USFWS IPaC system consultation in February 2023 identified tricolored bat (*Perimyotis subflavus*), proposed for listing as federally endangered, as potentially occurring in the study area. According to Nature Serve (2022), mature forests and riparian areas are important habitats for this bat species. Tricolored bat may occur as a transient within the limited remnant forest parcels along the Rockaway River.

The USFWS IpaC system identifies monarch butterfly (*Danaus plexippus*), a candidate species for potential listing as threatened or endangered in the future, as occurring in the project area. Monarch butterflies breed on milkweed plants throughout New Jersey in spring and summer. Milkweed plants could grow in the project area (NJDEP, 2017).

2.3. Community Setting

2.3.1. Population and Demographics

According to the U.S. Census Bureau, the Township of Denville in 2021 (including areas outside of the downtown business district) was estimated to have a population of 17,100, while Morris County had an estimated population of 510,981. The downtown business district comprises a small portion of the total township area. Utilizing USEPA, the downtown business district area has a population of 801 in 2019.

Table 2-3 presents the U.S. Census Bureau information on the 2021 population of the Township of Denville in comparison to the U.S. national average.

Table 2-3: The Township of Denville Population Characteristics in 2021

Characteristic		Denville	U.S. Nationally
Race/Origin	White, alone	84.6%	75.8%
	Black or African American, alone	2.5%	13.6%
	Asian, alone	6.9%	6.1%
	American Indian and Alaska Native, alone	0%	1.3%
	Native Hawaiian and Other Pacific Islander, alone	0%	0.3%
	Two or More Races	4.9%	2.9%
	Hispanic/Latino	7.9%	18.9%
	White alone, not Hispanic or Latino	80.6%	59.3%
Owner-occupied housing rate		82.7%	64.4%
Age 65 or older		17.9%	16.8%
Bachelor's degree or higher		61.0%	32.9%
Persons in poverty		4.7%	11.4%

2.3.2. Environmental Justice

A minority population exists where the percentage of minorities in an affected area either exceeds 50 percent or is meaningfully greater than in the general population (CEQ, 1997). Utilizing U.S. Census Bureau (2021) data, the Township of Denville population is 19 percent minority, whereas the population in the State of New Jersey is 47 percent. The Census Bureau defines a "poverty area" as a Census tract with 20 percent or more of its residents below the poverty threshold (Census Bureau, 2016). The population of the Township of Denville has 4.7 percent of persons living in 25poverty, below the State of New Jersey average at 11.4 percent, see Table 2-3. According to the Environmental Justice screening tool, the population of the Township of Denville's downtown business district, which includes the study area, is 13 percent low income, compared to 25 percent of the population in the State of New Jersey, see Appendix B (USEPA, 2019). USEPA (2019) maps no public housing within the downtown business district. A search of the Township of Denville on the Council of Environmental Quality's Climate and Economic Justice Screening Tool (CEJST) shows no mapped highlights to indicate being overburdened or underserved.

2.3.3. Schools

One school is located adjacent the downtown business district. Riverside Elementary School lies to the west side of St Mary's Place and just outside the study area (Figure 2-8).

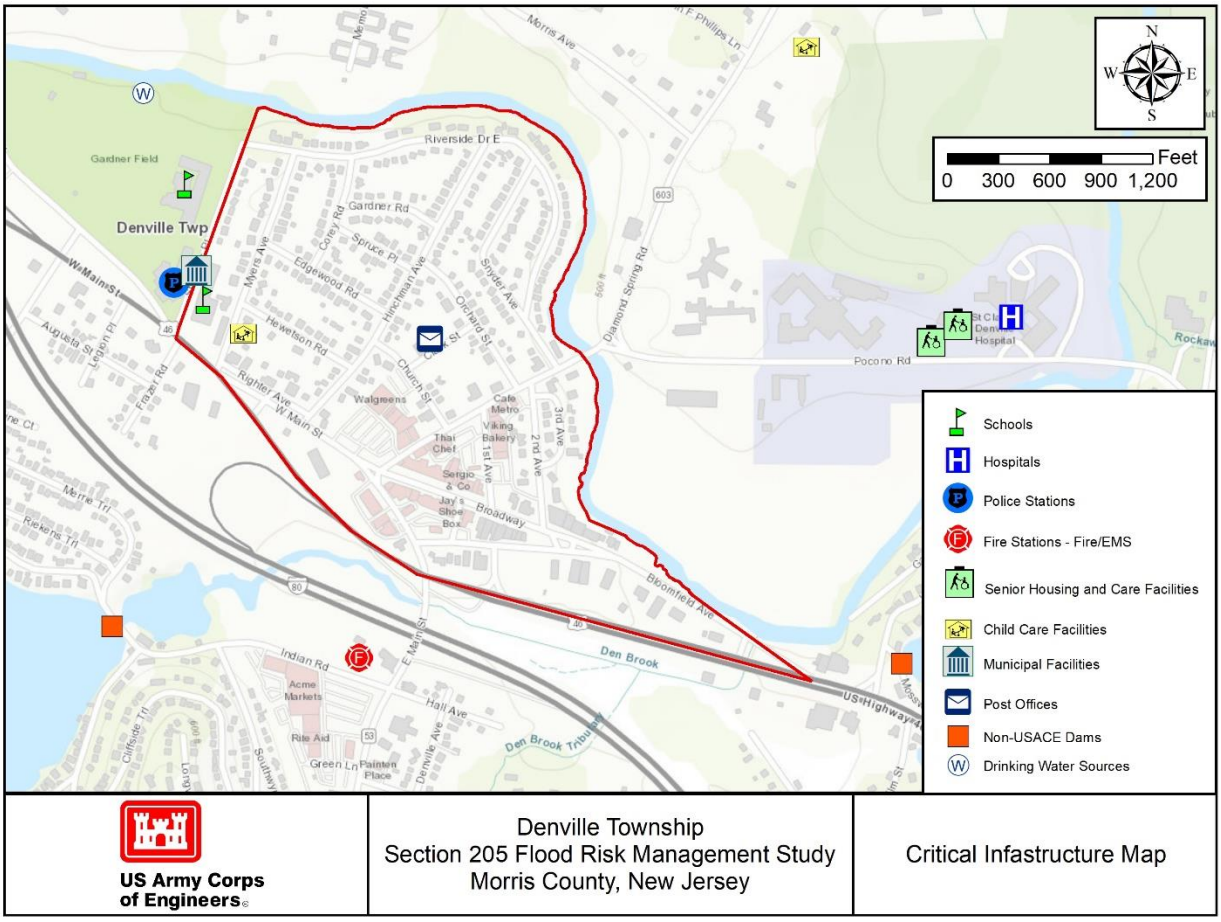

Figure 2-8: Critical Infrastructure

2.3.4. Employment and Income

Median household income for the Township of Denville is $144,685 in 2021, which is higher than the median household income of Morris County of $117,298 and the State of New Jersey of $85,245 (U.S. Census Bureau, 2022). The unemployment rate in 2021 for the Township of Denville (5 percent) is similar to the rest of Morris County (4 percent) and the State of New Jersey (5 percent). Health care and social assistance form the largest segment of the working population for the Township (32.2 percent). Manufacturing (16.1 percent) and retail (10.4 percent) are ranked second and third, respectively. Other sectors include professional, scientific, and technical services, construction, transportation, warehousing, and finance and insurance (U.S. Census Bureau, 2022).

2.3.5. Parks and Recreation

Several open space areas are located adjacent to the Denville downtown business district. These include two wooded areas, Diamond Spring Park (municipal park) on the east side of the Rockaway River and Cynthia's Landing (non-profit land trust) on the north side of the Rockaway River. Immediately west of the downtown business district across from Riverside Drive lies Gardner Field (municipal park), which contains multiple athletic fields. The Township of Denville purchased several repetitive loss flood-prone

homes adjacent to the Rockaway River, along Riverside Drive in the downtown business district. These lands were used to create a "pocket park" called Denville Park Meadow (Denville, 2018).

McCarter Park, located east of the downtown business district on the north bank of the Rockaway River about 400 feet downstream of Diamond Springs Road bridge, contains multiple sports fields. The privately operated sports park has substantial frontage on the Rockaway River. Approximately 0.9 miles downstream of Diamond Springs Road bridge on the Rockaway River lies open space of the Rockaway River Country Club. The private country club includes substantial frontage along the Rockaway River and contains a golf course and other recreational amenities.

Denville has an extensive sidewalk system that serves the central business district. The Township of Denville has a master plan of existing and proposed trails that includes a walking trail along the Rockaway River in the downtown business district (Denville, 2018). The Rockaway River is a popular fishing destination although public access is limited (Denville, 2018). The Rockaway River is also used for canoeing and kayaking, with both Gardner Field and McCarter Park serving as put-in and take-out locations (Paddling.com, 2019). NJDEP (Division of Fish and Wildlife) stocks the Rockaway River in many sections with rainbow and brown trout.

2.3.6. Aesthetics and Noise

The downtown business district has a concentration of small commercial buildings up to 3 stories in height, with residential areas lying immediately outside the business district to the west and north. The downtown generally has a gridded street network. Residences have mowed lawns, landscaping, and sidewalks. The area is typical of older urban areas that federal and state Smart Growth initiatives are seeking to maintain.

The downtown business district is within close proximity to U.S. Interstate 80, and U.S. Route 46 passes through town. Noises from vehicle traffic are audible most of the time. Additionally, noises of aircraft passing to and from nearby airports are also often audible. The Township of Denville regulates noise from sound sources both outdoors and indoors to protect the public (eCode360, 2020).

2.3.7. Cultural Resources

Cultural resources can be defined by expressions of human culture and history in the physical environment, such as prehistoric or historic archaeological sites, buildings, structures, objects, districts, and sacred sites among others. Cultural resources may also include natural features, plants, and animals that are deemed important or significant to a cultural group or community. In explaining the proposed actions' effects on cultural resources, this section provides an overall cultural context for the project area and discusses cultural resources identification efforts to date.

It is important to note that historic properties, as defined by 36 CFR 800, the implementing regulations of Section 106 of the National Historic Preservation Act (NHPA) of 1966, are cultural resources that are eligible for inclusion in the National Register of Historic Places (NRHP). Historic properties may include districts, sites, buildings, structures, artifacts, ruins, objects, works of art, properties of traditional religious and cultural importance, or natural features important in human history at the national, state, or local level.

Section 106 of the NHPA requires consultation with the State Historic Preservation Office (SHPO) for proposed actions that may affect historic properties. The New Jersey State Historic Preservation Office (NJ SHPO) is designated as the SHPO for New Jersey. Development of a Programmatic Agreement (PA) is being coordinated with the NJ SHPO, Delaware Nation, and the Shawnee Tribe pursuant to 36 CFR 800.14(b)(ii). The PA will stipulate additional cultural resources investigation requirements to be conducted during the design and implementation phase of the project when more detailed designs and formulation of nonstructural measures are produced.

As part of Section 106 coordination, an area of potential effect (APE) was defined to evaluate any potential cultural resources that could be affected by the project. The APE includes those areas where direct construction impacts are proposed, as well as areas within which the undertaking may directly or indirectly cause alterations in the character or use of historic properties, including visual effects. For this project, the APE includes buildings that will be subject to nonstructural alternatives, such as floodproofing or elevation raising. The APE also includes the viewsheds of any nearby historic properties.

The earliest human settlement in New Jersey is generally accepted as 13,000 to 14,000 years ago (11,000 – 12,000 Before Common Era [BCE]), after the retreat of the last glacial remnants of the Pleistocene. The chronological sequence of prehistoric occupation is divided into three major cultural periods: Paleo-Indian (circa 12,000 – 8,000 BCE), Archaic (circa 8,000 – 1,000 BCE), and Woodland (circa 1,000 BCE – 1600 CE).

Later in time, the Native Americans who occupied the area of Morris County called themselves the Lenni-Lenape, “Original People” or “Important People.” Those who lived within the project area identified themselves as members of the “Minsi” tribe, an arm of the Lenape nation. They settled along the streams and lakes in the valleys of New Jersey where the rich forests provided all of their essential needs (Perrucci, 1983).

Morris County lies in what was once known as West Jersey, the western half of a land grant that was divided by the Quintipartite Deed into two distinct political units in 1676. Most of Morris County was settled by the first half of the 18th century. No permanent European settlements were established in this area prior to 1700. Proprietors fully owned the New Jersey properties until 1702 when European settlement officially took hold. The earliest settlement in the county centered on rich iron deposits discovered in the area near Hanover, formerly part of Whippany, which paved the way for lucrative iron industries. The creation of Morris County resulted from its separation from Hunterdon County, and it was only in 1753, after separating from Sussex and Warren Counties, that its contemporary boundaries were established (Duerksen and Bergman, 1999).

British taxation during the mid to late-18th century devastated the local iron industries, but they were rejuvenated with George Perot MacCulloch’s idea for a canal that could connect the New York and New Jersey Bay area to inland North Jersey and Pennsylvania. The canal revitalized the economy of these areas and introduced supplies to the communities otherwise isolated from innovative New York enterprises. In 1823, engineer Ephraim Beach was selected to determine the most appropriate route for

the proposed canal. He was then assigned the responsibility to oversee construction for the first ten years. In 1825, the Morris Canal and Banking Company was created to manage the canal (Goller, 1999).

By the 1860s, with the increase in railroad construction, the canal began losing business. The speedier railroad easily competed with canal transportation and in 1871 the Morris Canal and Banking Company "perpetually leased" its lands to the Lehigh Valley Railroad Company. In the 1920s, the Lehigh Valley Railroad Company turned over its unused land to the state of New Jersey and the state destroyed or filled most of the canal. Although the locks and incline planes do not remain as they were in the canal's booming years of operation, the canal had an immense impact on the community's histories and the surrounding landscape reflects these impacts (Goller, 1999).

Denville was incorporated into Morris County in 1739. Local subsistence consisted of farming and cattle raising along with various industrial pursuits such as milling and iron forging. Shortly thereafter, Denville's population began to increase along with the highly successful iron industry. Most immigrants to the area, mainly of German origin, were drawn to the jobs created from the rise of the mining industry in the mid-18th century (EAC, 1980). The population rapidly expanded once again with the opening of the Morris Canal in 1831 and continued with the arrival of the Morris and Essex Railroad in 1854 (Denville, 2014).

The decline o^{f} the iron Industry, the closing of the canal, and the increase in commuter rail use in the latter part of the 1^{9t}h century influenced the economic structure of Denville (Walezac and Lee, 1998). New Jersey's resort period in the late 1^{9t}h and early 2^{0t}h centuries also had a strong impact on the town, which became a favored destination to "urbanites" seeking a place to cleanse and restore themselves and to get away from the cities. Spas, such as St. Francis Health Resort, summer bungalow communities, and later tent colonies changed the socioeconomic and visual character of the community. It was with this refined identity that Denville became its own municipality in 1913.

Further development of summer communities was focused around Rock Ridge Lake, Lake Arrowhead, and Indian Lake. Suburban development took hold in Denville into the present and now the once summer-only bungalows are year-round dwellings. As a result, Denville is a characteristically residential community with a unique character (EAC, 1980).

NJ SHPO's Cultural Resources Geographical Information System (NJ CRGIS) online viewer, LUCY, was utilized to identify previously mapped cultural resources within 0.5 miles of the project area (NJ CRGIS, 2019). Due to the limited information available in the NJ CRGIS, a USACE archaeologist visited the NJ SHPO to review their maintained site files. Information gathered from both the NJ CRGIS and the NJ SHPO included files pertaining to previously mapped archaeological and architectural resources and cultural resource surveys conducted within 0.5 miles of the project area.

No archaeological resources have been documented within the project area or within 0.5 miles of it. No architectural resources have been documented within the project area, but three architectural resources were documented within 0.5 miles of it. These were the Morris Canal, the Old Main Delaware, Lackawanna, and Western Railroad Historic District, and the St. Francis Health Resort.

2.3.8. Contamination and Toxic Substances, Explosive and Flammable Hazards

This section addresses Hazardous, Toxic and Radioactive Waste (HTRW) materials that may pose a risk to human health due to their harmful attributes. Denville does not have a history of large-scale industry with which larger contaminated sites are associated; however, smaller scale contaminated sites could potentially be a local concern to human health or the environment. A preliminary desktop environmental site assessment of the downtown business district to screen for environmental contamination issues was conducted.

USEPA Envirofacts website, which provides a means to obtain environmental condition and pollution information for an area using Geographic Information System (GIS) data depicts 11 facility point locations within the study area. These locations occur primarily along West and East Main Streets and within a couple of blocks of Main Street, and also along Route 46. The facility point locations include hazardous waste, air pollution, or toxic releases regulated under various environmental laws. The majority of the sites are hazardous waste generators regulated under the Resources Conservation and Recovery Act of 1976 (RCRA). It is assumed that hazardous waste from these sites is managed in accordance with RCRA (which was established for the purpose of pollution prevention rather than clean-up), so these facilities have minimal likelihood of pollutants escaping the facility and entering the natural or built environment beyond the facility. No Superfund nor Brownfield sites, which are of substantial concern for pollutants having escaped uncontrolled into the built and natural environment, are within the study area or in close proximity.

NJDEP maintains a Known Contaminated Sites List (KCSL) where contamination of soil or groundwater has been confirmed at levels equal to or greater than applicable standards (such that sites are potentially or likely unsafe). Mapping of these sites for the downtown business district vicinity shows that there are four KCSL sites along West Main Street and Broadway. Three of these sites are associated with gas/auto service stations (Table 2-4; Figure 2-9). The fourth site is located in the Denville Square shopping center.

Common hazards that may be found in and around residences include lead-based paint (LBP), asbestos-containing materials (ACM), mold, dust, and heating oil contamination. Common hazards in and around commercial buildings and facilities may include LBP, ACM, mold, dust, heating oil contamination, and fuel contamination.

Table 2-4: KCSL Locations in Downtown Business District and Within 500 feet

Facility Name	Location
Denville Alignment and Service	West Main Street
Exxon PMG 8139	West Main Street
Denville Square	Diamond Springs Road
Broadway Gulf, Inc.	Broadway Avenue
Center Shell Service	Broadway Avenue

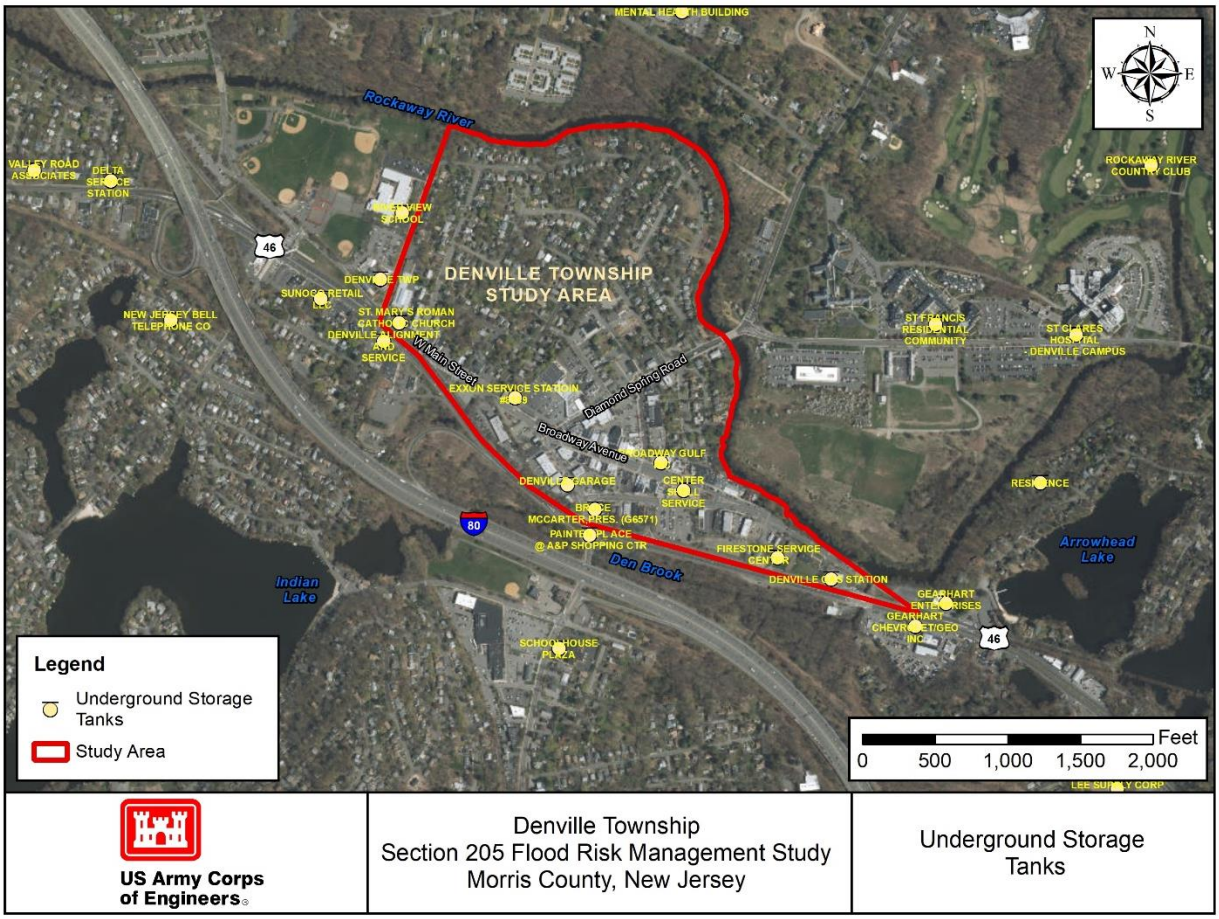

Figure 2-9: KCSL Locations in Downtown Business District and Within 500 feet.

2.3.9. Public Safety

Flooding represents a public safety hazard. Morris County's Disaster Mitigation Act of 2000 (DMA) Hazard Mitigation Plan Update (2015) provides an overview of the Township of Denville problems, safety hazards, and proposed initiatives to reduce public safety threats. The plan identifies the downtown business district as an area of severe repetitive loss.

The majority of the downtown business district lies in FEMA Flood Zone A (Special Flood Hazard Areas) 100-year flood or base flood (1 percent AEP) where flood insurance is mandatory. A minority of the downtown business district lies in the 0.2 percent AEP floodplain (Township of Denville, 2014). Structures were mostly constructed prior to the implementation of the NFIP and adoption of the associated Floodplain Management Regulations. Local building codes relating to flooding follow the Uniform Construction Code (UCC) and when applicable, Denville's Flood Hazard Ordinance.

Focal points of public safety in flood-prone areas include consideration of whether schools, hospitals, fire, and police stations are present. The downtown business district contains one school, Riverside Elementary School, located on the east side of Saint Mary's Place. Additionally, one childcare facility is located adjacent to the school. No hospitals, fire stations, or police stations are located within the downtown business district. However, a Denville police station is located on the west side of Saint Mary's

Place, adjacent to but just outside the downtown business district. A Denville fire station occurs south of Route 80, just south of the downtown business district.

Multiple involuntary residential evacuations have occurred throughout the township in severe storm and flood events. Over the period of 2010 through 2012, four different involuntary residential evacuation events occurred, including Hurricanes Irene and Sandy (Morris County, 2015). It was not determined how many of these evacuations occurred in the downtown business district.

Because numerous mature trees have been dying in the area in recent years, dead and dying trees locally constitute an important safety hazard.

2.3.10. Structure Inventory and Valuation

One of the chief inputs in developing a model using the HEC-FDA program is the structure inventory. The structure inventory was created considering the floodplain boundary developed by FEMA. A shapefile was paired with digital elevation data presented in the North American Vertical Datum of 1988 (NAVD88) elevation datum to obtain ground elevations of structures within the flood zone. Structures that fell within the FEMA flood zone were selected as the structure inventory.

The residential structure values were calculated using Marshall & Swift Residential Estimator 7 version 7.7.7, which assesses their cost primarily through the building material, the type of roof, the square footage, the effective age, the story number, and the location factor. Generic depth-damage functions developed by the USACE Institute for Water Resources (IWR) were used within the tool to show the percentage of structure value damaged by varying water levels. Depth-damage functions for this study are from IWR Report 96-R-12 *Nonresidential Content Value and Depth-Damage for Flood Damage Reduction Studies* (May 1996) and are considered appropriate for this study because they were developed for similar occupancies in a location relatively close to the Township of Denville, New Jersey. Based on the Economic Guidance Memorandum (EGM) 01-03 and (EGM) 04-01, the residential content value was assumed to be equal to 100 percent of the structure value, since the depth-damage functions model content value as a percentage of the structure value. Table 2-5 is a condensed structure inventory that contains Structure Occupancy Types, Structure Values, and Content Values. Additional information can be found in Appendix D: Economics.

Table 2-5: Existing Residential and Non-Residential Structure Inventory

Structure Occupancy Type	Description	Number of Structures	Structure Value	Content Value	Total Value
IWR1	One Story/ No Basement	28	6,583	6,583	13,166
IWR2	Two Story/ No Basement	44	12,025	12,025	24,050
IWR3	Split-Level/ No Basement	11	2,798	2,798	5,596
IWR4	One Story/ With Basement	14	3,220	3,220	6,440
IWR5	Two Story/ With Basement	89	35,052	35,052	70,104
IWR6	Split-Level/ With Basement	88	22,732	22,732	45,464
N13	Nonresidential/ No Basement	61	64,355	41,944	106,299
N14	Nonresidential/ With Basement	36	34,327	10,502	44,829
T77	Emergency Flood Fighting	1	51	1,544	1,595
	Total	**372**	**181,143**	**94,456**	**317,543**

Note: $ in 000s

2.4. Infrastructure

2.4.1. Traffic and Transportation

Two major east-west routes, U.S. Route 46 and Interstate 80, cross the Township of Denville. U.S. Route 46 lies along the southern edge of the downtown business district, with Interstate 80 lying immediately to the south. Additionally, Main Street (Route 53), passes through the downtown business district with an east-west orientation, but turns south on the east side. Diamond Spring Road (Route 603) has its southern terminus in the Denville downtown business district with a north-south orientation (see Figure 2-10).

Streets and highways are grouped in functional classification classes or systems according to the character of service that they are intended to provide (Table 2-6) (New Jersey Department of Transportation [NJDOT], 2019). Traffic count data for Denville is available from Morris County and State of New Jersey data. Streets in the downtown business district are classified by NJDOT predominantly as local roads. However, Diamond Spring Road and West Main Street are classified as minor arterial roads.

NJ Transit provides commuter rail service to Denville, with a large station in Denville located on Estling Lake Road, about half a mile south of the downtown business district off Route 53. The NJ Transit station serves the Morristown Line and the Montclair-Boonton Line, with service to Hoboken or to New York City.

NJ Transit operates passenger bus service along its Rockaway/Morristown local bus Number 880 route, which passes through the Denville downtown business district. NJ Transit offers additional passenger bus service along Route 10, about 2.5 miles south of the Denville downtown business district.

Table 2-6: Functional Classification of Important Roads

Road	Functional Classification	Maintained By
80	Interstate	Federal
46	Other Principal Arterial	State
53	Other Principal Arterial	State
603	Minor Arterial	County

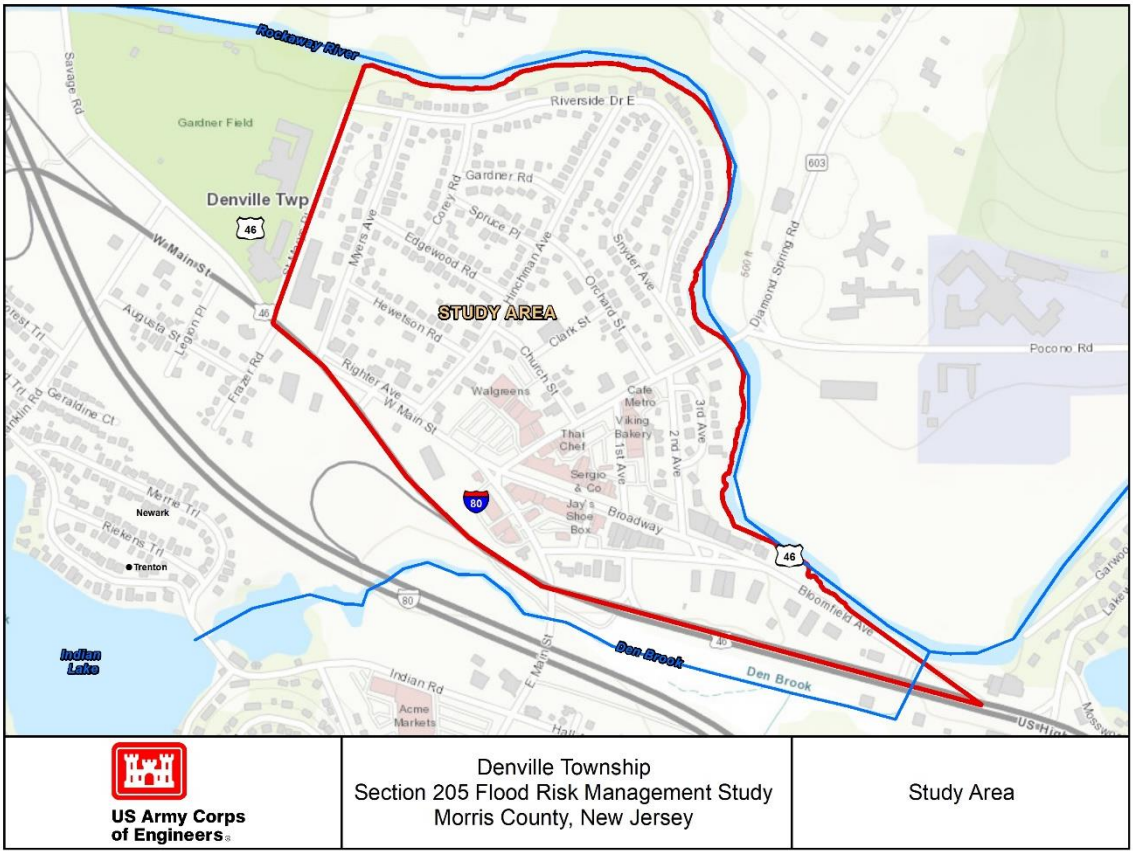

Figure 2-10: Study Area Street View

2.4.2. Utilities

Groundwater is the primary source for drinking water for the residents of the Township of Denville. Denville downtown business district businesses and residents obtain water from the Township Water Department, which is a public community water system consisting of five wells. This system's source water comes from the Glacial Sand and Gravel Aquifer System. This system can also purchase water from

the following water systems: Rockaway Borough Water Department, Boonton Township Water Department, Morris County Municipal Utilities Authority (MUA), Mountain Lakes Water Department, Parsippany Troy Hills Water Department, Randolph MUA (Denville, 2017).

The Township of Denville has public community wells owned by the Denville Water Department, for which wellhead protection areas have been established to protect groundwater resources. No public community wells nor wellhead protection areas occur within the downtown business district. A wellhead protection area occurs along the Rockaway River about 1,500 feet upstream of the downtown business district. An additional wellhead protection area occurs about 1,500 feet east of the downtown business district in the vicinity of McCarter Park (Township of Denville, 2014).

The entirety of Morris County lies within USEPA-designated "sole source aquifers," recognizing the importance of area groundwater resources for communities. the Township of Denville lies within two designated sole source aquifers. The majority of the Township of Denville, including the downtown business district area, lies within the USEPA-designated "Upper Rockaway River Sole Source Aquifer." The southeastern portion of the township lies within the "Buried Valley Aquifers, Central Basin, Essex and Morris Counties." Within designated sole-source aquifer areas, USEPA reviews proposed projects that will receive federal funding to protect groundwater resources (USEPA, 2019).

All sewer mains in the downtown business area are gravity-driven and flow to Rockaway Valley Regional Sewerage Authority. There is a sewage pump station on Riverside Drive. The force main from that station crosses the river and discharges to a gravity line on Diamond Spring Road (Ruschke, Denville Twp, personal communication, 2019).

Electricity is provided by Jersey Central Power & Light (JCP&L), and natural gas by New Jersey Natural Gas (NJNG). In general, electric lines are above ground with some local areas underground. All-natural gas lines are underground.

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3. Plan Formulation

The plan formulation for this study is detailed in Sections 3 and 4 of this Report. The plan formulation process for this study is summarized in Figure 3-1. In this section, the report outlines the identified problems and opportunities, study goals and objectives, constraints, and considerations. The study identified suitable FRM measures by using the study objectives, constraints, and other criteria (see 3.6.3) and to screen FRM measures appropriate for addressing identified problems for the Township of Denville. The FRM measures that were retained were combined into an array of alternatives. Section 4 will describe alternative plans and detail the evaluation and comparison process used to identify a tentatively selected plan (TSP).

Figure 3-1. Plan formulation process for study

3.1. Problems and Opportunities

3.1.1. Problems

The Township of Denville has endured numerous severe flooding events, the most severe, occurred during Hurricane Irene on August 27–- 28, 2011. The primary source of flooding is the Rockaway River and its tributaries. The Rockaway River receives flow from Beaver Brook just before entering the Township of Denville from Rockaway Borough to the west. The river then flows to the east under I-80

(where the reported tributary drainage area is 87.1 square miles) and through the central portion of the Township where it receives flow from Den Brook just prior to turning to the northeast. The river continues flowing to the northeast through the Township of Denville and into Boonton Township, where it eventually turns to the east and flows through the Town of Boonton and into the Boonton Reservoir.

Township residents and businesses have suffered extensive losses and damage from several severe flooding events in recent decades. According to the township's Flood Mitigation Report, the central business district has experienced $17.8 million in building and content losses between 2008 and 2014 (Township of Denville, 2016). FEMA's repetitive loss statistics for the Township of Denville lists 54 residential and 3 non-residential structures with repetitive losses and 31 residential and 1 non-residential structure with severe repetitive losses (Morris County, 2020).

Hurricane Irene's aftermath caused the Denville Police Department to order evacuations for residents and businesses, including its own operations (Izzo, 2014), which impacts the ability to provide emergency services during a crisis. A local newspaper account of the flooding event provides reference:

> In the aftermath of Hurricane Irene, Denville Volunteer Fire Department Co. 3 was forced to operate out of a Department of Public Works shed [...].
>
> *When there used to be heavy rains at the original firehouse–- built in 1963 by the firefighters–- all the equipment in the basement would be placed on tables to avoid flooding. "They were accustomed to getting water in the basement but Irene was a catastrophe" Andes said, adding "the new firehouse has no basement. Irene was a once every 100 years storm, a 500-year event."*

Substantial developed portions of the Township remain subject to flooding. Development in the floodplain is extensive, and in some areas, the 1% AEP flood inundation depth can exceed 6 feet. Several homes and other structures are in the floodway. Structures are vulnerable to flooding during flood events, especially homes located within 20 feet of the edge of the river and brook. The Township of Denville has existing procedures for mandatory evacuation of residents living in flood prone areas to relocate to the Townships' Emergency Shelter at Lakeview Elementary School. The egress route from the township's flood prone areas and shelter location are not impacted by FRM measures proposed in this feasibility study.

3.1.2. Opportunities

Opportunities exist to:

- Reduce the flood risk to structures and life safety from fluvial flooding.
- Communicate flood risk to the surrounding community, and
- Review potential impacts to critical infrastructure, emergency services, and evacuation routes that could be impacted from recurring or significant flood events.

3.2. Goals, Objective, Constraints and Considerations

3.2.1. Goals

- Reduce damages to property and risk to life safety resulting from fluvial flooding experienced in Denville, New Jersey associated with the Rockaway River and its tributaries; and
- Provide a plan that is compatible with future FRM and economic development opportunities.

3.2.2. Objectives

The federal objective of water and related land resources planning is to contribute to National Economic Development (NED) while protecting the nation's environment. The contributions will be in accordance with national environmental statutes, applicable executive orders, and other federal planning requirements, including USACE nonstructural policies. The specific objectives for this study are:

- Reduce damages to existing structures in the study area due to fluvial flooding associated with the Rockaway River and its tributaries through year 2075.
- Reduce risk to life safety in the study area due to fluvial flooding, associated with the Rockaway River and its tributaries through year 2075.
- Support community resilience and cohesion by advocating for FRM measures that are compatible with economic development of the township.

3.2.3. Constraints

The planning constraints identified in this study are as follows:

- Structures along Rockaway River and within the FEMA floodway are prohibited from receiving substantial improvements, unless it has been demonstrated that such work would not result in any increase in flood levels.

3.2.4. Considerations

- Avoid or minimize induced damages resulting from the implementation of FRM measures.
- Avoid or minimize impacts to existing critical infrastructure in the study area.
- Avoid or minimize environmental impacts from FRM measures.
- Avoid or minimize impacts to historic and cultural resources in the study area.
- Avoid or minimize impacts to areas with hazardous, toxic, or radioactive waste.

3.3. Future Without Project Conditions

The future without project (FWOP) condition, which is also the No Action Alternative, is the most likely condition expected to exist in the future in the absence of a federal FRM project or program at Den Brook and/or Rockaway River. The FWOP condition constitutes the benchmark against which FRM alternatives are evaluated.

The FWOP condition was determined by projecting conditions in the study area over a 50- year period of analysis. The period of analysis was determined to be from 2026 to 2075. In the absence of federal action, flooding problems associated with rainfall events in the study area are expected to continue.

These problems may be exacerbated by increased damage potential in the floodplain of the Township of Denville, New Jersey within the Upper Rockaway River Basin and its tributary, Den Brook, related to climate change, which is expected to lead to an increase in intensity and frequency of storm events. It is expected, based on future land use projections in the study area, there will be limited additional development within the basin through 2075. In general, no significant developmental changes are expected. A summary of Equivalent Annual Damages (EAD) for the FWOP condition is presented in Table 3-1. Appendix D: Economics includes additional detail on how annualized damages were estimated for the study area.

Table 3-1: Summary of Equivalent Annual Damages for the FWOP Conditions

Damage Reach	Annual Damages by Reach	Total Annual Damages
Den Brook	$343,000	$2,381,000
Upper Rockaway	$2,038,000	

3.4. Peak Discharges

Peak discharges were determined for various locations along the Rockaway River and Den Brook reaches using the USACE Hydraulic Engineering Center-Hydrologic Modeling System (HEC-HMS) model developed as part of the May 2017 Passaic River FRM study. FEMA models of the Passaic River watersheds were updated against observed USGS stream gages from Tropical Storm Irene and remain valid for the existing conditions. Additional details can be found in Appendix A: Hydrology and Hydraulics.

3.5. Water Surface Elevation

Water surface elevations were developed using the HEC-RAS model developed to determine flood elevations at the time of this study. These water surface elevations were used as a baseline to determine the benefits and impacts of flood risk management measures in future phases of the Rockaway River hydraulic study. HEC-RAS was used to develop a geo-referenced hydraulic model for Rockaway River and Den Brook Reaches for the existing conditions 50 percent AEP (2-year), 20 percent AEP (5-year), 10 percent AEP (10-year), 4 percent AEP (25-year), 2 percent AEP (50-year), 1 percent AEP (100-year), 0.5 percent AEP (200-year), and 0.2 percent AEP (500-year) inundation events. All elevations in the modeling and mapping are referenced to the NAVD88 with a horizontal coordinate system of New Jersey State Plane. Additional details can be found in Appendix A: Hydrology and Hydraulics.

3.6. Measures to Achieve Planning Objectives

The study considered structural measures, nonstructural measures, and natural and nature-based features (NNBF) to address flood risk in the township of Denville. During alternative formulation, management measures were combined to develop an array of alternatives.

3.6.1. Structural Measures

Structural FRM measures are man-made, constructed measures that counteract a flood event in order to reduce the hazard or to influence the course or probability of occurrence of the event. This includes dams, levees, and floodwalls that are implemented to protect people and property.

Floodwalls: Floodwalls are structures used to reduce risk in relatively small areas or in areas where there is not enough space to accommodate a levee. They are similar to seawalls and are usually constructed from concrete. Floodwalls were considered in combination with stop log closures where appropriate to address road and railroad crossings present in the study area.

Levees: Levees are soil embankments constructed along a waterfront to prevent flooding in relatively large areas. They have a wider footprint than floodwalls and are more stable yet require large tracts of real estate. Since the study area is highly developed, levee applicability is limited.

Pump Stations: Pump stations are intended to provide a mechanical means of moving floodwater from an undesirable location, including from within communities. Pump stations provide interior drainage for smaller areas and can be effective in reducing ponding areas behind a levee or floodwall system.

Dredging: Dredging is a restoration action that improves aquatic habitat and water quality by excavating surplus sediment from behind dams, or from streams, lakes, and ponds that have experienced a decrease in water depth due to additional sediment loading.

Reservoir (retrofit existing): Retrofitting is a method of utilizing previously constructed facilities designed for quantity control by modifying the structure to capture initial runoff of a precipitation event. This typically involves modifying the riser or control structure as well as regrading part of the facility to accommodate the water quality portion of the retrofit. There are cases where additional volume is needed for quantity control where a facility is over excavated, but this method typically does not involve extensive embankment work.

Dams (new): Flood control dams are man-made earthen or concrete structures designed to detain water that can slowly be released, reducing risk to downstream communities.

Bypass Culvert: Culverts may be used to divert river overflow from upstream of a developed area. Flood flows contained within the culvert will bypass developed areas and re-enter the river downstream. Under normal conditions, base flow would continue to flow within the river channel. This type of alternative can also minimize environmental impacts by avoiding alterations within the river channel.

Channel Modification: Modifications of the cross-section of a channel may improve flow and reduce or prevent fluvial flooding. Channel modifications can include dredging, deepening and widening, re-channelization, and elevating or widening bridges.

Clearing and Snagging: Clearing and snagging includes the removal of vegetation along the bank (clearing) and/or selective removal of snags, drifts, or other obstructions (snagging) from natural or improved channels and streams.

Road Raising: Roads are elevated to heights that would minimize or eliminate the impacts of flooding. Road raisings are often combined with other structural FRM measures.

Natural and Nature-Based Features (NNBF): NNBFs are habitats or features such as marsh/stream restoration, that may reduce flood risk while providing ecosystem benefits.

3.6.2. Nonstructural Measures

Nonstructural FRM measures are permanent or contingent measures applied to a structure and/or its contents that prevent or provide resistance to damage from flooding. Nonstructural measures differ from structural measures in that they focus on reducing the consequences of flooding instead of focusing on reducing the probability of flooding. Relocation, home elevation, and floodproofing are examples of nonstructural measures.

Acquisition: Buildings may be removed from vulnerable areas by acquisition, subsequent demolition, and relocation of the residents. Acquisition is usually reserved for structures that experience frequent flood damage, classified as repetitive loss or severe repetitive loss properties under the NFIP, or are located within a FEMA Regulatory Floodway.

Elevation: For this study, elevation refers to increasing the height of a structure's foundation at least equal to or greater than the design flood elevation to reduce damages from flooding. Elevation can be performed using fill material on extended foundation walls, piers, post, piles, and columns. Elevation is also a very successful technique for reinforced concrete slab-on-grade structures. This measure was limited to residential structures in this study.

Relocation: Relocation requires physically moving the at-risk structure. This measure achieves a high level of FRM when structures can be relocated from a high flood hazard area to an area that is located completely outside the floodplain. Relocation of the structure was not considered in this study due to the developed nature of the watershed.

Wet Floodproofing: This measure allows floodwater to get inside lower, non-living-space areas via vents and openings to reduce the effects of hydrostatic pressure and reduce flood-related damages to the

structur''s foundation. Wet floodproofing is applicable as either a stand-alone measure or as a measure combined with other measures such as elevation. As a stand-alone measure, all construction materials and finishing materials for a building are required to be water resistant to a specified height. All utilities must be elevated above the design flood elevation. Because of these requirements, wet floodproofing of finished residential structures is generally not recommended. This measure is generally not applicable to large flood depths and high velocity flows.

Dry Floodproofing: Dry floodproofing of existing structures is a common floodproofing technique applicable for flood depths of three (3) feet or less on buildings that are structurally sound. Dry floodproofing involves sealing building walls by waterproofing preventing the entry of floodwaters into a structure. Installation of temporary closures or flood shields is a commonly used floodproofing technique. Exterior walls must also be made watertight. This technique is not applicable to areas subject to flash flooding (less than one hour) or where flow velocities are greater than three (3) feet per second. Additional features including enclosures for windows and doors and sump pumps may be required to fully implement this measure.

3.6.3. Screening of Measures

FRM measures were evaluated during multiple project delivery team (PDT) meetings to determine the most suitable solutions. The evaluation of FRM measures consisted of three primary screening criteria and secondary planning considerations that were qualitatively evaluated using available information. The primary criteria used to screen measures was the determination of whether the measure meets the study objectives. Either the measure did contribute to accomplishing the objective or it did not (yes or no). The secondary criteria were used to determine whether the measure avoids the study constraints (likely, unlikely, or N/A) and whether the measure is engineeringly feasible, environmentally acceptable, and economically justified using best professional judgment and information from previous reports (likely, unlikely, or N/A). Table 3-2 details the reasoning for the screening of measures following this initial evaluation, noting that some measures were retained for further analysis after discussions with the non-Federal sponsor. Table 3-3 shows the detailed information on the screening of FRM measures using the previously listed screening criteria.

Table 3-2: Screening of Measures to form Array of Alternatives

Description	Meets Study Objectives/Avoids Study Constraints?	Carry Forward to Alternatives?
Structural		
Floodwalls	Urban impacts, unknown resources in current location, potentially economically justified depending on the level of performance. Potential impacts to other areas including induced flooding. This measure met all criteria and was considered in combination with stop log closures to address road and railroad crossings present in the study area.	Retain
Levees	Likelihood of obtaining the proper real estate is low. Locally available material may not be suitable. Costs are high. Likely for the environmental acceptability depending on placement. However, can be optimized with a floodwall alternative if applicable. This measure did not meet all criteria due to physical constraints of the site.	Screened
Pump stations	Generally high cost and further investigation during interior drainage needed. Pump stations are not a stand-alone alternative and while they meet all criteria, they would only be considered in combination with a floodwall or levee feature. Pump stations were not considered applicable with other measures after further evaluation and was screened from consideration	Screened
Dredging	Typically dredging reduces flooding on smaller events. Temporary solution and high maintenance costs. This measure did not meet all criteria.	Screened
Reservoir (retrofit existing)	Reservoir/dam retrofit or modification was examined in the 2008 USACE study—Upper Rockaway River, New Jersey, Flood Damage Reduction and Ecosystem Restoration: Alternative Plan Formulation Report, and again in the Flood Risk Reduction Program: Alternative Action Plan (2014) from the Township of Denville. The 2008 USACE Study recommended removal of the Powerville Dam and replacement with a crest gate in combination with channel modification to reduce flooding in the Township of Denville. The hydraulic analysis completed at the time indicated that flood levels would be reduced between 0.2 and 1.1 feet in the Township of Denville from the combined effects of Dam replacement with a crest gate and bridge removal, therefore these measures would not provide substantial flood reduction on their own. This plan also did not have support from the state or local stakeholders due to concerns for environmental impacts, downstream effects to Boonton Reservoir, and public concerns associated with the recommended action. Therefore, this measure was screened out from further analysis using information from these previous studies.	Screened
Dam (new)	Dam would need to be constructed far upstream due to existing topography and urbanization. High costs. This measure did not meet all criteria.	Screened
Bypass Culverts	Can induce flooding by moving the problem elsewhere. Unlikely to be environmentally acceptable and economically justified. While this measure did not meet the criteria, it was carried forward for further consideration as there was interest for the public and the non-Federal sponsor to examine this measure further. This measure was considered a stand-alone measure and was not combined with any other measures.	Retain at non-Federal sponsor's request
Channel Modification	Can induce flooding due to existing channel geometry. Is unlikely to be environmentally acceptable and economically justified. Not enough area to widen banks in the urbanized area and deepening needed to meet storage needs. This measure did not meet all criteria.	Screened
Clearing and Snagging	Not an effective measure. This measure did not meet all criteria.	Screened
Road Raising	Roads are elevated to heights that would minimize or eliminate the impacts of flooding. Road raisings are often combined with other structural FRM measures. Measure meets all objectives and was asked to be considered by the stakeholders.	Retain

Description	Meets Study Objectives/Avoids Study Constraints?	Carry Forward to Alternatives?
Natural and Nature-Based Features (NNBF)	Needed to be undertaken on a mass scale and involve entire upstream area. Regional approach, not applicable here. This measure did not meet all criteria.	Screened
Nonstructural		
Acquisition	Nonstructural plans that include acquisition as a measure requires the acquisition to be mandatory per Planning Bulletin 2016-01 (22 December 2015). Acquisition has significant impacts on the local tax base and community cohesion. In Denville, most structures have flood elevations not exceeding 6 feet, therefore USACE in coordination with the non-Federal sponsor and the township of Denville ruled out acquisitions in favor of measures with fewer impacts to community cohesion including elevation and floodproofing. Therefore, the measure was removed from consideration.	Screened
Elevations	Elevating a structure physically raises the main floor of the structure above the specified design protection level and therefore reduces the damages due to flooding. This measure met all criteria.	Retain
Relocation	Relocations of structures were not considered in this analysis, due to lack of available suitable land. Therefore, the measure did not meet all criteria.	Screened
Wet Floodproofing	Wet floodproofing reduces risk to structures by removing basements and raising vulnerable utilities. This measure meets all criteria.	Retain
Dry Floodproofing	Dry floodproofing reduces risk to structures by preventing water from getting inside the structure through sealing openings, installing watertight barriers, and waterproofing exterior walls. This measure meets all criteria. Structures with foundation types that did not allow for elevations or wet floodproofing were able to be protected with dry floodproofing. In some instances, the dry floodproofing offered FRM at a lower level of performance as allowed within the National Nonstructural Matrix.	Retain

Table 3-3: Screening of Measures

	Does the Measure meet the Planning Objectives?			Avoids impacts to:	Is the Measure[1]:			
Measures	Obj 1: Manage the risk of flood damages	Obj 2: Manage the risk to life safety	Obj 3: Supports community resilience & cohesion	Physical Constraints	Engineer-ingly Feasible	Environ-mentally Acceptable	Economic-ally Justified	Meets All Criteria
Floodwalls	Yes	Yes	Yes	Likely	Likely	Likely	Likely	Retain
Levees	Yes	Yes	Yes	Unlikely	Likely	Likely	Unlikely	Screened
Pump Station	Yes	Yes	Yes	Likely	Likely	Likely	Likely	Screened[2]
Dredging	No	No	No	Likely	Likely	Unlikely	Unlikely	Screened
Reservoir (Retrofit existing)	Yes	Yes	Yes	Likely	Likely	Unlikely	Likely	Screened
Dam (New)	Yes	Yes	Yes	Unlikely	Likely	Unlikely	Unlikely	Screened
Bypass Culverts	Yes	Yes	Yes	Unlikely	Likely	Unlikely	Unlikely	Retain[3]
Channel Modification	No	No	No	Likely	Likely	Unlikely	Unlikely	Screened
Clearing and Snagging	No	No	No	Likely	Likely	Unlikely	Unlikely	Screened
Road Raising	Yes	Yes	Yes	Likely	Likely	Likely	Likely	Retain
Natural and Nature-Based Features (NNBF)	Yes	Yes	Yes	Unlikely	Likely	Likely	Unlikely	Screened
Acquisition	Yes	Yes	No	N/A	Likely	Likely	Unlikely	Screened
Elevation	Yes	Yes	Yes	N/A	Likely	Likely	Likely	Retain
Relocation	Yes	Yes	Yes	N/A	Unlikely	Likely	Unlikely	Screened
Wet Floodproofing	Yes	Yes	Yes	N/A	Likely	Likely	Likely	Retain
Dry Floodproofing	Yes	Yes	Yes	N/A	Likely	Likely	Likely	Retain

[1] The PDT used best professional judgment and information from previous reports to determine if measures were engineeringly feasible, environmentally acceptable, and economically justified. Note that economic justification is based on previous evaluations completed in previous USACE studies, see prior studies in Table 1-2.

[2] Pump stations were screened as they were not considered stand-alone solutions to identified FRM problems and were not considered applicable after examining the identified problems and objectives.

[3] Bypass culverts did not meet all screening criteria but were retained for further evaluation at the request of the non-Federal sponsor.

3.7. Formulation of Alternative Plans

Plan formulation consists of an iterative process of developing, comparing, and evaluating alternatives. This includes evaluating alternatives alongside the study goals and objectives; engineering, economic and environmental feasibility; public and agency input; and other criteria. The level of detail was increased in each stage of the analysis to reduce the level of uncertainty with associated decisions.

3.7.1. Array of Alternatives

Alternative plans were formulated after screening the FRM measures and include the following measures retained during the initial screening: floodwalls, bypass culverts, road raising, elevation, wet and dry floodproofing. Alternative plans were developed by combining compatible management measures into plans and are listed in Table 3-4. Two separate floodwall plans were formulated based on previous work and include a combination of floodwall, stop log closures, and road raising. A bypass culvert plan proposed in previous USACE work was also examined in this study. Lastly, a nonstructural plan was formulated by evaluating flood risk at each structure. A combination of measures was developed based on the level of flood risk, type of structure, and size of structure. More information on the nonstructural plan is included in Section 4.2.4 and Appendix D: Economics.

Protection above the 1 percent AEP (100-year) event was not considered in the array of alternatives for structural measures based on professional judgment. This is because the higher level, and less frequent, events as modeled would impact a limited number of additional properties based on the topography of the study area, therefore net benefits would increase at a lower rate than annualized cost of implementing higher levels of protection. Higher levels of protection would have a considerable impact on costs particularly for floodwalls included in the structural measures, where constructing floodwalls six feet above the ground would require significantly costlier foundations. Alternative 4 is a plan consisting of nonstructural measures, which were optimized to various LOPs later in the study as detailed in Section 4.4.

Table 3-4: Array of Alternatives

Alternative	
Alternative 1	Floodwalls with various levels of performance and stop log structures
Alternative 2	Floodwalls and Road Raising
Alternative 3	Bypass Culvert
Alternative 4	Nonstructural Plan: Combination of Elevations, Wet and Dry Floodproofing
No Action	The No Action Alternative would involve no action from USACE to reduce flooding risk. Although the No Action Alternative would not accomplish the purpose of this study, it must be included in the analysis and can serve as a basis for comparison.

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4. Alternative Plan Evaluation, Comparison, and Selection

The plan formulation process detailed in the previous section is expanded in Figure 4-1 to highlight the process that was used in the study to evaluate and compare alternatives, identify a TSP, and optimize the TSP detailed in this section.

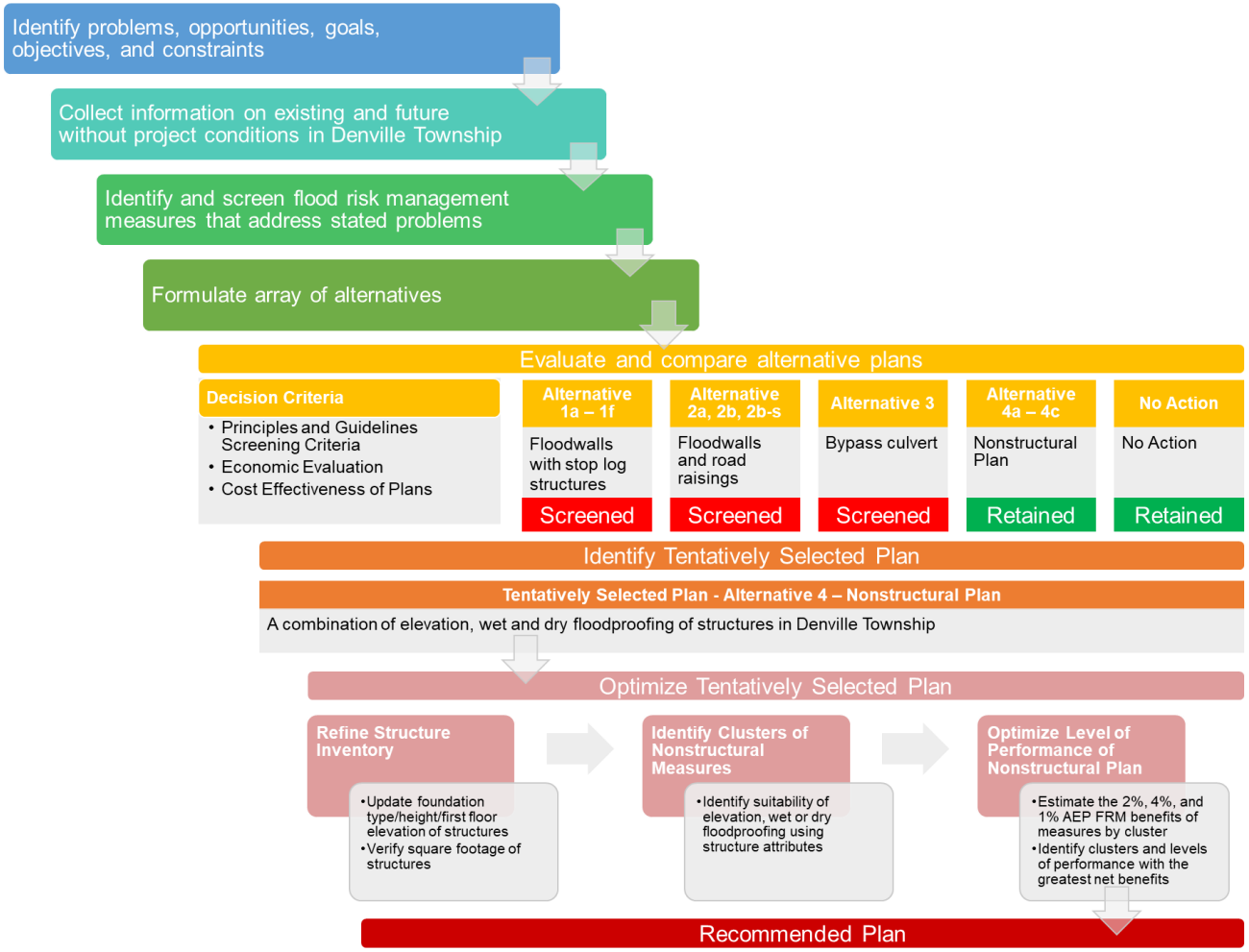

Figure 4-1: Plan Formulation Strategy to Recommended Plan

4.1. No Action

The No Action Alternative would involve no project implementation from USACE to reduce flood damage. Although the No Action Alternative would not accomplish the purpose of this study, it must always be included in the analysis and can serve several purposes. First, it is warranted for situations where the impacts are great, and the need is relatively minor. Second, it will be used as a benchmark, enabling decision makers to compare the magnitude of economic, environmental, and social effects of the actionable alternatives.

4.2. Structural Alternatives

Structural alternatives were developed through an iterative process of design, cost estimation and evaluation to identify the most cost-effective solutions. Alternatives 1 and 2, which primarily consist of floodwalls, both include several variations to determine cost effectiveness by changing the location and length of the alignment, reducing the number of closure structures, and evaluating various levels of performance based on the 1 percent, 2 percent, and 4 percent AEP flood events. Cost estimates were developed as rough order of magnitude costs based on the designs presented in this section and typical cross sections from other USACE projects.

4.2.1. Alternative 1: Floodwalls in combination with stop log structures

Alternative 1 consisted of floodwalls with various levels of performance and stop log structures. The team looked at various levels of performance (LOP) to optimize the cost of floodwalls in comparison to reductions of damages. In conjunction with floodwalls, the team incorporated stop log structures in locations where floodwalls could not be constructed. This analysis consisted of three levels of performance based on the 4 percent, 2 percent, and 1 percent AEP flood elevations and two options for the number of stop log structures. As a result of this variation in the design, Alternative 1 resulted in evaluation of 6 iterations designated as Alternative 1a through 1f. More detail on each alternative is included in Appendix C: Civil Engineering.

4.2.1.1. Alternative 1a: 1 percent AEP (100-yr) LOP with 10 Stop Log Structures

Alternative 1a was designed to reduce risk to the maximum number of structures associated with the 1 percent AEP inundation from the Rockaway River and Den Brook. Alternative 1a consists of a floodwall around the perimeter of the study area exposed to high floodwaters from the Upper Rockaway River and Den Brook (Figure 4-2). Ten closure structures, or stop log structures, are proposed within Alternative 1a. The closure structures would be designed to avoid the floodwall passing through a deed restricted area held by FEMA, avoid crossing major roads, and to allow access to the downtown business district. The total length of the floodwall is approximately 7,026 feet. The floodwall has three segments along the Upper Rockaway reach. The first segment of the floodwall has an average height of 12.54 feet above grade. The second segment of the floodwall has an average height of 9.03 feet above grade and the third segment of the floodwall has an average height of 7.82 feet above grade. The floodwall segment along the Den Brook reach, adjacent to Route 46, has an average height of 5.10 feet above grade. More information on the flood elevations is included in Appendix C: Civil Engineering.

Figure 4-2: Alternative 1a: 1% AEP (100-yr) LOP with 10 Stop Log Structures

4.2.1.2. Alternative 1b: 1 percent AEP (100-Yr) LOP with 6 Stop Log Structures

The flood risk management system and dimensions of Alternative 1b are the same as in Alternative 1a and would provide FRM to the same areas. The only difference is that four closure structures are eliminated to reduce costs. Hence, six closure structures, or stop log structures, were proposed within Alternative 1b (Figure 4-3). The four eliminated closures will be replaced with permanent floodwall and the alternative will permanently limit access from U.S Route 46 to the Enrite Gas Station and the Firestone Complete Auto Care tire shop. Access to the businesses will only (or continue to) be provided from Bloomfield Avenue. Alternative 1b would lower the cost of Alternative 1a by eliminating the cost of four closure structures, but still designed to reduce risk for the 1 percent AEP flood event. More information on the flood elevations is included in Appendix C: Civil Engineering.

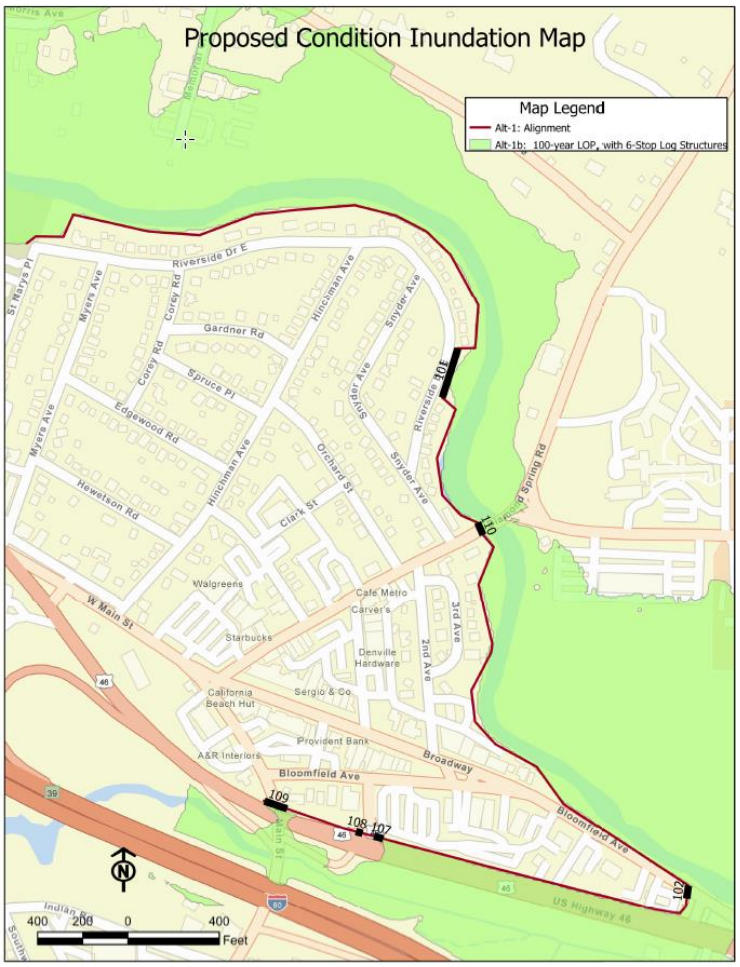

Figure 4-3: Alternative 1b: 1% AEP (100-yr) LOP with 6 Stop Log Structures

4.2.1.3. Alternative 1c: 2 percent AEP (50-yr) LOP with 10 Stop Log Structures

Alternative 1c was designed to keep floodwaters associated with the 2 percent AEP storm from inundating the Township of Denville, New Jersey (Figure 4-4). As in Alternative 1a, Alternative 1c contains ten closures, or stop log structures. The floodwall of Alternative 1c also has three segments along the Upper Rockaway reach. The first segment of the floodwall has an average height of 11.1 feet above grade. The second segment of the floodwall has an average height of 8.09 feet above grade and the third segment of the floodwall has an average height of 6.29 feet above grade. The floodwall segment along the Den Brook reach, adjacent to Route 46, has an average height of 5.10 feet above grade. More information on the flood elevations is included in Appendix C: Civil Engineering.

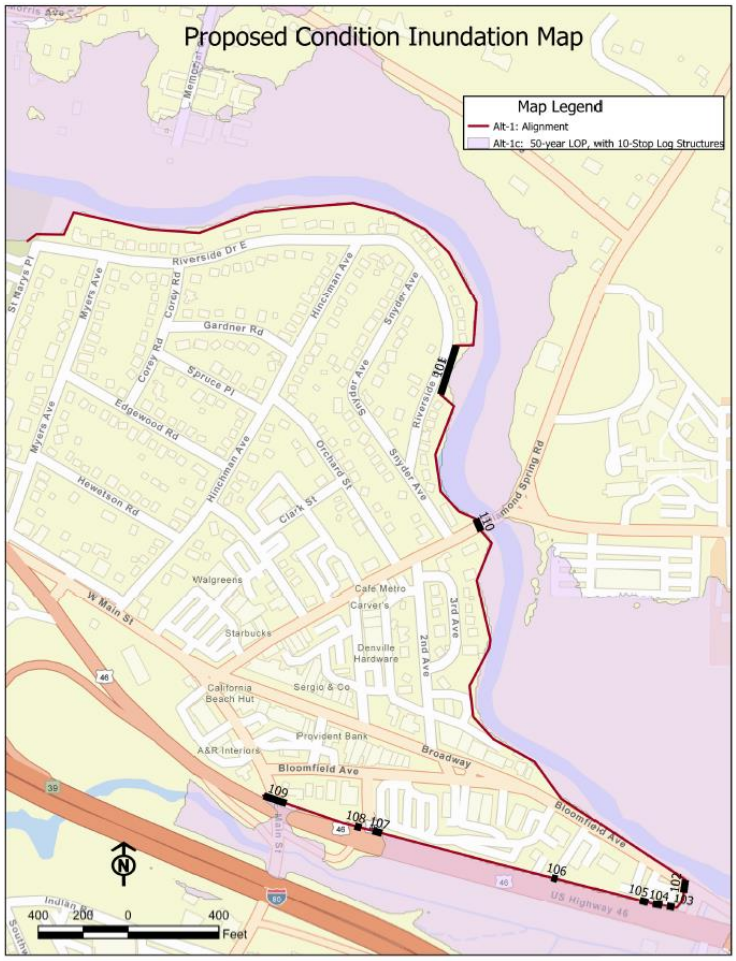

Figure 4-4: Alternative 1c: 2% AEP (50-yr) LOP with 10 Stop Log Structures

4.2.1.4. Alternative 1d: 2 percent AEP (50-yr) LOP with 6 Stop Log Structures

The flood risk reduction structures and dimensions of Alternative 1d are similar to Alternative 1c. The only difference is that four closure structures are eliminated to reduce costs. Hence, six closure, or stop log structures, are designed within Alternative 1d (Figure 4-5). The eliminated closures will be replaced with permanent floodwall and the alternative will permanently limit access from U.S Route 46 to the Enrite Gas Station and the Firestone Complete Auto Care tire shop. Access to the businesses will only (or continue to) be provided from Bloomfield Avenue. Alternative 1d will reduce the cost of Alternative 1c by eliminating the cost of four closure structures, was designed for the 2 percent AEP flood event, and was modeled similar to Alternative 1c. The removal of the additional closure structures would not affect the mapped area and the resulting flood elevation levels. More information on the flood elevations is included in Appendix C: Civil Engineering.

Figure 4-5: Alternative 1d: 2% AEP (50-yr) LOP with 6 Stop Log Structures

4.2.1.5. Alternative 1e: 4 percent AEP (25-yr) LOP with 8 Stop Log Structures

Alternative 1e is designed to keep floodwaters associated with the 4 percent AEP storm from inundating the Township of Denville, New Jersey (Figure 4-6). As in Alternative 1a, Alternative 1e contains the same FRM structures but with eight stop log closures, instead of ten, due to the lower elevation of the water level under this alternative. The floodwall of Alternative 1e also has three segments along the Upper Rockaway reach. The first segment of the floodwall has an average height of 9.57 feet above grade. The second segment of the floodwall has an average height of 6.44 feet above grade and the third segment of the floodwall has an average height of 5.39 feet above grade. The floodwall segment along the Den Brook reach, adjacent to Route 46, has an average height of 3.69 feet above grade. More information on the flood elevations is included in Appendix C: Civil Engineering.

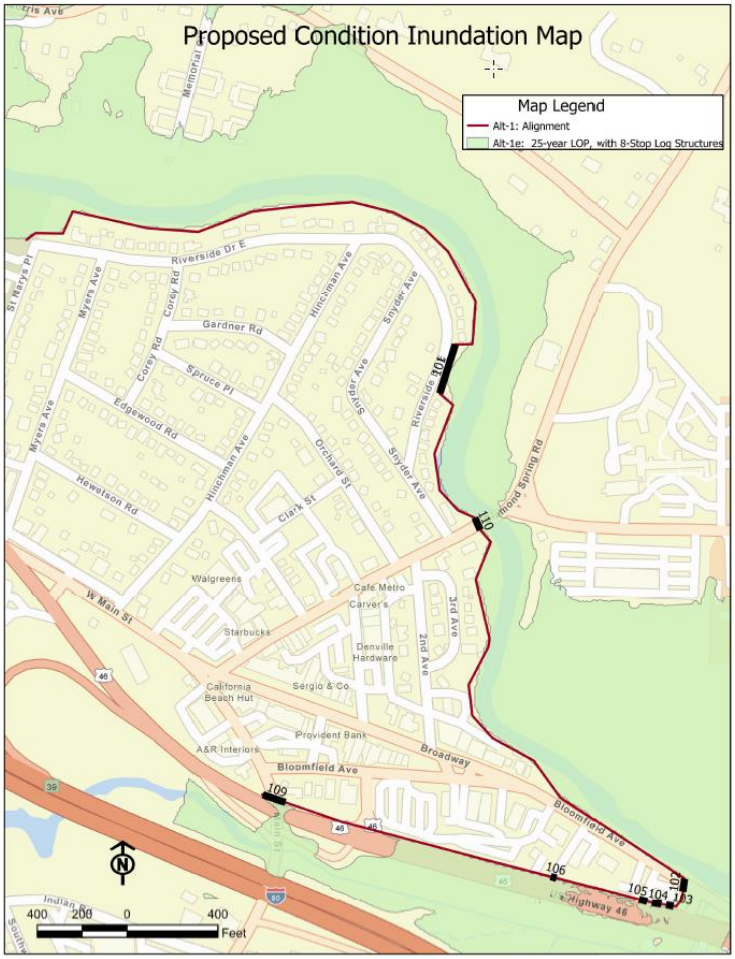

Figure 4-6: Alternative 1e: 4% (25-yr) LOP with 8 Stop Log Structures

4.2.1.6. Alternative 1f: 4 percent (25-yr) LOP with 4 Stop Log Structures

The flood risk management structures and dimensions of Alternative 1f are similar to Alternative 1e (Figure 4-7). The difference is that four closure structures are eliminated to reduce costs. Hence, four stop log structures are designed within Alternative 1f. The eliminated closures will be replaced with permanent floodwall and the alternative will permanently limit access from U.S Route 46 to the Enrite Gas Station and the Firestone Complete Auto Care tire shop. Access to the businesses will continue to be provided from Bloomfield Avenue. Alternative 1f was designed for the 4 percent AEP flood event and would further reduce the cost to the project by the elimination of four closure structures. More information on the flood elevations is included in Appendix C: Civil Engineering.

Figure 4-7: Alternative 1f: 4% AEP (25-yr) LOP with 4 Stop Log Structures

4.2.2. Alternative 2: Floodwalls and Road Raising with Stop Log Structures

Alternative 2 consisted of a combination of floodwalls, closure structures, and road raisings. The specific location of the measures varied depending on the topography and available space in the study area. Three iterations of the Alternative 2 design were developed based on the topography at specific locations in the study area designated as Alternatives 2a, Alternative 2b, and Alternative 2b sensitivity (a variation of 2b). More detail on these alternatives can be found in Appendix C: Civil Engineering.

4.2.2.1. Alternative 2a: 4 percent (25-yr) LOP with 4-Stop Log Structures

Alternative 2a is designed to reduce risk from the 4 percent AEP inundation. Alternative 2a contains four closure structures, elevating five roads, the construction of a jersey barrier along the Second Avenue centerline, and floodwalls on the Upper Rockaway and Den Brook reaches (Figure 4-8). Note that some structures along Riverside Drive, Hinchman Avenue, Snyder Avenue, and Third Avenue would remain exposed to flood risk in this alternative, but no critical infrastructure assets were identified along this exposed area.

Corey Road, Gardner Road, Hinchman Avenue, Orchard Street, and Diamond Spring Road would be raised by 4.12, 3.78, 3.32, 3.30, and 1.32 feet, respectively. Second Avenue Jersey barrier construction,

and floodwalls on the Upper Rockaway reach and Den Brook reach would have an average height of 3.41, 5.58, and 3.2 feet, respectively.

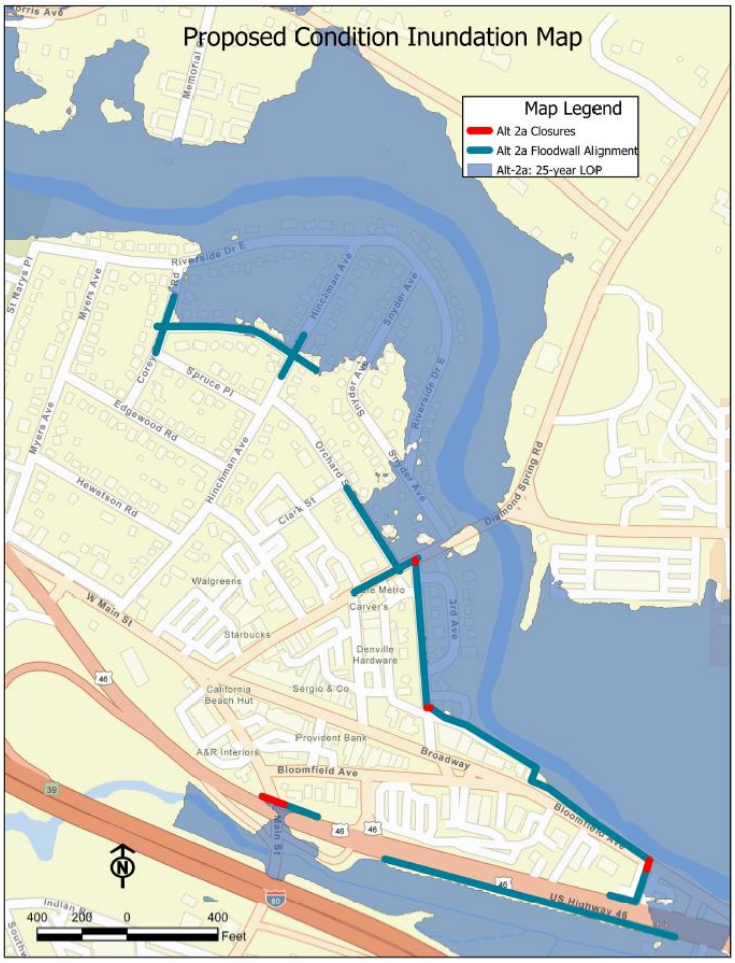

Figure 4-8: Alternative 2a: 4% (25-yr) LOP with 4-Stop Log Structures

4.2.2.2. Alternative 2b: 4 percent AEP (25-yr) LOP, with 4-Stop Log Structures

Alternative 2b is designed to reduce risk with 4 percent AEP inundation. Alternative 2b is a modification of Alternative 2a. Alternative 2b does not include a Jersey barrier structure on Second Avenue and the alignment is moved further east near the Rockaway River and includes a floodwall structure east of Third Avenue (Figure 4-9). All other roads and floodwall elevations remain the same as in the Alternative 2a. This alternative would provide for flood risk reduction through downtown Denville similar to Alternative 2a with the addition of structures along Third Avenue. The short floodwall along Route 46, and other protection structures remain the same as described in Alternative 2a. Note that some structures along Riverside Drive, Hinchman Avenue, and Snyder Avenue would remain exposed to flood risk in this alternative, but no critical infrastructure assets were identified along this exposed area.

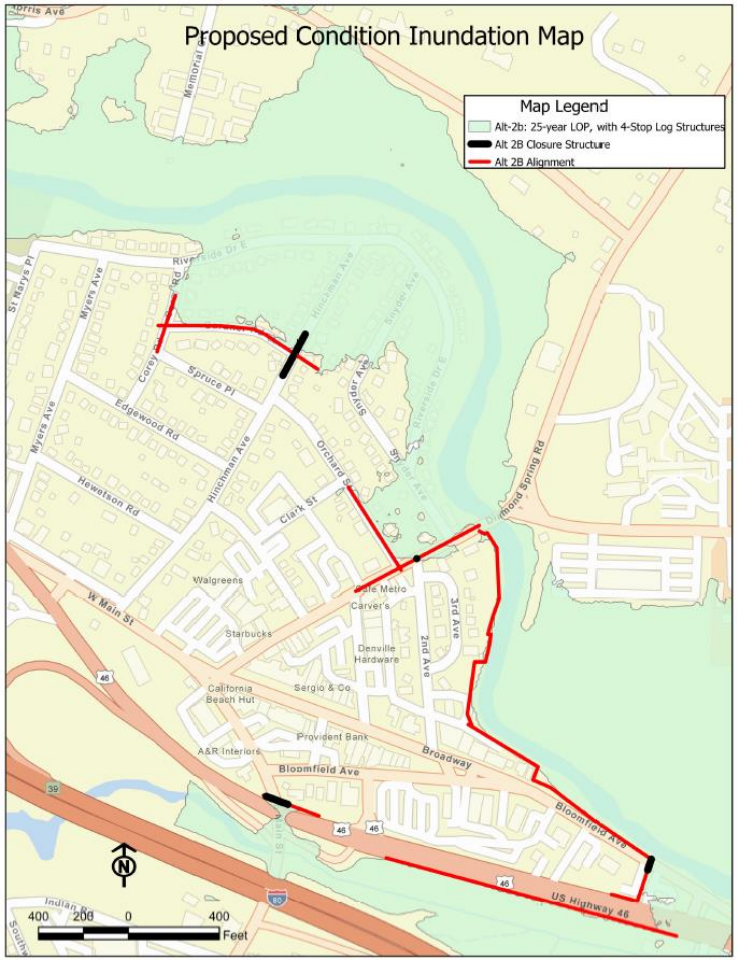

Figure 4-9: Alternative 2b: 4% AEP (25-yr) LOP, with 4-Stop Log Structures

4.2.2.3. Alternative 2b sensitivity: 4 percent AEP 25-yr LOP, with 2-Stop Log Structures

Alternative 2b sensitivity is designed to reduce risk with 4 percent AEP inundation. Alternative 2b sensitivity is a modification of Alternative 2b. In Alternative 2b sensitivity, the elevation of Orchard Street and Diamond Spring Road are eliminated to reduce the costs of the project. Snyder Road is raised to a top height of 4.28 feet (Figure 4-9). Alternative 2b sensitivity also only has two stop log closures on Bloomfield Avenue and Main Street. Note that some structures along Riverside Drive, Hinchman Avenue, and Snyder Avenue would remain exposed to flood risk in this alternative, but no critical infrastructure assets were identified along this exposed area. This alternative was formulated following analysis of the other structural solutions to maximize construction cost savings in an effort to develop an alternative that would be economically justified.

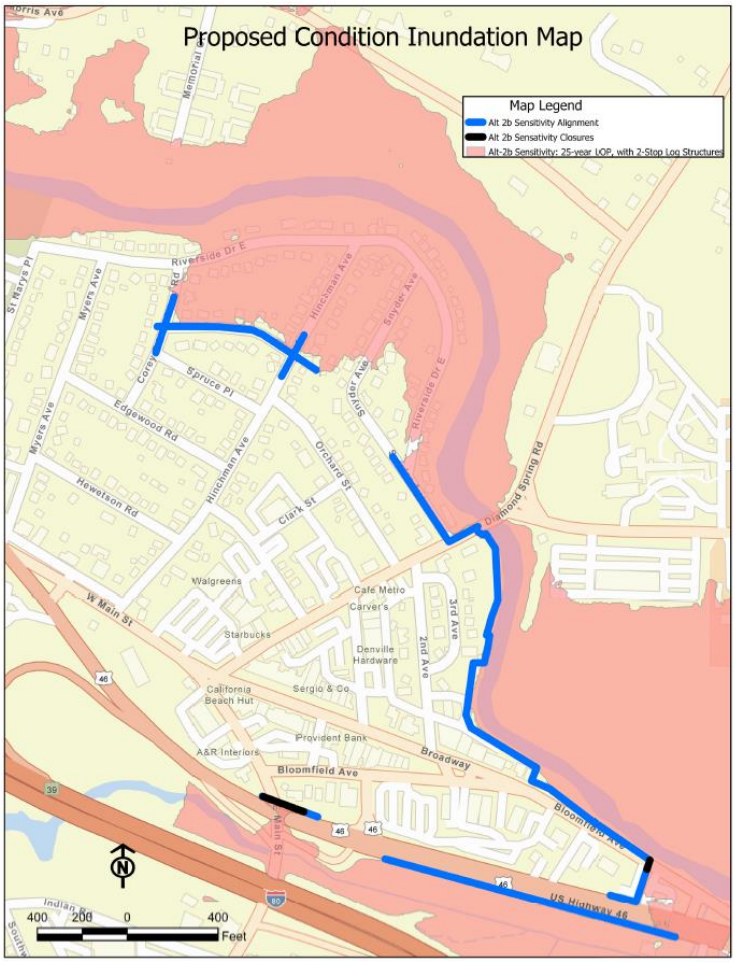

Figure 4-9: Alternative 2b Sensitivity

4.2.3. Alternative 3: 4 percent AEP (25-yr) LOP, Divert Flow with a 8'x20' bypass culvert

Alternative 3 includes a 20-foot wide, 8-foot high, and 6,600-foot long (1.25 miles) bypass culvert that will take a substantial amount of the 4 percent AEP floodwaters away from the project area and redistribute it further downstream (Figure 4-10). This diversion structure will redirect floodwater from the Rockaway River through a bypass culvert and reduce excessive energy before re-entering the Rockaway River 1.25 miles downstream.

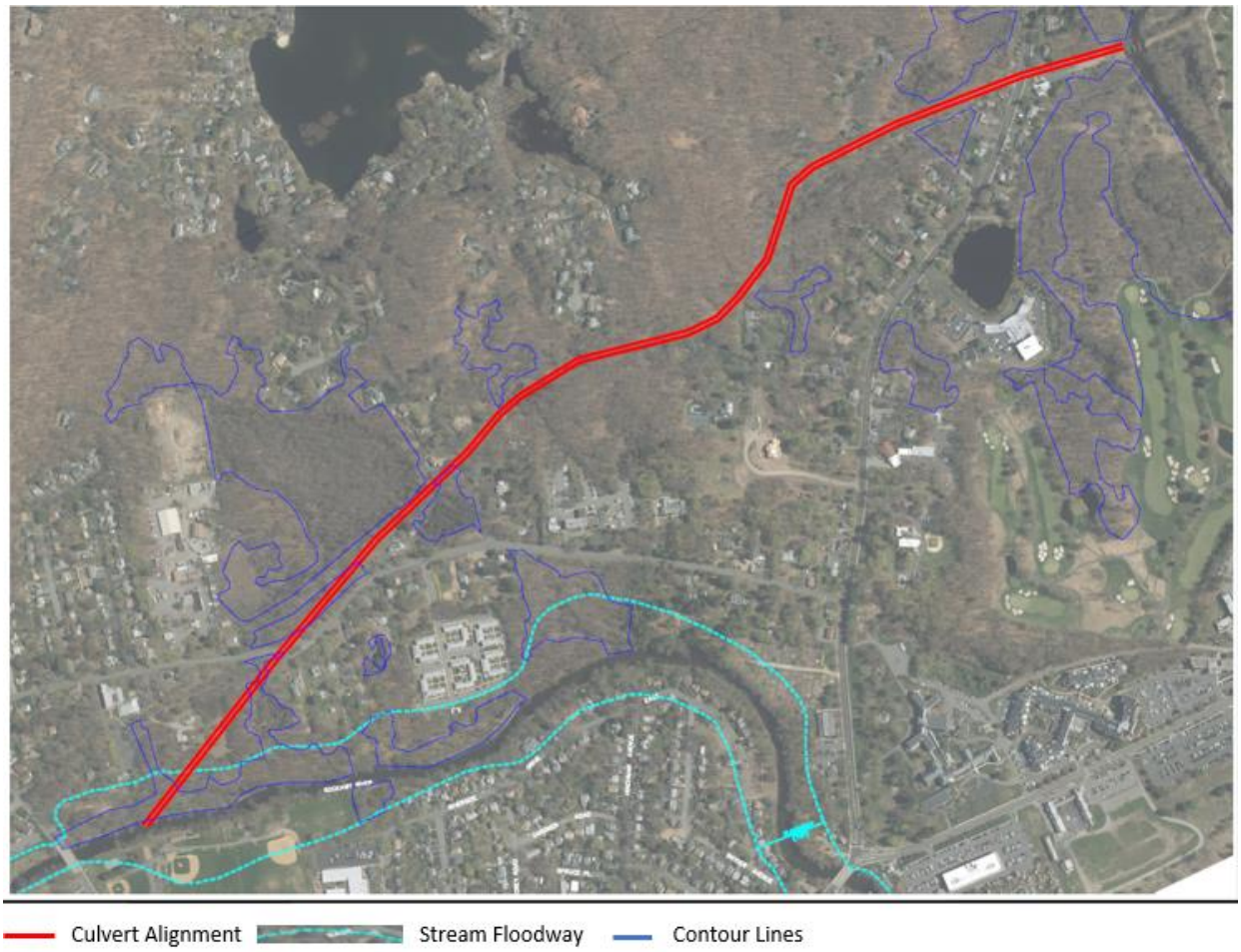

Figure 4-10: Alternative 3: Culvert Bypass Location

4.2.4. Alternative 4: Nonstructural Treatments

A nonstructural alternative is one in which the physical mechanism and extent of flooding is largely unchanged but the existing buildings within the floodplain are adapted, or the regulatory framework that governs new development is modified to reduce the damage incurred during flood events. The analysis of nonstructural treatments considered three physical measures with a combination of relocation and various nonphysical measures such as evacuation plans, land use regulation, flood emergency preparedness plans, flood insurance, flood mapping, flood warning systems, risk communication, and zoning. The three physical measures can be described under the following:

- Elevation: For this study, elevation refers to increasing the height of the foundation of a structure at least equal to or greater than the design flood elevation to reduce damages from flooding. Elevation can be performed using fill material, on extended foundation walls, on piers, post, piles, or columns. Elevation is also a very successful technique for reinforced concrete slab-on-grade structures.

- Dry floodproofing: Dry floodproofing allows floodwater to reach the structure but reduces the flood damage by preventing water from getting inside the structure by sealing openings, installing

watertight barriers, and waterproofing exterior walls. Structures with foundation types that did not allow for elevations or wet floodproofing could be protected with dry floodproofing. In some instances, the dry floodproofing offered risk reduction during more infrequent storms (2 percent and 1 percent AEP).

- Wet floodproofing: This is generally applied to structures with a main floor elevation already above the design storm, but that would still incur significant damages due to the presence of basements and vulnerable utilities. This measure allows floodwater to enter lower, non-living space areas via vents and openings to reduce the effects of hydrostatic pressure and reduce flood-related damages to the foundation of the structure. Vulnerable utilities are raised or relocated above flood elevations. As floodwaters recede, any remaining water is pumped out of the structure.

An iterative process was performed to refine the nonstructural plan and arrive at the selected plan for nonstructural measures. First, the 372 structures within the 1 percent AEP floodplain were grouped into clusters by neighborhood blocks, generally bounded by roads, as they shared similar flood characteristics within the study area. A matrix from the USACE National Nonstructural Committee (NNC) was utilized to develop proposed nonstructural measures to be applied to the structures. The Benefit-Cost Ratio (BCR) for each cluster was computed for various LOPs and the clusters with negative net benefits were dropped, which included 227 structures. The structures within the seven clusters that remained (showed positive net benefits in the first iteration) were further evaluated. The seven clusters were named Southwest, Center, North Riverside Drive, North, Hinchman-Snyder, South, and Southeast and are shown in Figure 4-12. A summary description of each cluster is provided, with additional information in Appendix D: Economics.

The costs and benefits for each cluster were refined in coordination with the NNC, and annualized costs and benefits of nonstructural measures were redeveloped for the remaining seven clusters. The clusters were then aggregated by various levels of protection: 10 percent AEP, 4 percent AEP, and 2 percent AEP, which produced the three iterations of Alternative 4. Once overall BCRs were developed for the nonstructural alternatives, the structures in the seven clusters were optimized per USACE policy as discussed in Section 4.5. The purpose of the optimization was to reasonably maximize the net benefits of a proposed Recommended Plan.

Construction costs were developed for all the nonstructural measures based upon a previous USACE project in Somerset County, New Jersey. The cost estimates were based on the attributes of each structure in the structure inventory and are based on the square footage of the structure, type of foundation, foundation height, number of stories, and type of FRM measure proposed for each structure.

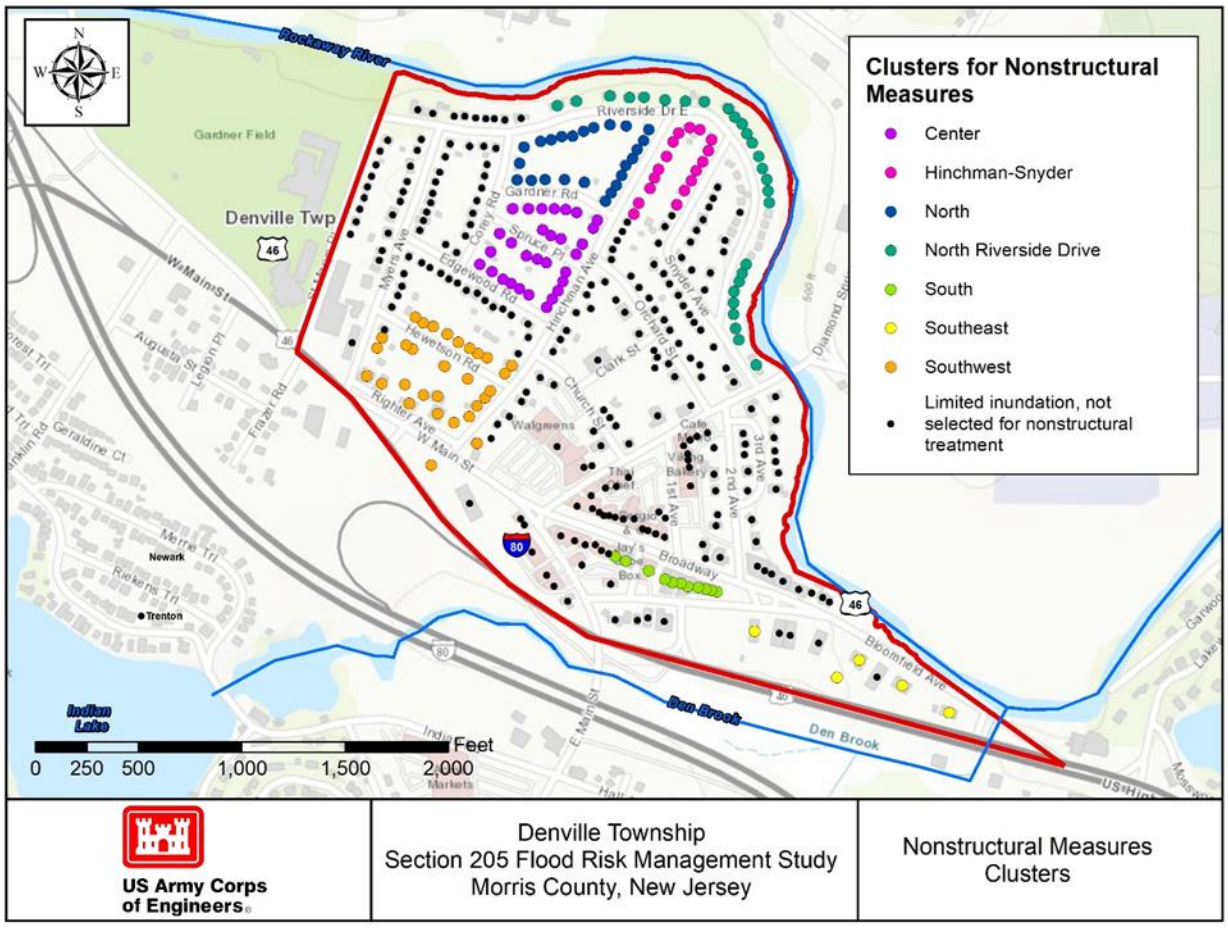

Figure 4-12: Nonstructural Clusters

4.3. Evaluation and Comparison

4.3.1. Alternatives Screening

A total of 13 action alternatives and a no action alternative were formulated in consideration of study area problems and opportunities, as well as study goals, objectives, and constraints with 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.
- Effectiveness is the extent to which an alternative plan alleviates the specified problems and achieves the specified opportunities.
- Efficiency is the extent an alternative plan is the most cost-effective means of alleviating the specified problems and realizing the specified opportunities, consistent with protecting the Nation's environment.
- Acceptability is 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.

It was determined that all 10 structural alternatives discussed above, as well as non-structural alternatives at 3 levels of protection, and the no action alternative met the criteria of completeness, effectiveness, efficiency, and acceptability. No alternatives were eliminated from consideration at this point.

In the 1970 Flood Control Act, Congress identified four accounts for use in water resources development planning: NED, Regional Economic Development (RED), Environmental Quality (EQ), and Other Social Effects (OSE). For this study, these benefits are measured by looking at the changes between the future with project (FWP) and FWOP conditions. The RED, EQ, and OSE were examined using available qualitative information detailed in this section. The four accounts are described in this section and the evaluation is detailed later in this report.

- **National Economic Development (NED)–**- Contributions to NED are increases in the net value of the national output of goods and services, expressed in monetary units. Contributions to NED are the direct benefits that accrue in the planning area and the rest of the nation. Contributions to NED include increases in the net value of those goods and services that are marketed, and also that may not be marketed.
- **Regional Economic Development (RED)**–- The RED account registers changes in the distribution of regional economic activity that result from each alternative plan. Two measures of the effects of the plan on regional economies are used in the account: regional income and regional employment.
- **Environmental Quality (EQ)**–- Beneficial effects in the EQ account are favorable changes in the ecological, aesthetic, and cultural attributes of natural and cultural resources. Adverse effects in the EQ account are unfavorable changes in the ecological, aesthetic, and cultural attributes of natural and cultural resources.
- **Other Social Effects (OSE)**–- The OSE account is a means of displaying and integrating into water resource planning information on alternative plan effects from perspectives that are not reflected in the other three accounts. The categories of effects in the OSE account include the following: community/economic vitality; life, health, and safety factors; impacts to socially vulnerable populations; social connectedness, community identity, resiliency, participation, and leisure and recreation.

4.3.2. National Economic Development (NED)

The NED evaluation was completed to compare benefits and costs of FRM alternatives in monetary terms. Benefits and costs were calculated for the 13 action alternatives examined in this study (Table 4-1). The benefits were calculated using HEC-FDA software for the base year and future years with each alternative in place, and EAD were calculated for the 50-year period of analysis, using the 2021 fiscal year (FY) USACE project evaluation discount rate of 2.50 percent. Similarly, with-project (2026) and future with-project hydraulic conditions (2075) were used to compute equivalent annual benefits over a 50-year project life using an interest rate of 2.50 percent.

The equivalent annual benefits were then compared to the average annual costs to develop net benefits and a BCR for each alternative. The net benefits for each alternative were calculated by subtracting the average annual costs from the equivalent average annual benefits (AAB). A BCR was derived by dividing

average benefits by average annual costs (AAC). Net benefits were used in conjunction with a BCR above 1.0 to identify the NED plan, which is the one that maximizes net benefits. For comparative purposes, Table 4-1 summarizes the equivalent annual benefits, AAC, net benefits, and the BCR for each alternative.

For projects to be considered in the federal interest for construction, project benefits must be greater than the costs of project implementation, creating a BCR greater than one. Table 4-1 details the evaluation of all 13 alternative plans by comparing the annualized costs with the annualized benefits. The 10 structural alternatives were screened because they have negative net benefits and a BCR below parity. When screening the alternatives in this study, Alternative 4a – 4c, the nonstructural alternatives were the only alternatives to return positive net benefits and a BCR greater than 1.0. All LOPs for nonstructural plans in Alternatives 4a–- 4c had positive net benefits and BCRs above parity. In consultation with the non-Federal sponsor, Alternative 4b – Nonstructural Plan to 4 percent AEP was identified as the NED Plan as it maximizes net benefits as shown in Table 4-1 and was carried forward for optimization and further analysis. For further description of the Plan Evaluation and Comparison process see Appendix D: Economics.

Table 4-1: Summary of Benefits, Costs, and BCR for each Alternative

Plan	Damage Reach	Annual Benefits by Reach	Annual Benefits by Plan	Total Cost by Plan	Annual Cost by Plan	Net Benefits by Plan	BCR*
Alt-1a: 1% AEP LOP With 10 Stop Log Structures	Den Brook	$205,000	$937,000	$90,930,000	$3,206,000	($2,269,000)	0.29
	Upper Rockaway	$937,000					
Alt-1b: 1% AEP LOP With 6 Stop Log Structures	Den Brook	$205,000	$937,000	$88,405,000	$3,117,000	($2,180,000)	0.30
	Upper Rockaway	$732,000					
Alt-1c: 2% AEP LOP With 10 Stop Log Structures	Den Brook	$162,000	$850,000	$77,457,000	$2,731,000	($1,881,000)	0.31
	Upper Rockaway	$688,000					
Alt-1d: 2% AEP LOP With 6 Stop Log Structures	Den Brook	$162,000	$850,000	$74,990,000	$2,644,000	($1,794,000)	0.32
	Upper Rockaway	$688,000					
Alt-1e: 4% AEP LOP With 8 Stop Log Structures	Den Brook	$119,000	$674,000	$66,510,000	$2,345,000	($1,671,000)	0.29
	Upper Rockaway	$555,000					
Alt-1f: 4% AEP LOP With 4 Stop Log Structures	Den Brook	$119,000	$674,000	$64,099,000	$2,260,000	($1,586,000)	0.30
	Upper Rockaway	$555,000					
Alt-2a: Combination of Road raising and Floodwall	Den Brook	$48,000	$454,000	$24,817,000	$875,000	($421,000)	0.52
	Upper Rockaway	$406,000					
Alt-2b: Combination of Road raising and Floodwall	Den Brook	$78,000	$924,000	$28,788,000	$1,015,000	($91,000)	0.91
	Upper Rockaway	$846,000					
Alt-2b Sensitivity Analysis: Combination of Road raising and Floodwall	Den Brook	$78,000	$922,000	$28,589,000	$1,008,000	($86,000)	0.91
	Upper Rockaway	$844,000					
Alt-3: Bypass Culvert	Den Brook	$10,000	$473,000	$59,589,217	$2,163,000	($1,690,000)	0.22
	Upper Rockaway	$463,000					
Alt-4a Nonstructural: 10% AEP (10 Year)[1]	All	$26,462,000	$933,000	$8,411,000	$297,000	$636,000	3.14
Alt-4b Nonstructural: 4% AEP (25 Year)[1]	All	$35,368,000	$1,247,000	$16,110,000	$568,000	$679,000	2.20
Alt-4c Nonstructural: 2% AEP (50 Year)[1]	All	$36,389,000	$1,238,000	$18,257,000	$644,000	$639,000	1.99

**Each alternative was also analyzed based on comprehensive benefits (Section 4.4), but found them insufficient to justify the projects*

***Analysis completed in FY 2021 using the 2021 fiscal year (FY) discount rate of 2.50 percent.*

[1]Nonstructural plans include costs associated with acquisition and administration of easement agreements in accordance with USACE policy.

4.3.3. Regional Economic Development (RED)

The RECONS 2.0 model was used to estimate RED benefits for the nonstructural plan in the Township of Denville. A total cost of $19,045,000 used as input into the RECONS model based on the nonstructural plan optimized later in the study. This RED analysis, using RECONS, employs input-output economic analysis, which measures the interdependence among industries and workers in an economy. This analysis uses a matrix representation of a region's economy to predict the effect of changes, the implementation of a USACE project, to the various industries that would be impacted. The greater the interdependence among industry sectors, the larger the multiplier effect on the economy. Direct effects represent the impacts the new federal expenditures have on industries that directly support the new project. Labor and construction materials are direct components to the project. Indirect effects represent changes to secondary industries that support the direct industries.

Of the total expenditures, 99 percent will be captured within the local study area. The remainder of the expenditures will be captured within the state or national level. These direct expenditures generate additional economic activity, often called secondary or multiplier effects. The direct and secondary impacts are measured in output, jobs, labor income, and gross regional product (value added) as summarized in Table 4-2. The construction stimulus in the Township of Denville would generate 284 full-time equivalent jobs, $28,541,052 dollars labor income, and $51,221,903 dollars output at the national level.

RED changes are factors that have an impact on the local Denville economy but may not have wider effects in the outside region. A significant factor in this account is local businesses' revenue and job gain or loss as well as future business prospects. Localized flood events could lead to closure of businesses creating a loss in revenue for the business and income for its employees. Road and bridge closure due to flooding may also contribute to revenue/income loss for the area from the decreased ease of travel in and out of the study area. Flood prone areas are also much less attractive for potential new companies who want to move in and would bring employment opportunities with them. Preserving a tax base is also an important contributor for local economies and keeping viable industries and workforce sustained is a large factor in contributing to that goal. As discussed earlier in this report, the township saw many people leave the area following large flood events that caused severe damage. Losses like this cause a reduction in the employment and tax base in the study area.

Table 4-2: Summary of Regional Economic Development Impacts of the Recommended Plan

Area	Local Capture	Output	Jobs	Labor Income	Value Added
Local					
Direct Impact		$18,980,628	110	$17,266,628	$16,215,189
Secondary Impact		$18,517,595	83	$7,277,543	$12,224,544
Secondary Impact	$18,980,628	$37,498,223	193	$24,544,171	$28,439,733
State					
Direct Impact		$18,980,628	121	$17,379,640	$16,215,189
Secondary Impact		$21,453,263	102	$8,021,794	$13,464,241
Total Impact	$18,980,628	$40,433,891	223	$25,401,434	$29,679,430
US					
Direct Impact		$19,016,152	132	$17,965,575	$16,234,920
Secondary Impact		$32,205,751	152	$10,575,477	$18,105,221
Total Impact	$19,016,152	$51,221,903	284	$28,541,052	$34,340,141

4.3.4. Environmental Quality (EQ)

Environmental quality can include factors such as ecosystem restoration, habitat creation, and endangered species protection. Cultural resources are also included in this account such as historic buildings and preservation sites. When compared to other plan alternatives presented in this report, the selected nonstructural plan has little effect on the environment in the Township of Denville as changes will be made to the structures affected and not the surrounding floodplain area. The nonstructural plan would be an effective measure to protect culturally or historically important buildings in the study area and while optional, the owners of these types of buildings may be more inclined to participate to preserve their cultural status.

Heathy Community Planning New Jersey (HCP-NJ) data show concerns to Air Cancer Risk, Surface Water Quality, and Flooding that have the respective indicators 132, 71, and 11.7 in the Township of Denville (Table 4-3). The nonstructural plan selected will have a minor contribution of improving environmental quality of the community.

Table 4-3: Environmental Indicators

Environmental Indicators	Units	Time Period	The Township of Denville	Morris County	County Comparison[1]
Air Cancer Risk	Risk per Million	2017	132	115	49
Air Non Cancer	Combined Hazard Index	2017	2.1	1.7	64
Air Quality Index (AQI)	Days AQI above 100 (3 year Avg)	2018 to 2020	3.5	3.4	49
Community Drinking Water	Number of MCL, TT and AL exceedances(3 year)	2019 to 2021	0	8	0
Private Wells	% of Private Wells above Primary Standard	2002 to 2018	5.4	6.5	32
Ground Water/Soil	% Area Restricted Use	2022	0.5	4.7	41
Surface Water Quality	% Designated Uses Not Supported	2016	71.0	74.6	46
Flooding (Urban Land Cover)	% Urban Land Use Area Flooded	2021	11.7	6.1	84
Air Permit Sources	Sites per Sq Mile	2022	1.02	0.55	62
Combined Sewer Overflow	Number per Town	2019	0	0	0
Brownfield Development Areas	Number per Town	2019	0	0	0
Contaminated Sites	Sites per Sq Mile	2022	1.99	1.16	64
Scrap Metal Facilities	Sites per Sq Mile	2022	0.04	0.03	77

The numbers in the last three columns are numeric results for each indicator

[1] The county comparison column compares the municipality to all other municipalities in their county and presents the comparison as a percentile of all municipalities in the county.

4.3.5. Other Social Effects (OSE)

4.3.5.1. Life Loss

The other social effects (OSE) account includes impacts to life safety, vulnerable populations, local economic vitality, and community optimism. Impacts on these topics are a natural outcome of civil works projects and are qualitatively discussed. HEC-FIA and HEC-LifeSim modeling software quantify loss of life for alternatives, especially the structural alternatives, to determine if life safety risk decreases or increases as a result of federal investment. Hence, only the qualitative assessment was evaluated for the Township of Denville study.

The potential for flooding creates a life safety risk for people working in, living in, or passing through an affected area such as the Township of Denville. The population of the Township of Denville was around 18,000 people as of 2020. With limited warning time, the potential for life loss is present in the study area due to the concentration of homes and businesses along the path of the rivers. There are also risks associated with hindered deployment and cost of emergency vehicles from a flood event. While those affected will need to voluntarily participate in the nonstructural treatment, those who do should gain from the investment in the form of increased structure value. A structure that is protected from flood is likely to yield a higher value than one that is vulnerable to a flood event. Conversely, those that choose not to participate in nonstructural treatment may see a reduction in structure value or have the

increased cost of flood insurance making it a less attractive option. Any implemented plan to reduce flood risk minimizes many of these risks.

4.3.5.2. Health and Safety

The health and safety of people living in the community within the project area were considered. Heathy Community Planning New Jersey (HCP-NJ) was used to assess social vulnerability of the population in the Township of Denville, New Jersey. Some indicators that have concerns in the recent years are Heart Attack, Cancer Deaths Stroke, Childhood Blood Lead, and Heat Related Illness, and were compared to the Morris County statistics as shown in Table 4-4.

Table 4-4: Demographics and Public Health Indicators

Demographics and Public Health Indicators	Units	Time Period	Denville Township	Morris	County Comparison[1]
Poverty	% Under 2 times Poverty	2016 to 2020	10.2	12.1	46
Minority	% Minority	2016 to 2020	19.4	29.5	41
Health Insurance	% with no Insurance	2016 to 2020	3.9	4.5	56
Low Birth Weight	% All Births < 5 lb, 8 oz	2016 to 2020	4.0	6.1	BELOW
Childhood Blood Lead	% Children tested > 5 µg/dL	2019 (SFY)	N/A	1.1	SUPPRESSED
Asthma (ED)	Age Adjusted Rate per 10,000	2016 to 2019	19.9	24.7	NO DIFFERENCE
Heart Attack (AMI) (IP)	Age Adjusted Rate per 10,000	2016 to 2019	16.1	12.5	ABOVE
Heart Disease Deaths	Age Adjusted Death Rate per 100,000	2015 to 2019	174.9	140.3	ABOVE
COPD (ED)	Age Adjusted Rate per 10,000	2016 to 2019	16.4	16.4	NO DIFFERENCE
Stroke (IP)	Age Adjusted Rate per 10,000	2016 to 2019	18.1	16.2	NO DIFFERENCE
All Cancer Deaths	Age Adjusted Death Rate per 100,000	2015 to 2019	143.6	131.5	NO DIFFERENCE
Lung Cancer Deaths	Age Adjusted Death Rate per 100,000	2015 to 2019	35.9	27.5	NO DIFFERENCE
Smoking	% of Adults	2018	11.7	12.4	NO DIFFERENCE
Obesity	% of Adults	2018	25.9	26.3	NO DIFFERENCE
Heat Related Illness (ED)	Age Adjusted Rate per 10,000	2016 to 2019	SUPPRESSED	0.6	SUPPRESSED

The numbers in the last three columns are numeric results for each indicator

[1] The county comparison column compares the municipality to all other municipalities in their county and presents the comparison as a percentile of all municipalities in the county, except for public health indicators where rates are compared. For a few indicators, where the numbers are too small for percentiles to be relevant, the indicator for the entire county is shown, if available.

4.3.6. Identification of the NED Plan

Based on the analysis detailed in Table 4-1, the 10 structural alternatives were screened because they have negative net benefits and a BCR below parity. The nonstructural alternatives, Alternative 4a – 4c, were the only alternatives to return positive net benefits and a BCR greater than 1.0. All LOPs for

nonstructural plans in Alternatives 4a–- 4c had positive net benefits and BCRs above parity. Alternative 4b – Nonstructural Plan to 4 percent AEP was identified as the NED Plan as it reasonably maximizes net benefits in accordance with the Federal objective and was carried forward for optimization and further analysis.

4.3.7. Identification of the Total Benefits Plan

The evaluation of the four accounts is summarized in Sections 4.3.2 to 4.3.5 and Appendix D: Economics. A review of the RED, EQ, and OSE accounts found no significant variation in benefits in these accounts between the alternative plans; therefore, qualitative information was used to assess the differences between the plans. This analysis concluded that no structural plans are likely to be justified based on comprehensive benefits. This study identified the NED Plan, but no total benefits plan was identified as at the time of selection of the TSP in 2020 as policy did not include guidance for selection of a plan based on total benefits.

4.3.8. Identification of the Tentatively Selected Plan (TSP)

The evaluation and comparison of alternatives is detailed in this section. The NED Plan was identified as Alternative 4b Nonstructural Plan to 4 percent AEP and is also identified as the TSP in accordance with the federal objective. The TSP was further optimized to identify the LOP that maximizes net benefits for each cluster as described in Section 4.3.9. Note that overall Alternative 4b maximizes net benefits, but plan optimization and further evaluation was used to identify LOPs for nonstructural measures in each cluster therefore the LOP for all structures were not selected on the 4 percent AEP in the Recommended Plan. See Appendix D: Economics for more information.

4.4. Optimization of the Tentatively Selected Plan (TSP)

During the initial analysis and to develop preliminary BCRs, the nonstructural plan was developed using the 4 percent AEP, but during optimization as described in Section 5 each cluster was analyzed to determine the most efficient aggregation of structures using three aggregations: 10 percent AEP, 4 percent AEP, and 2 percent AEP. For those structures where elevation was identified as the most effective measure, the 1 percent AEP was used to determine the cost of elevating the structure because the incremental cost of raising is relatively low. For the remaining structures, dry or wet floodproofing was more appropriate based on flood risk. Dry floodproofing is limited to flooding of less than 3 feet. Floodproofing can minimize but will not eliminate flood damages to the structure and may require cleanup and maintenance. Updated costs for the TSP were provided by USACE Cost Engineering staff in coordination with the NNC. This update indicated an approximate 15 percent increase in costs. See Appendix D: Economics for further information.

To ensure that the economic damages reduced by the TSP reasonably maximize net benefits, the factors that could be optimized in support of the TSP were analyzed during the study review process. These factors include the aggregation of structures in the economic analysis, elevation height, and floodproofing effectiveness.

In compliance with Planning Bulletin 2019-03, all nonstructural analyses will formulate and evaluate measures and plans using a logical aggregation method. The logical aggregation method utilized for the Township of Denville study used flood depths relative to first floor elevation for various probability events. This method was determined to be logical because it excludes previous critiques of economic analysis, namely prioritizing high property value structures and excluding low-income populations that typically reside in smaller homes with a lower structure value. The logical aggregation method utilized is not biased to structure size, value, or any other economic attribute. Instead, it is based on being flood-prone, and therefore treats the study area more equitably relative to studies that use a logical aggregation focused on maximizing individual structure's net benefits.

Once the logical aggregation method was determined (using flood depths relative to first floor), the USACE Planning Guidance Notebook specifies that net benefits must be reasonably maximized, meaning the aggregation method must also be optimized. The aggregation method sorted all structures within the study area by existing condition depth of flooding, which was sourced from the hydraulic model. Three different depth of flooding thresholds, other than the 1 percent AEP that contains 89 nonstructural treatments, were utilized to determine which aggregation method maximized net benefits. These depth thresholds were the 10 percent AEP, 4 percent AEP, and 2 percent AEP flood frequencies. A total of 28, 55, and 63 structures were found in the 10 percent, 4 percent and 2 percent AEP floodplains respectively. Every structure with a depth of flooding greater than zero for each depth threshold was included in the three depth threshold aggregations. The aggregation optimization analysis followed the same assumptions described in Appendix D: Economics and the HEC-FDA model was re-run to reflect the nonstructural measure for each structure in the aggregation.

The results in Table 4-1 show that the net benefits are optimized in the Nonstructural 4 percent AEP aggregation. Since neither bracket (10 percent AEP, 2 percent AEP, or 1 percent AEP) of the optimization exceeded the net benefits of the 4 percent AEP aggregation, and the net benefits are negative for all the structural alternatives, it was determined that the 4 percent AEP aggregation would be used for optimization. As a result of the comparison of the alternatives, Alternative 4b Nonstructural Plan to the 4 percent AEP was identified as the TSP and NED. Alternative 4b Nonstructural Plan to the 4 percent AEP yielded the highest net benefits with a BCR greater than 1.0.

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5. The Recommended Plan

5.1. Description of the Recommended Plan

The alternative that offered the highest net benefits is Alternative 4b Nonstructural Plan to 4 percent AEP and was therefore identified as the Recommended Plan. USACE then began a detailed feasibility analysis of the Recommended Plan within each cluster to optimize project dimensions that would maximize net benefits as summarized in Appendix D: Economics. All seven clusters were evaluated using LOPs ranging from the 10 percent AEP to the 0.5 percent AEP flood event. The detailed analyses included a structure-by-structure assessment as to what type of measure would be most appropriate for each structure (elevation, wet or dry floodproofing), and what level of protection would be most appropriate. Following plan optimization, the Recommended Plan was selected by using the aggregation that produced the highest net benefits for each cluster based on the updated costs including real estate easement costs (see Appendix E: Real Estate Plan). Only five of the seven clusters returned BCRs above parity and positive net benefits and were retained as part of the study's evaluation (Table 5-1). As the total project costs for the five clusters with positive net benefits exceeds the $10 million federal per project limit of the CAP Section 205 program authority, USACE is recommending a prioritized implementation strategy for the Recommended Plan to include clusters with the highest flood risk with a total project cost within the program's implementation authority. Therefore, the Recommended Plan was developed by selecting the three clusters with the highest flood risk: North, North Riverside, and Southwest.

Table 5-1: Final Aggregation by Cluster

Cluster	Raise	Floodproof (Wet/Dry)	Total Nonstructural Plan Costs[1]	Average Annual Costs[2]	Average Annual Benefits	BCR[2]	Net Benefits[2]
North	11	1	$4,060 - $5,230	$184	$244	1.33	$60
North Riverside	13	1	$5,313 - $6,625	$234	$503	2.15	$269
Southwest	6	6	$5,668 - $7,190	$254	$405	1.59	$151
Recommended Plan Total	30	8	$15,041 - $19,045	$672	$1,153	1.72	$481
Center	10	2	$5,125	$181	$243	1.34	$62
Southeast	0	4	$2,716	$96	$130	1.35	$34
Hinchman Snyder	6	7	$4,786	$169	$111	0.66	-$58
South	0	8	$5,047	$178	$107	0.60	-$71

Note: Dollars shown in thousands. Rows highlighted in blue constitute the Recommended Plan
Nonstructural plans include costs associated with acquisition and administration of easement agreements in accordance with USACE policy.
**Analysis completed in FY 2023 using and are shown in October 2022 (FY 2023) price levels and use a discount rate of 2.50 percent.*
[1]Total nonstructural plan costs for the Recommended Plan includes a low estimate ($15M) based on total project cost that includes the administrative cost of obtaining easement agreements but does not include compensation to property owners for real property interest that are acquired. The high end of the estimated cost range ($19M) includes the administrative cost of LERRD acquisition plus additional compensation to property owners for the real property interests acquired in the easement agreement. This cost range presents a

range of potential implementation costs associated with the Recommended Plan and will be updated during the design and implementation of the project as USACE policy for nonstructural plans evolves. Note that only the Recommended Plan total costs were revised after plan selection to reflect this range.
[2]Average annual costs, BCR, and net benefits are estimated based on the total project cost including easement costs in accordance with existing USACE policy. This represents the high end of the range of costs and may be updated in the future based on evolving USACE policy for nonstructural plans.

The Recommended Plan consists of nonstructural measures in a total of 38 residential and commercial structures that include elevation, wet floodproofing, and dry floodproofing. A total of 30 structures were identified for elevation, 2 structures for wet floodproofing, and 6 structures for dry floodproofing (Table 5-2). The total project cost for the Recommended Plan is between $15.0 and $19.0 million, which reflects a range of design and implementation costs. The low end of that range ($15M) assumes that property owners who elect to participate and have nonstructural measures implemented on their property will be required, as a condition of eligibility, to contribute the requisite easement without a payment from the project. The higher end of the range ($19M) includes estimated costs for easements if donations are not required. The CAP Section 205 authority is cost shared 65 percent federal, 35 percent non-Federal. The non-Federal sponsor for project implementation must cover all costs beyond the $10 million federal per project statutory limit of the CAP Section 205 program.

The total project cost for the Recommended Plan is between $15.0 and $19.0 million assuming a 100 percent participation rate. Experience from similar projects indicates that 100 percent participation is unlikely, and the actual cost will be lower and fall within the statutory limit of the CAP 205 program authority. Net benefits are maximized for the Recommended Plan with annualized net benefits of $481,000 and a BCR of 1.72 in October 2022 (FY 2023) price levels and use a discount rate of 2.5 percent. The NJDEP and the Township of Denville have indicated support for this plan. The Township of Denville submitted a letter on March 3, 2023 starting that they will be willing to serve as the non-Federal sponsor for design and implementation of this project.

Although the Recommended Plan was based on structures within the 4 percent AEP floodplain, all elevated structures will be raised to the 1 percent AEP flood level plus 1 foot. The floodproofed structures will be protected to a level of 3 feet above ground level due to the structural limitations of floodproofing. This equates to 1 percent AEP level protection for the floodproofed structures.

Table 5-2: Number of Structures Receiving Treatment

Mitigation Measure	Total # of Structures Impacted	Residential	Non-residential
RECOMMENDED PLAN – NORTH, NORTH RIVERSIDE & SOUTHWEST CLUSTERS			
Elevation	30	28	2
Wet Floodproofing	2	2	0
Dry Floodproofing	6	0	6
RECOMMENDED PLAN TOTAL	**38**	**30**	**8**

**The number of structures in the Recommended Plan may change as USACE guidance for nonstructural plan evolves. Therefore, the number of eligible structures and proposed measures may be revised as additional analysis is completed during the design and implementation of this project, particularly if assumptions regarding participation rates are revised. See additional information provided below.*

Currently, the total project cost in this IFR/EA includes easement agreement costs to allow for the installation, construction, maintenance, and operation of the various voluntary nonstructural treatments in buildings within the Recommended Plan in compliance with existing USACE policy. This IFR/EA also relied on general assumptions related to participation rates, implementation strategy, contracting approach, and requirements related to the terms of conditions for participation in USACE nonstructural plans. However, USACE policy for nonstructural plans is evolving. It is anticipated that the policy under development will require that, as a condition of participation in a nonstructural floodproofing or elevation project, the property owner must agree to provide an easement to the non-Federal sponsor without additional compensation for that property interest. These easement agreements will allow for installation of the nonstructural measures and provide rights for inspection and maintenance by the non-Federal sponsor. The easements are also expected to include future use restrictions prohibiting human habitation below the base target elevation, prohibiting new structures, additions, or renovations to existing structures below the target elevation, prohibiting installation of mechanical systems below the target elevation, and prohibiting alterations of the topography that may change the flow patterns or flood retention characteristics of the property. Therefore, the Recommended Plan may be revised as a result of additional analysis required by USACE policy that will result in changes in total project costs, participation rates, eligibility requirements, the total number of structures being recommended, contracting approach, and the overall implementation strategy. Even with these anticipated changes, the Recommended Plan is estimated to be$19.0 million or less.

The changes to total costs and participation rates will have broader implications for selection of individual buildings and clusters for nonstructural measures in the Recommended Plan. This Draft IFR/EA details five clusters in the Denville Study with positive net benefits (Section 5) and are therefore economically justified for federal participation as part of this project: North, North Riverside, Southwest, Center, and Southeast. These five clusters consist of a total of 54 buildings with recommendations for nonstructural measures in the Township of Denville– 40 for elevation and 14 for floodproofing. The Final IFR/EA will reflect changes to the total number of structures and clusters in the Recommended Plan that may include consideration of measures for all 54 buildings within these five clusters. While there may be

overall changes to the Recommended Plan in the Final IFR/EA as a result of public comment or additional analysis, these changes are not anticipated to substantively impact the environmental evaluation and conclusions in the National Environmental Policy Act (NEPA) documentation included in the Draft IFR/EA being released for public comment as the Draft IFR/EA has already considered and evaluated potential impacts to all 54 structures being considered for implementation in the Denville Study.

The implementation of this project as detailed in this Draft IFR/EA assumed that construction methods would be similar to those described in FEMA (2014) and the USACE 2016 "Leonardo, Raritan Bay, and Sandy Hook Bay, New Jersey Coastal Storm Risk Management Study." Project construction would not be technically complex, and work at each individual structure would be localized.

During the elevation process, most frame, masonry veneer, and masonry homes are separated from their foundations, physically lifted and raised on hydraulic jacks, and held by temporary supports while a new or extended foundation is constructed below. When homes are lifted with this technique, the new or extended foundation can consist of continuous walls or separate piers, posts, columns, or piles. The method used depends largely on construction type, foundation type, and flooding conditions (FEMA, 2014).

Wet floodproofing techniques include raising utilities and important contents to or above the flood protection level, installing and configuring electrical and mechanical systems to minimize disruptions and facilitate repairs, installing flood openings or other methods to equalize the hydrostatic pressure exerted by floodwaters, and installing pumps to gradually remove floodwater from basement areas after the flood. Wet floodproofing requires a variety of modifications to a structure, including its walls, construction and finishing materials, and service equipment (FEMA, 2014).

Dry floodproofing involves completely sealing the exterior of a building to prevent the entry of floodwaters. Dry floodproofing seals all openings below the flood level and relies on the walls of the building to keep water out. Even if a structure is dry floodproofed, water can still seep through small openings in the sealant system or through the gaskets of shields that are protecting openings (doors and windows). Internal drainage systems, utilizing sump pumps, are required to remove any water that has seeped through and to remove water collected from any necessary underdrain systems in the below-grade walls and floor of the structure (FEMA, 2014).

Each of these methods (elevation, wet floodproofing, dry floodproofing) could require transport of construction equipment and material to the structure, local excavation, and soil disturbance, import of fill material, utility disconnection/reconnection, and removal of excavated material and construction debris.

Neither dry nor wet floodproofing would increase the structure footprint nor cause an increase in water surface elevations during flood events. Following implementation of nonstructural measures, residual risk would remain; therefore, it is critical that local residents evacuate promptly during significant storm

events. The Township of Denville has existing procedures for mandatory evacuation of residents living in flood prone areas to the Townships' Emergency Shelter at Lakeview Elementary School. The egress route from the township's flood prone areas and shelter location are not impacted by FRM measures proposed in this feasibility study. More details are available in Appendix G: Nonstructural Implementation Plan.

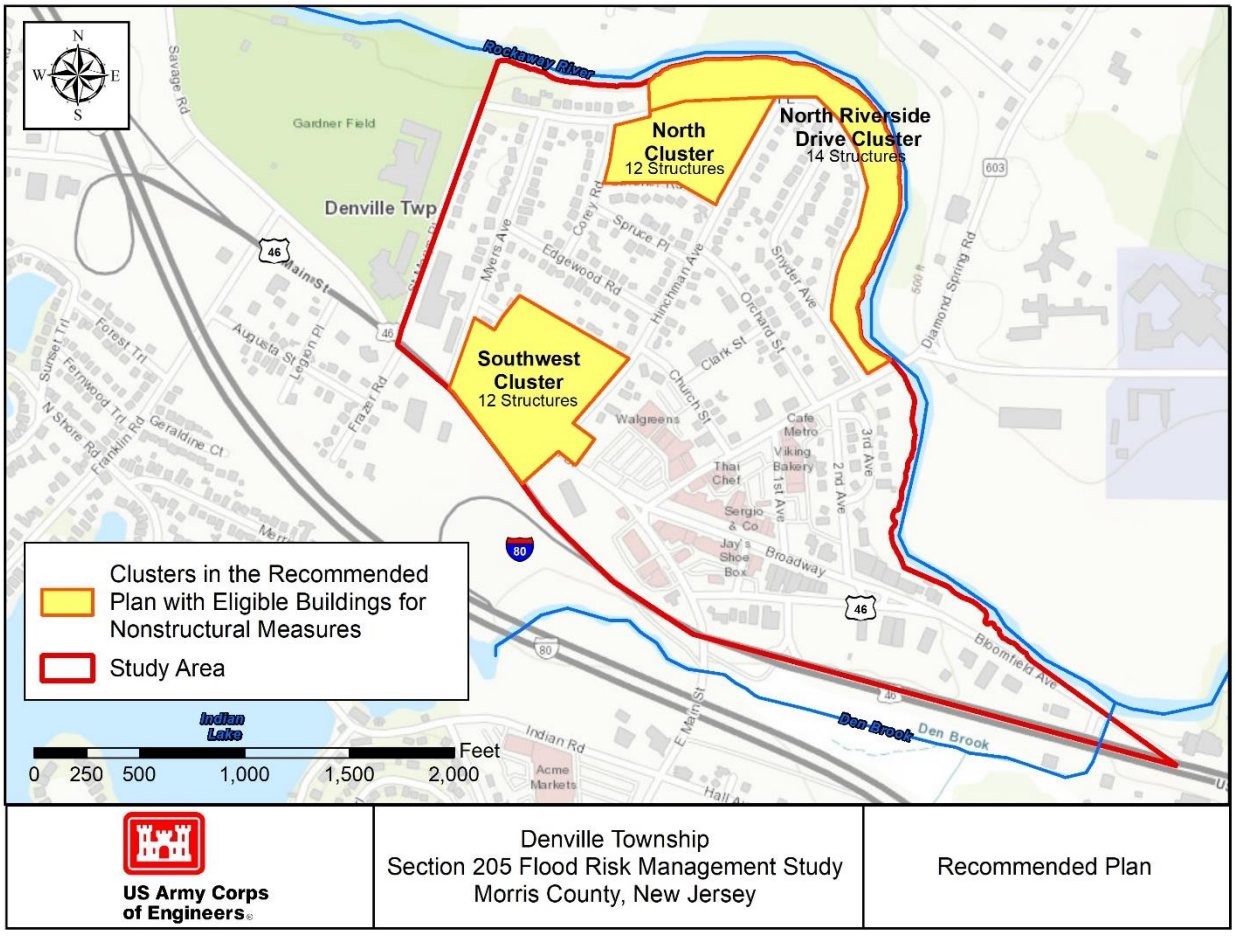

Figure 5-1: Recommended Plan Map

5.2. Nonstructural Participation Rate Estimation

A nonstructural participation rate sensitivity analysis was performed to describe the uncertainty of a voluntary risk reduction program's effects on the net benefits, the BCR, and the total project cost. Initially, as preliminary BCRs were being calculated and a TSP was being identified, the assumption was made that 100 percent of structure owners within each cluster would participate in implementation of a nonstructural measure. As this is an unrealistic assumption, USACE used the USACE NNC's Best Practice Guide 03 (BPG 2020-03), which provides guidance on how to compute various participation rates, to conduct a sensitivity analysis. The sensitivity analysis is important to ensure the soundness of the BCR.

In the final evaluation, the team adopted the theory of the top 80 percent scenario and bottom 80 percent scenario selection approach, where the structures selected were based on the net benefits. The

top 80 percent scenario includes the 80 percent of structures that bring the highest net benefits while the bottom 80 percent scenario includes the 80 percent of structures with the lowest net benefits. This method ensures that a small number of structures are not overly impacting the BCR. The nonstructural participation rate estimation for all five clusters is included in Tables 56 to 60 in Appendix D: Economics and highlight top 80 percent scenario, bottom 80 percent scenario, and the 100 percent participation rate results. The results of the sensitivity analysis generally showed that the groupings still generate positive net benefits even with the lowest 80th percentile of structures.

5.3. Relative Sea Level Rise

Sea level change does not impact flooding within the Township of Denville as the area is located inland from the Atlantic Ocean in a non-tidally influenced area.

5.4. Climate Change

Engineering and Construction Bulletin (ECB) 2018-14 requires USACE studies to provide a qualitative description of climate change impacts to inland hydrology studies. The objective of this ECB is to enhance USACE climate preparedness and resilience by incorporating relevant information about observed and expected climate change impacts in hydrologic analyses for new and existing USACE projects. The analysis was performed after the identification of the TSP and included the relevant climate variables of precipitation, temperature, and streamflow. Note that, as discussed above, sea level change does not impact flooding in the Township of Denville and is not factored in this analysis. It should be noted that there is uncertainty with predicting future flood flows due to the interaction between streamflow, precipitation, and temperature, and that methods of quantitatively accounting for climate change impacts or long-term persistent climate trends in an engineering analysis are not currently outlined in USACE guidance. The results of this analysis indicate that though climate change is evident in the basin, this analysis does not support any specific increase of peak flows due to climate change. Therefore, predicted FWOP conditions would remain the same as existing conditions. Additional details can be found in Appendix A: Hydrology and Hydraulics.

5.5. Real Estate Requirements

The required Lands, Easements, and Rights-of-Way (LER) for the Recommended Plan is to acquire an easement over the structure to be elevated or floodproofed. The easement will allow for the construction, operation, and maintenance of the project, and prevent future work on the site that would undermine the benefits of the project. Additional information can be found in Appendix E Real Estate Plan.

The recommended plan includes up to 38 structures located on 37 properties. Assuming 100% participation rate, 37 easements would be acquired. Owners will also be expected to sign a Participation Agreement with the non-Federal sponsor, the Township of Denville, prior to providing the easement. The Participation Agreement will document the owner voluntarily elected to participate in the project and outline actions and steps that must be taken by the property owner prior to commencement of the nonstructural treatment, including the requirement to sign an easement. The non-Federal Sponsor is

responsible for acquiring all LERRD, including these easements, which will require title searches, recording executed easements, and mortgage subordinations on properties where applicable.

As a nonstructural plan, implementation of the Recommended Plan will be performed on a voluntary basis. Property owners will have the option to voluntarily participate in the project to have their structure either elevated or floodproofed (as determined by the USACE). If an owner chooses not to participate in the project or cannot provide the required real estate access and easement, the nonstructural project will not take place on that property.

Real property acquisition for nonstructural projects that meet all of the conditions in 49 CFR § 24.101(b)1 do not fall within the procedural requirements of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, as amended (42 USC §§ 4601, et seq.) (the "URA"). The four conditions in that regulation include: (i) No specific site or property must be acquired, (ii) the property is not part of a group of properties where all (or substantially all) must be acquired within a specific timeframe, (iii) the property will not be acquired by eminent domain if voluntary negotiations are unsuccessful, and the owner is so informed in writing, and (iv) the property owner is informed in writing of the market value of the property interest that is being acquired. Recent USACE interim nonstructural real estate guidance clarifies that an easement is required for nonstructural plan implementation. The interim guidance has further indicated that, as a condition of participation in this voluntary program, property owners will not be provided compensation for that easement. Property owners are, however, entitled to know, in writing, the value of the easement they provide and impact to their property value. While appraisals are not required, the non-Federal Sponsor must have a reasonable method to estimate value of the real estate interest to be acquired and communicate that to the owner in accordance with 49 CFR § 101(b)(1)(iv).

Nonstandard estates are necessary when there is no corresponding USACE approved standard estate for the real property interest required, or when material changes to a standard estate (or previously approved nonstandard estate) is desired. Since there is no standard estate available for nonstructural features, a nonstandard easement is necessary to enable the construction, operation, and maintenance of the nonstructural feature. It will include securing certain access rights and impose land use restrictions on the lands of the owner, which the owner must agree to and comply with to ensure the long-term performance of the nonstructural feature.

The approved nonstandard estate will be incorporated into the body of an easement agreement between the non-Federal Sponsor and the property owner. The easement will be recorded in the county land records and will run with the land. Once recorded, the easement agreement will provide notice to subsequent owners of the rights and restrictions associated with the nonstructural treatment. Once the project is approved and the project is authorized for construction, proposed nonstandard estate language will be coordinated with USACE North Atlantic Division and submitted to USACE HQ for review and approval. Should USACE establish a standard estate, it is possible that the restrictive easement recommended herein will change.

5.6. Relocation Benefits

The availability of relocation assistance benefits for persons affected by this project is determined pursuant to the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, as amended ("Uniform Act"), and its implementing regulations at 49 C.F.R. Part 24 ("Uniform Relocation Assistance and Real Property Acquisition for Federal and Federally-Assisted Programs"). The National Nonstructural Committee (NNC) Best Practice Guide (BPG) 2020-02 addresses temporary relocation for nonstructural plans. It states the ability of an owner to afford temporarily relocate at their own expense and only applies to structures being elevated. Therefore, implies that no relocation is necessary for wet or dry floodproofing, which is consistent with the intent of the Recommended Plan.

According to the Uniform Act, owner occupants participating in voluntary actions are not eligible for relocation assistance benefits. Therefore, structure owners who voluntarily elect to participate in the Recommended Plan and who may be required to temporarily relocate during construction must do so at their own expense. The Uniform Act generally provides relocation assistance benefits to tenants who are permanently displaced. However, Appendix A of the Uniform Act, provides that tenants who are subject to temporary relocation assistance must be reimbursed for all reasonable out-of-pocket expenses incurred in connection with the temporary relocation even if they do not meet the criteria of a "displaced person" as defined by the Uniform Act.

Census information for the Town of Denville indicates an approximate 33% rental rate. With 28 residential structures being elevated, approximately 10 may have tenant occupants who will require temporary relocation assistance. For planning purposes, relocation assistance benefits are estimated based each eligible tenant consisting of a married couple with two children and one pet who will require temporary housing (hotel with kitchen) for a 90-day construction period. Temporary relocation assistance for the approximately 10 tenants is estimated to be $234,500.

There are two non-residential structures proposed for elevation. As of this report, there is a dance studio and a day care present, and it is assumed these are tenants to the building. Often, businesses are relocated on a permanent basis; therefore, it is assumed the elevation of the two non-residential structures will require permanent relocation assistance for two businesses. Permanent relocation for the two business is estimated to be $155,000, which includes cost associated with moving and related expenses and business reestablishment expenses.

5.7. Utility & Facility Relocation

For flood risk management projects, the non-Federal Sponsor is required to relocate affected public facilities and utilities necessary for the construction, operation, and maintenance of a project. A relocation may take the form of an alteration, lowering, raising, or replacement (and attendant removal) of the affected public facility/utility or part thereof. Since the Recommended Plan consists of an entirely of a nonstructural plan in which the construction of the nonstructural features will be performed on privately owned structures located on private property, there is no expectation to perform a relocation of a public utility or facility. All service utilities will be elevated to the designed flood elevation for the nonstructural feature as part of the overall construction cost.

5.8. Phased Implementation

For the CAP Section 205 project to move forward to the Design and Implementation (D&I) phase, USACE must sign a Project Partnership Agreement (PPA) with a non-Federal sponsor. The Township of Denville submitted a letter dated March 3, 2023 that confirmed that they are willing to participate as the non-Federal sponsor for the design and implementation phase of this project (see Appendix B). The D&I phase is cost shared 65 percent federal and 35 percent non-Federal and is subject to the availability in the CAP Section 205 program and availability of funds from the non-Federal sponsor.

The Recommended Plan will be refined in the D&I phase including identification of specific nonstructural measures applicable at each property and the total number of structures based on the initial eligibility framework outlined in the Recommended Plan of this Report. Property owners located in the study area will be informed of the details of project implementation including eligibility criteria, the eligibility process, and the related duties and obligations of USACE, the non-Federal sponsor, and the property owner.

Construction for this project is anticipated to be implemented in phases of approximately 5 structures at a time for design and construction over 45 days each. Construction is anticipated to take two years from October 2026 to November of 2028.

5.9. Cost Sharing and Responsibilities of the Non-Federal Sponsor

Cost sharing for the Recommended Plan will be done in accordance with Section 205 of the Flood Control Act of 1948, as amended, and is summarized in Table 5-3. The Recommended Plan will be cost-shared 65 percent federal and 35 percent non-Federal up to the maximum federal cost for planning, design, and construction of $10 million. The non-Federal sponsor for project implementation must cover all costs beyond the statutory limit of the CAP Section 205 program.

Table 5-3: Cost Sharing for Recommended Plan

CONSTRUCTION ITEM	FEDERAL COST	NON-FEDERAL COST[2]	TOTAL[2]
Feasibility Phase (Sunk Costs)	**$828,300**	**$728,300**	**$1,556,600**
Project Costs (Design and Implementation)			
Construction Item			
01 LANDS AND DAMAGES[1]	-	$1,078,000 – $5,042,000	$1,078,000 – $5,042,000
18 CULTURAL RESOURCE PRESERVATION	$135,850	$73,150	$209,000
19 BUILDINGS, GROUNDS & UTILITIES	$7,465,450	$3,872,550	$11,338,000
Subtotal	$7,601,300	$5,023,700 - $8,987,700	$12,625,000 - $16,589,000
30 PLANNING, ENGINEERING AND DESIGN	$961,350	$517,650	$1,479,000
31 CONSTRUCTION MANAGEMENT	$609,050	$327,950	$937,000
Total Project First Costs*	**$9,171,700**	**$5,869,300 - $9,833,300**	**$15,041,000 - $19,005,000**
Total Project Costs Including Feasibility	**$10,000,000**	**$6,597,600 - $10,561,600**	**$16,597,600 - $20,541,600**

[1] Costs in excess of the CAP 205 program limit are primarily real estate costs associated with acquisition of easement agreements, which are included in total project costs shows here. These are shown as a non-Federal cost as they are the responsibility of the non-Federal sponsor. However, real estate costs are subject to cost sharing requirements and therefore a policy waiver will be required for design and implementation of the Recommended Plan summarized in this report.

[2] Total nonstructural plan costs for the Recommended Plan includes a low estimate based on total project cost excluding the cost of an easement agreement and high cost that includes the cost of an easement agreement. This cost range presents a range of potential implementation costs associated with the Recommended Plan and will be updated during the design and implementation of the project as USACE policy for nonstructural plans evolves. Design and implementation costs rounded to the nearest thousand.

5.10. Project Performance

ER 1105-2-101, Risk Assessment for Flood Risk Management Studies, provides the requirement to describe project performance by annual exceedance probability (AEP), assurance (conditional non-exceedance probability), and long-term exceedance probability (LTEP). Project performance describing these attributes is computed within HEC-FDA and is based on a target stage 1% AEP plus one foot of confidence levels. Table 5-4 presents the project performance consistent with ER 1105-2-101 for the existing. The future without project conditions provides the same results as the future with project condition because nonstructural treatments do not impact the hydraulic/flood stages in the future condition.

Table 5-4: Project Performance

Reach Name	Target Stage AEP		Long-Term Risk (Years)			Conditions Non-Exceedance Probability by Events					
	Median	Expected	10	30	50	10%	4%	2%	1%	0.4%	0.2%
Upper Rockaway	32	32	98	100	100	0.51	0.04	0.02	0.02	0	0
Den Brook	100	100	100	100	100	0	0	0	0	0	0

In the Recommended Plan, no structures are located on Den Brook reach. It is worth noting that reaches were not developed to provide responses to the nonstructural project performance analysis.

5.11. View of Non-Federal Sponsor

The NJDEP understands that the USACE will undertake the FRM project when funds are appropriated by Congress to the CAP 205 program and allocated to the New York District. The NJDEP Division of Dam Safety and Flood Engineering and the Township of Denville support the plan recommended in this IFR/EA. The Township of Denville will serve as the non-Federal sponsor for the design and implementation of this project. The Township of Denville submitted a letter of support for the project and associated cost share obligations on March 3, 2023.

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6. Environmental Effects and Consequences

This section evaluates potential effects of the proposed action to undertake nonstructural FRM within 5 cluster areas of the Township of Denville's downtown business district. As noted previously the Recommended Plan selected by USACE for implementation includes a total of 38 structures including 28 residential structures for elevation, 2 non-residential structures for elevation, 2 residential structures for wet floodproofing, and 6 non-residential structures for dry floodproofing in 3 clusters - North, North Riverside & Southwest clusters. Whereas the Recommended Plan includes just 3 clusters, this section assumes the maximum potential of the proposed action to include the 5 clusters determined to have positive net benefits. This was done to assess the environmental, social, and cultural impacts of all potential clusters proposed for nonstructural measures, if for instance participation rates fall below 100 percent and nonstructural measures are recommended in clusters not included in the Recommended Plan as detailed in this Draft IFR/EA.

The maximum potential proposed action includes approximately 54 structures. A total of 40 structures were identified for elevation. All structures for which raising was determined to be the best solution would be raised to the 1 percent AEP level plus one foot. This is because once a structure is being raised, the incremental cost of raising higher is very small. A total of 4 structures were identified for wet floodproofing to LOP including the 10 percent AEP (10-year) LOP, 2 percent AEP (50-year) LOP, and 1 percent AEP (100-year) LOP plus one foot. The remaining 10 structures were identified for dry floodproofing to various LOP including 10 percent AEP (10-year) LOP, 4 percent AEP (25-year) LOP, 2 percent AEP (50-year) LOP, 1 percent AEP (100-year) LOP, and 0.5 percent AEP (200-year) LOP.

Under flooding events more severe than the level of floodproofing, commercial structures would continue to be vulnerable to flood damage. This impacts analysis was prepared anticipating that construction methods would be similar to those described in FEMA (2014) and the USACE 2016 "Leonardo, Raritan Bay, and Sandy Hook Bay, New Jersey Coastal Storm Risk Management Study." Project construction would not be technically complex, and work at each individual structure would be localized. It is likely that the construction contractor would have multiple crews working five days a week. A single structure would take approximately eight weeks to accomplish with one group of five overlapping with the next group by one week. It is assumed that minimal work would occur during the months of December, January, and February because of winter weather and the potential for disconnected plumbing to freeze and difficulty of masonry to cure.

For the purposes of this study, these individual types of nonstructural FRM measures are lumped for consideration over the area of effect. Impacts at individual structures are not considered. Impacts at individual structures would be evaluated in the future when developing plans and specifications for the Recommended Plan.

6.1. Physical Environment

6.1.1. Land Use and Land Cover

6.1.1.1. No Action Alternative/FWOP

Under the no action alternative/FWOP, there would be no anticipated changes in land use and land cover in the study area.

6.1.1.2. Proposed Action

Use of land at the structures would be temporarily disrupted during construction, and land cover would likely be locally disturbed by construction activities at each structure. It is not anticipated that land use zoning would change, and all parcels would continue to be used as residential or commercial properties once construction is completed. Land cover would be restored to the small-town character of the area once construction is complete. There would be no long-term impacts to land use or land cover within the project area.

6.1.2. Geology, Topography and Soils

6.1.2.1. No Action Alternative/FWOP

Under the no action alternative/FWOP, there would be no impacts on topography, geology, or soils within the study area.

6.1.2.2. Proposed Action

The proposed action would cause localized minor soil disturbance in the vicinity of affected structures in association with minor excavation, filling, and grading. The soils are urban in character and would be restored to approximately pre-project conditions following construction, depending on conditions at each structure. No long-term soil impacts are expected.

6.1.3. Hydrologic Setting

6.1.3.1. No Action Alternative/FWOP

Under the no action alternative/FWOP , there would be no impacts to the hydrologic setting as the study area would remain in its current condition.

6.1.3.2. Proposed Action

Nonstructural FRM physical measures are applied to individual structures to increase resiliency to flooding without adversely affecting or changing the natural characteristics of the floodplain. Because of their adaptation to flood risk, these measures generally cause no adverse effects to the natural floodplain, flood stage, velocity, or duration (USACE, 2019).

6.1.4. Climate and Air Quality

6.1.4.1. No Action Alternative/FWOP

Under the no action alternative/FWOP, no activities would take place and general emissions would stay at their current rate. There would be no impact to air quality, GHG emissions, or climate change from this alternative.

6.1.4.2. Proposed Action

Project emissions would contribute cumulatively to greenhouse gas emissions, but not be a noteworthy source in comparison to other activities.

The Clean Air Act requires that the federal action be conducted in compliance with the New Jersey state implementation plan (SIP). A Statement of Conformity (SOC) or Record of Non Applicability (RONA) of the project's compliance with the SIP and NAAQS should be incorporated into the National Environmental Policy Act (NEPA) document.

USACE prepared an estimate of emissions for priority air pollutants and their precursors of concern (CO, NOx, SO_2, VOC, and PM2.5) that would have been emitted by construction of a preliminary alternative plan under consideration in March 2021. This plan, which would involve substantially more construction work than the Recommended Plan, would have involved retrofit construction of nonstructural FRM measures on approximately 145 structures in the downtown business district. Estimated total emissions from the proposed alternative were in every case substantially less in tons per year than the *de minimis* thresholds under the Clean Air Act (USEPA, 2017). Appendix B contains detailed information on how estimates were determined.

Table 6-1: Air pollutant *de minimis* emissions compared to estimated emissions.

Priority Pollutant or Precursor of Concern	*De minimis* emission (tons per year)	Estimated Emissions (tons per year)
Carbon monoxide	100	4.733
NO_x	100	3.923
Fine Particulate Matter (PM2.5)	100	0.253
SO_2	100	0.005
VOC	50	0.838

While the proposed action would detrimentally impact air quality, impacts would be temporary and local in nature. Construction would be undertaken in accordance with applicable state or local requirements to minimize fugitive dust. Because the Recommended Plan is of smaller scale than the alternative plan for which emissions were estimated, construction emissions would be even less than the estimates presented in Table 6-1. The proposed action would not violate Clean Air Act total annual project-specific de minimal emissions. A RONA is included in Appendix B.

6.1.5. Water Quality

6.1.5.1. No Action Alternative/FWOP

No adverse impacts to water quality would be expected from the no action alternative/FWOP as the study area would remain in its current condition.

6.1.5.2. Proposed Action

No direct impacts to waterways are anticipated as a result of the proposed action. The project would be constructed in accordance with stormwater management and sediment and erosion control regulations of the State of New Jersey and Morris County. State and local stormwater management regulations are applicable for projects that increase impervious coverage by a quarter acre or more or disturb over 1 acre total. Because of the localized nature of construction at each existing structure, it is not anticipated that those regulations will come into effect, and only minor, localized, and temporary impacts to surface water quality are anticipated. If, however, project soil disturbance is greater than 5,000 square feet (SF) on a subject property, a Soil Erosion & Sediment Control permit would be obtained from the Morris County Soil Conservation District. A 404(b)(1) Analysis is not needed because there is no proposed discharge of dredged or fill material into waters of the United States. A Water Quality Certificate/Permit pursuant to Section 401 of the Clean Water Act (CWA) is not required because no withdrawals of water or direct releases of pollutants into waters are proposed.

6.1.6. Riparian Vegetation

6.1.6.1. No Action Alternative/FWOP

No adverse impacts to riparian vegetation would be expected from the no action alternative/FWOP as the study area would remain in its current condition.

6.1.6.2. Proposed Action

The proposed action would have no impacts to vegetated wetlands as they do not occur in the vicinity of the structures proposed for nonstructural FRM in the downtown business district. The proposed action may impact landscaped vegetation growing in proximity to structures to which nonstructural FRM improvements would be applied. It is anticipated that impacts to landscaping and the corrective actions that would be negotiated with individual property owners. No or negligible impacts to riparian or instream habitat conditions are anticipated.

6.1.7. Fish and Wildlife

6.1.7.1. No Action Alternative/FWOP

No adverse impacts to fish and wildlife would be expected from the no action alternative/FWOP as the study area would remain in its current condition.

6.1.7.2. Proposed Action

No work would occur in aquatic habitats and only minor indirect impacts to aquatic habitats are anticipated, via stormwater runoff, which will be minimized in accordance with state and county regulations. Accordingly, no or negligible impacts to fish or other aquatic life would occur.

Because of the urban character of the project area, it is likely that wildlife of the downtown business district is highly tolerant of human activity and disturbance. No terrestrial natural habitat areas would be impacted, and only minimal disturbance to landscaping and shade trees would occur. Wildlife, including migratory birds, may relocate from the vicinity of structures where work is occurring. Following completion of the FRM improvements, it is anticipated that urban wildlife would re-occupy the downtown business district at levels comparable to pre-project conditions.

6.1.8. Rare, Threatened, and Endangered Species

6.1.8.1. No Action Alternative/FWOP

No adverse impacts to rare, threatened, and endangered species would be expected from the no action alternative/FWOP as the study area would remain in its current condition.

6.1.8.2. Proposed Action

Because of the urban character of the project area, absence of mapped occurrence of federal or state-listed species, lack of proposed disturbance to natural aquatic or terrestrial habitats, and localized nature of the proposed FRM improvement measures, it is likely that the project would have no effect on bog turtle, Indiana bat, northern long-eared bat, or tricolored bat.

Consideration of effects on the candidate species monarch butterfly are not required under the Endangered Species Act. However, the proposed action would be expected to have negligible effects on the monarch butterfly population because of minimal occurrence of milkweed and lack of concentrated numbers of monarch individuals expected to occur in the area of effect.

USACE coordinated with USFWS in April and May 2019 to determine the magnitude of USFWS involvement appropriate to meet requirements of the Fish and Wildlife Coordination Act (FWCA), Endangered Species Act (ESA), Migratory Bird Treaty Act, and Anadromous Fish Conservation Act. USACE made a no effect determination to ESA listed species.

6.2. Community Setting

6.2.1. Population and Demographics

6.2.1.1. No Action Alternative/FWOP

No adverse impacts to population and demographics would be expected from the no action alternative/FWOP as the study area would remain in its current condition. Under worst case scenario (500yrs flood event Table 2-6), it would be suggested that residents withing the inundation areas should evacuate.

6.2.1.2. Proposed Action

The proposed action would temporarily displace residents and businesses who utilize or live-in structures where FRM improvements would be constructed. During construction, residents would temporarily relocate elsewhere and there could be a disruption to personal and community activities in the vicinity. Depending on timing of construction and number of structures within a given cluster being improved, the proposed action could cause temporary depopulation of clusters during construction, which could take

months to complete. Because the number of people to be displaced is small in comparison to the dense population of the region, no regional effects are anticipated from temporary relocation.

6.2.2. Environmental Justice

6.2.2.1. No Action Alternative

Under the no action alternative/FWOP, there would be no change to socioeconomics, environmental justice, or protection of children.

6.2.2.2. Proposed Action

The project is not anticipated to disproportionately affect minority or impoverished residents or businesses and is thus not anticipated to cause environmental injustice. The benefits would extend to residents of the community but would not provide any environmental justice benefits as the area largely lacks low-income and minority residents.

6.2.3. Schools

6.2.3.1. No Action Alternative/FWOP

Under the no action alternative/FWOP, Riverview Elementary School and nearby daycare center would continue to be vulnerable to flooding during a 500-year storm event (Fig 2-6). This may result in temporary closing of the school and daycare center, while clean up and possible construction occurs.

6.2.3.2. Preferred Alternative

The project could have temporary traffic effects upon the Riverside School. In the event this becomes likely, a traffic plan would be developed with the Township of Denville that would minimize impacts. Once construction is completed, the project would have no effect on schools.

6.2.4. Employment and Income

6.2.4.1. No Action Alternative/FWOP

Under the no action alternative/FWOP, there would be adverse effects to employment and income within the study area. Dwellings and businesses located in the inundation areas (Tables 2-3 to 2-6) would continue to have negative impacts from flooding events. Reoccurring costs of cleaning up and rebuilding following flood events would continue.

6.2.4.2. Proposed Action

Presence of construction workers could result in a minor local increase in economic activity. This would cease upon completion of construction. There would be no substantial impact on the area economy. However, recurrent cost to affected residents of cleaning up and rebuilding after floods would be alleviated.

Nonstructural FRM measures support the intent of the NFIP as administered by FEMA, although not all nonstructural measures may result in a flood insurance premium reduction (USACE, 2019). This topic would be addressed by FEMA rather than USACE.

Property owners and occupants of residential and occupants of commercial structures who willingly participate in dry and wet floodproofing are not considered displaced persons (in accordance with 49 CFR Part 24), and therefore are not entitled to receive relocations assistance benefits. However, displaced occupants of eligible residential structures to be elevated would be eligible for temporary relocation assistance benefits.

Directly affected residents, as well as the surrounding community, would have long-term benefits both economically as well as socially by implementation of the proposed project. The proposed action would maintain community cohesion, as no long-term change in population of the business district would be necessary. The project would increase community resiliency, by reducing flood damages and thus speeding up recovery following flooding events.

Overall, implementation of the Recommended Plan would have minimal to no impact on long-term employment and income in the region.

6.2.5. Parks and Recreation

6.2.5.1. No Action Alternative/FWOP

Under the no action alternative/FWOP, there would be adverse effects to parks and recreation within the study area. Parks and recreation venues located in the inundation areas (Tables 2-3 to 2-6) would continue to have negative impacts from flooding events. Reoccurring costs of cleaning up and rebuilding following flood events would continue, causing these facilities to be possibly closed during this time.

6.2.5.2. Proposed Action

The project could have temporary effects associated with traffic disruptions upon Gardner Field, and affect use of the park facilities, including its ballfields. In the event this occurs, it is anticipated that a traffic plan will be developed with Township of Denville to minimize these impacts. Once construction is completed, the project would have no effect on parks or recreation.

6.2.6. Aesthetics and Noise

6.2.6.1. No Action Alternative/FWOP

Under the no action alternative/FWOP, there would be no change to noise or the aesthetic environment within the study area.

6.2.6.2. Proposed Action

Presence of construction equipment, vehicles, and activities would temporarily alter the downtown business district aesthetic character to that of a construction site in the vicinity of structures being improved. Implementation of the proposed action may cause disruption of views for some residents. Any visual impacts associated with elevating structures would be minimized through proper design and construction, while conforming to local and state building codes. However, some views may be permanently lost. Some vegetation on the affected properties would be removed to provide construction access. However, construction would involve replacing landscaping to the previous condition.

Construction activity would generate noise over the period of construction at each project site. Noises generated during project construction would have minimal effect on area residents as the downtown business district has chronic vehicle noise because of its close proximity to U.S. Interstate 80. The Township of Denville's ordinances regulate noise in the municipality. Project work would be conducted in accordance with the local noise control ordinance to minimize effects on residents and businesses. Once construction work is completed, the proposed action would have no effects on noise.

6.2.7. Cultural Resources

6.2.7.1. No Action Alternative/FWOP

Under the no action alternative/FWOP, there would be no impacts to cultural resources as the study area would remain in their current condition.

6.2.7.2. Proposed Action

The Recommended Plan proposes nonstructural measures to numerous residential and commercial buildings within the Township of Denville that have not been evaluated for the NRHP. Consultation with the NJ SHPO is currently ongoing to determine the eligibility of these buildings for the NRHP. Due to the voluntary nature of the project, USACE is unable to fully identify and evaluate cultural resources and determine effects of the Recommended Plan on historic properties prior to completion of the Environmental Assessment. Therefore, pursuant to 54 U.S. C. 306108 and 36 CFR 800.4(b)(2), USACE is deferring final identification and evaluation of historic properties until after Project approval and prior to construction by executing a Programmatic Agreement. USACE continued consultation with the NJ SHPO in January 2021, and with Tribal Nations in October 2022, regarding the project and requested assistance with the development of the Programmatic Agreement. Consultation and development of the Programmatic Agreement is ongoing.

6.2.8. Contamination and Hazardous, Toxic, and Radioactive Wastes (HTRW)

6.2.8.1. No Action Alternative/FWOP

Under the no action alternative/FWOP, there would be no impacts to contamination and hazards as the study area would remain in their current condition.

6.2.8.2. Proposed Action

The structures for which nonstructural FRM measures are recommended do not lie within or in close proximity to any potentially contaminated sites identified in the desktop analysis. Although unlikely, historic industrial activity could have produced HTRW not identified in the desktop analysis. It is likely that the structures, particularly those that are older, contain at least minor quantities of contaminants, such as lead-based paint, asbestos, and fuel storage tanks. Property grounds could contain minor levels of these contaminants. Work on older structures, ground disturbance, and work on associated infrastructure connections could liberate some contaminants into the human environment that could pose a risk to construction workers and residents of the area. To minimize risks, USACE would conduct an assessment of each structure and utilities in the D&I phase, identify potential contaminants, possible sample collection, and develop appropriate mitigation measures (handling, removal, transport, and disposal) in coordination with USEPA and NJDEP (and county or municipal agencies, if applicable). In the

unlikely event any structure presents a substantial risk, it could be eliminated from consideration for nonstructural FRM work. Overall, while some release of minor quantities of pollutants into the environment is expected, contaminants or hazardous, toxic, or radioactive substances are not anticipated to be released at levels of concern.

At this time, details on dealing with structure and ground contaminants have not been discussed with the Township of Denville or NJDEP. It is assumed that no significant impact to the environment from HTRW is expected as a result of implementation of the proposed action. All activities are anticipated to occur within the footprint of an existing structure. All structures slated for elevation will be inspected for any potential environmental issues (e.g., LBP, ACM, friable asbestos, fuel storage tanks). Prior to any actions being conducted, LBP, ACM, or friable asbestos that may be disturbed by the elevation or floodproofing activity must be abated at the owner's expense. For all structures proposed for nonstructural activities, an asbestos investigation will be conducted to confirm the presence/absence of damaged or friable asbestos, ACM, or LBP. If damaged or friable asbestos, ACM, or exposed LBP are confirmed on a property and have been determined to be impacted by the implementation of nonstructural measures, the property owner and/or non-Federal sponsor will be obligated, at their sole expense, to conduct all necessary response and remedial activities in compliance with all applicable local, state, and federal laws and regulations. Asbestos, ACM, and LBP that would not be affected by construction of the recommended nonstructural element(s) would not need to be abated prior to construction.

6.2.9. Public Safety

6.2.9.1. No Action Alternative/FWOP

Under the no action alternative/FWOP, public safety would continue to be a concern. Residents and businesses would still need to be cognizant of flood risk and evacuate in the event a serious flood occurs. The study area would remain in a flood-vulnerable location and public safety risks would remain the same.

6.2.9.2. Proposed Action

No information has been obtained to determine whether any of the roads in the downtown business district constitute formal or informal flood evacuation routes. This would need to be determined during development of a traffic plan with the Township of Denville to ensure none are blocked during construction.

It is anticipated that the proposed Recommended Plan is consistent with the intent and specific needs of the Morris County (2015) Hazard Mitigation Plan for the Township of Denville.

Nonstructural measures themselves would not affect public safety once completed. Residents and businesses would still need to be cognizant of risk and evacuate the downtown business district in the event a serious flood occurs. This analysis assumes that the majority of the population evacuates damage prone areas in adequate time to effectively reduce life safety risk.

The project may induce the population to remain in a flood-vulnerable location, rather than relocating out of the floodway or floodplain. Public safety risks of the Recommended Plan are thus greater than if the structures were relocated out of the floodway or floodplain.

6.3. Infrastructure

6.3.1. Traffic and Transportation

6.3.1.1. No Action Alternative/FWOP

Under the no action alternative/FWOP, there would be adverse effects to traffic and transportation within the study area. Roads located in the inundation areas (Tables 2-3 to 2-6) would continue to have negative impacts from flooding events. Reoccurring costs of cleaning up and rebuilding following flood events would continue, causing roadways to be possibly closed during this time.

6.3.1.2. Proposed Action

Streets that would be temporarily impacted are classified by NJDOT predominantly as local roads, and thus are poorly suited for heavy construction traffic volumes or weight. Only Diamond Spring Road and West Main Street are classified as minor arterial roads upon which construction traffic impacts would be less of a concern. It is anticipated that a traffic plan will be developed with the Township of Denville to identify measures to minimize impacts to residents and businesses. Use of downtown business district streets in the vicinities of structures to be improved would likely be affected by transport of equipment and materials, and construction activities. Once construction is complete, effects of the proposed action would cease and there would be no long-term traffic impacts.

6.3.2. Utilities

6.3.2.1. No Action Alternative/FWOP

Under the no action alternative/FWOP, there would be adverse effects to utilities within the study area. Electric power, water supply, natural gas and other utilities located in the inundation areas (Tables 2-3 to 2-6) would continue to have negative impacts from flooding events. Reoccurring costs of repairs following flood events would continue, causing possible utility outages during this time.

6.3.2.2. Proposed Action

Electric power, water supply, natural gas, and other utilities would be temporarily shut down as needed at individual structures during construction to protect utilities and public safety. Utilities would be returned to normal working conditions as soon as possible after construction completion at each of the proposed buildings. However, some minor inconveniences to residents or businesses are possible by interruption of water, electric, natural gas, or sewer service.

The proposed construction activities lie more than 1500 feet from wellhead protection areas and would cause negligible change in impervious surfaces. Thus, the proposed action would have negligible impacts on groundwater recharge and not be expected to impact the public water supply system.

6.3.3. Sustainability

6.3.3.1. No Action Alternative/FWOP

Under the no action alternative/FWOP, there would be no impacts to sustainability as the study area would remain in their current condition.

6.3.3.2. Proposed Action

Because the study area is urban and landfill space is often in short supply, reuse and recycling of any demolition or dismantled buildings or other materials is an important concern. Construction and demolition waste generated in Morris County and classified as Type 13C by State of New Jersey Code is required to go to Morris County Municipal Utilities Authority transfer stations if it is being disposed. Morris County has a NJDEP-approved solid waste management plan. The Plan serves as a blueprint for how Morris County implements its solid waste management strategy with respect to waste reduction, recycling, and disposal (Morris County, No Date). It is anticipated that construction and demolition waste would be managed in accordance with this plan, thus minimizing environmental impacts.

6.3.4. Irreversible and Irretrievable Commitments

The proposed action includes voluntary nonstructural measures that involve a limited scope of building modification (elevation or floodproofing) at the structure level. Therefore, no irreversible or irretrievable commitment of resources were identified as part of the FWOP and only funding for project design and implementation was identified as a irreversible and irretrievable commitment under the proposed action.

6.3.5. Cumulative Impacts

As defined by CEQ, cumulative effects are those that "result from the incremental impact of the Proposed Action when added to other past, present, and reasonably foreseeable future actions, without regard to the agency (federal or non-federal) or individual who undertakes such other actions" (40 CFR 1508.7). Cumulative effects analysis captures the effects that result from the Proposed Action in combination with the effects of other actions taken during the duration of the Proposed Action at the same time and place. Cumulative effects may be accrued over time and/or in conjunction with other pre-existing effects from other activities in the area (40 CFR 1508.25); therefore, pre-existing impacts and multiple smaller impacts should also be considered. Overall, assessing cumulative effects involves defining the scope of the other actions and their interrelationship with the Proposed Action to determine if they overlap in space and time.

The proposed alternative has minor cumulative impacts within the project area and includes impacts to air quality, noise, and aesthetics. In all cases described, the cumulative impacts will be minor and temporary as the proposed alternative is implemented. Impacts would cease upon the completion of each non-structural measure.

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7. Environmental Compliance, Coordination & Public Involvement

7.1. Environmental Compliance

The Morris County solid waste plan describes requirements for providing solid waste for Morris County waste generators and establishes mandates and goals for keeping recyclables separate from garbage. Additionally, the Plan lists all solid waste facilities located in Morris County that require Plan inclusion prior to starting solid waste management activities as required by the Solid Waste Management Act (N.J.S.A. 13:1E-1 et. seq.) and regulations promulgated by NJDEP (primarily located in N.J.A.C. 7:26 et. seq.) (Morris County, No Date). The plan will be reviewed with NJDEP to determine if any state "right to know" laws are applicable.

The Rockaway River and Den Brook classification as C1 by NJDEP prohibits new development within 300 feet of the waterway. It is anticipated that because all work would be undertaken on existing structures that this regulation would not be applicable.

The proposed federally funded project is presumably regulated for groundwater effects under the USEPA Sole Source Aquifer (SSA) Program. The SSA program enables USEPA to designate an aquifer as a sole source of drinking water and establish a review area. The proposed action is not anticipated to impact groundwater and would thus be in compliance with the program. USEPA review of the proposed action would be conducted during public/agency review.

Morris County is not within New Jersey's coastal zone, and thus provisions of the Coastal Zone Management Act of 1972 (CZMA) are not applicable (NJDEP, 2020).

The Township of Denville is located within the New Jersey Highlands region as designated by the New Jersey Highlands Water Protection and Planning Act. The vast majority of land in the Township is within the Planning Area where conformance with the regional master plan is voluntary and the strict regulations on development contained in the Act are not mandatory. Only the northwestern portion of the township is in a preservation area strictly regulated under the act (i.e., not the downtown business district) (Denville Trails Master Plan, 2018). Thus, provisions of the New Jersey Highlands Water Protection and Planning Act are not applicable.

State and local stormwater management regulations are applicable for projects that increase impervious coverage by a quarter acre or more or disturb over 1 acre total. It is not anticipated that these regulations would come into effect. If project disturbance is greater than 5,000 square feet on a subject property, a Soil Erosion & Sediment Control permit would need to be obtained from the Morris County Soil Conservation District and the permit conditions met.

Undertaking FRM in the downtown business district portion of the Township of Denville would be consistent with New Jersey smart growth principles that seek to prioritize state-funding in designated "Metropolitan Planning Areas" by the State of New Jersey.

Because this would be a federal action, evaluation is required for compliance with potentially applicable laws and executive orders. Tables 7-1 and 7-2 provide summary information on this topic.

Table 7-1: Compliance of the Proposed Action with Applicable Federal Laws

Law or Regulation	Concurrence or Permit
Clean Air Act (CAA)	A General Conformity Rule determination and analyses and a final Record of Non-Applicability (RONA) for Clean Air Act Conformity are included in Appendix B
Clean Water Act (CWA)	Not applicable. No impacts to waters or wetlands.
Endangered Species Act (ESA)	Completed via USFWS IPAC – January 2019 and updated May 2023. No impacts to listed species. Project location does not contain critical species habitat. See Appendix B
Fish and Wildlife Coordination Act (FWCA)	Completed via informal coordination with USFWS. No FWCA Report necessary. Appendix B
National Environmental Policy Act (NEPA)	Preparation and circulation of this Integrated EA
National Historic Preservation Act (NHPA)	Coordinated with the NJ SHPO in January 2021 and American Indian Tribes in October 2022 via letter to fulfill requirements (Appendix B)
National Pollutant Discharge Elimination System (NPDES)/ Stormwater Pollution Prevention Plan (SWPP)	Any stormwater permits required will be obtained during the preconstruction engineering and design phase

Table 7-2: Compliance of the Proposed Action with Applicable Executive Orders

Executive Order Content and Number	Demonstration of Compliance
Protection and Enhancement of Cultural Environment (11593)	Coordination with NJ SHPO B -
Floodplain Management (11988)	Determination presented in this EA
Protection of Wetlands (11990)	Circulation of this report for public and agency review fulfills the requirements of this order.
Environmental Justice (12898)	Analysis determined no disproportionate negative impact on minority or low-income groups anticipated.
Indian Sacred Sites (13007)	Coordination with tribal interests
Protection of Children from Environmental Health Risks and Safety Risks (13045)	Circulation of this report for public and agency review fulfills the requirements of this order.
Safeguarding the Nation from the Impacts of Invasive Species (13751)	Will be addressed by implementing best management practices during construction including equipment specifications including methods to reduce spread of invasive species
Protection of Children from Environmental Health Risks and Safety Risks (13045)	Circulation of this report for public and agency review fulfills the requirements of this order.
Tackling Climate Crisis at Home and Abroad (14008)	This project will not significantly contribute to climate change

7.2. Resource Agency Coordination

In compliance with NEPA, the proposed action has been and is being coordinated with relevant resource agencies and the public. The purpose of coordination is to ensure that environmental and social factors are considered while planning and executing a prudent and responsible action. Appendix B: Environmental and Cultural contains a summary of coordination efforts, a copy of the study initiation notice, and copies of important correspondence with agencies and organizations.

USACE mailed out letters to resource agencies and public notices announcing study initiation in April and May 2019. Letters were sent to resource agencies anticipated to be of potential relevance because of their review responsibility and/or expertise. The public notice was sent to elected officials and leaders of local civic organizations. The public notice was posted on the New York District Internet website in May 2019 (https://www.nan.usace.army.mil/Missions/Civil-Works/Projects-in-New-Jersey/Denville-Flood-Risk-Management-Study/). Information on the project was provided to the Delaware Nation, Delaware Tribe of Indians, and the Shawnee Tribe in June 2019. The notice requested comments within the agencies' areas of responsibility and citizens' interests. The notice drew general responses as presented in Appendix B. No major concerns were identified.

USACE initiated consultation with the NJ SHPO, Delaware Nation, Delaware Tribe of Indians, and Shawnee Tribe in May 2019 informing them of the project and requesting their assistance in identifying effects to historic properties. Due to the voluntary nature of the project, USACE is unable to fully identify and evaluate cultural resources and determine effects of the Recommended Plan on historic properties prior to completion of the Environmental Assessment. Therefore, pursuant to 54 U.S. C. 306108 and 36 CFR 800.4(b)(2), USACE is deferring final identification and evaluation of historic properties until after Project approval and prior to construction by executing a Programmatic Agreement. USACE continued consultation with the NJ SHPO in January 2021, and with Tribal Nations in October 2022, regarding the project and requested assistance with the development of the Programmatic Agreement. Consultation and development of the Programmatic Agreement is ongoing.

USACE coordinated with USFWS in April and May 2019 to determine the magnitude of USFWS involvement appropriate to meet requirements of the Fish and Wildlife Coordination Act (FWCA), Endangered Species Act (ESA), Migratory Bird Treaty Act, and Anadromous Fish Conservation Act. USACE determined a no effect for ESA listed species.

7.3. Public Coordination and Views

A public notice will be released in September 2023 to announce the availability of the draft IFR/EA for public review and will also be available on the USACE New York District website. Public and agency comments will be accepted for 30-days from the date of the public notice. A public meeting will be held during the 30-day review period. Public and agency comments will be considered and summarized in the final version of this report.

8. Draft Recommendations

The New York District endorses the Recommended Plan consisting of nonstructural measures, developed in coordination with the non-Federal sponsor, and recommends that the Plan proceed to the design and implementation phase. This Draft Feasibility Report and Environmental Assessment consists of all planning and design activities that demonstrate that federal participation is warranted at this time. The proposed action will have no significant adverse impact to the environment and will not constitute a major federal action affecting the quality of the human environment. Therefore, an Environmental Impact Statement will not be prepared. A Finding of No Significant Impact (FONSI) was prepared, a Draft copy of which is provided in Appendix B: Environmental and Cultural of this Draft IFR/EA. A signed copy will be made available upon completion of public and agency review.

Plans consisting of structural measures were eliminated from consideration because they were not economically justified, and the costs of the plans significantly exceeded the funding constraint of the CAP. New York District is recommending a prioritized implementation strategy for the Recommended Plan under the CAP Section 205 program that includes a Recommend Plan comprised of the 3 clusters with the highest flood risk: North, North Riverside and Southwest. The Recommended Plan includes a total of 38 structures including 28 residential structures for elevation, 2 non-residential structures for elevation, 2 residential structures for wet floodproofing, and 6 non-residential structures for dry floodproofing.

The total project cost for the Recommended Plan is between $15.0 and $19.0 million, assuming a 100 percent participation rate, which reflects a range of design and implementation costs that exclude/include the costs for acquisition of easement agreements for project implementation in accordance with changing policy as detailed in this Draft IFR/EA. USACE policy related to nonstructural plans is evolving and changes in policy may dictate further analysis that will impact total project costs, participation rates, eligibility requirements, the total number of structures being recommended, contracting approach, and the overall implementation strategy, which may lead to changes during the design and implementation of the proposed project. Net benefits are maximized with annualized net benefits of $481,000 and a BCR of 1.72 in October 2022 (FY 2023) price levels and use a discount rate of 2.5 percent. The CAP Section 205 authority has a maximum federal cost for planning, design, and construction of $10 million and is cost shared 65 percent federal, 35 percent non-Federal. The non-Federal sponsor for project implementation must cover all costs beyond the statutory limit of the CAP Section 205 program.

Neither dry nor wet floodproofing would increase the structure footprint nor cause an increase in water surface elevations during flood events. Following implementation of nonstructural measures, residual risk would remain; therefore, it is critical that local residents evacuate promptly during significant storm events. The Township of Denville has existing procedures for mandatory evacuation of residents living in flood prone areas to the Townships' Emergency Shelter at Lakeview Elementary School. The egress route from the township's flood prone areas and shelter location are not impacted by FRM measures proposed in this feasibility study.

The Draft Feasibility Report and Environmental Assessment documents consideration of aspects in the overall public interest, including environmental, social, and economic impacts; feasibility; and the ability and interests of the non-Federal sponsor, NJDEP. The costs of the Recommended Plan, depending on the voluntary participation rates, either fall within the CAP funding constraints or exceed the limit by an amount acceptable to NJDEP and the Township of Denville. The Township of Denville submitted a letter dated March 3, 2023 that confirmed that they are willing to participate as the non-Federal sponsor for the design and implementation phase of this project

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 higher review levels within the Executive Branch. Consequently, the recommendations may be modified before they are transmitted to higher authority as proposals for authorization and implementation funding. However, prior to transmittal to higher authority, the sponsor, the states, interested federal agencies, and other parties will be advised of any modifications and will be afforded an opportunity to comment further.

Signed in Final Feasibility Report after Public Review

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Date Signed

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Alexander Young
Colonel, U.S. Army
Commander and District Engineer

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