HUDSON COUNTY HAZARD MITIGATION PLAN

2020 Update

Volume I

Prepared for:
Hudson County Office of Emergency Management
Authorized by Hudson County Executive
Tom DeGise and Board of Chosen Freeholders

Prepared by:
Tetra Tech, Inc.
6 Century Drive, Suite 300
Parsippany, NJ 07054

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APRIL 2020

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TETRA TECH

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6 Century Drive, Suite 300

Parsippany, NJ 07054

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SECTION 1. INTRODUCTION

1.1 Background

In response to the requirements of the Disaster Mitigation Act of 2000 (DMA 2000), Hudson County and the jurisdictions located therein have developed this Hazard Mitigation Plan (HMP), which represents a regulatory update to the *2015 Hudson County Hazard Mitigation Plan* (HMP). The DMA 2000 amends the Robert T. Stafford Disaster Relief and Emergency Assistance Act (Stafford Act) and is designed to improve planning for, response to, and recovery from disasters by requiring state and local entities to implement pre-disaster mitigation planning and develop HMPs. The Federal Emergency Management Agency (FEMA) has issued guidelines for HMPs. The New Jersey Office of Emergency Management (NJOEM), also supports plan development for jurisdictions in New Jersey.

> ***Hazard Mitigation*** *is any sustained action taken to reduce or eliminate the long-term risk and effects that can result from specific hazards.*
>
> *FEMA defines a* ***Hazard Mitigation Plan*** *as the documentation of a state or local government evaluation of natural hazards and the strategies to mitigate such hazards.*

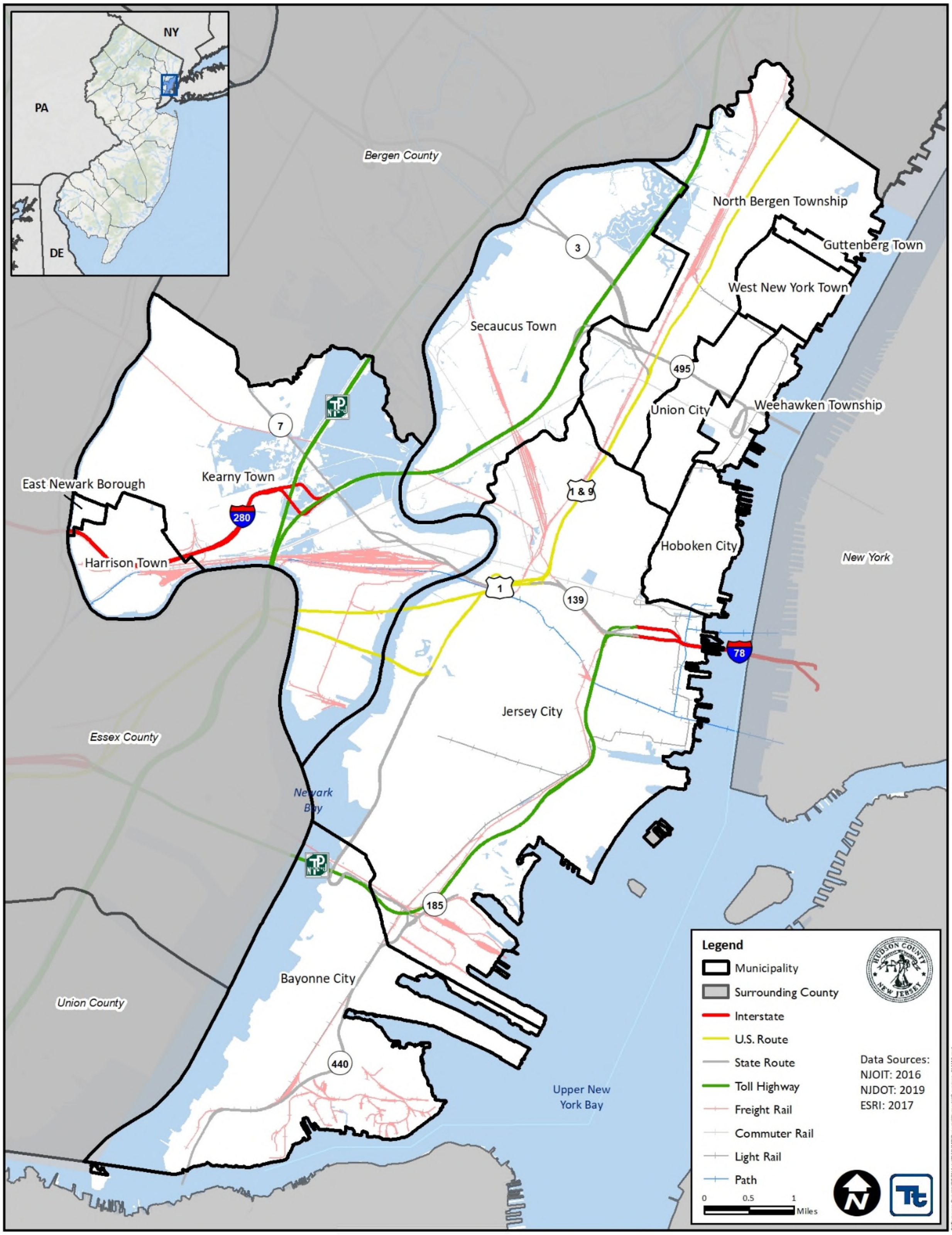
Specifically, the DMA 2000 requires that states, with support from local governmental agencies, develop and update HMPs on a five-year basis to prepare for and reduce the potential impacts of natural hazards. The DMA 2000 is intended to facilitate cooperation between state and local authorities, prompting them to work together. This enhanced planning better enables local and state governments to articulate accurate needs for mitigation, resulting in faster allocation of funding and more effective risk reduction projects.

Hudson County, all municipalities as well as Municipal Utility Authorities (MUAs) are participating in the plan update; refer to Table 1-1 and Figure 1-1. The only jurisdiction that participated in 2015 that did not participate in the 2020 update is the Bayonne MUA because the agency dissolved.

Table 1-1. Participating Jurisdictions

County	
Hudson County	
Municipalities	
City of Bayonne	Town of Kearny
Borough of East Newark	Township of North Bergen
Town of Guttenberg	Town of Secaucus
Town of Harrison	City of Union City
City of Hoboken	Township of Weehawken
City of Jersey City	Town of West New York
Municipal Utility Authorities	
Jersey City MUA	North Hudson Sewerage Authority
Kearny MUA	Secaucus MUA
North Bergen MUA	

Figure 1-1. Hudson County New Jersey



1.2 DMA 2000 Origins -The Stafford Act

In the early 1990s, a new federal policy regarding disasters began to evolve. Rather than reacting whenever disasters strike communities, the federal government began encouraging communities to first assess their vulnerability to various disasters and proceed to take actions to reduce or eliminate potential risks. The logic is that a disaster-resistant community can rebound from a natural disaster with less loss of property or human injury, at much lower cost, and, consequently, more quickly. Moreover, these communities minimize other costs associated with disasters, such as the time lost from productive activity by business and industries.

The DMA 2000 provides an opportunity for states, tribes, and local governments to take a new and revitalized approach to mitigation planning. The DMA 2000 amended the Stafford Act by repealing the previous mitigation planning provisions (Section 409) and replacing them with a new set of requirements (Section 322). Section 322 sets forth the requirements that communities evaluate natural hazards within their respective jurisdictions and develop an appropriate plan of action to mitigate those hazards, while emphasizing the need for state, tribal and local governments to closely coordinate mitigation planning and implementation efforts.

The amended Stafford Act requires that each local jurisdiction identify potential natural hazards to the health, safety, and well-being of its residents and identify and prioritize actions that the community can take to mitigate those hazards—before disaster strikes. To remain eligible for hazard mitigation assistance from the federal government, communities must first prepare and then maintain and update an HMP (this plan).

Responsibility for fulfilling the requirements of Section 322 of the Stafford Act and administering the FEMA Hazard Mitigation Program has been delegated to the State of New Jersey, specifically to NJOEM. FEMA also provides support through guidance, resources, and plan reviews.

1.3 Benefits of Mitigation Planning

Mitigation planning forms the foundation for Hudson County's long-term strategy to reduce disaster losses and break the cycle of disaster damage, reconstruction, and repeated damage. Mitigation planning also allows Hudson County, as a whole and with participating jurisdictions, to remain eligible for mitigation grant funding for mitigation projects that will reduce the impact of future disaster events. The long-term benefits of mitigation planning include the following:

National Benefit-Cost Ratio (BCR) Per Peril *BCR numbers in this study have been rounded	Beyond Code Requirements	Federally Funded
Overall Hazard Benefit-Cost Ratio	$4:1	$6:1
Riverine Flood	$5:1	$7:1
Hurricane Surge	$7:1	Too few grants
Wind	$5:1	$5:1
Earthquake	$4:1	$3:1
Wildland-Urban Interface Fire	$4:1	$3:1

Source: FEMA 2018; Federal Insurance Mitigation Administration 2018
Note: Natural hazard mitigation saves $6 on average for every $1 spent on federal mitigation grants.

- An increased understanding of hazards faced by Hudson County and their inclusive jurisdictions.
- Building more sustainable and disaster-resistant communities.
- Increasing education and awareness of hazards and their threats, as well as their risks.
- Developing implementable and achievable actions for risk reduction in the county and its jurisdictions.

- Building relationships by involving residents, organizations, and businesses.
- Identify implementation approaches that focus resources on the greatest risks and vulnerabilities.
- Financial savings through partnerships that support planning and mitigation efforts.
- Focused use of limited resources on hazards that have the biggest impact on the community.
- Reduced long-term impacts and damages to human health and structures.
- Reduced repair costs.

1.4 Hazard Mitigation Plan Overview

The structure of this HMP follows the four-phase planning process recommended by FEMA and summarized in Figure 1-2. Table 1-2 summarizes the requirements outlined in the DMA 2000 Interim Final Rule and provides the section where each is addressed in this HMP. This HMP is organized in accordance with FEMA and NJOEM guidance. This plan was prepared in accordance with the following regulations and guidance:

- FEMA Local Mitigation Planning Handbook, March 2013.
- FEMA Integrating Hazard Mitigation into Local Planning, March 1, 2013.
- FEMA Plan Integration: Linking Local Planning Efforts, July 2015.
- Local Mitigation Plan Review Guide, October 1, 2011.
- DMA 2000 (Public Law 106-390, October 30, 2000).
- 44 Code of Federal Regulations (CFR) Parts 201 and 206 (including: Feb. 26, 2002, Oct. 1, 2002, Oct. 28, 2003, and Sept. 13, 2004 Interim Final Rules).
- FEMA How-To Guide for Using HAZUS-MH-MH for Risk Assessment FEMA Document No. 433, February 2004.
- FEMA Mitigation Planning How-to Series (FEMA 386-1 through 4), 2002, available at: http://www.fema.gov/fima/planhowto.shtm.
- FEMA Mitigation Ideas: A Resource for Reducing Risk to Natural Hazards, January 2013

Figure 1-1. Hudson County Hazard Mitigation Planning Process

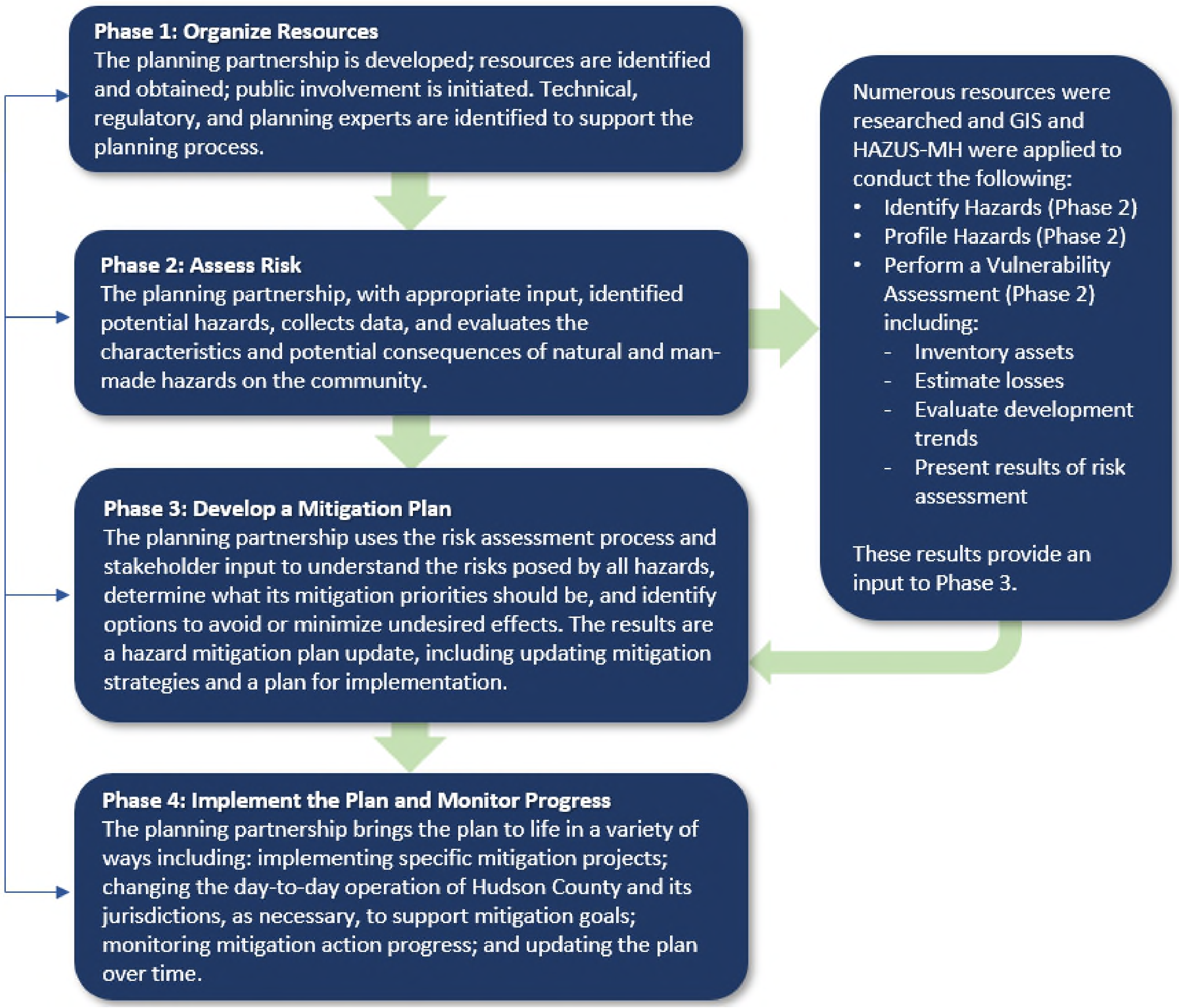


Table 1-1. FEMA Local Mitigation Plan Review Crosswalk

HMP Criteria	Primary Location in the HMP
Prerequisites	
Adoption by the Local Governing Body: §201.6(c)(5)	Section 1.0; Appendix A
Planning Process	
Documentation of the Planning Process: §201.6(b) and §201.6(c)(1)	Section 2.0; Section 8.0
Risk Assessment	
Identifying Hazards: §201.6(c)(2)(i)	Sections 4.1
Profiling Hazards: §201.6(c)(2)(i)	Section 4.3
Assessing Vulnerability: Overview: §201.6(c)(2)(ii)	Section 4.3
Assessing Vulnerability: Identifying Structures: §201.6(c)(2)(ii)(A)	Section 3.0, 4.2, Section 4.3; Section 9
Assessing Vulnerability: Estimating Potential Losses: §201.6(c)(2)(ii)(B)	Section 4.3; Section 9
Assessing Vulnerability: Analyzing Development Trends: §201.6(c)(2)(ii)(C)	Section 3.0; Section 4.3; Section 9
Mitigation Strategy	
Local Hazard Mitigation Goals: §201.6(c)(3)(i)	Section 6.0; Section 9
Identification and Analysis of Mitigation Actions: §201.6(c)(3)(ii)	Section 6.0; Section 9
Implementation of Mitigation Actions: §201.6(c)(3)(iii)	Section 6.0; Section 9
Multi-Jurisdictional Mitigation Actions: §201.6(c)(3)(iv)	Section 6.0; Section 9
Plan Maintenance Process	
Monitoring, Evaluating, and Updating the Plan: §201.6(c)(4)(i)	Section 7.0
Incorporation into Existing Planning Mechanisms: §201.6(c)(4)(ii)	Section 6.0, 7.0; Section 9
Continued Public Involvement: §201.6(c)(4)(iii)	Section 7.0

1.5 Planning Process Overview

Hudson County and the participating jurisdictions intend to implement this HMP with full coordination and participation of county and local departments, organizations and groups, and relevant state and federal entities. Coordination helps to ensure that stakeholders have established communication channels and relationships necessary to support mitigation planning and mitigation actions included in Section 6 (Mitigation Strategy) and Section 9 (Jurisdictional Annexes).

During the Hudson County HMP planning process, the nation, the State of New Jersey and Hudson County were facing the COVID-19 pandemic. The COVID-19 pandemic was declared a major disaster on March 25, 2020 (DR-4488). The Governor issued a stay-at-home Executive Order beginning March 21, 2020, which remained in effect the duration of the planning process, through submittal to the State of New Jersey Office of Emergency Management (NJOEM). Hudson County has been greatly impacted by the COVID-19 pandemic with, at the time of this submittal, the second highest number of positive COVID-19 test results in the State.

Similar to the 2015 HMP, Hudson County kept the list of hazards to be evaluated to natural hazards that align with the same natural hazards listed in the State Hazard Mitigation Plan. Hudson County acknowledges that other non-natural/human-caused or health-related hazards may impact the County (i.e., COVID-19); however, these hazards are covered in other County and State-level planning documents.

The Hudson County Office of Emergency Management (OEM), Steering Committee members and the planning partners (County departments, municipalities and municipal utility authorities) were facing the COVID-19 pandemic concurrent with completing the update to the HMP. Hudson County and all planning partners made their best effort to work through this unprecedented time to complete the HMP update and meet FEMA and State requirements. The majority of the public and stakeholder engagement strategy was implemented earlier in the planning process; however, in-person Steering Committee meetings and a final in-person draft HMP meeting was not scheduled due to the Executive Order in place and for the safety of residents and all planning partners. Instead, the Steering Committee continued to communicate via email and telephone to complete the review of the draft plan prior to submittal. The Hudson County OEM website was updated and social media was utilized to advertise the draft plan posting. All planning partners were notified that the draft plan was posted for public and stakeholder review, were provided social media posts/images, and were asked to distribute these notifications in their jurisdictions. Last, all stakeholders invited to the February 2020 workshop were notified via email that the draft plan was posted for public review and comment. Public and stakeholder comments received on the draft plan were shared with the planning partners via email. To complete the update to the draft plan prior to submission to NJOEM, teleconference meetings were held in a best effort to complete jurisdictional annexes given staffing constraints during the active pandemic.

1.6 Multiple Agency Support for Hazard Mitigation

Primary responsibility for the development and implementation of mitigation strategies and policies lies with local governments. However, local governments are not alone; various partners and resources at the regional, state, and federal levels are available to assist communities in the development and implementation of mitigation strategies. Within New Jersey, NJOEM is the lead agency providing hazard mitigation planning assistance to local jurisdictions. NJOEM provides guidance to support mitigation planning. In addition, FEMA provides grants, tools, guidance, and training to support mitigation planning.

> ***Steering Committee (SC)** is comprised of County and municipal representatives that guide and lead the HMP update process on behalf of the Planning Partnership.*
>
> ***Planning Committee (PC)** is comprised of representatives from each participating jurisdiction (County, municipal and MUAs).*
>
> ***Planning Partnership = SC + PC***

The Hudson County Office of Emergency Management and the Steering Committee provided project management and oversight of the planning process. Participating jurisdictions were asked to identify a primary and alternate local point of contact (POC) to be members of the Planning Committee and lead the planning process update on behalf of the jurisdiction. At the start of the planning process, each municipality identified their Floodplain Administrator and requested their involvement. Further, each jurisdiction was encouraged to form a 'mitigation team' comprised of representatives across departments to ensure broad participation, share the work of the update process and ensure accurate information was captured in their chapter, or annex. The mitigation team worked directly with the primary and alternate POCs and contributed to the jurisdictional annexes presented in Section 9. Together, the Steering Committee and Planning Committee are referred to as the Planning Partnership for the Hudson County HMP update. A list of Steering Committee and jurisdiction POCs is provided in Section 2 (Planning Process), while Appendix B (Participation Documentation) provides further documentation of the broader level of municipal involvement. Additional input and support for this planning effort was obtained from a range of agencies and through public and stakeholder involvement (as discussed in Section 2).

1.7 Goals and Objectives

The planning process included a review and update of the prior mitigation goals and objectives as a basis for the planning process and selection of appropriate mitigation actions addressing all hazards of concern. Further, the goal development process considered the mitigation goals expressed in the 2019 State of New Jersey HMP, as well as other relevant county and local planning documents, as discussed in Section 6 (Mitigation Strategy).

1.8 Hazards of Concern

Hudson County and participating jurisdictions reviewed the hazards that caused measurable impacts based on events, losses, and information available since the development of the 2015 Hudson County HMP and the 2019 State of New Jersey HMP. A list of potential hazards of concern was reviewed by the Planning Partnership, and each was evaluated to identify the hazards of concern for the 2020 update planning process. The list was presented to each of the participating jurisdictions where they evaluated their risk and vulnerability from each hazard of concern. While the overall hazard rankings were calculated for the County and each participating jurisdiction, the specific hazard rankings displayed in each annex reflect jurisdictional input. The hazard risk rankings were used to focus and prioritize individual jurisdictional mitigation strategies.

1.9 Plan Integration into Other Planning Mechanisms

Plan integration is the process by which jurisdictions look at their existing planning framework and align efforts with the goal of building a safer, smarter, and more resilient community. It is specific to each community and depends on the vulnerability of the built environment. Community-wide plan integration supports risk reduction through various planning and development measures, both before and after a disaster. Plan integration involves a community's plans, policies, codes, and programs that guide development and the roles of people and government in implementing these capabilities. Successful integration occurs through collaboration among a diverse set of stakeholders in the community (FEMA 2015).

Effective mitigation is achieved when hazard awareness and risk management approaches and strategies are integrated into local planning mechanisms and become an integral part of public activities and decision making. Within Hudson County, there are numerous existing plans and programs that support hazard risk management and reduction, and thus, it is critical that the 2020 HMP update integrates, coordinates with, and complements those mechanisms.

Section 5 (Capability Assessment) provides a summary and description of the existing plans, programs and regulatory mechanisms at all levels of government (federal, state, county, local) that support hazard mitigation within the County. Within each jurisdictional annex in Section 9 (Jurisdictional Annexes), the County and each participating jurisdiction identified how they have integrated hazard risk management into their existing planning, regulatory and operational/administrative framework ("existing integration"), and how they intend to promote this integration ("opportunities for future integration").

A further summary of these continued efforts to develop and promote a comprehensive and holistic approach to hazard risk management and mitigation is presented in Section 9 (Jurisdictional Annexes).

1.10 Implementation of Prior and Existing Local Hazard Mitigation Plans

Section 9 (Jurisdictional Annexes) of the plan present the status of the mitigation projects identified in the 2015 Hudson County HMP. Numerous projects and programs have been implemented that have reduced hazard vulnerability to assets in the planning area. The County and jurisdictional annexes, as well as plan maintenance procedures in Section 7 (Plan Maintenance), were developed to encourage specific activities. Future actions include integrating hazard mitigation goals into master plan updates; reviewing the HMP during updates of codes, ordinances, zoning, and development; and ensuring a more thorough integration of hazard mitigation, with its related benefits into municipal operations, will be completed within the upcoming five-year planning period.

1.11 Implementation of the Planning Process

The planning process and findings are required to be documented in local HMPs. To support the planning process in developing this HMP, Hudson County and the participating jurisdictions have accomplished the following:

- Developed a Steering Committee and countywide planning partnership with jurisdictions and stakeholders.
- Reviewed the 2015 Hudson County Hazard Mitigation Plan.
- Identified and reviewed those hazards that are of greatest concern to Hudson County and its jurisdictions (hazards of concern) to be included in the plan.
- Profiled the relevant hazards.
- Estimated the inventory at risk and potential losses associated with the relevant hazards.
- Reviewed and updated the hazard mitigation goals and objectives.
- Reviewed mitigation strategies identified in the 2015 Hudson County HMP.
- Developed new mitigation actions to address reduction of vulnerability of hazards of concern.
- Involved a wide range of stakeholders and the public in the plan process.
- Developed mitigation plan maintenance procedures to be executed after obtaining approval of the plan from NJOEM and FEMA.

As required by the DMA 2000, Hudson County and its participating jurisdictions have informed the public and provided opportunities for public comment and input. Numerous agencies and stakeholders have participated as core or support members by providing input and expertise throughout the planning process. Refer to Appendix D (Public and Stakeholder Outreach Documentation) for copies of public service announcements, social media posts and other forms of public and stakeholder outreach conducted.

1.12 Adoption

Upon FEMA Approval Pending Adoption (APA) status of the 2020 HMP update, Hudson County and each municipality will adopt the plan by resolution of local governing body. An example resolution to be submitted authorizing adoption of the 2020 Hudson County Hazard Mitigation Plan. The Hudson County and jurisdiction adoption resolutions will be included in Appendix A upon receipt of the FEMA APA status. Please refer to Section 8 (Planning Partnership) for additional information on plan adoption procedures.

1.13 Organization of the Hazard Mitigation Plan

The Hudson County HMP update is organized as a two-volume plan. Volume I provides information on the overall planning process and hazard profiling and vulnerability assessments, which serves as a basis for understanding risk and identifying mitigation actions. As such, Volume I is intended for use as a resource for on-going mitigation analysis. Volume II provides an annex dedicated to each participating jurisdiction. Each annex summarizes the jurisdiction's legal, regulatory, and fiscal capabilities; identifies vulnerabilities to hazards; documents mitigation plan integration with other planning efforts; records status of past mitigation actions; and presents an individualized mitigation strategy. The annexes are intended to provide a useful resource for each jurisdiction for implementation of mitigation projects and future grant opportunities, as well as place for each jurisdiction to record and maintain their local aspect of the countywide plan.

Volume I of this HMP includes the following sections:

Section 1: Introduction: Overview of participants, planning process and information regarding adoption of the HMP by Hudson County and each participating jurisdiction.

Section 2: Planning Process: Description of the HMP methodology and development process; Steering Committee, Planning Committee, Planning Partnership, and stakeholder involvement efforts; and a description of how this HMP will be incorporated into existing programs.

Section 3: County Profile: Overview of Hudson County, including: (1) physical setting, (2) land use, (3) land use trends, (4) population and demographics, (5) general building stock and (6) critical facilities and community lifelines.

Section 4: Risk Assessment: Documentation of the hazard identification and hazard risk ranking process, hazard profiles, and findings of the vulnerability assessment (estimates of the impact of hazard events on life, safety, health, general building stock, critical facilities, the economy); description of the status of local data; and planned steps to improve local data to support mitigation planning.

Section 5: Capability Assessment: A summary and description of the existing plans, programs and regulatory mechanisms at all levels of government (federal, state, county, local) that support hazard mitigation within the County.

Section 6: Mitigation Strategy: Information regarding the mitigation goals and objectives in response to priority hazards of concern and the process by which Hudson County and local mitigation strategies have been developed or updated.

Section 7: Plan Maintenance Procedures: System established to continue to monitor, evaluate, maintain, and update the HMP.

Volume II of this plan includes the following sections:

Section 8: Planning Partnership: Description of the planning partnership, their responsibilities, and description of jurisdictional annexes.

Section 9: Jurisdictional Annexes: Jurisdiction-specific annex for Hudson County and each participating jurisdiction containing their hazards of concern, hazard ranking, capability assessment, mitigation actions, action prioritization specific only to Hudson County or that jurisdiction, progress on prior mitigation activities (as applicable), and a discussion of prior local hazard mitigation plan integration into local planning processes.

Appendices include the following:

Appendix A: Plan Adoption: Resolutions from the County and each jurisdiction included as each formally adopts the HMP update.

Appendix B: Participation Documentation: Matrix to give a broad overview of who attended meetings and when input was provided to the HMP update, as well as Letters of Intent to Participate described in Section 2 (Planning Process), annex sign-off sheets discussed in Section 6 (Mitigation Strategy) and additional worksheets submitted during workshops conducted throughout the planning process.

Appendix C: Meeting Documentation: Agendas, attendance sheets, minutes, and other documentation (as available and applicable) of planning meetings convened during the development of the plan.

Appendix D: Public and Stakeholder Outreach Documentation: Documentation of the public and stakeholder outreach effort including webpages, informational materials, public and stakeholder meetings and presentations, surveys, and other methods used to receive and incorporate public and stakeholder comment and input to the plan process.

Appendix E: Risk Assessment Supplementary Data: Expanded explanation of community lifelines; critical facility storm surge exposure results by municipality; and the previous hazard events from the 2015 HMP.

Appendix F: Mitigation Strategy Supplementary Data: Documentation of the broad range of actions identified during the mitigation process; types of mitigation actions; the mitigation catalog developed using jurisdiction input and potential mitigation funding sources.

Appendix G: Plan Maintenance Tools: Examples of plan review tools and templates available to support annual plan review.

1.14 The Updated Plan – What is Different?

Both the planning process and the 2020 HMP have been enhanced for this update. An increased effort to actively engage stakeholders and the public was a focus of the update; as well as the continued education of the Planning Partnership of mitigation and available grant funding opportunities. Further, the sections in the 2020 HMP have been realigned to increase the readability of the plan. The following summarizes process and plan changes that differ from the 2015 process and HMP:

- Section 2 (Planning Process) was formerly Section 3 in the 2015 HMP and now comprises the Planning Process section of the plan. Adoption information has been re-located to Section 8 (Planning Partnership) and Appendix A.
- Section 5 (Capability Assessment) and Section 9 (Jurisdictional Annexes) are subject to several changes of the capability assessment, both in Volumes I and II of the plan.
    - Section 5 (Capability Assessment) is now a stand-alone section for the capability assessment summarizing existing plans, programs and regulatory mechanisms at all levels of government (federal, state, county, local) that support hazard mitigation within the County. This information was formerly part of Section 6 (Mitigation Strategy) in the 2015 HMP.
    - Section 9 (Jurisdictional Annexes) has an expanded capability assessment to include additional planning mechanisms in New Jersey as well as information regarding plan integration in the Planning, Legal and Regulatory table.
- The jurisdictional annexes in Section 9 have been enhanced to include the following:
    - Identification of the NFIP Floodplain Administrator as part of the hazard mitigation planning team.
    - Expanded capability assessment including the identification of additional administrative and technical capabilities and catalog of adaptive capacity for each hazard of concern for each jurisdiction.
    - Inclusion of a table of jurisdiction-specific risk assessment results per hazard.
    - Expansion of the critical facility and lifeline flood hazard exposure table to include a mitigation action, if appropriate.
    - A user-friendly presentation of the hazard ranking results.
    - A revised 2015 previous mitigation strategy status table to more clearly identify if the action is to be included in the 2020 HMP update.
    - An increased focus on actionable projects has been applied; removing actions that are capabilities and focusing on high-ranked hazards.
    - A more detailed proposed mitigation action table that now specifies the problem statement and the proposed solution (mitigation action). The more detailed mitigation strategy is also reflected in the mitigation action worksheets that also include additional details.
    - A table that summarizes the actions across the ranked hazards and their mitigation action types.
    - Individuals that contributed to the annex are specifically listed at the end of the section.
    - Mitigation action worksheets have only been developed for FEMA-eligible projects, per NJOEM guidance.
- Newly available data provided for a more detailed and accurate risk assessment.
    - The updated plan is based on new inventory data and hazard data.
    - The topic of FEMA lifelines is included. All jurisdictions identified critical facilities considered lifelines in accordance with FEMA's definition.

  - o The flood hazard was expanded to include urban flooding or flooding outside of the floodplain. The Planning Partnership identified locations of urban flooding which was developed into a spatial layer to inform the mitigation strategy.
- A focused stakeholder engagement session was held where State and regional agencies across numerous sectors were involved including utilities, academia, transportation, neighboring counties including New York City, the New Jersey Sports Exposition Authority and others to inform the risk assessment, capability assessment and mitigation strategy.
- To increase public engagement, the following efforts were made:
  - o Multi-lingual public outreach strategy (English, Spanish, Chinese and Hindi) to reach a broader audience in the County (informational materials, social media posts and translator at a public engagement event).
  - o All Planning Partnership meetings were made open to the public.
  - o Social media (Facebook and Twitter) was used to inform the public of meetings and to take the citizen survey.
- A grant-funding webinar was conducted to summarize the upcoming fiscal year 2019 FEMA Hazard Mitigation Assistance grant funding opportunity and how jurisdictions can leverage the HMP update and develop competitive applications and benefit-cost analyses. In addition, the planning consultant and NJOEM met with individual municipalities that expressed interest in applying to assist with identifying projects and providing guidance on the information needed to complete the grant application and BCA process.
- A user-friendly tone was used to cater to the strong desire for this plan to be understandable to the general public and not overly technical. This includes limiting the hazard profile section to brief summaries and providing an increased number of graphical summaries throughout the risk assessment.
- An enhanced mitigation strategy process was utilized to develop a robust and actional action plan.
  - o A mitigation toolbox was built to assist with mitigation action identification.
  - o Utilizing the risk assessment and capability assessment results, problem statements were drafted by each municipality and used to inform the mitigation action development.
  - o Actions are identified, rather than strategies. Strategies provide direction, but actions are fundable under grant programs. The identified actions are designed to meet multiple measurable objectives, so that each planning partner can measure the effectiveness of their mitigation actions.
- The plan maintenance strategy is more clearly defined to provide a roadmap for the annual monitoring of the plan.

Table 1-2 indicates the major changes between the two plans as they relate to 44 CFR planning requirements.

Table 1-2. HMP Changes Crosswalk

44 CFR Requirement	2015 HMP	2020 Updated HMP
Requirement §201.6(b): In order to develop a more comprehensive approach to reducing the effects of natural disasters, the planning process shall include: (1) An opportunity for the public to comment on the plan during the drafting stage and prior to plan approval; (2) An opportunity for neighboring communities, local and regional	The 2015 plan followed an outreach strategy utilizing multiple media developed and approved by the Steering Committee. This strategy involved the following: • Public participation on an oversight Steering Committee. • Establishment of a plan informational website. • Press releases.	Building upon the success of the 2015 plan, the 2020 planning effort deployed an enhanced public engagement methodology: • Multi-lingual informational materials and news release • Use of social media. • Web-deployed survey • All meetings open to the public • Stakeholder session

44 CFR Requirement	2015 HMP	2020 Updated HMP
agencies involved in hazard mitigation activities, and agencies that have the authority to regulate development, as well as businesses, academia and other private and non-profit interests to be involved in the planning process; and (3) Review and incorporation, if appropriate, of existing plans, studies, reports and technical information.	• Use of public and stakeholder information surveys. Stakeholders were identified and coordinated with throughout the process. A comprehensive review of relevant plans and programs was performed by the planning team.	As with the 2015 plan, the 2020 planning process identified key stakeholders and coordinated with them throughout the process. A comprehensive review of relevant plans and programs was performed by the planning team.
§201.6(c)(2): The plan shall include a risk assessment that provides the factual basis for activities proposed in the strategy to reduce losses from identified hazards. Local risk assessments must provide sufficient information to enable the jurisdiction to identify and prioritize appropriate mitigation actions to reduce losses from identified hazards.	The 2015 plan included a comprehensive risk assessment of hazards of concern. Risk was defined as (probability x impact), where impact is the impact on people, property, and economy of the planning area. All planning partners ranked hazard risk as it pertains to their jurisdiction. The potential impacts of climate change are discussed for each hazard.	The same methodology, using new, updated data, was deployed for the 2020 plan update. The flood hazard was expanded to include urban flooding (or flooding outside of the floodplain). The hazard ranking methodology was expanded to include adaptive capacity and climate change. Jurisdiction-specific risk assessment results are summarized in Section 4 (Risk Assessment) and in each jurisdictional annex (Section 9).
§201.6(c)(2)(i): [The risk assessment] shall include a] description of the … location and extent of all-natural hazards that can affect the jurisdiction. The plan shall include information on previous occurrences of hazard events and on the probability of future hazard events.	The 2015 plan presented a risk assessment of each hazard of concern. Each section included the following: • Hazard profile, including maps of extent and location, previous occurrences, and probability of future events. • Climate change impacts on future probability. • Impact and vulnerability on life, health, safety, general building stock, critical facilities, and economy. • Future growth and development.	The same format, using new and updated data, was used for the 2020 plan update. Each section of the risk assessment includes the following: • Hazard profile, including maps of extent and location, previous occurrences, and probability of future events. • Climate change impacts on future probability using the best available data for New Jersey. • Newly available study from North Jersey Transportation Planning Authority (NJTPA) was used to inform the risk assessment. • Vulnerability assessment includes: impact on life, safety, and health, general building stock, critical facilities/lifelines, and the economy, as well as future changes that could impact vulnerability (population, development and climate). • The vulnerability assessment also includes changes in vulnerability since the 2015 plan.
§201.6(c)(2)(ii): [The risk assessment] shall include a] description of the jurisdiction's vulnerability to the hazards described in paragraph (c)(2)(i). This description shall include an overall summary of each hazard and its impact on the community.	Vulnerability was assessed for all hazards of concern. The HAZUS-MH-MH computer model was used for the coastal storm, earthquake, and flood hazards. These were Level 2 analyses using County data. Site-specific data on County-identified critical facilities were entered into the HAZUS-MH	The same methodology was deployed for the 2020 plan update, using new and updated data.

44 CFR Requirement	2015 HMP	2020 Updated HMP
	model. HAZUS-MH outputs were generated for other hazards by applying an estimated damage function to an asset inventory extracted from HAZUS-MH-MH.	
§201.6(c)(2)(ii): [The risk assessment] must also address National Flood Insurance Program insured structures that have been repetitively damaged floods.	A summary of NFIP insured properties including an analysis of repetitive loss property locations was included in the plan.	The same methodology was deployed for the 2020 plan update using new and updated data.
Requirement §201.6(c)(2)(ii)(A): The plan should describe vulnerability in terms of the types and numbers of existing and future buildings, infrastructure and critical facilities located in the identified hazard area.	A complete inventory of the numbers and types of buildings exposed was generated for each hazard of concern. The Steering Committee defined "critical facilities" for the planning area, and these were inventoried by exposure. Each hazard chapter provides a discussion on future development trends.	The same methodology was deployed for the 2020 plan update using new and updated data. In addition, all jurisdictions identified which critical facilities are considered lifelines in accordance with FEMA's definition.
Requirement §201.6(c)(2)(ii)(B): [The plan should describe vulnerability in terms of an] estimate of the potential dollar losses to vulnerable structures identified in paragraph (c)(2)(i)(A) and a description of the methodology used to prepare the estimate.	Loss estimates were generated for all hazards of concern. These were generated by HAZUS-MH-MH for the coastal storm, earthquake, and flood hazards. For the other hazards, loss estimates were generated by applying a regionally relevant damage function to the exposed inventory. In all cases, a damage function was applied to an asset inventory. The asset inventory was the same for all hazards and was generated in HAZUS-MH.	The same methodology was deployed for the 2020 plan update using new and updated data.
Requirement §201.6(c)(2)(ii)(C): [The plan should describe vulnerability in terms of] providing a general description of land uses and development trends within the community so that mitigation options can be considered in future land use decisions.	There is a summary of anticipated development in the County profile, as well as in each individual annex.	The same methodology was deployed for the 2020 plan update using new and updated data. If available, mitigation measures being considered for new development identified in hazard areas is noted in Section 9 (Jurisdictional Annexes).
§201.6(c)(3):[The plan shall include a mitigation strategy that provides the jurisdiction's blueprint for reducing the potential losses identified in the risk assessment, based on existing authorities, policies, programs and resources, and its ability to expand on and improve these existing tools.]	The 2015 plan contained goals, objectives and actions. Each planning partner identified actions that could be implemented within their capabilities. The actions were jurisdiction-specific and strove to meet multiple objectives. All objectives met multiple goals and stand alone as components of the plan. Each planning partner completed an assessment of its regulatory, technical, and financial capabilities.	The same methodology to review the goals and objectives, and actions was applied to the 2020 plan update. The Steering Committee reviewed and updated the goals, and objectives and they were approved by the Planning Committee. A mitigation strategy workshop with associated tools and guidance on problem statement development was deployed to inform the identification of mitigation actions. Actions that were completed or no longer considered to be feasible were removed; and actions considered capabilities were moved to the capability and integration sections. The balance of the actions was carried over to the 2020 plan, and in

44 CFR Requirement	2015 HMP	2020 Updated HMP
		some cases, new actions were added to the action plan.
Requirement §201.6(c)(3)(i): [The hazard mitigation strategy shall include a] description of mitigation goals to reduce or avoid long-term vulnerabilities to the identified hazards.	The Steering Committee identified goals, and objectives targeted specifically for this hazard mitigation plan. These planning components supported the actions identified in the plan.	The same methodology to review the goals and objectives, and actions was applied to the 2020 plan update. The Steering Committee reviewed and updated goals, and objectives and they were approved by the Planning Committee.
Requirement §201.6(c)(3)(ii): [The mitigation strategy shall include a] section that identifies and analyzes a comprehensive range of specific mitigation actions and projects being considered to reduce the effects of each hazard, with particular emphasis on new and existing buildings and infrastructure.	The 2015 plan included mitigation action worksheets that evaluated alternative actions considered for the final mitigation strategy.	For the 2020 update, a mitigation catalog was developed to provide a comprehensive range of specific mitigation actions to be considered. A table with the analysis of mitigation actions by type and hazard was used in jurisdictional annexes to the plan. Mitigation action worksheets with an alternatives evaluation were prepared for FEMA-eligible projects.
Requirement: §201.6(c)(3)(ii): [The mitigation strategy] must also address the jurisdiction's participation in the National Flood Insurance Program, and continued compliance with the program's requirements, as appropriate.	All municipal planning partners that participate in the National Flood Insurance Program indicated their commitment to maintain compliance and good standing under the program.	The same methodology was deployed for the 2020 plan update, using new and updated data. Municipalities with repetitive and severe repetitive loss properties included an action to mitigate those properties.
Requirement: §201.6(c)(3)(iii): [The mitigation strategy shall describe] how the actions identified in section (c)(3)(ii) will be prioritized, implemented and administered by the local jurisdiction. Prioritization shall include a special emphasis on the extent to which benefits are maximized according to a cost benefit review of the proposed projects and their associated costs.	Each recommended action was prioritized using a revised methodology based on the STAPLEE criteria was used to prioritize projects.	A revised methodology based on the STAPLEE criteria and using new and updated data was used for the 2020 plan update. The 14 criteria were used to evaluate each potential mitigation action. The evaluation included a qualitative benefits and cost review. The results of the evaluation were used to identify the actions to include in the plan and assist with the prioritization. An emphasis was placed on benefits and costs (quantified where possible and listed in the mitigation action worksheets), as well as timeline for implementation (also documented in the mitigation action worksheets for FEMA-eligible projects).
Requirement §201.6(c)(4)(i): [The plan maintenance process shall include a] section describing the method and schedule of monitoring, evaluating, and updating the mitigation plan within a five-year cycle.	The 2015 plan outlined a detailed maintenance strategy.	The 2020 plan details a plan maintenance strategy similar to that of the initial plan. It has been enhanced to provide a roadmap for the annual monitoring of the plan. This includes the inclusion of a summary plan maintenance matrix that provides an overview of the planning partner responsibilities for monitoring, evaluation, and update of the plan.

44 CFR Requirement	2015 HMP	2020 Updated HMP
Requirement §201.6(c)(4)(ii): [The plan shall include a] process by which local governments incorporate the requirements of the mitigation plan into other planning mechanisms such as comprehensive or capital improvement plans, when appropriate.	The 2015 plan details recommendations for incorporating the plan into other planning mechanisms.	The 2020 plan details recommendations for incorporating the plan into other planning mechanisms such as the following: • Master Plan • Emergency Response Plan • Capital Improvement Programs • Municipal Code
Requirement §201.6(c)(4)(iii): [The plan maintenance process shall include a] discussion on how the community will continue public participation in the plan maintenance process.	The 2015 plan details a strategy for continuing public involvement.	The 2015 plan maintenance strategy was enhanced for the 2020 plan. In addition, the County will use a proprietary online tool to support the annual progress reporting of mitigation actions. Section 7 (Plan Maintenance) also details the continued public participation in the plan maintenance process.
Requirement §201.6(c)(5): [The local hazard mitigation plan shall include] documentation that the plan has been formally adopted by the governing body of the jurisdiction requesting approval of the plan (e.g., City Council, County Commissioner, Tribal Council).	Hudson County and all jurisdictions participated in the 2015 HMP.	The 2020 plan achieves DMA compliance for Hudson County and all jurisdictions. Resolutions for each partner adopting the plan can be found in Appendix A of this volume.

SECTION 2. PLANNING PROCESS

2020 HMP Changes

- The sections in the 2020 HMP were realigned to increase the readability of the plan. Section 2 (formerly Section 3 in the 2015 HMP) now comprises the Planning Process section of the plan.
- All aspects of the planning process were updated for the 2020 HMP.
- Public outreach was enhanced to reach a broader audience by using additional medial outlines (Facebook, Twitter) and having multi-lingual materials (brochure, social media posts).
- Stakeholder outreach was enhanced by holding a workshop to obtain a comprehensive understanding of capabilities, vulnerabilities, and potential mitigation projects from local, regional and state stakeholders.
- Workshop-style meetings were held with the Planning Partnership to engage participants, using small break-out groups and large-scale poster maps to convey hazard vulnerability and assist with hazard ranking updates.

2.1 Introduction

This section includes a description of the planning process used to update the 2015 Hudson County Hazard Mitigation Plan (HMP), including how it was prepared, who was involved in the process, and how stakeholders and the public were involved. To ensure that the plan meets requirements of the DMA 2000 and that the planning process would have the broad and effective support of the participating jurisdictions, regional and local stakeholders, and the public, an approach to the planning process and plan documentation was developed to achieve the following goals:

- The HMP will be multi-jurisdictional. Hudson County invited all municipalities and Municipal Utility Authorities (MUAs) in the County to join with them in the preparation of the Hudson County Hazard Mitigation Plan. Hudson County and all invited participants actively participated in the HMP.

- The HMP will consider natural hazards facing Hudson County, thereby satisfying the natural hazards mitigation planning requirements specified in DMA 2000.

- The HMP will be developed following the process outlined by DMA 2000, FEMA regulations, and prevailing FEMA and NJOEM guidance. Following this process ensures all the requirements are met and support HMP review.

The Hudson County HMP update was written using the best available information obtained from a wide variety of sources. Throughout the HMP update process, a concerted effort was made to gather information from local and regional agencies and staff, as well as stakeholders, federal and state agencies, and the residents of the County. The HMP Steering and Planning Committees, described in subsection 2.2 below, solicited information from local agencies and individuals with specific knowledge of certain hazards and past historical events, as well as considering planning and zoning codes, ordinances, and other recent planning decisions. The hazard mitigation strategies identified in this HMP have been developed through an extensive planning process involving local, county and regional agencies, County residents and stakeholders.

This section describes the mitigation planning process, including (1) Organization of the Planning Process; (2) Stakeholder Outreach and Involvement; (3) Integration of Existing Data, Plans, and Technical Information; (4) Integration with Existing Planning Mechanisms and Programs; and (5) Continued Public Involvement.

2.2 Organization of the Planning Process

Many parties supported the preparation of this HMP update: County officials, municipal officials, stakeholders, and consultants. This planning process does not represent the start of hazard risk management in Hudson County, rather it is part of an ongoing process that various State, County and local agencies and individuals have continued to embrace. A summary of the past and ongoing mitigation efforts is provided in Section 6 (Mitigation Strategy), as well as in Volume II Section 9 (Jurisdictional Annexes), to give a historical perspective of the county and local activities implemented to reduce vulnerablity to hazards in the planning area.

This section of the HMP identifies how the planning process was organized with the many "planning partners" involved and outlines the major activities that were conducted in the development of this HMP update.

2.2.1 ORGANIZATION OF PLANNING PARTNERSHIP

Recognizing the need to manage risk within the County, and to meet the requirements of the DMA 2000, the Hudson County Office of Emergency Management led the update to the 2015 Hudson County Hazard Mitigation Plan. Hudson County was notified by NJOEM that their application for a planning grant to update their 2015 Hazard Mitigation Plan under FEMA's Hazard Mitigation Grant Program (PDMC-PL-02-NJ-2016-005) was approved. The County selected a contract planning consultant (Tetra Tech Inc. – Parsippany, NJ) to guide the County and participating jurisdictions through the HMP update process. A contract between Tetra Tech Inc. (Tetra Tech) and the County was executed in April 2019. Specifically, Tetra Tech, the "contract consultant", was tasked with the following:

- Assisting with the organization of a Steering Committee and Planning Committee.
- Assisting with the development and implementation of a public and stakeholder outreach program.
- Data collection.
- Facilitation and attendance at meetings (Steering Committee, Planning Committee, stakeholder, public and other).
- Review and update of the hazards of concern, and hazard profiling and risk assessment.
- Assistance with the review and update of mitigation planning goals and objectives.
- Assistance with the review of progress of past mitigation strategies.
- Assistance with the screening of mitigation actions and the identification of appropriate actions.
- Assistance with the prioritization of mitigation actions.
- Authoring of the draft and final HMP documents.

In March 2019, Hudson County's Office of Emergency Management notified all municipalities and MUAs in Hudson County of the pending planning process and invited them to formally participate. Municipalities and MUAs were provided with a copy of the Planning Partner Expectations and asked to formally notify the County of their intent to participate [via a Letter of Intent to Participate (LOIP)] and to identify a primary and secondary planning point of contact to serve on a Planning Committee and represent the interests of their respective community. In addition, each municipal Floodplain Administrator (FPA) was identified in the LOIP and requested to actively participate in the planning process. Section 9 (Jurisdictional Annexes) and Appendix B (Participation Documentation) detail contributions provided by the FPA. All jurisdictions returned their Letter of Intent to Participate. Appendix B also provides copies of their LOIPs.

To facilitate HMP development, Hudson County developed a Steering Committee to provide guidance and direction to the HMP update effort and to ensure the resulting document will be embraced both politically and by the constituency within the planning area. All jurisdictions participating in the plan update authorized the Steering Committee to perform certain activities on their behalf, via the LOIP. Specifically, the Steering Committee was charged with the following:

Steering Committee (SC) *is comprised of County and municipal representatives and stakeholders that guide and lead the HMP update process on behalf of the Planning Partnership.*
Planning Committee (PC) *is comprised of representatives from each participating jurisdiction (County and municipal).*

Planning Partnership = SC + PC

- Providing guidance and overseeing the planning process on behalf of the general planning partnership.
- Attending and participating in Steering Committee meetings.
- Assisting with the development and completion of certain planning elements, including the following:
  - Identification of "Hazards of Concern."
  - Public and Stakeholder Outreach.
  - Mitigation Planning Goals and Objectives.
  - Identification and screening of appropriate mitigation strategies and activities.
  - Reviewing and commenting on plan documents prior to submission to NJOEM and FEMA.

The organizational structure was successfully implemented for the 2020 HMP updated consistent with the development of the initial 2015 planning process; new Steering Committee member includes a representative from a local jurisdiction, the City of Hoboken's Resilience Officer (see Table 2-1). The Steering Committee provided guidance and leadership, oversight of the planning process, and acted as the point of contact for all participating jurisdictions and the various interest groups in the planning area.

Table 2-1. Hudson County Hazard Mitigation Steering Committee Members

Name	Title
James Woods	Hudson County OEM, Coordinator
George Johns	Hudson County OEM, Deputy Coordinator
Peter Nevins	Hudson County OEM, Emergency Planner
Nick Kormash	Hudson County Prosecutors Office, Critical Infrastructure
Chin Micko	Hudson County Prosecutors Office, Joint Terrorism Task Force
Kevin O'Reilly (Alt.)	Hudson County Prosecutors Office, Critical Infrastructure
David Drumeler	Hudson County Deputy Administrator
Sean O'Connor	Hudson County Communications
Francesca Giarratana	Hudson County Division of Planning, Director
Daryl Krasnuk	Hudson County Division of Planning, GIS
Thomas Malavasi	Hudson County Engineer
Ralph Sax	Hudson County Roads and Public Property, Deputy Director
Carrie Nawrocki (Alt)	Hudson Regional Health Commission
Angela DeQuina	Hudson Regional Health Commission

Name	Title
Norman Guerra	Hudson County Improvement Authority
Caleb Stratton	City of Hoboken, Resilience Officer

Each municipality and MUA received a copy of the “Planning Partner Expectations” which outlined the responsibilities of the participants and the agreement of the partners to authorize the Steering Committee to represent the jurisdiction in the completion of certain planning elements. Table 2-2 lists the current members of the Planning Partnership (Steering Committee and Planning Committee), at the time of this HMP’s publication. Please note that while Steering Committee members are also part of the overall project Planning Partnership fulfilling these responsibilities on behalf of Hudson County. The Planning Partnership was charged with the following:

- Represent their jurisdiction throughout the planning process.
- Assure participation of all department and functions within their jurisdiction that have a stake in mitigation (e.g., planning, engineering, code enforcement, police and emergency services, public works).
- Assist in gathering information for inclusion in the HMP update, including the use of previously developed reports and data.
- Support and promote the public involvement process.
- Report on progress of mitigation actions identified in prior or existing HMPs, as applicable.
- Identify, develop, and prioritize appropriate mitigation initiatives.
- Report on progress of integration of prior or existing HMPs into other planning processes and municipal operations.
- Support and develop a jurisdictional annex for their jurisdiction.
- Review, amend, and approve all sections of the plan update.
- Adopt, implement, and maintain the plan update.

The Planning Committee was charged with the following:

- Represent their jurisdiction throughout the planning process;
- Establish plan development goals;
- Establish a timeline for completion of the plan;
- Ensure that the plan meets the requirements of DMA 2000 and FEMA and NJOEM guidance;
- Solicit and encourage the participation of regional agencies, a range of stakeholders, and citizens in the plan development process;
- Assist in gathering information for inclusion in the plan, including the use of previously developed reports and data;
- Organize and oversee the public involvement process;
- Involve your local NFIP Floodplain Administrator in the planning process.
- Report on progress of 2015 HMP mitigation actions;
- Identify, develop and prioritize appropriate mitigation initiatives;
- Report on progress of 2015 HMP integration into other planning processes and municipal operations;
- Review, amend and approve all sections of the plan;
- Develop and author the jurisdictional annex for their jurisdiction;
- Develop, revise, adopt, and maintain the plan.

Table 2-2. Hudson County Hazard Mitigation Planning Partnership Members

Name	Organization/Title	Steering Committee Member
James Woods	Hudson County OEM, Coordinator	X
George Johns	Hudson County OEM, Deputy Coordinator	X
Peter Nevins	Hudson County OEM, Emergency Planner	X
Nick Kormash	Hudson County Prosecutors Office, Critical Infrastructure	X
Chin Micko	Hudson County Prosecutors Office, Joint Terrorism Task Force	X
Kevin O’Reilly (Alt.)	Hudson County Prosecutors Office, Critical Infrastructure	X
David Drumeler	Hudson County Deputy Administrator	X
Sean O’Connor	Hudson County Communications	X
Francesca Giarratana	Hudson County Division of Planning, Director	X
Daryl Krasnuk	Hudson County Division of Planning, GIS	X
Thomas Malavasi	Hudson County Engineer	X
Ralph Sax	Hudson County Roads and Public Property, Deputy Director	X
Carrie Nawrocki	Hudson Regional Health Commission	X
Angela DeQuina	Hudson Regional Health Commission	X
Norman Guerra	Hudson County Improvement Authority	X
Caleb Stratton	City of Hoboken, Resilience Officer	X

Jurisdiction	Name/Title	Primary POC	Secondary POC	NFIP Floodplain Administrator
Hudson County	Francesca Giarratana, Director, Division of Planning	X		
	James Woods, Coordinator, Hudson County OEM		X	
City of Bayonne	Edwardo Ferrante Jr, OEM Coordinator	X		
	Keith Weaver, Fire Chief		X	
	Rob Russo, City Engineer			X
Borough of East Newark	Dina Grilo	X		
	Anthony Monteiro		X	
	Mark Sadonis, Construction Official/Zoning Officer			X
Town of Guttenberg	Richard Delafuente, OEM Coordinator	X		
	Justin Mack, Deputy OEM Coordinator		X	
	Jorge Gonzalez, Construction Code Official			X
Town of Harrison	Harold Stahl, OEM Coordinator/Fire Chief	X		
	Rocco Russomanno, Construction Official and Engineer		X	X
City of Hoboken	Caleb Stratton, Chief Resilience Officer/Transportation/OEM	X		
	Sgt. William Montanez, Police/OEM		X	
	Ann Holtzman, Zoning Officer/Floodplain Administrator			X
City of Jersey City	W. Greg Kierce, OEM/Homeland Security	X		
	Robert Daily, Deputy Chief Fire Department		X	
	Raymond Meyer, Building Official			X
Town of Kearny	Sgt. Peter D. Blair, Deputy OEM Coordinator, Police Department	X		
	Chief George King, OEM Coordinator, Police Department		X	
	Anthony Chiasari, Construction/Zoning Official			X
Township of North Bergen	Dave Ricigliano, OEM Coordinator	X		
	Bernard Mirandi, Township Engineer		X	X
Town of Secaucus	Kevin O'Connor, DPW Supervisor	X		X
	Vincent Massaro Jr., OEM Coordinator		X	
City of Union City	Ralph Tango, Engineer	X		
	Mario Boron, OEM Director		X	
	Susan Colditz, Finance Director		X	
	Marty Martinetti, Building Code Official			X
Town of Weehawken	Giovanni D. Ahmad, Manager	X		
	Jeffrey Fulcher, Deputy Director, Weehawken DPS		X	
	Frank Tattoli, Construction Official			X
Town of West New York	Lewis Cannao, OEM Coordinator	X		
	Robert Antolos, Public Safety Director		X	
	Paul Cray, Engineer			X

Jurisdiction	Name/Title	Primary POC	Secondary POC	NFIP Floodplain Administrator
Jersey City MUA	Richard Haytas, Chief Engineer	X		
	Brian Messler, Engineer		X	
North Bergen MUA	Frank Pestana, Executive Director	X		
	Dave Ricigliano, OEM Coordinator		X	
	Bernie Mirandi, Floodplain Administrator			X
North Hudson Sewerage Authority	Philip Reeve, Assistant Project Director	X		
	Steven Hudock, Site Safety Coordinator		X	
Secaucus MUA	Glenn Beckmeyer, Engineer	X		
	Brian Bigler, Executive Director		X	
Kearny MUA	Ceren Aralp, MUA Engineer	X		
	Gregg Paster, MUA Attorney		X	

The jurisdictional Letter of Intent to Participate identifies the above "Planning Partner Expectations" as serving to identify those activities comprising overall participation by jurisdictions throughout the planning process. The jurisdictions in Hudson County have differing levels of capabilities and resources available to apply to the plan update process, and further have differing exposure and vulnerability to the hazard risks being considered in this HMP. Hudson County's intent was to encourage participation by all-inclusive municipalities and municipal utility authorities, and to accommodate their specific needs and limitations while still meeting the intents and purpose of plan participation. Such accommodations have included the establishment of a Steering Committee and engaging a contract consultant to assume certain elements of the planning process on behalf of the jurisdictions, and to provide additional and alternative mechanisms to meet the purposes and intent of mitigation planning.

Ultimately, jurisdictional participation is evidenced by a completed annex (chapter) of the HMP (Section 9) wherein the jurisdictions have identified their planning points of contact, evaluated their risk to the hazards of concern, identified their capabilities to effect mitigation in their community, and identified and prioritized an appropriate suite of mitigation initiatives, actions, and projects to mitigate their natural hazard risk; and eventually by the adoption of the updated plan via resolution.

Appendix B (Participation Documentation) identifies those individuals who represented their jurisdictions during this planning effort and indicates how they contributed to the planning process. This matrix is intended to give a broad overview of who attended meetings and when input was provided. All participants were encouraged to attend the Kick-off Meeting, Risk Assessment and Mitigation Action Workshop. During the planning process the planning consultant contacted each participant to offer support, explain the process, meet individually to collect updated information and to facilitate the submittal and review of critical documents.

All municipalities actively participate in the National Flood Insurance Program (NFIP) and have designated NFIP Floodplain Administrators (FPA). All known FPAs were informed of the planning process, were provided the opportunity to review the plan including the jurisdictional annex and provide direct input to the plan update. Local FPAs are identified in the Points of Contact and Administrative and Technical portions of the jurisdictional annexes in Section 9 (Jurisdictional Annexes).

2.2.2 PLANNING ACTIVITIES

Members of the Planning Partnership (individually and as a whole), as well as key stakeholders, convened and/or communicated regularly to share information and participate in workshops to identify hazards; assess risks; review existing inventories of and identify new critical facilities; assist in updating and developing new mitigation goals and strategies; and provide continuity through the process to ensure that natural hazards vulnerability information and appropriate mitigation strategies were incorporated. All members of the Steering Committee and Planning Partnership had the opportunity to review the draft plan and supported interaction with other stakeholders and assisted with public involvement efforts.

Figure 2-1. May 29, 2019 Risk Assessment Meeting

A summary of committee meetings (Steering Committee and Planning Partnership) held and key milestones met during the development of the HMP update is included in Table 2-3 that also identifies which DMA 2000 requirements the activities satisfy. Documentation of meetings (e.g., agendas, sign-in sheets, meeting notes) are in Appendix C (Meeting Documentation). Table 2-3 identifies only the formal meetings held during plan development but does not reflect all planning activities conducted by individuals and groups throughout the planning process. In addition to these meetings, each jurisdiction (County, municipal and MUAs) had several individual meetings (both in person and via teleconference) to work on their jurisdictional annexes (Section 9). Further, there was a great deal of communication between the County, committee members, and the contract consultant through individual local meetings, electronic mail (email), and by phone.

After completion of the HMP update, implementation and ongoing maintenance will become a function of the Planning Partnership as described in Section 7 (Plan Maintenance). The Planning Partnership is responsible for reviewing the HMP and soliciting and considering public comment as part of the five-year mitigation plan update.

Table 2-3. Summary of Planning Outreach

Date	Activity/DMA 2000 Requirement	Key Outcomes/Purpose*	Participants*
March 19, 2019	2	Project Management Kickoff Meeting	Hudson County OEM; Tetra Tech
March 20, 2019	2	Data collection – GIS	Hudson County OEM; Hudson County Division of Planning – GIS; Tetra Tech
March 22, 2019	1b, 2	Municipal OEM Coordinators Meeting *[Announced commencement of HMP update and distributed the LOIPs]*	Hudson County OEM; Municipal OEM Coordinators; Tetra Tech
April 18, 2019	1b, 2, 3a, 4a	Steering Committee Kickoff Meeting *[Review of mitigation; Review of Steering Committee Guidelines; 2015 HMP; Data Collection; Review of Mission Statement, Goals, and Objectives; Hazards of Concern Identification; Public Outreach Strategy; Participation Requirements]*	Hudson County OEM; Hudson County Regional Health Commission; Hudson County Division of Planning; City of Hoboken; Tetra Tech
May 29, 2019	1b, 2, 3a, 4a	Planning Partnership Kickoff Meeting – open to the public *[Importance of mitigation and HMP; Participation Requirements; Review of Steering Committee decisions in April 2019; Hazard of concern identification and previous events exercise; Distribution of multi-lingual brochure materials]*	Hudson County OEM; Hudson County Improvement Authority; Hudson County Division of Planning; Hudson County Administrator's Office; Hudson County Regional Health Commission; City of Bayonne; Town of Guttenberg; Town of Harrison; City of Hoboken; Jersey City; Town of Kearny; Township of North Bergen; Town of Secaucus; City of Union City; Town of Weehawken; Town of West New York; Jersey City MUA; Kearny MUA; North Hudson Sewerage Authority; North Bergen MUA; Secaucus MUA; Tetra Tech
June 2019 to February 2020	2, 3b, 3c, 3e, 4a, 4b, 4c	Local Support Meetings	Hudson County; City of Bayonne; Borough of East Newark; Town of Guttenberg; Town of Harrison; City of Hoboken; Jersey City; Town of Kearny; Township of North Bergen; Town of Secaucus; City of Union City; Town of Weehawken; Town of West New York; Jersey City MUA; Kearny MUA; North Hudson Sewerage Authority; North Bergen MUA; Secaucus MUA; Tetra Tech
September 23, 2019	2, 3, 4	Hudson County Meeting *[County capability assessment; County review of 2015 mitigation actions; County annex update]*	Hudson County Division of Planning; Tetra Tech
September 23, 2019	2, 3d, 4b	FEMA Coastal Restudy Meeting for Hudson and Essex Counties *[Status update on the coastal study for New York and New Jersey to update flood risk information]*	FEMA Region 2; New Jersey Department of Environmental Protection; Essex County and Essex County municipalities; Hudson County OEM; Hudson County Division of Planning; City of Bayonne; Town of Harrison; City of Hoboken; Jersey City; Town of Kearny; Town of Secaucus; City

Date	Activity/DMA 2000 Requirement	Key Outcomes/Purpose*	Participants*
			of Union City; Town of Weehawken; Tetra Tech
September 26, 2010	2, 4b	FEMA Pre-Disaster Mitigation and Flood Mitigation Assistance Grant Funding Webinar	Webinar offered to all plan participants
October 4, 2019	1b, 2, 4a, 4b	Steering Committee Meeting *[Review hazard ranking methodology and ranking; Strengths Weaknesses, Obstacles and Opportunities exercise; County annex update, Public and stakeholder outreach; Schedule upcoming meetings]*	Hudson County OEM; Hudson County Division of Planning; Hudson County GIS; Hudson County Regional Health Commission; Tetra Tech
October 18, 2019	1b, 2, 3a, 3b, 3c, 3d, 3e	Planning Partnership #2- Risk Assessment and SWOO Meeting – open to the public *[Presentation of draft risk assessment results, hazard ranking exercise, SWOO exercise for high-ranked hazards, introduction to development of problem statements]*	Hudson County OEM; Hudson County MIS; Hudson County Division of Planning; Hudson County Regional Health Commission; Town of Guttenberg; Jersey City; Town of Kearny; Township of North Bergen; Town of Secaucus; Town of West New York; Jersey City MUA; Kearny MUA; North Hudson Sewerage Authority; North Bergen MUA; Secaucus MUA; PSE&G; Tetra Tech
January 19, 2020	1b, 2, 4a, 4b, 4c	Mitigation Strategy Workshop – open to the public *[Annex checklists distributed; Problem statement development; Mitigation resources distributed including mitigation catalog and critical facility/lifeline risk assessment results; Review of Mitigation Action Worksheets and NJOEM requirements; Small group breakouts to update mitigation strategy]*	Hudson County OEM; Hudson County Roads and Public Property; Hudson County Engineer; Hudson County Division of Planning; Hudson County Regional Health Commission; City of Bayonne; Borough of East Newark; Town of Guttenberg; Town of Harrison; City of Hoboken; Town of Kearny; Township of North Bergen; City of Union City; Town of Weehawken; Town of West New York; North Hudson Sewerage Authority; NJOEM; NJ State Police; NJ Transit; NJ State Park Service – Liberty State Park; Tetra Tech
January 19, 2020	1b, 2, 3, 4	Hudson County annex meeting *[Capabilities; Vulnerabilities; Mitigation Strategy]*	Hudson County Engineer; Hudson County Roads and Public Property
January 20, 2020	1b, 2, 3, 4	Hudson County annex meeting *[Capabilities; Vulnerabilities; Mitigation Strategy]*	Hudson County OEM; Hudson County Division of Planning; Hudson County Division of Housing and Community Development; Tetra Tech
January – February 2020	1b, 2, 3, 4, 5	Draft plan sections distributed to the Steering Committee for review	
February 7, 2020	1-5	Project management meeting *[Annex updates including County; Plan Maintenance approval; Public Outreach/posting draft plan]*	Hudson County OEM; Tetra Tech
February 11, 2020	1b, 2, 3a, 3b, 4b	Liberty State Park Stakeholder Meeting *[Previous event impacts; Capabilities; Vulnerabilities; Mitigation Strategy]*	Liberty State Park; Tetra Tech

Date	Activity/DMA 2000 Requirement	Key Outcomes/Purpose*	Participants*
February 19, 2020	1b, 3a, 3c, 3d, 3e, 4b	Stakeholder Workshop *[Capabilities, Vulnerable areas and assets identified; Current and potential future mitigation actions]*	
March 9, 2020	1b	Draft HMP posted on Hudson County OEM's website for public review and comment	
April 13, 2020	1b	The draft HMP public and stakeholder comments were collected.	
April 29, 2020	1-5	The draft HMP was submitted to NJOEM for review.	

Note:
**Refer to Appendix B for sign-in sheets, agendas and meeting notes*
TBD = To be determined
Each number in column 2 identifies specific DMA 2000 requirements, as follows:
1a – Prerequisite – Adoption by the Local Governing Body
1b – Stakeholder and Public Participation
2 – Planning Process – Documentation of the Planning Process
3a – Risk Assessment – Identifying Hazards
3b – Risk Assessment – Profiling Hazard Events
3c – Risk Assessment – Assessing Vulnerability: Identifying Assets
3d – Risk Assessment – Assessing Vulnerability: Estimating Potential Losses
3e – Risk Assessment – Assessing Vulnerability: Analyzing Development Trends
4a – Mitigation Strategy – Local Hazard Mitigation Goals
4b – Mitigation Strategy – Identification and Analysis of Mitigation Measures
4c – Mitigation Strategy – Implementation of Mitigation Measures
5a – Plan Maintenance Procedures – Monitoring, Evaluating, and Updating the Plan
5b – Plan Maintenance Procedures – Implementation through Existing Programs
5c – Plan Maintenance Procedures – Continued Public Involvement

2.3 STAKEHOLDER OUTREACH AND INVOLVEMENT

Stakeholders are the individuals, agencies, and jurisdictions that have a vested interest in the recommendations of the hazard mitigation plan, including all planning partners.

Diligent efforts were made to assure broad regional, county and local representation in this planning process. To that end, a comprehensive list of stakeholders was developed with the support of the Steering and Planning Committees. Stakeholder outreach was performed early on, and continually throughout the planning process. This HMP update includes information and input provided by these stakeholders where appropriate, as identified in the references.

Regional Stakeholder Workshop

- Online survey distributed in advance to inform session
- Session Format:
  - Group discussion
  - Map Exercises
- Topics Covered
  - Vulnerabilities
  - Capabilities
  - Mitigation Strategy

This subsection discusses the various stakeholders that were invited to participate in the development of this HMP update, and how these stakeholders participated and contributed. This summary listing cannot possibly represent the total of stakeholders that were aware of and/or contributed to this HMP update, as outreach efforts were being made, both formally and informally, throughout the process by the many planning partners involved in the effort, and documentation of all such efforts is impossible. Instead, this summary is intended to demonstrate the scope and breadth of the stakeholder outreach efforts made during the plan update process:

- All Planning Partnership meetings were open to the public and advertised via the Hudson County's website and social media.
- Participated in the FEMA Coastal Restudy meeting
- Distributed a stakeholder survey to provide input regarding vulnerabilities, capabilities and mitigation projects.
- Invited to attend a Regional Stakeholder Workshop to discuss the hazard mitigation plan, identify vulnerable assets/areas in the County, discuss current and emerging capabilities related to planning and integration of hazards and climate change, and mitigation strategies to further inform the plan.
- Posted draft plan on the Hudson County OEM mitigation website and advertised using social media in Spanish, Hindi and Chinese.
- Distributed letters to regional stakeholders and neighboring counties to review the draft HMP.

2.3.1 FEDERAL AGENCIES

FEMA Region II: Provided updated planning guidance through meeting(s) with the New Jersey Office of Emergency Management Mitigation Unit and communicated to Hudson County; held the FEMA Risk MAP coastal restudy meeting; conducted plan review.

U.S. Army Corps of Engineers – New York District: Invited to the February 2020 Regional Stakeholder Workshop.

Information regarding hazard identification and the risk assessment for this HMP update was requested and received or incorporated by reference from the following agencies and organizations:

Figure 2-2. September 23, 2019 FEMA Coastal Restudy Meeting

- National Climatic Data Center (NCDC)
- National Hurricane Center (NHC)
- National Oceanic and Atmospheric Administration (NOAA)
- National Weather Service (NWS)
- Storm Prediction Center (SPC)
- U.S. Army Corps of Engineers (USACE)
- U.S. Census Bureau
- U.S. Department of Agriculture (USDA)
- U.S. Department of Health and Human Services
- U.S. Environmental Protection Agency (USEPA)

- U.S. Geological Survey (USGS)
- U.S. Fish and Wildlife Service

2.3.2 STATE AGENCIES

New Jersey Office of Emergency Management (NJOEM): Administered planning grant; provided updated planning guidance; attended the January 2020 Mitigation Strategy Workshop and worked with local jurisdictions in developing their updated mitigation strategy; consulted with individual municipalities and MUAs interested in applying for 2019 FEMA Hazard Mitigation Assistance grants; attended the February 2020 Regional Stakeholder Workshop; and provided review of the draft HMP update.

New Jersey Transit: Attended and contributed at the January 2020 Mitigation Strategy Workshop.

New Jersey Department of Environmental Protection: Attended the September 2019 FEMA Coastal Restudy meeting.

New Jersey Department of Transportation: The NJDOT Office of Emergency Management and the NJDOT Bureau of Environmental Program Resources were invited to the Regional Stakeholder Workshop. The NJDOT Bureau of Environmental Program Resources reviewed the stakeholder survey, and shared they are in the process of assessing our infrastructure vulnerability/resilience internally and look forward to keeping in communication with Hudson County moving forward. The NJDOT Office of Emergency Management attended and participated in the February 2020 Regional Stakeholder Workshop and sent the stakeholder survey to further contribute to the plan.

New Jersey State Police: Attended and contributed at the January 2020 Mitigation Strategy Workshop.

New Jersey State Park Service – Liberty State Park: Attended and contributed at the January 2020 Mitigation Strategy Workshop; met with the planning consultant in February 2020 to discuss impacts from Hurricane Sandy; mitigation projects completed; and mitigation capabilities.

New Jersey State Climatologist: The New Jersey State Climatologist, Dr. David A. Robinson, contributed to the capabilities, vulnerabilities and mitigation strategy online survey.

The following State agencies were invited to attend the February 2020 regional stakeholder workshop for their appropriate sector:

- New Jersey Department of Transportation
- Port Authority of New York and New Jersey

2.3.3 COUNTY AND REGIONAL AGENCIES AND COMMISSIONS

2.3.3.1 County

Several County departments were represented on the Steering Committee and involved in the HMP update planning process; refer to Table 2-2 for a complete list of County entities that participated in the planning process with departments and divisions listed below. As previously noted, Steering Committee members were invited to all meetings, were provided updates via email communication and invited to review the draft HMP.

- Hudson County Administrator
- Hudson County Office of Emergency Management
- Hudson County Improvement Authority
- Hudson County Department of Corrections
- Hudson County Roads and Public Property
- Hudson County Prosecutor's Office
- Hudson County Division of Planning
- Hudson County Division of Housing and Community Development
- Hudson County Division of Parks
- Hudson County Regional Health Commission

Figure 2-3. Hudson County OEM Social Media Posts about the HMP update

The following highlights three County entities that led HMP update and contributed to the County annex.

Hudson County Office of Emergency Management: The Office of Emergency Management (OEM) provided leadership of the planning process, acting as chair of the Steering Committee, provided data, and facilitated communication with plan participants as well as public outreach. Mr. James Woods was identified as the ongoing Hudson County HMP Coordinator in Section 7 (Plan Maintenance) and served in this role throughout the planning process. In addition, the OEM provided critical data, assisted with the update of the hazards of concern and ranking, updated the previous mitigation strategy, facilitated outreach to jurisdictions and stakeholders, contributed to the County's capability assessment and updated mitigation strategy, and reviewed draft sections of the HMP.

Figure 2-4. Hudson County Regional Stakeholder Workshop Map Exercise

Hudson County Division of Planning: The Division of Planning provides information and recommendations for the orderly and proper development of the County. The Division of Planning, led by Ms. Francesca Giarratana, served on the Steering Committee and attended meetings throughout the planning process. Ms. Giarratana and her team provided updated information on legal/regulatory and planning capabilities in the County, provided updated GIS data to support the asset inventory update and risk assessment, developed an ArcGIS Online map to display the floodplains and utilize during the risk assessment review meeting, updated the previous mitigation strategy, facilitated outreach to jurisdictions, other County departments and stakeholders, contributed to the County's updated mitigation strategy and annex, and reviewed draft sections of the HMP. The Division of Planning also actively participated in the Regional Stakeholder Workshop in February 2020 and supported public engagement.

Hudson County Department of Roads and Public Property: The Department of Roads and Public Property was also engaged as part of the Steering Committee, provided updated information on legal/regulatory and planning capabilities in the County, updated the previous mitigation strategy, contributed to the County's updated mitigation strategy and annex, and identified funding sources for mitigation actions.

2.3.3.2 Regional and Local Stakeholders

Hudson County Regional Health Commission: The Hudson County Regional Health Commission was an active member of the Steering Committee; attended meetings; assisted with public outreach including posting meetings and the citizen survey on social media.

New Jersey Sports Exposition Authority: The New Jersey Sports Exposition Authority attended the February 2020 regional stakeholder workshop and provided input on capabilities, current mitigation and upcoming plans. The New Jersey Exposition Authority was sent an online survey to contribute further to the planning process, and was sent a letter from the County requesting their review of the draft plan.

The following regional and local stakeholders were invited to attend the February 2020 regional stakeholder workshop; participate in a stakeholder survey to provide input on vulnerable assets, capabilities, and current/potential future mitigation projects; and invited to provide input on the draft HMP. Additional stakeholders are outlined below according to sector.

- New Jersey Sports Exposition Authority
- New York City Office of Emergency Management – Preparedness and Mitigation
- New Jersey Future
- NY/NJ Baykeeper
- Sustainable Jersey
- Rutgers Cooperative Extension Water Resources Program
- Hudson County Hospitals
- Hackensack Riverkeeper
- Together North Jersey

2.3.3.3 Emergency Services

The Steering and Planning Committee is comprised of several members of the emergency services sector. All emergency management Municipal Coordinators have been briefed on the plan update at their quarterly meetings and many are their municipality's HMP primary or secondary point of contact and attended meetings. In addition, the Hudson County OEM notified the following when the draft plan was available for public review/comment and encouraged their continued participation:

- Emergency Management Municipal Coordinators
- Local Emergency Management Committee (LEPC) members
- Police Chiefs
- Fire Chiefs
- Community Emergency Response Team (CERT) members

2.3.3.4 Academia

When the draft plan became available for public review, the Hudson County OEM requested all Planning Partnership contacts distribute the draft plan announcement to local public and private schools. The following were invited to the February 2020 Regional Stakeholder Workshop:

- Stevens Institute of Technology
- Rutgers University
    - Office of the State Climatologist
    - School of Planning and Public Policy
- St. Peter's
- New Jersey City University
- Hudson County Community College

2.3.3.5 Utilities

Utility providers in the County and regional stakeholders were invited to attend the February 2020 Regional Stakeholder Workshop; participate in a utility sector stakeholder survey to provide input on vulnerable assets, capabilities, and current/potential future mitigation projects; and invited to provide input on the draft HMP. In addition, when the draft plan became available for public review, utility providers were also emailed the announcement and encouraged to review and comment. Areas of involvement in the planning process are noted below.

PSE&G: Attended the October 2019 Risk Assessment meeting; invited to the February 2020 Regional Stakeholder Workshop.

In addition, the following utility stakeholders were invited to attend the February 2020 stakeholder focus group session, participate in the survey and provide input on the draft HMP:

- Verizon
- PSE&G – Electric
- PSE&G – Gas
- JCP&L
- New Jersey American Water
- NJ Board of Public Utilities
- Passaic Valley Sewerage Commission
- United Water/Suez

2.3.3.6 Transportation

Transportation providers in the County and regional stakeholders were invited to attend the February 2020 Regional Stakeholder Workshop; participate in a transportation sector stakeholder survey to provide input on vulnerable assets, capabilities, and current/potential future mitigation projects; and invited to provide input on the draft HMP. Areas of involvement in the planning process are noted below.

North Jersey Transportation Planning Authority (NJTPA): Collaborated with the planning consultant and discussed the recently published Passaic River Basin Climate Resilience Planning Study; Shared the spatial data used to inform the Climate Resilience Plan; invited to the February 2020 workshop.

NJ Transit: Attended the January 2020 Mitigation Strategy Workshop.

New Jersey Department of Transportation: Attended and participated in the February 2020 Regional Stakeholder Workshop.

In addition to stakeholders listed above, the following transportation stakeholders were invited to attend the February 2020 Regional Stakeholder Workshop, participate in the transportation survey and provide input on the draft HMP:

- Port Authority of New York and New Jersey
- NJTPA
- Transportation Operations Coordinating Committee (TRANSCOM)

2.3.4 NEIGHBORING COUNTIES

Hudson County has tried to keep surrounding and nearby counties and municipalities apprised of the project and allowed the opportunity to provide input to this planning process. In September 2019, the FEMA coastal map restudy meeting was a joint meeting with FEMA, NJDEP, Hudson County, Essex County and affected municipalities where the hazard mitigation plan update was discussed.

The following counties were invited to the Regional Stakeholder Workshop in February 2020 and were contacted via formal letter and email from the Hudson County OEM to inform them about the draft plan documents and to invite them to provide input. Refer to Appendix D (Public and Stakeholder Outreach).

- New York City, New York – invitation to the stakeholder workshop and letter regarding the draft plan being posted for public review
- Bergen County, New Jersey – invitation to the stakeholder workshop and letter regarding the draft plan being posted for public review
- Essex County, New Jersey – invitation to the stakeholder workshop and letter regarding the draft plan being posted for public review
- Union County, New Jersey - invitation to the stakeholder workshop and letter regarding the draft plan being posted for public review

2.3.5 PUBLIC PARTICIPATION - CITIZEN INVOLVEMENT

In order to facilitate better coordination and communication between the Planning Partnership and citizens and to involve the public in the planning process, it was determined that meeting dates/locations will be made available to the public via the Hudson County OEM website dedicated to the HMP update and social media; and the and draft documents available on the Hudson County website dedicated to the HMP update. The participating partners also feel that community input on the HMP will increase the likelihood of hazard mitigation becoming one of the standard considerations in the evolution and growth of the County.

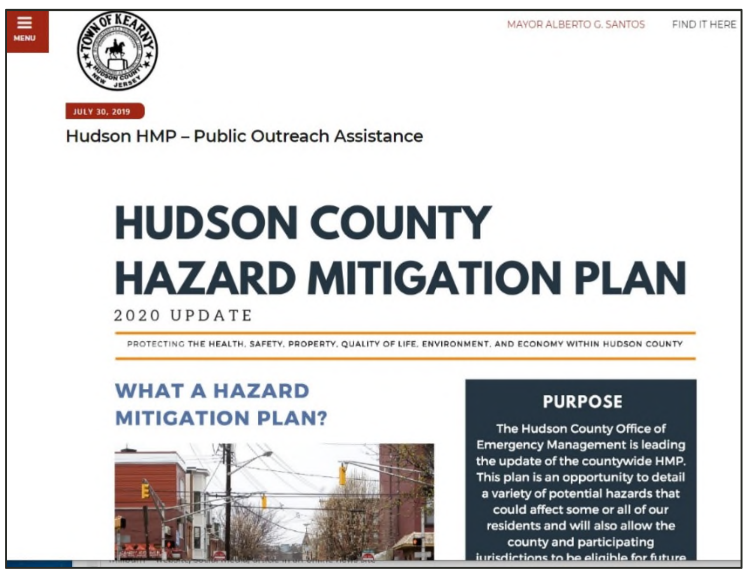


Figure 2-5. 2020 HMP Brochure on the Town of Kearny's website

The Planning Partnership has made the following efforts toward public participation in the development and review of the HMP:

- The Hudson County posted a news release on their website to announce the commencement of the HMP update; refer to Appendix D (Public and Stakeholder Outreach Documentation) for the news release.

- A public project website was developed and is being maintained to facilitate communication between the Steering Committee, Planning Committee, public and stakeholders. The public website provides a project overview, access to the citizen's survey, multi-lingual brochures (English, Spanish, Chinese and Hindi) and various stakeholder surveys, and the HMP for public review and comment. Figure 2-1 provides a screenshot of the current website homepage.

- An online natural hazards preparedness citizen survey was developed to gauge household preparedness relevant to hazards in Hudson County and to assess the level of knowledge of tools and techniques to assist in reducing risk and loss of those hazards. The questionnaire asks quantifiable questions about citizen perception of risk, knowledge of mitigation, and support of community programs, as well as several demographic questions to help analyze trends. The questionnaire was posted on the County public website in May 2019 and available throughout the planning process. The survey results were sorted by municipality and provided to the Steering Committee and Planning Partnership members to use to identify vulnerabilities and develop mitigation strategies. A summary of survey results is provided in Appendix D (Public and Stakeholder Outreach Documentation).

- A hazard mitigation planning brochure (see Appendix D) was developed to inform the public of the planning process, provide local contact information, and encourage the public to review the plan and provide input. This brochure was provided to all plan participants to distribute in their communities. It was also available for download on the hazard mitigation plan website. The brochure was made available in four languages: English, Spanish, Chinese and Hindi.

- All plan participants were encouraged to distribute the project brochure and post the links to the project webpage and citizen survey. In addition, all participating municipalities and MUAs were requested to advertise the availability of the project website via local homepage links, and other available public announcement methods (e.g., Facebook, Twitter, email blasts).

- All hazard mitigation Planning Partnership meetings that were open to the public were advertised on the Hudson County website and social media (Facebook and Twitter).

- The draft HMP was posted on the Hudson County OEM website for public review and comment. All jurisdictions were requested to assist with advertising the plan was posted.

Additional examples of public outreach efforts are presented in Appendix D (Public and Stakeholder Outreach Documentation). Hudson County residents were provided opportunity to comment on the draft HMP before submittal to FEMA. The HMP was posted on the public website on March 9, 2020 for review. Public comments received through April 13, 2020 were distributed to the members of the Steering Committee members for their consideration. Due to the COVID-19 pandemic, the Hudson County and Steering Committee members opted to communicate via email to discuss comments received. The only comment received was from the NJSEA to expand their capabilities documented in the plan. Hudson County reached out directly to the NJSEA and requested the additional information; this information will be incorporated once received.

Figure 2-6. Screenshots of the Hudson County OEM Website Home Page

HUDSON COUNTY
NEW JERSEY

Search

Home | About Hudson County | Services | News | Municipalities

Office of Emergency Management (OEM) > Hudson County Hazard Mitigation Planning (HMP) Page

- ArcGIS Online Interactive Mapping Initiative
- Hudson County Hazard Mitigation Planning (HMP) Page
- Hudson County Hazard Mitigation Planning 2020 Draft Plan
- Hurricane Survival Guide
- Welcome
- Mission Statement and What We Do
- Stay Informed and Preparedness
- Resources
- Volunteer
- Keep Pets Safe
- All Hazard Mitigation Plan
- Links

Hudson County Hazard Mitigation Planning (HMP) Page

Select Language

Welcome to the Hudson County Hazard Mitigation Planning (HMP) page. This webpage provides project updates, resources, and links to hazard mitigation in support of the HMP project.

The goal of the HMP update is to save lives and property through the reduction of hazard vulnerability for the community. During the course of this planning project, county and local leaders and the participating communities will work in tandem to identify risks, assess capabilities, and formulate a strategy to reduce disaster vulnerability.

Hudson County is pleased to kick-off the 2020 HMP update. Please check back to this site regularly for updates on the planning process. -

The 2015 All Hazard Mitigation Plan can be viewed at: http://www.hudsoncountynj.org/all-hazard-mitigation-plan/

Hudson County is pleased to post the draft of the 2020 Hazard Mitigation Plan update for public review and comment. Public review is open through April 11, 2020. We welcome your input on this important planning process.

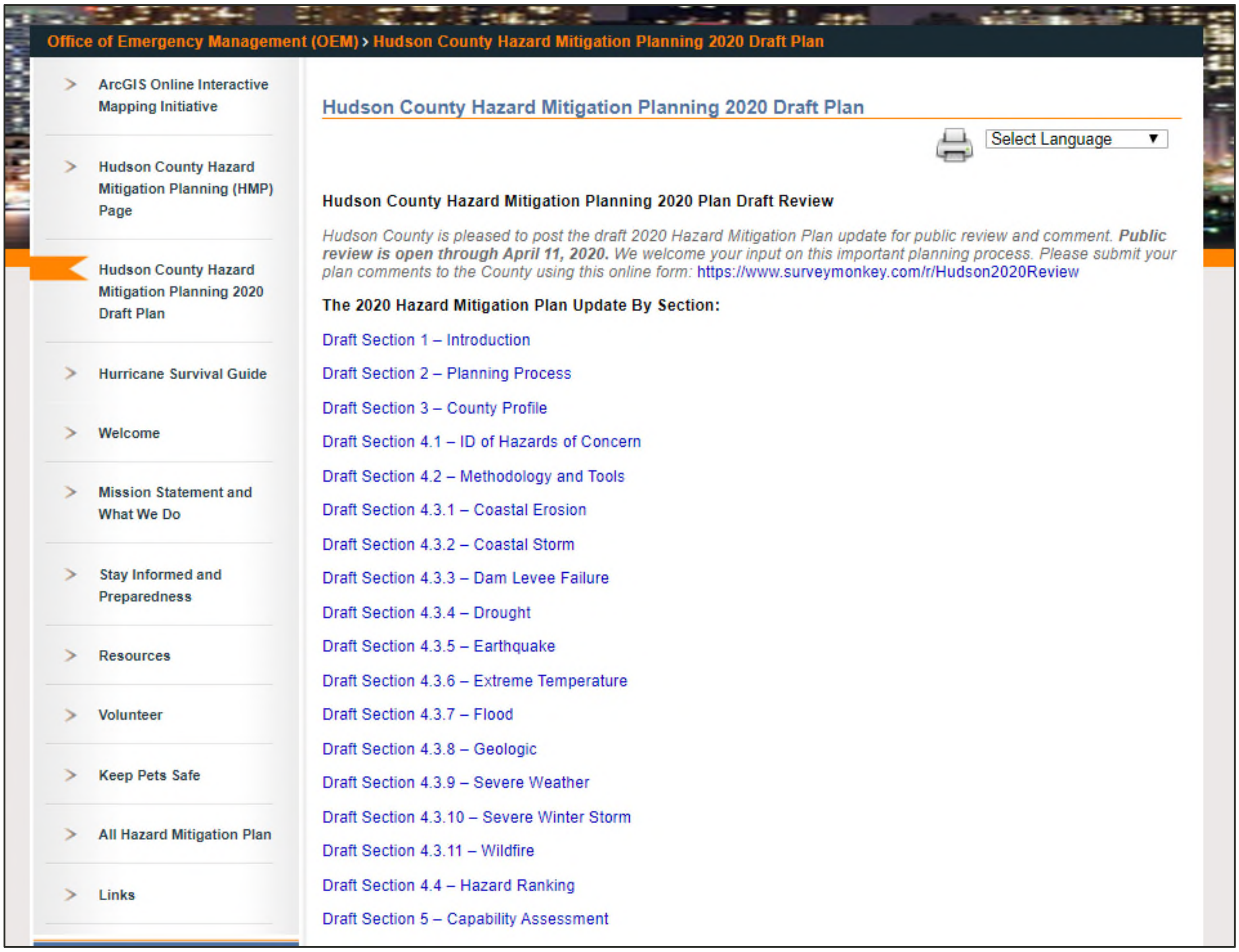
The draft plan may be accessed here: http://www.hudsoncountynj.org/hudson-county-hazard-mitigation-planning-2020-draft-plan/ Please submit your plan comments to the County using this online form: https://www.surveymonkey.com/r/Hudson2020Review

If you would like more information regarding how to get involved in the project, please contact the Hudson County Office of Emergency Management at: 201-369-5200

Announcements

- Third Public Meeting: Mitigation Strategy Workshop, January 9, 2020 at 10am. USS Juneau Memorial Building, 110 South Hackensack Ave, Kearny
- 2nd public meeting: October 18, 2019 at 10:00am: USS Juneau Memorial Building,110 South Hackensack Ave, Kearny.
- First public meeting: May 29, 2019 at 10:30am: USS Juneau Memorial Building,110 South Hackensack Ave, Kearny.
- HMP Press Release: http://www.hudsoncountynj.org/Hazard-Mitigation-Plan-Update
- Hudson HMP Newsletter: Hudson County HMP Newsletter,
- Hudson HMP Newsletter (Spanish): Hudson County HMP Span. Newsletter
- Hudson HMP Newsletter (Hindi): Hudson County HMP Newsletter Hindi
- Hudson HMP Newsletter (Chinese): Hudson County HMP Newsletter Chinese
- Citizens Preparedness Questionnaire: https://www.surveymonkey.com/r/hudsonhmp2020

Purpose:



Office of Emergency Management (OEM) > Hudson County Hazard Mitigation Planning 2020 Draft Plan

- ArcGIS Online Interactive Mapping Initiative
- Hudson County Hazard Mitigation Planning (HMP) Page
- Hudson County Hazard Mitigation Planning 2020 Draft Plan
- Hurricane Survival Guide
- Welcome
- Mission Statement and What We Do
- Stay Informed and Preparedness
- Resources
- Volunteer
- Keep Pets Safe
- All Hazard Mitigation Plan
- Links

Hudson County Hazard Mitigation Planning 2020 Draft Plan

Select Language

Hudson County Hazard Mitigation Planning 2020 Plan Draft Review

Hudson County is pleased to post the draft 2020 Hazard Mitigation Plan update for public review and comment. ***Public review is open through April 11, 2020.*** *We welcome your input on this important planning process. Please submit your plan comments to the County using this online form:* https://www.surveymonkey.com/r/Hudson2020Review

The 2020 Hazard Mitigation Plan Update By Section:

Draft Section 1 – Introduction
Draft Section 2 – Planning Process
Draft Section 3 – County Profile
Draft Section 4.1 – ID of Hazards of Concern
Draft Section 4.2 – Methodology and Tools
Draft Section 4.3.1 – Coastal Erosion
Draft Section 4.3.2 – Coastal Storm
Draft Section 4.3.3 – Dam Levee Failure
Draft Section 4.3.4 – Drought
Draft Section 4.3.5 – Earthquake
Draft Section 4.3.6 – Extreme Temperature
Draft Section 4.3.7 – Flood
Draft Section 4.3.8 – Geologic
Draft Section 4.3.9 – Severe Weather
Draft Section 4.3.10 – Severe Winter Storm
Draft Section 4.3.11 – Wildfire
Draft Section 4.4 – Hazard Ranking
Draft Section 5 – Capability Assessment

Source: *http://www.hudsoncountynj.org/hudson-county-hazard-mitigation-planning-hmp-page/*

2.4 Incorporation of Existing Plans, Studies, Reports and Technical Information

The Hudson County HMP update strives to use the best available technical information, plans, studies, and reports throughout the planning process to support hazard profiling; risk and vulnerability assessment; review and evaluation of mitigation capabilities; and the identification, development, and prioritization of county and local mitigation strategies.

The asset and inventory data used for the risk and vulnerability assessments are presented in the County Profile (Section 3). Details of the source of this data, along with technical information on how the data was used to develop the risk and vulnerability assessment, are presented in the Risk Assessment, specifically in Section 4.2 - Methodology and Tools, as well as throughout the hazard profiles in Section 4.4 (Hazard Profiles). Further, the source of technical data and information used can be found within Volume I under *References*.

Plans, reports, and other technical information were identified and provided directly by the County, participating jurisdictions, and numerous stakeholders involved in the planning effort, as well as through independent research by the planning consultant. The County and participating jurisdictions were tasked with updating the inventory of their Planning and Regulatory capabilities in Section 9 (Jurisdictional Annexes) and providing relevant planning and regulatory documents, as applicable. Relevant documents, including plans, reports, and ordinances were reviewed to identify the following:

- Existing County and municipal capabilities.
- Needs and opportunities to develop or enhance capabilities, which may be identified within the County or local mitigation strategies.
- Mitigation-related goals or objectives considered in the review and update of the overall Goals [and Objectives] in Section 6 (Mitigation Strategy).
- Proposed, in-progress, or potential mitigation projects, actions, and initiatives to be incorporated into the updated County and local mitigation strategies.

The following local regulations, codes, ordinances, and plans were reviewed during this process to develop mitigation planning goals, objectives, and strategies that are consistent across local and regional planning and regulatory mechanisms to accomplish complementary and mutually supportive strategies:

- Master Plans
- Building Codes
- Zoning and Subdivision Ordinances
- NFIP Flood Damage Prevention Ordinances
- Site Plan Requirements
- Stormwater Management Plans
- Emergency Management and Response Plans
- Land Use and Open Space Plans
- Capital Plans
- New Jersey State Hazard Mitigation Plan (2019)

A partial listing of the plans, reports, and technical documents reviewed in the preparation of this plan is included in Table 2-4. Refer to Section 9 (Jurisdictional Annexes) which outlines the updated programs, policies and plans that were researched and available for each jurisdiction.

Table 2-4. Record Review - Record of the Review of Existing Plans and Technical Documents for Participating Jurisdictions

Existing plan, program or technical documents	Date	Jurisdictional Applicability
North Atlantic Coast Comprehensive Study: Resilient Adaptation to Increasing Risk	Jan-15	Hudson County and all jurisdictions
Comprehensive Economic Development Strategy	August 22 2016	Hudson County and all jurisdictions
Hudson County Strategic Recovery Report	Feb-14	Hudson County and all jurisdictions
Master Plan Re-Examination Report	Aug-16	Hudson County and all jurisdictions
Hudson County Emergency Support Functions	Jan-20	Hudson County and all jurisdictions
Borough of East Newark Master Plan	1984, Updated 1992	Borough of East Newark
East Newark Redevelopment Plan	March 14 2007	Borough of East Newark
City of Bayonne Reexamination on Report of the Master Plan	Aug-17	City of Bayonne
Hoboken Climate Action Plan & Greenhouse Gas Emission Inventories	Apr-19	City of Hoboken
2018 Master Plan Reexamination Report	Jun-18	City of Hoboken
Master Plan Land Use Element	Jun-18	City of Hoboken
City of Hoboken Master Plan	Apr-04	City of Hoboken
2010 City of Hoboken Reexamination Report	March 16 2011	City of Hoboken
Resilient Building Design Guidelines	October 19 2015	City of Hoboken
Greenhouse Gas Emissions Inventory, Government Operations - City of Hoboken, New Jersey Activities - Year 2017	Apr-19	City of Hoboken
City of Hoboken Master Plan - Green Building and Environmental Sustainability Element	Dec-17	City of Hoboken
City of Hoboken - New Jersey Town Center Distributed Energy Resources Microgrid Feasibility Study	January 24 2019	City of Hoboken
City of Hoboken Energy Surety Analysis:	Sep-14	City of Hoboken
Preliminary Design Summary	October 2019	City of Jersey City
City of Jersey City Adaptation Master Plan	June 13 2017	City of Jersey City
8 Erie Street Redevelopment Plan	May 08 2019	City of Jersey City
Recreation & Open Space Master Plan	Jun-08	City of Jersey City
RESILIENT JERSEY CITY	Oct-19	City of Jersey City
The Jersey City Plan - Volume 2	May-00	City of Jersey City
City of Jersey City Resiliency Master Plan	June 13 2017	City of Jersey City
Jersey City Tree Canopy Assessment	Jun-15	City of Jersey City
Sandy Recovery Strategic Planning Report	Aug-14	City of Jersey City

Existing plan, program or technical documents	Date	Jurisdictional Applicability
Urban Environmental Green Infrastructure Design Plan	June 13 2017	City of Jersey City
JC Walks Pedestrian Enhancement Plan	May 2018	City of Jersey City
Vision Zero Action Plan	Feb-19	City of Jersey City
Jersey City Stormwater Management Plan	August 2008	JCMUA and City of Jersey City
Non-Condemnation Redevelopment Plan	February 7 2019	City of Union City
Master Plan Reexamination Report	Jan-19	City of Union City
City of Union City Master Plan	April 23 2009	City of Union City
Master Plan Update - Reexamination Report and Land Use Plan Element Amendment	June 15 2009	Town of Guttenberg
Town of Harrison Master Plan Reexamination Report	December 14 2017	Town of Harrison
Town of Harrison Master Plan	December 5 2007	Town of Harrison
Town of Harrison Municipal Public Access Plan	November 5 2015	Town of Harrison
Amended Harrison Waterfront Redevelopment Plan 2012	April 3 2012	Town of Harrison
Master Plan Reexamination Report/Master Plan Revision	December 3 2008	Town of Kearny
Kearny Area Redevelopment Plan	Jun-14	Town of Kearny
Kearny Passaic Avenue Redevelopment Area Assessment Report	Jun-13	Town of Kearny
Industrial Park Redevelopment Plan	Dec-13	Town of Kearny
Open Space and Recreation Plan	February 18 2014	Town of Secaucus
Town of Secaucus Community Forestry Management Plan	September 19 2014	Town of Secaucus
Town of West New York Master Plan	January 28 2015	Town of West New York
Periodic Reexamination of The Master Plan	October 22 2009	Township of North Bergan
Municipal Stormwater Management Plan	Feb-07	Township of North Bergan
Housing Element and Fair Share Plan	October 22 2009	Township of North Bergan
Hackensack Meadowlands District Master Plan Update 2020	Aug-19	NJSEA Jurisdictions
Hackensack Meadowlands Floodplain Management Plan	October 24 2005	NJSEA Jurisdictions
Development and Evaluation Of Alternatives For Long Term Control Planning For Combined Sewer Systems - Regional Report	Jun-19	Passaic Valley Sewerage Commission - Bayonne, East Newark, Harrison, JCMUA, Kearny, Newark, NBMUA, and Paterson

2.5 Integration with Existing Planning Mechanisms and Programs

Effective mitigation is achieved when hazard awareness and risk management approaches and strategies become an integral part of public activities and decision-making. Within Hudson County, there are many existing plans and programs that support hazard risk management, and thus it is critical that this hazard mitigation plan integrate, coordinate with, and complement, those existing plans and programs.

Section 5 – Capability Assessment provides a summary and description of the existing plans, programs, and regulatory mechanisms at all levels of government (federal, state, county, and local) that support hazard mitigation within the County. Within each jurisdictional annex in Section 9, the County and each participating jurisdiction identified how they integrated hazard risk management into their existing planning, regulatory, and operational/administrative framework (*integration capabilities*) and how they intend to promote this integration (*integration actions*).

A further summary of these continued efforts to develop and promote a comprehensive and holistic approach to hazard risk management and mitigation is presented in Section 7 (Plan Maintenance).

2.6 Continued Public Involvement

Hudson County and all participating jurisdictions are committed to the continued involvement of the public in the hazard mitigation process. This HMP update will be posted online at http://www.hudsoncountynj.org/hudson-county-hazard-mitigation-planning-hmp-page/ and municipalities will be encouraged to maintain links to the plan website. Further, the County will make hard copies of the HMP available for review at public locations as identified on the website.

A notice regarding annual updates of the plan and the location of plan copies will be publicized annually after the annual plan evaluation meeting (refer to Section 7 – Plan Maintenance) and posted on the public website at http://www.hudsoncountynj.org/hudson-county-hazard-mitigation-planning-hmp-page/.

The public will have an opportunity to comment on the HMP update as a part of the annual mitigation planning evaluation process and the next five-year mitigation plan update. The HMP Coordinator (currently Mr. James Woods, Office of Emergency Management) is responsible for coordinating the plan evaluation portion of the meeting, soliciting feedback, collecting and reviewing the comments, and ensuring their incorporation in the 5-year plan update as appropriate; however, members of the Steering and Planning Committees will assist the HMP Coordinator. Additional meetings may also be held as deemed necessary by the Planning Partnership. The purpose of these meetings would be to provide the public an opportunity to express concerns, opinions, and ideas about the HMP.

Further details regarding continued public involvement are provided in Section 7 (Plan Maintenance).

After completion of this plan update, implementation and ongoing maintenance will continue to be a function of the Planning Partnership. The Planning Partnership will review the plan and accept public comment as part of an annual review and as part of five-year mitigation plan updates.

A notice regarding annual updates of the plan will be publicized annually after the HMP Committee's annual evaluation and posted on the public web site.

Mr. Woods of the Hudson County OEM is identified as the ongoing County All Hazard Mitigation Plan Coordinator (see Section 7), and is responsible for receiving, tracking, and filing public comments regarding this plan. Contact information is:

Name: Mr. James Woods
Email Address: jwoods@hcnj.us

SECTION 3. COUNTY PROFILE

3.1 Physical Setting

Hudson County is the smallest, most urbanized and most densely populated county in the State of New Jersey. Comparatively, Hudson County is the sixth most densely populated county in the nation. The County is a peninsula located in the northeast section of New Jersey, west of New York City, and located within the New York Metropolitan area. Hudson County is bordered by Newark Bay and the Passaic and Hackensack Rivers to the west, the Hudson River and New York City to the east, the Kill Van Kull to the south and Bergen County to the north. The Hackensack River runs through the center of the County from north to south.

The County is 46.6 square miles in size and is divided into 12 jurisdictions. Figure 3-1 provides a map of Hudson County and its municipalities. Residential areas, business districts, commercial and industrial areas, various transportation systems, natural features, waterfront areas, and educational facilities are all located and make up today's Hudson County. This combination of natural and developed features including proximity to water, along with a growing population and being the most densely populated county in New Jersey, lays the foundation for Hudson County's vulnerability to natural hazards and effects of climate change, both in terms of exposure to and the potential impacts from hazard events.

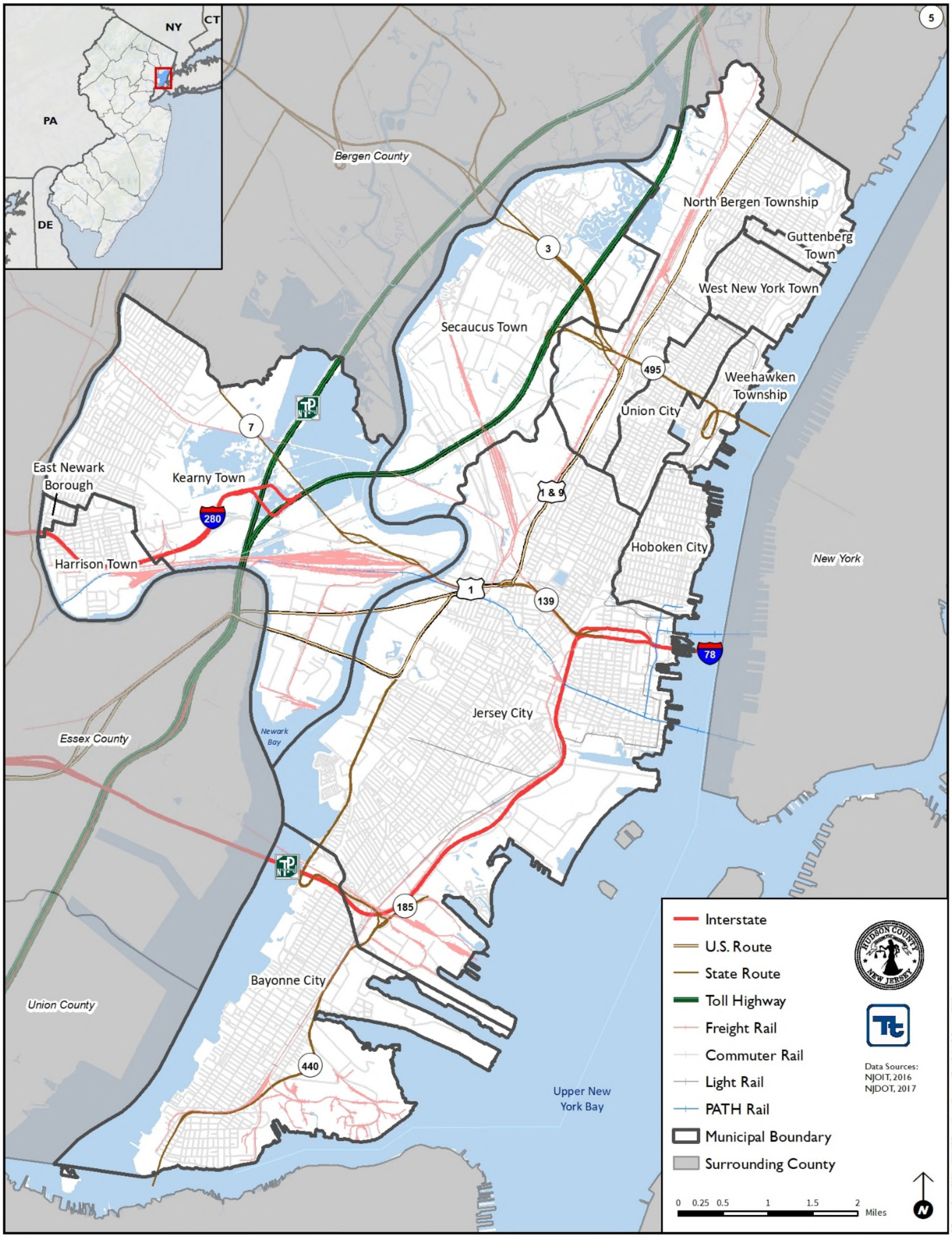
The County's urbanized core is comprised of the Cities of Hoboken and Jersey City. The northern area of the County is made up of five densely populated communities: The Towns of Guttenberg and West New York, Townships of North Bergen and Weehawken, and the City of Union City. The City of Bayonne makes up the County's southern peninsula. Western Hudson County contains smaller, less densely populated areas and includes the Borough of East Newark and the Towns of Harrison and Kearny. The northwestern area of the County consists of the Town of Secaucus.

3.1.1 Topography and Geology

The topography of Hudson County varies from gentle rolling hills to flat lowland areas. Vegetation consists of planted lawns, trees, and shrubbery and is typical of residential, commercial areas (FEMA Flood Insurance Study 2013). Hudson County is located within the Piedmont Province, one of the four major physiographic regions of New Jersey. This province has an area of approximately 1,600 square miles and makes up about one-fifth of the state. The Piedmont Province is mainly underlain by slightly folded and faulted sedimentary rocks of the Triassic and Jurassic age and igneous rocks of the Jurassic age. In Hudson County, there are small bands of highly metamorphosed rocks ranging in age from Middle Proterozoic to Cambrian (Dalton 2003).

According to the New Jersey Geological Survey (NJGS), the Piedmont Province is a low rolling plain divided by a series of higher rides. The width varies from approximately 16 miles near the New York border to over 30 miles at the Delaware River. The most prominent feature of the eastern portion of the province is the Palisades, which has a maximum elevation of 547 feet near Closter and provides views of the Hudson River and New York City. Near the Newark Bay, toward its boundary with the Coastal Plain Province, the elevation is at sea level (Dalton 2003).

Figure 3-1. Hudson County, New Jersey



3.1.2 Hydrography and Hydrology

Hudson County is located in two Watershed Management Areas: The Lower Passaic Saddle River (WMA 4) and the Hackensack-Hudson-Pascack (WMA 5) (Figure 3-2). The WMA 4 drainage area is approximately 180 square miles and lies within portions of Passaic, Essex, Hudson, Morris and Bergen Counties. Two watersheds comprise WMA 4: The Lower Passaic River Watershed and Saddle River Watershed. Land in this watershed is extensively developed and contains many older cities and industrial centers including Newark, Paterson, Clifton and East Orange (NJDEP 2012a).

WMA 5 has a drainage area of approximately 165 square miles, which includes parts of Hudson and Bergen Counties. WMA 5 is comprised of three watersheds: Hackensack River Watershed, Hudson River Watershed and Pascack Brook Watershed. Although WMA 5 is the most populated of all the WMAs, approximately 50% of the land is still undeveloped, with more than 30% residential development. The remaining developed land is commercial/industrial use. Much of the lower Hackensack River Watershed is tidal marsh known as the Hackensack Meadowlands District (NJDEP 2012b).

Four communities in Hudson County are located in the Hackensack Meadowlands District (Meadowlands), a large ecosystem of wetlands located in northeastern New Jersey: Jersey City, Kearny, North Bergen and Secaucus. The Meadowlands stretch mainly along the Hackensack and Passaic Rivers as they flow into Newark Bay. Tributaries of the Hackensack River (Sawmill Creek, Berrys Creek, and Overpeck Creek) also make up the Meadowlands. This area in New Jersey consists of approximately 30.3 square miles of open, undeveloped space, in addition to developed areas. The Meadowlands are home to more than 700 plant and animal species including several rare and threatened species. Refer to Figure 3-3 which displays the Hudson County jurisdictions located in the Meadowlands.

The Hackensack Meadowlands Development Commission (HMDC) was created by an act of the New Jersey Legislature in 1968 and was passed into law in January 1969. The act gave the HMDC three mandates; environmental protection, economic development and solid waste management (NJDEP 2012b). In February 2015, the Hackensack Meadowlands Agency Consolidation Act (Consolidation Act) merged the former New Jersey Meadowlands Commission and its core functions into the North Jersey Sports Exposition Authority (NJSEA). The fundamental mandates for the Meadowlands are unchanged since the merger (NJSEA 2019).

Figure 3-2. Hudson County Watersheds

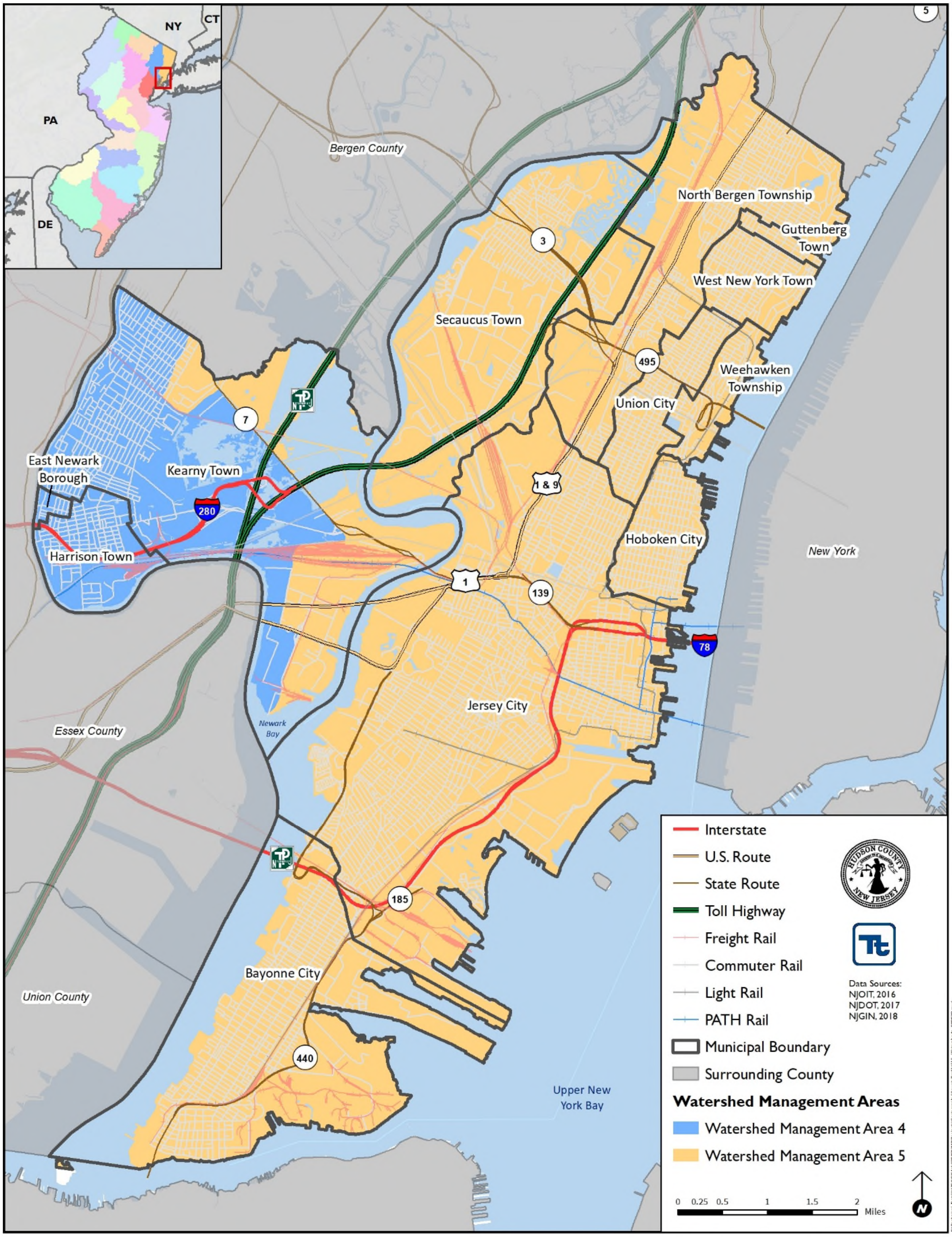
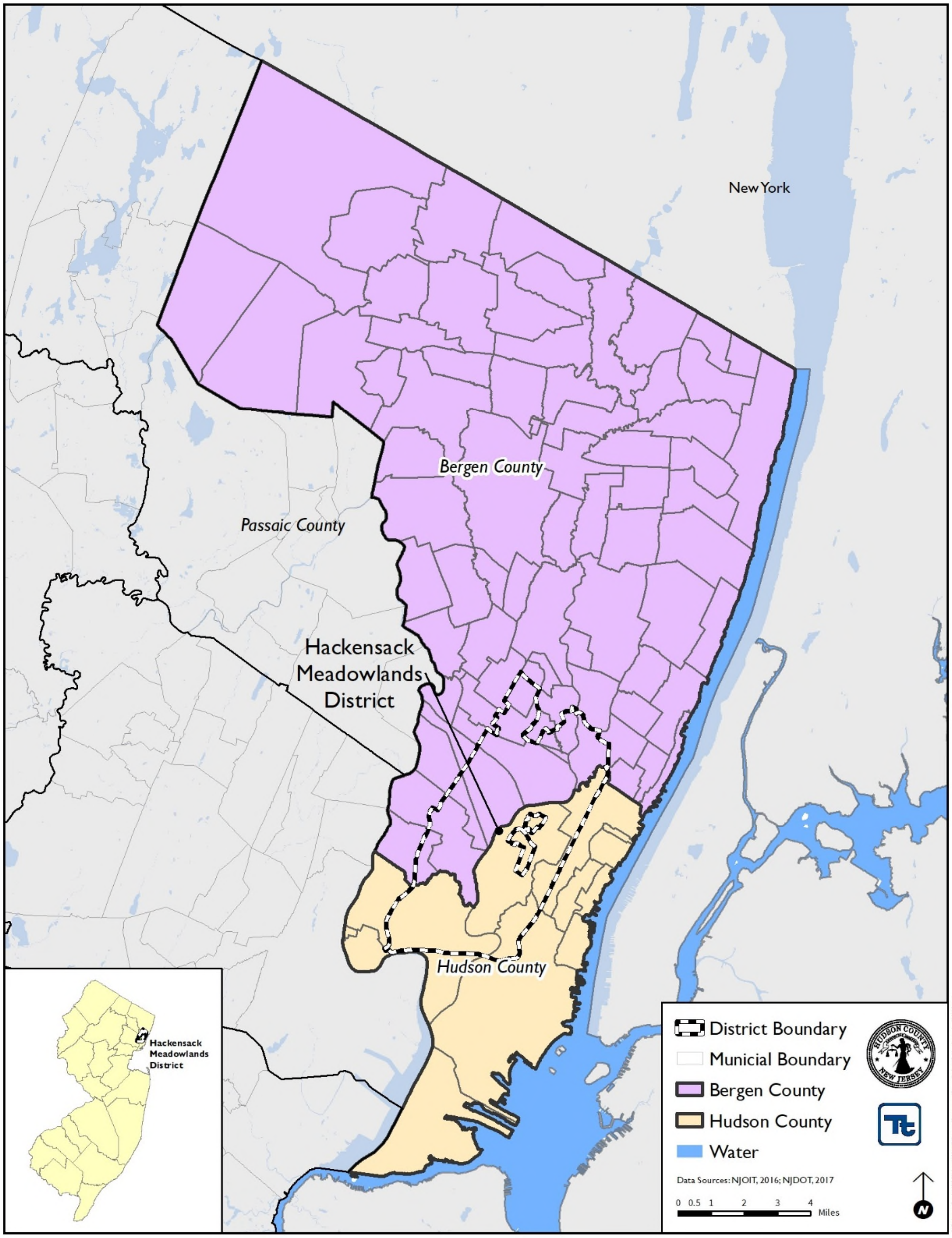


Figure 3-3. Hackensack Meadowlands District



3.1.3 Climate

Hudson County is located in New Jersey's Central climate zone. The Central Zone has a northeast to southwest orientation, running from New York Harbor and the Lower Hudson River to the great bend of the Delaware River in the vicinity of Trenton. This region has many urban locations with large amounts of pollutants produced by the high volume of automobile traffic and industrial processes. The concentration of buildings and paved surfaces serve to retain more heat, thereby affecting the local temperatures. Because of the asphalt, brick, and concrete, the observed nighttime temperatures in heavily developed parts of the zone are regularly warmer than surrounding suburban and rural areas. This phenomenon is often referred to as a "heat island" (ONJSC Date Unknown).

The climate of Hudson County is characteristic of the Mid-Atlantic and is variable with cold, dry winters and warm, humid summers. The average annual rainfall is approximately 42.4 inches and snowfall averages about 30 inches each year. The average annual temperature is approximately 55°F with the lowest average (32.2°F) in January and the highest average (77.9°F) in July.

3.1.4 Land Use and Land Cover

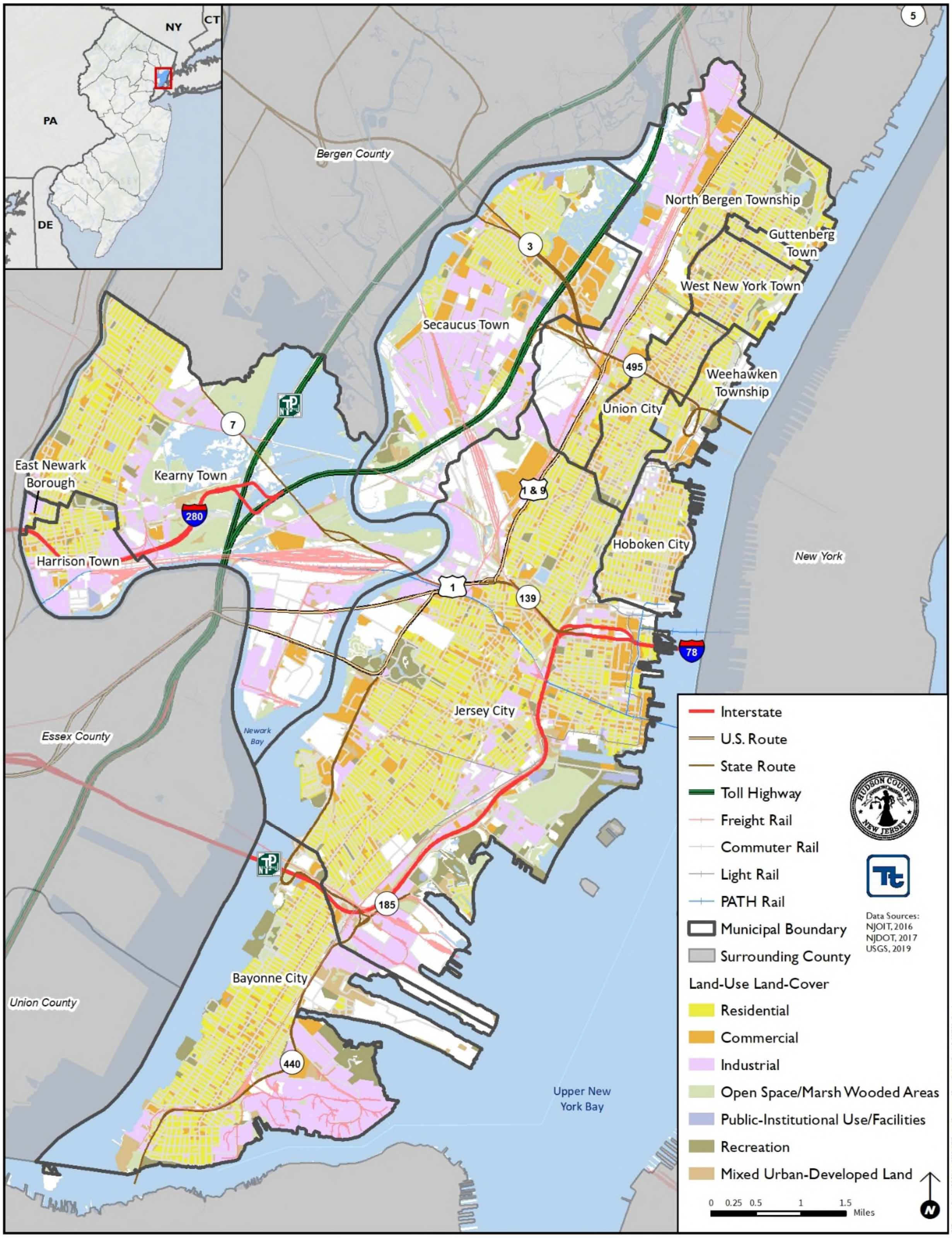
The Hudson County Master Plan Re-examination report of 2017 documented a number of the County's land use and land cover data and trends, covering topics such as: housing, circulation, and land use. The following section, 3.1.4, incorporates data presented in the 2017 Re-examination report for the purposes for a broad overview and discussion on the County's past, current, and future land use and land cover trends. Hudson County's land area includes residential, commercial, industrial, public and semi-public, parks and open space, vacant land, streets and right-of-ways, and water. In 2007, the majority of land (or 56.7%) in Hudson County was occupied by urban or built-up land. When compared to 2007, the 2012 data does not show a substantial amount of change, indicating that 47.5% of the County is urban land, which is a 9.2% decrease from 2007. Additionally, 2007 land use data also stated that 2.8% of the County's total land (or 1,258.8 acres) was identified as barren land; 4.2% of the County's total land area (or 1,868.8 acres) was identified as forested; and 3.2% of the County's total land area (or 1,433.6 acres) was identified as wetlands. As compared to 2007 data, the County experienced a decrease in forest land (0.8% decrease) and wetlands (0.5% decrease). Barren land experienced a small increase. Refer to Table 3-1 and Figure 3-4 below.

Table 3-1. Land Use Summary for Hudson County, 2007 and 2012

	2007 Data		2012 Data	
Land Use Category	**Acreage**	**% of Hudson County**	**Acreage**	**% of Hudson County**
Agriculture	0.0	0%	0.0	0%
Barren	1,258.8	2.8%	1,493.9	2.9%
Forest	1,868.8	4.2%	1,759.0	3.4%
Urban	25,052.0	56.7%	24,518.2	47.5%
Wetland	1,433.6	3.2%	1,397.3	2.7%

Source: NJDEP 2019 (2012 LULC)
Note: Urban land includes residential, industrial, transportation, and recreational land. Water is not included in the table above.

Figure 3-4. Land Use Land Cover for Hudson County



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3.1.4.1 Residential and Commercial

As reported by the 2014 U.S. Census, over 50% of housing units in the County are more than 50 years old; built prior to 1940. However, a housing construction boom took place during the 1950's and 1960's where approximately 30,000 new housing units were added each decade. After the 1960's, housing construction declined, but this trend reversed in the 2000's with construction of more than 35,000 housing units being built, especially in Hoboken and Jersey City (Hudson County Planning Board, Re-Examination 2017).

An increased emphasis on mixed-use development is a recurring theme in the Hudson County Master Plan Re-examination Report; this is to encourage development and re-development which is more conducive to economic growth and increasing access to employment, educational facilities, commercial facilities, entertainment and recreation facilities. Additionally, other objectives include retrofitting to be compliant for individuals with access and functional needs and refurbishment of older structures helps to rejuvenate neighborhoods and municipalities by attracting new residents. In addition to the goal of increasing mixed-use development, another identified goal was the integration of land use planning with transportation planning with a specific focus on pedestrian and bicycle accessibility and infrastructure. This goal is to increase use of public transportation options and reduce the congestion on roadways (Hudson County Planning Board, Re-Examination 2017).

An identified issue in Hudson County Master Plan Re-examination Report related to housing in Hudson County is increasing household resiliency and reducing the impacts of natural hazards on the County's building stock and the general population. Fifteen percent of the County's population was exposed to storm surges during Hurricane Sandy, and the New Jersey Department of Community Affair's Action Plan identified 4,407 housing units with major or severe damaged as a result of Sandy. Approximately 84 percent (3,702) of the buildings identified in the Action Plan were located in Bayonne, Hoboken, and Jersey City. Over 60-percent of housing units damaged in Sandy were owner-occupied. The total estimated damage to households in Hudson County from Hurricane Sandy exceeded $25 million dollars. Further compounding the impacts were the number of socially vulnerable individuals such as those aged 65 and older and individuals with low-income. Preventing or directing new residential construction out of the floodplain can reduce the impacts of flooding. It's not viable to move all housing structures because of the considerable number of the structures already located in the floodplain, but retrofitting and implementation of green stormwater infrastructure may help to reduce impacts. Mixed-use development in the floodplain can utilize underground parking space for stormwater detention/infiltration system during storm or hazard events. Identifying locations for interim housing may be important in order to house County residents should their primary dwelling be uninhabitable from damage sustained during flood or storm events (Hudson County Planning Board, Re-Examination 2017).

3.1.4.2 Industrial

The majority of industrial areas in Hudson County are located along the southern waterfront of Jersey City and Bayonne, between Routes 1 and 9 and the New Jersey Turnpike in North Bergen and Jersey City, the southern end of Harrison, the southern end of Secaucus, and south of Belleville Turnpike and east of Schuyler Avenue in Kearny. Smaller industrial areas are also found throughout many parts of Hudson County. Industries in the County include manufacturing, wholesale trade, transportation/warehousing and private sector (Hudson County Planning Board, Re-Examination 2017).

The 2002 & 2008 Master Plan Reexaminations noted Hudson County and the nation were affected by a downturn in manufacturing, wholesale trade, and transportation/warehousing establishments. Although large industrial development has occurred in Hudson County, there has been a slight decrease in industrial uses (Hudson County Planning Board, Re-Examination 2017).

The industrial land use category also includes the ports. Development at the ports continues to grow, driven by growth in global trade. Major port infrastructure projects include deepening at the Global Marine Terminal; improved efficiency at Global Container Terminals in Bayonne; redevelopment of Greenville Yards; Bayonne Bridge Navigational Clearance Project and the Roadway Capital Plan from Port Authority of New York and New Jersey for an improved road network into Port Jersey (Hudson County Planning Board, Re-Examination 2017).

3.1.4.3 Parks and Open Space

Open space is important in Hudson County because it helps create a balance between the urban environment and the natural environment. Parks and playgrounds provide needed recreational opportunities for its residents. Open space also improves air and water quality and enhances social cohesion among other social benefits (Hudson County Department of Parks and Community Services 2013). Residents and visitors enjoy the many local neighborhood parks and nine parks in the County Park System – listed below. In addition, Hudson County is home to Liberty State Park, a state-owned and operated park located in Jersey City, which is considered one of the region's most important open space assets (Hudson County Planning Board, Re-Examination 2017).

1. Columbus Park
2. James J. Braddock Park
3. Laurel Hill Park
4. Lincoln Park
5. Mercer Park
6. Stephen G. Gregg Bayonne Park
7. Washington Park
8. West Hudson Park
9. 14th Street Viaduct

Greenways, or linear open space systems connecting existing parks and neighborhoods through trails, scenic roads and bikeways are an important and vital component to the County's open space. The Hudson County Open Space Trust Fund, discussed further in Section 5 (Capability Assessment) and the Hudson County annex (Section 9.1) assists in creating, enhancing and maintaining parks throughout the County.

3.2 Population and Demographics

Knowledge of the composition of the population, how it has changed in the past and how it may change in the future is needed to make informed decisions. Information about population is a critical part of planning because it directly relates to needs such as housing, industry, stores, public facilities and services, and transportation.

The population of Hudson County was estimated at 679,756 in 2017 according to the American Community Survey 5-year estimates. In 2010, Hudson County had a population of 634,266 people which represents a 4.2% increase from the 2000 U.S. Census population of 608,975. HAZUS-MH demographic data will be used in the loss estimating analyses in Section 4 (Risk Assessment) of this plan. All demographic data in HAZUS corresponds to the 2010 U.S. Census data.

Table 3-2 presents the population statistics for Hudson County based on the 2010 decennial census and 2013-2017 American Community Survey 5-Year Estimates. Figure 3-5 shows the distribution of the general population density (person per square mile) in 2010 by Census block.

Hudson County has experienced a population increase over the past few decades. After nearly six decades of population decline, Hudson County is now growing. Between 1990 and 2010, almost every municipality within the County grew by at least 10%. The 2015 population estimates from the U.S. Census indicate continued strong growth. According to these estimates, four municipalities already exceeded a 10% population increase since 2010. This recent population growth is the result of strong housing construction and significant immigration (Hudson County Planning Board, Re-Examination 2017).

Table 3-2. Hudson County Population Statistics (2010 U.S. Census)

Municipality	U.S. Census 2010							2013-2017 ACS						
	Total	Pop. 65+	% Pop. 65+	Population Under 5	% Under 5	Low Income Population**	% Low Income Pop.**	Total	Pop. 65+	% Pop. 65+	Pop Under 5	% Under 5	Below Poverty Level*	% Below Poverty Level
City of Bayonne	63,024	8,325	13.2	3,846	6.1	7,046	11.2	66,719	9,389	14.1	4,221	6.3	10,475	15.7
Borough of East Newark	2,406	175	7.3	158	6.6	178	7.4	2,725	247	9.1	131	4.8	354.25	13
Town of Guttenberg	11,176	1,268	11.3	721	6.5	1,527	13.7	11,733	1,528	13	714	6.1	1,971	16.8
Town of Harrison	13,620	1,262	9.3	858	6.3	1,122	8.2	15,898	1,503	9.5	1,002	6.3	2,575	16.2
City of Hoboken	50,005	3,155	6.3	3,388	6.8	4,109	8.2	54,117	3,404	6.3	3,804	7	5,628	10.4
City of Jersey City	247,597	22,354	9	17,501	7.1	28,479	11.5	265,932	26,830	10.1	20,480	7.7	49,729	18.7
Town of Kearny	40,684	4,362	10.7	2,231	5.5	2,911	7.2	42,487	5,512	13	2,498	5.9	4,971	11.7
Township of North Bergen	60,773	8,188	13.5	3,823	6.3	6,779	11.2	63,438	8,660	13.7	4,005	6.3	10,023	15.8
Town of Secaucus	16,264	2,537	15.6	872	5.4	962	5.9	19,279	3,191	16.6	1,275	6.6	1,311	6.8
City of Union City	66,455	6,958	10.5	4,845	7.3	8,908	13.4	69,815	7,340	10.5	4,379	6.3	16,057	23
Township of Weehawken	12,554	1,542	12.3	649	5.2	1,492	11.9	14,268	1,644	11.5	764	5.4	1,641	11.5
Town of West New York	49,708	5,940	11.9	3,694	7.4	6,452	13.0	53,345	6,736	12.6	4,168	7.8	11,683	21.9
Hudson County (Total)	**634,266**	**66,066**	**10.4**	**42,586**	**6.7**	**69,965**	**11.0**	**679,756**	**75,984**	**11.2**	**47,441**	**7**	**116,238**	**17.1**

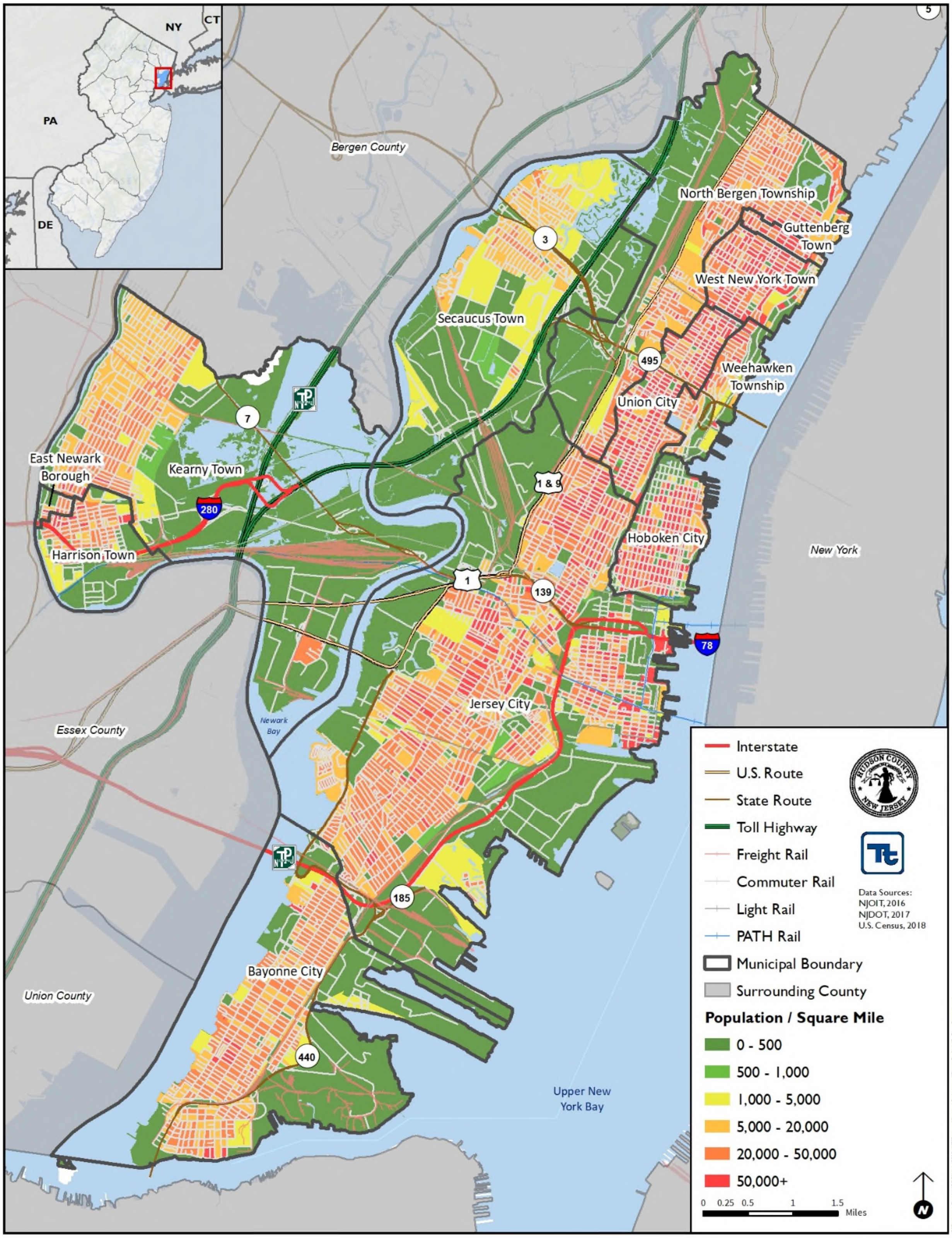
Source: U.S. Census 2010, 2018 (U.S. Census Bureau); HAZUS-MH v4.2 (for 2010 U.S. Census low income data)

Note: Pop. = population

** Low income population from HAZUS-MH v4.2 is the total of individuals with income $0-$10,000 and $10,000-$20,000 and $20,000-$30,000/year .*

***Low income population from the 2013-2017 ACS 5-Year Estimate is provided as percentage (%) of the municipal population, therefore the value displayed are calculated based on the percentage provided.*

Figure 3-5. Distribution of General Population for Hudson County



The physical, economic, and social structure of Hudson County has been largely influenced by the number of immigrants who have settled in the area over the past 150 years. Hudson County has historically been home to immigrants entering the U.S. due to the availability of jobs, affordable housing, and freedom. Throughout the 19th Century, immigrants made up most of Hudson County's population and labor force. By the 20th Century, during World War II, the need for factory workers increased, which brought in new immigrants to the area to fill these positions. When Congress changed the immigration law in 1965, more immigrants arrived into the Hudson County and changed the ethnic and racial composition of the area. Immigrants have been behind the different industries and the development pattern in Hudson County over the years (Heyer, Gruel & Associates, PA 2008).

Hudson County still attracts many people from different countries. According to the 2008-2012 estimates, foreign-born residents made up over 40% of the County's total population. The Borough of East Newark has the largest percentage of foreign-born residents, nearly 60%. Table 3-3 depicts the immigration population in Hudson County.

Table 3-3. Immigration Population in Hudson County

Jurisdiction	Total Population	Foreign Born Population		Foreign Born Entered U.S. before 2010	
		Population	% of Total Population	Population	% of Total Population
Bayonne	63,024	16,935	26.9	15,905	25.2
East Newark	2,297	1,375	59.9	1,331	57.9
Guttenberg	11,166	6,022	53.9	5,885	52.7
Harrison	13,683	7,706	56.3	7,427	54.3
Hoboken	49,898	7,428	14.9	6,786	13.6
Jersey City	248,435	95,919	38.6	90,777	36.5
Kearny	40,744	15,939	39.1	15,804	38.8
North Bergen	60,772	30,115	49.6	29,371	48.3
Secaucus	16,809	5,194	30.9	5,021	29.9
Union City	66,646	37,969	57.0	36,870	55.3
Weehawken	12,764	4,843	37.9	4,416	34.6
West New York	49,816	29,858	59.9	29,207	58.6
Hudson County (Total)	**636,194**	**259,303**	**40.8**	**248,800**	**39.1**

Source: U.S. Census 2010

Note: The statistics in this table are based on the 2008-2012 American Community Survey 5-Year Estimates. This is an ongoing survey that provides data every year.

3.2.2 Vulnerable Populations

Identifying concentrations of vulnerable populations can assist communities in targeting preparedness, response and mitigation actions. For the purposes of this planning process, vulnerable populations in Hudson County include children, elderly, low-income, the physically or mentally disabled, non-English speakers and the medically or chemically dependent. Hudson County is one of the State's most vulnerable areas socially. Low income levels, heavy public transit dependent and lack of vehicle access, and lack of homeowner's insurance all reduce the ability of individuals and families to prepare for, cope with, and recover from a storm event (Hudson County Division of Planning Strategic Recovery 2014).

3.2.2.1 Age

Children are considered vulnerable to hazard events because they are dependent on others to safely access resources during emergencies and may experience increased health risks from hazard exposure. The elderly is more apt to lack the physical and economic resources necessary for response to hazard events and are more likely to suffer health-related consequences making recovery slower. Those living on their own may have more difficulty evacuating their homes. The elderly is also more likely to live in senior care and living facilities (described in Section 3.4) where emergency preparedness occurs at the discretion of facility operators. Figure 3-6 shows the distribution of persons under the age of 5 and over 65 in Hudson County.

According to the 2013-2017 American Community Survey 5-Year Estimates, 47,441 (7.0%) of the County's population is under the age of 5 and 75,984 people (11.2%) of the County's total population were age 65 and older. Compared to the rest of the State, Hudson County has the greatest share of the 'young adult' age cohort (aged 25 to 35 years) and the lowest percentage of senior citizen population (aged 65+ years).

3.2.2.2 Income

It is noted that the Census data for household income provided in HAZUS-MH includes two ranges (Less than $10,000 and $10,000-$20,000/year) that were totaled to provide the "low-income" data used in this study. This does not correspond exactly with the "poverty" thresholds established by the 2013 U.S. Census Bureau, which identifies households with two adults and two children with an annual household income below $23,624 per year as "low income" for this region. This difference is not believed to be significant for the purposes of this planning effort.

The 2018 U.S. Census American Community Survey 1-year estimate data identified 22,731 families as having an annual income of less than $25,000. The 2013 New Jersey Department of Community Affairs (DCA) Action Plan identified high levels of low-income residents as one of the most visible areas of social vulnerability in Hudson County, with a substantial population located within the FEMA floodplain (Hudson County Division of Planning Strategic Recovery 2014). Figure 3-6 shows the distribution of low-income persons.

3.2.2.3 Physically or Mentally Disabled

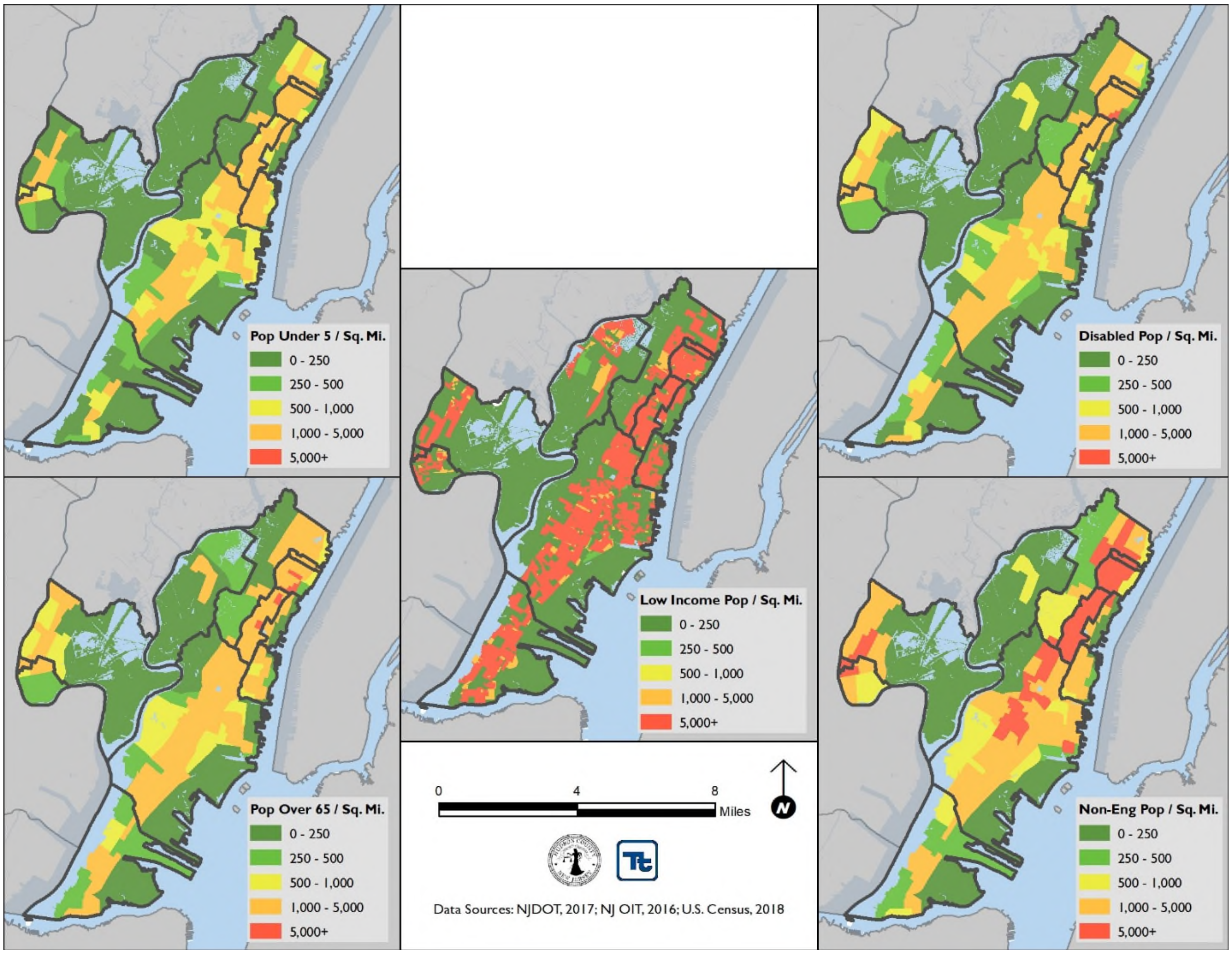
"Persons with a disability include those who have physical, sensory, or cognitive impairment that might limit a major life activity (Centers for Disease Control (CDC) 2015)." These impairments may increase the level of difficulty that individuals may face during an emergency. Cognitive impairments may reduce an individual's capacity to receive, process, and respond to emergency information or warnings. Individuals with a physical or sensory disability may face issues of mobility, sight, hearing, or reliance on specialized medical equipment. According to the 2013-2017 American Community Survey, 63,440 (9.4%) percent residents of Hudson County are living with a disability. shows the geographic distribution of disabled individuals throughout Hudson County, including individuals with hearing, vision, cognitive, ambulatory, self-care, and independent living difficulties.

3.2.2.4 Non-English Speakers

Individuals who are not fluent or working proficiency in English are vulnerable because they may have difficulty with understanding information being conveyed to them. Cultural differences can also add complexity to how information is being conveyed to populations with limited proficiency of English (Centers for Disease Control (CDC) 2015). According to the 2012-2016 American Community Survey, 10.4 percent of residents of the County's population over the age of 5 primarily speak a language other than English at home; of those 16,369 individuals are reported to speak English less than "very well." Of the County's population, 3.1% percent speak Spanish, 3.9% speak other Indo-European languages, 2.3% speak Asian and Pacific Island Languages, and 1.2% speak other languages. Figure 3-6 below shows the geographic distribution of individuals who speak English less than "very well."

According to the 2013-2017 American Community Survey, 59.2% of the County's population over the age of 5 primarily speaks a language other than English at home; this is significantly greater than the State average of 30.0%.

Figure 3-6. Distribution of Socially Vulnerable Populations in Hudson County



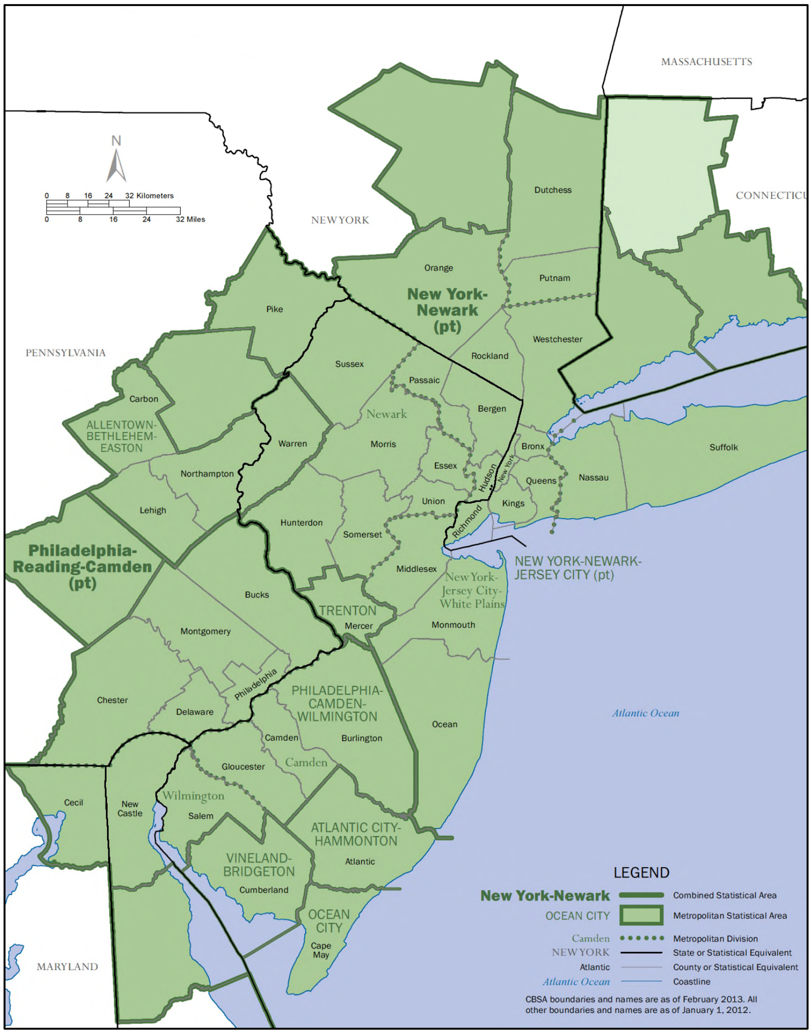
3.2.2.5 Metropolitan/Urban Area

Metropolitan statistical areas are geographic entities delineated by the New Jersey Office of Management and Budget (OMB) for use by Federal statistical agencies in collecting, tabulating, and publishing Federal statistics. The general concept of a metropolitan area is that of a large nucleus, together with adjacent communities, having a high degree of social and economic integration with that core (U. S. Census 2010).

Northeast New Jersey and portions of New York State are located in the New York-Newark Combined Statistical Area. This area is broken down into smaller metropolitan statistical areas (MSA). Hudson County is located within the New York-Newark Combined Statistical Area and the New York-Newark-Jersey City Metropolitan Statistical Area (U.S. Census 2014).

Due to the size of the New York-Newark-Jersey City Metropolitan Statistical Area, it is further divided into four metropolitan divisions which are separately identifiable employments centers within the MSA. Passaic County is part of the New York-Jersey City-White Plains NY-NJ Metropolitan Division labor market. Figure 3-7 illustrates the different statistical areas in New Jersey and parts of New York State.

Figure 3-7. New York Combined Statistical Area



Source: U.S. Census 2014

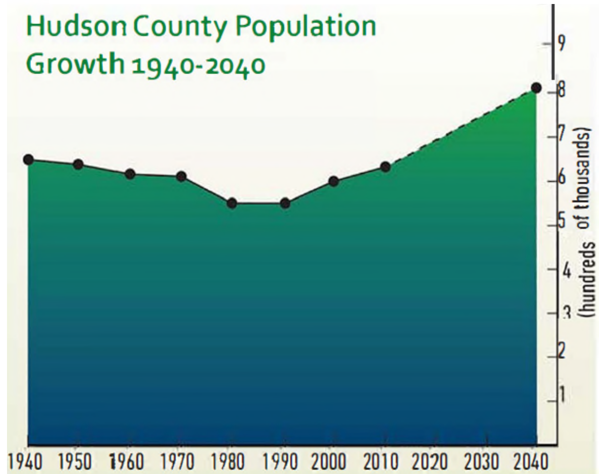
3.2.3 Population Trends

This section discusses population trends to use as a basis for estimating future changes that could result from the seasonal character of the population and significantly change the character of the area. Population trends can provide a basis for making decisions on the type of mitigation approaches to consider and the locations in which these approaches should be applied. This information can also be used to support planning decisions regarding future development in vulnerable areas.

Hudson County experienced an overall population decline in the latter half of the twentieth century Figure 3-8. From 1990 to 2010, almost every municipality within the County grew by at least 10%. This recent population growth is attributed to strong housing construction and significant immigration.

Despite Hudson County's high levels of density and limited developable space, the County continues to see high rates of population growth. According to the Hudson County Master Plan, Re-Examination in 2017, the County's population is expected to increase to approximately 817,300 by 2040; a 28.85% or 183,000 person increase from 2010. Table 3-4 lists the forecasted population growth for each municipality (2010 to 2040).

Figure 3-1. Hudson County Population Growth (1940 – 2040)



Source: *Hudson County Master Plan Re-Examination 2017 (2010 Census, NJTPA Population Forecasts)*

Table 3-4. Hudson County Forecasted Population Growth (2010 to 2040)

Jurisdiction	2010	2040	Change	% Change
Bayonne	63,200	78,650	15,630	24.8%
East Newark	2,410	4,510	2,100	87.14%
Guttenberg	11,180	11,650	470	4.20%
Harrison	13,620	32,050	18,430	135.32%
Hoboken	50,010	57,630	7,620	15.24%
Jersey City	247,640	356,250	108,610	43.86%
Kearny	40,680	43,000	2,320	5.7%
North Bergen	60,770	70,830	10,060	16.55%
Secaucus	16,260	22,840	6,580	40.47%
Union City	66,440	69,870	3,430	5.16%
Weehawken	12,550	17,200	4,650	37.05%
West New York	49,710	52,840	3,130	6.30%
Hudson County	**634,300**	**817,300**	**183,000**	**28.85%**

Source: Hudson County Master Plan Re-Examination 2017 (2010 Census, NJTPA Population Forecasts)

The most recent projections indicate the Town of Harrison will experience the highest population growth rate (135.32%) accounting for 18,430 new residents. In terms of the greatest amount of growth, Jersey City is forecasted to see over 100,000 new residents by 2040 (Hudson County Master Plan Re-Examination 2017).

The North Jersey Transportation Planning Authority estimates population as well as employment projections. Similar to the population forecast, Hudson County is anticipated to see a growth in employment with the greatest increase in Jersey City.

Table 3-5. Population and Employment Forecast (2015 to 2045)

Jurisdiction	2015 Employment	2045 Employment	Annualized % Employment Change 2015-2045
Bayonne	17,966	22,208	0.7%
East Newark	537	740	1.1%
Guttenberg	1,506	2,061	1.1%
Harrison	5,784	13,067	2.8%
Hoboken	23,485	27,076	0.5%
Jersey City	130,189	160,912	0.7%
Kearny	15,754	18,717	0.6%
North Bergen	23,028	26,727	0.5%
Secaucus	42,859	45,764	0.2%
Union City	14,050	17,293	0.7%
Weehawken	8,219	9,596	0.5%
West New York	9,425	11,891	0.8%

Source: North Jersey Transportation Planning Authority (NJTPA) Approved Demographic and Employment Forecasts 2017
Pop. = population
** = Calculated based on the North Jersey Transportation Authority 2005 data and known areas of the municipalities (population per square mile).*

3.3 General Building Stock

Hudson County has a diverse built environment. In terms of the housing stock, over 60% of housing units are within structures with three or more units. According to the American Community Survey (2014) nearly 70% of the County's housing stock is renter occupied which is nearly double compared to the State average. Looking across the County, Secaucus is the only municipality with a higher proportion of owners than renters. The median price of an owner-occupied in Hudson County was estimated at $360,400 (U.S. Census, ACS 2014).

The 2010 Census data indicates that just over 10% (27,307 units) of housing units in Hudson County are single-family detached units. The 2011 U.S. Census Bureau's County Business Patterns data identified 12,786 business establishments employing 210,468 people in Hudson County. The retail trade industry has the greatest number of establishments in the County, with 2,126 establishments. This is followed by the health care and social assistance industry with 1,416 establishments and the accommodation and food services industry with 1,383 establishments (U.S. Census, 2011).

For the HMP update, a custom-building inventory for Hudson County was developed to assess the current built environment's risk to natural hazards. The building stock update was performed using the most current parcel and tax assessment data provided by Hudson County. There are 76,828 structures included in the custom-building inventory. The total replacement cost value of the structures is an estimated $43 billion. Estimated content value was calculated by using 50-percent of the residential replacement cost value, and 100-percent of the non-residential replacement cost values. Actual content value various widely depending on the usage of the structure. Using this methodology, there is approximately $33 billion in contents within these improved properties. The total replacement cost of structure and contents value in Hudson County combined is $76 billion. Approximately 83-percent of the total buildings in the County are classified as residential, 9.3-percent of buildings are classified as commercial, and 3.6-percent of buildings are classified as industrial. Table 3-6 presents building stock statistics by occupancy class for Hudson County used for the risk assessment presented in Section 4.

Figure 3-9 through Figure 3-11 show the distribution of residential, commercial and industrial buildings in Hudson County. Exposure density is the dollar value of structures per unit area, including building content value. The densities are shown in units of $1,000 ($K) per square mile. Viewing exposure distribution maps, such as Figure 3-9 through Figure 3-11, can assist communities in visualizing areas of high exposure and in evaluating aspects of the study area in relation to the specific hazard risks.

Table 3-6. Building Stock Count and Improved Value by Occupancy Class

Municipality	All Occupancies				Residential		Commercial		Industrial	
	Count	RCV (Structure Only)	RCV (Contents Only)	Total RCV (Structure + Contents)	Count	Total RCV (Structure + Contents)	Count	Total RCV (Structure + Contents)	Count	Total RCV (Structure + Contents)
City of Bayonne	6,802	$4,982,211,116	$3,873,867,989	$8,856,079,105	5,171	$3,325,029,379	384	$1,691,685,390	968	$2,627,717,143
Borough of East Newark	403	$137,536,753	$103,351,699	$240,888,451	352	$102,555,162	23	$16,443,472	19	$101,308,514
Town of Guttenberg	1,227	$395,512,817	$255,994,752	$651,507,569	990	$418,554,195	144	$97,521,137	56	$55,043,320
Town of Harrison	2,537	$1,361,009,465	$1,037,966,291	$2,398,975,757	2,075	$969,129,523	265	$253,842,845	69	$707,607,099
City of Hoboken	4,470	$2,257,582,128	$1,652,620,106	$3,910,202,233	3,424	$1,814,886,066	745	$929,855,661	27	$294,358,387
City of Jersey City	35894	$14,623,176,332	$11,070,745,635	$25,693,921,967	30,273	$10,657,292,089	3,485	$4,537,629,667	678	$4,594,671,605
Town of Kearny	7,209	$4,329,985,772	$3,544,481,018	$7,874,466,790	6,241	$2,356,514,260	328	$670,836,628	382	$3,822,501,779
Township of North Bergen	6,005	$4,681,579,483	$3,711,565,158	$8,393,144,641	5,126	$2,910,042,975	417	$1,923,521,205	208	$2,921,565,495
Town of Secaucus	3,845	$5,076,387,732	$4,516,875,030	$9,593,262,762	3,280	$1,678,538,104	239	$1,827,410,001	174	$5,506,564,848
City of Union City	1,729	$2,201,455,454	$1,541,426,930	$3,742,882,384	1,252	$1,980,085,573	286	$962,794,677	23	$170,322,858
Township of Weehawken	2,113	$904,290,070	$605,829,859	$1,510,119,929	1,926	$895,380,635	102	$348,707,419	21	$128,477,368
Town of West New York	4,594	$1,666,285,689	$1,158,726,983	$2,825,012,673	3,583	$1,522,676,117	759	$643,615,649	123	$179,301,289
Hudson County	**76,828**	**$42,617,012,810**	**$33,073,451,450**	**$75,690,464,261**	**63,693**	**$28,630,684,080**	**7,177**	**$13,903,863,749**	**2,748**	**$21,109,439,706**

Source: Hudson County

Figure 3-9. Distribution of Residential Building Stock Replacement Cost Value in Hudson County

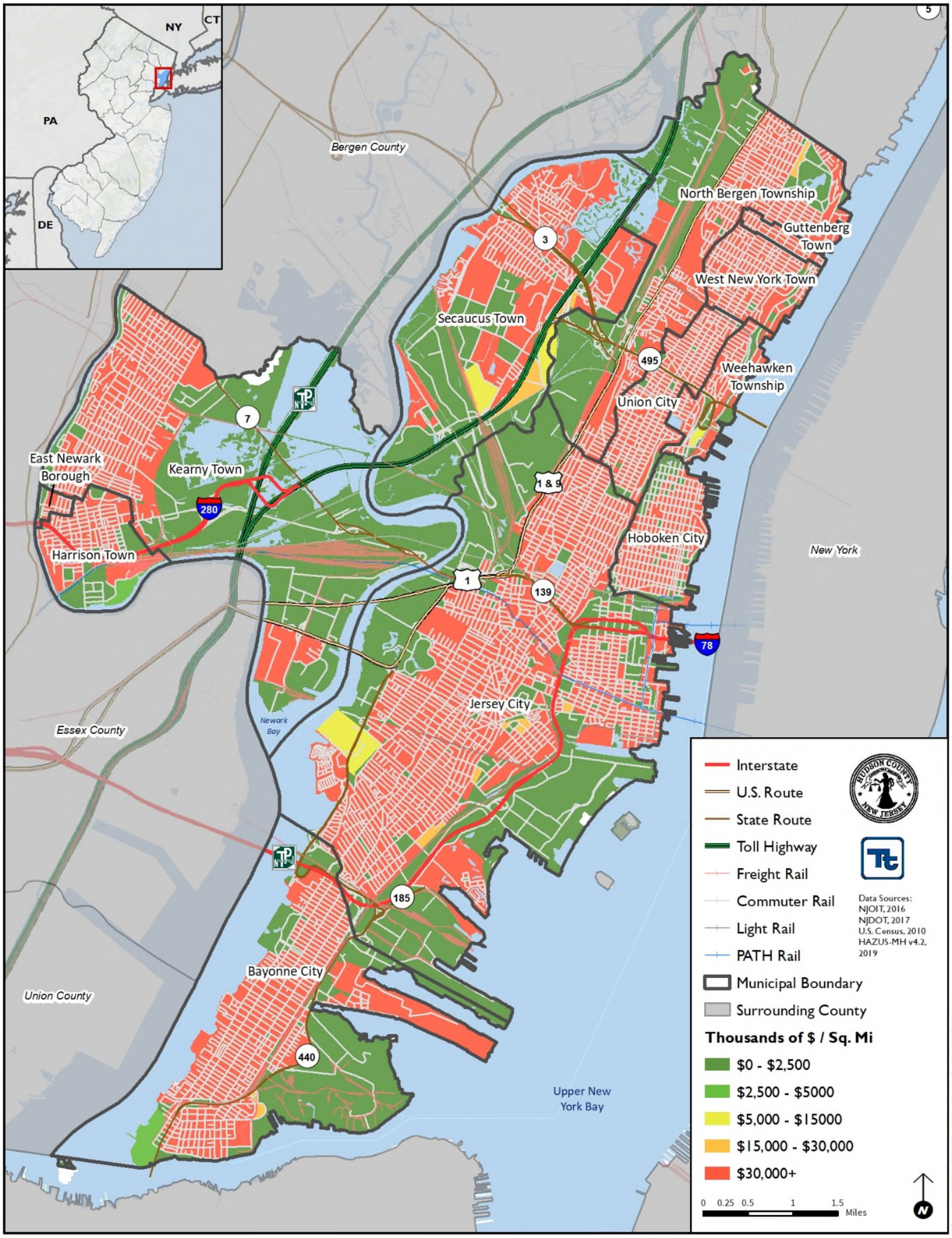


Figure 3-10. Distribution of Commercial Building Stock Replacement Cost Value in Hudson County

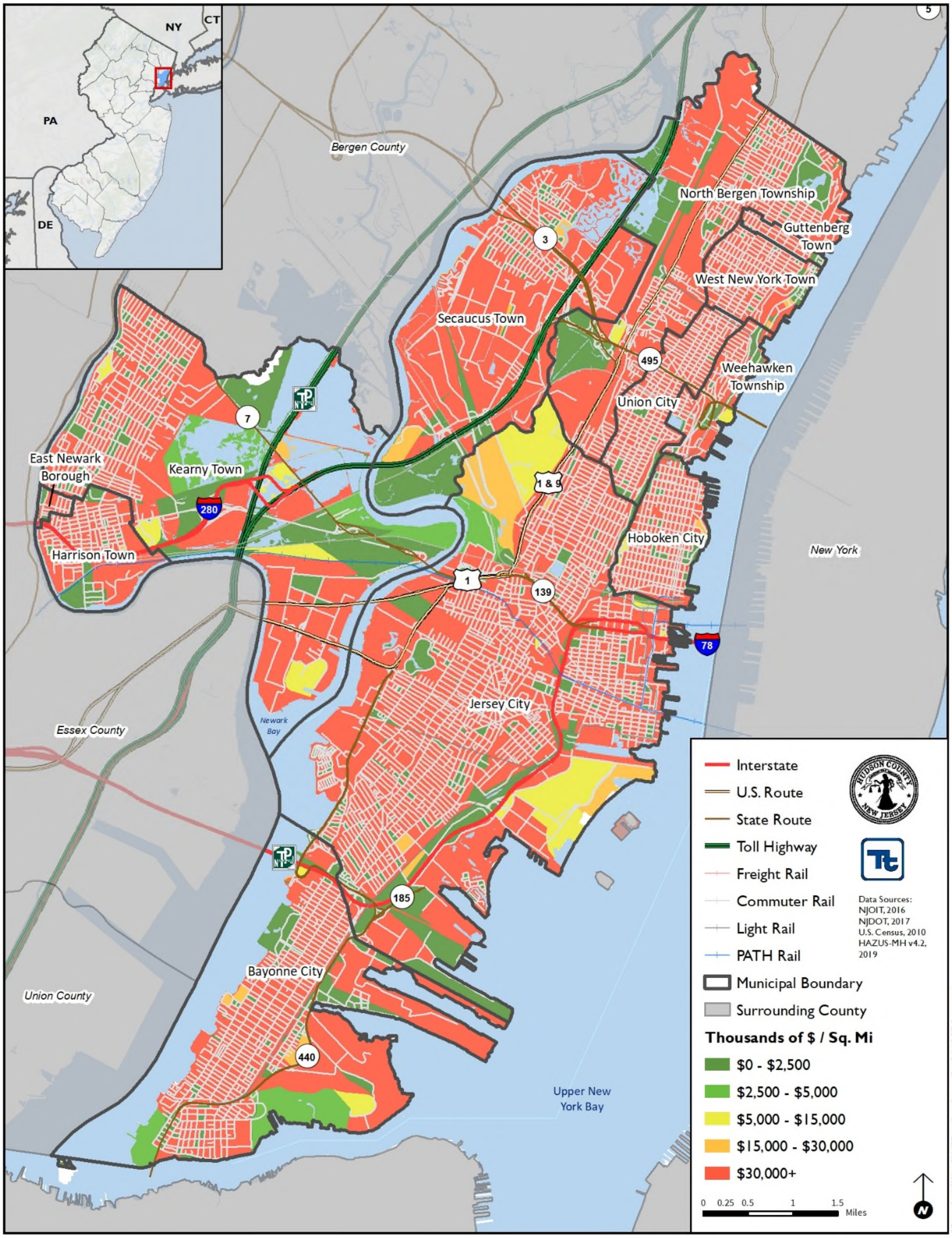
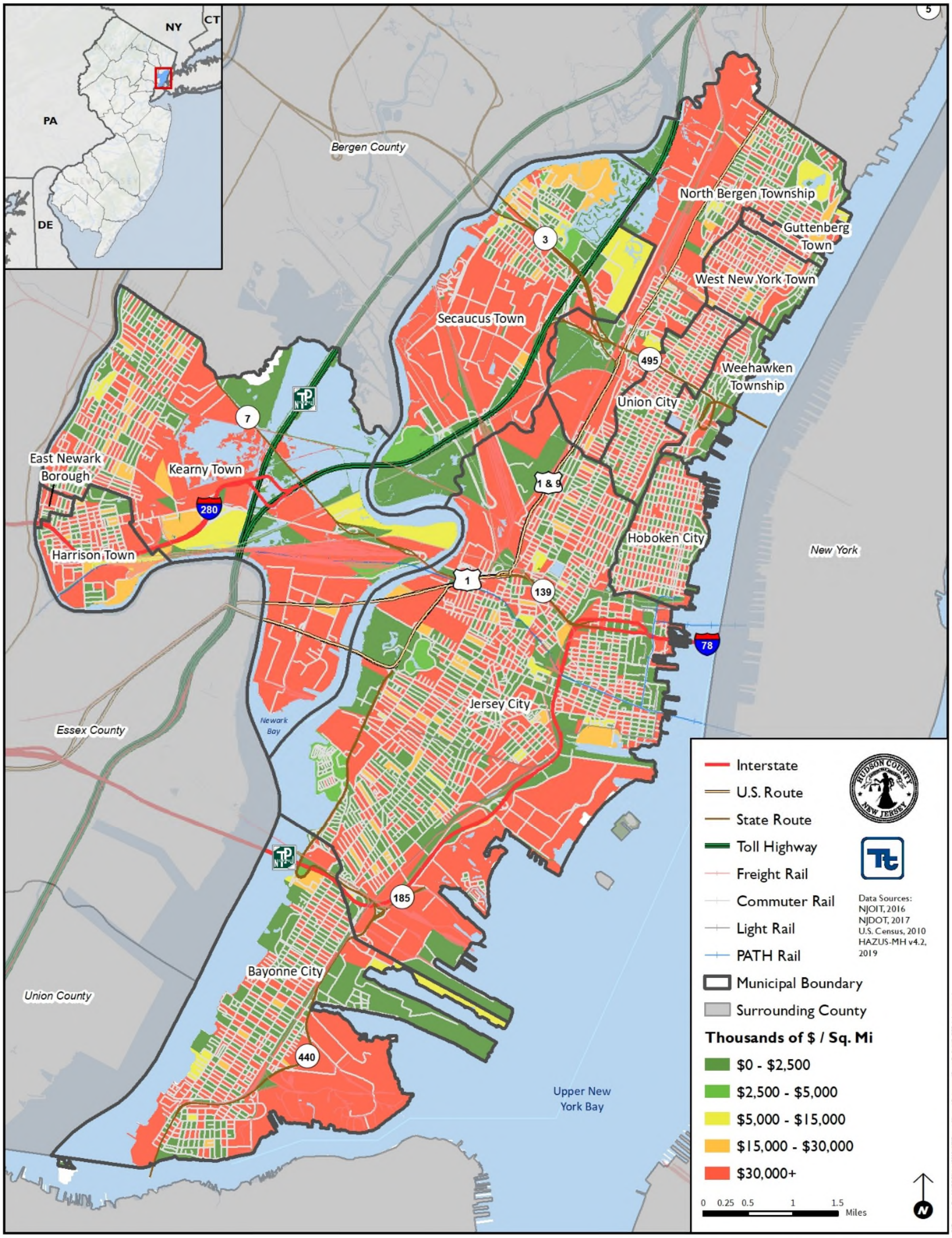


Figure 3-11. Distribution of Industrial Building Stock Replacement Cost Value in Hudson County



3.3.2 Development Trends and New Development

Local zoning and planning authority are provided for under the New Jersey Municipal Land Use Law, which gives municipalities zoning and planning authority. The NJSEA holds zoning jurisdiction over the portions of each municipality within its borders. The Consolidation Act allows municipalities to administer the majority of the zoning requirements of the NJSEA, upon adoption of an 'opt-out' resolution agreeing to follow the land use provisions of the Meadowlands zoning regulations. To date, the Towns of Secaucus and Kearny have become 'opt-out' municipalities (NJSEA 2019).

In recent years, Hudson County has identified the need for land use resiliency through zoning regulations. Large portions of Hudson county are located in flood-prone areas with approximately 80% of this land being developed. Severe weather and normal rainfall events can disrupt the daily lives of citizens. Most of the developable land in Hudson County has been built out, and redevelopment is commonly occurring throughout many municipalities. As part of this redevelopment process, the 2016 Land Development Regulations Update, provides guidelines for implementation of Green Stormwater Infrastructure methods when development is adjacent to a County roadway or facility. The City of Hoboken has developed a Green Infrastructure Strategic Plan which recommends incentive zoning for incorporating on-site green infrastructure to reduce the expansion of impervious surface. The 2014 Jersey City Sandy Recovery Strategic Planning Report identified that Jersey City was working towards the development and codification of zoning and flood damage prevention ordinances for building rehabilitation and new construction (Hudson County Planning Board, Re-Examination 2017).

An understanding of land use trends and types of development occurring can assist in planning for future development and ensuring that appropriate mitigation, planning, and preparedness measures are in place to protect human health and community infrastructure.

Hudson County Master Plan Re-examination Report Goal 10:

To minimize the negative effects of development and redevelopment on the natural built environments and to discourage development on environmentally sensitive areas.

Hudson County has limited land use powers. While site plan review and approval is within the County's powers for traffic and drainage projects abutting a County road, they have no zoning authority. However, the County promotes a variety of land use options that support economic activity, recreational and education opportunities, and protects human health and the natural environment. In addition, the County makes recommendations to support responsible land use decision-making by municipalities (Hudson County Planning Board, Re-Examination 2017).

The Land Use and Land Cover subsection presented earlier discusses some of the residential, commercial and industrial changes in Hudson since the 2008 Master Plan. According to the Hudson County Master Plan Re-examination Report, between 2013 and 2015, the Hudson County Planning Board approved various site plans that impacted steep slopes, freshwater wetlands or floodplains. However, all approved applications involved sites that were already developed. Under County jurisdiction, no new developments have occurred in environmentally constrained areas (Hudson County Planning Board, Re-Examination 2017.

According to the U.S. Census, Hudson County has experienced an increase in both households and housing units. From 2000 to 2010, Hudson County experienced a 6.9% increase in households (one or more persons, whether related or note living together in a dwelling unit); this is an increase of nearly 16,000 households. As for housing units, the County experienced an increase of 12.2% between 2000 and 2010. Note, you may have more than one household per housing unit. The North Jersey Transportation Authority forecasts a 32% increase in households over the next 30 years in Hudson County. In addition, NJTPA forecasts that Jersey City will experience the greatest growth compared to the rest of the County; refer to Figure 3-12.

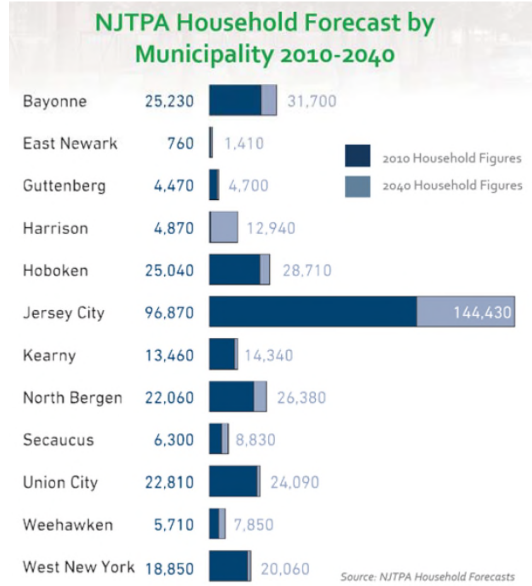


Figure 3-2. Hudson County Projected Household Growth (2010 – 2040)

Source: Hudson County Master Plan Re-Examination 2017 (NJTPA Household Forecasts)

County and community capabilities to manage development to minimize increased natural hazard risk are discussed in the capability assessment subsection of Section 5, as well as within each jurisdictional annex in Section 9. Also identified within each annex are actions the jurisdiction has or will take to further integrate the findings and recommendations of this plan into other planning mechanisms and programs, many of which support land use and development so as to minimize the increase of natural hazard risk.

Each jurisdiction was asked to provide known new major development that has occurred since 2014 and anticipated major development within their jurisdiction over the next five years. A spatial analysis was then conducted to determine the presence of natural hazards that may impact the future investment. These results were communicated to each plan participant to discuss potential mitigation measures to reduce future impacts to these areas. Refer to Section 9 (Jurisdictional Annexes) for more detailed results of the analysis.

3.4 CRITICAL FACILITIES AND LIFELINES

Critical facilities and infrastructure provide services and functions essential to a community, especially during and after a disaster. Critical facilities include essential facilities, transportation systems, lifeline utility systems, high potential loss facilities and hazardous material facilities. Transportation systems include roadways, bridges, airways, and waterways. Utility systems include potable water, wastewater, oil, natural gas, electric power facilities, and emergency communication systems.

Critical facilities and infrastructure provide services and functions essential to a community, especially during and after a disaster. As defined for this HMP, critical facilities include essential facilities, transportation systems, lifeline utility systems, high-potential loss facilities and hazardous material facilities.

A ***community lifeline****,* a type of critical facility, enables the continuous operation of government functions and critical business and is essential to human health and safety or economic security.

An enhancement to the 2020 HMP was the identification of community lifelines across Hudson County. Hudson County's definition for a lifeline aligns with FEMA: *"a type of critical facility that provides indispensable service that enables the continuous operation of critical business and government functions, and is critical to human health and safety, or economic security."* Identifying community lifelines will help government officials and stakeholders to prioritize, sequence, and focus response efforts towards maintaining or restoring the most critical services and infrastructure within their respective jurisdiction(s). Identifying potential impacts to lifelines can help to inform the planning process and determining priorities in the event an emergency occurs; refer to Appendix E for the FEMA fact sheet on lifelines.

A comprehensive inventory of critical facilities and lifelines in Hudson County was developed from various sources including HAZUS-MH provided data, Hudson County Planning Department, PSE&G, American Red Cross, municipal representatives, and input from the Planning Committee. The inventory presented in this section represents the current state of this effort at the time of publication of the draft HMP and used for the risk assessment in Section 5.

The inventory of critical facilities and lifelines identified for the HMP is considered sensitive information. It is protected by the Protected Critical Infrastructure Information (PCII) program and under New Jersey Executive Order 21. Therefore, individual facility names and addresses are not provided in this HMP. A summary of the facility types used for the risk assessment are presented further in this section.

3.4.1 Essential Facilities

This section provides information regarding Hudson County's emergency facilities, hospital and medical facilities, schools, shelters, senior care and living facilities and government facilities. As stated above, these assets provide indispensable services that need to remain in operation before, during and after natural hazard events. Refer to Section 9 (Jurisdictional Annexes) for mitigation strategies identified by plan participants to reduce future impacts to vulnerable essential facilities and lifelines.

Essential facilities are a subset of critical facilities that include those facilities that are important to ensure a full recovery following the occurrence of a hazard event. For the County risk assessment, this category was defined to include police, fire, EMS, EOCs, schools, shelters, senior facilities and medical facilities.

Emergency Facilities are for the purposes of this Plan, emergency facilities include police, fire, emergency medical services (EMS) and emergency operations centers (EOC).

Emergency Facilities

Public safety services at the county-level are provided by the County Sheriff's Department. The County Sheriff's Department is responsible for policing the Hudson County Parks and County roads, providing security in all court rooms, serving warrants and transporting prisoners. Police departments, fire departments, first aid and public works departments provide emergency services to the municipalities they are located in. However, North Hudson Regional Fire & Rescue responds to emergencies within Guttenberg, North Bergen, Union City, Weehawken and West New York (Heyer, Gruel, & Associates, PA, 2002; Hudson County Planning Board, Re-Examination 2017).

Each municipality has at least one police department and fire department servicing its residents. The larger municipalities, such as Jersey City, have multiple departments to ensure safety in times of need. Additionally, the county has seven hospitals and major medical facilities suited to aid in emergency management. There are 34 police stations, 61 fire stations, 6 EMS/public safety squads, 14 EOCs, 7 medical facilities, 96 shelters.

Schools and Shelters

Residents are served by nearly 200 schools throughout the County including several higher academic institutions. Schools can function as shelters in times of needs and are important resource for the community. There are 96 shelters located in Hudson County.

Senior Facilities

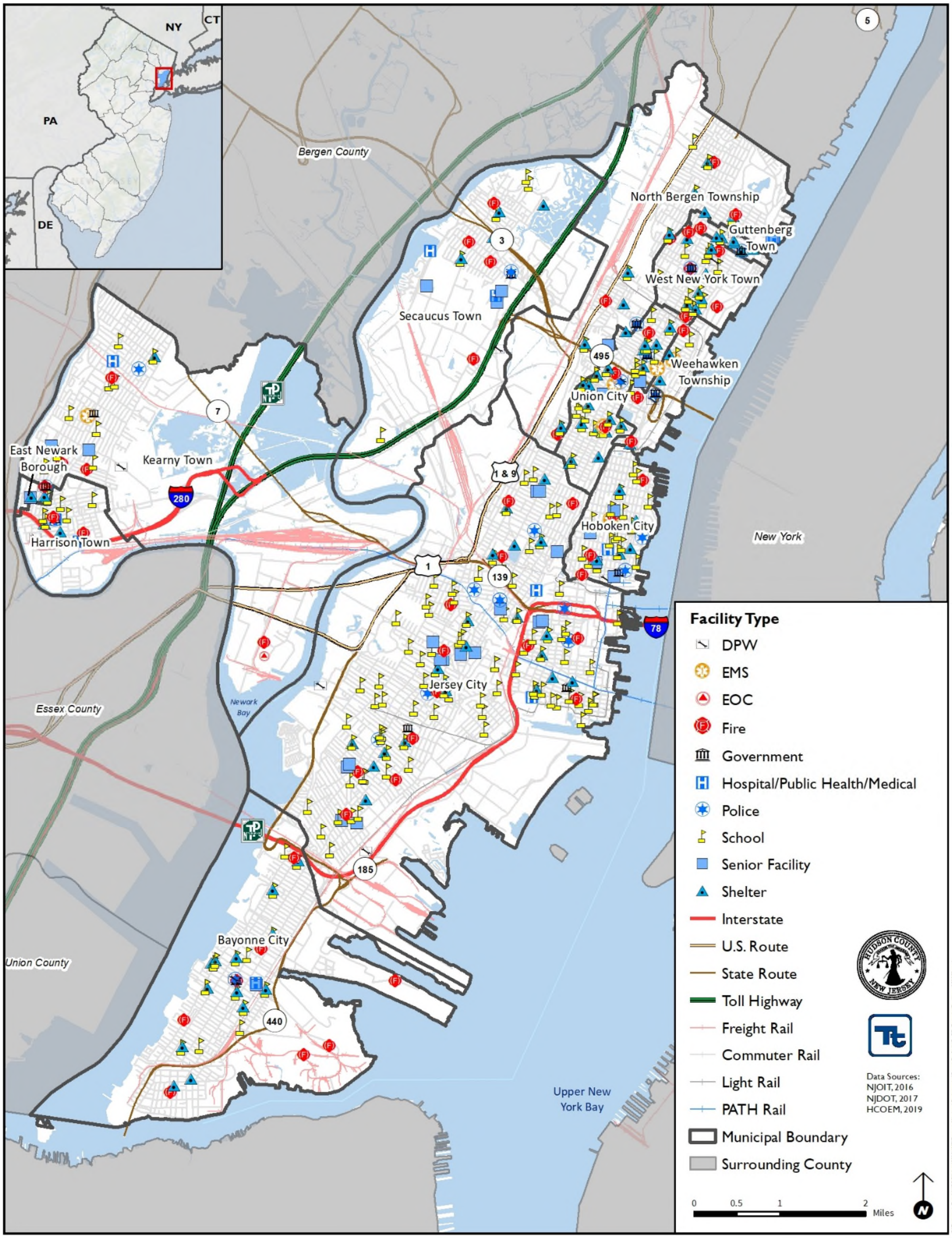
Senior care and living facilities are highly vulnerable to potential impacts from natural and anthropogenic disasters and therefore, must be identified. By understanding the distribution and quantity of these facilities, it would enable better management of an emergency response plan after a disaster. There are 29 senior facilities located in Hudson County.

Government Facilities

In addition to the facilities discussed, county and municipal buildings, department of public works facilities and public health departments are essential to the continuity of operations pre-, during and post-disasters. These facilities are included in the risk assessment. There are approximately 28 government facilities within Hudson County.

Figure 3-13 illustrates the inventory of these emergency and government facilities in Hudson County.

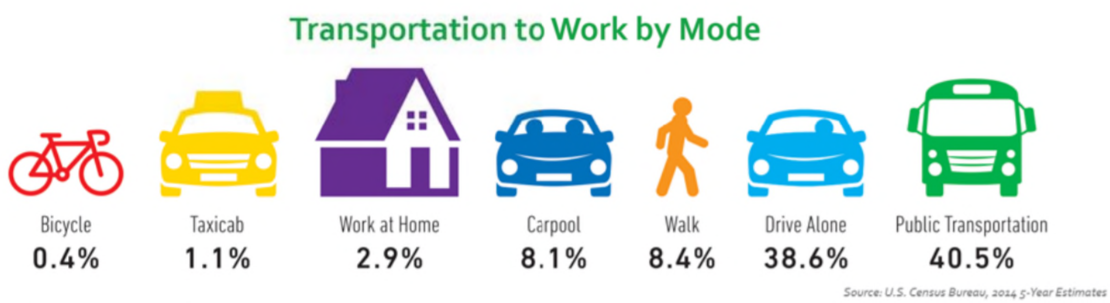
Figure 3-13. Essential Facilities in Hudson County



3.4.2 Transportation Systems

Hudson County has a highly developed and well-established transportation network that serves as a major transportation hub for the Northeast, providing access to national highways, state freeways and toll roads, and water crossings. The Hudson County transportation system consists of passenger rails; New Jersey Transit commuter rail lines, the Port Authority Trans-Hudson (PATH) rapid transit system; New Jersey Transit; trans-Hudson tunnels; private, regional, and local bus services; the cross-Hudson ferry/water taxi system; and streets and highways (Hudson County Planning Board, Re-Examination 2017). This complex network is relied upon by residents, commuters and to maintain County operations. Hudson County's population relies on public transportation services; and 32.4% of households have no automobiles (US Census 2014, 5-year estimates). Refer to Figure 3-14 for the modes of transportation Hudson County residents rely on to commute to work.

Figure 3-3. Transportation to Work by Mode in Hudson County



Source: Hudson County Master Plan Re-examination Report 2016

Truck access to large intermodal facilities is vital to the State and regional economy. In addition, due to the large regional market and geographic proximity to several Hudson River crossings into New York City and the availability of the port, rail and distribution infrastructure, freight is also a major user of the transportation network in the County (Hudson County Planning Board, Re-Examination 2017).

It is essential that the transportation network in Hudson County remains accessible and operational before, during and after natural hazard events to ensure safe evacuation, continuity of essential services and maintain economic activity in the County. Hurricane Sandy is one recent example of the immediate and long-term significant impacts on mobility in Hudson County. Refer to Section 9 (Jurisdictional Annexes) for mitigation strategies identified by the plan participants to increase the resilience of transportation assets in which they have jurisdiction.

The following generally describes the transportation assets in Hudson County. Refer to Figure 3-15 which displays these transportation lifelines connecting Hudson County to surrounding counties and states.

3.4.2.1 Highways, Roadways and Associated Systems

The New Jersey Turnpike includes Interstate Routes 95 and 78. The Turnpike is a limited access toll road with a general north/south orientation. Within Hudson County, the Turnpike consists of Interstate Route 95 (I-95) (eastern and western spurs) and Interstate Route 78 (I-78) (Hudson County extension). I-78 begins to the west of Hudson County, in Warren County and becomes the Hudson County Extension at Turnpike Interchange 14 in Essex County. I-78 ends at its intersection with the Holland Tunnel. With the County, I-78 is four lanes separated by a concrete median with a speed limit of 50 miles per hour (mph). I-78 provides a direct route from central New Jersey to Manhattan. I-95 runs from the Delaware Memorial Bridge to the George Washington Bridge in New Jersey and continues north towards the New England states. In Hudson County, I-95 separates into the Eastern and Western Spurs. Both Spurs consists of six travel lanes with a speed limit of 55 mph (Heyer, Gruel, & Associates, PA, 2002).

Interstate 280 (I-280) is a limited access roadway with a general east/west orientation. I-280 begins to the west of Hudson County as an extension of Interstate Route 80 in Morris County. This roadway has a speed limit of 50 mph and ends at the New Jersey Turnpike exchange in Kearny, New Jersey. The Holland Tunnel and Manhattan can be reached from I-280 (Heyer, Gruel, & Associates, PA, 2002).

U.S. Route 1 & 9 begins as a grade separated limited access roadway and continues as an at grade arterial roadway with a general north/south orientation, in Hudson County. The elevated section of U.S. Route 1 & 9 is known as the Pulaski Skyway and runs between Newark and Jersey City, with four travel lanes and a posted speed limit of 45 mph. The Tonnelle Circle is located at the base of the elevated section in Jersey City. From this intersection, U.S. Route 1 & 9 continues at grade north as Tonnelle Avenue with four travel lanes and a speed limit of 40 mph. Tonnelle Avenue provides a major north/south route to Bergen County and access to the George Washington Bridge (Heyer, Gruel & Associates PA, 2008).

New Jersey State Highway 3 (NJ Route 3) is a limited access arterial roadway with a general east/west orientation. NJ Route 3 is a major northern New Jersey highway, running between Passaic County and Secaucus. This roadway consists of six lanes and has a speed limit of 50 mph. NJ Route 3 provides access to the Meadowlands Sports Complex and the Lincoln Tunnel (Heyer, Gruel & Associates PA, 2008).

New Jersey State Highway 7 (NJ Route 7) is an arterial roadway which runs east/west within Hudson County. This roadway acts as a border between Hudson and Bergen Counties in Kearny, and is known as the Belleville Turnpike. NJ Route 7 has four lanes with a speed limit ranging from 30 to 50 mph. It ends at the Holland Tunnel and provides an interchange with US Route 1 & 9 (Heyer, Gruel & Associates PA, 2008).

New Jersey State Route 139 (NJ Route 139) is an arterial roadway with an east/west orientation. The upper level of the highway extends from the Tonnelle Circle of U.S. Route 1 & 9 to Hoboken Avenue and provides access to the local street system. The lower level is a limited access roadway between the Tonnelle Circle and the Holland Tunnel (Heyer, Gruel, & Associates PA, 2008). According to the NJDOT, Route 139 Lower Roadway will have one eastbound lane open throughout the duration of the Pulaski Skyway project.

New Jersey State Route 185 (NJ Route 185) is a minor arterial roadway with a general north/south orientation. The roadway ends in the north at Linden Avenue in Jersey City and ends in the south at New Jersey State Route 440. NJ Route 185 has four travel lanes and a speed limit of 40 mph. It is proposed to continue north to Caven Point Road, which provides access to Liberty State Park (Heyer, Gruel & Associates PA, 2008).

New Jersey State Route 440 (NJ Route 440) is a limited access arterial roadway with a general north/south orientation. It is a continuous roadway from Jersey City to the Bayonne Bridge. The southern portion of the roadway connects to Staten Island. The northern section connects to Communipaw Avenue in Jersey City. NJ Route 440 consists for four lanes with a speed limit ranging from 45 to 50 mph in Hudson County (Heyer, Gruel & Associates PA, 2008).

New Jersey State Route 495 (NJ Route 495) is a limited access roadway with an east/west orientation. This roadway runs between the NJ Turnpike Interchange and the Lincoln Tunnel. NJ Route 1 & 9 and NJ Route 3 all connect to NJ

Route 495. This roadway consists of six travel lanes with a speed limit of 50 mph. NJ Route 495 is the main connection to the Lincoln Tunnel and New York City (Heyer, Gruel & Associates PA, 2008).

3.4.2.2 Air and Heliport

Air travel to and from and within Hudson County is limited to helicopter traffic. Major airports in the vicinity of Hudson County are Newark Liberty International Airport in Newark, John F. Kennedy International Airport in Jamaica, New York and LaGuardia Airport in Flushing, New York. There are 11 heliports in the County. Figure 3-15 illustrates the inventory of these heliports in Hudson County.

3.4.2.3 Railway Facilities

Rail transportation in Hudson County is used for freight and public transportation. The major freight lines in Hudson County include the CSX Transportation, East Jersey Railroad and Terminal Company, New York Cross Harbor Railroad Company, and Norfolk Southern.

CSX Transportation (CSX) is a Class I railroad in the U.S. that serves most of the east coast. It operates the Juice Train, which transports Tropicana juice between Bradenton, Florida to its distribution center in Jersey City and Cincinnati, Ohio. Major rail yards and intermodal terminals for CSX in Hudson County are located in North Bergen and South Kearny (CSX Transportation, 2006).

East Jersey Railroad and Terminal Company (EJRR) operates a 2.4 mile line segment in Bayonne. It was established in 1901 and operates switching trackage within the International Matex Tank Terminal (IMTT) complex (formerly Tidewater Oil) in Bayonne (Oliveto, 2001).

New York Cross Harbor Railroad Company is a freight shortline and holds the exclusive franchise to float rail freight cars across the Upper New York Bay. It is based at Bush Terminal in Brooklyn, New York and interchanges with Conrail at Greenville Yard in Jersey City (Oliveto, 2001).

The Norfolk Southern (NS) is a major Class I railroad in the U.S. that serves 22 eastern states. NS operates 21,500 miles of rail in these states; with the most common commodity hauled is coal. NS's distribution network is located in throughout NJ, including Hudson County. Some of these distribution networks are Port Jersey Distribution Services (Bayonne), Supor Industrial Park (Harrison), Supor (Harrison), Harrison Warehousing (Harrison), CTX Lambie (Hoboken), Transload Services LLC (Jersey City), Rapid Industrial Plastics Company (Jersey City), and Mid-States Packaging (Jersey City) (Norfolk Southern, Date Unknown).

Port Jersey Railroad (PJRR) is a freight shortline that provides rail freight transportation in Jersey City (PJRR, Date Unknown). PJRR was established in 1970 and is a 2.4 mile terminal railroad within the Port Jersey distribution center complex. It connects with Conrail at Greenville Yard in Jersey City (Oliveto, 2001).

There are 24 railroad facilities in the County. Figure 3-15 illustrates the inventory of these railroad facilities in Hudson County.

3.4.2.4 Passenger Rail Facilities

The existing passenger rail system within Hudson County is directed to New York City with limited service to the different counties. It primarily serves commuters from northern and central New Jersey, traveling to and from New York City. The New Jersey Transit rail system consists of two rail stations in Hudson County, which include: Secaucus Junction in Secaucus, and Hoboken Terminal in Hoboken. Secaucus Junction is the primary transfer station between lines servicing New York Penn Station and Hoboken, as well as other New Jersey Transit lines entering the County (Nelson\Nygaard, 2008). The Hoboken Terminal is served directly by the Boonton Line, the Main Line, the Bergen County Line, the Pascack Valley Line, and the Morris and Essex Lines. This terminal is also served by the North Jersey Coast Line, the Raritan Valley Line, and the Northeast Corridor Line (Heyer, Gruel, & Associates, PA, 2002).

The PATH transit system is the primary link between New York City and urban communities in New Jersey. With approximately 45 percent of Hudson commuters using rail transit into Manhattan, this is the most frequently used method of transportation by Hudson County residents and other commuters to travel to and from New York City. The PATH system consists of four lines through Hudson County, which include the Newark-World Trade Center Line, the Journal Square-33rd Street Line, the Hoboken-World Trade Center Line, and the Hoboken-33rd Street Line (Heyer, Gruel, & Associates, PA, 2002). At night and on weekends, these lines are altered to service two lines; Newark-World Trade Center Line and 33rd Street to Journal Square via Hoboken (Nelson\Nygaard, 2008).

The Hudson Bergen Light Rail is Hudson County's regional passenger rail service. It is made up by three service configurations: Bayonne to Hoboken, Tonnelle Avenue to Hoboken, and Tonnelle Avenue to West Side Avenue; these lines service Bayonne, Jersey City, Hoboken, Union City, Weehawken and North Bergen. This line is primarily designed to service the employment, retail and residential developments of downtown Jersey City and Hoboken, while connecting them to the other municipalities it serves (Nelson\Nygaard, 2008).

There are 31 passenger rail facilities in the County. Figure 3-15 illustrates the inventory of these passenger rail facilities in Hudson County.

3.4.2.5 Bus Services

Hudson County bus service is provided by a variety of private and public operators. The largest of these providers is New Jersey Transit. According to NJ Transit, there are 59 bus routes in the County that transport passengers locally, around New Jersey and outside of New Jersey. The major bus routes have a north/south orientation to serve the heavily populated areas in eastern Hudson County (Heyer, Gruel, & Associates, 2002).

Both public and private companies operate commuter bus services for different travel purposes throughout the County. These bus services are designed for longer commutes to bring people from residential areas to places of employment during peak commuting periods. The major destinations for these commuter buses in Hudson County include Journal Square, Exchange Place, and Hoboken. The 30th/31st Street Corridor in Union City functions as a service corridor for I-495 into Manhattan (Nelson\Nygaard, 2008).

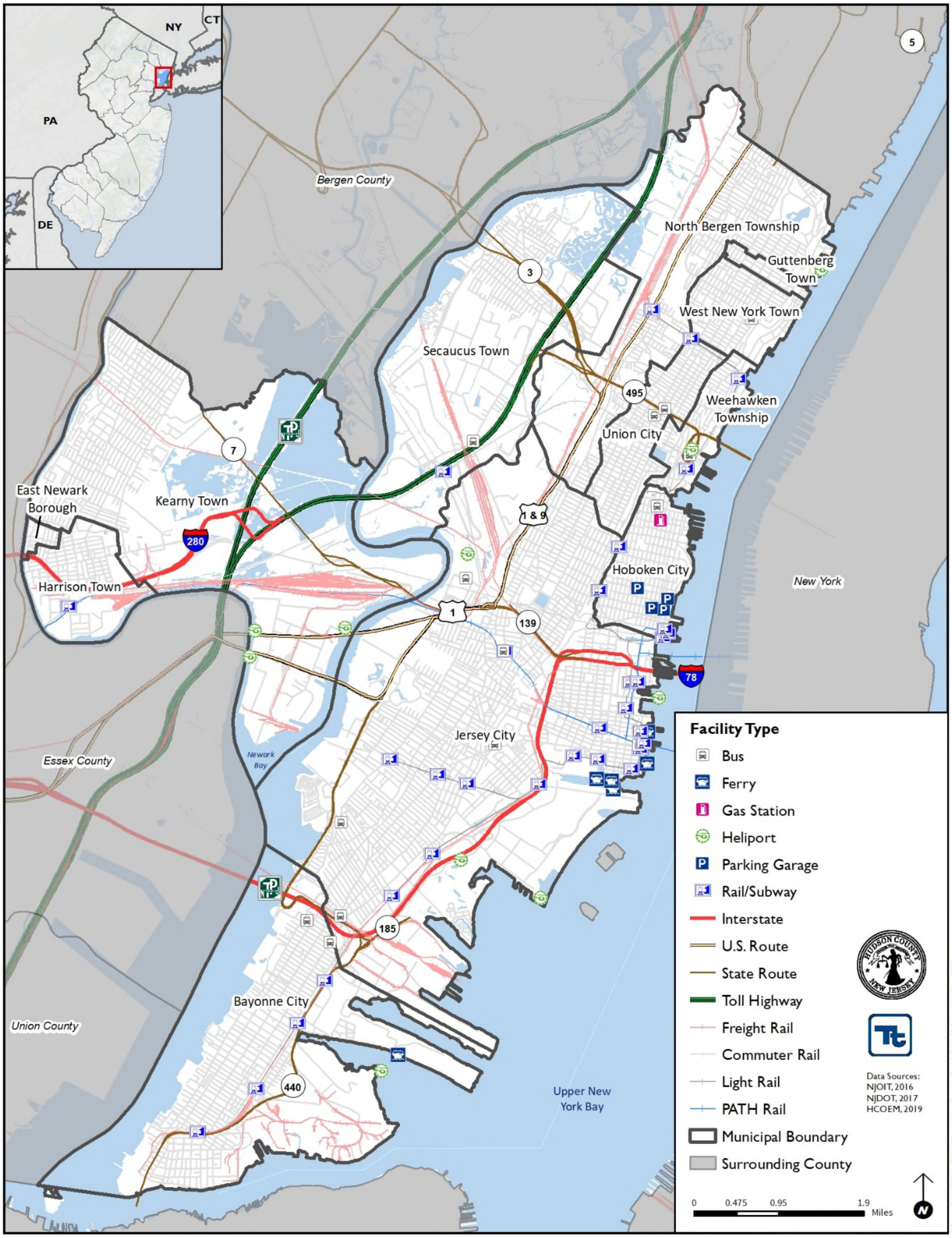
There are 14 bus facilities in the County. Figure 3-15 illustrates the inventory of these bus facilities in Hudson County.

3.4.2.6 Ferry, Marina and Port Facilities

As a coastal county, water transportation is a major component of the transportation system in Hudson County. HAZUS-MH defines ports and harbor transportation systems as waterfront structures, cranes/cargo handling equipment, warehouses and fuel facilities. In addition to the ports, the County also has an extensive ferry system between New

York City and other New Jersey counties, and multiple marinas. There are 29 ferry, 5 marina, and 45 port facilities in the County. Figure 3-15 illustrates the inventory of these facilities in Hudson County.

Figure 3-15. Transportation Facilities in Hudson County



3.4.3 Lifeline Utility Systems

This section presents potable water, wastewater, energy resource utility system data and communication resources. Due to heightened security concerns, local utility lifeline data sufficient to complete the analysis have only partially been obtained. The location of the lifeline utility systems is displayed in Figure 3-17.

3.4.3.1 Potable Water

Hudson County receives all of its water supply from sources outside the County, managed by several water service companies including the Passaic Valley Water Commission, United Water Company, and North Jersey District Water Supply Commission.

3.4.3.2 Wastewater Facilities

The County is primarily serviced by public sewers. These sewers are divided into two jurisdictions; the Passaic Valley Sewerage Commission (PVSC) and Hudson County. Hudson County is divided into the Jersey City Municipal Utility Authority (MUA), Kearny MUA, Secaucus MUA, North Bergen MUA and the North Hudson MUA. Five wastewater treatment plants and 29 wastewater pump stations were identified in the County. There are 5 wastewater treatment facilities and 31 wastewater pump stations in the County evaluated in the risk assessment. Figure 3-16 illustrates the inventory of these facilities in Hudson County.

Table 13: Sewer Infrastructure Inventory

Location	Sewerage Operator	CSOs
Bayonne	Bayonne Municipal Utilities Authority (BMUA)/PVSC	30
East Newark	Passaic Valley Sewerage Commission (PVSC)	1
Guttenberg	North Bergen Municipal Utilities Authority (NBMUA)	1
Harrison	Passaic Valley Sewerage Commission (PVSC)	7
Hoboken	North Hudson Sewerage Authority (NHSA)	8
Jersey City	Jersey City Municipal Utilities Authority (JCMUA)/PVSC	21
Kearny	Kearny Municipal Utilities Authority (KMUA)/PVSC	5
North Bergen	North Bergen Municipal Utilities Authority (NBMUA)/ PVSC	10
Secaucus	Secaucus Municipal Utility Authority (SMUA)	--
Union City	North Hudson Sewerage Authority (NHSA)/PVSC	--
Weehawken	North Hudson Sewerage Authority (NHSA)	--
West New York	North Hudson Sewerage Authority (NHSA)	2
*Passaic Valley Sewerage Authority (PVSC)		85

Source: various sewerage operator websites

Figure 3-4. CSO Inventory in Hudson County

Source: Hudson County Master Plan Re-examination Report 2016

Typically, stormwater and sewer infrastructure function separately; however, in several of Hudson County municipalities, stormwater and sewage are combined into what is called Combined Sewer Systems. During wet-weather events such as heavy rainfall or snowmelt, the additional high volume of rainwater overwhelms the capacity of the pipes and the stormwater/sewage mixture gets discharged directly into local waterways without treatment. A total of 11 of the 12 Hudson Counties share 85 combined sewer outfalls. In 2015, a new permit system requires Long Term Control Combined Discharge Reduction Plans and enhanced public outreach for combined sewer overflows (CSOs) (Hudson County Planning Board, 2016). These plans identify strategies to mitigate and are included in Section 9 (Jurisdictional Annexes).

3.4.3.3 Energy Resources

PSE&G is the primary provider for electric and gas utilities in Hudson County. HAZUS-MH and PSE&G provided the location of seven electric generating stations. Additionally, PSE&G provided the location of 53 electric sub- and switching stations. There is also an oil refinery located in the City of Bayonne, and a Transco gas pipeline that runs through the Town of Guttenberg and North Bergen and through the Town of Kearny. There are 7 power facilities and

53 substations in the County evaluated in the risk assessment. Figure 3-17 illustrates the inventory of these facilities in Hudson County.

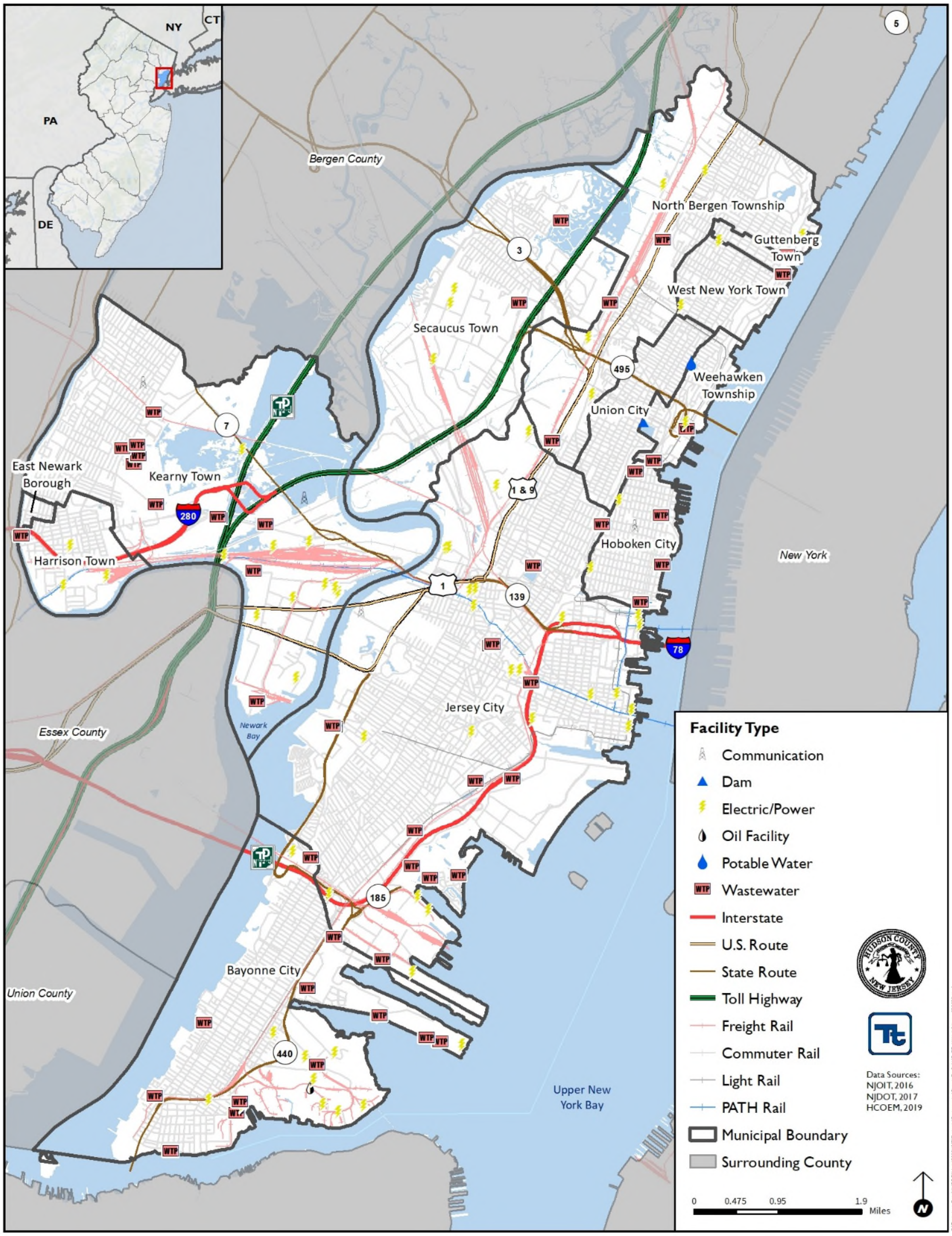
3.4.3.4 Communication Resources

Telephone and wireless communication services are available through multiple providers in the County. Specific information about the various resources is omitted from this plan due to the quantity of information and the diverse sources it would come from. However, the emergency communication systems are provided by five critical broadcast facilities in Hudson County, according to local resources and HAZUS-MH. There are 5 communication facilities in the County evaluated in the risk assessment. Figure 3-17 illustrates the inventory of these facilities in Hudson County.

3.4.3.5 Oil Facilities

There is 1 oil facility in the County. Figure 3-17 illustrates the inventory of this facility in Hudson County.

Figure 3-17. Utility Lifelines in Hudson County



3.4.4 High-Potential Loss Facilities

High-potential loss facilities include dams, levees, hazardous materials facilities (HAZMAT), nuclear power plants and military installations. There are no nuclear facilities in Hudson County. Dams, HAZMAT facilities, and military installations are discussed below. Figure 3-18 shows the locations of the High-Potential Loss Facilities in the County.

3.4.4.1 Dams and Levees

According to the New Jersey Department of Environmental Protection (NJDEP), there are four hazard classifications of dams in New Jersey. The classifications relate to the potential for property damage and/or loss of life should the dam fail:

- Class I (High-Hazard Potential) - Failure of the dam may result in probable loss of life and/or extensive property damage
- Class II (Significant-Hazard Potential) - Failure of the dam may result in significant property damage; however, loss of life is not envisioned.
- Class III (Low-Hazard Potential) - Failure of the dam is not expected to result in loss of life and/or significant property damage.
- Class IV (Small-Dam Low-Hazard Potential) - Failure of the dam is not expected to result in loss of life or significant property damage.

According to the NJDEP Bureau of Dam Safety and the U.S. Army Corps of Engineers National Inventory of Dams, there are a total of three dams located in Hudson County, one of which is classified as a high-hazard dam. There are 3 dams in the County. Figure 3-18 illustrates the inventory of these facilities in Hudson County.

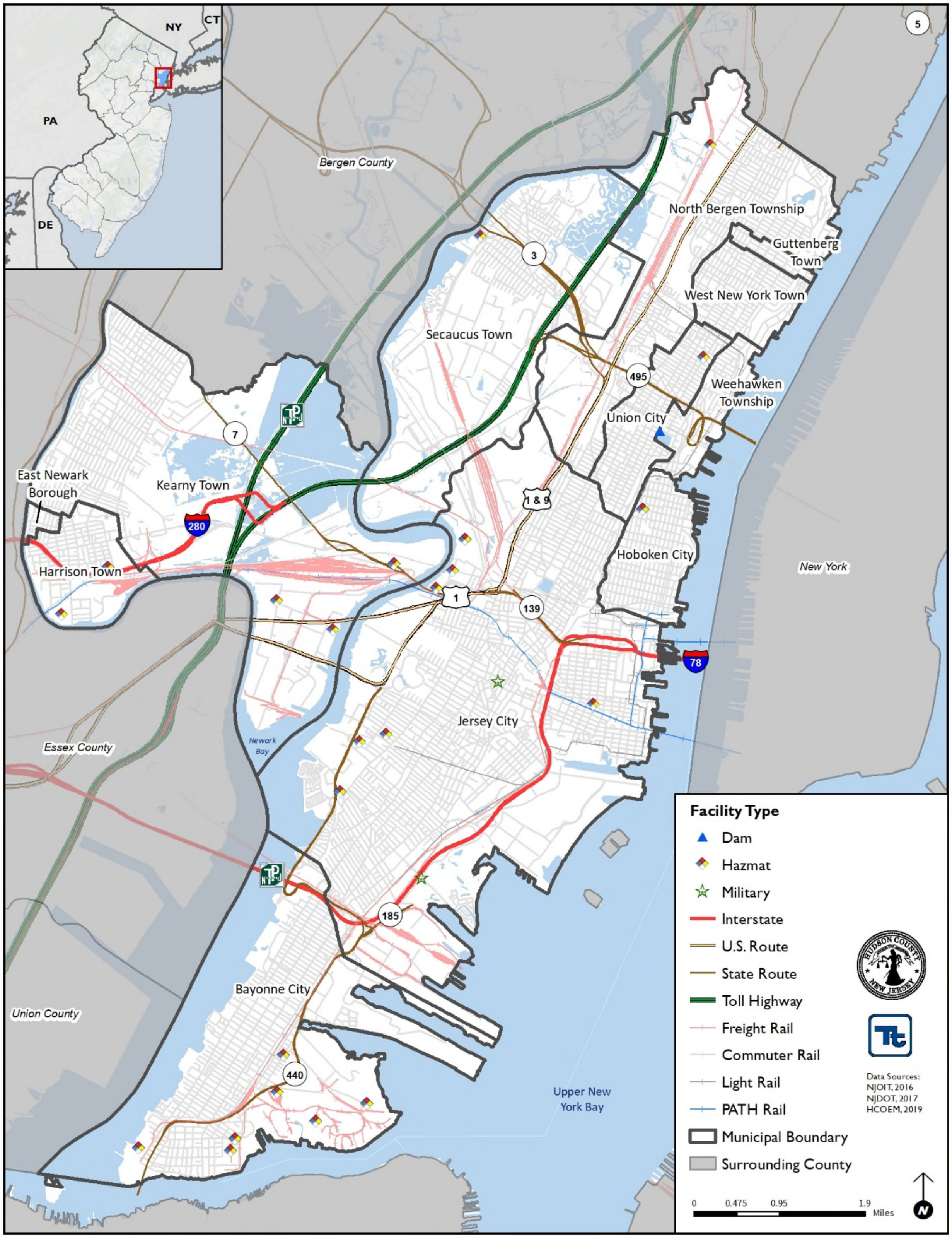
3.4.4.2 HAZMAT Facilities

HAZUS-MH identified 29 hazardous materials facilities within Hudson County. This data is used to determine their potential for damage and release due to natural hazard events, including floods, hurricanes or earthquakes.

3.4.4.3 Military Installations

Two military installations were identified including an armory and a National Guard facility in Jersey City. Figure 3-18 illustrates the inventory of these facilities in Hudson County.

Figure 3-18. High-Potential Loss Facilities in Hudson County



SECTION 4. RISK ASSESSMENT

A risk assessment is the process of measuring the potential loss of life, personal injury, economic and property damage resulting from identified hazards. It allows planning personnel to address and reduce hazard impacts and emergency management personnel to establish early response priorities by identifying potential hazards and vulnerable assets. Results of the risk assessment are used to inform mitigation planning processes, including determining and prioritizing mitigation actions that reduce a community's risk to a specified hazard. Past, present, and future conditions must be evaluated to most accurately assess risk for the County and each jurisdiction. The Hudson County risk assessment presented in Section 4 and outlined as follows:

- Identification of hazards of concern that impact Hudson County
- Methodology and tools used to conduct the risk assessment
- Hazards of concern profiles and vulnerability assessment
- Hazard ranking

4.1 Identification of Hazards of Concern

Hazards of Concern are defined as those hazards that are considered most likely to impact a community. These are identified using available data and local knowledge.

2020 HMP Changes

- The sections in the 2020 HMP have been realigned to increase the readability of the plan. Section 4.1 (formerly Section 5.2 in the 2015 HMP) now comprises the Identification of Hazards of Concern section of the plan.
- The 2015 Coastal Erosion hazard section included discussion on sea level rise; however, the name of the section is now called Coastal Erosion and Sea Level Rise to align with the State of New Jersey HMP (2019).
- Dam / levee failure was added as a separate hazard because of the presence of a reservoir in Weehawken and the Rebuild by Design project underway in the City of Hoboken,
- The flood hazard has been expanded to discuss urban flooding.

To provide a strong foundation for mitigation strategies considered in Sections 6 and 9, Hudson County considered a full range of natural hazards that could impact the area, and then identified and ranked those hazards that presented the greatest concern. Similar to the 2015 HMP, Hudson County kept the list of hazards to be evaluated to natural hazards that align with the same natural hazards listed in the State Hazard Mitigation Plan. Hudson County acknowledges that other non-natural/human-caused and health-related hazards may impact the County; however, these are covered in other County and State-level planning documents.

The natural hazard of concern identification process incorporated input from the County and participating jurisdictions; review of the State of New Jersey Hazard Mitigation Plan (NJ HMP) and previous hazard identification efforts; research and local, state, and federal information on the frequency, magnitude, and costs associated with the various hazards that have previously, or could feasibly, impact the region; and qualitative or anecdotal information regarding natural hazards and the perceived vulnerability of the study area's assets to them.

Table 4.1 1 documents the process of identifying the natural hazards of concern for further profiling and evaluation.

Table 4.1-1. Identification of Natural Hazards of Concern for Hudson County

Hazard	Is this a hazard that may occur in Hudson County?	If yes, does this hazard pose a significant threat to the County?	Why was this determination made?	Source(s)
Avalanche	No	No	• The NJ HMP does not identify avalanche as a hazard of concern for New Jersey. • The topography and climate of Hudson County does not support the occurrence of an avalanche event. • New Jersey in general has a very low occurrence of avalanche events based on statistics provided by the American Avalanche Association (AAA) between 1950 and 2014.	• NJ HMP • Review of NAC-AAA database between 1998 and 2014. • Steering and Planning Committee Input
Coastal Erosion & Sea Level Rise	Yes	Yes	• The NJ HMP identifies coastal erosion as a hazard of concern for New Jersey. Counties bounded by coastal waters are most affected by coastal erosion. A majority of Hudson County is bounded by coastal waters; therefore, coastal erosion was identified as a hazard of concern by the Steering and Planning Committee. • The following municipalities are located in the Coastal Erosion Hazard Area (CEHA): City of Bayonne, City of Hoboken, City of Jersey City, Township of North Bergen, Town of Secaucus, Township of Weehawken, and the Town of West New York; a certain percentage of these populations are located in the CEHA and vulnerable to coastal erosion. Overall, 0.5% of the County's total population is located in the CEHA. • As for sea level rise, 277 people are exposed to 1 foot of sea level rise and 736 people are exposed to 3 feet of sea level rise.	• NJ HMP • NJDEP • NOAA • Steering and Planning Committee Input
Coastal Storm	Yes	Yes	• The NJ HMP identifies coastal storms as a hazard of concern for New Jersey. • The County is bounded by coastal waters. Due to its proximity to the Atlantic Ocean, Hudson County is susceptible to hurricanes, tropical storms, and Nor'Easters. • Since 2015, Hudson County has been included in one FEMA declarations related to coastal storms: • January 22-24, 2016 – FEMA-DR-4264 – Severe Winter Storm and Snowstorm • Between 1842 and 2013, 38 tropical cyclones tracked within 65 nautical miles of Hudson County, with none occurring between 2014 and 2019.	• NJ HMP • FEMA • NOAA • Steering and Planning Committee Input
Dam/Levee Failure	Yes	Yes	• The NJ HMP includes dam and levee failure in the flood hazard. • The Weehawken Reservoir No. 2 Dam is located in the Township of Weehawken. A hybrid levee is planned for construction in Hoboken.	• NJ HMP • FEMA • USACE
Drought	Yes	Yes	• The NJ HMP identifies drought as a hazard of concern for New Jersey. • According to the NJHMP, counties most often affected by a drought are densely populated areas that rely on above-ground reservoirs for water supplies. Hudson County fits into this description. The drought hazard is a concern for Hudson County because the County's water is supplied by both surface water and	• NJ HMP • USGS • NRCC • NOAA

Hazard	Is this a hazard that may occur in Hudson County?	If yes, does this hazard pose a significant threat to the County?	Why was this determination made?	Source(s)
			groundwater. Surface water supplies are affected more quickly during droughts than groundwater sources. • Since 2015, the County has been impacted by three drought events. • Hudson County is located in the Northern Climate Division. According to the NRCC, this climate division has been impacted by the following periods of severe and extreme drought: • August – September 1932 • November 1949 – January 1950 • September – November 1957 • August 1964 – August 1966 • December 1980 – January 1981 • March – April 1985 • August – September 1995 • July – August 1999 • December 2001 – May 2002 • July – September 2002 • October 11, 2016 – January 23, 2017	• NOAA-NCDC Storm Database • Steering and Planning Committee Input
Earthquake	Yes	No	• The NJ HMP identifies earthquake as a hazard of concern for New Jersey. Although they are known to occur on a regular basis, records indicate that no major earthquakes have struck the state since the establishment of historical record-keeping (1500's). Between 1783 and 2017, there have been 214 documented earthquakes in New Jersey. Four of these events have been epic entered in Hudson County. • The Steering and Planning Committees identified earthquake as a hazard of concern for Hudson County.	• NJ HMP • NJDEP • NJGS • Steering and Planning Committee Input
Expansive Soils	No	No	• The NJ HMP does identify expansive soils as a hazard of concern for New Jersey; however, the Planning Committee did not identify this as a hazard of concern for Hudson County. • USGS indicated that less than 50% of Hudson County is underlain by soils with abundant clays of slight to moderate swelling potential and there are areas in Hudson County underlain by soils with little to no clays with swelling potential.	• NJ HMP • USGS 1989 Swelling Clays Map of the Conterminous U.S. • Steering and Planning Committee Input
Extreme Temperature	Yes	Yes	• The NJ HMP identifies extreme temperature as a hazard of concern for New Jersey as a type of severe weather.	• NJ HMP • NOAA – NCDC Storm Database • ONJSC

Hazard	Is this a hazard that may occur in Hudson County?	If yes, does this hazard pose a significant threat to the County?	Why was this determination made?	Source(s)
			• The NOAA-NCDC storm event database indicated that between January 2014 and January 2019, Hudson County had one reported extreme temperature events, an excessive heat event. • The Steering and Planning Committee identified extreme temperature as a hazard of concern for Hudson County	• Steering and Planning Committee Input
Flood (Riverine and Coastal)	Yes	Yes	• The NJ HMP identifies flooding as a hazard of concern in New Jersey. However, ice jams were not identified as a hazard of concern in Hudson County due to the fact that they have not occurred and/or impacted the County. • There are 98,288 people in Hudson County living in the 1% annual chance flood zone and 127,904 living in the 0.2% annual chance flood zone. Over 8,500 acres of the County are located in the 1% annual chance flood zone and over 17,000 acres in the 0.2% zone. • The County has 5,049 NFIP policies with total loss payments equaling over $141 million. • Between January 2014 and January 2019, Hudson County was included in one FEMA declaration related to flooding: • January 22-24, 2015 – FEMA-DR-4264 – Severe Winter Storm and Snowstorm • The Steering and Planning Committees identified flooding as a hazard of concern for Hudson County.	• NJ HMP • FEMA • FEMA FIS • NFIP • NOAA-NCDC Storm Database • Steering and Planning Committee Input
Geological Hazards	Yes	Yes	• The NJ HMP identifies geological hazards as a hazard of concern for New Jersey. • For the 2015 Plan Update, the Planning Committee identified landslides and land subsidence as hazards of concern for Hudson County. • Nearly all of the County does not have landslide susceptibility. There are small areas in the northeast region of the County that are susceptible to landslide events (Class AI, AII, AIV and BIV) • Between 2015 and 2019, there were no identified geological hazard events in Hudson County though events have occurred in the past.	• NJHMP • NJGWS • NJDEP • Steering and Planning Committee Input
Hailstorm	Yes	Yes	Please see Severe Weather	
Hurricane (and other Tropical Cyclones)	Yes	Yes	Please see Coastal Storm	
Ice Storm	Yes	Yes	Please see Severe Winter Weather	
Infestation	Yes	No	• The NJ HMP does not identify infestation as a hazard of concern for New Jersey. • Although some infestations of ticks, mosquitoes, and/or other types of pest may be present, no sources indicate that this is a major hazard of concern for the County. • The Steering and Planning Committees did not identify infestation as a hazard of concern for Hudson County.	• NJ HMP • USGS • NJDOH

Hazard	Is this a hazard that may occur in Hudson County?	If yes, does this hazard pose a significant threat to the County?	Why was this determination made?	Source(s)
				• Steering and Planning Committee Input
Land Subsidence	Yes	No	Please see Geological Hazards	
Landslide	Yes	No	Please see Geological Hazards	
Nor'Easters	Yes	Yes	Please see Coastal Storms	
Severe Weather (Windstorms, Thunderstorms, Hail, Lightning, and Tornados)	Yes	Yes	• The NJ HMP identifies severe weather as a hazard of concern for New Jersey. • According to FEMA, between 2015 and 2019, Hudson County was included in one declaration associated with Severe Weather events. • January 22-24, 2016 – FEMA-DR-4264 – Severe Winter Storm and Snowstorm • New Jersey has experienced 91 tornadoes between 1986 and 2016, with none of those occurring in Hudson County.	• NJ HMP • NOAA – NCDC • FEMA • NJ OEM • SPC • Steering and Planning Committee Input
Severe Winter Weather (Heavy Snow, Blizzards, Freezing Rain/Sleet, Ice Storms)	Yes	Yes	• The NJHMP identifies Severe Winter Weather as a hazard of concern for New Jersey. • Normal seasonal snowfall in Hudson County is approximately 25.2 inches. • According to FEMA, between 2015 and 2019, Hudson County was included in one declaration associated with Severe Winter Weather events: • January 22-24, 2016 – FEMA-DR-4264 – Severe Winter Storm and Snowstorm • The Steering and Planning Committees identified Severe Winter Weather as a hazard of concern for Hudson County.	• NJ HMP • FEMA • NOAA – NCDC Storm Database • ONJSC • Steering and Planning Committee Input
Tornado	Yes	Yes	Please see Severe Weather	
Tsunami	No	No	• The NJ HMP does identify tsunami as a hazard of concern for New Jersey. • Hudson County is bounded by coastal waters; however, the Steering and Planning Committees did not identify tsunami as a hazard of concern for Hudson County.	• NJ HMP • Steering and Planning Committee Input
Volcano	No	No	• The NJ HMP does not identify volcano as a hazard of concern for New Jersey. • The Steering and Planning Committees did not identify volcano as a hazard of concern for Hudson County.	• NJ HMP • Steering and Planning Committee Input
Wildfire	Yes	Yes	• The NJHMP identifies as wildfire as a hazard of concern for New Jersey. • In Hudson County, approximately 7.98 square miles of the County are located in the low to moderate NJFFS Risk Area and 4.81 square miles is located in the high to extreme risk area. • The Planning and Steering Committees identified wildfires as a hazard of concern for Hudson County.	• NOAA – NCDC Storm Events Query • USGS • NJ HMP

Hazard	Is this a hazard that may occur in Hudson County?	If yes, does this hazard pose a significant threat to the County?	Why was this determination made?	Source(s)
				• NJFFS • Steering and Planning Committee Input
Windstorm	Yes	Yes	Please see Severe Weather	

DR	*Presidential Disaster Declaration Number*
EM	*Presidential Disaster Emergency Number*
FEMA	*Federal Emergency Management Agency*
FIS	*Flood Insurance Study*
HMP	*Hazard Mitigation Plan*
NCDC	*National Climatic Data Center*
NFIP	*National Flood Insurance Program*
NJ	*New Jersey*
NJDOH	*New Jersey Department of Health*
NJDOT	*New Jersey Department of Transportation*
NJFFS	*New Jersey Forest Fire Service*
NJGWS	*New Jersey Geological and Water Survey*
NRCC	*Northeast Regional Climate Center*
NOAA	*National Oceanic and Atmospheric Administration*
NTSB	*National Transportation Safety Board*
OEM	*Office of Emergency Management*
SPC	*Storm Prediction Center*
USGS	*U.S. Geological Survey*

According to input from the County, and review of all available resources, a total of 11 natural hazards of concern were identified as significant hazards affecting the entire planning area, to be addressed at the county level in this plan:

- Coastal Erosion and Sea Level Rise
- Coastal Storm (including Nor'Easter, Hurricane, Tropical Storm, Storm Surge)
- Dam and Levee Failure
- Drought
- Earthquake
- Extreme Temperatures
- Flood (riverine, coastal and urban)
- Geological Hazards
- Severe Weather (High Winds, Tornadoes, Thunderstorms, Hail)
- Severe Winter Weather (Heavy Snow, Blizzards, Ice Storms)
- Wildfire

Other natural and human-caused hazards of concern have occurred within Hudson County, but have a low potential to occur and/or result in significant impacts within the County. Therefore, these hazards will not be further addressed within this version of the HMP. However, if deemed necessary by the County, these hazards may be considered in future versions of the HMP.

4.2 Methodology and Tools

2020 HMP Changes

- The risk assessment was updated using best available information.
  - Hazard events and associated impacts were researched and summarized from 2014 to 2019
  - 2013-2017 American Community Survey 5-year estimates were utilized
  - Building footprints from Microsoft and Open Street Map, updated parcels and RS Means 2019 were used to develop a structure-level building inventory and estimate replacement cost value for each building.
  - The 2015 critical facility was reviewed and updated by the Hudson County Division of Planning GIS Services followed by the Planning Partnership.
  - Lifelines were identified in the critical facility inventory to align with FEMA's lifeline definition
  - HAZUS-MH v4.2 was used to estimate potential impacts to the flood, wind and seismic hazards
  - Best available hazard data was used as described in this section.

4.2.1 ASSET INVENTORIES

Hudson County assets were identified to assess potential exposure and loss associated with the hazards of concern. For the HMP update, Hudson County assessed vulnerability of the following types of assets: population, buildings and critical facilities/infrastructure and the environment. Some assets may be more vulnerable because of their physical characteristics or socioeconomic uses. To protect individual privacy and the security of critical facilities, information on properties assessed is presented in aggregate, without details about specific individual personal or public properties.

The risk assessment included the collection and use of an expanded and enhanced asset inventory to estimate hazard exposure and vulnerability.

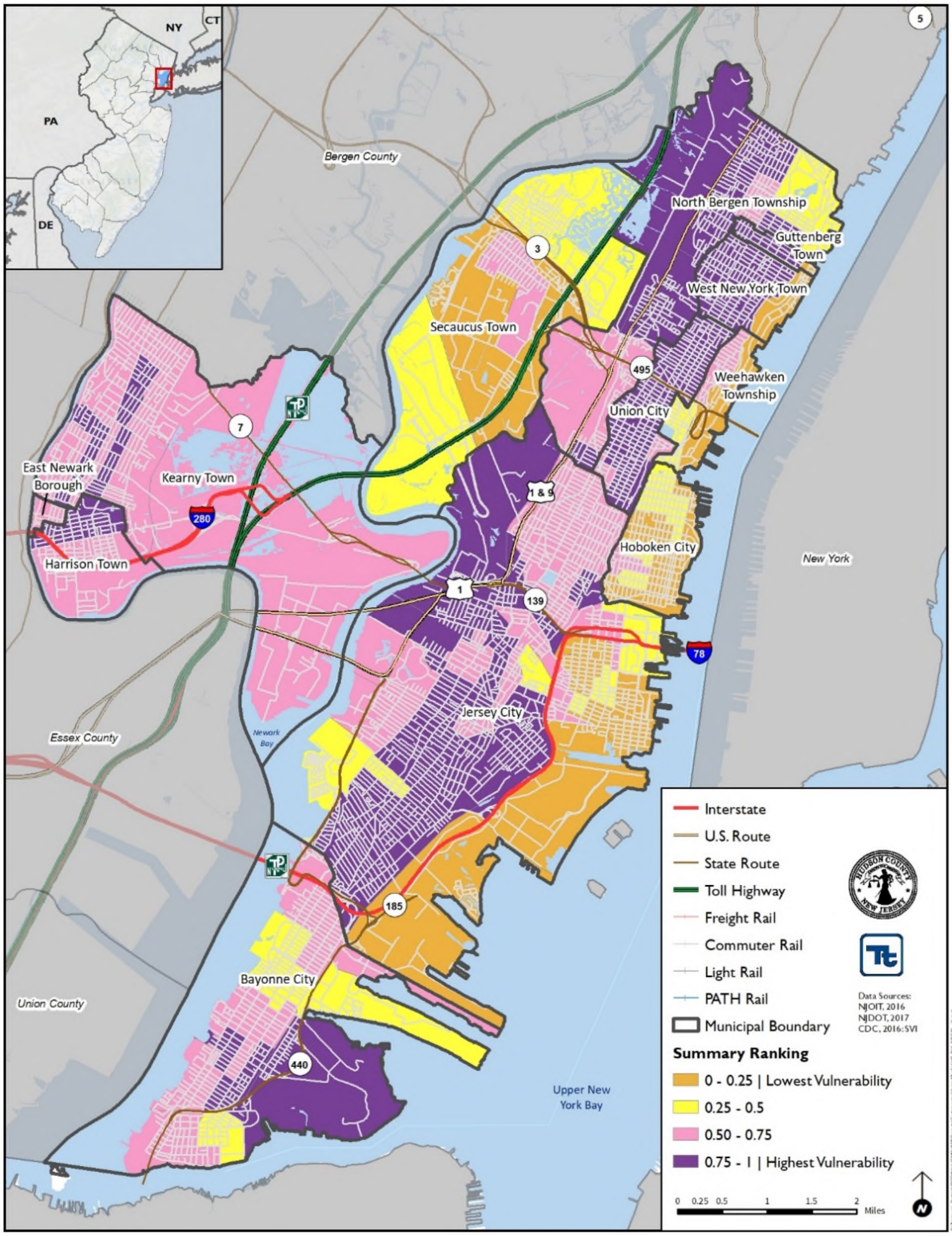
POPULATION

As discussed in Section 3 (County Profile) research has shown that some populations are at greater risk from hazard events because of decreased resources or physical abilities. For the purposes of this planning process, vulnerable populations in Hudson County include children, elderly, population below the poverty level, the physically or mentally disabled, non-English speakers and the medically or chemically dependent.

FEMA's HAZUS-MH program contains 2010 U.S. Census data and was used to estimate sheltering and injuries as part of the hazard analysis. Total population statistics from the 2013-2017 American Community Survey 5-year estimate were used to estimate the impacts to the County's population in place of the 2010 U.S. Census block estimates for the exposure analysis. Population counts at the Census tract level were averaged among the residential structures in the County to estimate the population at the structure level. This estimates a more precise distribution of population around the County than using the census block or census tract boundaries. Limitations of these analyses are recognized, and thus the results are used only to provide a general estimate.

Research has shown that some populations, while they may not have more hazard exposure, may experience exacerbated impacts and prolonged recovery if/when impacted. This is due to many factors including their physical and financial ability to react or respond during a hazard. This population is referred to as socially vulnerable to hazard events. The Center for Disease Control and Prevention's (CDC) 2016 Social Vulnerability Index (SVI) ranks U.S. Census tracts on socioeconomic status, household composition and disability, minority status and language, and housing and transportation. Hudson County's overall score is 0.6425, indicating that its communities have moderate to high vulnerability (CDC 2016, refer to Figure 4.2.2-1).

Figure 4.2.2-1. CDC Social Vulnerability Index in Hudson County



BUILDINGS

The general building stock was updated countywide with a custom-building inventory. To develop the building inventory, the 2018 parcels and MODIV tax assessor data obtained from the New Jersey Geographic Information Network Open Data portal and building footprint spatial layers from Microsoft and Open Street Maps were utilized. Attributes provided in the spatial files were used to further define each structure in terms of occupancy class, construction type, etc. The centroid of each building footprint was used to estimate the building location. Structural and content replacement cost values (RCV) were calculated for each building utilizing available assessor data and RSMeans 2019 values; a regional location factor for Hudson County was applied (1.19 for residential structures; 1.15 for non-residential structures). Replacement cost value is the current cost of returning an asset to its pre-damaged condition, using present-day cost of labor and materials. Total replacement cost value consists of both the structural cost to replace a building and the estimate value of contents of a building. The occupancy classes available in HAZUS-MH v4.2 were condensed into the following categories (residential, commercial, industrial, agricultural, religious, governmental, and educational) to facilitate the analysis and the presentation of results. Residential loss estimates address both multi-family and single-family dwellings.

CRITICAL FACILITIES AND LIFELINES

The 2015 HMP critical facility inventory, which includes essential facilities, utilities, transportation features and user-defined facilities was updated by the Planning Partnership. The update involved a review for accuracy, additions or deletions of new/moved critical assets, identification of backup power for each asset (if known) and whether the critical facility is considered a lifeline in accordance with FEMA's definition; refer to Appendix E (Risk Assessment Supplement). To protect individual privacy and the security of assets, information is presented in aggregate, without details about specific individual properties or facilities.

*A **lifeline** provides indispensable service that enables the continuous operation of critical business and government functions, and is critical to human health and safety, or economic security (FEMA).*

ENVIRONMENT

New Jersey Department of Environmental Protection (NJDEP), Office of Information Resources Management (OIRM), and the Bureau of Geographic Information Systems (BGIS) updated their 2012 Land-Use/Land Cover data in 2015 to delineate the land-use and land cover areas in the County. Version 3.3 of the NJDEP's Landscape Project released in May 2017 was used to delineate the areas of critical habitats for endangered species in the State. The Landscape Project combines documented wildlife locations with NJDEP aerial photo-based 2012 Land Use/Land Cover (LULC) to delineate imperiled and special concern species habitat within New Jersey. Many species occurrence locations cannot be published because they may represent nest sites, roost sites, dens and other sites used by species that are vulnerable to human disturbance and, in some cases, susceptible to illegal collection. At the same time, wildlife moves, as individual animals use various habitat features within the landscape to fulfill their foraging, sheltering and breeding needs. Therefore, protecting individual occurrences or the area used by one individual is generally not sufficient to protect the local population. Landscape Project maps address these issues by displaying habitat patches that animals use and that are required to support local populations, rather than pinpointing exact locations of the most sensitive wildlife sites or simply protecting points where species happened to be observed at one point in time.

New Development

In addition to assessing the vulnerability of the built environment, Hudson County examined recent and anticipated new development. Each jurisdiction was asked to provide a list by parcel ID or address of major development that has taken place over the last 5 years and anticipated major development over the next 5 years. An exposure analysis was conducted in GIS to determine hazard exposure. Identifying these changes and integrating into the risk assessment provides communities information to consider when developing the mitigation strategy to reduce these vulnerabilities in the future (one tool in the Mitigation Toolbox discussed in Section 6 – Mitigation Strategy). The identified new development is listed in Section 9 (Jurisdictional Annexes) as a table in each annex.

4.2.2 METHODOLOGY

To address the requirements of the DMA 2000 and better understand potential vulnerability and losses associated with hazards of concern, Hudson County used standardized tools, combined with local, state, and federal data and expertise to conduct the risk assessment. Three different levels of analysis were used depending upon the data available for each hazard as described below. Table 4.2-1 summarizes the type of analysis conducted by hazard of concern.

1) **Historic Occurrences and Qualitative Analysis** – This analysis includes an examination of historic impacts to understand potential impacts of future events of similar size. In addition, potential impacts and losses are discussed qualitatively using best available data and professional judgement.

2) **Exposure Assessment** – This analysis involves overlaying available spatial hazard layers, or hazards with defined extent and locations, with assets in GIS to determine which assets are located in the impact area of the hazard. The analysis highlights which assets may be affected by the hazard. *If the center of each asset is located in the hazard area, it is deemed exposed and potentially vulnerable to the hazard.*

3) **Loss estimation** — The FEMA Hazus modeling software was used to estimate potential losses for the following hazards: Flood, Earthquake, Hurricane. In addition, an examination of historic impacts and an exposure assessment was conducted for these spatially-delineated hazards.

Table 4.2-1. Summary of Risk Assessment Analyses

Hazard	Data Analyzed				
	Population	General Building Stock	Critical Facilities	Environment	New Development
Coastal Erosion and Sea Level Rise	E	E	E	Q	E
Coastal Storm	E, H	E, H	E, H	E	E
Dam and Levee Failure	Q	Q	Q	Q	Q
Drought	Q	Q	Q	Q	Q
Earthquake	E, H	E, H	E, H	Q	E
Extreme Temperatures	Q	Q	Q	Q	Q
Flood	E, H	E, H	E, H	E	E
Geological Hazards	E	E	E	Q	E
Severe Weather	Q	Q	Q	Q	Q
Severe Winter Storm	Q	Q	Q	Q	Q
Wildfire	E	E	E	Q	E

E – Exposure analysis; H – Hazus analysis; Q – Qualitative analysis

HAZARDS U.S. – MULTI-HAZARD (HAZUS-MH)

In 1997, FEMA developed a standardized model for estimating losses caused by earthquakes, known as Hazards U.S. or HAZUS. HAZUS was developed in response to the need for more effective national-, state-, and community-level planning and the need to identify areas that face the highest risk and potential for loss. HAZUS was expanded into a multi-hazard methodology, HAZUS-MH with new models for estimating potential losses from wind (hurricanes) and flood (riverine and coastal) hazards. HAZUS-MH is a Geographic Information System (GIS)-based software tool that applies engineering and scientific risk calculations, which have been developed by hazard and information technology experts, to provide defensible damage and loss estimates. These methodologies are accepted by FEMA and provide a consistent framework for assessing risk across a variety of hazards. The GIS framework also supports the evaluation of hazards and assessment of inventory and loss estimates for these hazards.

HAZUS-MH uses GIS technology to produce detailed maps and analytical reports that estimate a community's direct physical damage to building stock, critical facilities, transportation systems and utility systems. To generate this information, HAZUS-MH uses default HAZUS-MH provided data for inventory, vulnerability, and hazards; this default data can be supplemented with local data to provide a more refined analysis. Damage reports can include induced damage (inundation, fire, threats posed by hazardous materials and debris) and direct economic and social losses (casualties, shelter requirements, and economic impact) depending on the hazard and available local data. HAZUS-MH's open data architecture can be used to manage community GIS data in a central location. The use of this software also promotes consistency of data output now and in the future and standardization of data collection and storage. More information on HAZUS-MH is available at http://www.fema.gov/hazus.

In general, probabilistic analyses were performed to develop expected/estimated distribution of losses (mean return period losses) for the flood, wind and seismic hazards. The probabilistic model generates estimated damages and losses for specified return periods (e.g., 100- and 500-year). For annualized losses, HAZUS-MH calculates the maximum potential annual dollar loss resulting from various return periods averaged on a "per year" basis. It is the summation of all HAZUS-supplied return periods (e.g., 10, 50, 100, 200, 500) multiplied by the return period probability (as a weighted calculation). In summary, the estimated cost of a hazard each year is calculated. Table 4.2-2 displays the various levels of analyses that can be conducted using the HAZUS-MH software.

Table 4.2-2. Summary of HAZUS-MH Analysis Levels

HAZUS-MH Analysis Levels	
Level 1	HAZUS-MH provided hazard and inventory data with minimal outside data collection or mapping.
Level 2	Analysis involves augmenting the HAZUS-MH provided hazard and inventory data with more recent or detailed data for the study region, referred to as "local data"
Level 3	Analysis involves adjusting the built-in loss estimation models used for the hazard loss analyses. This Level is typical done in conjunction with the use of local data.

4.2.2.1 Coastal Erosion and Sea Level Rise

A USGS report for the National Assessment of Shoreline Change entitled *Historical Shoreline Change along the New England and Mid-Atlantic Coasts* was released in 2011. The New England and Mid-Atlantic shores were subdivided into a total of 10 analysis regions for the purpose of reporting regional trends in shoreline change rates. The average rate of long-term shoreline change for the New England and Mid-Atlantic coasts was -0.5 meters per year.

There are no NJDEP-identified shoreline types in Hudson County characterized as vulnerable to erosion. However, to estimate exposure to long-term coastal erosion for purposes of this risk assessment, the entire shoreline was analyzed. To generate the extent of the estimated coastal erosion hazard area (CEHA), an erosion rate of 0.5 meters per year was multiplied by 60 to include all structure types and developed/undeveloped areas (annual erosion rate of 0.5 meters x 60 years = 30 meters or approximately 98 feet). Therefore, population, buildings, and infrastructure within 98 feet of the shoreline are identified as vulnerable to long-term coastal erosion. Please note this methodology assumes that once lost to erosion, an area of land is not subsequently restored. This methodology is consistent with that used to evaluate coastal erosion in the 2019 New Jersey State Hazard Mitigation Plan.

In addition, projected sea-level rise data (in one-foot increments) available from the NOAA Office of Coastal Management (https://coast.noaa.gov/slrdata/) was considered and used for this analysis. Please note these levels do not include additional storm surge due to a hurricane or Nor'easter. The current Flood Insurance Rate Maps (FIRMs) also do not include the effects of sea-level rise. Rutgers University Science and Technical Advisory Panel (STAP) Report, entitled, Assessing New Jersey's Exposure to Sea-Level Rise and Coastal Storms: Report of the New Jersey Climate Adaptation Alliance Science and Technical Advisory Panel details several projected sea level rise scenarios for New Jersey between 2030 and 2100. Using these estimates, the sea level rise +1 ft and sea level rise +3 ft inundation areas were chosen and used in the 2019 New Jersey State Hazard Mitigation Plan. To be consistent with the State HMP, these spatial datasets were used for the 2020 Hudson County All Hazard Mitigation Plan update.

Asset data (population, building stock, critical facilities, and new development) were used to support an evaluation of assets exposed and potential impacts and losses associated with this hazard. To determine what assets are exposed to sea-level rise, the County's assets were overlaid with the hazard area. Assets with their centroid located in the hazard area were totaled to estimate the totals and values exposed to sea-level rise.

Coastal Storm

A HAZUS-MH v4.2 probabilistic analysis was performed to analyze the wind hazard losses for Hudson County. The probabilistic hurricane hazard activates a database of thousands of potential storms that have tracks and intensities reflecting the full spectrum of Atlantic hurricanes observed since 1886 and identifies those with tracks associated with Hudson County. HAZUS-MH contains data on historic hurricane events and wind speeds. It also includes surface roughness and vegetation (tree coverage) maps for the area. Surface roughness and vegetation data support the modeling of wind force across various types of land surfaces. Annualized losses and the 100- and 500-year Mean Return Periods (MRPs) were examined for the wind/severe storm hazard. Default demographic and updated building and critical facility inventories in HAZUS-MH v4.2 were used for the analysis.

There is currently a FEMA-acknowledged issue with importing user-defined facilities in HAZUS-MH v4.2. To estimate potential losses to user-defined facilities identified by Hudson County, they were appended to the Emergency Operation Centers input in HAZUS-MH Comprehensive Data Management System (CDMS) and uploaded to the program.

In addition to estimating potential losses due to wind, an exposure analysis was conducted using the "Sea – Lake Overland Surge from Hurricanes – SLOSH Model, which represents potential flooding from worst-case combinations of hurricane direction, forward speed, landfall point, and high astronomical tide were used to estimate exposure. Please note these inundation zones do not include riverine flooding caused by hurricane surge or inland freshwater flooding. The model, developed by the NOAA National Hurricane Center to forecast surges that occur from wind and pressure forces of hurricanes, considers only storm surge height and does not consider the effects of waves. The SLOSH spatial data includes boundaries for Category 1 through Category 4 hurricane events.

Asset data (population, building stock, critical facilities, and new development) were used to support an evaluation of assets exposed and potential impacts and losses associated with this hazard. To determine what assets are exposed to storm surge, the County's assets were overlaid with the SLOSH hazard area. Assets with their centroid located in the hazard area were totaled to estimate the totals and values exposed to the hazard.

Dam and Levee Failure

A qualitative analysis was conducted for the dam and levee failure. This is a new hazard to the Hudson County HMP update. For security reasons, these asset locations and downstream inundation due to a failure are not displayed on maps or discussed in this plan.

Drought

To assess the vulnerability of Hudson County to drought and its associated impacts, a qualitative assessment was conducted. Resources from the Center for Disease Control and the U.S. Environmental Protection Agency were used to assess the potential impacts to the population from a drought event.

Earthquake

A probabilistic assessment was conducted for Hudson County for the 100-, 500- and 2,500-year MRPs through a Level 2 analysis in HAZUS-MH v4.2 to analyze the earthquake hazard and provide a range of loss estimates. The probabilistic method uses information from historic earthquakes and inferred faults, locations and magnitudes, and computes the probable ground shaking levels that may be experienced during a recurrence period by Census tract.

> As noted in the HAZUS-MH Earthquake User Manual, "*Uncertainties are inherent in any loss estimation methodology. They arise in part from incomplete scientific knowledge concerning earthquakes and their effects upon buildings and facilities. They also result from the approximations and simplifications that are necessary for comprehensive analyses. Incomplete or inaccurate inventories of the built environment, demographics and economic parameters add to the uncertainty. These factors can result in a range of uncertainty in loss estimates produced by the HAZUS Earthquake Model, possibly at best by a factor of two or more*" (FEMA 2015f). However, HAZUS' potential loss estimates are acceptable for the purposes of this HMP.

Ground shaking is the primary cause of earthquake damage to man-made structures and soft soils amplify ground shaking. One contributor to the site amplification is the velocity at which the rock or soil transmits shear waves (S-waves). The National Earthquake Hazard Reductions Program (NEHRP) has developed five soil classifications defined by their shear-wave velocity that impact the severity of an earthquake. The soil classification system ranges from A to E, where A represents hard rock that reduces ground motions from an earthquake and E represents soft soils that amplify and magnify ground shaking and increase building damage and losses.

An exposure analysis was also conducted for the County's assets (population, building stock, critical facilities, and new development) using the NEHRP soil data and liquefaction susceptibility data. NEHRP Soil Classes Type D and Type E and liquefaction susceptibility Class 4 were used to determine what assets are exposed to the soils most susceptible to seismic activity. Assets with their centroid in the hazard areas were totaled to estimate the numbers and values vulnerable to these soil types.

Data from the New Jersey Geologic and Water Survey was used in HAZUS-MH v4.2 to replace default NEHRP, liquefaction susceptibility, and landslide susceptibility conditions. Groundwater was set at depth of five (5) feet (default setting). The default assumption is a magnitude 7.0 earthquake for all return periods. Damage and loss due to liquefaction, landslide, or surface fault rupture were not included in this analysis. Although damages are estimated at the census tract level, results were presented at the municipal level.

Damage estimates are calculated for losses to buildings (structural and non-structural) and contents; structural losses include load carrying components of the structure, and non-structural losses include those to architectural, mechanical, and electrical components of the structure, such as nonbearing walls, veneer and finishes, HVAC systems, boilers, etc. For census tracts encompassing multiple municipalities, the default general building stock inventory was used to calculate the percent of the total census tract replacement cost value in each municipality. This percentage was applied to the census tract losses to estimate the municipal-level losses. For example, the census blocks from two municipalities are located within one census tract. The total replacement cost value of Municipality A is 60% of the total census tract replacement cost value, while Municipality B is 40% of the total value. Therefore, 60% of the losses for the census tract will be applied to Municipality A, and 40% will be applied to Municipality B.

In addition to the probabilistic scenarios cited, an annualized loss run was conducted to estimate annualized general building stock dollar losses in the County. The loss methodology combines estimated losses associated with ground shaking for eight return periods: 100-, 250-, 500-, 750-, 1,000-, 1,500-, 2,000-, and 2,500-year, which are based on values from USGS seismic probabilistic curves.

Extreme Temperatures

A qualitative assessment was conducted for the extreme temperatures hazard. Information from the Center for Disease Control, Hudson County, and the Planning Committee were used to assess the potential impacts to the County's assets.

Flood

The 1- and 0.2-percent chance flood events were examined to evaluate Hudson County's risk and vulnerability to the riverine flood hazard. These flood events are generally those considered by planners and evaluated under federal programs such as the NFIP.

The preliminary Hudson County FEMA Digital Flood Insurance Rate Map (DFIRM) dated January 2015 and the preliminary Bergen County FEMA DFIRM dated July 2018 were used to evaluate exposure and determine potential future losses. A depth grid was generated using the preliminary DFIRMs and 1-meter resolution Digital Elevation Model (DEM) provided by the Hudson County Division of Planning and integrated into the HAZUS-MH v4.2 riverine flood model used to estimate potential losses for the 1-percent annual chance flood event.

To estimate exposure to the 1-percent- and 0.2-percent annual chance flood events, the DFIRM flood boundaries, updated assets (population, building stock, critical facilities, and new development) with their centroid in the hazard areas were totaled to estimate the numbers and values vulnerable to a flooding event. A Level 2 HAZUS-MH v4.2 riverine flood analysis was performed. Both the critical facility and building inventories were formatted to be compatible with HAZUS-MH v4.2 and its Comprehensive Data Management System (CDMS). Once updated with the inventories, the HAZUS-MH v4.2 riverine flood model was run to estimate potential losses in Hudson County for the 1-percent annual chance flood event. A user-defined analysis was performed for the building stock; buildings located within the floodplain were imported as user-defined facilities to estimate potential losses to the building stock at the structural level. HAZUS-MH v4.2 calculated the estimated potential losses to the population (default 2010 U.S. Census data) and potential damages to the general building stock and critical facility inventories based on the depth grid generated and the default HAZUS-MH v4.2 damage functions in the flood model.

The NFIP policies, claims, and repetitive and severe repetitive loss properties were examined.

Areas of forests, wetlands, and critical habitat landscapes located within the 1- and 0.2-percent annual chance flood event boundaries were also calculated to estimate impacts on the environment. The boundaries of these areas were intersected with the floodplains in ArcGIS to calculate the areas exposed to the 1- and 0.2-percent annual chance flood events.

4.2.2.2 Geological Hazards

The New Jersey Geologic and Water Survey delineated a landslide susceptibility layer that differentiates areas based on the ground surface and slope. This layer was updated in July 2016 and utilized for this analysis. The categories are defined as follows:

- Class A
  - AI – Strongly cemented rock; slope angle of 15-20 degrees
  - AII – Strongly cemented rock; slope angle of 20-20 degrees
  - AIV – Strongly cemented rock; slope angle of 30-40 degrees
  - AVI – Strongly cemented rock; slope angle of greater than 40 degrees
- Class B
  - BIII – Weakly cemented rock and sandy soil; slope angle of 10-15 degrees
  - BIV – Weakly cemented rock and sandy soil; slope angle of 15-20 degrees
  - BV – Weakly cemented rock and sandy soil; slope angle 20-30 degrees
- Class C
  - CVI – Shales and clayey soil; slope angle of 10-15 degrees
  - CVII – Shales and clayey soil; slope angle of 15-20 degrees
  - CIX – Shales and clayey soil; slope angle of 20-40 degrees if dry or 10-15 degrees if groundwater at surface
  - CX – Shales and clayey soil, groundwater at surface; slope angle greater than 15 degrees

To determine what assets are exposed to landslide, the County's assets were overlaid with the hazard area. Assets with their centroid located in the hazard area were totaled to estimate the number (or count) and replacement cost values exposed to a hazard event.

Severe Weather

All of Hudson County is exposed to severe weather events. A qualitative assessment was conducted for the severe weather hazard. Information from Hudson County and the Planning Committee were used to assess the potential impacts to the county's assets.

Severe Winter Storm

The entire general building stock inventory in Hudson County is exposed and vulnerable to the winter storm hazard. In general, structural impacts include damage to roofs and building frames, rather than building content. Current modeling tools are not available to estimate specific losses for this hazard. A percentage of the custom-building stock structural replacement cost value was utilized to estimate damages that could result from winter storm conditions. Given professional knowledge and the currently available information, the potential losses for this hazard are considered to be overestimated; hence, providing a conservative estimate for losses associated with winter storm events.

Wildfire

The NJFFS uses Wildfire Fuel Hazard data to assign wildfire fuel hazard rankings across the State. This data, developed in 2009, is based upon NJDEP's 2002 Land Use/Land Cover datasets and NJDEP's 2002 10-meter Digital Elevation Grid datasets. For the wildfire hazard, the NJFFS Wildfire Fuel Hazard "extreme', 'very high' and 'high' areas are identified as the wildfire hazard area. The defined hazard area was overlaid upon the asset data (population, building stock, critical facilities and potential new development) to estimate the exposure to each hazard.

Asset data (population, building stock, critical facilities, and new development) were used to support an evaluation of assets exposed and potential impacts and losses associated with this hazard. To determine what assets are exposed to wildfire, the County's assets were overlaid with the hazard area. Assets with their centroid located in the hazard area were totaled to estimate the totals and values exposed to a wildfire event.

Considerations for Mitigation and Next Steps

The following items are to be discussed for considerations for the next plan update to enhance the vulnerability assessment:

- All Hazards
  - Utilize updated and current demographic data. If 2020 U.S. Census demographic data is available at the U.S. Census Block level during the next plan update, use the census block estimates and residential structures for a more precise distribution of population, or the current American Community Survey 5-Year Estimate populations counts at the census tract level and residential structures should be used.
- Coastal Erosion and Sea Level Rise
  - If available during the next plan update, update the risk assessment using a comprehensive coastal erosion hazard area map and updated sea level rise inundation areas.
  - Collect data on historic costs incurred to reconstruct buildings, cultural resources and/or infrastructure due to coastal erosion impacts.
- Coastal Storms
  - General building stock inventory can be updated to include attributes regarding protections against strong winds, such as hurricane straps, to enhance loss estimates.

  - Estimate storm surge related losses using the HAZUS-MH Flood model, if the data is available.
- Dam and Levee Failure
  - Updated information on the Rebuild by Design project in Hoboken will further inform this section.
- Flood
  - General building stock inventory can be updated to include attributes regarding first floor elevation and foundation type (basement, slab on grade, etc.) to enhance loss estimates.
  - Conduct a HAZUS-MH loss analysis for more frequent flood events (e.g., 10 and 50-year flood events).
- Earthquake
  - Identify unreinforced masonry in critical facilities and privately-owned buildings (i.e., residences) by accessing local knowledge, tax assessor information, and/or pictometry/orthophotos. These buildings may not withstand earthquakes of certain magnitudes and plans to provide emergency response/recovery efforts at these properties can be developed.
- Extreme Temperature
  - Track extreme temperature data for injuries, deaths, shelter needs, pipe freezing, agricultural losses, and other impacts to determine distributions of most at risk areas.
- Geological Hazards
  - A pilot study conducted in Schenectady County, NY (Landslide Susceptibility – A Pilot Study of Schenectady County, NY) provided a detailed methodology for delineating high-risk landslide areas. This study looked at a variety of environmental characteristics including slope and soil conditions to determine areas at risk to landslide. To coincide with the methodology of that study, the generated slopes were categorized into five classes: 0%-2%; 3%-7%; 8%-15%; 16%-25%; Greater than 25%. Should the County determine the need for a more detailed assessment of risk, the slopes greater than 25% should be used to delineate the hazard area for the vulnerability assessment. Additional environmental and soil characteristics used in the Schenectady County plan can be collected and used to follow the methodology used to further delineate the County's most at risk areas.
- Severe Winter Storm
  - If available for the region, obtain average snowfall distributions to determine if various areas in the County have historically received higher snowfalls and may continue to be more susceptible to higher snowfalls and snow loads on the building stock and critical facilities and infrastructure.
- Wildfire
  - General building stock inventory can be updated to include attributes such as roofing material or fire detection equipment.

4.2.1 DATA SOURCE SUMMARY

Table 4.2-3 summarizes the data sources used for the risk assessment for this plan.

Table 4.2-3. Risk Assessment Data Documentation

Data	Source	Date	Format
Population data	U.S. Census Bureau	2010; 2017	Digital (GIS) format
Building footprints	Microsoft; Open Street Map	2018; 2019	Digital (GIS) format
MODIV Tax Assessor data	NJ Office of Information Technology	2018	Digital (GIS/Tabular) format
Critical facilities	Hudson County Division of Planning and Planning Committee	2019	Digital (GIS) format
Hudson County Digitized preliminary FIRM maps	FEMA	2015	Digital (GIS) format
Bergen County Digitized preliminary FIRM maps	FEMA	2018	Digital (GIS) format
NEHRP Soil	NJGWS	2016	Digital (GIS) format
Liquefaction Susceptibility	NJGWS	2016	Digital (GIS) format
Landslide Susceptibility	NJGWS	2016	Digital (GIS) format
Wildfire Fuel Hazard	NJFFS	2012	Digital (GIS) format
Future projected flood inundation extents	North Jersey Transportation Planning Authority (NJTPA)	2019	Digital (GIS) format
Census of Agriculture	USDA	2017	Digital (PDF Report) format
1-foot Sea Level Rise	NOAA	2016	Digital (GIS) Format
3-foot Sea Level Rise	NOAA	2016	Digital (GIS) Format
Sea-Lake Overland Surge from Hurricanes (SLOSH) Model	NOAA	2016	Digital (GIS) Format
1-meter Resolution Digital Elevation Model	Hudson County Division of Planning		Digital (GIS) Format

LIMITATIONS

For this risk assessment, the loss estimates, exposure assessments, and hazard-specific vulnerability evaluations rely on the best available data and methodologies. Uncertainties are inherent in any loss estimation methodology and arise in part from incomplete scientific knowledge concerning natural hazards and their effects on the built environment. Uncertainties also result from the following:

- Approximations and simplifications necessary to conduct such a study
- Incomplete or dated inventory, demographic, or economic parameter data
- The unique nature, geographic extent, and severity of each hazard
- Mitigation measures already employed by the participating municipalities
- The amount of advance notice residents have to prepare for a specific hazard event

These factors can result in a range of uncertainty in loss estimates, possibly by a factor of two or more. Therefore, potential exposure and loss estimates are approximate. These results do not predict precise results and should be used to understand relative risk. Over the long term, Hudson County will collect additional data to update and refine existing inventories, to assist in estimating potential losses.

Potential economic loss is based on the present value of the general building stock utilizing best available data. The County acknowledges significant impacts may occur to critical facilities and infrastructure as a result of these hazard events causing great economic loss. However, monetized damage estimates to critical facilities and infrastructure, and economic impacts were not quantified and require more detailed loss analyses. In addition, economic impacts to industry such as tourism and the real-estate market were not analyzed.

4.3 Hazards of Concern

The Hudson County hazards of concern are presented in Section 4.3 and outlined as follows:

- **Hazard Profile**
  - Location - geographic area most affected by the hazard
  - Extent – severity of each hazard
  - Previous Occurrences and Losses
  - Impacts of Climate Change
  - Probability of Future Hazard Events
- **Vulnerability Assessment**
  - Impact to Population
  - Impact to Buildings
  - Impact to Critical Facilities and Lifelines
  - Impact to Economy
  - Future Changes that may Impact Vulnerability
  - Vulnerability Changes Since 2015

4.3.1 COASTAL EROSION AND SEA LEVEL RISE

This section provides a profile and vulnerability assessment of the coastal erosion and sea level rise hazard in Hudson County.

2020 HMP Changes

- This section was called Coastal Erosion in the 2015 HMP; it is updated to Coastal Erosion and Sea Level Rise to align with the State of New Jersey HMP.
- More recent and localized sea level rise projections from Rutgers University are referenced for the State of New Jersey.
- Previous occurrences were updated with events that occurred between 2015 and 2019.
- Updated sea level rise data from NOAA was used in the Vulnerability Assessment. The 1-foot and 3-foot sea level rise boundaries from NOAA's 2016 dataset were used to align with the 2019 New Jersey State HMP.
- Added additional analyses including: social vulnerability analysis, evacuation route analysis, sea level rise mapping at the MUA level

4.3.1.1 PROFILE

COASTAL EROSION

Coastal erosion is the gradual breakdown and removal of land material into a sea or lake due to physical and chemical processes, such as wind, wave, and tidal action, with contribution from man-made interferences. Coastal erosion can take place at two different rates: gradual erosion, which occurs continually along all coastlines, and sudden or catastrophic erosion primarily due to storm events, which can result in changes to coasts over a very short period of time.

Many natural factors affect erosion of the shoreline, including shore and nearshore morphology, shoreline orientation, and the response of these factors to storm frequency and sea level rise. Coastal shorelines change constantly in response to wind, waves, tides, sea-level fluctuation, seasonal and climatic variations, human alteration, and other factors that influence the movement of sand and material within a shoreline system.

Unsafe tidal conditions, as a result of high winds, heavy surf, erosion, and fog are ordinary coastal hazard phenomena. Some or all of these processes can occur during a coastal storm, resulting in an often-detrimental impact on the surrounding coastline. Factors that contribute to these coastal hazards include (1) storms such as Nor'Easters and hurricanes, (2) decreased sediment supplies, and (3) sea-level rise. Nor'easters and hurricanes are further discussed in Section 4.3.2 (Coastal Storm), while sea level rise is discussed below.

Coastal erosion can result in significant economic loss through the destruction of buildings, roads, infrastructure, natural resources, and wildlife habitats. Damage often results from an episodic event with the combination of severe storm waves and dune or bluff erosion.

SEA LEVEL RISE

Evidence supports that global sea level is rising at an increased rate and will continue rising over the next century. The two major causes of sea level rise are thermal expansion, caused by the warming of the oceans, and the loss of land-based ice (glaciers and polar ice caps), due to increased melting. Thermal expansion can account for 50% of sea level rise and is a result of warming atmospheric temperatures and subsequent warming of ocean waters causing the expansion. Since 1900, records and research have shown that sea level has been steadily rising at a rate of 0.04 to 0.1 inches per year (NOAA 2013).

There are two ways sea level rise is discussed: global and relative. Global sea level rise refers to the increase currently observed in the average global sea level trend (primarily attributed to changes in ocean volume due to ice melt and thermal expansion). The melting of glaciers and continental ice masses can contribute significant amounts of freshwater input to the earth's oceans. In addition, a steady increase in global atmospheric temperature creates an expansion of salt water molecules, increasing ocean volume.

Relative sea level refers to the height of the water as measuring along the coast relative to a specific point on land. Water level measurements at tide stations are referenced to stable vertical points on the land and a known relationship is established. Measurements at any given tide station include both global sea level rise and vertical land motion (subsidence, glacial rebound, or large-scale tectonic motion). The heights of both the land and water are changing; therefore, the land-water interface can vary spatially and temporally and must be defined over time. Relative sea level trends reflect changes in local sea level over time and are typically the most critical sea level trend for many coastal applications (coastal mapping, marine boundary delineation, coastal zone management, coastal engineering, and sustainable habitat restoration) (NOAA 2013).

Short-term variations in sea level typically occur daily and include waves, tides, or specific flood events. Long-term variations in sea level occur over various time scales, from monthly to several years and can be repeatable cycles, gradual trends, or intermittent differences. Seasonal weather patterns (changes in the earth's declination), changes in coastal and ocean circulation, anthropogenic influences, and vertical land motion can influence changes in sea level over time. When estimating sea level trends, a minimum of 30 years of data are used in order to account for long-term sea level variations and reduce errors in computing sea level trends based on monthly mean sea level (NOAA 2013).

Sea-level rise in New Jersey has resulted in an increase in sea level of roughly 16 inches in the past century. The rate of sea-level rise is anticipated to increase as time goes on, with the rate of increase being tied to the rate of greenhouse gas emissions and the corresponding increase in global temperatures (Rutgers 2016). As sea levels continue to rise, an increase in the frequency and severity of coastal flooding events from coastal storms is expected. Rising sea levels can result in permanent inundation of land that is currently above the high tide line, increase flooding risk from coastal storms, increase erosional rates, reduce the effectiveness of infrastructure, such as stormwater systems, and damage or destroy critical habitats.

EXTENT

COASTAL EROSION

Coastal erosion is measured as the rate of change in the position or horizontal displacement of a shoreline over a period of time (FEMA 1996). Many factors determine whether a community exhibits greater long-term erosion or accretion, including the following:

- Exposure to high-energy storm waves.
- Sediment size and composition of eroding coastal landforms feeding adjacent beaches.
- Near-shore bathymetric variations which direct wave approach.
- Alongshore variations in wave energy and sediment transport rates.
- Relative sea level rise.
- Frequency and severity of storm events.
- Human interference with sediment supply (e.g. revetments, seawalls, jetties) (Woods Hole Sea Grant 2003).

Such erosion can be intensified by human activities and effects, such as boat wakes, shoreline hardening, or dredging. Natural recovery after erosive episodes can take months or years. If a dune or beach does not recover quickly enough via natural processes, coastal and upland property could be exposed to further damage in subsequent events. Coastal erosion can cause the destruction of buildings and infrastructure (FEMA 1996).

Erosion is typically expressed as a rate: rate of linear retreat (feet of shoreline recession per year) or volumetric loss (cubic yards of eroded sediment per linear foot of shoreline frontage per year). Erosion rates are cited as positive numbers, with corresponding shoreline change rates as negative numbers. For example, an erosion rate of two feet per year is equivalent to a shoreline change rate of "-2 feet per year". Accretion rates are stated as positive numbers, with corresponding shoreline change rates as positive numbers. For example, an accretion rate of two feet per year is equivalent to a shoreline change rate of "2 feet per year".

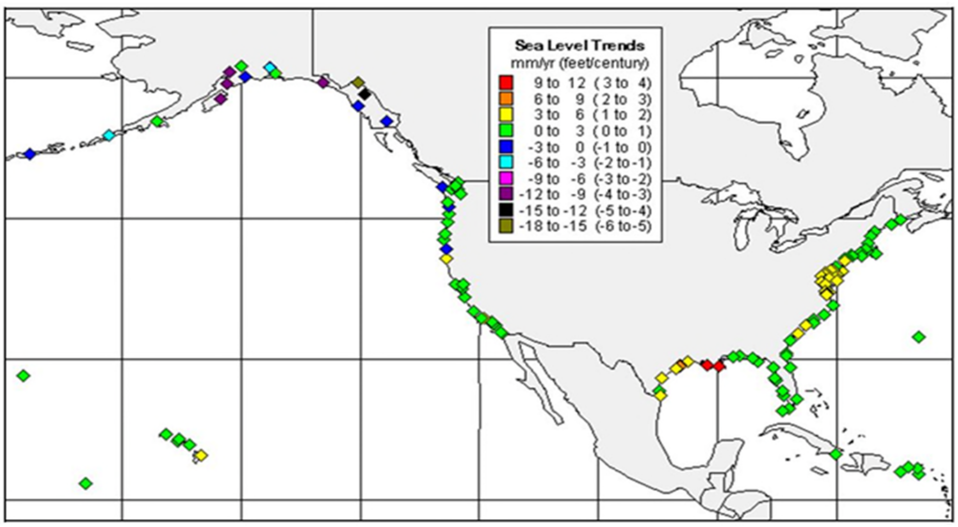
Erosion rates are usually computed and cited as long-term, average annual rates. However, erosion rates are not uniform in time or space and can vary substantially, including from one location along the shoreline to another (even when the two locations are only a short distance apart), over time at a single location, or seasonally.

SEA LEVEL RISE

The Center for Operational Oceanographic Products and Services has been measuring sea level for over 150 years, with tide stations of the National Water Level Observation Network operating on all coastlines of the United States. Changes in mean sea level (MSL), either a sea level rise or sea level fall, has been computed at 128 long-term water level stations using a minimum span of 30 years of observations at each location. The measurements have been averaged by month to remove the effect of higher frequency phenomena (storm surge) in order to compute an accurate linear sea level trend (NOAA 2012).

Figure 4.3.1-1 is a map of regional MSL in the United States. This map provides an overview of variations in the rates of relative local MSL at long-term tide stations. The variations in sea level trends primarily reflect differences in rates and sources of vertical land motion. Areas that experienced little-to-no change in MSL are shown in green, including stations consistent with average global sea level rise rate of 1.7 to 1.8 mm/year. These stations do not experience significant vertical land motion. Stations that experienced positive sea level trends (yellow to red) experience both global sea level rise and lowering or sinking of the local land, causing an apparent exaggerated rate of relative sea level rise. Stations that are blue to brown have experienced global sea level rise and a greater vertical rise in local land, causing an apparent decrease in relative sea level. The rates of relative sea level rise reflect actual observations and must be accounted for in any coastal planning or engineering applications (NOAA 2013).

Figure 4.3.1-1. Relative Sea Level Variations of the United States



Source: NOAA, 2013

Figure 4.3.1-2 presents the most recent NOAA relative sea level variations along the Mid-Atlantic coast. Three NOAA tide gauge stations are located on the New Jersey coastline, where tide gauge measurements are made with respect to a local fixed reference level on land: Sandy Hook, Atlantic City, and Cape May.

Figure 4.3.1-2. Sea Level Trends in New Jersey

Source: NOAA 2013

For this HMP update, more recent and localized projections from Rutgers University are referenced for the State of New Jersey. Local and regional sea level projections for New Jersey are summarized in a 2016 Rutgers University Science and Technical Advisory Panel (STAP) Report (Kopp et al. 2016). This STAP Report was requested by the New Jersey Climate Adaptation Alliance, which is a network of policymakers, public and private sector practitioners, academics, nongovernmental organizations, and business leaders designed to build climate change preparedness capacity in New Jersey. Projected sea level rise estimates for New Jersey from the STAP Report are presented in Table 4.3.1-1.

Under a low emissions scenario, New Jersey coastal areas are likely (about 67% probability) to experience rates of 0.2-0.4 in/yr. through 2100. Under a high emissions scenario, New Jersey coastal areas are likely (about 67% probability) to experience rates of 0.3-0.5 in/yr. over the 2030-2050-time period and 0.3-0.7 in/yr. over the 2050-2100-time period (Kopp et al. 2016).

Table 4.3.1-1. Projected Sea Level Rise for New Jersey

	Central Estimate	Likely Range	1-in-20 Chance	1-in-200 Chance	1-in-1000 Chance
Year	50% probability SLR meets or exceeds…	67% probability SLR is between…	5% probability SLR meets or exceeds…	0.5% probability SLR meets or exceeds…	0.1% probability SLR meets or exceeds…
2030	0.8 ft	0.6 – 1.0 ft	1.1 ft	1.3 ft	1.5 ft
2050	1.4 ft	1.0 – 1.8 ft	2.0 ft	2.4 ft	2.8 ft
2100 (Low Emissions)	2.3 ft	1.7 – 3.1 ft	3.8 ft	5.9 ft	8.3 ft
2100 (High Emissions)	3.4 ft	2.4 – 4.5 ft	5.3 ft	7.2 ft	10 ft

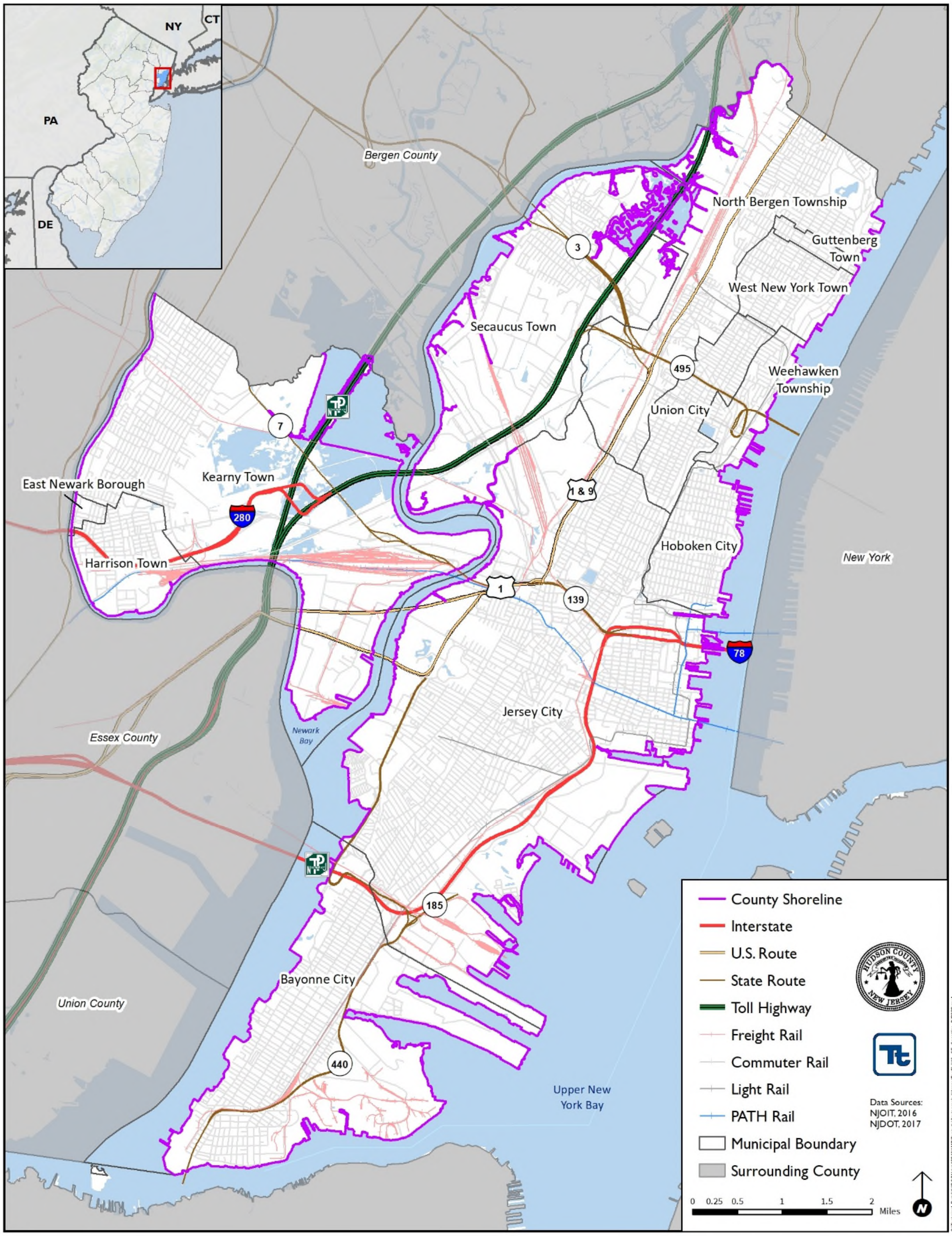
	Central Estimate	Likely Range	1-in-20 Chance	1-in-200 Chance	1-in-1000 Chance
Estimates are based on Kopp et al. (2014). Columns correspond to different projection probabilities. For example, the 'Likely Range' column corresponds to the range between the 17th and 83rd percentile; consistent with the terms used by the Intergovernmental Panel on Climate Change (*Mastrandrea et al., 2010*). All values are with respect to a 1991-2009 baseline. Note that these results represent a single way of estimating the probability of different levels of SLR; alternative methods may yield higher or lower estimates of the probability of high-end outcomes.					

Source: Kopp et al. 2016

LOCATION

The coastal boundary of New Jersey encompasses the Coastal Area Facility Review Act area and the New Jersey Meadowlands District. The coastal area includes coastal waters to the limit of tidal influence, including the following areas: the Atlantic Ocean (to the limit of New Jersey's seaward jurisdiction); Upper New York Bay, Newark Bay, Raritan Bay and the Arthur Kill; the Hudson, Raritan, Passaic, and Hackensack Rivers, and the tidal portions of the tributaries to these bays and rivers. Hudson County is considered a coastal county because several municipalities are located along the tidal portion of the Hudson River (the Cities of Jersey City and Hoboken). Figure 4.3.1-3. Coastline of Hudson County illustrates the coastal areas of Hudson County.

Figure 4.3.1-3. Coastline of Hudson County



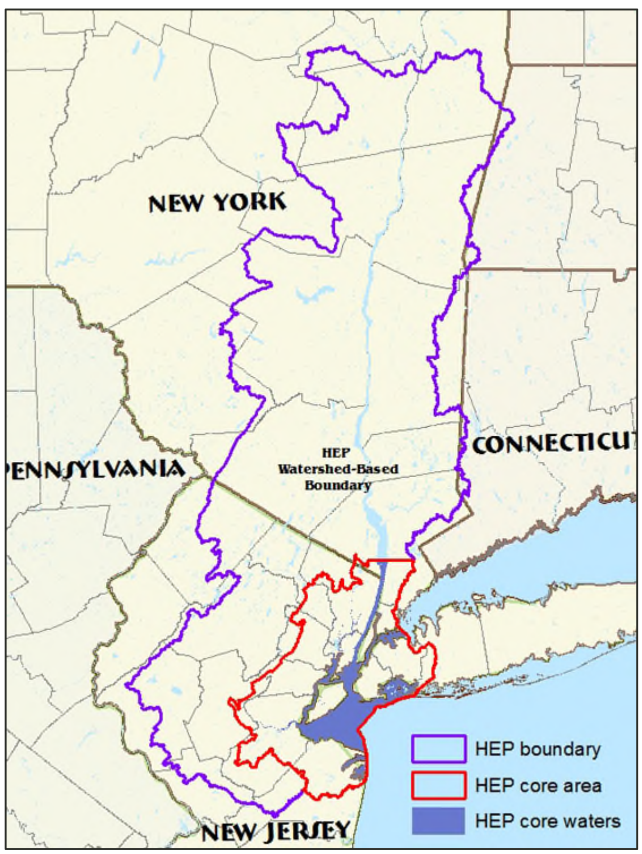
NEW JERSEY MEADOWLANDS

The New Jersey Meadowlands are a large ecosystem of wetlands located in northeastern New Jersey. The Meadowlands stretch mainly along the Hackensack and Passaic Rivers as they flow into Newark Bay. Tributaries of the Hackensack River (Sawmill Creek, Berrys Creek, and Overpeck Creek) also make up the Meadowlands. This area in New Jersey consists of approximately 30.4 square miles of open, undeveloped space, in addition to developed areas. Four communities in Hudson County are located in the Meadowlands and are prone to flooding: Jersey City, Kearny, North Bergen, and Secaucus. The annexes in Section 9 provide details regarding floodprone areas in each municipality.

NEW YORK-NEW JERSEY HARBOR ESTUARY (NEWARK BAY)

Hudson County is located within the New York-New Jersey Harbor Estuary (Newark Bay). An estuary is a body of water where rivers meet the ocean and salt water meets fresh water. The Harbor Estuary is positioned at the confluence of the Hudson River and smaller rivers such as the East, Hackensack, and Raritan Rivers. It then opens into the New York Bight and Long Island Sound. The watershed of the Harbor Estuary encompasses a large area that includes the Hudson River watershed up to the Troy Dam, as well as the watersheds of the Raritan, Passaic, and Hackensack Rivers. Coastal storms can cause significant impacts to coastlines, both to the built and natural environments. In an urban region like the Harbor Estuary, the impacts to the built environment can exacerbate the level of impact incurred by natural systems (New York-New Jersey Harbor & Estuary Program 2014). Figure 4.3.1-4 shows the location of the New York-New Jersey Harbor Estuary and its boundaries.

Figure 4.3.1-4. New York-New Jersey Harbor Estuary



Source: New York-New Jersey Harbor & Estuary Program 2014

Located in the New York & New Jersey Harbor Estuary, Newark Bay is the center of the most urbanized and industrialized parts of the country. Newark Bay is approximately six miles long and one mile wide and is located at the confluence of the Passaic and Hackensack Rivers, between the shores of Newark and Elizabeth to the west, Jersey City and Bayonne to the east, and Staten Island to the south. Newark Bay is linked to Upper and Lower New York Bay by the Kill van Kull and the Arthur Kill. Port Newark is located on the western shore of Newark Bay (Our Newark Bay 2014).

Past Occurrence

Coastal erosion can occur gradually as a result of natural processes or from episodic events, such as hurricanes, Nor'Easters, and tropical storms. Coastal erosion also results from sea-level rise, which occurs for a variety of reasons.

Table 4.3.1-2 summarizes identified coastal erosion events that have impacted Hudson County between 2015 and 2019. For events prior to 2015, refer to Appendix E (Risk Assessment Supplement). The annexes in Section 9 provide detailed information regarding impacts and losses identified for each plan participants.

Table 4.3.1-2. Coastal Erosion Related Events Impacting Hudson County (2015 – 2019)

Dates of Event	Event Type	FEMA Declaration Number	County Designated?	Losses/Impacts
January 26, 2015	Nor'easter	N/A	N/A	A potent Alberta Clipper low moved from southwestern Canada on January 24 to the Plains states and Ohio Valley on January 25. The low then redeveloped off the Mid Atlantic coast on January 26 and rapidly intensified into a strong nor'easter, bringing heavy snow and strong winds to parts of northeast New Jersey just west of New York City. Trained spotters and the public reported snowfall of 8 to 9 inches. North winds gusted up to 33 mph at nearby Newark Liberty Airport, with blowing and drifting of snow.
February 1, 2015	Winter Storm	N/A	N/A	An area of low pressure tracked east from the Ohio Valley the night of February 1 to just south of Long Island the afternoon of February 2. The proximity of the low with arctic air to the north resulted in snow at the onset, which transitioned to a wintry mix during the morning hours before going back to snow by early afternoon. Northeast New Jersey received 5 to 12 inches of snowfall and up to a third of an inch of ice. Snowfall amounts averaged around 5 inches, along with a third of an inch of ice. Harrison reported 4.5 inches with North Bergen reporting 0.32 inches of ice.
January 22-23, 2016	Winter Storm, Blizzard	DR-4264	Yes	Low pressure moving across the deep South on Thursday, January 21 and Friday, January 22 intensified and moved off the Mid-Atlantic coast on Saturday, January 23, bringing heavy snow and strong winds to northeast New Jersey and blizzard conditions to the urban corridor and some nearby areas. The Governor declared a state of emergency for New Jersey on Friday January 22. New Jersey Transit stopped running trains, buses, and light rail at 2 AM Saturday, January 23. Bridges and tunnels from New York City into New Jersey were shut down by mid-afternoon Saturday. Travel in and out of airports lagged through Monday, January 25, as airlines pre-emptively cut hundreds of flights. More than 1,000 flights out of area airports were cancelled, and Teterboro Airport was shuttered due to whiteout conditions. Trained spotters and an NWS cooperative observer in Harrison reported snowfall of 25 to 27 inches. Nearby Central Park and Newark Airport. ASOS observations showed blizzard conditions, with visibility less than one quarter mile in heavy snow and frequent wind gusts over 35 mph through the day and into the early evening on Saturday, January 23.
February 9, 2017	Winter Storm	N/A	N/A	Low pressure developed along a cold front over the Mid-Atlantic states early Thursday, February 9. The low rapidly intensified as it moved off the Delmarva coast in the morning and then to the south and east of Long Island late

Dates of Event	Event Type	FEMA Declaration Number	County Designated?	Losses/Impacts
				morning into the afternoon. The low brought heavy snow and strong winds to portions of Northeast New Jersey. Numerous flights were cancelled or delayed at Newark Airport. A trained spotter reported 6 inches of snow in Harrison. Winds also gusted to 42 mph in Bayonne.
March 7, 2018	Winter Weather	N/A	N/A	A strong low-pressure system developed along the Mid-Atlantic coast during the morning of Wednesday, March 7. The low tracked along the coast through the early morning hours on Thursday, March 8. The storm brought heavy wet snow, strong gusty winds, and even some thundersnow across northeast New Jersey. Snowfall rates ranged from 1 to 3 inches per hour at times in the heaviest snow bands. Trained spotters and the public reported 6 inches of snowfall. Strong winds in combination with heavy, wet snow also brought down tree limbs and a few power lines.
March 21, 2018	Heavy Snow	N/A	N/A	A large and slow-moving low pressure developed along the Middle Atlantic coast on Wednesday, March 21 and moved slowly north and east along the coast through Thursday, March 22. Moderate to occasionally heavy snow bands moved across portions of northeast New Jersey. A COOP observer reported 9 inches of snow in Harrison. An Emergency Manager in Hoboken reported 8.7 inches of snow.
April 2, 2018	Heavy Snow	N/A	N/A	Waves of low pressure moved along a stalled frontal boundary across the Middle Atlantic. Moderate to heavy snow fell during the morning commute across northeast New Jersey. Snowfall rates reached 1 inch per hour at times. A daily record snowfall for April 2nd of 5 inches was set at Newark, NJ. An NWS COOP observer in Harrison reported 6.5 inches of snowfall. A trained spotter in Kearny reported 6.8 inches of snowfall.
November 15, 2018	Winter Storm	N/A	N/A	A wave of low pressure developed along the Mid-Atlantic coast during Thursday, November 15. The low was associated with a closed upper level trough across the Midwest. As the trough translated eastward into Friday, November 16, the low pressure moved up the northeast coast. The antecedent air mass ahead of the low was cold and dry for the middle of November, with temperatures during the morning and afternoon of November 15 in the upper 20s and low 30s. The moisture associated with the trough and low pressure was able to produce moderate to heavy bands of snow, as the precipitation began across the entire Tri-State area due to the cold air in place. Once the low drew warmer air from the south, the precipitation gradually changed to a wintry mix and then to rain, especially for the New York City metro and Long Island. The moderate to heavy wet snowfall significantly impacted the evening rush hour with 1-2 inch per hour snowfall rates. Hundreds of trees, tree limbs, and branches were brought down by the weight of the snow, which caused many power outages. Numerous accidents were reported, and many motorists were stranded on roads until the early morning hours the next day. There were over 1,000 flights cancelled at the New York City metro airports (Kennedy, La Guardia, and Newark). A COOP observer reported 5.8 inches of snow. The public reported 6 inches of snow in Kearny. Impacts were widely felt across Hudson county with major disruption to the evening commute. Trees branches and limbs were downed due to the weight of the heavy wet snow. One tree brought down power lines on 7th Street and Willow Avenue in Hoboken. Nearby Newark airport reported 1-2 inch per hour snowfall rates at times during the evening commute.

Source: NOAA-NCEI 2019, FEMA 2019

Note: Not all events that have occurred in Hudson County are included due to the extent of documentation and the fact that not all sources have been identified or researched.

Probability of Future Occurrence

Long-term coastal erosion is a continuous and dynamic process. It is anticipated that coastal erosion will continue due to the projected increase in sea level rise, storm frequency, and intensity.

The long-term patterns of coastal erosion are difficult to detect because of substantial and rapid changes in coastlines in the short-term (that is, over days or weeks from storms and natural tidal processes). It is usually severe short-term erosion events, occurring either singly or cumulatively over a few years, that cause concern and lead to attempts to influence the natural processes. Analysis of both long- and short-term shoreline changes are required to determine which is more reflective of the potential future shoreline configuration (FEMA 1996).

The return period of an episodic erosion event is directly related to the return period of a coastal storm, hurricane, or tropical storm. The one-percent annual chance erosion event can be determined using a predictive model that establishes either the one-percent annual chance tide and water surface level, or surge elevation and the resulting wave heights. Storm wave heights, periods, and directions have specific impacts on the dunes, currents, and other erosion processes. Analyses of coastal erosion impacts from the one-percent annual chance flood event are included in high-hazard zone determinations shown on NFIP maps. The impacts can vary for each reach of coastline.

A more significant measure of coastal erosion is the average annual erosion rate. Erosion rates can be used in land-use and hazard management to define areas where development should be limited or special construction measures should be used. The average annual erosion rate is based on analysis of historical shorelines derived from maps, charts, surveys, and aerial photography obtained over a period of record.

As discussed in next subsection, changes in atmospheric and oceanic temperature will impact the probability for future coastal storm events and sea level rise. Sea level rise takes place due to a combination of long term geological and climate related processes. Long term forecasts and recent data suggest the rate of sea level rise is likely to increase in the future (Kopp et al. 2016).

In Section 4.4, the identified hazards of concern for Hudson County are ranked. The probability of occurrence, or likelihood of the event, is one parameter used for hazard rankings. Based on historical records and input from the Planning Committee, the probability of occurrence for coastal erosion and sea level rise in the County is considered 'Occasional' (between 10 and 100% annual probability of a hazard event occurring, as presented in Table 4.4-4).

Climate Change

Providing projections of future climate change for a specific region is challenging. Shorter-term projections are more closely tied to existing trends, making longer term projections even more challenging. The further out a prediction reaches the more subject to changing dynamics it becomes. Coastal areas could be impacted by climate change in different ways.

Changes in global temperatures, hydrologic cycles, coverage of glaciers and ice sheets, and storm frequency and intensity are captured in long-term sea level records. Sea levels provide a key to understanding the impact of climate change (NOAA 2013). Sea level rise increases the risks coastal communities face from coastal hazards (floods, storm surges, and chronic erosion). It may also lead to the loss of important coastal habitats. Sea level along the New Jersey Coast has risen by more than 16 inches since 1911, double the global average (NOAA NCEI 2019). The historical rate of sea level rise along the New Jersey coast over the past 50 years was 0.12 to 0.16 inches per year. Future rates are predicted to increase to 0.5 inches/year (Miller and Kopp 2013).

Coastal areas are sensitive to sea-level rise, changes in the frequency and intensity of storms, increase in precipitation, and warmer ocean temperatures. According to NASA, warmer temperatures can lead to an increase in frequency of storms, thus leading to more weather events that cause coastal erosion.

4.3.1.2 Vulnerability Assessment

The County's proximity to water, along with a growing population and being the most densely populated county in New Jersey, lays the foundation for Hudson County's vulnerability to coastal events and sea level rise, both in terms of exposure to and the potential impacts from hazard events. Since Hudson County is a coastal peninsula bordered by the Hudson River to the east, the Kill Van Kull strait and the Upper New York Bay to the south, and the Passaic River and Newark Bay to the west, this County and its resources are vulnerable all around its perimeter (refer to Figure 4.3.1-3).

To better understand the County's risks to coastal erosion and sea level rise, the CEHA 98-foot buffer and projected sea-level rise data (in one-foot increments) available from the NOAA Office of Coastal Management was considered and used for this analysis (NOAA 2018). Please note these levels do not include additional storm surge due to a hurricane or Nor'easter. The current Flood Insurance Rate Maps (FIRMs) also do not include the effects of sea-level rise. Projected sea level rise inundation areas are considered areas of permanent loss of land and community assets. Refer to Section 4.2 (Methodology and Tools) for additional details on the methodology used to assess coastal erosion and sea level rise risk.

Impact on Population

To estimate population exposed and vulnerable to the coastal erosion and sea level rise hazards, a spatial analysis was conducted using the 98-foot buffer along shoreline and the NOAA sea level rise inundation areas; refer to Figure 4.3.1-6. Table 4.3.1-3 breaks down the impact of coastal erosion area and sea level rise for the 1-foot and 3-foot scenarios by Hudson County's municipalities. The sea level rise extents can also be seen for five of the six Municipal Utilities Authority (MUA) boundaries that have project sea level rise inundation areas (Figure 4.3.1-7 through Figure 4.3.1-11).

Figure 4.3.1-5. Number of Persons Exposed Coastal Erosion and Sea Level Rise Hazard Areas

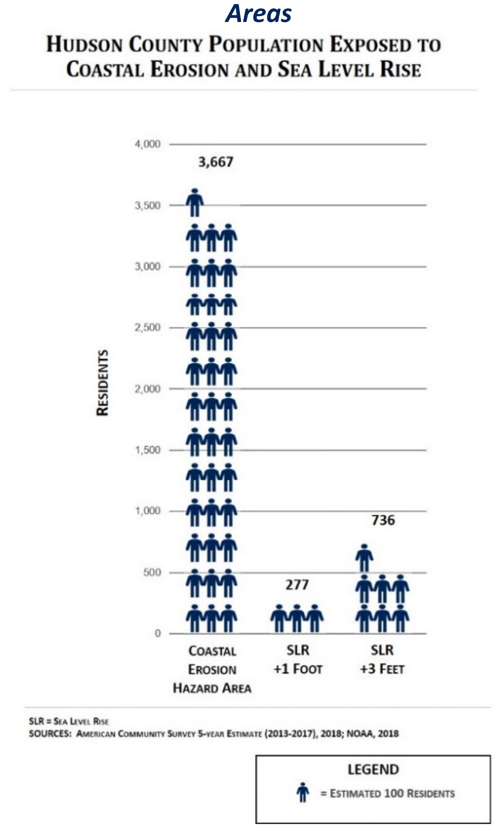


Figure 4.3.1-6. Estimated Coastal Erosion Hazard Area (CEHA)

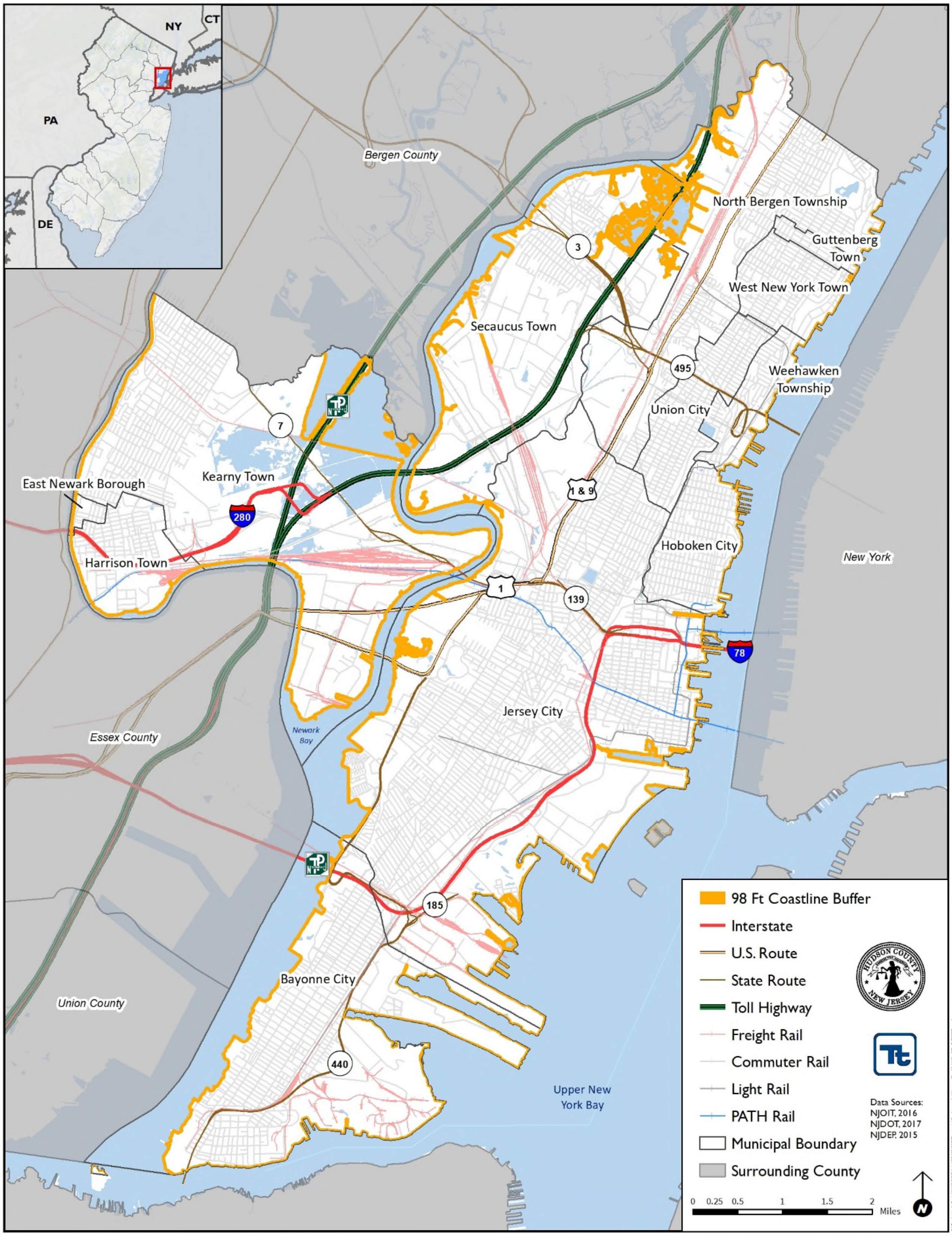


Table 4.3.1-3. Estimated Population Exposed to Coastal Erosion and Sea Level Rise 1-foot and 3-foot

Municipality	American Community Survey (2013-2017) Population	Estimated Population Exposed					
		Coastal Erosion Hazard Area	% of Total	Sea Level Rise +1 foot	% of Total	Sea Level Rise +3 foot	% of Total
Bayonne, City of	66,719	371	0.6%	0	0.0%	0	0.0%
East Newark, Borough of	2,725	0	0.0%	0	0.0%	0	0.0%
Guttenberg, Town of	11,733	0	0.0%	0	0.0%	0	0.0%
Harrison, Town of	15,898	16	0.1%	0	0.0%	0	0.0%
Hoboken, City of	54,117	562	1.0%	0	0.0%	0	0.0%
Jersey City, City of	265,932	1,571	0.6%	225	0.1%	225	0.1%
Kearny, Town of	42,487	0	0.0%	0	0.0%	92	0.2%
North Bergen, Township of	63,438	77	0.1%	0	0.0%	172	0.3%
Secaucus, Town of	19,279	510	2.6%	0	0.0%	196	1.0%
Union City, City of	69,815	0	0.0%	0	0.0%	0	0.0%
Weehawken, Township of	14,268	64	0.4%	51	0.4%	51	0.4%
West New York, Town of	53,345	495	0.9%	0	0.0%	0	0.0%
Hudson County (Total)	**679,756**	**3,667**	**0.5%**	**277**	**0.0%**	**736**	**0.1%**

Sources: American Community Survey 5-year Estimate (2013 – 2017), 2018; NOAA, 2018

Figure 4.3.1-7. Coastal Erosion and SLR 1-foot and 3-foot Hazard Areas for Hudson County

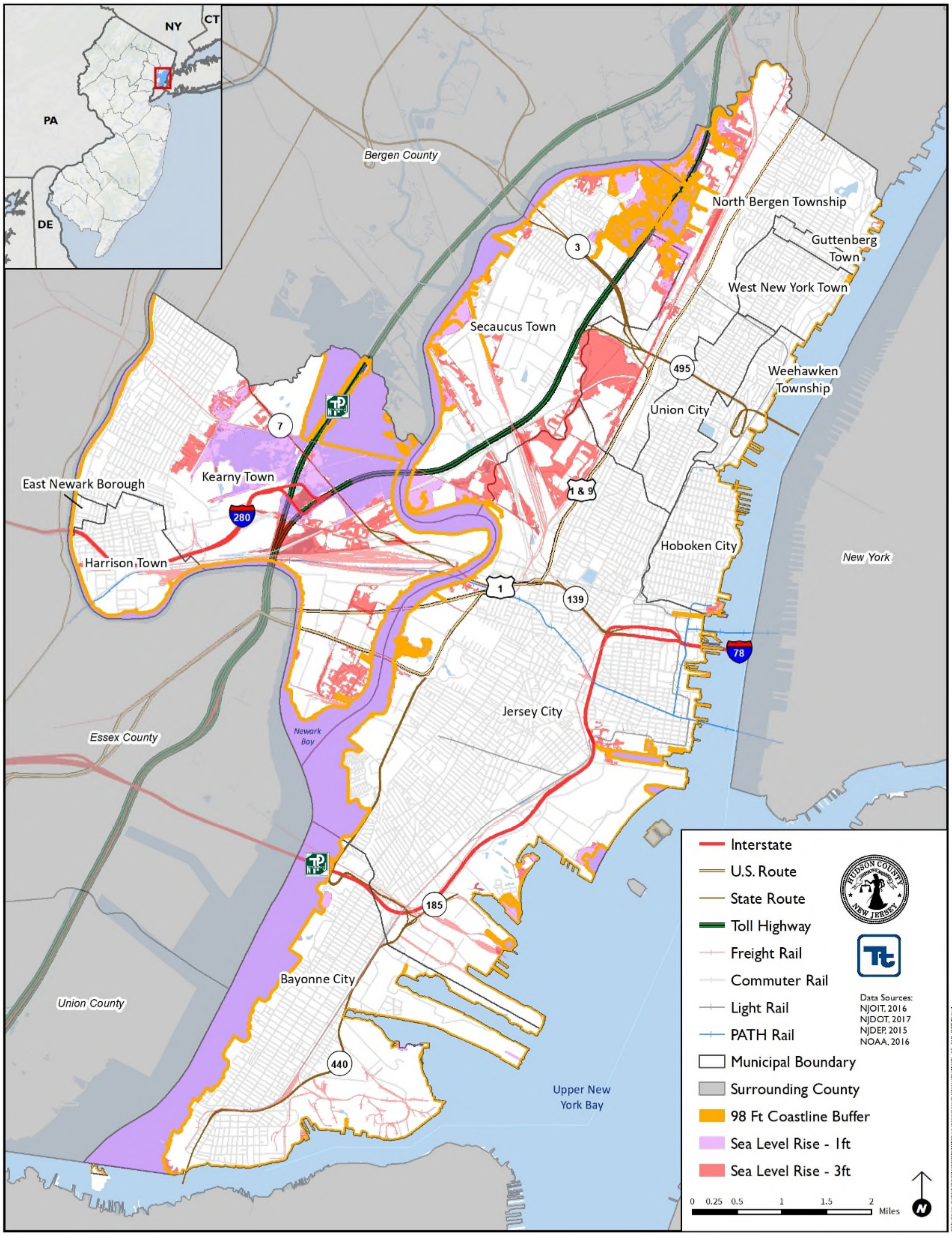


Figure 4.3.1-8. 1-foot and 3-foot Sea Level Rise for Jersey City Municipal Utilities Authority Boundary

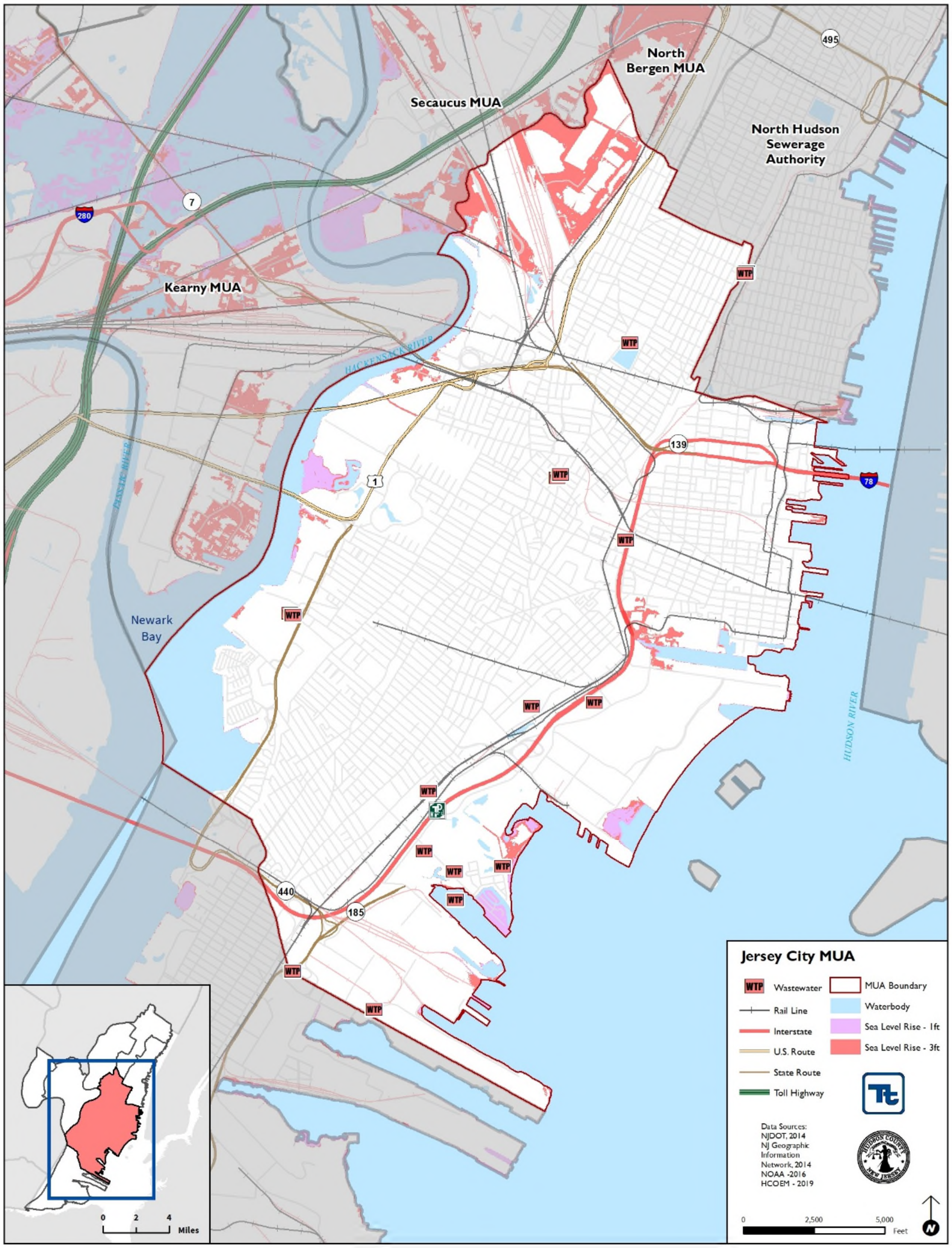


Figure 4.3.1-9. 1-foot and 3-foot Sea Level Rise for Kearny Municipal Utilities Authority Boundary

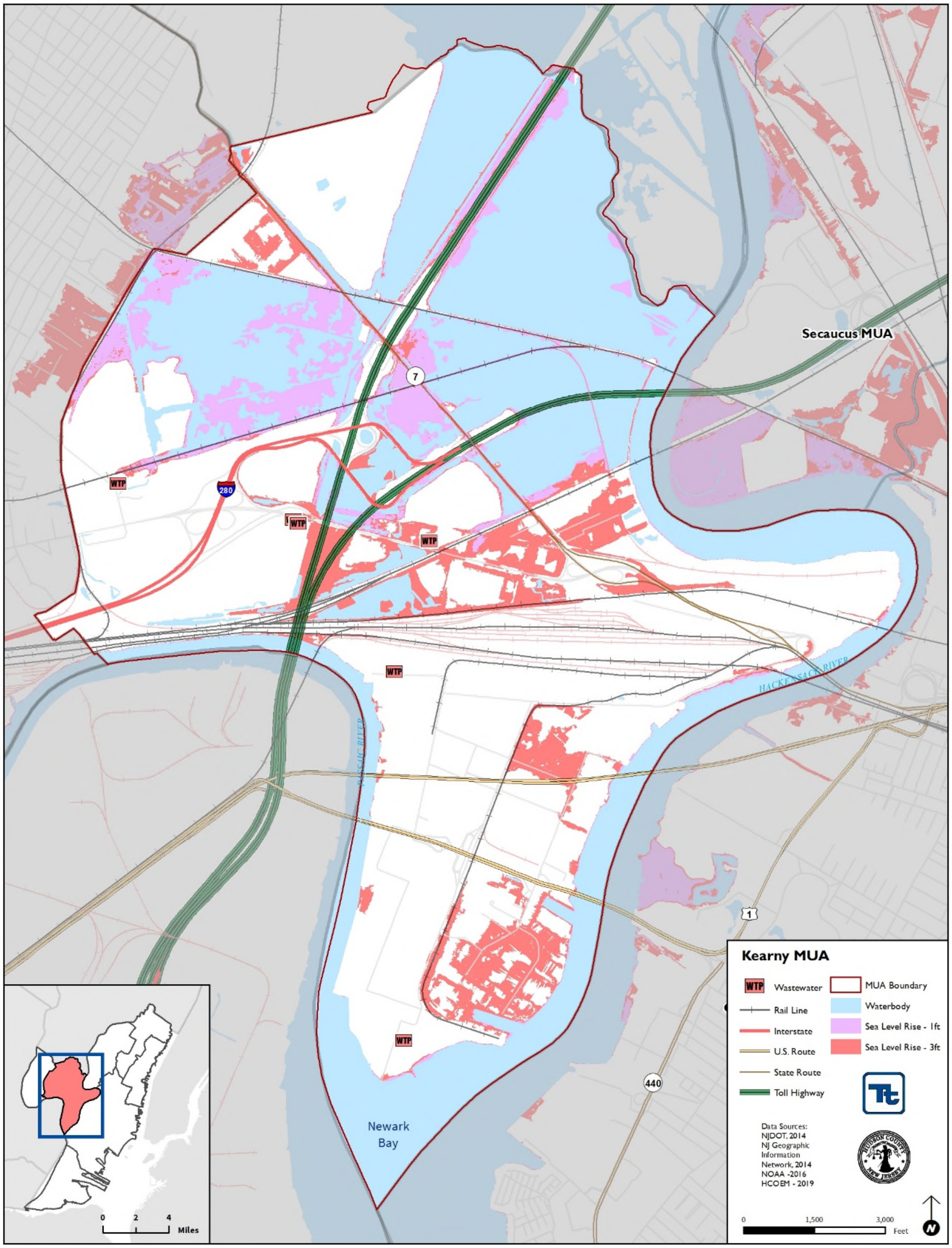


Figure 4.3.1-10. 1-foot and 3-foot Sea Level Rise for North Bergen Municipal Utilities Authority Boundary

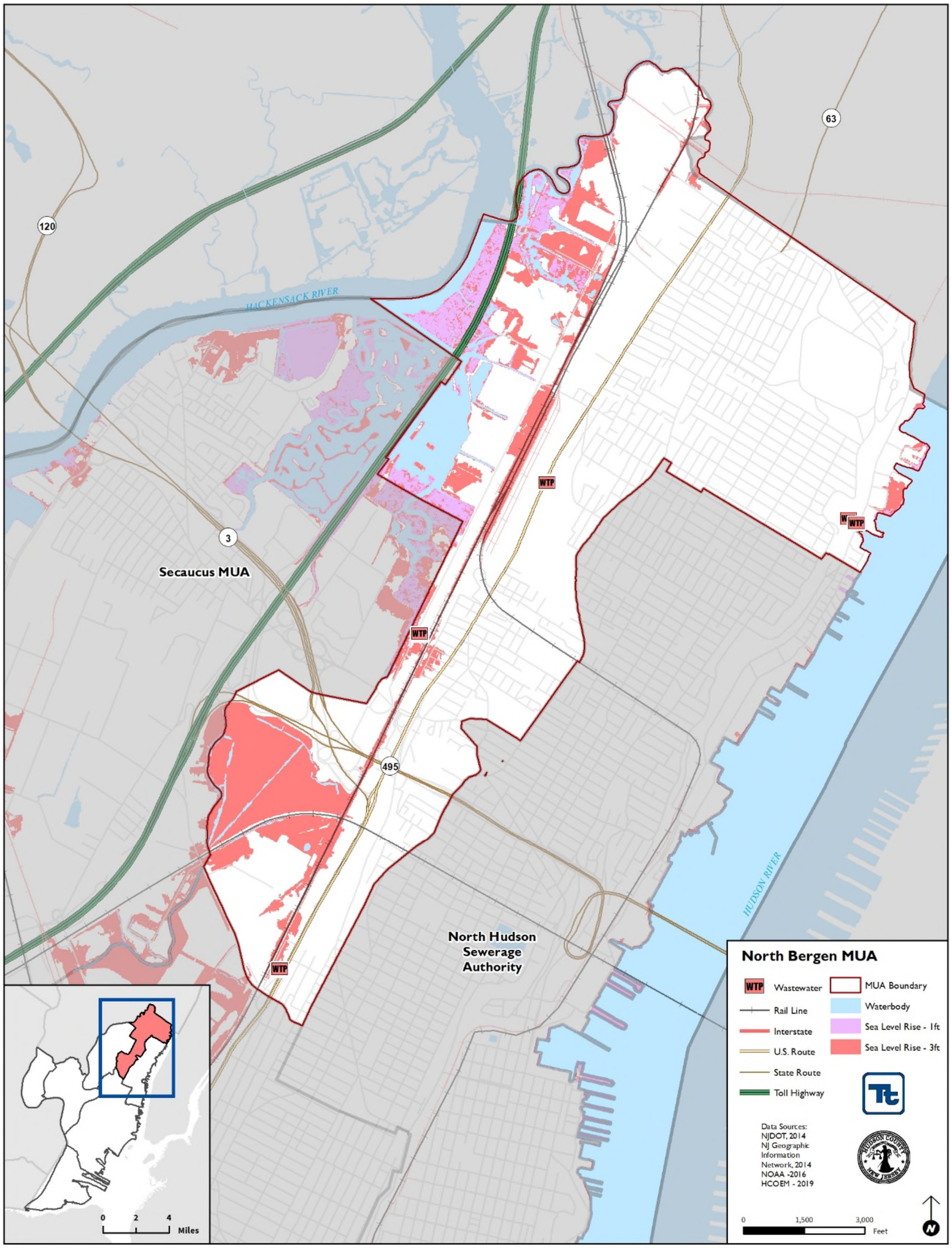


Figure 4.3.1-11. 1-foot and 3-foot Sea Level Rise for North Hudson Municipal Utilities Authority Boundary

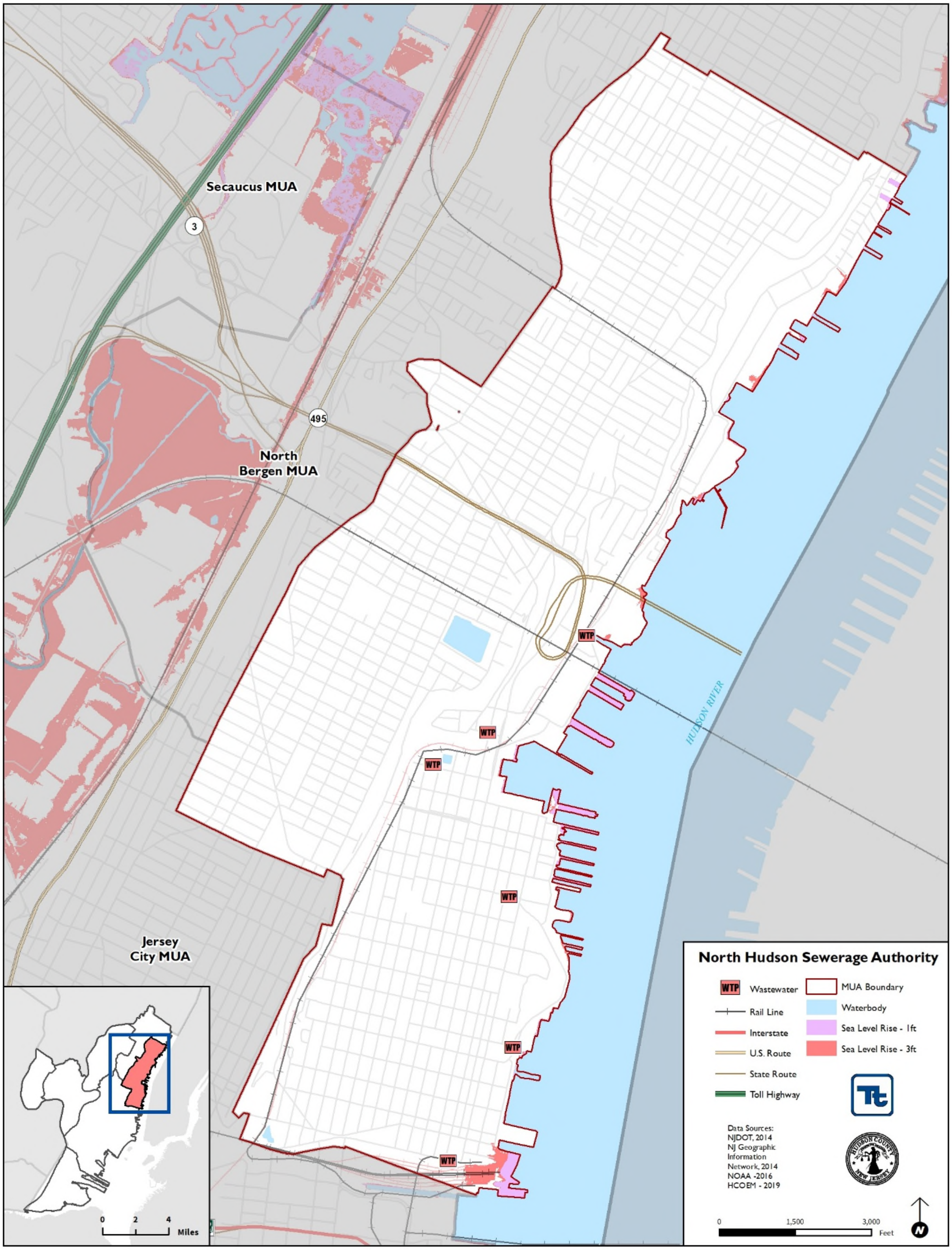
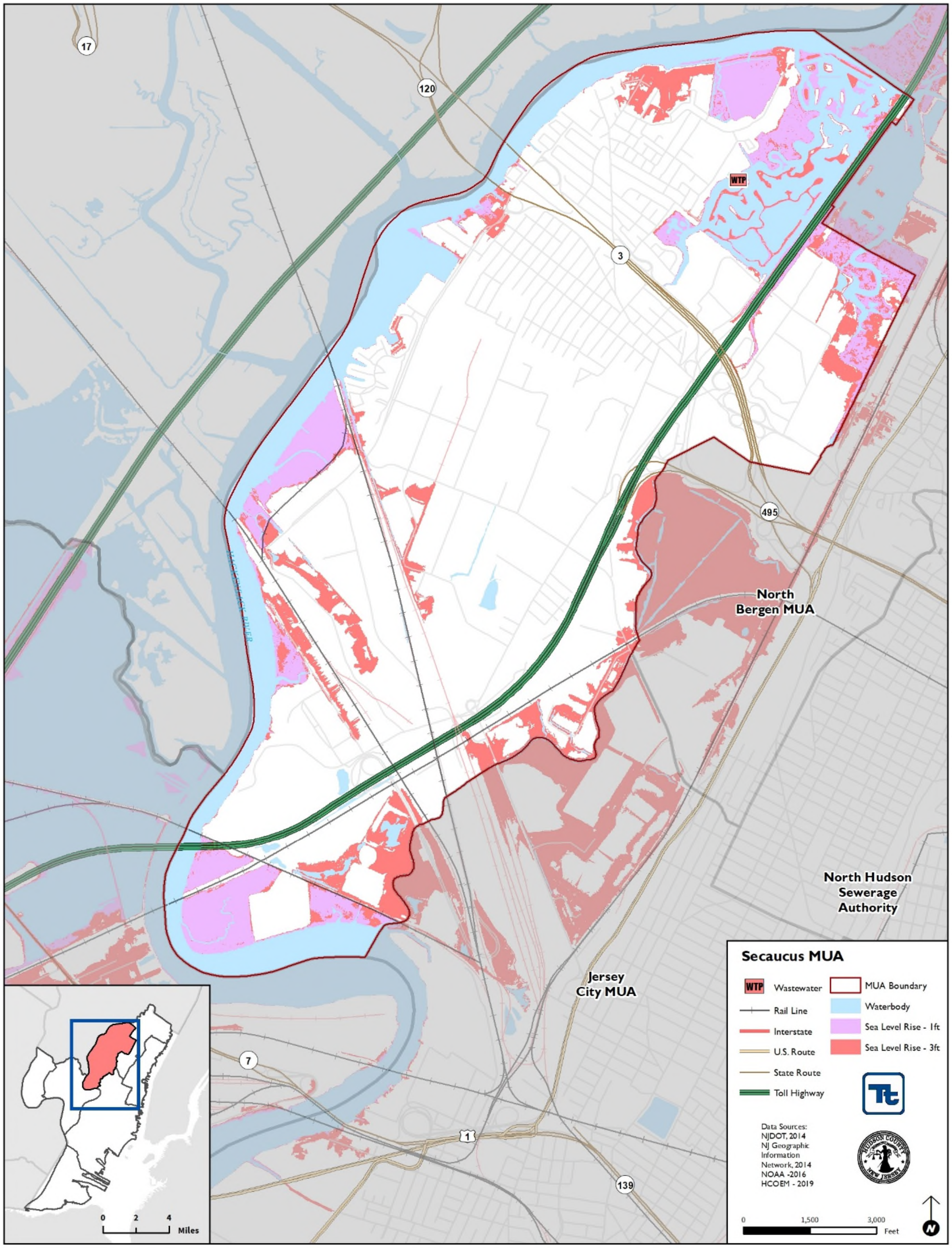


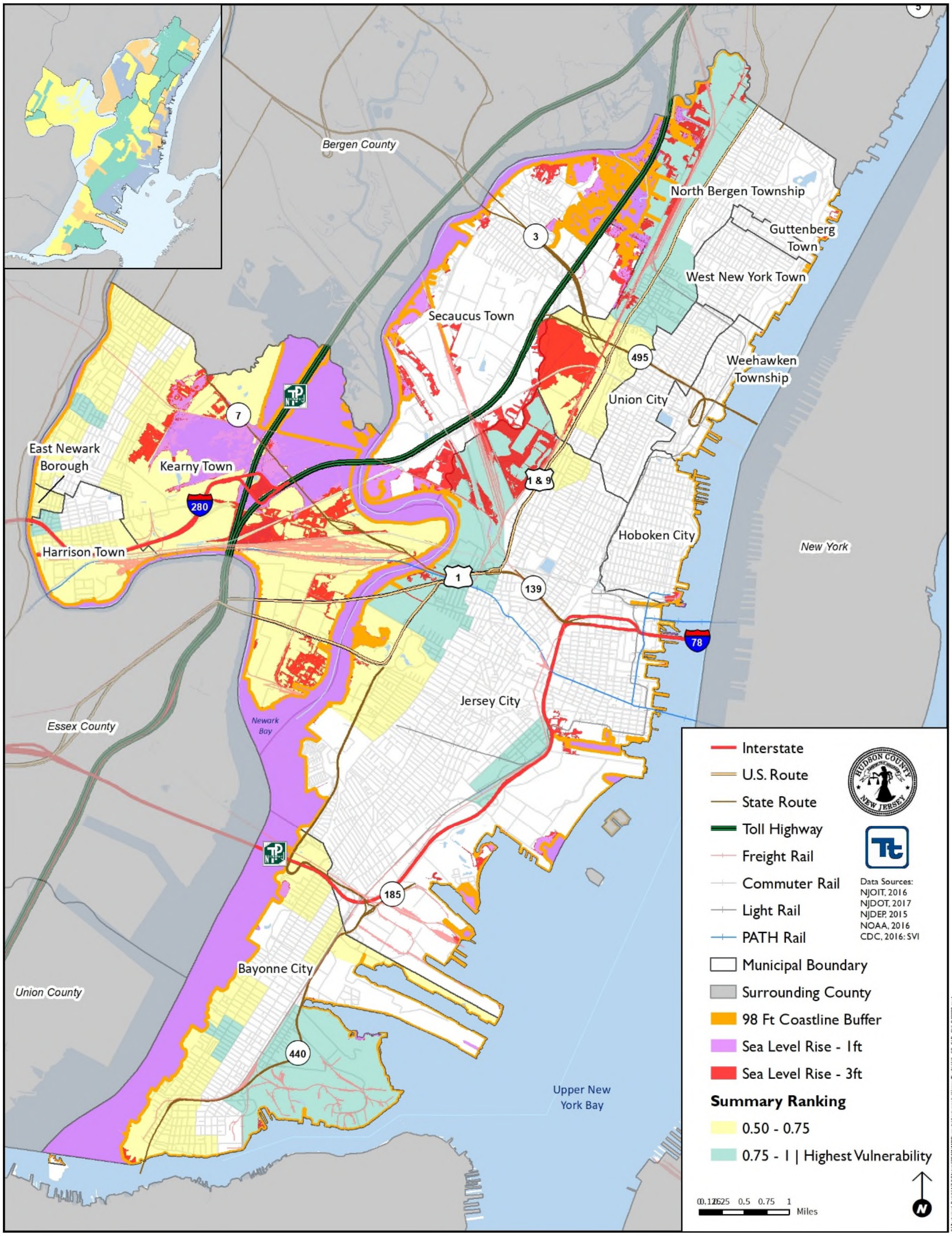
Figure 4.3.1-12. 1-foot and 3-foot Sea Level Rise for Secaucus Municipal Utilities Authority Boundary



Socially vulnerable populations (e.g. the elderly and low-income populations) are vulnerable to coastal erosion and sea level rise. Of the 3,667 people located in the coastal erosion hazard area, approximately 304 are over the age of 65 and approximately 351 are below poverty level. Within the sea level rise +1 ft inundation area, approximately 23 people are over the age of 65 and approximately 10 people are below the poverty level; within the sea level rise +3 ft inundation area, 109 people are over the age of 65 and approximately 39 people are below the poverty level.

Furthermore, the CDC 2016 Social Vulnerability Index (SVI) ranks U.S. Census tracts on socioeconomic status, household composition and disability, minority status and language, and housing and transportation. Hudson County's overall score is 0.6425, indicating that its communities have moderate to high vulnerability (CDC 2016, refer to Figure 4.3.1-12). The SVI map shows that most vulnerable populations are within the interior of the County, which are less vulnerable to coastal erosion and sea level rise compared to along the coastline. Figure 4.3.1-13 illustrates where the moderate and high vulnerable Census tracts intersect the sea level rise projection inundation areas.

Figure 4.3.1-13. CDC Social Vulnerability Index Rating for Hudson County and Coastal Erosion and SLR 1-foot and 3-foot Hazard Areas



IMPACT ON GENERAL BUILDING STOCK

The analysis shows that Hudson County's buildings are exposed to both coastal erosion and sea level rise (refer to Figure 4.3.1-14). The level of exposure is a small percentage compared to the entire building stock, however the results show that over $714 million of building stock is located in the coastal erosion hazard area and over $290 million and $1.75 billion of building stock is located in the 1-foot and 3-foot sea level rise inundation areas, respectively. The Town of Secaucus has the highest number of buildings exposed to coastal erosion (approximately 2.1% of its entire building stock), whereas the Township of Weehawken has the greatest value of exposure (approximately 6.1% of total replacement value). For the 3-foot sea level rise scenario, the Township of Weehawken and the Town of Kearny have the greatest building value exposure; approximately 5.1% and 10.1% of total replacement cost values for the 3-foot sea level rise inundation area, respectively. Refer to Table 4.3.1-4 for more information about coastal erosion and sea level rise exposure.

Figure 4.3.1-14. Building Exposure to Coastal Erosion and Sea Level Rise Hazard Areas

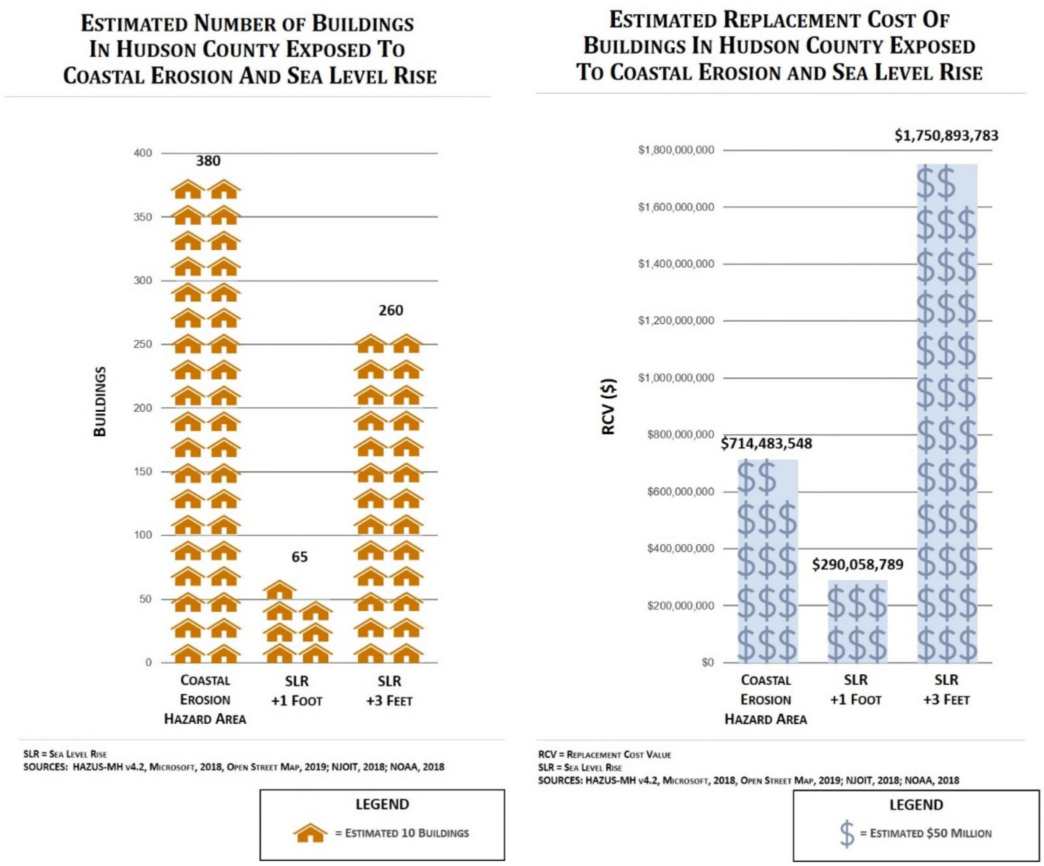


Table 4.3.1-4. Building Stock Exposure in Coastal Hazard Area and Sea Level Rise 1-Foot and 3-Foot Areas

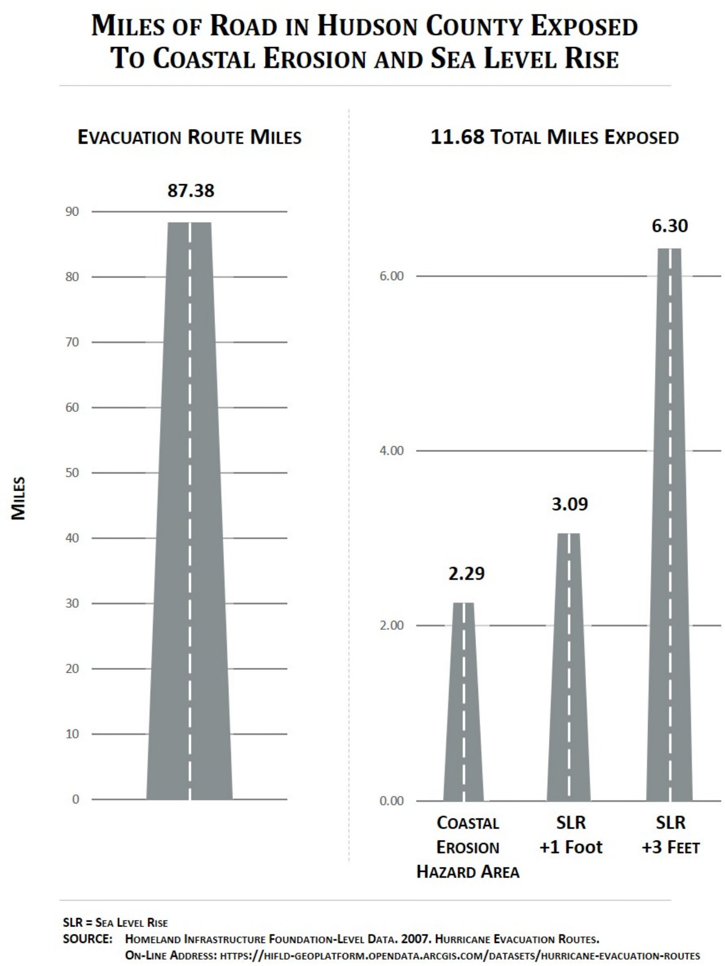
Municipality	Number of Buildings	Total Replacement Cost Value (RCV)	Estimated Building Stock Exposed											
			Number of Buildings in the Coastal Erosion Hazard Area	% of Total	RCV in the Coastal Erosion Hazard Area	% of Total	Number of Buildings - Sea Level Rise + 1 ft.	% of Total	RCV - Sea Level Rise + 1 ft.	% of Total	Number of Buildings - Sea Level Rise + 3 ft.	% of Total	RCV - Sea Level Rise + 3 ft.	% of Total
Bayonne, City of	6,802	$8,856,079,105	74	1.1%	$59,099,671	0.7%	5	0.1%	$53,954,742	0.6%	7	0.1%	$54,651,700	0.6%
East Newark, Borough of	403	$240,888,451	4	1.0%	$2,708,869	1.1%	0	0.0%	$0	0.0%	0	0.0%	$0	0.0%
Guttenberg, Town of	1,227	$651,507,569	4	0.3%	$16,745,907	2.6%	0	0.0%	$0	0.0%	0	0.0%	$0	0.0%
Harrison, Town of	2,537	$2,398,975,757	6	0.2%	$12,679,195	0.5%	0	0.0%	$0	0.0%	2	0.1%	$5,169,139	0.2%
Hoboken, City of	4,470	$3,910,202,233	15	0.3%	$21,465,160	0.5%	4	0.1%	$1,886,017	0.0%	7	0.2%	$167,419,492	4.3%
Jersey City, City of	35894	$25,693,921,967	154	0.4%	$357,953,844	1.4%	34	0.1%	$115,060,699	0.4%	45	0.1%	$135,493,519	0.5%
Kearny, Town of	7,209	$7,874,466,790	14	0.2%	$26,523,803	0.3%	11	0.2%	$39,086,523	0.5%	114	1.6%	$792,788,952	10.1%
North Bergen, Township of	6,005	$8,393,144,641	10	0.2%	$8,795,162	0.1%	1	0.0%	$74,259	0.0%	27	0.4%	$322,993,535	3.8%
Secaucus, Town of	3,845	$9,593,262,762	80	2.1%	$97,954,723	1.0%	1	0.0%	$2,099,959	0.0%	49	1.3%	$194,480,856	2.0%
Union City, City of	1,729	$3,742,882,384	0	0.0%	$0	0.0%	0	0.0%	$0	0.0%	0	0.0%	$0	0.0%
Weehawken, Township of	2,113	$1,510,119,929	12	0.6%	$92,076,261	6.1%	8	0.4%	$76,457,298	5.1%	8	0.4%	$76,457,298	5.1%
West New York, Town of	4,594	$2,825,012,673	7	0.2%	$18,480,954	0.7%	1	0.0%	$1,439,292	0.1%	1	0.0%	$1,439,292	0.1%
Hudson County (Total)	**76,828**	**$75,690,464,261**	**380**	**0.5%**	**$714,483,548**	**0.9%**	**65**	**0.1%**	**$290,058,789**	**0.4%**	**260**	**0.3%**	**$1,750,893,783**	**2.3%**

Source: HAZUS-MH v4.2, Microsoft, 2018, Open Street Map, 2019; NJOIT, 2018; NOAA, 2018

Impact on Critical Facilities

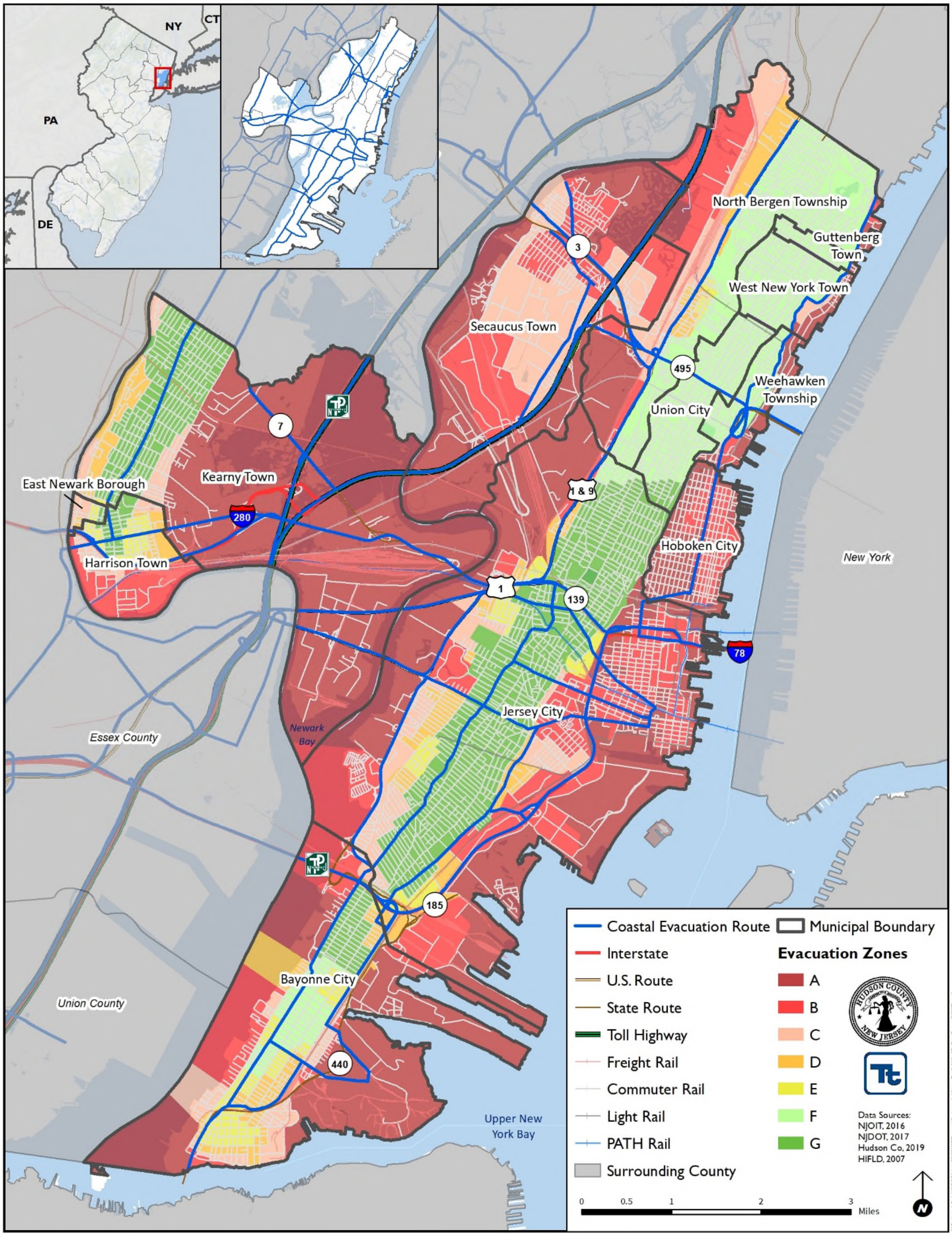
Coastal erosion and sea level rise can impact critical facilities. Coastal erosion can degrade the surrounding infrastructure and utility lines, depending on their location on the property. This could inhibit the ability to respond during or after an emergency event. In the case of a single, severe event, the structural foundation of a facility can be compromised as well. Furthermore, sea level rise can create access issues to critical facilities. Not only can the infrastructure leading to the critical facilities become permanently inundated, but the critical facilities themselves can become inundated.

Figure 4.3.1-15. Evacuation Route Exposure to Coastal Erosion and Sea Level Rise Hazard Areas



These hazards can have a major impact on the ability of communities to evacuate during coastal storm events, that may become exaggerated by sea level rise and erosion; discussed further in Section 4.3.2 (Coastal Storm). These evacuation zones depend on access to nearby evacuation routes, such as Interstate 78 and State Road 185 (refer to Figure 4.3.1-16). However, the hazard maps show that these major routes are also at risk of becoming breached with rising tide or erosion along the shoreline. If these routes become inoperable from flooding or the infrastructure becomes unstable from erosion, these communities can become isolated during an evacuation event. The spatial analysis found that 2.3 miles, 3.09 miles, and 6.30 miles of evacuation routes within Hudson County are inundated by the coastal erosion, sea level rise +1 foot, and sea level rise +3 foot hazard areas, respectively.

Figure 4.3.1-16. Evacuation Zones and Coastal Evacuation Routes in Hudson County



Interruptions in evacuation routes can simultaneously cause disruption to services provided by critical facilities within the County. Not only can flooded or breached roadways isolate these facilities from the community, they are also at risk of becoming structurally damaged due to flood and erosion exposure. There are few critical facilities at risk of becoming impacted by coastal erosion or sea level rise risks of the 1-foot and 3-foot hazard areas. Hudson County has 29 out of 1,184 critical facilities fall within the coastal erosion area; 6 of these are lifeline critical facilities. Further, ferries and heliports make up the majority of the at-risk critical facility types. Within the sea level rise hazard areas, Hudson County has 13 critical facilities and 21 critical facilities at risk of being inundated by the 1-foot and 3-foot hazard areas, respectively. The Town of Kearny has the greatest number of critical facilities that would be impacted by the 3-foot sea level rise hazard areas (3 structures total).

Impact on the Economy

Vulnerability to sea level rise is assessed as the potential permanent loss of land and assets. This permanent loss will severely impact the economy given the presence of major ports and infrastructure along the coast in Hudson County. In addition, the densely developed coast has high property values and contributors to the tax base, as well as local and regional economies. The total replacement cost value of structures located in the +1 and +3ft of sea level rise inundation areas are $290,058,789 and $1,750,893,783, respectively.

Additionally, disruption to business operations can occur in cases where infrastructure is breached by erosion or sea level rise. Loss of income may occur as a secondary impact if businesses are closed under repairs due to this breaching. To prevent these potential business losses, public expenditures may need to be spent to implement shoreline stabilizers and to protect key infrastructure like highways and interstates that follow along the coastline. This includes major routes such as the New Jersey Turnpike and 440. A study by NOAA shows that in 2004, $250 to $51,000 per hectare was spent to protect coastal wetlands (Paterson, O'Donnel, Loomis, and Hom, 2010). This level of protection may be required as development continues to expand in Hudson County.

Impact on the Environment

According to the State of New Jersey 2019 Hazard Mitigation Plan, coastal erosion can impact various natural land resources such as wetlands, marshes, and coastal habitats. Erosion would inhibit these natural landscapes to perform important ecosystem services such as buffering against future land loss, filtering pollutants, and maintaining a livable habitat that enhances the aesthetics of these coastal environments. Erosion rates can be exacerbated by storm events. Consequentially, natural habitat that would mitigate and protect the coastline become unstable and require replenishment actions (State of New Jersey 2019).

Future Changes That May Impact Vulnerability

Understanding future changes that effect vulnerability in the County can assist in planning for future development and ensure establishment of appropriate mitigation, planning, and preparedness measures. The County considered the following factors to examine potential conditions that may affect hazard vulnerability:

- Potential or projected development
- Projected changes in population
- Other identified conditions as relevant and appropriate, including the impacts of climate change

PROJECTED DEVELOPMENT

The County and participating jurisdictions intend to continue to discourage development within vulnerable areas or to encourage higher regulatory standards on the local level. Any areas of growth could be affected by the identified hazards if located within identified hazard areas. Each municipality identified areas of recent development and proposed development in their community (refer to Section 3 – County Profile and Section 9 – Jurisdictional Annexes). Developments that could be located using an address or Parcel ID were geocoded and overlaid with the hazard area boundaries to determine vulnerability to coastal erosion and sea level rise. There are several new development properties planned to be built in the 1-foot sea level rise, 3-foot sea level rise, and coastal erosion hazard areas in all of Hudson County. Refer to Figure 4.3.1-17 to view the location of the proposed development properties and parcels.

PROJECTED CHANGES IN POPULATION

Population growth in Hudson County is noteworthy. Factors like increased number of immigrants and a growing number of Millennials and young adults has become a driver for new development. For example, the increasing population has created a need for more school facilities, municipal services, and housing development (Hudson County 2017). The location of these additional facilities and housing will need to factor in the coastal erosion and sea level risk areas to avoid possible disruption in services and isolation of residents. According to the analysis, two public schools in Secaucus will be built in the 1-foot sea level rise hazard area. Furthermore, throughout Hudson County, new housing and commercial development is identified to be built in these hazard areas. This planning process was used as an opportunity to discuss their location relative to the projected sea level rise area and items to consider to mitigate future impacts. Accounting for this population change and increased flow of traffic along major roadways will need to be considered during evacuation events as well.

CLIMATE CHANGE

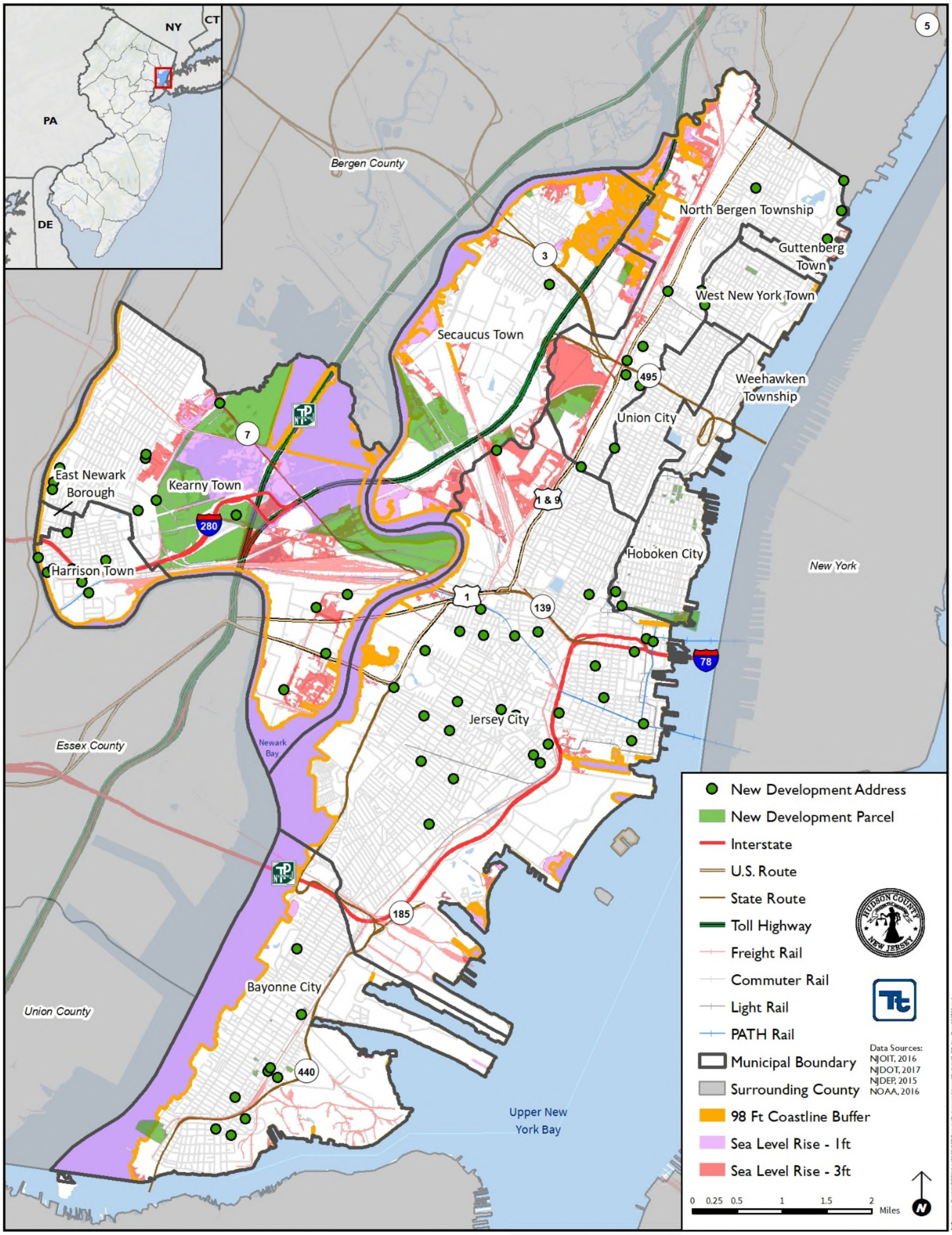
Coastal areas may be impacted by climate change in different ways. Impacts of climate change can lead to shoreline erosion, coastal flooding, and water pollution, affecting man-made coastal infrastructure and coastal ecosystems. Coastal areas are sensitive to sea-level rise, changes in the frequency and intensity of storms, increase in precipitation, and warmer ocean temperatures. Additionally, oceans are absorbing more carbon dioxide from the rising atmospheric concentrations of the gas, resulting in oceans becoming more acidic. This could have significant impacts on coastal and marine ecosystems (U.S. EPA 2013).

Coastal erosion is not generally considered an imminent threat to public safety when the changes are gradual over many years. However, drastic changes to the shoreline may occur as a result of a single storm event which can threaten public safety, buildings, and critical infrastructure. As previously stated, warmer temperatures may lead to an increase in frequency of storms, and an increase in the frequency and intensity of storms could increase the potential for severe coastal erosion events.

4.3.1.3 CHANGE OF VULNERABILITY SINCE 2015 HMP

Several differences exist between the 2015 HMP and this HMP update. For this HMP update, an updated general building stock based upon replacement cost value from MODIV tax assessment data and 2019 RS Means, and an updated critical facility inventory were used to assess the County's risk to the hazard areas. In addition, the 2017 American Community Survey population estimates were used and estimated at a structural level in place of the 2010 U.S. Census blocks. An updated hazard area was used as well; the 2016 sea-level rise spatial layer from NOAA. The original sea level rise data incorporated sea level rise into the floodplain, while this analysis looks at sea level rise only to be consistent with the 2019 NJ State HMP. Due to changes in the data used, a direct comparison of vulnerability between the plans is difficult. The updated vulnerability assessment provides a more current exposure analysis for the County.

Figure 4.3.1-17. Potential New Development and Coastal Erosion Hazards and Coastal Risk Areas



4.3.2 COASTAL STORM

This section provides a profile and vulnerability assessment of the coastal storm hazard in Hudson County.

2020 HMP Changes

- Previous occurrences were updated with events that occurred between 2015 and 2019.
- The vulnerability assessment was updated and enhanced using best available data.
- New HAZUS-MH hurricane wind modeling using the updated building and critical facility inventories
- Additional spatial analyses were conducted to examine the exposure of the following to storm surge inundation: socially vulnerable populations, land use, evacuation routes.
- A more detailed evaluation of future changes that may affect vulnerability to coastal storms was conducted.

4.3.2.1 PROFILE

For the purpose of this HMP update, the coastal storm hazard profile will include the following: hurricanes and tropical storms, Nor'Easters, and storm surge. Detailed information regarding these hazards in Hudson County are discussed further in this section.

HURRICANES AND TROPICAL STORM

A tropical cyclone is characterized by a low-pressure center and numerous thunderstorms that produce strong winds and heavy rain. Tropical depressions, tropical storms, and hurricanes are all considered tropical cyclones. Tropical cyclones strengthen when water evaporated from the ocean is released as the saturated air rises, resulting in condensation of water vapor contained in the moist air. These storms rotate counterclockwise in the northern hemisphere around the center and are accompanied by heavy rain and strong winds (NWS 2013). Almost all tropical storms and hurricanes in the Atlantic basin, which includes the Gulf of Mexico and Caribbean Sea, form between June 1 and November 30 (hurricane season). August and September are peak months for hurricane development (NOAA 2013a).

Tropical cyclones are fueled by a different heat mechanism than other cyclonic windstorms such as Nor'Easters and polar lows. The characteristic that separates tropical cyclones from other cyclonic systems is that at any height in the atmosphere, the center of a tropical cyclone will be warmer than its surroundings; a phenomenon called "warm core" storm systems (NOAA 1999).

The National Weather Service (NWS) issues hurricane and tropical storm watches and warnings. These watches and warnings are issued or will remain in effect after a tropical cyclone becomes post-tropical, when such a storm poses a significant threat to life and property. The NWS allows the National Hurricane Center (NHC) to issue advisories during the post-tropical stage. The following are the definitions of the watches and warnings:

- *Hurricane/Typhoon Warning* is issued when sustained winds of 74 mph or higher are expected somewhere within the specified area in association with a tropical, subtropical, or post-tropical cyclone. Because hurricane preparedness activities become difficult once winds reach tropical storm force, the warning is issued 36 hours in advance of the anticipated onset of tropical storm force winds. The warning can remain in effect when dangerously high water or combination of dangerously high water and waves continue, even though winds may be less than hurricane force.

- *Hurricane Watch* is issued when sustained winds of 74 mph or higher are possible within the specified area in association with a tropical, subtropical, or post-tropical cyclone. Because hurricane preparedness activities become difficult once winds reach tropical storm force, the hurricane watch is issued 48 hours prior to the anticipated onset of tropical storm force winds.
- *Tropical Storm Warning* is issued when sustained winds of 39 to 73 mph are expected somewhere within the specified area within 36 hours in association with a tropical, subtropical, or post-tropical storm.
- *Tropical Storm Watch* is issued when sustained winds of 39 to 73 mph are possible within the specified area within 48 hours in association with a tropical, sub-tropical, or post-tropical storm (NWS 2013a).

NOR'EASTER

A Nor'Easter is a cyclonic storm that moves along the East Coast of North America. It is called a Nor'Easter because the damaging winds over coastal areas blow from a northeasterly direction. Nor'Easters can occur any time of the year but are most frequent and strongest between September and April. These storms usually develop between Georgia and New Jersey within 100 miles of the coastline and typically move from southwest to northeast along the Atlantic Coast of the United States (NOAA 2013b). A Nor'Easter event can cause storm surges, waves, heavy rain, heavy snow, wind, and coastal flooding. Nor'Easters have diameters that can span 1,200 miles, impacting large areas of coastline. The forward speed of a Nor'Easter is usually much slower than a hurricane, so with the slower speed, a Nor'Easter can linger for days and cause tremendous damage to those areas impacted. In order to be called a Nor'Easter, a storm must have the following conditions, as per the Northeast Regional Climate Center (NRCC):

- Must persist for at least a 12-hour period.
- Have a closed circulation.
- Be located within the quadrilateral bounded at 45°N by 65° and 70°W and at 30°N by 85°W and 75°W.
- Show general movement from the south-southwest to the north-northeast.
- Contain wind speeds greater than 23 miles per hour (mph).

New Jersey can be impacted by 10 to 20 Nor'Easters each year, with approximately 5 to 10 of those having significant impact on the state (Storm Solutions 2013). The intensity of a Nor'Easter can rival that of a tropical cyclone in that, on occasion, it may flow or stall off the mid-Atlantic coast resulting in prolonged episodes of precipitation, coastal flooding, and high winds.

STORM SURGE

Storm surges inundate coastal floodplains through dune overwash, tidal elevation rise in inland bays and harbors, and backwater flooding through coastal river mouths. Strong winds can increase tide levels and water-surface elevations. Storm systems generate large waves that run up and flood coastal beaches. The combined effects create storm surges that affect the beach, dunes, and adjacent low-lying floodplains. Shallow, offshore depths can cause storm-driven waves and tides to pile up against the shoreline and inside bays.

Based on an area's topography, a storm surge can inundate only a small area (along sections of the northeast or southeast coasts) or coastal lands for a mile or more inland from the shoreline.

EXTENT

HURRICANE AND TROPICAL STORM

The extent of a hurricane is commonly categorized in accordance with the Saffir-Simpson Hurricane Scale. The Saffir-Simpson Hurricane Wind Scale is a 1-to-5 rating based on a hurricane's sustained wind speed. This scale estimates potential property damage. Hurricanes reaching Category 3 and higher are considered major hurricanes because of their potential for significant loss of life and damage. Category 1 and 2 storms are still dangerous and require preventative measures (NOAA 2013b). Table 4.3.2-1 presents this scale, which is used to estimate the potential property damage and flooding expected when a hurricane makes landfall.

Table 4.3.2-1. The Saffir-Simpson Scale

Category	Wind Speed (mph)	Expected Damage
1	74-95 mph	Very dangerous winds will produce some damage: Homes with well-constructed frames could have damage to roof, shingles, vinyl siding, and gutters. Large branches of trees will snap, and shallowly rooted trees may be toppled. Extensive damage to power lines and poles likely will result in power outages that could last a few to several days.
2	96-110 mph	Extremely dangerous winds will cause extensive damage: Homes with well-constructed frames could sustain major roof and siding damage. Many shallowly rooted trees will be snapped or uprooted and block numerous roads. Near-total power loss is expected with outages that could last from several days to weeks.
3 (major)	111-129 mph	Devastating damage will occur: Homes with well-built frames could incur major damage or removal of roof decking and gable ends. Many trees will be snapped or uprooted, blocking numerous roads. Electricity and water will be unavailable for several days to weeks after the storm passes.
4 (major)	130-156 mph	Catastrophic damage will occur: Homes with well-built frames can sustain severe damage with loss of most of the roof structure and/or some exterior walls. Most trees will be snapped or uprooted, and power poles downed. Fallen trees and power poles will isolate residential areas. Power outages will last weeks to possibly months. Most of the area will be uninhabitable for weeks or months.
5 (major)	>157 mph	Catastrophic damage will occur: A high percentage of framed homes will be destroyed, with total roof failure and wall collapse. Fallen trees and power poles will isolate residential areas. Power outages will last for weeks to possibly months. Most of the area will be uninhabitable for weeks or months.

Source: NOAA 2013b
Notes: mph = Miles per hour
> = Greater than

MEAN RETURN PERIOD

In evaluating the potential for hazard events of a given magnitude, a mean return period (MRP) is often used. The MRP provides an estimate of the magnitude of an event that may occur within any given year based on past recorded events. MRP is the average period, in years, between occurrences of a particular hazard event, equal to the inverse of the annual frequency of exceedance (Dinicola 2009).

Figure 4.3.2-1 and Figure 4.3.2-2 show the estimated maximum 3-second gust wind speeds that can be anticipated in the study area associated with the 100- and 500-year MRP events. These peak wind speed projections were generated using Hazards U.S. Multi-Hazard (HAZUS-MH) model runs. The maximum 3-second gust wind speeds for Hudson County range from 72 mph to 82 mph hurricane speeds for the 100-year MRP event and from 92 mph to 101 mph hurricane speeds for the 500-year MRP event. The associated impacts and losses from these 100-year and 500-year MRP hurricane event model runs are reported in the Vulnerability Assessment later in this section.

Figure 4.3.2-1. Wind Speeds for the 100-Year Mean Return Period Event Represented by the Saffir Simpson Scale

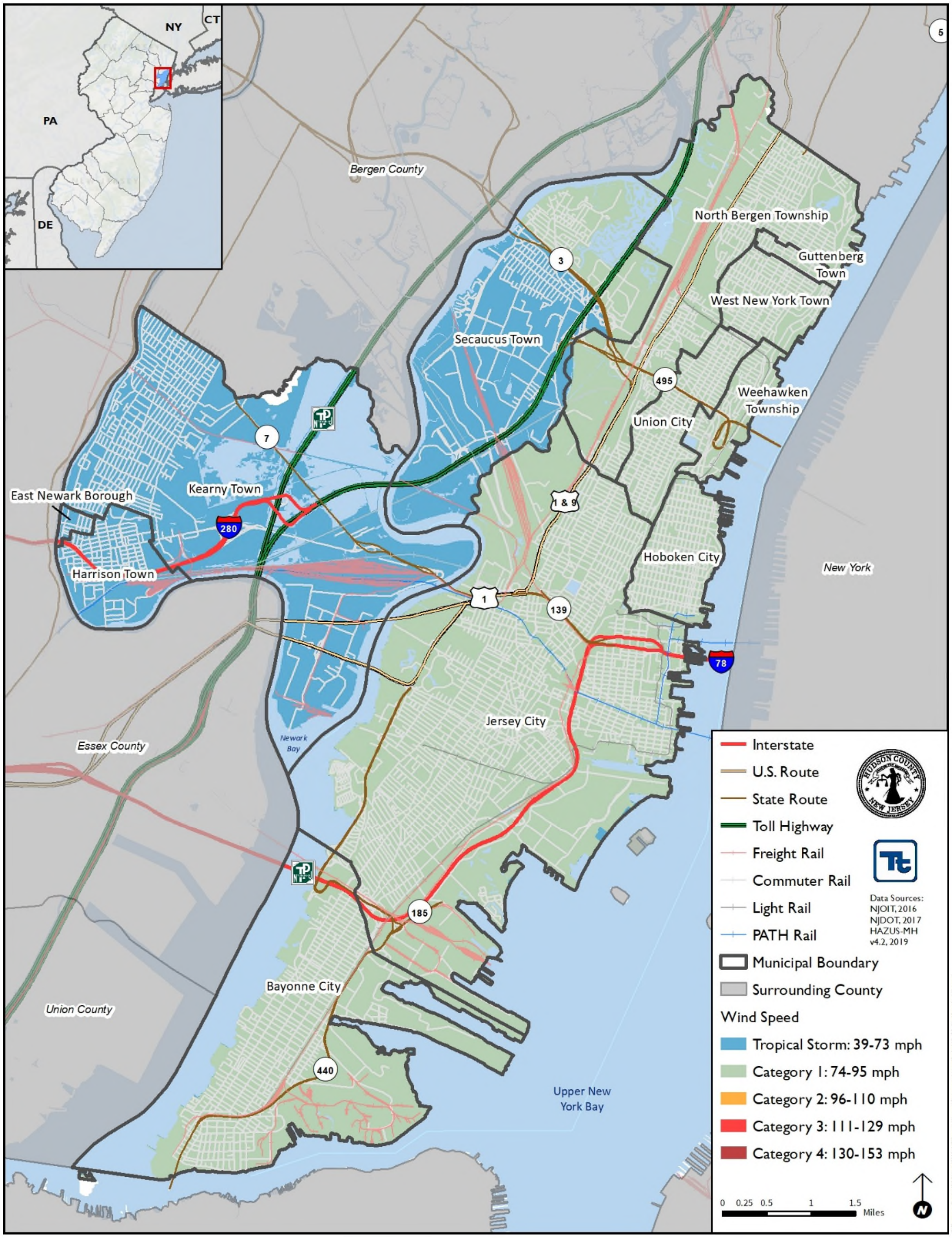
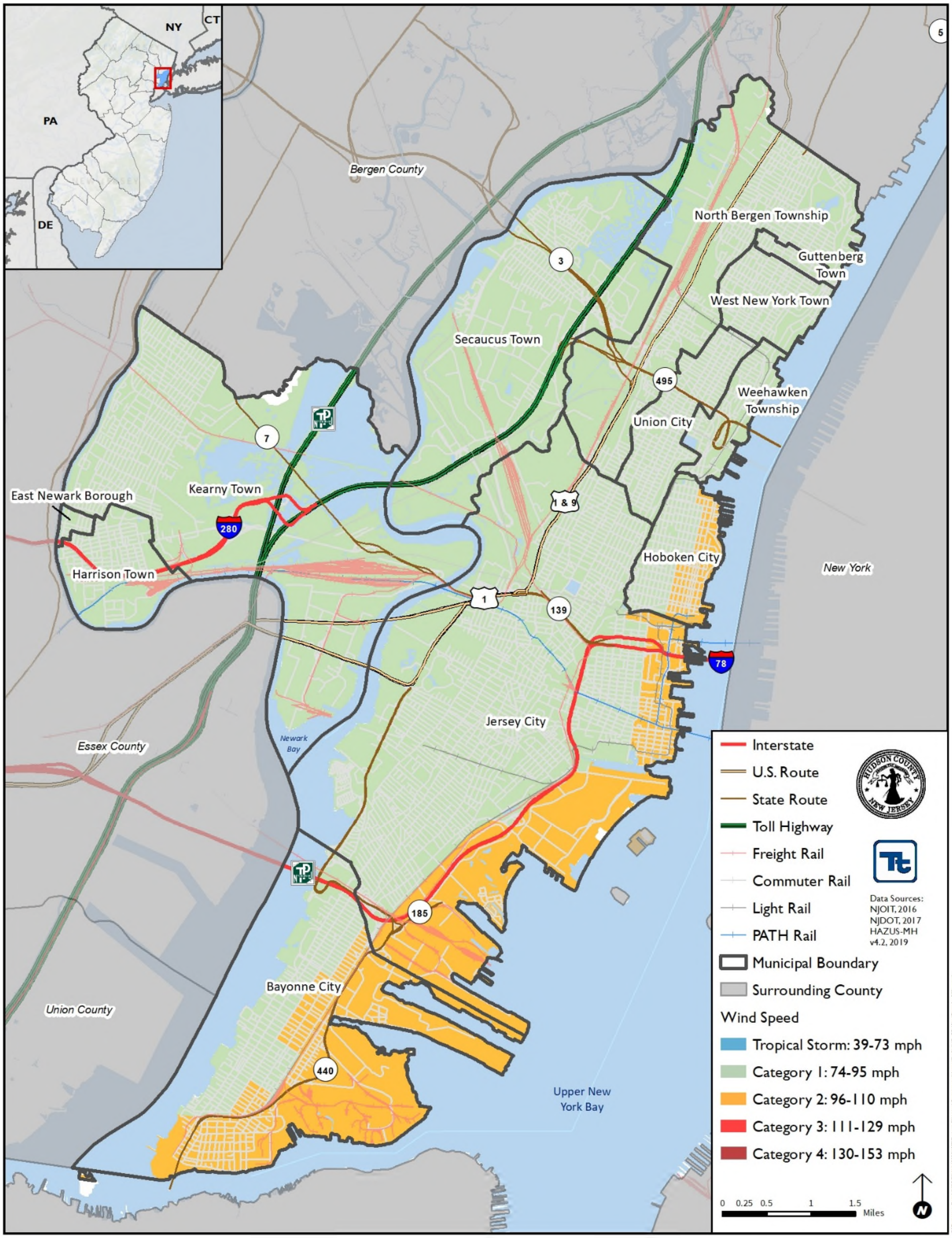


Figure 4.3.2-2. Wind Speeds for the 500-Year Mean Return Period Event by the Saffir Simpson Scale



NOR'EASTER

The severity of a Nor'Easter depends on many factors, including a region's climatological susceptibility to snowstorms, snowfall amounts, snowfall rates, wind speeds, temperatures, visibility, storm duration, topography, time of occurrence during the day (e.g., weekday versus weekend), and time of season. NOAA's National Climatic Data Center (NCDC) produces the Regional Snowfall Index (RSI) for significant snowstorms that impact the eastern two-thirds of the United States. The RSI ranks snowstorm impacts on a scale from 1 to 5 based on the spatial extent of the storm, the amount of snowfall, and the interaction of the extent and snowfall totals with population (based on the 2000 Census). The NCDC has analyzed and assigned RSI values to over 500 storms since 1900 (NOAA-NCDC 2011). Table 4.3.2-2 presents the five categories.

Table 4.3.2-2. RSI Ranking Categories

Category	Description	RSI Value
1	Notable	1-3
2	Significant	3-6
3	Major	6-10
4	Crippling	10-18
5	Extreme	18.0+

Source: NOAA-NCDC 2011
RSI Regional Snowfall Index

Nor'Easters have the potential to impact society to a greater extent than hurricanes and tornadoes. These storms often have a diameter three to four times larger than a hurricane, and therefore impact much larger areas. More homes and properties become susceptible to damage as the size and strength of a Nor'Easter intensifies (Storm Solutions 2013).

STORM SURGE

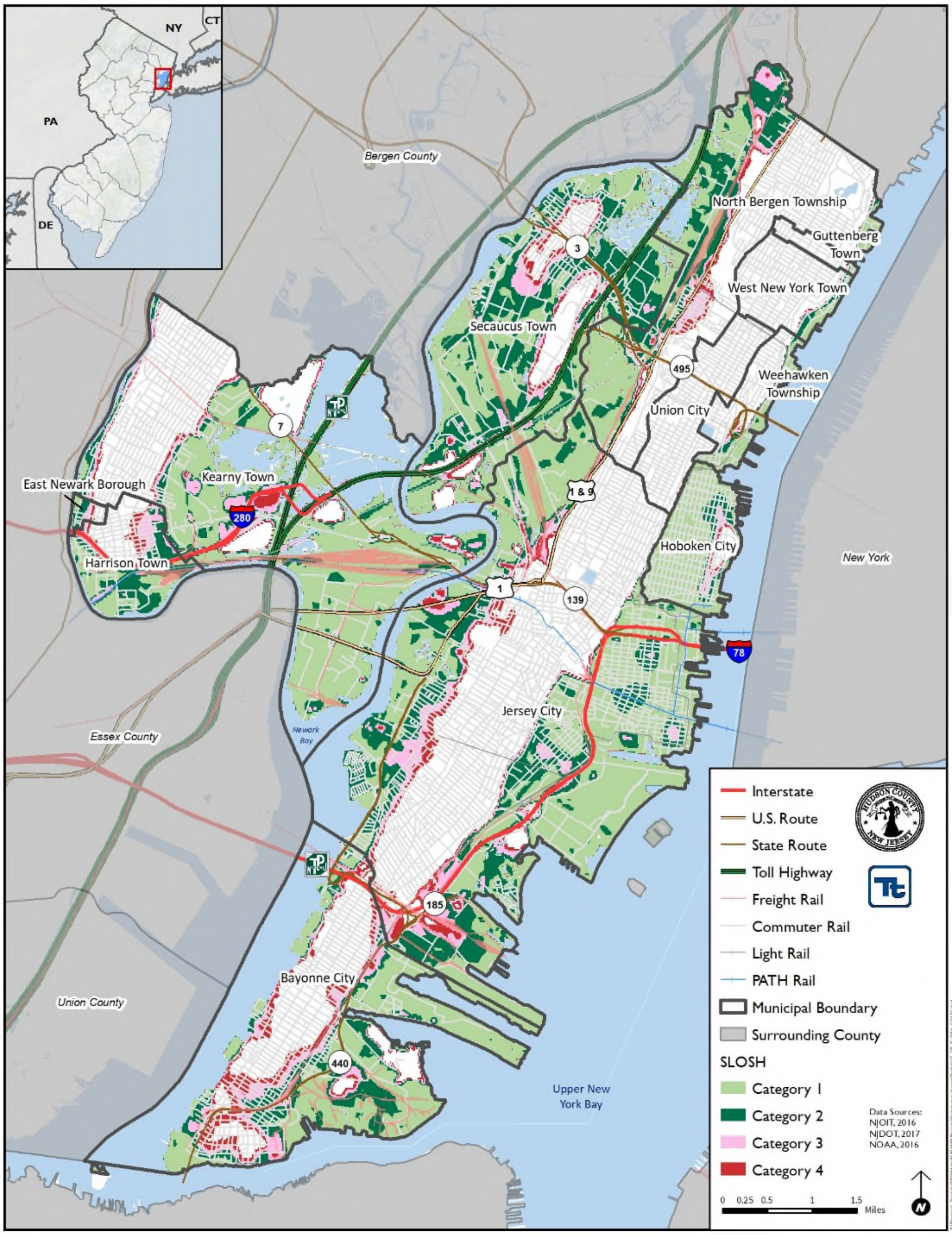
Typically, storm surge is estimated by subtracting the regular/astrological tide level from the observed storm tide. Typical storm surge heights range from several feet to more than 25 feet. The exact height of the storm surge and which coastal areas will be flooded depends on many factors, including strength, intensity, and speed of the hurricane or storm; the direction the storm is moving relative to the shoreline; how rapidly the sea floor is sloping along the shore; the shape of the shoreline; and the astronomical tide. Storm surge is the most damaging when it occurs along a shallow sloped shoreline, during high tide, in a highly populated and developed area with little or no natural buffers (for example, barrier islands, coral reefs, and coastal vegetation).

The most common reference to a return period for storm surges has been the elevation of the coastal flood having a one-percent chance of being equaled or exceeded in any given year, also known as the 100-year flood. Detailed hydraulic analyses include establishing the relationship of tide levels with wave heights and wave run-up. The storm surge inundation limits for the one-percent annual chance coastal flood event are a function of the combined influence of the water surface elevation rise and accompanying wave heights and wave run-up along the coastline.

The U.S. Army Corps of Engineers (USACE), in cooperation with FEMA, initially prepared Sea, Lake and Overland Surge from Hurricanes (SLOSH) inundation maps. SLOSH maps represent potential flooding from worst-case combinations of hurricane direction, forward speed, landfall point, and high astronomical tide. It does not include riverine flooding caused by hurricane surge or inland freshwater flooding. The mapping was developed for the coastal communities in New Jersey using the computer model to forecast surges that occur from wind and pressure forces of hurricanes coastline topography. In New Jersey, hurricane category is the predominant factor in worst-case hurricane surges. The resulting inundation areas are grouped into Category 1 and 2 (dangerous), Category 3 (devastating), and Category 4 (catastrophic) classifications. The hurricane category refers to the Saffir-Simpson Hurricane Intensity Scale.

FEMA Region IV Risk Analysis Team developed storm surge inundation grids for the state in a spatial format from the maximum of maximums outputs from the SLOSH model. These represent the worst-case storm surge scenarios for hurricane categories 1 through 4. The SLOSH boundaries do not account for any inland flash flooding. Figure 4.3.2-3 below illustrates the SLOSH zones in Hudson County.

Figure 4.3.2-3. NOAA National Hurricane Center SLOSH Model (Categories 1 through 4)



LOCATION

All of Hudson County is vulnerable to coastal storms, with the severity of impacts depending on the storm's track, intensity, and the timing of tides. The County is surrounded by coastal waters and susceptible to damage caused by the combination of both high winds and storm surge. Inland areas, especially those in floodplains, are also at risk for flooding because of heavy rain and winds. Section 4.3.1 (Coastal Erosion and Sea Level Rise) and Section 4.3.7 (Flood) discuss Hudson County's coastline and the flood hazard further. The annexes in Section 9 provide detailed maps that display the 1-percent floodplains and SLOSH inundation areas in each municipality.

The State of New Jersey has identified state roads as potential evacuation routes for coastal emergencies, such as approaching tropical storms or hurricanes. When local, county, or state officials order an evacuation, they will provide specific information about the roads that should be used for evacuation routes. Police and first responders' direct traffic and block unsafe roadways. Figure 4.3.2-4 illustrates the state road evacuation routes in Hudson County.

In addition, the County has initiated a study with the State and FEMA to develop risk-based hurricane evacuation zones to communicate when and where evacuation is required. The purpose of the study is to estimate population in the inundation areas, assist in developing a county-wide evacuation plan and update the State Hurricane Evacuation Study. In total, seven hurricane evacuation zones were identified including two evacuation zones located outside of the inundation area; refer to Figure 4.3.2-5.

Figure 4.3.2-4. Coastal Evacuation Routes in Hudson County

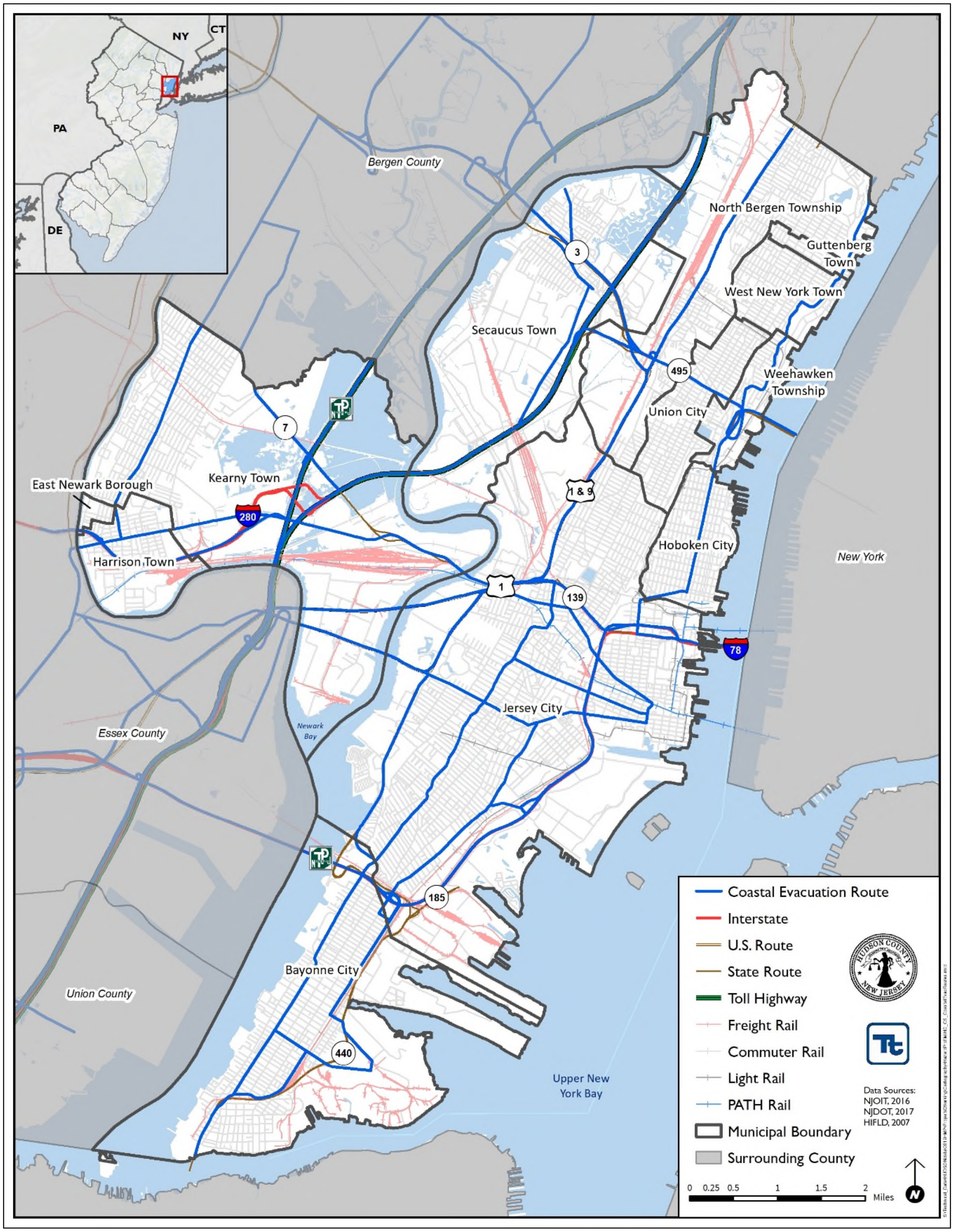
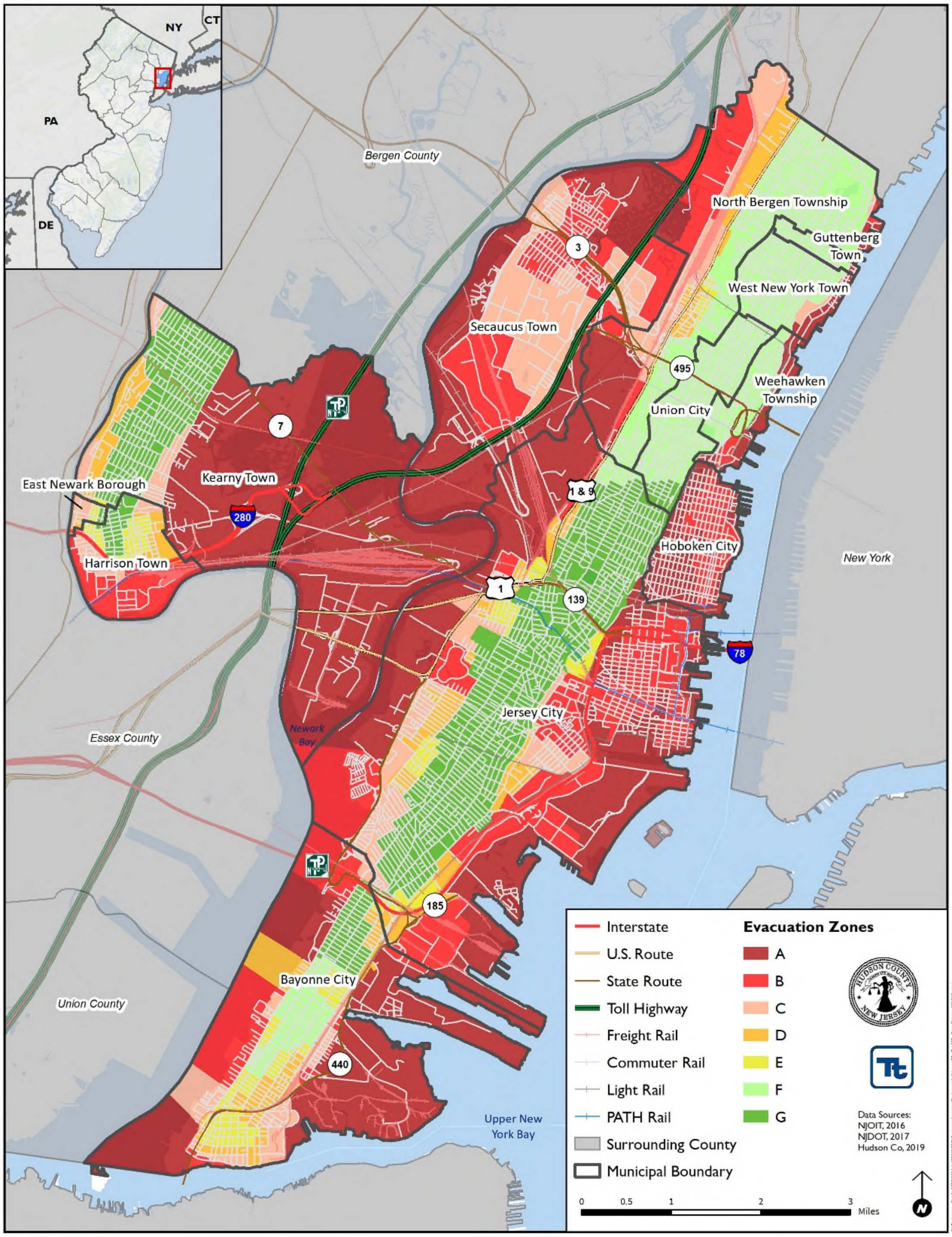


Figure 4.3.2-5. Evacuation Zones Designated in Hudson County



PAST OCCURRENCE

NOAA's Historical Hurricane Tracks tool is a public interactive mapping application that displays Atlantic Basin and East-Central Pacific Basin tropical cyclone data. This interactive tool catalogs tropical cyclones that have occurred from 1842 to 2017 (latest date available from data source). Using the default of 65 nautical miles from the NOAA historical hurricane tracks, between 1842 and 2017, 38 tropical cyclones tracked within 65 nautical miles of Hudson County. However, since 2014, no tropical cyclones have tracked within 65 miles of the County.

Between 1954 and 2019, FEMA issued a disaster (DR) or emergency (EM) declaration for the State of New Jersey for 37 coastal storm-related events that were classified as one or a combination of the following disaster types: hurricane, tropical storm, severe storm, flooding, Nor'Easter, tropical depression, coastal storm, high tides, and heavy rain (refer to Table 4.3.2-3). Of those events, Hudson County has been included in 10 coastal storm-related declarations (EM and DR) (FEMA 2019).

Table 4.3.2-3. Coastal Storm-Related Disaster (DR) and Emergency (EM) Declarations 1954-2019

Declaration	Event Date	Declaration Date	Event Description
DR-310	September 4, 1971	September 4, 1971	Flood: Heavy Rains & Flooding
DR-973	December 10-17, 1992	December 18, 1992	Flood: Coastal Storm, High Tides, Heavy Rain, & Flooding
DR-1145	October 18-23, 1996	November 19, 1996	Severe Storm(s): Severe Storms and Flooding
EM-3148	September 16-18, 1999	September 17, 1999	Hurricane: Hurricane Floyd Emergency Declarations
DR-1694	April 14-20, 2007	April 26, 2007	Severe Storm(s): Severe Storms and Inland and Coastal Flooding
EM-3332	August 26-September 5, 2011	August 27, 2011	Hurricane: Hurricane Irene
DR-4021	August 27-September 5, 2011	August 31, 2011	Hurricane: Hurricane Irene
EM-3354	October 26-November 8, 2012	October 28, 2012	Hurricane: Hurricane Sandy
DR-4086	October 26-November 8, 2012	October 31, 2012	Hurricane: Hurricane Sandy
DR-4264	January 22-24, 2016	March 14, 2016	Severe Storm(s): Severe Winter Storm and Snowstorm

Source: FEMA 2019

Coastal storm events that have impacted Hudson County between 2015 and 2019 are identified in Table 4.3.2-4. For events prior to 2015, refer to Appendix E (Risk Assessment Supplement). The annexes in Section 9 provide detailed information regarding impacts and losses to each plan participant.

Table 4.3.2-4. Coastal Storm Events Impacting Hudson County between 2015 and 2019

Dates of Event	Event Type	FEMA Declaration Number	County Designated?	Losses/Impacts
January 26, 2015	Nor'easter	N/A	N/A	A potent Alberta Clipper low moved from southwestern Canada on January 24 to the Plains states and Ohio Valley on January 25. The low then redeveloped off the Mid Atlantic coast on January 26 and rapidly intensified into a strong nor'easter, bringing heavy snow and strong winds to parts of northeast New Jersey just west of New York City. Trained spotters and the public reported snowfall of 8 to 9 inches. North winds gusted up to 33 mph at nearby Newark Liberty Airport, with blowing and drifting of snow.

Dates of Event	Event Type	FEMA Declaration Number	County Designated?	Losses/Impacts
February 1, 2015	Winter Storm	N/A	N/A	An area of low pressure tracked east from the Ohio Valley the night of February 1 to just south of Long Island the afternoon of February 2. The proximity of the low with arctic air to the north resulted in snow at the onset, which transitioned to a wintry mix during the morning hours before going back to snow by early afternoon. Northeast New Jersey received 5 to 12 inches of snowfall and up to a third of an inch of ice. Snowfall amounts averaged around 5 inches, along with a third of an inch of ice. Harrison reported 4.5 inches with North Bergen reporting 0.32 inches of ice.
January 22-23, 2016	Winter Storm, Blizzard	DR-4264	Yes	Low pressure moving across the deep South on Thursday, January 21 and Friday, January 22 intensified and moved off the Mid-Atlantic coast on Saturday January 23rd, bringing heavy snow and strong winds to northeast New Jersey and blizzard conditions to the urban corridor and some nearby areas. The Governor declared a state of emergency for New Jersey on Friday January 22. New Jersey Transit stopped running trains, buses, and light rail at 2 AM Saturday, January 23. Bridges and tunnels from New York City into New Jersey were shut down by mid-afternoon Saturday. Travel in and out of airports lagged through Monday, January 25as airlines pre-emptively cut hundreds of flights. More than 1,000 flights out of area airports were cancelled, and Teterboro Airport was shuttered due to whiteout conditions. Trained spotters and an NWS cooperative observer in Harrison reported snowfall of 25 to 27 inches. Nearby Central Park and Newark Airport ASOS observations showed blizzard conditions, with visibility less than one quarter mile in heavy snow and frequent wind gusts over 35 mph through the day and into the early evening on Saturday, January 23.
February 9, 2017	Winter Storm	N/A	N/A	Low pressure developed along a cold front over the Mid-Atlantic states early Thursday, February 9. The low rapidly intensified as it moved off the Delmarva coast in the morning and then to the south and east of Long Island late morning into the afternoon. The low brought heavy snow and strong winds to portions of northeast New Jersey. Numerous flights were cancelled or delayed at Newark Airport. A trained spotter reported 6 inches of snow in Harrison. Winds also gusted to 42 mph in Bayonne.
March 7, 2018	Winter Weather	N/A	N/A	A strong low-pressure system developed along the Mid-Atlantic coast during the morning of Wednesday, March 7. The low tracked along the coast through the early morning hours on Thursday, March 8. The storm brought heavy wet snow, strong gusty winds, and even some thundersnow across northeast New Jersey. Snowfall rates ranged from 1 to 3 inches per hour at times in the heaviest snow bands. Trained spotters and the public reported 6 inches of snowfall. Strong winds in combination with heavy, wet snow also brought down tree limbs and a few power lines.
March 21, 2018	Heavy Snow	N/A	N/A	A large and slow-moving low pressure developed along the Mid-Atlantic coast on Wednesday, March 21 and moved slowly north and east along the coast through Thursday, March 22. Moderate to occasionally heavy snow bands moved across portions of northeast New Jersey. A COOP observer reported 9 inches of snow in Harrison. An Emergency Manager in Hoboken reported 8.7 inches of snow.
November 15, 2018	Winter Storm	N/A	N/A	A wave of low pressure developed along the Mid. Atlantic coast during Thursday, November 15. The low was associated with a

Dates of Event	Event Type	FEMA Declaration Number	County Designated?	Losses/Impacts
				closed upper level trough across the Midwest. As the trough translated eastward into Friday, November 16, the low pressure moved up the northeast coast. The antecedent air mass ahead of the low was cold and dry for the middle of November, with temperatures during the morning and afternoon of November in the upper 20s and low 30s. The moisture associated with the trough and low pressure was able to produce moderate to heavy bands of snow as the precipitation began across the entire Tri-State area due to the cold air in place. Once the low drew warmer air from the south, the precipitation gradually changed to a wintry mix and then to rain, especially for the New York City metro and Long Island. The moderate to heavy wet snowfall significantly impacted the evening rush hour with 1-2 inch per hour snowfall rates. Hundreds of trees, tree limbs, and branches were brought down by the weight of the snow, which caused many power outages. Numerous accidents were reported, and many motorists were stranded on roads until the early morning hours the next day. There were over 1,000 flights cancelled at the New York City metro airports (Kennedy, La Guardia, and Newark). A COOP observer reported 5.8 inches of snow. The public reported 6 inches of snow in Kearny. Impacts were widely felt across Hudson county with major disruption to the evening commute. Trees branches and limbs were downed due to the weight of the heavy wet snow. One tree brought down power lines on 7th Street and Willow Avenue in Hoboken. Nearby Newark airport reported 1-2 inch per hour snowfall rates at times during the evening commute.

Source: FEMA 2019; NOAA NCEI 2019

Note: Not all events that have occurred in Hudson County are included in the table due to the extent of documentation and not all sources have been identified or researched. Loss and impact information for many events can vary depending on the source. Therefore, the accuracy of damages and monetary figures is based only on the available information identified during research for this HMP.

DR Major Disaster Declaration
mph miles per hour
N/A Not Applicable

PROBABILITY OF FUTURE OCCURRENCE

It is estimated that Hudson County will continue to experience direct and indirect impacts of coastal storms annually that may induce secondary hazards such as flooding, extreme wind, coastal erosion, storm surge in coastal areas, infrastructure deterioration or failure, utility failures, power outages, water quality and supply concerns, and transportation delays, accidents and inconveniences.

In Section 4.4, the identified hazards of concern for Hudson County are ranked. The probability of occurrence, or likelihood of the event, is one parameter used for hazard rankings. Based on historical records and input from the Planning Committee, the probability of occurrence for coastal storms in the County is considered 'frequent', as presented in Table 4.4-3).

HURRICANE AND TROPICAL STORM

As discussed earlier in this section, the MRP provides an estimate of the magnitude of an event that may occur within any given year based on past. FEMA's HAZUS-MH wind model estimates a 100-year MRP event for Hudson County is a Category 1 hurricane on the Saffir-Simpson Scale and 500-year MRP event is a Category 2 event.

Hurricane return periods are the frequency at which a certain intensity of hurricane can be expected within a given distance of a given location. According to the NHC, the return period of hurricanes for Hudson County is 18 to 19 years for a hurricane (greater than 64 mph winds) and 74 to 76 years for a major hurricane (greater than 110 mph winds) (NHC 2014).

NOR'EASTER

As with any weather phenomenon, it is nearly impossible to assign probabilities to Nor'Easters, except over the long-term. High activity seasons are when storm activity exceeds the historical 75th percentile, meaning that seasons with this number of storms are expected to occur during one out of four years. Lower activity seasons are defined as when storm activity falls below the historical 75th percentile, meaning this number of storms are expected to occur during three out of four years (East Coast Winter Storms, 2013). Based on the historic record, Hudson County has experienced one to two storm events causing impacts per year.

CLIMATE CHANGE

Providing projections of future climate change for a specific region is challenging. Shorter term projections are more closely tied to existing trends, making longer term projections even more challenging. The further out a prediction reaches the more subject to changing dynamics it becomes. Coastal areas can be impacted by climate change in different ways. Coastal areas are sensitive to sea-level rise, changes in the frequency and intensity of storms, increases in precipitation, and warmer ocean temperatures. According to NASA, warmer temperatures can lead to an increase in frequency of storms, thus leading to more weather events that cause coastal erosion.

Average annual temperatures have increased by 3°F in New Jersey over the past century (NOAA NCEI 2019). Most of this warming has occurred since 1970. The State of New Jersey has observed an increase in average annual temperatures of 1.2°F between the period of 1971-2000 and the most recent decade of 2001-2010 (ONJSC 2011). Winter temperatures across the Northeast have seen an increase in average temperature of 4 °F since 1970 (Northeast Climate Impacts Assessment [NECIA 2007). By the 2020s, the average annual temperature in New Jersey is projected to increase by 1.5°F to 3°F above the statewide baseline (1971 to 2000), which was 52.7°F. By 2050, the temperature is projected to increase 3°F to 5°F (Sustainable Jersey Climate Change Adaptation Task Force 2013).

Precipitation measurements indicate both northern and southern New Jersey have become wetter over the past century. Northern New Jersey's 1971-2000 precipitation average was over 5 inches (12%) greater than the average from 1895-1970. Southern New Jersey became 2 inches (5%) wetter late in the 20th century (Office of New Jersey State Climatologist). Average annual precipitation is projected to increase in the region by 5% by the 2020s and up to 10% by the 2050s. Most of the additional precipitation is expected to come during the winter months (NPCC2 2009).

Some climatologists predict that climate change might play a role in the frequency and intensity of Nor'Easters. Two ingredients are needed to produce strong Nor'Easters and intense snowfall: (1) temperatures which are just below freezing and (2) massive moisture coming from the Gulf of Mexico. When temperatures are far below freezing, snow is less likely. As temperatures increase in the winter months, they will be closer to freezing rather than frigidly cold. Future climate change has been predicted to produce more moisture, thus increasing the likelihood that these two ingredients (temperatures just below freezing and intense moisture) will cause more intense snow events.

Higher sea levels will increase the starting level for flooding from coastal storms and, therefore, smaller flooding events in the future will be able to reach the same flooding heights as present-day storms. Sea-level rise in New Jersey has resulted in an increase in sea level of roughly 16 inches in the past century. The rate of sea-level rise is anticipated to increase as time goes on, with the rate of increase being tied to the rate of greenhouse gas emissions and the corresponding increase in global temperatures (Rutgers 2016). As sea levels continue to rise, an increase in the frequency and severity of coastal flooding events from coastal storms is expected. Section 4.3.1 (Coastal Erosion) contains a discussion of the state's efforts to address sea level rise.

4.3.2.2 Vulnerability Assessment

A probabilistic assessment was conducted for the 100- and 500-year MRPs through a Level 2 analysis in HAZUSMH v4.2 to analyze the hazard and provide a range of loss estimates due to wind impacts. Storm surge impacts were assessed using SLOSH data from NOAA's National Hurricane Center. Refer to Section 4.2 (Methodology and Tools) for additional details on the methodology used to assess coastal storm risk.

Impact on Life, Health, and Safety

The impact of a coastal storm on life, health and safety is dependent upon several factors including the severity of the event and whether adequate warning time was provided to residents. For the purposes of this HMP, about one-third of the entire population of Hudson County (211,524 people) is exposed to a Category 4 coastal storm event (2013-2017 American Community Survey 5-year Estimate, refer to Figure 4.3.2-). Further, at least 10-percent of the population is exposed to impacts from a coastal storm event of the lowest category (Category 1). The impact of exposure to coastal storm events can cause residential displacement or require temporary to long-term sheltering. In addition, downed trees, damaged buildings, and debris carried by high winds can lead to injury or loss of life. Please refer to Section 3 (County Profile) for more information about Hudson County's demographics to gain more insight about persons vulnerable to this hazard.

The loss associated with coastal storms can vary across the County. Subsequent events such as secondary flooding associated with the torrential downpours during hurricanes/tropical storms are also a primary concern in the County (see flooding discussion in Section 4.3.6 - Flood). The estimated population living in the Category 1 through 4 SLOSH inundation zones is summarized in Table 4.3.2-5 by municipality. For the Category 1 through Category 4 inundation areas, the City of Jersey City has the greatest total exposure with 35,153 people, 47,796 people, 82,382 people, and 91,842 people, respectively.

Figure 4.3.2-5. Number of Residents Exposed to SOSH Categories 1-4

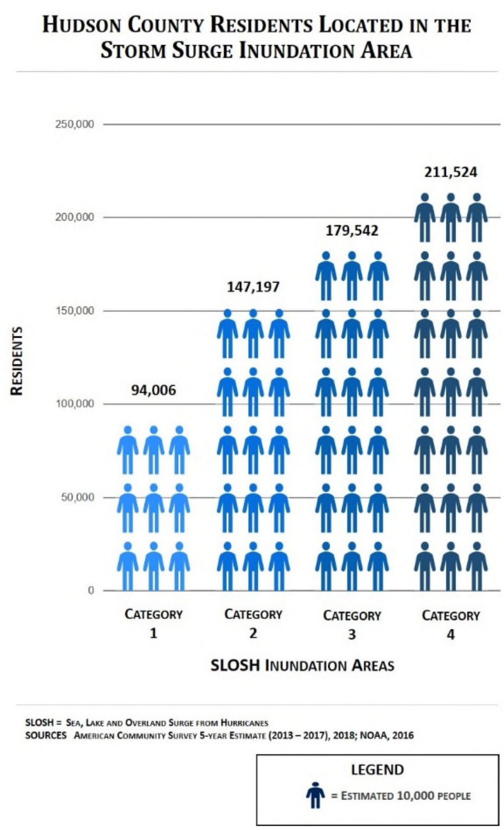


Table 4.3.2-5. Estimated Population in the Hurricane SLOSH Inundation Zones

Municipality	American Community Survey (2013-2017) Population	Estimated Population in SLOSH Inundation Zones							
		% Pop in Cat 1	Cat 1	% Pop in Cat 2	Cat 2	% Pop in Cat 3	Cat 3	% Pop in Cat 4	Cat 4
City of Bayonne	66,719	4.1%	2,735	13.7%	9,125	25.1%	16,772	42.0%	28,019
Borough of East Newark	2,725	0.0%	0	9.3%	252	21.6%	589	44.4%	1,211
Town of Guttenberg	11,733	0.0%	0	0.0%	0	4.7%	553	4.7%	553
Town of Harrison	15,898	4.6%	734	10.5%	1,676	28.1%	4,465	47.2%	7,501
City of Hoboken	54,117	65.0%	35,153	87.8%	47,541	94.3%	51,058	96.5%	52,245
City of Jersey City	265,932	18.0%	47,796	26.9%	71,463	31.0%	82,382	34.5%	91,842
Town of Kearny	42,487	2.6%	1,109	4.7%	1,990	7.2%	3,080	9.7%	4,136
Township of North Bergen	63,438	0.5%	348	1.3%	832	5.6%	3,556	9.5%	6,006
Town of Secaucus	19,279	9.4%	1,813	45.1%	8,700	58.9%	11,356	73.9%	14,244
City of Union City	69,815	0.0%	0	0.0%	0	0.0%	0	0.0%	0
Township of Weehawken	14,268	3.3%	466	3.5%	502	4.3%	616	4.6%	650
Town of West New York	53,345	7.2%	3,852	9.6%	5,116	9.6%	5,116	9.6%	5,116
Hudson County (Total)	**679,756**	**13.8%**	**94,006**	**21.7%**	**147,197**	**26.4%**	**179,542**	**31.1%**	**211,524**

Sources: American Community Survey 5-year Estimate (2013 – 2017), 2018; NOAA, 2016
Cat = Category
Pop = Population
SLOSH = Sea, Lake and Overland Surge from Hurricanes

Research has shown that some populations, while they may not have more hazard exposure, may experience exacerbated impacts and prolonged recovery if/when impacted. This is due to many factors including their physical and financial ability to react or respond during a hazard. The population over the age of 65 is also more vulnerable and, physically, they may have more difficulty evacuating. They may require extra time or outside assistance during evacuations and are more likely to seek or need medical attention which may not be available due to isolation during a storm event. Table 4.3.2-6 summarizes the estimated socially vulnerable population living in each SLOSH zone.

Table 4.3.2-6. Estimated Socially Vulnerable Populations Living in the Hurricane SLOSH Inundation Zones

SLOSH Inundation Area	Population Over 65 Years	Population Below the Poverty Level
Category 1	6,706	9,965
Category 2	12,397	16,130
Category 3	16,331	21,117
Category 4	75,984	116,383

Sources: American Community Survey 5-year Estimate (2013 – 2017), 2018; NOAA, 2016
SLOSH = Sea, Lake and Overland Surge from Hurricanes

Furthermore, the Center for Disease Control and Prevention's (CDC) 2016 Social Vulnerability Index (SVI) ranks U.S. Census tracts on socioeconomic status, household composition and disability, minority status and language, and housing and transportation. Hudson County's overall score is 0.6425, indicating that its communities have moderate to high vulnerability (CDC 2016, refer to Figure 4.3.2-6). The SVI map shows the boundary of the SLOSH categories compared to the vulnerability ranking of each municipality within the County. According to the maps, portions of the most vulnerable municipalities will be exposed to the Category 4 hazard area. Jurisdictions with vulnerability rankings of 0.5 – 0.75, such as Secaucus and Kearny, are almost completely exposed to all four SLOSH categories.

Figure 4.3.2-6. CDC Social Vulnerability Index and SLOSH Categories 1 – 4 in Hudson County

Residents may be displaced or require temporary to long-term sheltering. HAZUS-MH v4.2 estimates that the City of Jersey City, the City of Hoboken, and the Town of West New York will have less than 10 households each displaced during a 100-year MRP wind event (Tropical Storm – Category 1 wind speeds). For a 500-year MRP event (up to Category 2 wind speeds), Table 4.3.2-7 highlights the number of households that will be displaced and number of residents that will require short-term sheltering. There are less people estimated to require short-term sheltering because a portion will temporarily stay with local friends or family instead of relying on public resources. Of the municipalities impacted by the 500-year MRP event, the City of Jersey City has the greatest number of households impacted. Please note these estimates are based on wind speed only and do not account for sheltering needs associated with flooding and storm surge that may accompany coastal storm events.

Table 4.3.2-7. Number of households and persons impacted by 500-Year MRP

Municipality	500-Year MRP	
	Displaced Households	People Requiring Short-Term Shelter
Bayonne, City of	43	7
East Newark, Borough of	0	0
Guttenberg, Town of	20	4
Harrison, Town of	1	0
Hoboken, City of	194	28
Jersey City, City of	303	54
Kearny, Town of	2	0
North Bergen, Township of	44	11
Secaucus, Town of	13	2
Union City, City of	34	8
Weehawken, Township of	18	1
West New York, Town of	75	17
Hudson County (Total)	**747**	**132**

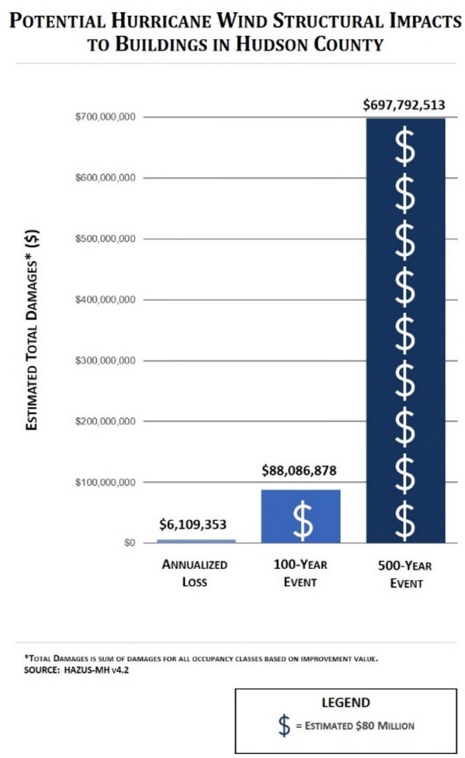
Source: HAZUS-MH v4.2

Impact on General Building Stock

Wind-Only Impacts

Damage to buildings is dependent upon several factors, including wind speed, storm duration, and path of the storm track. Building construction also plays a major role in the extent of damage resulting from a coastal storm. Due to differences in construction, residential structures are generally more susceptible to wind damage than commercial and industrial structures. Wood and masonry buildings, in general, regardless of their occupancy class, tend to experience more damage than concrete or steel buildings. Furthermore, high-rise buildings, like those being developed in Hudson County, are also very vulnerable structures. The expansion of high-rise buildings and urbanization of Hudson County makes this area more vulnerable to wind impacts compared to other, less urban parts of the State.

Figure 4.3.2-7. Hurricane Wind Impacts on Buildings



To better understand these risks, HAZUS-MH v4.2 was used to estimate the expected wind-related building damages. Figure 4.3.2- shows that a calculated annualized loss for Hudson County is $6.1 million for hurricane wind damages. However, it should be noted that less than 1% of the entire building stock may anticipate structural damages up to the 500-year hurricane wind event. Specific types of wind damages are also summarized in HAZUS-MH v4.2 at the following wind damage categories: no damage/very minor damage, minor damage, moderate damage, severe damage, and total destruction. Table 4.3.2-8 summarizes the definition of the damage categories.

Table 4.3.2-8. Description of Damage Categories

Qualitative Damage Description	Roof Cover Failure	Window Door Failures	Roof Deck	Missile Impacts on Walls	Roof Structure Failure	Wall Structure Failure
No Damage or Very Minor Damage Little or no visible damage from the outside. No broken windows, or failed roof deck. Minimal loss of roof over, with no or very Limited water penetration.	≤2%	No	No	No	No	No
Minor Damage Maximum of one broken window, door or garage door. Moderate roof cover loss that can be covered to prevent additional water entering the building. Marks or dents on walls requiring painting or patching for repair.	>2% and ≤15%	One window, door, or garage door failure	No	<5 impacts	No	No
Moderate Damage Major roof cover damage, moderate window breakage. Minor roof sheathing failure. Some resulting damage to interior of building from water.	>15% and ≤50%	> one and ≤ the larger of 20% & 3	1 to 3 panels	Typically 5 to 10 impacts	No	No

Qualitative Damage Description	Roof Cover Failure	Window Door Failures	Roof Deck	Missile Impacts on Walls	Roof Structure Failure	Wall Structure Failure
Severe Damage Major window damage or roof sheathing loss. Major roof cover loss. Extensive damage to interior from water.	>50%	> the larger of 20% & 3 and ≤50%	>3 and ≤25%	Typically 10 to 20 impacts	No	No
Destruction Complete roof failure and/or, failure of wall frame. Loss of more than 50% of roof sheathing.	Typically >50%	>50%	>25%	Typically >20 impacts	Yes	Yes

Source: HAZUS-MH Hurricane Technical Manual

Table 4.3.2-9 summarizes the building value (structure only) damage estimated for the 100- and 500-year MRP hurricane wind-only events. Damage estimates are reported for the County's probabilistic HAZUS-MH model scenarios. The data shown indicates total losses associated with wind damage to building structure.

Table 4.3.2-9. Estimated Building Value (Structure Only) Damaged by the 100-Year and 500-Year MRP Hurricane-Related Winds

Municipality	Total Replacement Cost Value (Structure Only)	Estimated Total Damages*		
		Annualized Loss	100-Year Event	500-Year Event
Bayonne, City of	$8,856,079,105	$653,257	$8,644,814	$71,179,206
East Newark, Borough of	$240,888,451	$14,346	$217,923	$1,994,578
Guttenberg, Town of	$651,507,569	$120,865	$1,835,342	$14,119,218
Harrison, Town of	$2,398,975,757	$123,720	$1,787,209	$16,551,300
Hoboken, City of	$3,910,202,233	$807,525	$13,950,554	$90,357,680
Jersey City, City of	$25,693,921,967	$2,087,926	$29,996,248	$236,586,921
Kearny, Town of	$7,874,466,790	$390,980	$4,935,400	$46,204,828
North Bergen, Township of	$8,393,144,641	$585,425	$8,400,955	$64,892,157
Secaucus, Town of	$9,593,262,762	$314,494	$4,072,852	$33,933,347
Union City, City of	$3,742,882,384	$497,375	$6,821,114	$61,891,735
Weehawken, Township of	$1,510,119,929	$170,037	$2,418,047	$19,655,431
West New York, Town of	$2,825,012,673	$343,404	$5,006,421	$40,426,112
Hudson County (Total)	**$75,690,464,261**	**$6,109,353**	**$88,086,878**	**$697,792,513**

*Source: HAZUS-MH v4.2 *Total Damages is sum of damages for all occupancy classes based on improvement value.*

The total estimated damage to buildings (structure only) for all occupancy types across Hudson County is $88 million for the 100-year MRP wind-only event, and $697 million for the 500-year MRP wind-only event. The majority of these losses are to the residential building category. Refer to Figure 4.3.2-9 and Figure 4.3.2-10 which illustrate the density of estimated building loss across Hudson County for these two events.

STORM SURGE HURRICANE IMPACTS

To estimate potential building exposure to storm surge, the SLOSH inundation zones were used. The estimated total number of buildings and replacement cost value are located in Categories 1 through 4 SLOSH inundation zones are summarized in Table 4.3.2-10 and Table 4.3.2-11 by municipality (also refer to Figure 4.3.2-). Overall, the City of Hoboken experiences the greatest amount of exposure (i.e., percent of building stock) in all four coastal storm categories, while the City of Jersey City has the greatest value of building exposure in all four coastal storm categories.

Figure 4.3.2-8. Buildings Exposed to SLOSH Categories 1-4

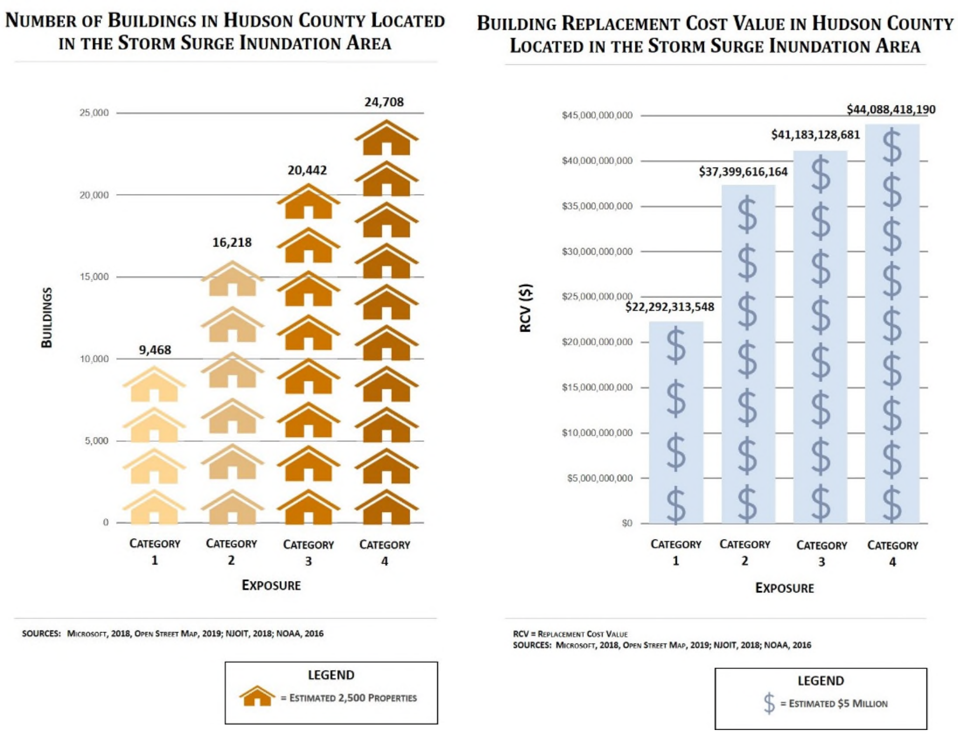


Figure 4.3.2-9. Density of Structural Losses (All Occupancies) as a Result of a 100-Year MRP Hurricane (Wind-Only) Event

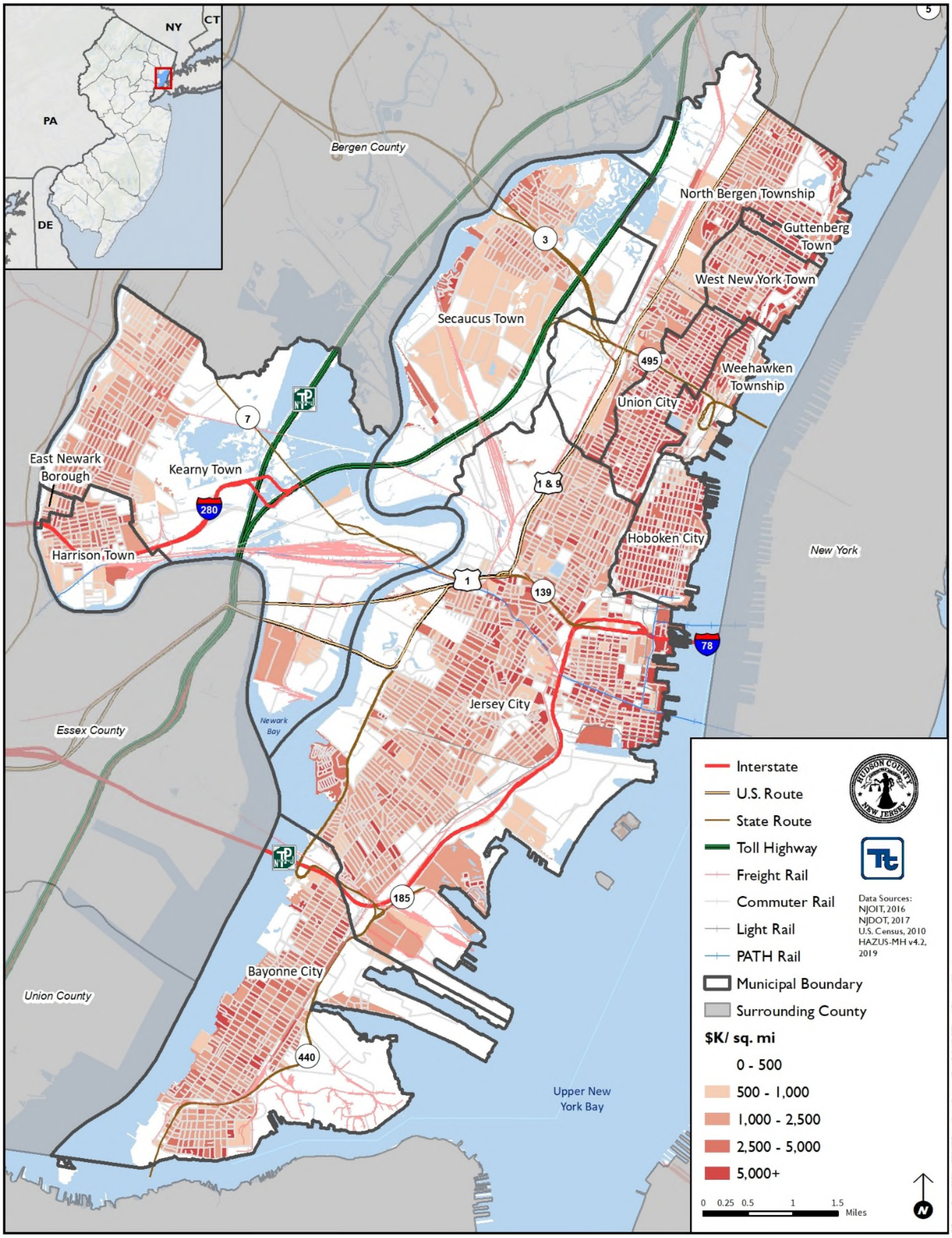


Figure 4.3.2-10. Density of Structural Losses (All Occupancies) as a Result of a 500-Year MRP Hurricane (Wind-Only) Event

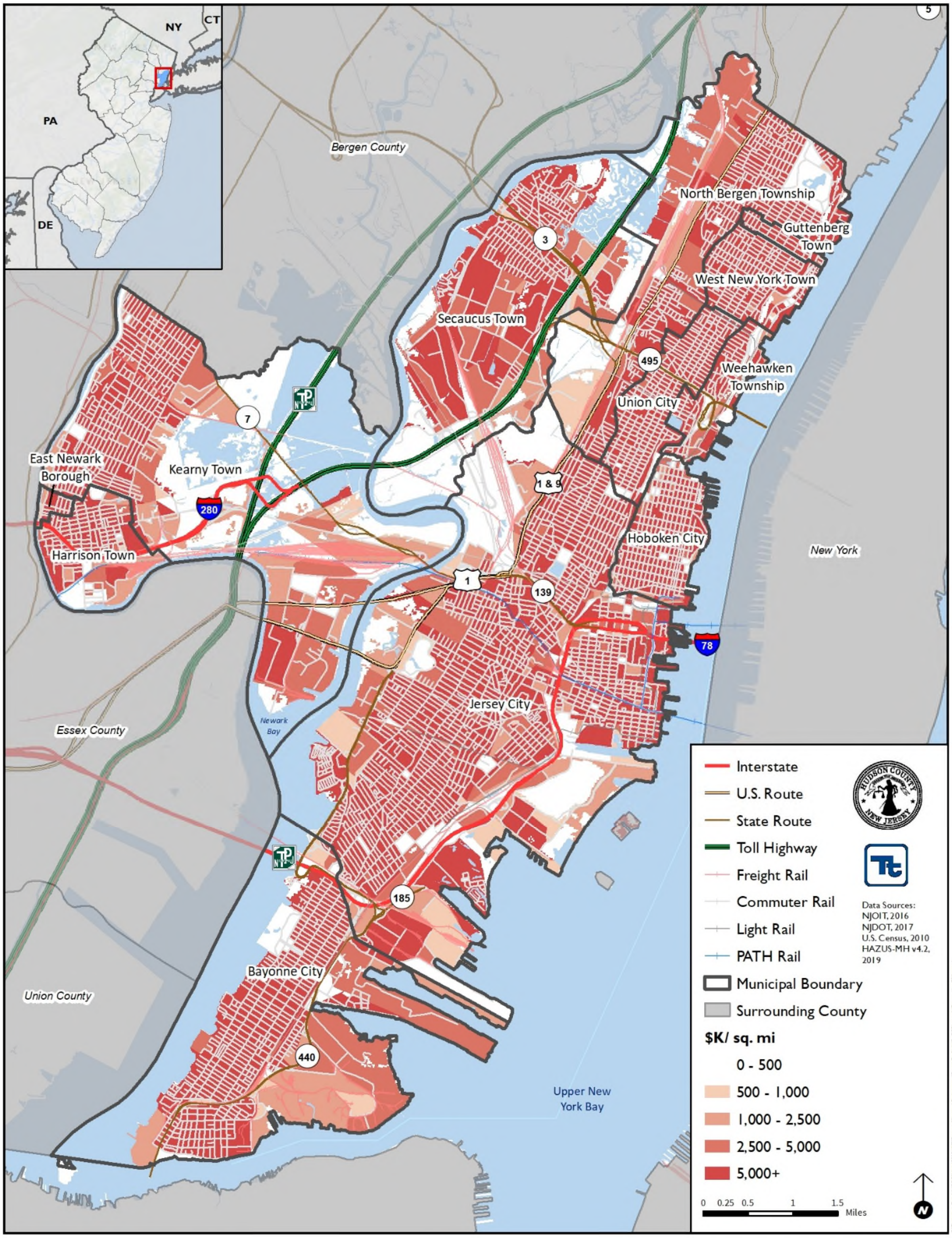


Table 4.3.2-10. Estimated Replacement Cost Value Located in the SLOSH Inundation Zones.

Municipality	Total Replacement Cost Value	Replacement Cost Value in Hazard Area							
		Cat 1 Exposure	% of Total	Cat 2 Exposure	% of Total	Cat 3 Exposure	% of Total	Cat 4 Exposure	% of Total
Bayonne, City of	$8,856,079,105	$2,565,554,311	29.0%	$3,845,976,939	43.4%	$4,839,902,630	54.7%	$5,797,165,489	65.5%
East Newark, Borough of	$240,888,451	$2,245,463	0.9%	$86,925,147	36.1%	$146,999,044	61.0%	$174,832,580	72.6%
Guttenberg, Town of	$651,507,569	$37,354,230	5.7%	$37,354,230	5.7%	$40,636,316	6.2%	$40,636,316	6.2%
Harrison, Town of	$2,398,975,757	$648,531,136	27.0%	$1,381,133,571	57.6%	$1,623,481,990	67.7%	$1,789,137,330	74.6%
Hoboken, City of	$3,910,202,233	$2,977,157,800	76.1%	$3,438,314,006	87.9%	$3,637,895,412	93.0%	$3,719,738,787	95.1%
Jersey City, City of	$25,693,921,967	$7,616,113,075	29.6%	$12,160,962,572	47.3%	$13,274,698,782	51.7%	$14,180,881,124	55.2%
Kearny, Town of	$7,874,466,790	$4,041,664,291	51.3%	$4,661,981,216	59.2%	$4,799,844,100	61.0%	$4,942,623,499	62.8%
North Bergen, Township of	$8,393,144,641	$1,288,473,885	15.4%	$3,427,456,106	40.8%	$3,872,198,633	46.1%	$4,167,432,868	49.7%
Secaucus, Town of	$9,593,262,762	$2,535,188,512	26.4%	$7,577,303,343	79.0%	$8,156,295,992	85.0%	$8,483,912,040	88.4%
Union City, City of	$3,742,882,384	$0	0.0%	$0	0.0%	$0	0.0%	$0	0.0%
Weehawken, Township of	$1,510,119,929	$406,141,018	26.9%	$505,973,121	33.5%	$514,939,869	34.1%	$515,518,819	34.1%
West New York, Town of	$2,825,012,673	$173,889,825	6.2%	$276,235,913	9.8%	$276,235,913	9.8%	$276,539,339	9.8%
Hudson County (Total)	**$75,690,464,261**	**$22,292,313,548**	**29.5%**	**$37,399,616,164**	**49.4%**	**$41,183,128,681**	**54.4%**	**$44,088,418,190**	**58.2%**

Sources: Microsoft, 2018, Open Street Map, 2019; NJOIT, 2018; NOAA, 2016

Table 4.3.2-11. Estimated Number of Buildings Located in the SLOSH Inundation Zones.

Municipality	Total # Buildings	Number of Buildings in Hazard Area							
		Cat 1 Exposure	% of Total	Cat 2 Exposure	% of Total	Cat 3 Exposure	% of Total	Cat 4 Exposure	% of Total
Bayonne, City of	6,802	964	14.2%	1,805	26.5%	2,466	36.3%	3,575	52.6%
East Newark, Borough of	403	2	0.5%	52	12.9%	116	28.8%	199	49.4%
Guttenberg, Town of	1,227	12	1.0%	12	1.0%	13	1.1%	13	1.1%
Harrison, Town of	2,537	137	5.4%	312	12.3%	733	28.9%	1,198	47.2%
Hoboken, City of	4,470	2,872	64.3%	3,735	83.6%	4,116	92.1%	4,269	95.5%
Jersey City, City of	35,894	4,162	11.6%	7,392	20.6%	9,001	25.1%	10,418	29.0%
Kearny, Town of	7,209	654	9.1%	875	12.1%	1,082	15.0%	1,268	17.6%

Municipality	Total # Buildings	Number of Buildings in Hazard Area							
		Cat 1 Exposure	% of Total	Cat 2 Exposure	% of Total	Cat 3 Exposure	% of Total	Cat 4 Exposure	% of Total
North Bergen, Township of	6,005	93	1.5%	245	4.1%	545	9.1%	787	13.1%
Secaucus, Town of	3,845	446	11.6%	1,627	42.3%	2,183	56.8%	2,788	72.5%
Union City, City of	1,729	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Weehawken, Township of	2,113	100	4.7%	116	5.5%	140	6.6%	145	6.9%
West New York, Town of	4,594	26	0.6%	47	1.0%	47	1.0%	48	1.0%
Hudson County (Total)	**76,828**	**9,468**	**12.3%**	**16,218**	**21.1%**	**20,442**	**26.6%**	**24,708**	**32.2%**

Sources: Microsoft, 2018, Open Street Map, 2019; NJOIT, 2018; NOAA, 2016
Cat = Category

Impact on Land Uses

A spatial analysis was completed to assess the exposure of the residential and non-residential land uses within the County to storm surge. To estimate the land use located in the Category 1 through Category 4 storm surge inundation zones, the SLOSH boundaries were overlaid upon the general building stock and 2018 parcel layer in GIS and used to calculate the estimated the number of structures and area of parcels located in each hazard area (refer to Figures 4.3.2-11 through 4.3.2-13).

Approximately 11-percent of the total residential land use acreage and 10-percent of the residential properties are located in the Category 1 storm inundation extent. Furthermore, approximately 33-percent of the total residential land use area and 39-percent of the residential properties are located in the Category 4 storm inundation extent (refer to Table 4.3.2-12). The spatial analysis also shows a substantial number of the non-residential properties are exposed to storm surge as well (refer to Table 4.3.2-13). Approximately 25-percent of the total non-residential land use acreage and 39-percent of the non-residential properties are located in the Category 1 storm inundation extent. Furthermore, approximately 48-percent of the total non-residential land use area and 64-percent of the non-residential properties are located in the Category 4 storm inundation extent. This analysis shows that Hudson County is vulnerable to surge from all coastal storm categories.

Figure 4.3.2-11. Residential Properties and Land Use Type Exposed to SLOSH Categories 1-4

Figure 4.3.2-12. Non-Residential Properties and Land Use Type Exposed to SLOSH Categories 1-4

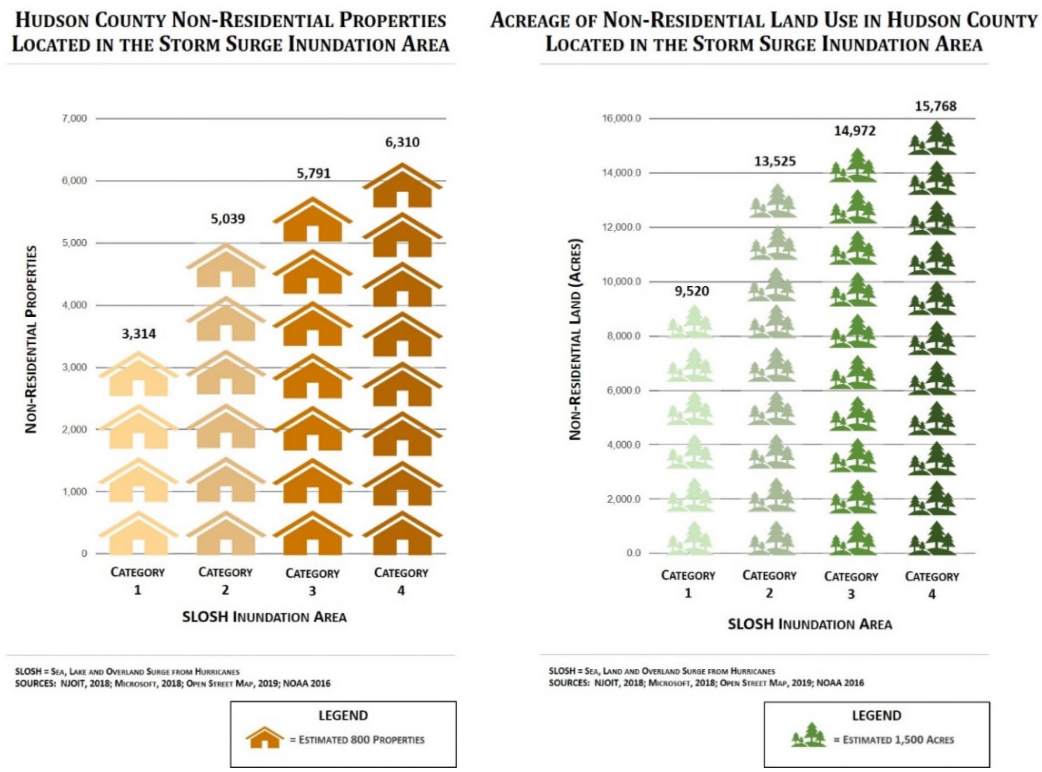


Figure 4.3.2-13. Residential parcels Exposed to Category 1 through 4 SLOSH Areas

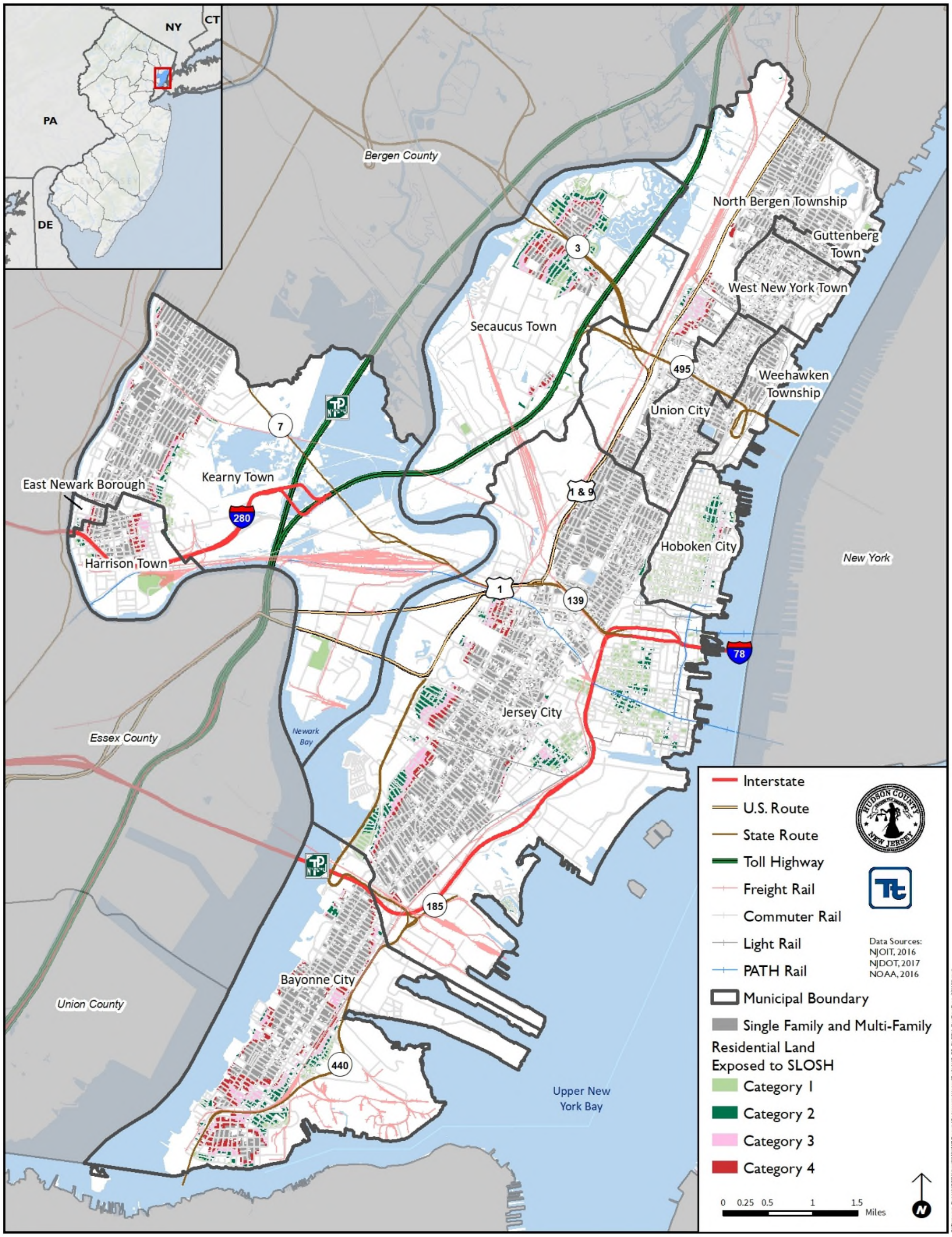


Table 4.3.2-12. Residential Land Use and Structure Exposure to SLOSH

Municipality	Total Residential Land Use Area (acres)	Total Number of Residential Properties	Number of Residential Properties in Category 1	% of Total	Residential Land Use Area Category 1 (acre s)	% of Total	Number of Residential Properties Category 2	% of Total	Residential Land Use Area in Category 2 (acres)	% of Total Residential Land Use Area	Number of Residential Properties Category 3	% of Total	Residential Land Use Area in Category 3 (acres)	% of Total Residential Land Use Area	Number of Residential Properties Category 4	% of Total	Residential Land Use Area in Category 4 (acres)	% of Total Residential Land Use Area
Bayonne, City of	1,194	5,171	211	4.1%	52.6	4.4%	705	13.6%	182.0	15.2%	1,268	24.5%	318.1	26.6%	3,575	69.1%	532	44.6%
East Newark, Borough of	29.45	352	0	0.0%	0.0	0.0%	33	9.4%	2.9	9.9%	88	25.0%	8.5	28.8%	199	56.5%	14.0	47.6%
Guttenberg, Town of	94.18	990	0	0.0%	5.9	6.2%	0	0.0%	7.0	7.5%	1	0.1%	7.7	8.2%	13	1.3%	8.2	8.7%
Harrison, Town of	200.17	2,075	84	4.0%	12.4	6.2%	196	9.4%	29.2	14.6%	552	26.6%	66.8	33.4%	1,198	57.7%	106.2	53.0%
Hoboken, City of	410.63	3,424	2,265	66.2%	305.1	74.3%	2,973	86.8%	365.4	89.0%	3,196	93.3%	387.6	94.4%	4,269	124.7%	394.6	96.1%
Jersey City, City of	3,011.71	30,273	3,002	9.9%	411.3	13.7%	5,601	18.5%	750.6	24.9%	6,984	23.1%	878.5	29.2%	10,418	34.4%	991.9	32.9%
Kearny, Town of	945.14	6,241	182	2.9%	18.2	1.9%	323	5.2%	37.1	3.9%	500	8.0%	65.2	6.9%	1268	20.3%	92.5	9.8%
North Bergen, Township of	862.45	5,126	9	0.2%	19.5	2.3%	42	0.8%	24.1	2.8%	223	4.4%	57.2	6.6%	787	15.4%	88.0	10.2%
Secaucus, Town of	551.15	3,280	319	9.7%	75.8	13.8%	1,207	36.8%	260.5	47.3%	1,720	52.4%	334.4	60.7%	2,788	85.0%	406.6	73.8%
Union City, City of	447.39	1,252	0	0.0%	0.0	0.0%	0	0.0%	0.0	0.0%	0	0.0%	0.0	0.0%	0	0.0%	0.0	0.0%
Weehawken, Township of	216.89	1,926	63	3.3%	16.9	7.8%	68	3.5%	18.6	8.6%	88	4.6%	20.1	9.3%	145	7.5%	20.8	9.6%
West New York, Town of	339.26	3,583	19	0.5%	30.7	9.0%	31	0.9%	51.7	15.2%	31	0.9%	53.9	15.9%	48	1.3%	54.7	16.1%
Hudson County (Total)	**8,302**	**63,693**	**6,154**	**9.7%**	**948**	**11.4%**	**11,179**	**17.6%**	**1,729**	**20.8%**	**14,651**	**23.0%**	**2,198**	**26.5%**	**24,708**	**38.8%**	**2,710**	**32.6%**

Source: NJOIT, 2018; Microsoft, 2018; Open Street Map, 2019; NOAA 2016

Figure 4.3.2-14. Non-Residential Parcels Exposed to Category 1 through 4 SLOSH Areas

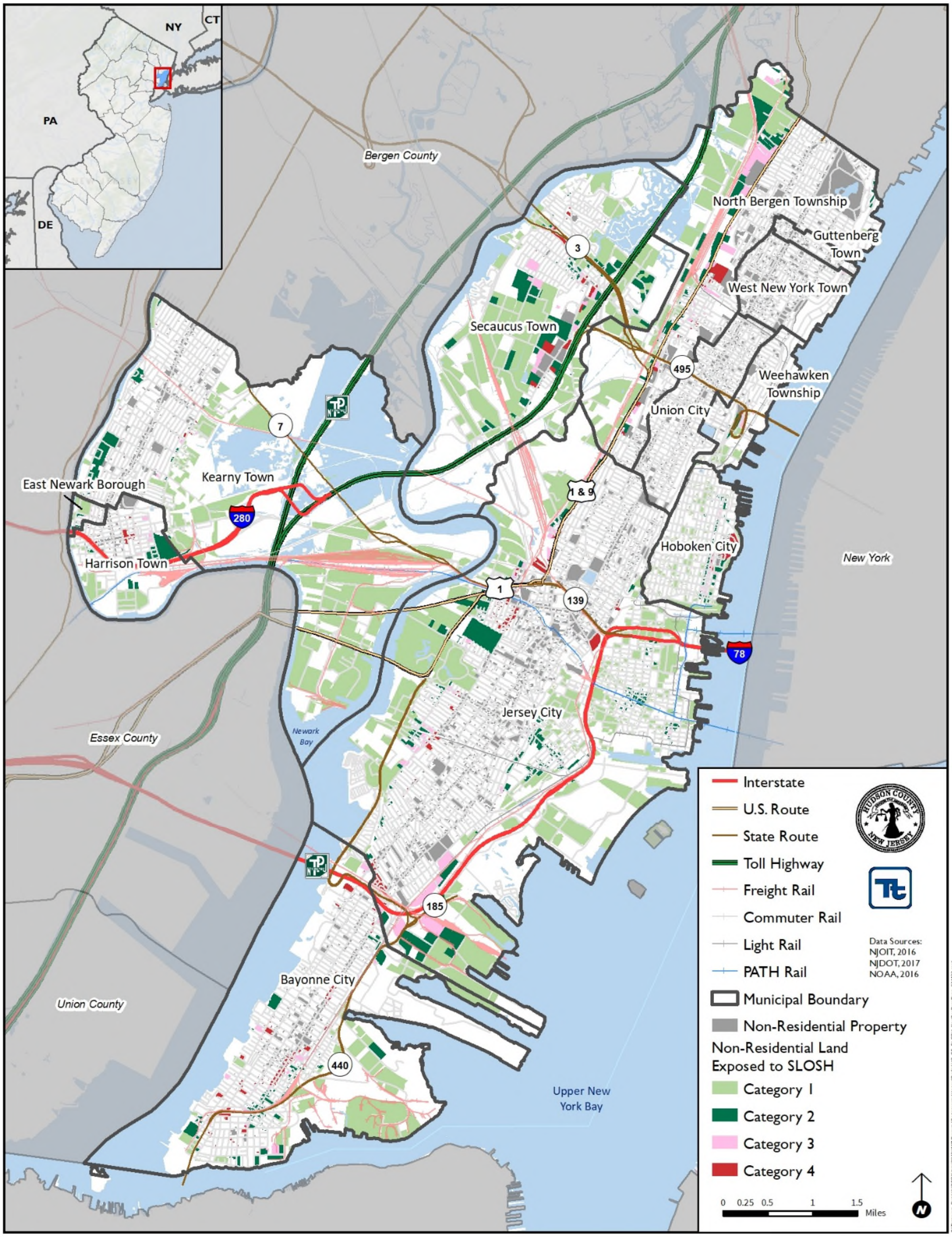


Table 4.3.2-13. Non-Residential Land Use Exposure to SLOSH

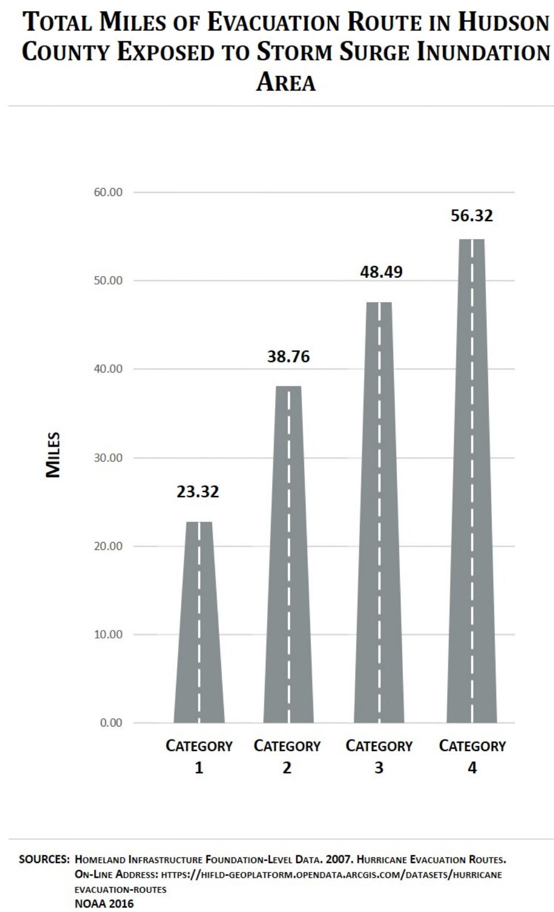
Municipality	Total Non-Residential Land Use Area (acres)	Total Number of Non- Residential Properties	Number of Non-Residential Properties in Category 1	% of Total	Non-Residential Land Use Area Category 1 (acres)	% of Total	Number of Non- Residential Properties Category 2	% of Total	Non-Residential Land Use Area in Category 2 (acres)	% of Total Non-Residential Land Use Area	Number of Non-Residential Properties Category 3	% of Total	Non-Residential Land Use Area in Category 3 (acres)	% of Total Non-Residential Land Use Area	Number of Non-Residential Properties Category 4	% of Total	Non-Residential Land Use Area in Category 4 (acres)	% of Total
Bayonne, City of	3,724.7	1,631	753	46.2%	1,330.8	35.7%	1,100	67.4%	1,773.2	47.6%	1,198	73.5%	1,986	53.3%	1,304	80.0%	2,143.5	57.5%
East Newark, Borough of	43.1	51	2	3.9%	7.1	16.6%	19	37.3%	24.5	56.9%	28	54.9%	29.9	69.4%	37	72.5%	31.0	72.1%
Guttenberg, Town of	29.6	237	12	5.1%	0.7	2.4%	12	5.1%	1.2	4.0%	12	5.1%	1.41	4.8%	12	5.1%	1.5	5.2%
Harrison, Town of	648.2	462	53	11.5%	177.2	27.3%	116	25.1%	402.7	62.1%	181	39.2%	464.48	71.7%	226	48.9%	487.7	75.2%
Hoboken, City of	382.9	1,046	607	58.0%	275.4	71.9%	762	72.8%	301.8	78.8%	920	88.0%	324.88	84.9%	995	95.1%	334.2	87.3%
Jersey City, City of	7,118.4	5,621	1,160	20.6%	3,132.6	44.0%	1,791	31.9%	4,292.3	60.3%	2,017	35.9%	4,748.57	66.7%	2,179	38.8%	5,008.3	70.4%
Kearny, Town of	5,575.0	968	472	48.8%	2,354.8	42.2%	552	57.0%	2,803.3	50.3%	582	60.1%	3,093.51	55.5%	595	61.5%	3,228.9	57.9%
North Bergen, Township of	2,521.2	879	84	9.6%	787.0	31.2%	203	23.1%	1,349.3	53.5%	322	36.6%	1,526.01	60.5%	406	46.2%	1,616.9	64.1%
Secaucus, Town of	3,645.5	565	127	22.5%	1,311.4	36.0%	420	74.3%	2,395.9	65.7%	463	81.9%	2,597.26	71.2%	488	86.4%	2,701.5	74.1%
Union City, City of	377.6	477	0	0.0%	1.3	0.3%	0	0.0%	3.6	1.0%	0	0.0%	5.23	1.4%	0	0.0%	7.0	1.8%
Weehawken, Township of	294.3	187	37	19.8%	128.1	43.5%	48	25.7%	153.7	52.2%	52	27.8%	166.98	56.7%	51	27.3%	176.1	59.8%
West New York, Town of	296.7	1,011	7	0.7%	13.3	4.5%	16	1.6%	23.6	8.0%	16	1.6%	28.2	9.5%	17	1.7%	32.3	10.9%
Hudson County (Total)	**24,657.0**	**13,135**	**3,314**	**25.2%**	**9520.0**	**38.6%**	**5,039**	**38.4%**	**13525.2**	**54.9%**	**5,791**	**44.1%**	**14,972**	**60.7%**	**6,310**	**48.0%**	**15768.9**	**64.0%**

Source: NJOIT, 2018; Microsoft, 2018; Open Street Map, 2019; NOAA 2016

Impact on Critical Facilities

Critical facilities are at risk of being impacted by high winds associated with structural damage, or falling tree limbs/flying debris, which can result in the loss of power. Power loss can greatly impact households, business operations, public utilities, and emergency personnel. For example, vulnerable populations in Hudson County are at risk if power loss results in interruption of heating and cooling services, stagnated hospital operations, and potable water supplies. Emergency personnel such as police, fire, and EMS will not be able to effectively respond in a power loss event to maintain the safety of its citizens. The critical facilities and utilities located in the Category 1 through 4 inundation zones are summarized Table 4.3.2-14 by municipality. Bus assets have the greatest number of locations exposed to each SLOSH inundation category, followed by electric substations and fire stations.

Figure 4.3.2-15. Evacuation Routes Exposed to SLOSH Categories 1-4



HAZUS-MH v4.2 estimates the probability that critical facilities (i.e., medical facilities, fire/EMS, police, EOC, schools, shelters and municipal buildings) may sustain damage as a result of 100-year and 500-year MRP winds. Additionally, HAZUS-MH v4.2 estimates the loss of use for each facility in number of days. HAZUS-MH v4.2 estimates that critical facilities in Hudson County will experience minor damage, and continuity of operations at these facilities will not be interrupted (loss of use is estimated to be zero days) as a result of a 100-year MRP event (tropical storm to Category 1 wind speeds). However, these facilities will begin experiencing moderate to severe damage up to the 1000-year MRP event. Table 4.3.2-15 summarizes the estimated impacts to critical facilities as a result of the 50-, 100-, 200-, 500-, and 1000-year MRP events.

At this time, HAZUS-MH v4.2 does not estimate losses to transportation lifelines and utilities as part of the hurricane model. Transportation lifelines are not considered particularly vulnerable to the wind hazard; they are more vulnerable to cascading effects such as flooding, falling debris etc. Impacts to transportation lifelines affect both short-term (e.g., evacuation activities) and long-term (e.g., day-to-day commuting) transportation needs. This is particularly a concern for Hudson County because nearly half of its working population relies on public transportation (DataUSA 2018). Any issue with the public transportation system can be detrimental to residents and commuting populations. Furthermore, evacuation routes are vulnerable to coastal storm surge events and hurricane wind events (refer to Figure 4.3.2-11). This analysis found that 23.3 miles, 38.76 miles, 48.5 miles, and 56.3 miles of evacuation routes in Hudson County are exposed to the Category 1, Category 2, Category 3, and Category 4 storm inundation hazard areas (refer to Figure 4.3.2-). Figure 4.3.2-16 shows that most of the major evacuation routes are inundated by the SLOSH hazard areas. Evacuation routes within the center of the County are least vulnerable to these hazard areas, however, these central routes are within cities that have the highest concentration of single and multi-family homes (refer to Figure 4.3.2-11). If the evacuation routes around the perimeter of Hudson County become inundated and shut down due to coastal surge, households within Hudson County can become isolated due to road closures or traffic build-up on routes that are not closed due to less exposure of SLOSH categories (i.e., Routes 1&9).

Figure 4.3.2-16. Coastal Evacuation Routes and SLOSH Categories 1 – 4 in Hudson County

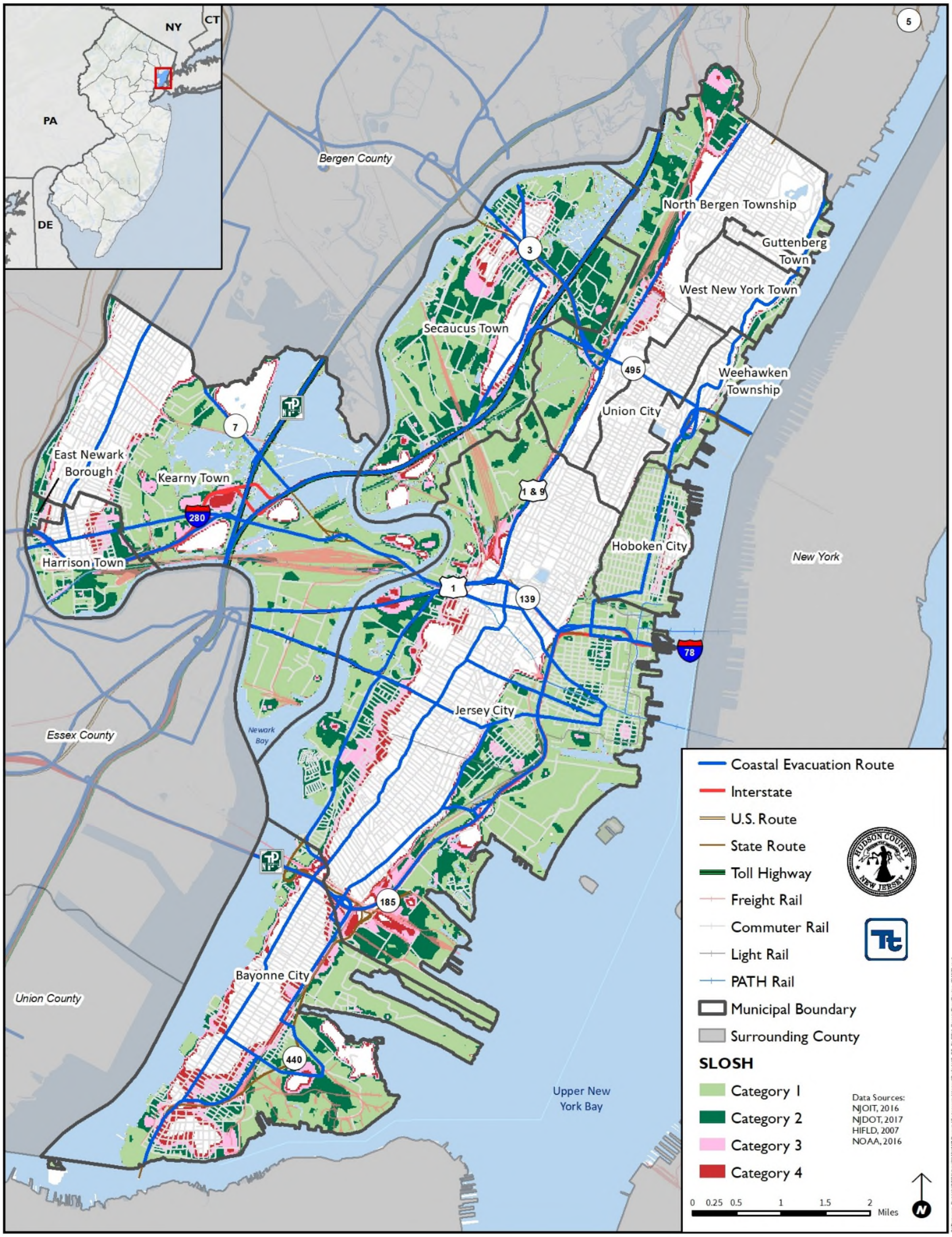


Table 4.3.2-14. Number of Critical Facilities Located in the SLOSH Inundation Zones.

Municipality	Facility Types																															
	Affordable Housing	Backup Data Centers	Bus	Child Care	Communication	DPW	Electric Power	Electric Substation	EMS	EOC	Ferry	Fire	Gas Station	Groceries	Hazmat	Heliport	Library	Marina	Medical	Military	Municipal Hall	Oil Facility	Parking Garage	Pharmacy	Police	Post Office	Rail	School	Senior	Shelter	Subway	Wastewater Pump	Wastewater Treatment
Category 1																																	
Hudson County	1	0	3	7	2	5	3	7	1	1	1	5	1	1	6	3	3	2	2	0	1	1	0	1	0	1	1	4	3	3	3	1	6
Category 2																																	
Hudson County	1	1	3	8	2	5	3	7	1	1	2	7	1	1	6	3	4	3	2	0	1	2	1	1	1	1	3	6	4	4	4	1	6
Category 3																																	
Hudson County	1	1	5	8	2	5	3	7	1	1	1	8	1	1	7	3	4	3	2	1	1	2	1	1	1	2	4	6	5	5	6	1	6
Category 4																																	
Hudson County	1	1	5	8	2	5	3	7	1	1	1	9	1	1	7	3	4	3	2	1	1	2	1	1	1	2	5	7	6	5	7	1	6

Source: Hudson County, 2019; NOAA, 2016

Table 4.3.2-15. Estimated Impacts to Critical Facilities for Mean Return Period Hurricane-Related Storm Events

Facility Type	50 YEAR MRP					100 YEAR MRP					200 YEAR MRP					500 YEAR MRP					1000 YEAR MRP				
		Percent Probability of Sustaining Damage					Percent Probability of Sustaining Damage					Percent Probability of Sustaining Damage					Percent Probability of Sustaining Damage					Percent Probability of Sustaining Damage			
	Loss of Days	Minor	Moderate	Severe	Complete	Loss of Days	Minor	Moderate	Severe	Complete	Loss of Days	Minor	Moderate	Severe	Complete	Loss of Days	Minor	Moderate	Severe	Complete	Loss of Days	Minor	Moderate	Severe	Complete
EMC	0	0-1%	0.0%	0.0%	0.0%	0	1-4%	0.0%	0	0.0%	0	2-6%	0-1%	0.0%	0.0%	0	5-18%	0-1%	0-1%	0.0%	0	6-22%	1-21%	0-7%	0.0%
Medical	0	0.0%	0.0%	0.0%	0.0%	0	<1%	0.0%	0	0.0%	0	1-3%	0.0%	0.0%	0.0%	0	4-8%	1-3%	0.0%	0.0%	0	5-11%	1-7%	0.0%	0.0%
Police	0	0-1%	0.0%	0.0%	0.0%	0	1%	0.0%	0	0.0%	0	2-3%	0.0%	0.0%	0.0%	0	5-10%	1-2%	0.0%	0.0%	0	7-17%	1-7%	0-1%	0.0%
Fire	0	0.0%	0.0%	0.0%	0.0%	0	0-1%	0.0%	0	0.0%	0	1-3%	0.0%	0.0%	0.0%	0	2-7%	0-2%	0.0%	0.0%	0	3-11%	0-5%	0-1%	0.0%
Schools	0	0.0%	0.0%	0.0%	0.0%	0	0-2%	0.0%	0	0.0%	0	1-5%	0-2%	0.0%	0.0%	0	5-11%	2-11%	0.0%	0.0%	0-4	6-12%	2-25%	0-1%	0.0%

Source: HAZUS-MH v4.2

Impact on the Economy

Damage to structures from flooding and wind can be the most immediate result of coastal storm events; however, this damage can have long-lasting impacts on the economy. When a business is closed during storm recovery, there is lost economic activity in the form of day-to-day business and wages to employees. Overall, economic impacts include the loss of business function (e.g., tourism, recreation), damage to inventory, relocation costs, wage loss and rental loss due to the repair/replacement of buildings. As evidenced by Hurricane Sandy, the State of New Jersey, including Hudson County, lost millions of dollars in wages and economic activity.

HAZUS-MH estimates the total economic loss associated with each storm scenario (direct building losses and business interruption losses). Direct building losses are the estimated costs to repair or replace the damage caused to the building. This is reported in the "Impact on General Building Stock" section discussed earlier. Business interruption losses are the losses associated with the inability to operate a business because of the wind damage sustained during the storm or the temporary living expenses for those displaced from their home because of the event.

For the 20-year MRP wind event, HAZUS-MH v4.2 estimates approximately $5,476 in relocation costs, but no estimated losses are calculated for income loss, rental costs, lost wages, or inventory losses. For the 500-year MRP wind only event (Category 2 wind speeds), HAZUS-MH v4.2 estimates approximately $102 million in business interruption losses for the County, which includes loss of income, relocation costs, rental costs and lost wages, in addition to approximately $1.4 million in inventory losses. Refer to Table 4.3.2-16 for a summary of these losses.

Table 4.3.2-16. Approximate Estimated Business Interruption Losses for Hudson County for Mean Return Period Hurricane Wind Events

Mean Return Period (MRP)	Inventory Loss	Relocation Loss	Capital Related Loss	Wages Losses	Rental Income Loss	Total Loss
20-year MRP	$0	$5,476	$0	$0	$0	**$5,476**
50-year MRP	$0	$513,687	$0	$0	$791,882	**$1,305,570**
100-year MRP	$9,831	$2,480,832	$2,865	$4,073	$3,357,971	**$5,855,574**
200-year MRP	$219,350	$10,407,537	$1,957,357	$994,765	$11,397,947	**$24,976,958**
500-year MRP	$1,406,316	$38,413,232	$8,506,538	$18,512,278	$35,226,593	**$102,064,958**
1000-year MRP	$3,799,315	$69,868,217	$14,311,532	$33,363,074	$56,736,166	**$178,078,305**

Source: HAZUS-MH v4.2

Impacts to transportation lifelines affect both short-term (e.g., evacuation activities) and long-term (e.g., day-to-day commuting and goods transport) transportation needs. Utility infrastructure (power lines, gas lines, electrical systems) could suffer damage and impacts can result in the loss of power, which can impact business operations and can impact heating or cooling provision to the population.

Debris management can be costly and may also impact the local economy. HAZUS-MH estimates the amount of building and tree debris that may be produced as result of the 100- and 500-year MRP wind events. Because the estimated debris production does not include flooding, this is likely a conservative estimate and may be higher if multiple impacts occur. According to the HAZUS-MH Hurricane User Manual, estimates of weight and volume of eligible tree debris consist of downed trees that would likely be collected and disposed at public expense. Refer to the User Manual for additional details regarding these estimates. Table 4.3.2-17 summarizes debris production estimates for the 100- and 500-year MRP wind events.

Table 4.3.2-17. Debris Production for 100- and 500-Year Mean Return Period Hurricane-Related Winds

Municipality	Brick and Wood (tons)		Concrete and Steel (tons)		Tree (tons)		Eligible Tree Volume (cubic yards)	
	100-Year	500-Year	100-Year	500-Year	100-Year	500-Year	100-Year	500-Year
Bayonne, City of	1,480	11,298	0	2	0	0	0	0
East Newark, Borough of	34	339	0	0	0	0	0	0
Guttenberg, Town of	273	2,143	0	0	0	0	0	0
Harrison, Town of	271	2,651	0	0	0	0	0	0
Hoboken, City of	2,035	12,516	0	0	0	0	0	0
Jersey City, City of	4,631	34,890	0	0	0	0	0	0
Kearny, Town of	715	6,783	0	1	0	0	0	0
North Bergen, Township of	1,202	9,821	0	0	0	0	0	0
Secaucus, Town of	553	4,629	0	4	0	0	0	0
Union City, City of	1,141	9,925	0	0	0	0	0	0
Weehawken, Township of	341	2,997	0	0	0	0	0	0
West New York, Town of	745	5,952	0	0	0	0	0	0
Hudson County (Total)	**13,421**	**103,944**	**0**	**7**	**0**	**0**	**0**	**0**

Source: HAZUS-MH v4.2

IMPACT ON THE ENVIRONMENT

According to the State of New Jersey 2019 Hazard Mitigation Plan, coastal storms can impact various natural land resources such as wetlands, marshes, and coastal habitats. Extreme winds from coastal storms may create several tons of debris because the wind tears apart foliage and trees in Hudson County. The coastline can also be altered because of storm surge. Coastline plants may be uprooted causing even further instability and alterations of the shoreline. Consequentially, natural habitat that shelters the County from wind and storm surge can be destroyed, impacting future mitigation (State of New Jersey 2019).

FUTURE CHANGES THAT MAY IMPACT VULNERABILITY

Understanding future changes that effect vulnerability in the County can assist in planning for future development and ensure establishment of appropriate mitigation, planning, and preparedness measures. Changes in the natural environment and built environment and how they interact can also provide insight about ways to plan for the future.

PROJECTED DEVELOPMENT

As discussed and illustrated in Section 3 (County Profile), areas targeted for future growth and development have been identified across the County. As the County continues to grow and recognizing that the northern municipalities of Hudson County are already densely populated, the County has identified a need to implement land use resiliency planning to mitigate future risk of hazards. By 2040, the County expects a minimum population growth of 4% and maximum population growth of over 100% across its municipalities (Hudson County Planning Board, Re-Examination 2017). This growth will require increased housing development and infrastructure to support the local economy. Implementing higher standards and codes can help reduce the risk of wind-related and coastal storm-related damage for the new development. These standards are especially valuable because the entire County is vulnerable to hurricane winds and a large portion is located in Category 1 through 4 SLOSH boundaries (see Figure 4.3.2-3).

Projected Changes in Population

Population growth in Hudson County is noteworthy. Factors like increased number of immigrants and a growing number of Millennials and young adults has become a driver for new development. For example, the increasing population has created a need for more school facilities, municipal services, and housing development (Hudson County Planning Board, Re-Examination 2017). Higher density can, not only create issues for local residents during evacuation of a natural hazard event but can also have an effect on commuters that travel into and out of the County for work, particularly during a coastal storm incident that may impact transportation corridors from storm surge inundation. Major roads that are utilized for coastal evacuation include but are not limited to major commuter roads such as Interstate 78, Route 495, and Route 1 & 9 (State of New Jersey 2020, refer to Figure 4.3.2-4).

Climate Change

As discussed above, most studies project that the State of New Jersey will see an increase in average annual temperatures and precipitation. An increase in temperatures may also lead to an increase in the frequency and intensity of coastal storms. More frequent and severe storms will increase the County's vulnerability to both wind-related and storm surge impacts.

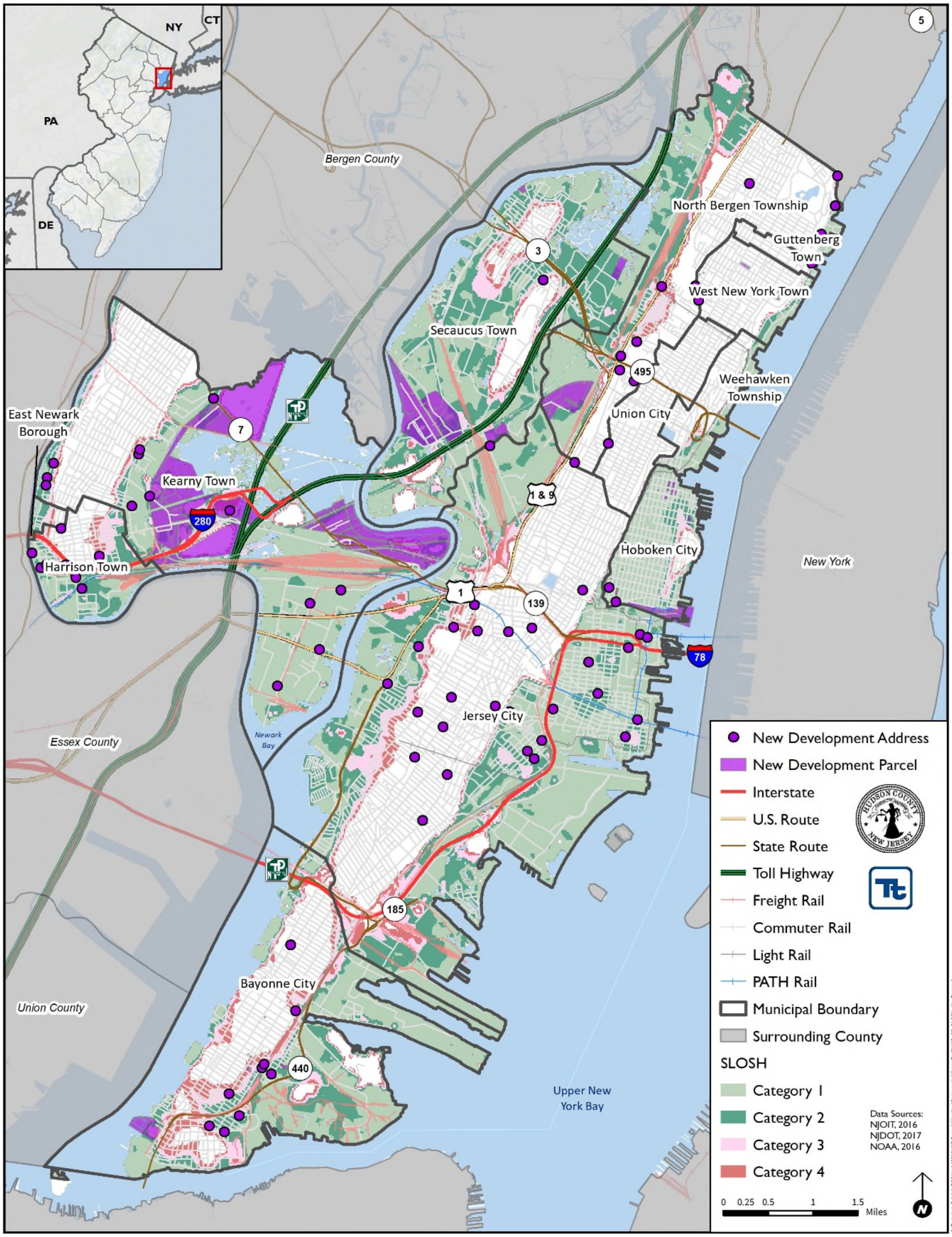
In addition to the impacts of increasing temperatures from both the local and global climate changes, as well as greater precipitation, sea level rise will increase the County's vulnerability to coastal storms. For example, increases in mean sea level will lead to subsequent increases in storm surge inundation depths. According to a study written by scientists from Rutgers University, sea level rise at the New Jersey shoreline is rising faster than the global average because of land subsidence (Miller et al. n.d.). According to the research, sea level rise has risen by 12 inches at the City of Bayonne and other bedrock locations. The effects of sea level rise in New Jersey have already been witnessed in the coastal regions, which can be indicators of change to happen in Hudson County. For example, the researchers found that Hurricane Sandy's storm tide in Atlantic City flooded 27 square miles greater than it would have in 1880 (Miller et al. n.d.).

Change of Vulnerability Since 2015 HMP

There are a few updates that were made since the 2015 HMP was published for Hudson County. Since then, the population statistics were updated to reflect the 2013-2017 American Community Survey 5-year estimates for population changes. The building stock footprints were updated using Microsoft and Open Street Maps. Further, the building stock inventory replacement cost values were updated using RS Means 2019 values. Additional updates include changes to the critical facility inventory provided by Hudson County Division of Planning and the Planning Committee.

Furthermore, changes to the data modeling were implemented in the updated HMP. An updated version of FEMA's HAZUS-MH hurricane module (Version 4.2) was utilized to estimate potential losses. This updated model includes longer historical records to pull from to generate probabilistic events, such as the wind scenario losses generated in this report. Additionally, the NOAA National Hurricane Center released updated SLOSH inundation boundaries in 2016 that were incorporated into the exposure analysis.

Figure 4.3.2-17. New Development in Hudson County within SLOSH Category Boundaries.



4.3.3 DAM/LEVEE FAILURE

This section provides a profile and vulnerability assessment of the dam and levee hazard in Hudson County.

2020 HMP Changes

- This profile is new to the 2020 HMP. Dam and levee failure were previously discussed in the Flood profile (Section 4.3.7).

4.3.3.1 PROFILE

A dam or a levee is an artificial barrier built to contain, control or divert water, wastewater, or any liquid-borne material for many reasons including: flood control, power production, agriculture, water supply, recreation (FEMA 2007). A failure is any malfunction or abnormality outside of the design that adversely affects the primary function of impoundment (FEMA 2007).

Dams and levees can fail for one or a combination of the following reasons:

- Overtopping caused by floods that exceed the capacity of the dam or levee (inadequate spillway capacity);
- Prolonged periods of rainfall and flooding;
- Deliberate acts of sabotage (terrorism);
- Structural failure of materials used in dam construction;
- Movement and/or failure of the foundation supporting the dam;
- Settlement and cracking of concrete or embankment dams;
- Piping and internal erosion of soil in embankment dams;
- Inadequate or negligent operation, maintenance and upkeep;
- Failure of upstream dams on the same waterway; or
- Earthquake (liquefaction / landslides) (FEMA 2018).

REGULATORY OVERSIGHT OF DAMS

The potential for catastrophic flooding caused by dam failures led to enactment of the National Dam Safety Act (Public Law 92-367), which for 30 years has protected Americans from dam failures. The National Dam Safety Program (NDSP) is a partnership among states, federal agencies, and other stakeholders that encourages individual and community responsibility for dam safety. Under FEMA's leadership, state assistance funds have allowed all participating states to improve their programs through increased inspections, emergency action planning, and purchases of needed equipment. FEMA has also expanded existing and initiated new training programs. Grant assistance from FEMA provides support for improvement of dam safety programs that regulate most dams in the United States (FEMA 2016).

New Jersey Department of Environmental Protection – Dam Safety Section

The NJDEP Dam Safety Section under the Bureau of Dam Safety and Flood Control has responsibility for overseeing dam safety in the State. In 1912, the New Jersey legislature passed a series of safety regulations related to the construction, repair, and inspection of existing and proposed dams in the State. In 1981, the law was amended and became the Safe Dam Act, N.J.S.A. 58:4. In 1985, the Dam Safety Standards, N.J.A.C. 7:20 regulations were passed, leading to the Dam Safety Section.

The primary goal of the program is to ensure the safety and integrity of dams in New Jersey and, thereby, protect people and property from the consequences of dam failures. The Dam Safety Section also coordinates with the Division of State Police, local and county emergency management officials in the preparations and approval of Emergency Action Plans.

The Dam Safety Section reviews plans and specifications for the construction of new dams or for the alternation, repair, or removal of existing dams and must grant approval before the owner can proceed with construction. Existing dams are periodically inspected to assure that they are adequately maintained, and owners are directed to correct any deficiencies found. The regulations require the owner to obtain a professional engineer to inspect their dams on a regular basis. These investigations include a comprehensive review of all pertinent material contained in the Department's files, a visual inspection, technical studies when necessary, and the preparation of a comprehensive report (NJDEP 2012).

The owners or operators of all dams which raise the waters of any stream more than 70 feet above its usual mean low-water height or which impound more than 10,000 acre-feet of water shall have a regular inspection performed annually and formal inspections performed every three years by a New Jersey licensed professional engineer obtained by the owner. In addition, these inspections must be attended by a professional engineer assigned from the NJDEP (State of NJ HMP 2019).

U.S. Army Corps of Engineers Dam Safety Program

The U.S. Army Corps of Engineers (USACE) is responsible for safety inspections of some federal and non-federal dams in the United States that meet the size and storage limitations specified in the National Dam Safety Act. USACE has inventoried dams and has surveyed each state's and federal agency's capabilities, practices, and regulations regarding design, construction, operation, and maintenance of the dams. USACE has also developed guidelines for inspection and evaluation of dam safety (USACE 2019).

Federal Energy Regulatory Commission Dam Safety Program

The Federal Energy Regulatory Commission (FERC) has the largest dam safety program in the United States. FERC cooperates with a large number of federal and state agencies to ensure and promote dam safety and, more recently, homeland security. A total of 3,036 dams are part of regulated hydroelectric projects and are included in the FERC program. Two-thirds of these dams are more than 50 years old. Concern about their safety and integrity grows as dams age, rendering oversight and regular inspection especially important (FERC 2017). FERC staff inspect hydroelectric projects on an unscheduled basis to investigate the following:

- Potential dam safety problems
- Complaints about constructing and operating a project
- Safety concerns related to natural disasters
- Issues concerning compliance with terms and conditions of a license (FERC 2017)

Every five years, an independent consulting engineer, approved by FERC, must inspect and evaluate projects with dams higher than 32.8 feet (10 meters) or with total storage capacity of more than 2,000 acre-feet (FERC 2017).

FERC monitors and evaluates seismic research in geographic areas where seismic activity is a concern. This information is applied to investigate and analyze structures of hydroelectric projects within these areas. FERC staff also evaluates effects of potential and actual large floods on safety of dams. FERC staff visit dams and licensed projects during and after floods, assess extents of damage, and direct any studies or remedial measures the licensee must undertake. FERC's *Engineering Guidelines for the Evaluation of Hydropower Projects* guides FERC engineering staff and licensees in evaluations of dam safety. The publication is frequently revised to reflect current information and methodologies (FERC 2017).

FERC requires licensees to prepare EAPs and conducts training sessions on developing and testing these plans. The plans outline an early warning system in the event of an actual or potential sudden release of water from a dam failure. The plans include operational procedures that may be implemented during regulatory measures, such as reducing reservoir levels and downstream flows, as well as procedures for notifying affected residents and agencies responsible for emergency management. These plans are frequently updated and tested to ensure that all applicable parties are informed of the proper procedures in emergencies (FERC 2017).

Regulatory Oversight of Levees

New Jersey

Currently in New Jersey, no single agency oversees the operation and maintenance of levees or levee systems nor has specific regulatory authority or responsibility over the safety of existing or proposed levees or levee systems. Rather, the oversight is accomplished through coordination of federal, state and local authorities (State of NJ HMP 2019).

USACE and FEMA

USACE and FEMA have differing roles and responsibilities related to levees. USACE addresses a range of operation and maintenance, risk communication, risk management, and risk-reduction issues as part of its responsibilities under the Levee Safety Program. FEMA addresses mapping and floodplain management issues related to levees, and it accredits levees as meeting requirements set forth by the National Flood Insurance Program.

Depending on the levee system, USACE and FEMA may be involved with the levee sponsor and community independently or—when a levee system overlaps both agency programs—jointly. Under both scenarios, the long-term goals are similar: to reduce risk and lessen the devastating consequences of flooding. Some USACE and FEMA partnering activities related to levees include:

- Joint meetings with levee sponsors and other stakeholders
- Integration of levee information into the National Levee Database
- State Silver Jackets teams
- Sharing of levee information
- Targeted task forces to improve program alignment

The Silver Jackets is a program that provides an opportunity to consistently bring together multiple state, federal, tribal, and local agencies to learn from each other and apply their knowledge to reduce risk. The Program's primary goals include the following:

- Create or supplement a mechanism to collaboratively identify, prioritize, and address risk management issues and implement solutions

- Increase and improve risk communication through a unified interagency effort
- Leverage information and resources and provide access to such national programs as FEMA's Risk Mapping, Assessment, and Planning (MAP) and USACE's Levee Inventory and Assessment Initiative
- Provide focused, coordinated hazard mitigation assistance in implementing high-priority actions such as those identified by state hazard mitigation plans
- Identify gaps among agency programs and/or barriers to implementation, such as conflicting agency policies or authorities, and provide recommendations for addressing these issues

Coordination between USACE and FEMA with regard to levees is now standard within many of each agency's policies and practices. Over the past several years, both agencies coordinated policies where appropriate; jointly participated in meetings with stakeholders; and participated in many multiagency efforts, such as the National Committee on Levee Safety, the Federal Interagency Floodplain Management Task Force, and the Silver Jackets Program.

National Committee on Levee Safety

Congress created the National Committee on Levee Safety to "develop recommendations for a national levee safety program, including a strategic plan for implementation of the program." The Committee is made up of representatives from state, regional, and local agencies; the private sector; USACE; and FEMA (National Committee on Levee Safety 2018).

EXTENT

The NJDEP classifies dams according to their hazard potential using the following criteria:

- Class I - High Hazard Potential: This classification includes those dams, the failure of which may cause the probable loss of life or extensive property damage.
  - i. The existence of normally occupied homes in the area that are susceptible to significant damage in the event of a dam failure will be assumed to mean "probable loss of life".
  - ii. Extensive property damage means the destructive loss of industrial or commercial facilities, essential public utilities, main highways, railroads or bridges. A dam may be classified as having a high hazard potential based solely on high projected economic loss.
  - iii. Recreational facilities below a dam, such as a campground or recreation area, may be sufficient reason to classify a dam as having a high hazard potential.
- Class II - Significant Hazard Potential: This classification includes those dams, the failure of which may cause significant damage to property and project operation, but loss of human life is not envisioned. This classification applies to predominantly rural, agricultural areas, where dam failure may damage isolated homes, major highways or railroads or cause interruption of service of relatively important public utilities.
- Class III - Low Hazard Potential: This classification includes those dams, the failure of which would cause loss of the dam itself but little or no additional damage to other property. This classification applies to rural or agricultural areas where failure may damage farm buildings other than residences, agricultural lands or non-major roads.
- Class IV - Small Dams: This classification includes any project which impounds less than 15 acres/feet of water to the top of the dam, has less than 15 feet height-of-dam and which has a drainage area above the dam of 150 acres or less in extent. No dam may be included in Class IV if it meets the criteria for Class I or II. Any applicant may request consideration as a Class III dam upon submission of a positive report and demonstration proving low hazard.

Dam failures cause serious downstream flooding either because of partial or complete dam collapse. Failures are usually associated with intense rainfall and prolonged flood conditions; however, dam breaks may occur during dry periods as a result of progressive erosion of an embankment. The greatest threat from a dam break is to areas immediately downstream. Dam failures may or may not leave enough time for evacuation of people and property, depending on their abruptness. Seepages in earth dams usually develop gradually, and if the embankment damage is detected early, downhill residents have at least a few hours or days to evacuate. Failures of concrete or masonry dams tend to occur suddenly, sending a wall of water and debris down the valley at more than 100 mph. Survival would be a matter of having the good fortune not to be in the flood path at the time of the break. Dam failures due to the overtopping of a dam normally give sufficient lead time for evacuation.

A levee failure or breach causes flooding in landward areas adjacent to the structure. The failure of a levee or other flood protection structure could be devastating, depending on the level of flooding for which the structure is designed and the amount of landward development present. Large volumes of water may be moving at high velocities, potentially causing severe damage to buildings, infrastructure, trees, and other large objects. Levee failures are generally worse when they occur abruptly with little warning and result in deep, fast-moving water through highly developed areas.

Levees require maintenance to continue to provide the level of protection they were designed and built to offer. Maintenance responsibility belongs to a variety of entities including local, state, and federal government and private landowners. Well-maintained levees may obtain certification through independent inspections. Levees may not be certified for maintaining flood protection when the levee owner does not maintain the levee or pay for an independent inspection. The impacts of an un-certified levee include higher risk of levee failure. In addition, insurance rates may increase because FEMA identifies on Flood Insurance Rate Maps that the structures are not certified to protect from a one-percent annual chance flood event (FEMA, 2004).

Location

The Weehawken Reservoir No. 2 Dam is located in the Township of Weehawken. The reservoir is surrounded on all four sides by embankments comprised of soil, with a clay layer, covered by stone block. The entire embankment is considered to be part of the dam. The dam is an earthen dam with conduits for overflow and water distribution and was constructed around 1900. The dam was previously owned by the United Water Company but is currently owned by the Township of Weehawken. The dam is a classified as a class III (low hazard potential) and the most recent inspection found the dam to be in satisfactory condition (Maser 2017).

According to the National Levee Database, Hudson County has no active levee systems. However, the City of Hoboken is planning construction of a hybrid levee and flood wall system to protect the City from severe coastal flooding events. The system would be constructed on the northern and southern ends of the City with other flood protection techniques installed elsewhere in the City.

Past Occurrence

According to the National Performance of Dams Program (NPDP), no dam failure incidents have taken place in Hudson County. According to the NCEI database, no flooding events associated with levee failure have taken place in the County. In addition, there have been no FEMA disaster declarations associated with dam or levee failures.

PROBABILITY OF FUTURE OCCURRENCE

There is minimal history of occurrence of dam and levee failure between 1950 and 2019. This suggests a low probability of future occurrence though the construction of new dam and levee structures could increase dam and levee failure risk. Likelihood of a dam or levee failure in Hudson County is difficult to predict. Dam failure events are infrequent and usually coincide with events that cause them, such as earthquakes, landslides, and excessive rainfall and snowmelt. However, the risk of such an event increases for each dam as the dam's age increases or frequency of maintenance decreases. A complete levee failure is rather infrequent and typically coincides with events that cause them such as heavy rainfall, storm surge, or hurricanes. Additionally, future climate change may impact storm patterns, increasing the probability of more frequent, intense storms with varying duration.

"Residual risk" to dams is risk that remains after implementation of safeguards. Residual risk to dams and levees is associated with events beyond those that the facility was designed to withstand. However, probability of any type of dam failure is low in today's dam safety regulatory and oversight environment.

In Section 4.4, the identified hazards of concern for Hudson County are ranked. The probability of occurrence, or likelihood of the event, is one parameter used for ranking hazards. Based on historical records and input from the Planning Committee, the probability of occurrence for dam and levee failure is considered "unlikely" in the County.

CLIMATE CHANGE

New Jersey has become wetter over the past century. Northern New Jersey's 1971-2000 precipitation average was over five inches (12-percent) greater than the average from 1895-1970 (Sustainable Jersey Climate Change Adaptation Task Force [CATF] 2011). The heaviest 1% of daily rainfalls have increased by approximately 70% between 1958 and 2011 in the Northeast (Horton et al. 2015). Average annual precipitation is projected to increase in the region by four to 11-percent by the 2050s and five to 13-percent by the 2080s (New York City Panel on Climate Change [NPCC] 2015).

Dams are designed partly based on assumptions about a river's flow behavior, expressed as hydrographs. Changes in weather patterns can significantly affect the hydrograph used for the design of a dam. If the hygrograph changes, the dam conceivably could lose some or all of its designed margin of safety, also known as freeboard. Loss of designed margin of safety increases the possibility that floodwaters would overtop the dam or create unintended loads, which could lead to a dam failure. Similarly, levees are designed based upon the calculated base flood elevation for a river or coastal water body. Changes in the base flood elevation as a result of sea level rise and precipitation patterns increases the possibility that a levee could be overtopped.

4.3.3.2 VULNERABILITY ASSESSMENT

To assess Hudson County's risk to dam and levee failure, a qualitative review was implemented and supplemented with information from Section 4.3.7 (Flood) from this HMP.

IMPACT ON LIFE, HEALTH, AND SAFETY

The impact of dam and levee failure on life, health, and safety is dependent on several factors such as the class of dam/levee, the area that the dam/levee is protecting, the location of the dam/levee, and the proximity of structures, infrastructure, and critical facilities to the dam or levee structure. According to the 2019 State of New Jersey Hazard Mitigation Plan, the level of impact that a failure would have can be predicted based upon the hazard potential classification as rated by the United States Army Corps of Engineers (State of NJ 2019). Table 4.3.3-1 outlines the hazard classifications.

Table 4.3.3-1. United States Army Corps of Engineers Hazard Potential Classification

Hazard Category(a)	Direct Loss of Life (b)	Lifeline Losses (c)	Property Losses (d)	Environmental Losses
Low	None (rural location, no permanent structures for human habitation)	No disruption of services (cosmetic or rapidly repairable damage)	Private agricultural lands, equipment, and isolated buildings	Minimal incremental damage
Significant	Rural location, only transient or day-use facilities	Disruption of essential facilities and access	Major public and private facilities	Major mitigation required
High	Certain (one or more) extensive residential, commercial, or industrial development	Disruption of essential facilities and access	Extensive public and private facilities	Extensive mitigation cost or impossible to mitigate

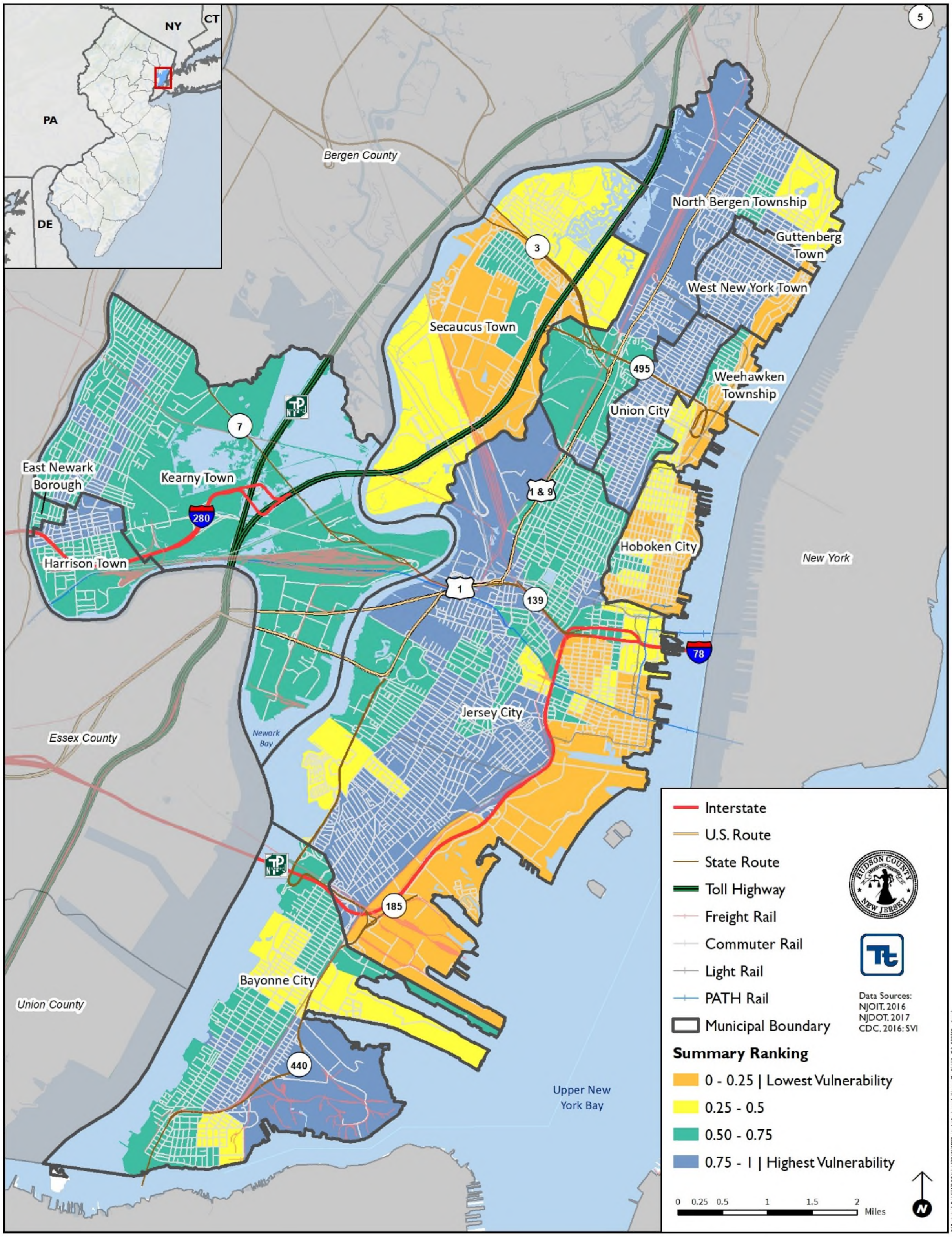
a. Categories are assigned to overall projects, not individual structures at a project.
b. Loss-of-life potential is based on inundation mapping of area downstream of the project. Analyses of loss-of-life potential should take into account the population at risk, time of flood wave travel, and warning time.
c. Lifeline losses include indirect threats to life caused by the interruption of lifeline services from project failure or operational disruption; for example, loss of critical medical facilities or access to them.
d. Property losses include damage to project facilities and downstream property and indirect impact from loss of project services, such as impact from loss of a dam and navigation pool, or impact from loss of water or power supply.
e. Environmental impact downstream caused by the incremental flood wave produced by the project failure, beyond what would normally be expected for the magnitude flood event under which the failure occurs.

Source: State of NJ 2019

As mentioned in the earlier sections, dam failure can cause, in the most extreme case, loss of life and extensive property damage. In Hudson County, the only dam found is located in Weehawken and is not expected to result in loss of life and/or significant property damage. Once the levee in Hoboken is built and rated, Hudson County will have a better understanding of the potential risk this new structure will have on the community.

The Centers for Disease Control and Prevention's (CDC) 2016 Social Vulnerability Index (SVI) ranks U.S. Census tracts on socioeconomic status, household composition and disability, minority status and language, and housing and transportation. Hudson County's overall score is 0.6425, indicating that its communities have moderate to high vulnerability (CDC 2016, refer to Figure 4.3.3-1). This map shows that Weehawken Township and City of Hoboken have a variation in vulnerability ratings. A majority of Weehawken's rating ranges between 0.25 and 0.75, whereas Hoboken ranges mostly from 0 – 0.5.

Figure 4.3.3-1. CDC Social Vulnerability Index Rating for Hudson County



Impact on General Building Stock

Buildings located downstream of a dam or levee are at risk to damages should there be a failure. Downstream inundation areas were not available to quantify any potential losses to structures. If the dam in Weehawken were to breach or overflow due to an extreme rain event, it is surrounded by structures that may experience potential flood damage.

Hoboken's "Rebuild by Design" program aims to protect the community's infrastructure and building stock from future flood surge risk, particularly from future events such as Hurricane Sandy (State of New Jersey 2017). The project objectives suggest that this levee is part of a greater plan to protect the low-lying areas from future flood risks.

Impact on Critical Facilities

Similar to the discussion on the general building stock, estimated damages to critical facilities cannot be quantified for the dam and levee failure at this time.

Impact on the Economy

The State of New Jersey does not have a historical record of dams or levees breaching in Hudson County, however previous events throughout the State indicate great loss at the local level. Dams within Sussex and Morris Counties were damaged following a large storm event in 2000, which caused an estimated damage of $179 million (State of NJ 2019). The State of New Jersey All Hazard Mitigation Plan discusses damages from dam failures ranging from $7 million to $25 million as a result of previous events in the State. This cost likely varies because of the density of structures and businesses that surround the protected area.

Severe flooding that follows an event like a dam or levee failure can cause extensive damage to public utilities and disruptions to delivery of services. Loss of power and communications may occur and drinking water and wastewater treatment facilities can become temporarily out of operation. Debris from surrounding buildings can accumulate should the dam mimic major flood events, such as the 1-percent annual chance flood event that is discussed in Section 4.3.7 - Flood.

Impact on the Environment

The environmental impacts of a dam or levee failure can include significant water-quality and debris-disposal issues. Flood waters can back up sanitary sewer systems and inundate wastewater treatment plants, causing raw sewage to contaminate residential and commercial buildings and the flooded waterway. The contents of unsecured containers of oil, fertilizers, pesticides, and other chemicals get added to flood waters. Hazardous materials may be released and distributed widely across the floodplain. Water supply and wastewater treatment facilities could be offline for weeks. After the flood waters subside, contaminated and flood-damaged building materials and contents must be properly disposed of. Contaminated sediment must be removed from buildings, yards, and properties. In addition, severe erosion is likely; such erosion can negatively impact local ecosystems.

Future Changes That May Impact Vulnerability

Understanding future changes that affect vulnerability can assist in planning for future development and ensure establishment of appropriate mitigation, planning, and preparedness measures. Several factors are examined in this section to assess hazard vulnerability.

Projected Development

As discussed in Section 3 (County Profile), areas targeted for future growth and development have been identified across the County. Any areas of growth could be potentially impacted by a dam or levee failure event if the structures are located within the flood protection area and mitigation measures are not considered. Since the proposed levee system will likely be used to buffer against future storm surge risk, it is likely that future development will be encouraged to build new structures within the modeled SLOSH storm surge hazard areas. Therefore, it is the intention of the County and all participating municipalities to discourage development in vulnerable areas or to encourage higher regulatory standards at the local level.

Projected Changes in Population

Factors like increased number of immigrants and a growing number of Millennials and young adults has become a driver for new development. For example, the increasing population has created a need for more school facilities, municipal services, and housing development (Hudson County Planning Board, Re-Examination 2017). Higher density can, not only create issues for local residents during evacuation of a dam or levee failure event but can also have an effect on commuters that travel into and out of the County for work, particularly during a flood event that may impact transportation corridors, which are also major commuter roads. Refer to Section 4.3.1, Population Trends in the County Profile, which includes a discussion on population trends for the County.

Climate Change

Annual precipitation amounts in the region are projected to increase, primarily in the form of heavy rainfalls, which have the potential to increase the risk to dam or levee failures. Increases in precipitation may stress a dam or levee wall. Further, existing flood control structures may not be designed to retain and manage increases in water flow from more frequent, heavy rainfall events. Heavy rainfalls may result in more frequent overtopping and flooding in adjacent inundation areas. However, the probable maximum flood used to design each dam may be able to accommodate changes in climate.

Change of Vulnerability Since 2015 HMP

This is the first time that dam and levee failure has been discussed as a separate hazard of concern for Hudson County. Previously, the dam and levee failure discussion occurred in the Flood section of previous HMPs. However, due to the anticipated levee being constructed in the City of Hoboken, the age of the existing dam in Weehawken, and the evolving severity of storm and flood events in the County, it was important to highlight this hazard as a possible new risk for the County while it experiences exponential rates of growth within each of its municipalities. More information about storm surge and flood risks tied to the dam and levee failures can be found in Sections 4.3.2 and 4.3.7, respectively.

4.3.4 DROUGHT

This section provides a profile and vulnerability assessment of the drought hazard in Hudson County.

2020 HMP Changes

- Previous occurrences were updated with events that occurred between 2015 and 2019.
- Information on the Palmer Drought Severity Index was added to the profile. Past occurrence information included Palmer Drought Severity categories.
- Additional analyses include: social vulnerability analysis, impacts to agricultural land, and water supplies assessment.

4.3.4.1 PROFILE

Drought is a period characterized by long durations of below normal precipitation. Drought conditions occur in virtually all climatic zones, yet characteristics of drought vary significantly from one region to another, relative to normal precipitation within respective regions. Drought can affect agriculture, water supply, aquatic ecology, wildlife, and plant life. Drought is a temporary irregularity in typical weather patterns and differs from aridity, which reflects low rainfall within a specific region and is a permanent feature of the climate of that area.

EXTENT

The severity of a drought depends on the degree of moisture deficiency, the duration, and the size and location of the affected area. The longer the duration of the drought and the larger the area impacted, the more severe the potential impacts.

NEW JERSEY DIVISION OF WATER SUPPLY AND GEOSCIENCE

The State of New Jersey's Division of Water Supply and Geoscience within the NJDEP utilizes several drought indicators to assess the status of water supply and hydrogeologic conditions for each drought region. The indicators are precipitation, stream flow, shallow ground water levels, and reservoir storage (as applicable). Each indicator is weighted according to its importance within a particular region (e.g. reservoirs are a significant factor in the Northeast drought region because they are a critical water supply source there). The indicators are ranked according to the status of current conditions relative to a statistical average. Each is then evaluated as either: near/above normal, moderately dry, severely dry, or extremely dry. The indicators are one set of factors the Department uses to determine if a drought-related administrative action (i.e. watch, warning, or emergency) is warranted.

The Division regularly monitors various water supply conditions within the state based on the different Water Supply Regions. The water supply conditions aid the NJDEP in declaring the regions as being within one of the four stages of water supply drought, Normal, Drought Watch, Drought Warning, and Drought Emergency.

- A ***Drought Watch*** is an administrative designation made by the Department when drought or other factors begin to adversely affect water supply conditions. A Watch indicates that conditions are dry but not yet significantly so. During a drought Watch, the Department closely monitors drought indicators (including precipitation, stream flows and reservoir and ground water levels, and water demands) and consults with affected water suppliers.

- A ***Drought Warning*** represents a non-emergency phase of managing available water supplies during the developing stages of drought and falls between the Watch and Emergency levels of drought response. The aim of a Drought Watch is to avert a more serious water shortage that would necessitate declaration of a water emergency and the imposition of mandatory water use restrictions, bans on water use, or other potentially drastic measures.

- A ***Drought Emergency*** can only be declared by the governor. While drought warning actions focus on increasing or shifting the supply of water, efforts initiated under a water emergency focus on reducing water demands. During a water emergency, a phased approach to restricting water consumption is typically initiated. Phase I water use restrictions typically target non-essential, outdoor water use (NJDEP Division of Water Supply and Geoscience 2018).

PALMER DROUGHT SEVERITY INDEX

The Palmer Drought Severity Index is commonly used by drought monitoring agencies for drought reporting. The PDSI is primarily based on soil conditions. Soil with decreased moisture content is the first indicator of an overall moisture deficit. Table 4.3.4-1 lists the PDSI classifications. At the one end of the spectrum, 0 is used as normal and drought is indicated by negative numbers. For example, -2 is moderate drought, -3 is severe drought, and -4 is extreme drought. The PDSI also reflects excess precipitation using positive numbers; however, this is not shown in Table 4.3.4-1 (National Drought Mitigation Center [NDMC] 2013).

Table 4.3.4-1. Palmer Drought Category Descriptions

Category	Description	Possible Impacts	Palmer Drought Index
D0	Abnormally Dry	Going into drought: short-term dryness slowing planting and growth of crops or pastures; fire risk above average. Coming out of drought: some lingering water deficits; pastures or crops not fully recovered.	-1.0 to -1.99
D1	Moderate drought	Some damage to crops and pastures; fire risk high; streams, reservoirs, or wells low; some water shortages developing or imminent; voluntary water-use restrictions requested.	-2.0 to -2.99
D2	Severe drought	Crop or pasture losses likely; fire risk very high; water shortages common; water restrictions imposed.	-3.0 to -3.99
D3	Extreme drought	Major crop or pasture losses; extreme fire danger; widespread water shortages or restrictions.	-4.0 to -4.99
D4	Exceptional drought	Exceptional and widespread crop/pasture losses; exceptional fire risk; shortages of water in reservoirs, streams, and wells, creating water emergencies.	-5.0 or less

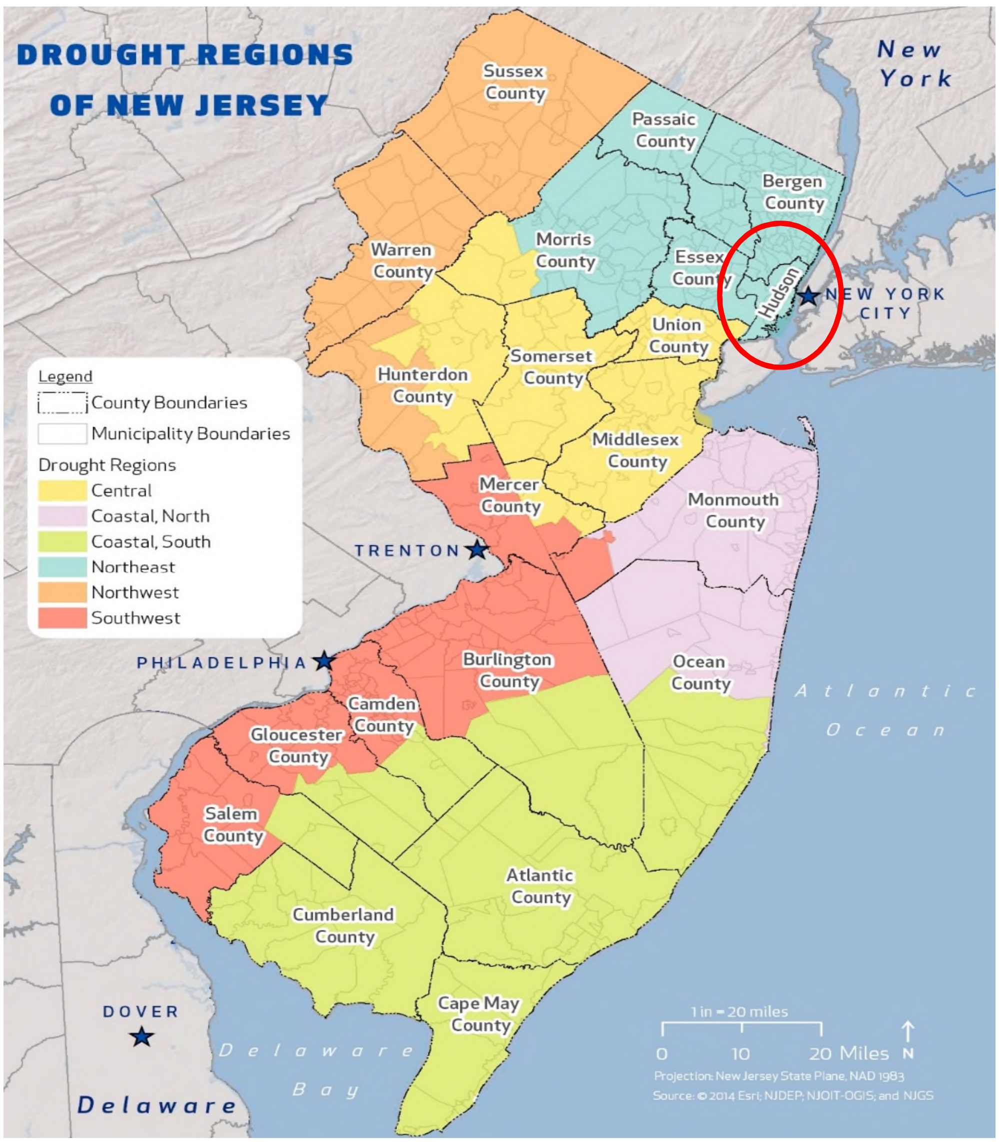
Source: NDMC 2013

LOCATION

Climate divisions are regions within a state that are climatically homogenous. The National Oceanic and Atmospheric Administration (NOAA) has divided the U.S. into 359 climate divisions. The boundaries of these divisions typically coincide with the county boundaries, except in the western U.S., where they are based largely on drainage basins (U.S. Energy Information Administration, Date Unknown). According to NOAA, New Jersey is made up of three climate divisions: Northern, Southern, and Coastal (NOAA no date). Hudson County is located in the Northern Region.

Drought regions allow New Jersey to respond to changing conditions without imposing restrictions on areas not experiencing water supply shortages. The NJ DEP divides New Jersey into six drought regions that are based on regional similarities in water supply sources and rainfall patterns. Figure 4.3.4-1 shows the drought regions of New Jersey with Hudson County circled. Hudson County is located in the Northeast Drought Region.

Figure 4.3.4-1. Drought Regions of New Jersey



Source: NJDEP GWS, 2004, NJ HMP 2019
Note: The red circle indicates the location of Hudson County

Past Occurrence

Hudson County does not typically experience severe or extreme drought due to its proximity to the Atlantic Ocean, which adds moisture that generates precipitation throughout the region. Based on available historical records, the communities in the planning area are equally susceptible to drought events and should mitigate to an extent of moderate drought.

Between 1954 and 2019, FEMA declared that the State of New Jersey experienced one drought-related disaster (DR) or emergency (EM) that was classified as a water shortage. Generally, drought-related disasters affect a wide region of the State and thus may have impacted many counties. Hudson County was included in both disaster declarations.

The U.S. Department of Agriculture (USDA) keeps records of agricultural disasters. In 2016, USDA Agricultural Disaster S34017 was declared in Hudson County for drought, heat/excessive heat/high temperatures, and frost/freeze. USDA-reported crop losses provide another indicator of previous events. USDA records indicate that Hudson County did not experience crop losses from drought events from 2015 to 2019.

Table 4.3.4-2. Drought Events in Hudson County Between 2015 and 2019

Dates of Event	Losses/Impacts
May 5-June 22, 2015	According to the U.S. Drought Monitor, conditions held at a D0 or "abnormally dry" status across Hudson County from May 5 – May 25, D1 or "moderate drought" states from May 26 – June 1, and D0 or "abnormally dry" from June 2 – June 22.
August 4, 2015-January 18, 2016	According to the U.S. Drought Monitor, conditions held at a D0 or "abnormally dry" status across Hudson County from August 4 – August 31 and D1 or "moderate drought" status from September 1, 2015 – January 18, 2016. New Jersey was placed under a drought watch from September 23, 2015 - March 1, 2016.
April 19, 2016-April 10, 2017	According to the U.S. Drought Monitor, conditions held at a D0, or "abnormally dry" status across Hudson County from April 19 - June 13, D1 or "moderate drought" status from June 14 - October 10, D2 or "severe drought" status from October 11, 2016 – January 23, 2017, D1 or "moderate drought" status from January 24 – March 20, and D0 or "abnormally dry" status from March 21 - April 10. A drought watch was issued for northern New Jersey was placed under a drought watch from July 25, 2016 – October 18, 2016. The entire state was placed under a drought warning on October 21, 2016. Water conservation was urged.
October 3-October 31, 2017	According to the U.S. Drought Monitor, conditions held at a D0 or "abnormally dry" status across Hudson County from October 3 – October 30.
December 17, 2017-February 12, 2018	According to the U.S. Drought Monitor, conditions held at a D0 or "abnormally dry" status across Hudson County from December 17, 2017-February 12, 2018. Low reservoirs were reported in northern New Jersey.

Source: USDA 2019, NDMC 2019

Note: Many sources provide historical information regarding previous occurrences and losses associated with drought events throughout New Jersey and Hudson County. Information about losses and impacts resulting from each of many events can vary depending on the source. Notably, monetary amounts cited in this section on drought derive solely from information obtained during research for this HMP.

PROBABILITY OF FUTURE OCCURRENCE

Based on the historical occurrences for drought, Hudson County can anticipate a range of drought from abnormally dry to severe, or D0 to D2, based on the Palmer Drought Category. Therefore, the County's communities are equally susceptible to drought events and should mitigate to an extent of moderate drought. In addition, as temperatures increase (see climate change impacts), the probability for future droughts will likely increase as well.

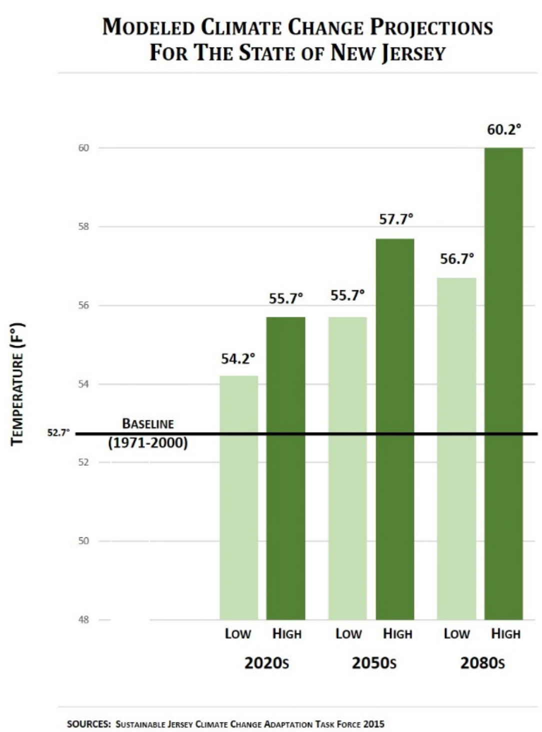
It is estimated that Hudson County will continue to experience direct and indirect impacts of drought and its impacts on occasion, with the secondary effects causing potential disruption or damage to agricultural activities and creating shortages in water supply within communities.

In Section 4.4, the identified hazards of concern for Hudson County are ranked. The probability of occurrence, or likelihood of the event, is one parameter used for hazard rankings. Based on historical records and input from the Planning Committee, the probability of occurrence for drought in the County is considered 'occasional' ; refer to Section 4.4.

CLIMATE CHANGE

The climate of New Jersey is already changing and will continue to change over the course of this century. From 1900 to 2014 annual average temperatures in New Jersey have increased approximately 3°F (NOAA NCEI, 2017). In terms of winter temperatures, the northeast region has seen an increase in the average temperature of 4°F since 1970 (Northeast Climate Impacts Assessment [NECIA] 2007). By the 2020s, the average annual temperature in New Jersey is projected to increase by 1.5°F to 3°F above the statewide baseline (1971 to 2000), which was 52.7°F. By 2050, the temperature is projected to increase 3°F to 5°F, and by 2080 projections show an increase of 4°F to 7.5°F (Sustainable Jersey Climate Change Adaptation Task Force 2011, also refer to Figure 4.3.4-2). With an overall increase in temperature, drought conditions may become more frequent.

Figure 4.3.4-2. Expected Climate Change From 2020 - 2080



The future drought potential that New Jersey is modeled to experience indicates the state will experience more frequent but not necessarily more severe droughts. While all droughts impose some level of stress on water supplies, some will have long term effects. If the projected more frequent droughts are spaced out over time, then New Jersey's water supply systems should be capable of recovering between droughts. However, more frequent droughts raise the potential for sequential droughts that do not allow for recovery of reservoir levels or aquifer storage, resulting in a scenario where moderate droughts could have aggregate results that severely test our water supply capabilities (NJ Climate Adaptation Alliance, 2016).

As temperatures rise, people and animals will need more water to maintain their health and to thrive. Many economic activities, such as hydropower, raising livestock, and growing foods, will also require water. The amount of water available for these activities may be reduced as temperatures rise and if competition for water resources increases. As shown in the paragraph above, these trends will certainly affect the probability and frequency of dryer conditions that could lead to drought events in Hudson County.

4.3.4.2 Vulnerability Assessment

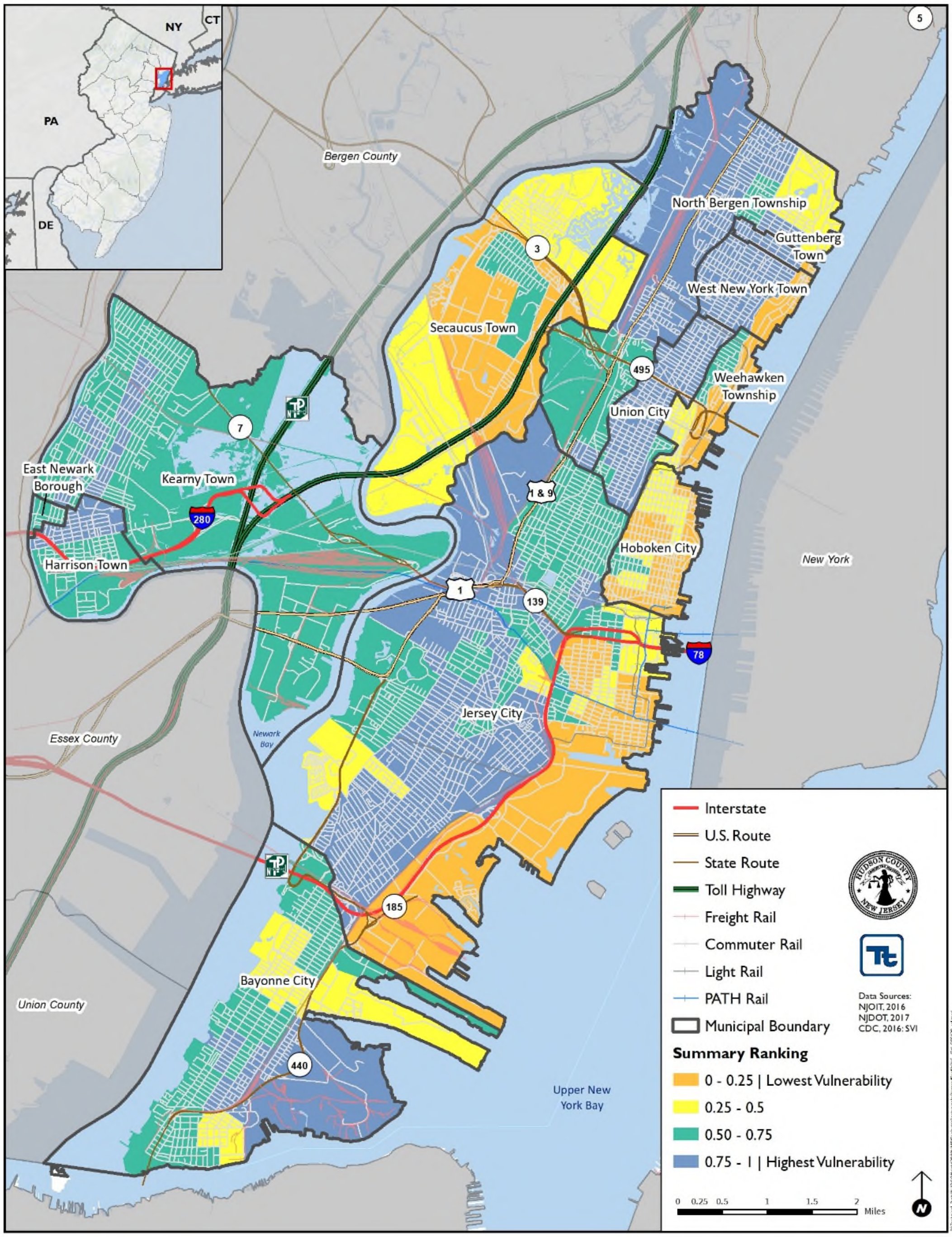
To understand risk, a community must evaluate its assets that are exposed or vulnerable to the identified hazard. The following discusses Hudson County's vulnerability, in a qualitative nature, to the drought hazard.

Impact on Life, Health, and Safety

The entire population of Hudson County is exposed to drought events (population of 679,756 people, according to the 2013-2017 American Community Survey population estimates). Drought conditions can cause a shortage of potable water for human consumption, both in quantity and quality. A decrease in available water may also impact power generation and availability to residents.

Public health impacts may include an increase in heat-related illnesses, waterborne illnesses, recreational risks, limited food availability, and reduced living conditions. Vulnerable populations could be particularly susceptible to the drought hazard and cascading impacts due to age, health conditions, and limited ability to mobilize to shelter, cooling and medical resources. Other possible impacts to health due to drought include increased recreational risks; effects on air quality; diminished living conditions related to energy, air quality, and sanitation and hygiene; compromised food and nutrition; and increased incidence of illness and disease. Health implications of drought are numerous. Some drought-related health effects are short-term while others can be long-term (CDC 2020). Furthermore, the Centers for Disease Control and Prevention's (CDC) 2016 Social Vulnerability Index (SVI) ranks U.S. Census tracts on socioeconomic status, household composition and disability, minority status and language, and housing and transportation. Hudson County's overall score is 0.6425, indicating that its communities have moderate to high vulnerability (CDC 2016, refer to Figure 4.3.4-3). This map shows that areas that are more likely to be vulnerable to drought are located within the interior of Hudson County.

Figure 4.3.4-3. CDC Social Vulnerability Index Map for Hudson County



According to a study in 2009, Hudson County uses mostly groundwater supplies to sustain its freshwater needs (NJDEP 2009). This study also shows that Hudson County's surface water supplies come from rivers and private suppliers like Suez. Surface water supplies are affected more quickly during droughts than groundwater sources; however, groundwater supplies generally take longer to recover. The public water systems currently listed on the New Jersey Drinking Water Watch page are outlined in Table 4.3.4-3.

Table 4.3.4-3. Primary Surface Water Supplies in Hudson County

Water System Name	Primary Source of Water	Principal City Served
City of Bayonne	Purchased Surface Water	Bayonne City
East Newark Water Department	Purchased Surface Water	East Newark
Harrison Water Department	Purchased Surface Water	Harrison
Suez Water Hoboken	Purchased Surface Water	Hoboken
Jersey City MUA	Surface Water	Jersey City
Kearny Water Department	Purchased Surface Water	Kearny

Source: NJ Drinking Water Watch 2019

Impact on General Building Stock

No structures are anticipated to be directly affected by a drought event. However, droughts contribute to conditions conducive to wildfires and reduce fire-fighting capabilities. Risk to life and property is greatest in those areas where forested areas adjoin urbanized areas (high density residential, commercial and industrial) also known as the wildfire urban interface (WUI). Therefore, all assets in and adjacent to, the WUI zone, including population, structures, critical facilities, lifelines, and businesses are considered vulnerable to wildfire. Refer Section 4.3.10 for the Wildfire risk assessment.

Impact on Critical Facilities

As mentioned, drought events generally do not impact buildings; however, droughts have the potential to impact agriculture-related facilities and critical facilities that are associated with potable water supplies. As noted above, droughts contribute to conditions conducive to wildfires and may create increased strain on fire-fighting capabilities.

Impact on the Economy

Drought can produce a range of impacts that span many economic sectors and can reach beyond an area experiencing physical drought. As previously discussed, water withdrawals are not only used for potable water but for use in the commercial/industrial/mining sectors and power generation. When a state of water emergency is declared by the Governor (when a potential or actual water shortage endangers the public health, safety and welfare), the NJDEP may impose mandatory water restrictions and require specific actions to be taken by water suppliers. According to the New Jersey Water Supply Plan, a water emergency seeks to cause as little disruption as possible to commercial activity and employment (NJDEP 2017).

A prolonged drought can have a serious economic impact on a community. Increased demand for water and electricity can result in shortages and higher costs for these resources. Industries that rely on water for business could be impacted the most (e.g., landscaping businesses). Although most businesses will still be operational, they may be impacted aesthetically. These aesthetic impacts are most significant within the recreation and tourism industry. Moreover, droughts within another area could impact the food supply and price of food for residents within the county.

Direct impacts of drought include reduced crop yield, increased fire hazard, reduced water levels, and damage to wildlife and fish habitat. The many impacts of drought can be listed as economic, environmental, or social. Direct and indirect losses include the following:

- Damage to crop quality and crop losses.

- Insect infestation leading to crop and tree losses.
- Plant diseases leading to loss of agricultural crops and trees.
- Reduction in outdoor activities.
- Increased risk of brush fires and wildfires due to dried crops, grasses, and dying trees.

Based on information from the 2017 Census of Agriculture, farmland is economically insignificant in Hudson County compared to the rest of the land use in the County. Therefore, impacts of drought to agricultural activity is minimal in the County. Table 4.3.4-4 lists the acreage of agricultural land exposed to the drought hazard.

Table 4.3.4-4. Agricultural Land in Hudson County in 2017

Number of Farms	Land in Farms (acres)	Number of Harvested Cropland Farms	Estimated Market value of land and buildings per farm
4	26	2	$327,000

Source: USDA 2017

Impact on the Environment

Drought can impact the environment because it can trigger wildfires, increase insect infestations, and exacerbate the spread of disease (NOAA 2020). Droughts will also impact water resources that are relied upon by aquatic and terrestrial species. Ecologically sensitive areas, such as wetlands, can be particularly vulnerable to drought periods because they are dependent on steady water levels and soil moisture availability to sustain growth. As a result, these types of habitats can be negatively impacted after long periods of dryness (NJDEP 2017).

Future Changes That May Impact Vulnerability

Understanding future changes that impact vulnerability in the County can assist in planning for future development and ensuring that appropriate mitigation, planning, and preparedness measures are in place. The County considered the following factors to examine potential conditions that may affect hazard vulnerability:

- Potential or projected development
- Projected changes in population
- Other identified conditions as relevant and appropriate, including the impacts of climate change.

Projected Development

As discussed in Section 3 (County Profile), areas targeted for future growth and development have been identified across Hudson County. The New Jersey Water Supply Plan indicates seasonal outdoor water use is rising and is attributable to continued suburbanization and increases in residential and commercial lawn and landscape maintenance. Changes in water demands by commercial/industrial users will depend on future development of this water type use and how effectively efficiency techniques are implemented (NJDEP 2017).

Projected Changes in Population

Potable water use is the second largest water use sector and largest consumptive use in New Jersey. As such, population projections, per capita water use and percent non-residential water use by water system are important factors to consider when assessing future water needs. According to population projections from Hudson County, the area is expected to grow by 29% by 2040 (Hudson County Planning Board, Re-Examination 2017). NJDEP assessed future water needs for public water systems factoring in future projected population growth for each municipality. The analysis suggests an additional 32 million gallons per day (mgd) (over 2015 rates) will be needed by 2020 to meet the anticipated growth in potable demand, 68 mgd by 2025, 103 mgd by 2030, 134 mgd by 2035, and 164 mgd by 2040 (NJDEP 2017).

Climate Change

As discussed above, most studies project that the State of New Jersey will see an increase in average annual temperatures. Additionally, the State is projected to experience more frequency droughts which may affect the availability of water supplies, primarily placing an increased stress on the population and their available potable water. A decrease in water supply, or increase in water supply demand, may increase the County's vulnerability to structural fire and wildfire events. Critical water-related service sectors may need to adjust management practices and actively manage resources to accommodate for future changes.

Vulnerability Change Since the 2015 HMP

Overall, the entire County remains vulnerable to droughts. Statewide total water withdrawals, excluding power generation, have decreased from 1990 to 2015 due to reduced demands in the commercial/industrial/mining sectors. However, potable water withdrawal and demand continues to increase as population increases (NJDEP 2017).

4.3.5 EARTHQUAKE

This section provides a profile and vulnerability assessment of the earthquake hazard in Hudson County.

2020 HMP Changes

- New and updated figures from federal and state agencies are incorporated.
- Previous occurrences were updated with events that occurred between 2015 and 2019.
- The New Jersey Geologic and Water Survey released update NEHRP soil and liquefaction susceptibility spatial data in 2016; both layers were used for the exposure analysis and imported into the HAZUS-MH Earthquake model to update the default soil data.
- Additional analyses performed include: impacts to critical facilities by municipality, impacts to evacuation routes and social vulnerability analysis.

4.3.5.1 PROFILE

An earthquake is the sudden movement of the Earth's surface caused by the release of stress accumulated within or along the edge of the Earth's tectonic plates, a volcanic eruption, or by a manmade explosion (Federal Emergency Management Agency [FEMA] 2001; Shedlock and Pakiser 1997). Most earthquakes occur at the boundaries where the Earth's tectonic plates meet (faults); less than 10% of earthquakes occur within plate interiors. New Jersey is in an area where it is rare for plate interior-related earthquakes to occur. As plates continue to move and plate boundaries change geologically over time, weakened boundary regions become part of the interiors of the plates. These zones of weakness within the continents can cause earthquakes in response to stresses that originate at the edges of the plate or in the deeper crust (Shedlock and Pakiser 1997).

The location of an earthquake is commonly described by its focal depth and the geographic position of its epicenter. The focal depth of an earthquake is the depth from the Earth's surface to the region where an earthquake's energy originates, also called the focus or hypocenter. The epicenter of an earthquake is the point on the Earth's surface directly above the hypocenter (Shedlock and Pakiser 1997). Earthquakes usually occur without warning and their effects can impact areas of great distance from the epicenter (FEMA 2001).

According to the U.S. Geological Survey (USGS) Earthquake Hazards Program, an earthquake hazard is any disruption associated with an earthquake that may affect residents' normal activities. This includes surface faulting, ground shaking, landslides, liquefaction, tectonic deformation, tsunamis, and seiches; each of these terms is defined below; however, not all occur within the Hudson County planning area:

- *Surface faulting*: Displacement that reaches the earth's surface during a slip along a fault. Commonly occurs with shallow earthquakes—those with an epicenter less than 20 kilometers.
- *Ground motion (shaking):* The movement of the earth's surface from earthquakes or explosions. Ground motion or shaking is produced by waves that are generated by a sudden slip on a fault or sudden pressure at the explosive source and travel through the Earth and along its surface.
- *Landslide*: A movement of surface material down a slope.
- *Liquefaction*: A process by which water-saturated sediment temporarily loses strength and acts as a fluid, like the wet sand near the water at the beach. Earthquake shaking can cause this effect.
- *Tectonic Deformation*: A change in the original shape of a material caused by stress and strain.

- *Tsunami*: A sea wave of local or distant origin that results from large-scale seafloor displacements associated with large earthquakes, major sub-marine slides, or exploding volcanic islands.
- *Seiche*: The sloshing of a closed body of water, such as a lake or bay, from earthquake shaking (USGS 2012a).

Earthquakes also contribute to other natural hazards including landslide, dam failure (most common to earth-fill dams) and tsunamis. A secondary effect of earthquakes that is often observed in low-lying areas near water bodies is ground liquefaction. Liquefaction is the conversion of water-saturated soil into a fluid-like mass. This can occur when loosely packed, waterlogged sediments lose their strength in response to strong shaking. Liquefaction effects may occur along the shorelines of the ocean, rivers, and lakes and they can also happen in low-lying areas away from water bodies in locations where the ground water is near the earth's surface.

EXTENT

An earthquake's magnitude and intensity are used to describe the size and severity of the event. Magnitude describes the size at the focal point of an earthquake, and intensity describes the overall severity of shaking felt during the event. The earthquake's magnitude is a measure of the energy released at the source of the earthquake. Magnitude was formerly expressed by ratings on the Richter scale but is now most commonly expressed using the moment magnitude (Mw) scale. This scale is based on the total moment release of the earthquake (the product of the distance a fault moved, and the force required to move it). The scale is as follows:

- Great Mw > 8
- Major Mw = 7.0 – 7.9
- Strong Mw = 6.0 – 6.9
- Moderate Mw = 5.0 – 5.9
- Light Mw = 4.0 – 4.9
- Minor Mw = 3.0 – 3.9
- Micro Mw = 3.0 – 3.9

The most commonly used intensity scale is the modified Mercalli intensity scale. Ratings of the scale, as well as the perceived shaking and damage potential for structures, are shown in Table 4.3.1-1. The modified Mercalli intensity scale is generally represented visually using shake maps, which show the expected ground shaking at any given location produced by an earthquake with a specified magnitude and epicenter. An earthquake has only one magnitude and one epicenter, but it produces a range of ground shaking at sites throughout the region, depending on the distance from the earthquake, the rock and soil conditions at sites, and variations in the propagation of seismic waves from the earthquake due to complexities in the structure of the earth's crust. A USGS shake map shows the variation of ground shaking in a region immediately following significant earthquakes.

Table 4.3.1-1. Modified Mercalli Intensity Scale and PGA Equivalents

Mercalli Intensity	Shaking	Acceleration (%g) (PGA)	Potential Damage	Description
I	Not Felt	< .17	None	Not felt except by a very few under especially favorable conditions.
II	Weak	.17 – 1.4	None	Felt only by a few persons at rest, especially on upper floors of buildings.
III	Weak	.17 – 1.4	None	Felt quite noticeably by persons indoors, especially on upper floors of buildings. Many people do not recognize it as an earthquake. Standing motor cars may rock slightly. Vibrations similar to the passing of a truck. Duration estimated.

Mercalli Intensity	Shaking	Acceleration (%g) (PGA)	Potential Damage	Description
IV	Light	1.4 – 3.9	None	Felt indoors by many, outdoors by few during the day. At night, some awakened. Dishes, windows, doors disturbed; walls make cracking sound. Sensation similar to heavy truck striking building. Standing motor cars rocked noticeably.
V	Moderate	3.9 – 9.2	Very Light	Felt by nearly everyone; many awakened. Some dishes, windows broken. Unstable objects overturned. Pendulum clocks may stop.
VI	Strong	9.2 – 18	Light	Felt by all, many frightened. Some heavy furniture moved; a few instances of fallen plaster. Damage slight.
VII	Very Strong	18 – 34	Moderate	Damage negligible in buildings of good design and construction; slight to moderate in well-built ordinary structures; considerable damage in poorly built or badly designed structures; some chimneys broken.
VIII	Severe	34 – 65	Moderate to Heavy	Damage slight in specially designed structures; considerable damage in ordinary substantial buildings with partial collapse. Damage great in poorly built structures. Fall of chimneys, factory stacks, columns, monuments, walls. Heavy furniture overturned.
IX	Violent	65-124	Heavy	Damage considerable in specially designed structures; well-designed frame structures thrown out of plumb. Damage great in substantial buildings, with partial collapse. Buildings shifted off foundations.
X	Extreme	>124	Very Heavy	Some well-built wooden structures destroyed; most masonry and frame structures destroyed with foundations. Rails bent.

Source: Freeman et al. (Purdue University) 2004; USGS 2016c
Note: PGA Peak Ground Acceleration

The ground experiences acceleration as it shakes during an earthquake. The peak ground acceleration (PGA) is the largest acceleration recorded by a monitoring station during an earthquake. PGA is a measure of how hard the earth shakes in a given geographic area. It is expressed as a percentage of the acceleration due to gravity (%g). Horizontal and vertical PGA varies with soil or rock type. Earthquake hazard assessment involves estimating the annual probability that certain ground accelerations will be exceeded, and then summing the annual probabilities over a time period of interest. Damage levels experienced in an earthquake vary with the intensity of ground shaking and with the seismic capacity of structures, as noted in Table 4.3.5-2.

Table 4.3.5-2. Damage Levels Experienced in Earthquakes

Ground Motion Percentage	Explanation of Damage
1-2%g	Motions are widely felt by people; hanging plants and lamps swing strongly, but damage levels, if any, are usually very low.
Below 10%g	Usually causes only slight damage, except in unusually vulnerable facilities.
10 - 20%g	May cause minor-to-moderate damage in well-designed buildings, with higher levels of damage in poorly designed buildings. At this level of ground shaking, only unusually poor buildings would be subject to potential collapse.
20 - 50%g	May cause significant damage in some modern buildings and very high levels of damage (including collapse) in poorly designed buildings.
≥50%g	May cause higher levels of damage in many buildings, even those designed to resist seismic forces.

Source: NJOEM 2011
Note: %g Peak Ground Acceleration

National maps of earthquake shaking hazards provide information for creating and updating seismic design requirements for building codes, insurance rate structures, earthquake loss studies, retrofit priorities, and land use planning. After thorough review of the studies, professional organizations of engineers update the seismic-risk maps and seismic design requirements contained in building codes (Brown et al., 2001). The USGS updated the National Seismic Hazard Maps in 2014. New seismic, geologic, and geodetic information on earthquake rates and associated ground shaking were incorporated into these revised maps. The 2014 map represents the best available data, as determined by the USGS (refer to Figure 4.3.5-1).

Figure 4.3.5-1. 2014 Seismic Hazard Map, PGA with 10% Probability of Exceedance in 50 Years

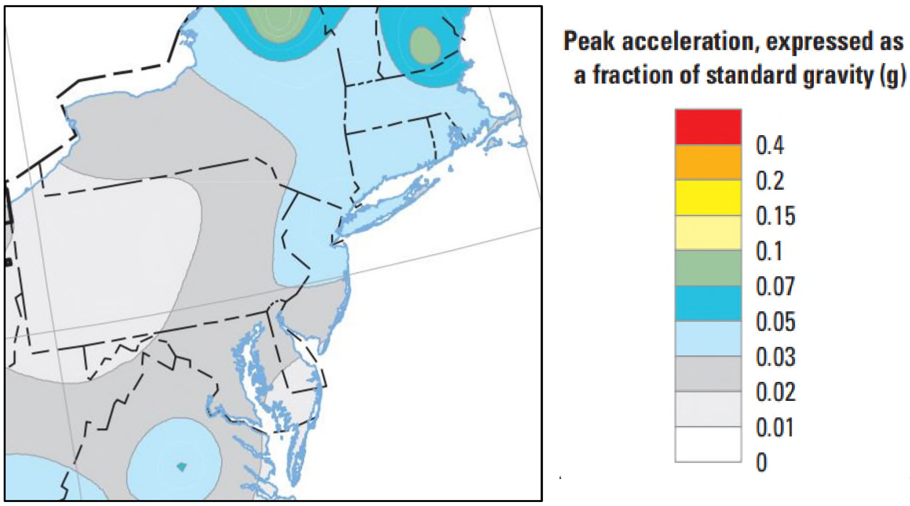


Figure 4.3.5-2 through Figure 4.3.5-4 illustrate geographic distributions of the Modified Mercalli Scale based on PGAs (*g*) across Hudson County for 100-, 500-, and 2,500-year MRP events at the census-tract level. A 100-year mean return period (MRP) event is an earthquake with 1 percent chance that mapped ground motion levels (PGA) will be exceeded in any given year. A 500-year MRP is an earthquake with 0.2 percent chance that mapped PGAs will be exceeded in any given year. A 2,500-year MRP is an earthquake with 0.04 percent chance that mapped PGAs will be exceeded in any given year.

Figure 4.3.5-2. Peak Ground Acceleration 100-Year Mean Return Period for Hudson County

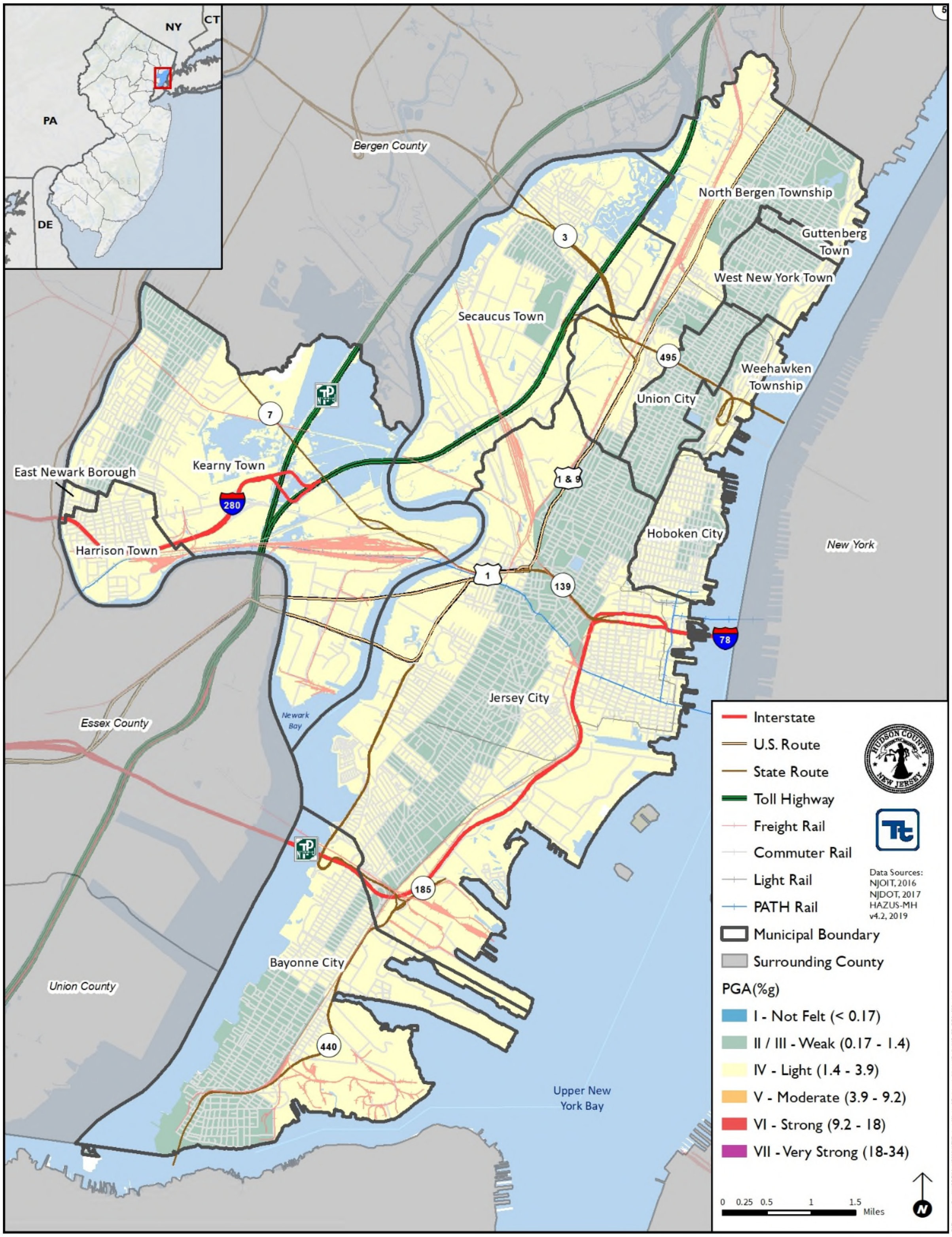


Figure 4.3.5-3. Peak Ground Acceleration 500-Year Mean Return Period for Hudson County

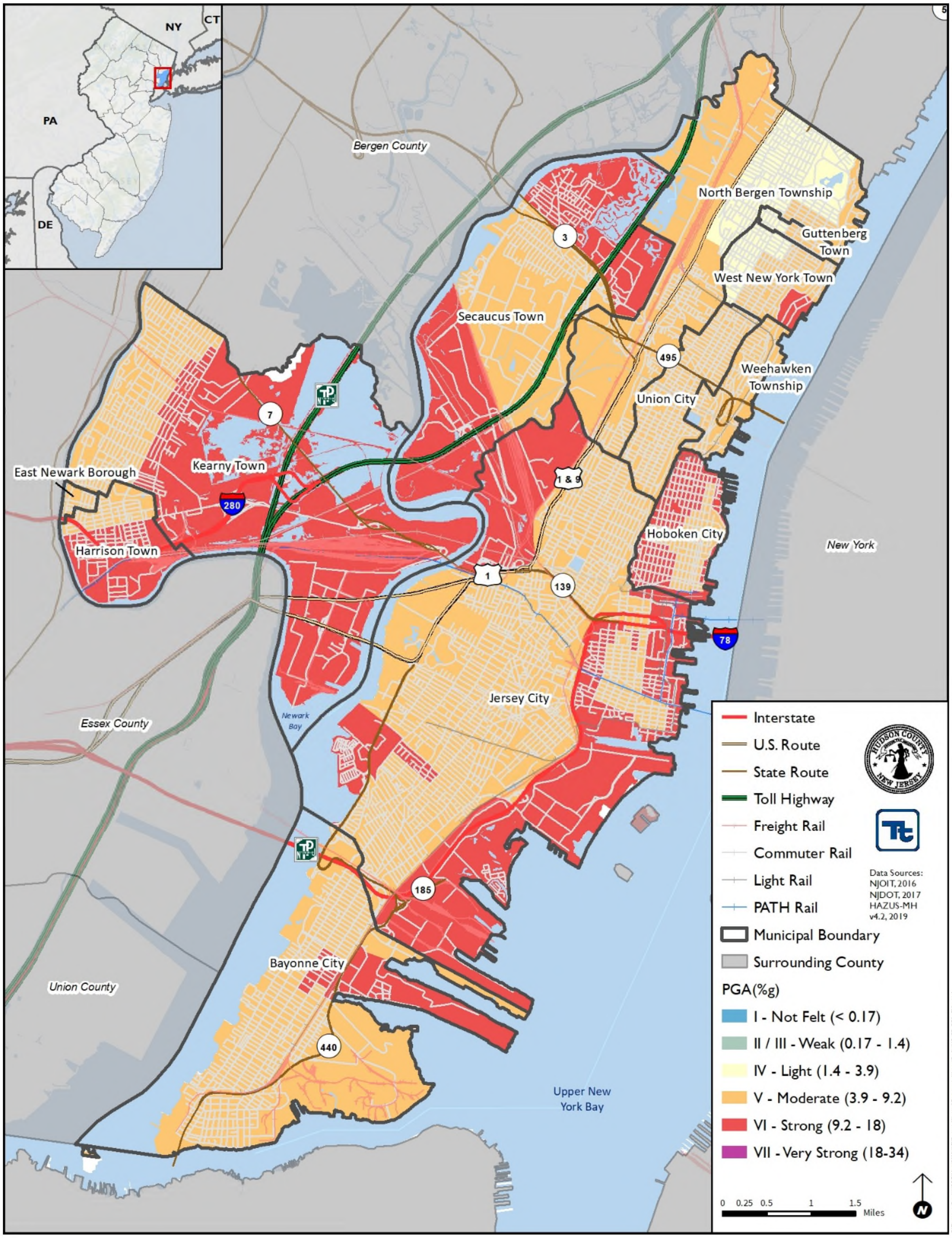
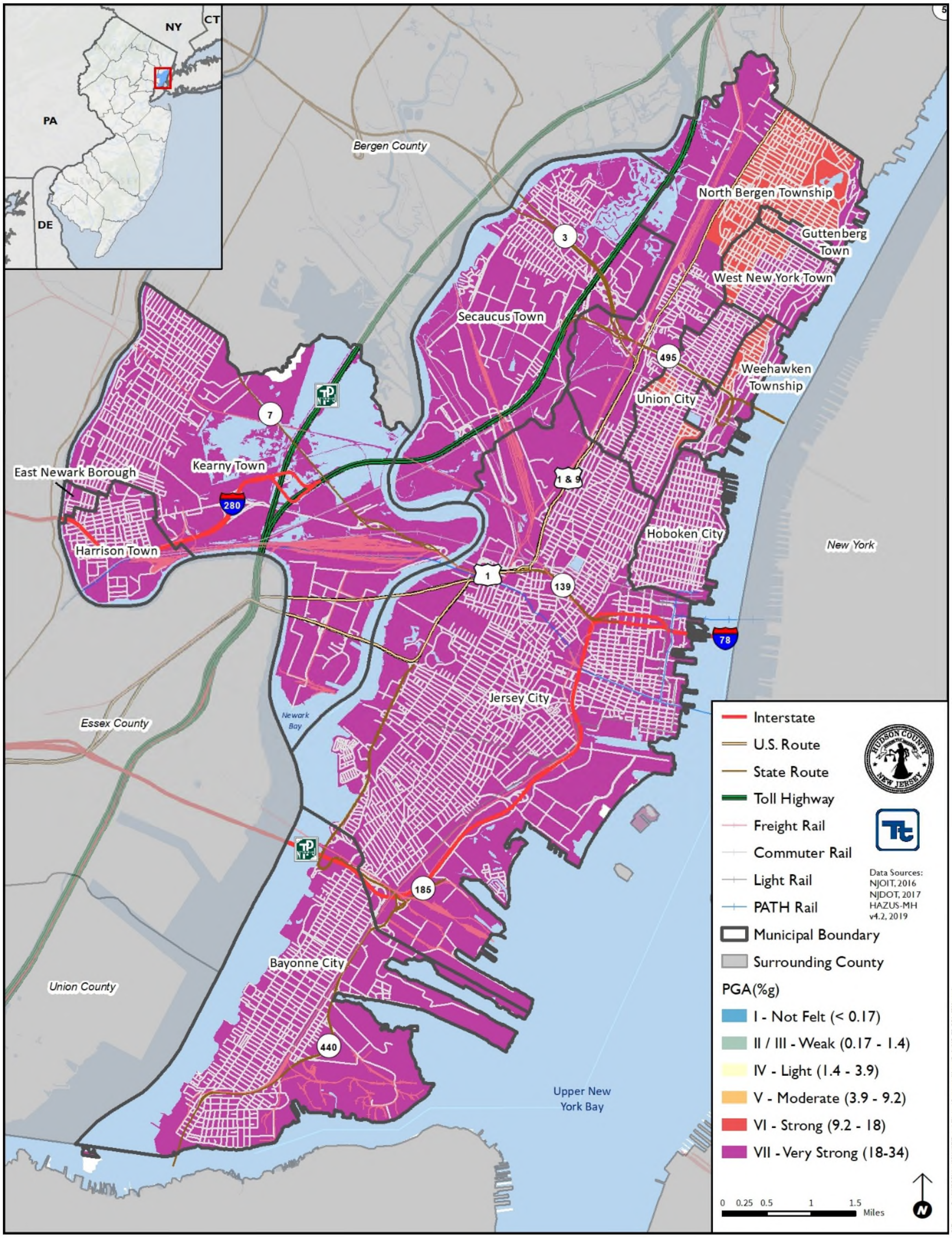


Figure 4.3.5-4. HMP Peak Ground Acceleration 2,500-Year Mean Return Period for Hudson County



LOCATION

Earthquakes are most likely to occur in the northern parts of New Jersey, which includes Hudson County, where significant faults are concentrated; however, low-magnitude events can and do occur in many other areas of the State. The National Earthquake Hazard Reduction Program (NEHRP) developed five soil classifications defined by their shear-wave velocity that impact the severity of an earthquake. The soil classification system ranges from A to E, as noted in Table 4,3,5-3, where A represents hard rock that reduces ground motions from an earthquake and E represents soft soils that amplify and magnify ground shaking and increase building damage and losses.

Table 4.3.5-3. NEHRP Soil Classifications

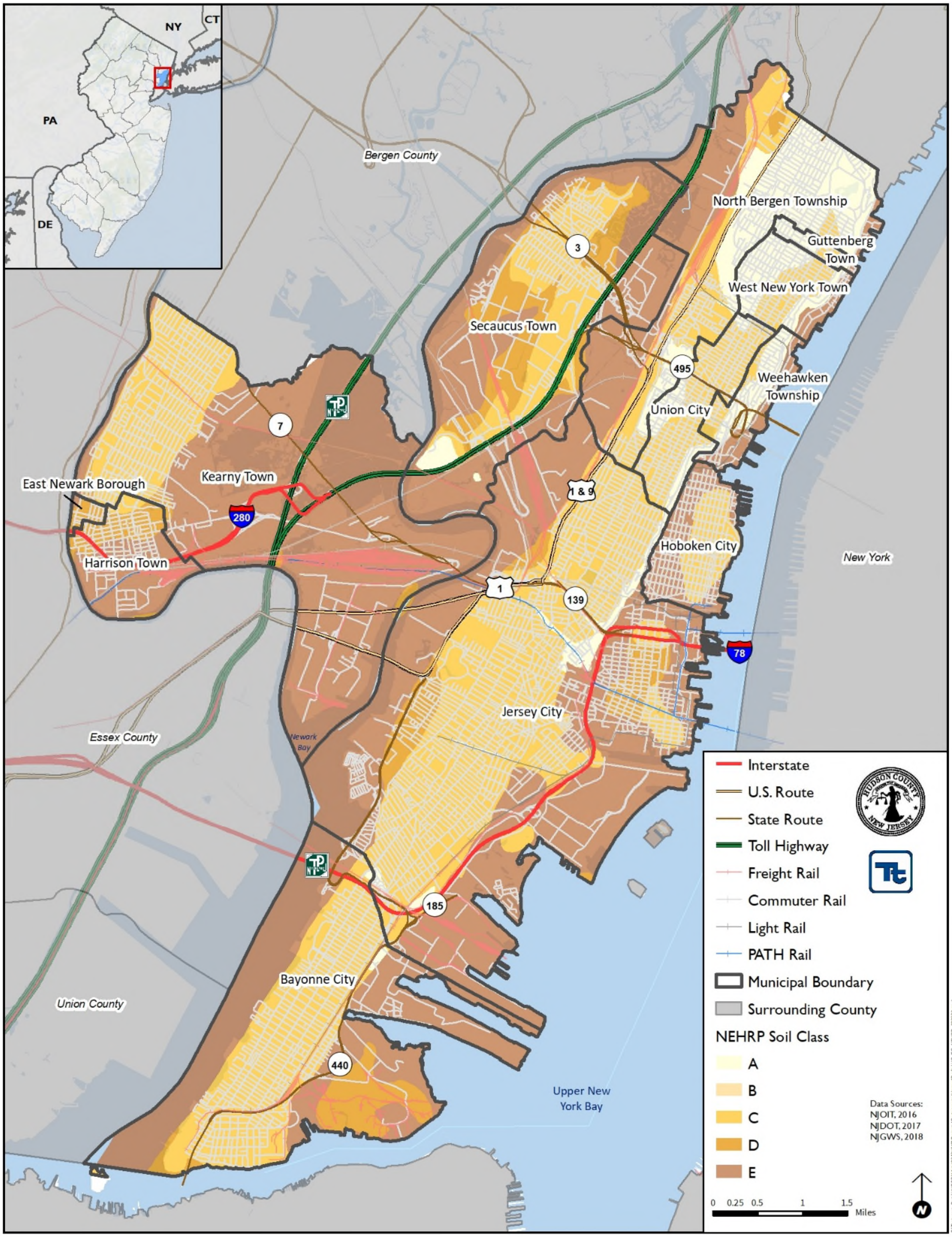
Soil Classification	Description
A	Hard rock
B	Rock
C	Very dense soil and soft rock
D	Stiff soils
E	Soft soils

Source: FEMA 2014

Figure 4.3.5-5 illustrates the NEHRP soils located in Hudson County from the New Jersey Geologic and Water Survey (NJGWS). The available NEHRP soils information is incorporated into the HAZUS-MH earthquake model for the risk assessment (discussed in further detail later in this section). According to this figure, Hudson County is predominately underlain by Class E soils (soft soil) with a band of Class A running north-south in the eastern portion of the County.

Class E soils include water-saturated mud and artificial fill. The strongest amplification of shaking due is expected for this soil type. Seismic waves travel faster through hard rock than through softer rock and sediments. As the waves pass from harder to softer rocks, the waves slow down and their amplitude increases. Shaking tends to be stronger at locations with softer surface layers where seismic waves move more slowly. Ground motion above an unconsolidated landfill or soft soils can be more than 10 times stronger than at neighboring locations on rock for small ground motions (FEMA 2014).

Figure 4.3.5-5. NEHRP Soils in Hudson County



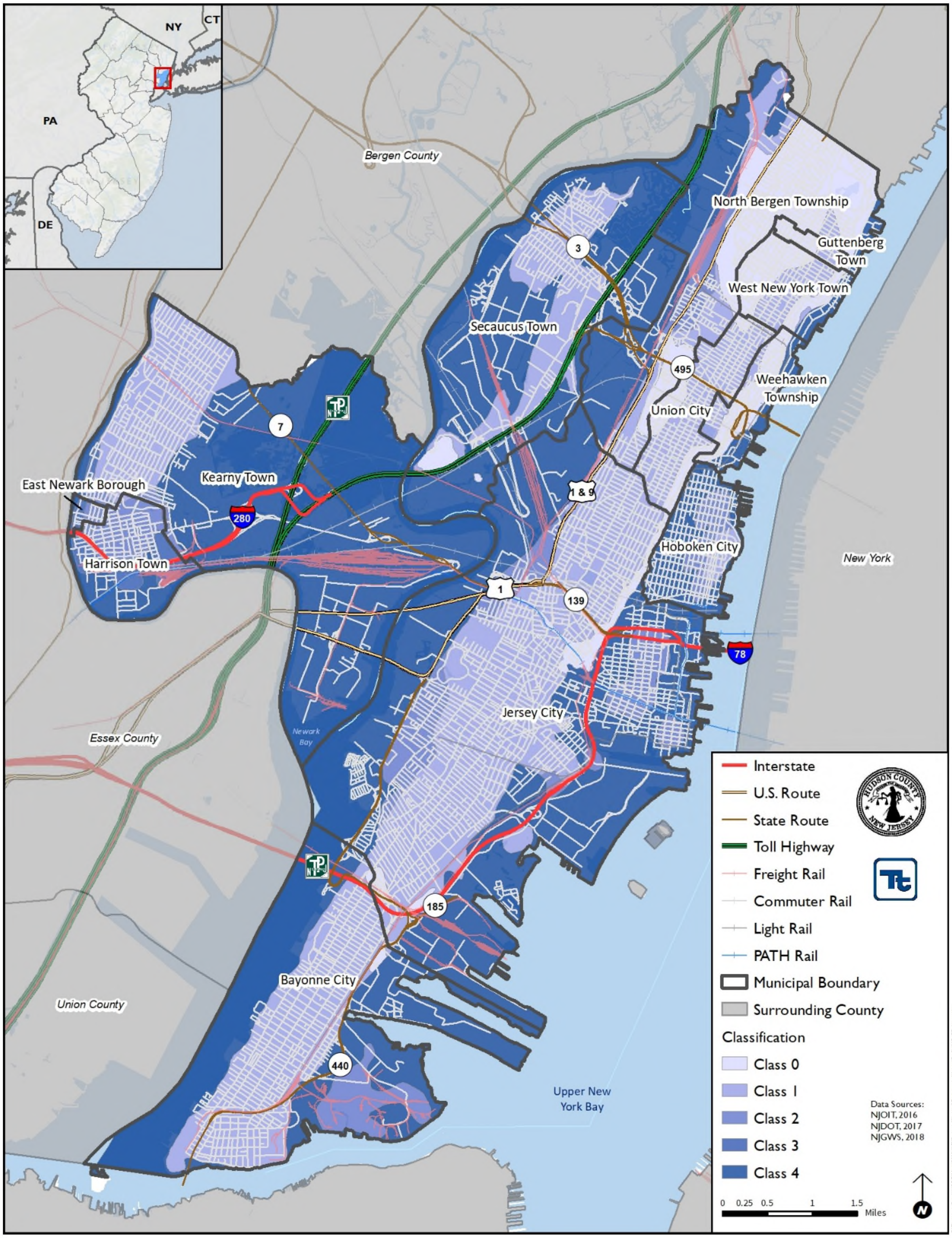
Liquefaction has been responsible for tremendous amounts of damage in historical earthquakes around the world. Shaking behavior and liquefaction susceptibility of soils are determined by their grain size, thickness, compaction, and degree of saturation. These properties, in turn, are determined by the geologic origin of the soils and their topographic position. This was done in Hudson County by the New Jersey Geological Survey. Soils were classed into the HAZUS categories using Standard Penetration Test (SPT) data, which were acquired during the drilling of test borings. Approximately 300 borings in the Hudson County-Newark area contained engineering data usable for HAZUS soil classification. The boring logs also reported the water table depth, which marks the upper limit of saturation. This information, along with the grain size and compaction of the soil, was used to map liquefaction susceptibility in Hudson County.

Figure 4.3.5-6 illustrates the liquefaction susceptibility for Hudson County. The classification categories are from the HAZUS User's Manual, Table 9.1. The coverage shows the liquefaction susceptibility of natural soils. Man-made fill overlies these soils, particularly those in Category 4, in some areas. Typically, fill has a low liquefaction susceptibility, uncompacted sand, and silt fills may liquefy. The behavior or fill during seismic shaking should be addressed on a site-specific basis. The categories are as follows:

- Category 1 – Very Low
- Category 2 – Low
- Category 3 – Moderate
- Category 4 – High

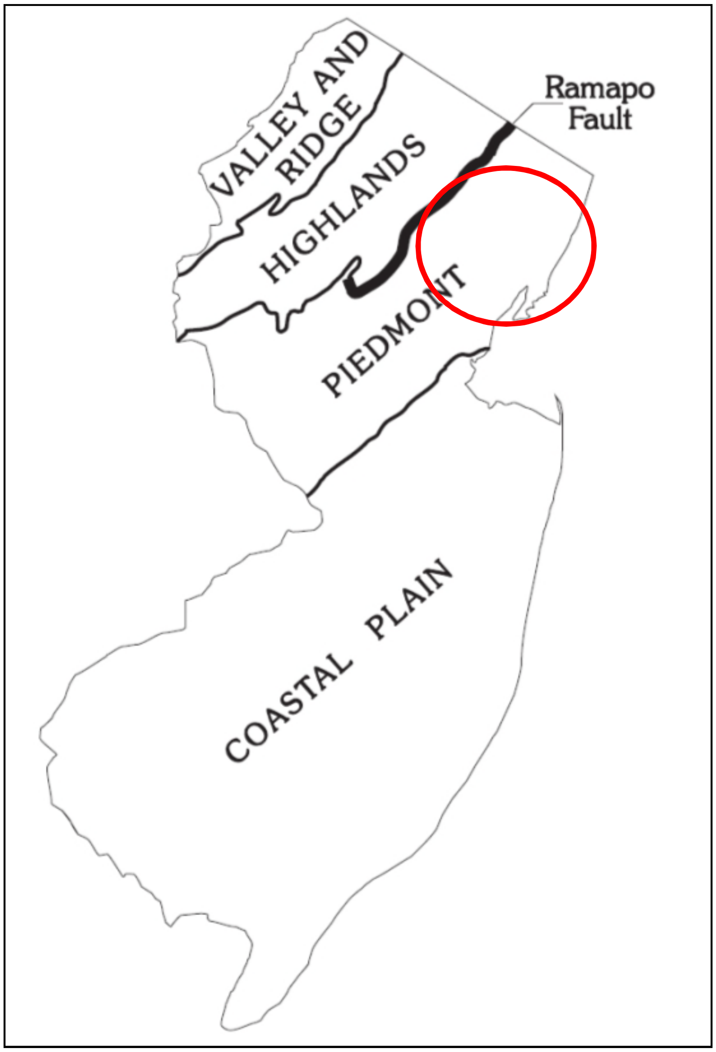
As shown in Figure 4.3.5-6, liquefaction susceptibility varies throughout Hudson County. A central band of the County, from the Town of Guttenberg to the City of Bayonne is shown as having a very low susceptibility. Areas along the Newark Bay and Upper New York Bay and Hudson River are shown as having high liquefaction susceptibility. Parts of Secaucus, East Newark, Hoboken, and Jersey City have areas of low to moderate susceptibility.

Figure 4.3.5-6. Liquefaction Classes in Hudson County.



There are many faults in New Jersey; however, the Ramapo Fault, which separates the Piedmont and Highlands Physiographic Provinces, is best known. Numerous minor earthquakes have been recorded in the Ramapo Fault zone, a 10- to 20-mile-wide area lying adjacent to, and west, of the actual fault (Dombroski 1973 [revised 2005]). Figure 4.3.5-7 illustrates the relationship of the Ramapo fault line with the physiologic provinces of New Jersey. Hudson County is located in the Piedmont Province and within the vicinity of the Ramapo Fault line.

Figure 4.3.5-7. Physiographic Provinces of New Jersey and Ramapo Fault Line



Source: Dombroski 1973 (revised 2005)
Note: The red circle indicates the approximate location of Hudson County.

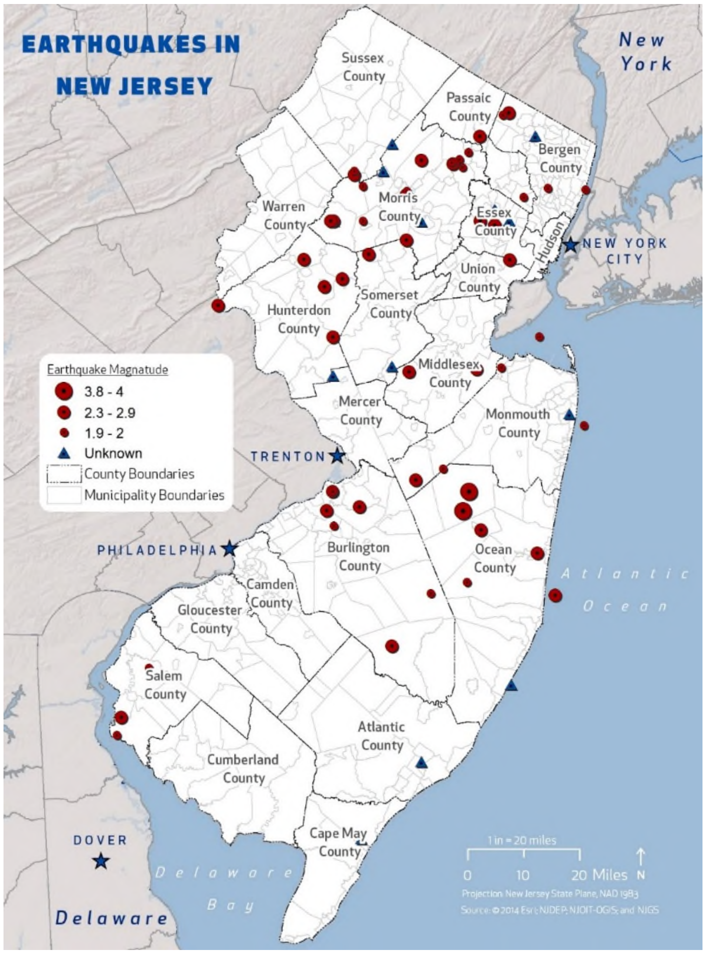
Past Occurrence

Historically, New Jersey and Hudson County have not experienced a major earthquake. Between 1954 and 2019, the state of New Jersey was not included in any FEMA earthquake-related major disaster (DR) or emergency (EM) declarations. However, there have been a number of earthquakes of relatively low intensity.

According to the NJGWS, records for the New York City area, which have been kept for 300 years, provide good information for estimating the frequency of earthquakes in New Jersey. Earthquakes with a maximum intensity of VII have occurred in the New York City area in 1737, 1783, and 1884. One intensity VI, four intensity V's, and at least three intensity III shocks have also occurred in the New York area over the last 300 years.

Figure 4.3.5-8 illustrates epicenters of historical earthquakes in New Jersey that occurred between 1783 and 2017. Multiple earthquakes originating outside the state borders have also been felt within the State.

Figure 4.3.5-8. Earthquake Epicenters and Magnitude, October 1975 to September 2013



Source: State of NJ HMP 2019

According to NJ GeoWeb, Hudson County has been impacted by three earthquake events with an epicenter in the County (Table 4.3.5-4).

Table 4.3.5-4. Historical Earthquake Events in Hudson County, 1816 to 2019

Dates of Event	Magnitude	Fault Depth (km)
September 13, 1939	2.2	-
October 24, 1997	0.5	7
July 8, 2014	1.6	11.1

Source: NJ GeoWeb 2019

Table 4.3.5-5 summarizes the known earthquake events that have impacted Hudson County between 2015 and 2019. For events prior to 2015, refer to Appendix X (Risk Assessment Supplement). The annexes in Section 9 provide detailed information regarding impacts and losses identified for each plan participants, if any and available.

Table 4.3.5-5. Earthquake Events Impacting Hudson County Between 2015 and 2019

Dates of Event	Event Type	FEMA Declaration Number	County Designated?	Location	Losses/Impacts
November 30, 2017	4.1 Earthquake	N/A	N/A	Dover, Delaware	Hudson County residents felt ground shake from nearby 4.1 magnitude earthquake in Dover, Delaware. The quake was felt from central Virginia to Massachusetts.
April 12, 2019	1.8 Earthquake	N/A	N/A	Clifton, New Jersey	A magnitude 1.8 earthquake took place in Clifton, NJ. The quake was faintly felt in the northern portion of Hudson County.
April 12, 2019	1.8 Earthquake	N/A	N/A	Clifton, New Jersey	A magnitude 1.8 earthquake took place in Clifton, NJ. The quake was faintly felt in the northern portion of Hudson County.

Source: *USGS 2019*
Note: *Not all events that have occurred in Hudson County are included due to the extent of documentation and the fact that not all sources have been identified or researched.*
K: Thousand

Probability of Future Occurrence

Earthquakes cannot be predicted and may occur any time of the day or year. The probability of damaging earthquakes affecting New Jersey and Hudson County is low. However, there is a definite threat of major earthquakes that could cause widespread damage and casualties in New Jersey. Major earthquakes are infrequent in the State and may occur only once every few hundred years or longer, but the consequences of major earthquakes would be very high.

For the purposes of this HMP update, the probability of future occurrences is defined by the number of events over a specified period of time. There have been zero earthquake-related disasters declared for the State of New Jersey, therefore the entire historical record was consulted. The historical record indicates 204 earthquakes recorded for New Jersey from 1783 to 2017. Based on this statistic, the State may experience one earthquake of any magnitude each year.

In Section 4.4, the identified hazards of concern for Hudson County were ranked. The probability of occurrence, or likelihood of the event, is one parameter used for hazard rankings. Based on historical records and input from the Planning Committee, the probability of occurrence for earthquake events in the County is considered ‘Rare' (hazard event is likely to occur 1 to 10% annual chance) that will cause impacts as described in the vulnerability assessment below.

Climate Change

Providing projections of future climate change for a specific region is challenging. Shorter term projections are more closely tied to existing trends making longer term projections even more challenging. The further out a prediction reaches the more subject to changing dynamics it becomes. The potential impacts of global climate change on earthquake probability are unknown. Some scientists feel that melting glaciers could induce tectonic activity. As ice melts and water runs off, tremendous amounts of weight are shifted on the Earth's crust. As newly freed crust returns to its original, pre-glacier shape, it could cause seismic plates to slip and stimulate volcanic activity according to research into prehistoric earthquakes and volcanic activity. National Aeronautics and Space Administration (NASA) and USGS scientists found that retreating glaciers in southern Alaska might be opening the way for future earthquakes (New Jersey State HMP 2014).

Secondary impacts of earthquakes could be magnified by future climate change. Soils saturated by repetitive storms could experience liquefaction during seismic activity because of the increased saturation. Dams storing increased volumes of water from changes in the hydrograph could fail during seismic events. There are currently no models available to estimate these impacts (New Jersey State HMP 2014).

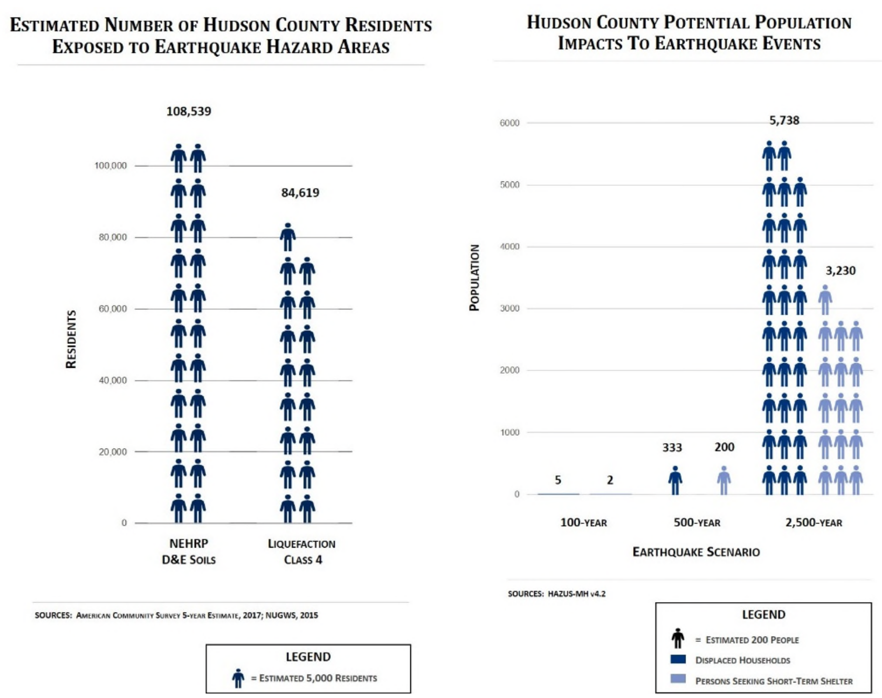
4.3.5.2 Vulnerability Assessment

A probabilistic assessment was conducted for the 100-, 500- and 2,500-year MRPs through a Level 2 analysis in HAZUS-MH to analyze the earthquake hazard and provide a range of loss estimates. Figure 4.3.5-5 shows the geographic distribution of the NEHRP soil types in the County. Figure 4.3.5-6 shows the geographic distribution of the liquefaction soil types in the County. Refer to Section 4.2 (Methodology and Tools) for additional details on the methodology used to assess earthquake risk.

Impact on Life, Health, and Safety

The entire County may experience an earthquake. However, the degree of impact is dependent on many factors including the age and type of construction people live in, the soil types their homes are located on, the intensity of the earthquake. Whether directly or indirectly impacted, residents could be faced with business closures, road closures that could isolate populations, and loss of function of critical facilities and utilities.

Figure 4.3.5-1. Impacts of Persons Exposed to Earthquake Hazard Areas and Earthquake Events



According to the 2017 American Community Survey annual estimate, Hudson County had a population of 679,756 people. Overall, risk to public safety and loss of life from an earthquake in the County is minimal. However, there is a higher risk to public safety for those inside buildings due to structural damage or people walking below building ornamentations and chimneys that may be shaken loose and fall because of an earthquake.

As noted earlier, NEHRP Soil Classes D and E and liquefaction Class 4 soils can amplify ground shaking to damaging levels even during a moderate earthquake, and thus increase risk to the population. Populations within municipalities located on NEHRP Class D and E soils and high liquefaction susceptible soils were estimated and are listed in Table 4.3.5-6 below (also refer to Figure 4.3.5-9). Overall, approximately 108,539 residents (16% of the County's population) are located on NEHRP class D and E soils. In addition, 84,619 people (12.4% of the County's population) are located in areas of high susceptibility to liquefaction. The Town of Harrison has the greatest percent of its population residing on NEHRP Class D and E soils (96.8% of total population). The City of Hoboken has the greatest number of residents located in the Liquefaction Class 4 area (46.5% of total population).

Table 4.3.5-6. Approximate Population within NEHRP and Liquefaction Areas

Municipality	American Community Survey (2013-2017) Population	Estimated Population Exposed			
		NEHRP D&E Soils	% of Total	Liquefaction Class 4	% of Total
Bayonne, City of	66,719	1,266	1.9%	2,460	3.7%
East Newark, Borough of	2,725	2,573	94.4%	0	0.0%
Guttenberg, Town of	11,733	0	0.0%	0	0.0%
Harrison, Town of	15,898	15,393	96.8%	57	0.4%
Hoboken, City of	54,117	20,478	37.8%	25,152	46.5%
Jersey City, City of	265,932	55,946	21.0%	44,734	16.8%
Kearny, Town of	42,487	2,118	5.0%	1,559	3.7%
North Bergen, Township of	63,438	374	0.6%	374	0.6%
Secaucus, Town of	19,279	4,734	24.6%	4,865	25.2%
Union City, City of	69,815	0	0.0%	0	0.0%
Weehawken, Township of	14,268	542	3.8%	302	2.1%
West New York, Town of	53,345	5,116	9.6%	5,116	9.6%
Hudson County (Total)	**679,756**	**108,539**	**16.0%**	**84,619**	**12.4%**

Sources: American Community Survey 5-year Estimate, 2017; NJGWS, 2015

Populations considered most vulnerable are those located in/near the built environment, particularly those near unreinforced masonry structures. Of these most vulnerable populations, socially vulnerable populations, including the elderly (persons over age 65) and individuals living below the census poverty threshold, are most susceptible. Factors leading to this higher susceptibility include decreased mobility and financial ability to react or respond during a hazard, and the location and construction quality of their housing. Within the NEHRP Class D and E soils, there are 8,689 people over the age of 65 and 12,393 people below the poverty level. Within Liquefaction Class 4 soils, there are 6,008 people over the age of 65 and 9,109 people below the poverty level.

The CDC 2016 Social Vulnerability Index (SVI) ranks U.S. Census tracts on socioeconomic status, household composition and disability, minority status and language, and housing and transportation. Hudson County's overall score is 0.6425, indicating that its communities have moderate to high vulnerability (CDC 2016, refer to Figure 4.3.6-10 and Figure 4.3.6-

11). These maps show that areas most vulnerable to liquefaction and ground shaking hazards have low to mid-level social vulnerability rankings.

Figure 4.3.6-10. CDC Social Vulnerability Index Rating for Hudson County and Liquefaction Classes

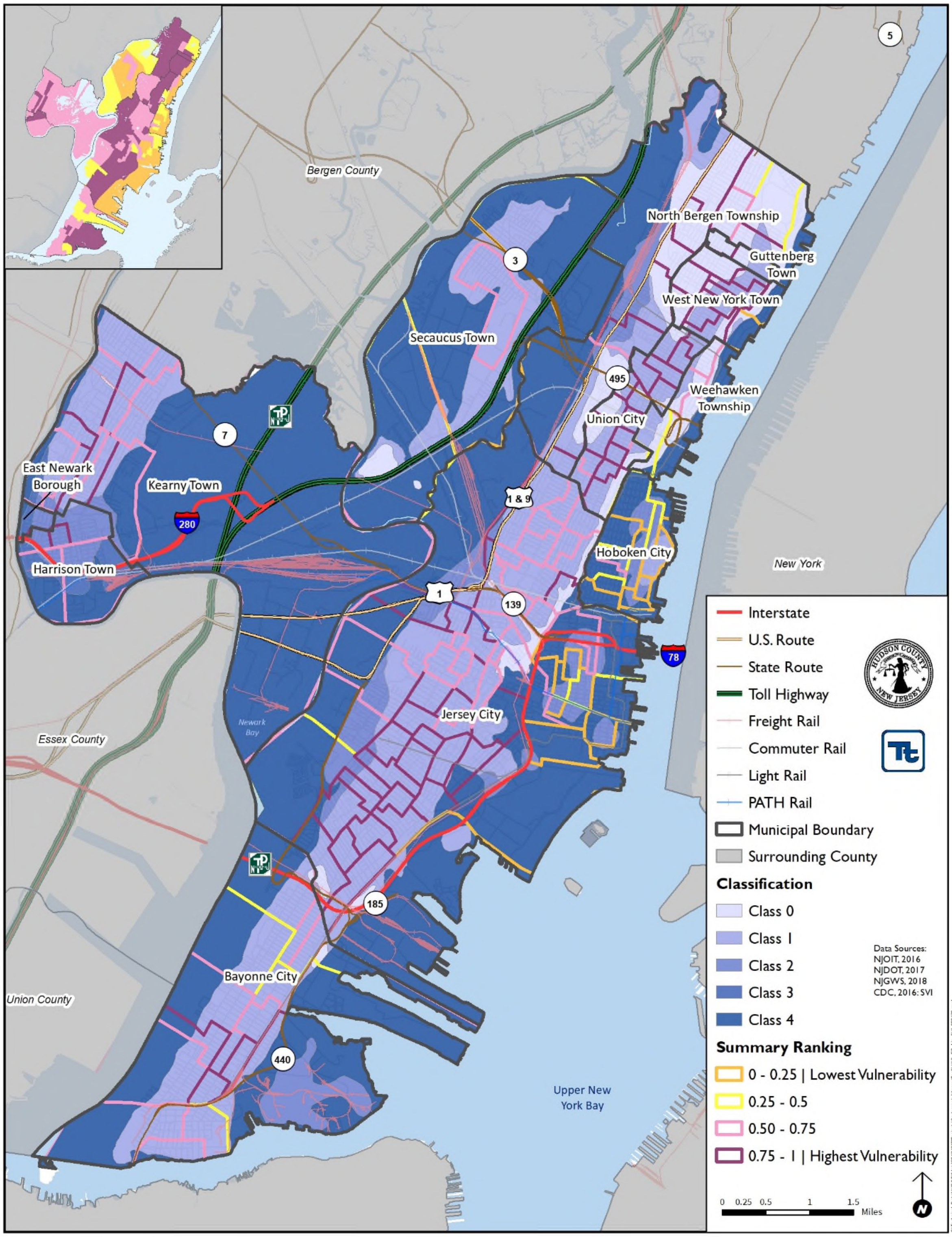
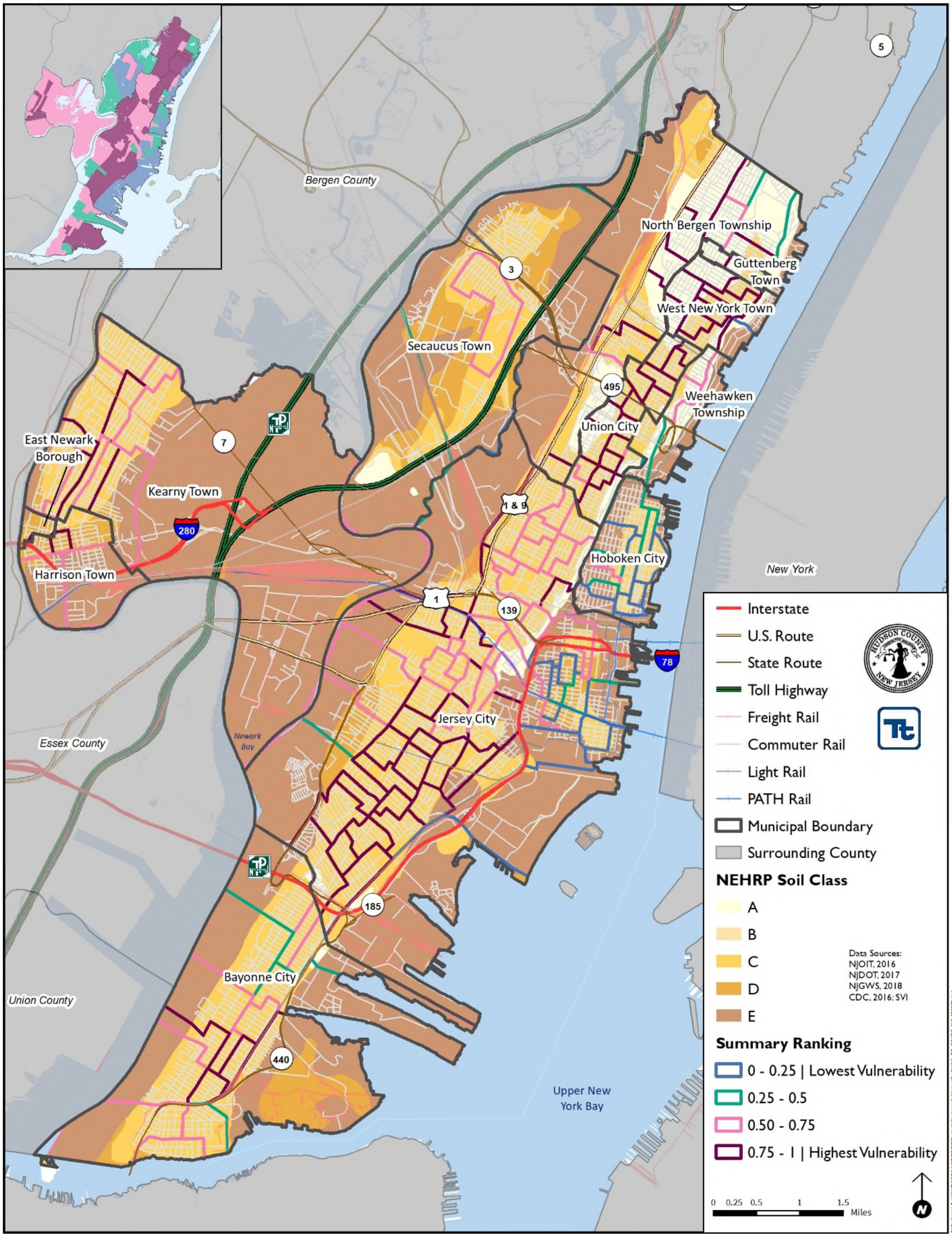


Figure 4.3.6-11. CDC Social Vulnerability Index Rating for Hudson County and NEHRP Soils



Residents may be displaced or require temporary to long-term sheltering due to an earthquake event. The number of people requiring shelter is generally less than the number displaced as some displaced persons use hotels or stay with family or friends following a disaster event. Table 4.3.5-7 summarizes the households HAZUS-MH v4.2 estimates will be displaced and population that may require short-term sheltering as a result of the 100-, 500- and 2,500-year MRP earthquake events.

Table 4.3.5-7. Summary of Estimated Sheltering Needs for Hudson County

Scenario	Displaced Households	Persons Seeking Short-term Shelter
100-Year Earthquake	5	2
500-Year Earthquake	333	200
2,500-Year Earthquake	5,738	3,230

Source: HAZUS-MH v4.2

According to the 1999-2003 NYCEM Summary Report (Earthquake Risks and Mitigation in the New York / New Jersey / Connecticut Region), a strong correlation exists between structural building damage and number of injuries and casualties from an earthquake event. Further, time of day also exposes different sectors of the community to the hazard. For example, HAZUS-MH v4.2 considers residential occupancy at its maximum at 2:00 AM, whereas educational, commercial, and industrial sectors are at their maximum at 2:00 PM, and peak commute time is at 5:00 PM. Whether directly impacted or indirectly impacted, the entire population will be affected to some degree. Business interruption could prevent people from working, road closures could isolate populations, and loss of utilities could impact populations that suffered no direct damage from an event.

Table 4.3.5-8 summarizes the County-wide injuries and casualties estimated for the 100-, 500-, and 2,500-year MRP earthquake events.

Table 4.3.5-8. Estimated Number of Injuries and Casualties from the 100-, 500-, and 2,500-Year MRP Earthquake Events

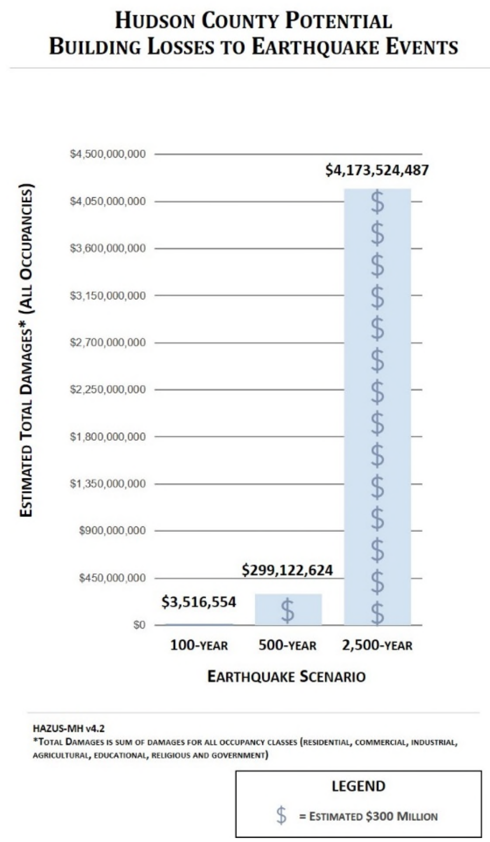
Level of Severity	Time of Day		
	2:00 AM	2:00 PM	5:00 PM
100-year MRP			
Injuries	1	1	1
Hospitalization	0	0	0
Casualties	0	0	0
500-year MRP			
Injuries	45	48	40
Hospitalization	7	7	6
Casualties	1	1	1
2,500-year MRP			
Injuries	542	599	503
Hospitalization	115	133	128
Casualties	23	28	25

Source: HAZUS-MH v4.2

Impact on General Building Stock

The entire County's general building stock is considered at risk and exposed to this hazard. As stated earlier, soft soils (NEHRP Soil Classes D and E) can amplify ground shaking to damaging levels even during a moderate earthquake (NYCEM 2003). Therefore, buildings located on NEHRP Classes D and E soils and high liquefaction susceptible soils are at increased risk of damage from an earthquake. Table 4.3.5-9 summarizes the number and replacement cost value of buildings in Hudson County located on NEHRP Soils Classes D and E and liquefaction Class 4 soils.

Figure 4.3.5-2. Estimated Building Losses for Earthquake Events



There is a strong correlation between PGA and damage a building might undergo (NYCEM 2003). The HAZUS-MH model is based on best available earthquake science and aligns with these statements. The HAZUS-MH probabilistic earthquake model was applied to analyze effects from the earthquake hazard on general building stock in Hudson County. See Figure 4.3.5-2 through Figure 4.3.5-4 earlier in this profile which illustrates the geographic distribution of PGA (g) across the County for 100-, 500- and 2,500-year MRP events at the Census-tract level.

A building's construction determines how well it can withstand the force of an earthquake. The NYCEM report indicates that unreinforced masonry buildings are most at risk during an earthquake because the walls are prone to collapse outward, whereas steel and wood buildings absorb more of the earthquake's energy. Additional attributes that affect a building's capability to withstand an earthquake's force include its age, number of stories, and quality of construction. HAZUS-MH v4.2 considers building construction and age of building as part of the analysis. Because a custom general building stock was used for this HAZUS-MH v4.2 analysis, the building ages and building types from the inventory were incorporated into the HAZUS-MH v4.2 model.

Table 4.3.5-9. Number and Replacement Cost Value of Buildings within NEHRP and Liquefaction Areas

Municipality	Number of Buildings	Total Replacement Cost Value (RCV)	Estimated Building Stock Exposed							
			Number of Buildings - NEHRP D&E Soils	% of Total	RCV - NEHRP D&E Soils	% of Total	Number of Buildings - Liquefaction Class 4	% of Total	RCV - Liquefaction Class 4	% of Total
Bayonne, City of	6,802	$8,856,079,105	1080	15.9%	$3,146,811,619	35.5%	622	9.1%	$2,382,647,595	26.9%
East Newark, Borough of	403	$240,888,451	384	95.3%	$233,042,574	96.7%	2	0.5%	$2,245,463	0.9%
Guttenberg, Town of	1,227	$651,507,569	12	1.0%	$37,354,230	5.7%	12	1.0%	$37,354,230	5.7%
Harrison, Town of	2,537	$2,398,975,757	2460	97.0%	$2,363,243,880	98.5%	48	1.9%	$651,525,986	27.2%
Hoboken, City of	4,470	$3,910,202,233	1340	30.0%	$2,115,190,072	54.1%	1755	39.3%	$2,488,578,360	63.6%
Jersey City, City of	35894	$25,693,921,967	5845	16.3%	$10,964,517,476	42.7%	3715	10.3%	$9,776,897,942	38.1%
Kearny, Town of	7,209	$7,874,466,790	887	12.3%	$4,728,851,785	60.1%	771	10.7%	$4,622,081,272	58.7%
North Bergen, Township of	6,005	$8,393,144,641	112	1.9%	$2,288,410,575	27.3%	137	2.3%	$2,488,637,269	29.7%
Secaucus, Town of	3,845	$9,593,262,762	695	18.1%	$6,619,629,526	69.0%	713	18.5%	$6,649,809,810	69.3%
Union City, City of	1,729	$3,742,882,384	0	0.0%	$0	0.0%	0	0.0%	$0	0.0%
Weehawken, Township of	2,113	$1,510,119,929	123	5.8%	$584,359,934	38.7%	68	3.2%	$483,010,990	32.0%
West New York, Town of	4,594	$2,825,012,673	48	1.0%	$276,539,339	9.8%	48	1.0%	$276,539,339	9.8%
Hudson County (Total)	**76,828**	**$75,690,464,261**	**12,986**	**16.9%**	**33,357,951,012**	**44.1%**	**7,891**	**10.3%**	**29,859,328,258**	**39.4%**

Sources: American Community Survey 5-year Estimate, 2017; Microsoft, 2018, Open Street Map, 2019; NJOIT, 2018; NJGWS, 2016
RCV Replacment Cost Value.

Potential building damage was evaluated using HAZUS-MH v4.2 across the following damage categories: none, slight, moderate, extensive, and complete. Table 4.3.5-10 provides definitions of these five categories of damage to a light wood-framed building; definitions of categories of damage to other building types appear in HAZUS-MH technical manual documentation.

Table 4.3.5-10. Example of Structural Damage State Definitions for a Light Wood-Framed Building

Damage Category	Description
None	No damage recorded.
Slight	Small plaster or gypsum-board cracks at corners of door and window openings and wall-ceiling intersections; small cracks in masonry chimneys and masonry veneer.
Moderate	Large plaster or gypsum-board cracks at corners of door and window openings; small diagonal cracks across shear wall panels exhibited by small cracks in stucco and gypsum wall panels; large cracks in brick chimneys; toppling of tall masonry chimneys.
Extensive	Large diagonal cracks across shear wall panels or large cracks at plywood joints; permanent lateral movement of floors and roof; toppling of most brick chimneys; cracks in foundations; splitting of wood sill plates and/or slippage of structure over foundations; partial collapse of room-over-garage or other soft-story configurations.
Complete	Structure might have large permanent lateral displacement, can collapse, or be in imminent danger of collapse due to cripple wall failure or the failure of the lateral load resisting system; some structures can slip and fall off the foundations; large foundation cracks.

Source: HAZUS-MH Technical Manual

Building damage as a result of the 100-, 500- and 2,500-year MRP earthquake events was estimated using HAZUS-MH v4.2. Damage loss estimates include structural and non-structural damage to the building and loss of contents. Table 4.3.5-12 lists estimated replacement cost values (RCVs) of buildings and contents damaged by the 100-, 500- and 2,500-year MRP earthquake events.

Table 4.3.5-11. Estimated Buildings Damaged by General Occupancy for 100-year and 2,500-year MRP Events

Category	Expected Building Damage by Occupancy									
	100-Year MRP					2,500-Year MRP				
	None	Slight	Moderate	Extensive	Complete	None	Slight	Moderate	Extensive	Complete
Single Family	32,037.38 (35.44%)	13.10 (21.60%)	3.19 (20.91%)	0.31 (21.40%)	0.02 (24.72%)	30,150.08 (35.15%)	5,183.32 (32.34%)	1,568.66 (19.91%)	358.55 (15.88%)	73.39 (18.43%)
Other Residential	37,506.05 (41.49%)	15.43 (25.43%)	4.11 (27.00%)	0.38 (26.35%)	0.02 (27.45%)	38,643.83 (45.06%)	6,929.56 (43.24%)	3,210.09 (40.75%)	850.90 (37.68%)	143.62 (36.06%)
Commercial	12,919.37 (14.29%)	17.02 (28.06)	4.18 (27.41%)	0.40 (27.64%)	0.02 (27.32%)	11,291.48 (13.17%)	2,464.94 (15.38%)	1,838.00 (23.33%)	589.29 (26.10%)	102.29 (25.69%)
Education	455.48 (0.50%)	0.41 (0.68%)	0.10 (0.66%)	0.01 (0.66%)	0.00 (0.75%)	458.15 (0.53%)	87.69 (0.55%)	60.94 (0.77%)	17.22 (0.76%)	3.00 (0.75%)
Government	1,967.32 (2.18%)	4.56 (7.52%)	1.02 (6.69%)	0.09 (6.23%)	0.00 (5.05%)	1,282.76 (1.50%)	334.58 (2.09%)	305.17 (3.87%)	108.58 (4.81%)	19.91 (5.00%)
Industrial	4,462.36 (4.94%)	9.07 (14.94%)	2.34 (15.36%)	0.23 (15.58%)	0.01 (11.96%)	2,878.98 (3.36%)	808.12 (5.04%)	761.52 (9.67%)	291.00 (12.89%)	48.38 (12.15%)
Agriculture	95.86 (0.11%)	0.11 (0.18%)	0.02 (0.15%)	0.00 (0.16%)	0.00 (0.07%)	64.90 (0.08%)	17.09 (0.11%)	10.44 (0.13%)	3.10 (0.14%)	0.47 (0.12%)
Religion	955.73 (1.06%)	0.96 (1.58%)	0.28 (1.83%)	0.03 (1.98%)	0.00 (2.67%)	996.41 (1.16%)	201.96 (1.26%)	123.01 (1.56%)	39.43 (1.75%)	7.19 (1.80%)
Total	**90,400**	**61**	**15**	**1**	**0**	**85,767**	**16,027**	**7,878**	**2,258**	**398**

Source: HAZUS-MH v4.2

Table 4.3.5-12. Estimated Value (Building and Contents) Damaged by the 100-, 500-, and 2,500-Year MRP Earthquake Events

Municipality	Estimated Total Damages (All Occupancies)			
	Annualized Loss	100-Year	500-Year	2,500-Year
Bayonne, City of	$384,077	$83,150	$24,836,873	$334,452,644
East Newark, Borough of	$12,067	$0	$785,069	$11,129,058
Guttenberg, Town of	$23,635	$0	$1,494,173	$23,193,507
Harrison, Town of	$233,191	$235,387	$14,685,813	$183,138,727
Hoboken, City of	$456,515	$359,007	$26,998,811	$397,869,640
Jersey City, City of	$1,598,470	$1,232,508	$95,775,077	$1,377,771,875
Kearny, Town of	$1,041,145	$1,287,169	$60,212,104	$843,983,073
North Bergen, Township of	$348,701	$0	$22,664,795	$305,170,029
Secaucus, Town of	$569,133	$278,057	$37,091,903	$470,204,175
Union City, City of	$100,868	$0	$6,325,027	$102,824,966
Weehawken, Township of	$51,086	$0	$3,226,059	$47,003,496
West New York, Town of	$79,262	$41,276	$5,026,918	$76,783,296
Hudson County (Total)	**$4,898,150**	**$3,516,554**	**$299,122,624**	**$4,173,524,487**

*Source: HAZUS-MH v4.2 *Total Damages is sum of damages for all occupancy classes (residential, commercial, industrial, agricultural, educational, religious and government).*

HAZUS-MH estimates approximately $3.5 million, $299 million, and $4.17 billion of damage as a result of the 100-year MRP event, 500-Year MRP event, and 2,500-year MRP event, respectively. These damages account for less than 1-percent of total building replacement value in Hudson County for the 100- and 500-year MRP events, and 5.5% of total building replacement value in Hudson County for the 2,500-year MRP event. The sum of damages calculated in HAZUS include structural damage, non-structural damage, and loss of contents. Residential buildings account for less than 1-percent of total building replacement cost for both the 100- and 500-year MRP events, and 1.6-percent of total building replacement cost for the 2500-year MRP event. Commercial losses account for less than 1-percent of total building replacement cost for both the 100- and 500-year MRP events, and 1.9-percent of total building replacement cost for the 2500-year MRP event.

Historically, Building Officials Code Administration (BOCA) regulations in the northeast states were developed to address local concerns, including heavy snow loads and wind. Seismic requirements for design criteria are not as stringent as those of the west coast of the United States, which rely on the more seismically focused Uniform Building Code. As such, a smaller earthquake in the northeast can cause more structural damage than if it would occur in the west.

Impact on Critical Facilities

More than half of the critical facilities in Hudson County are considered exposed to the earthquake hazard. Refer to subsection "Critical Facilities" in Section 3 (County Profile) of this HMP for a complete inventory of critical facilities in Hudson County. Of the 583 critical facilities in the county, 367 are located on NEHRP Classes D or E soils and 313 are located on liquefaction class 4 soils. Jersey City has the greatest number of critical facilities exposed in both of these hazard areas, and majority of the exposed critical facilities are childcare facilities. Appendix E (Risk Assessment Supplement) summarizes the number of critical facilities, by type, located on NEHRP Soil Classes D or E and liquefaction Class 4 soils. Figures summarizing the number of critical facilities by type per municipality in Hudson County located on NEHRP Soil Classes D or E and liquefaction Class 4 soils are illustrated by Figure 4.3.5-13 to Figure 4.3.5-15).

Figure 4.3.5-3. Critical Facilities Exposed to Earthquake Hazard Areas

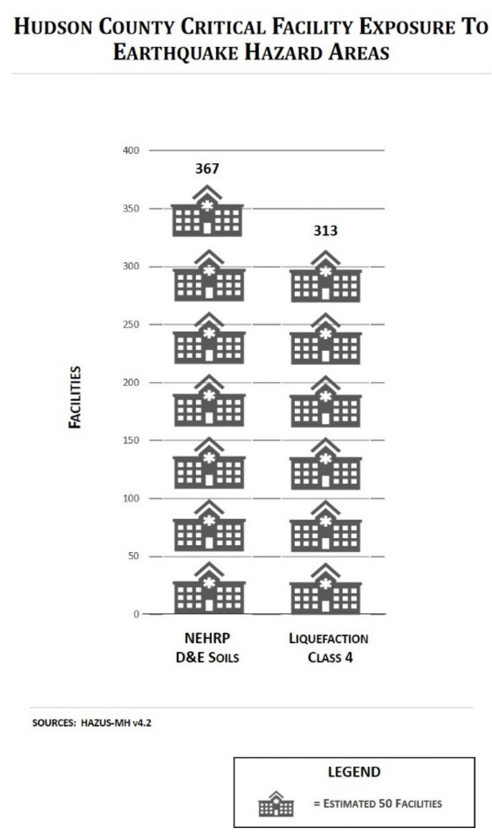


Figure 4.3.5-14. Number of Critical Facilities within the Liquefaction Class 4 Soil Hazard Area

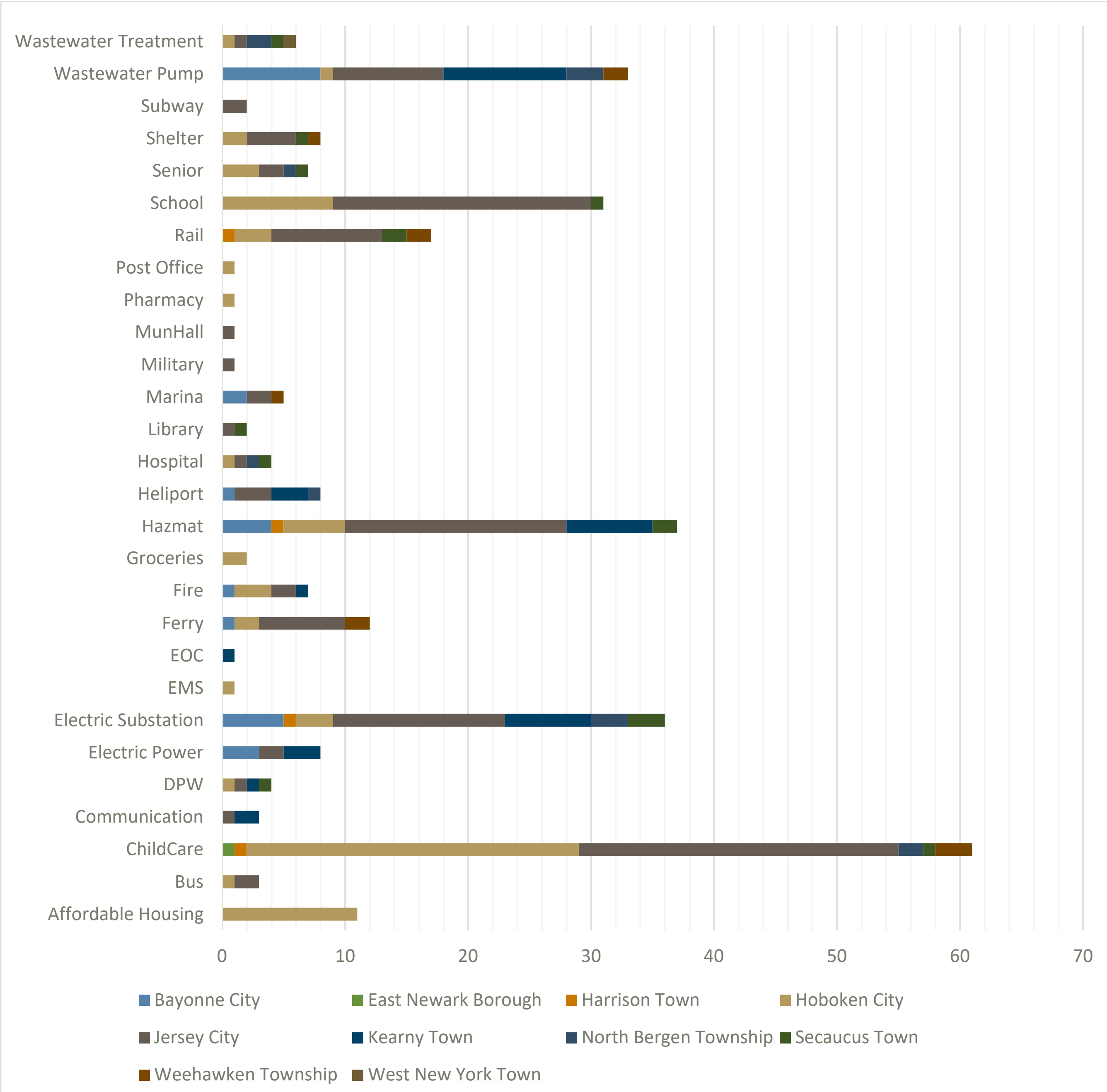
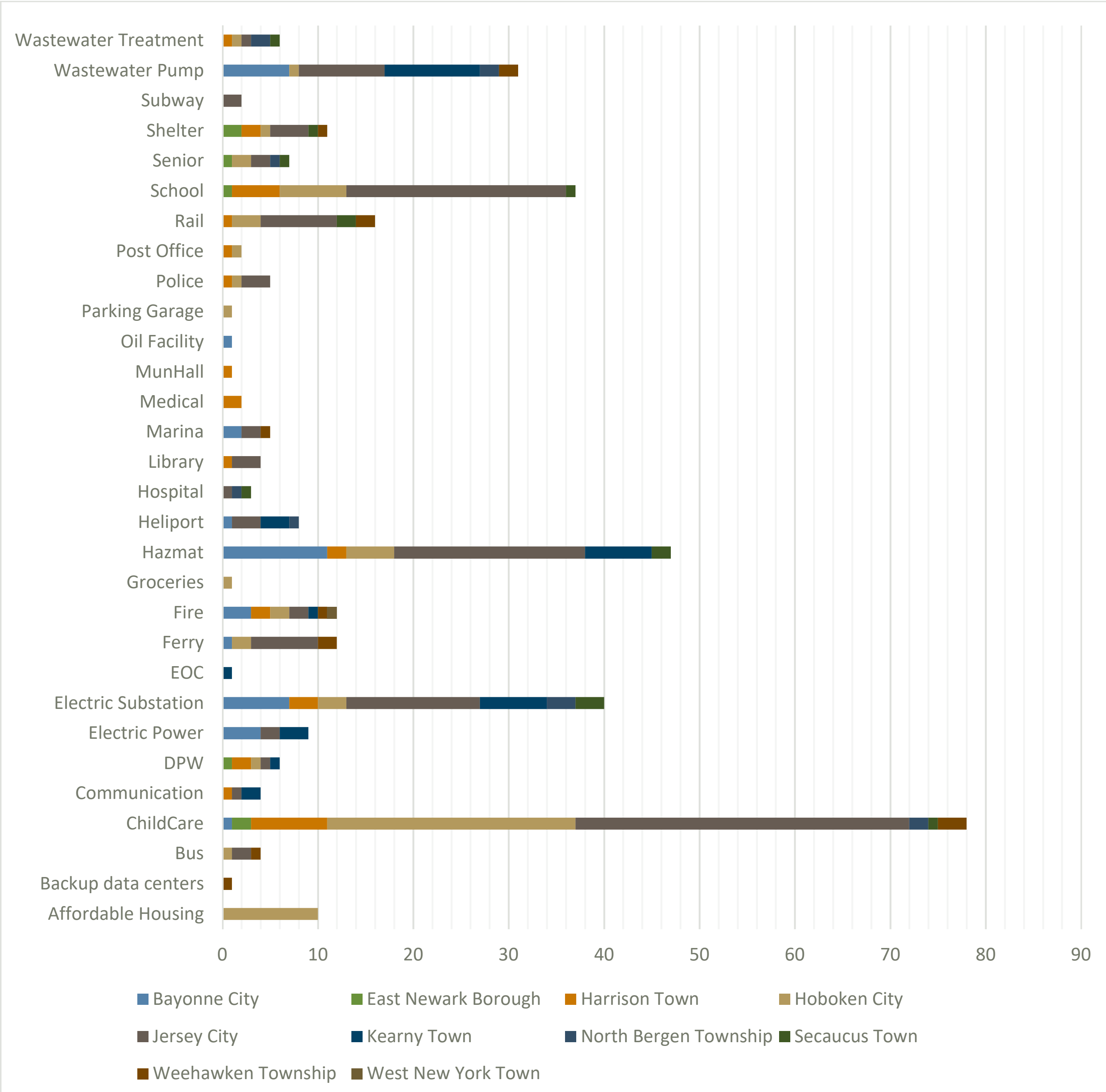


Figure 4.3.5-15. Number of Critical Facilities within the NEHRP Class D or E Soil Hazard Area



The analysis found that evacuation routes in Hudson County are built on NEHRP D and E soils and liquefaction class 4 soil. There is a total 87.4 miles of evacuation routes within Hudson County. There are approximately 39 miles and 36.7 miles of these evacuation routes located on NEHRP D and E and liquefaction class 4 soils, respectively.

Furthermore, the HAZUS-MH v4.2 earthquake model was used to assign a probability of each damage state category defined in Table 4.3.5-13 through Table 4.3.5-15 to every critical facility in the planning area for the 100-, 500-, and 2,500-year MRP events, which was then averaged across the facility category. In addition, HAZUS-MH v4.2 estimates the time to restore critical facilities to fully functional use. Results are presented as probability of being functional at specified time increments (days after the event). For example, HAZUS-MH v4.2 might estimate that a facility has 5 percent chance of being fully functional at Day 3, and a 95-percent chance of being fully functional at Day 90. For percent probability of sustaining damage, the minimum and maximum damage estimated value for that facility type is presented. As a result of a 100-year MRP event, HAZUS-MH v4.2 estimates that critical facilities will be nearly 100-percent functional with negligible damages. Therefore, the impact to critical facilities is not significant for the 100-year event. Whereas, for the 500- and 2,500-year MRP events, functionality can approximately decrease as low as 20- and 70-percent, respectively.

Table 4.3.5-13. Estimated Damage and Loss of Functionality for Critical Facilities and Utilities for the 100-Year MRP Earthquake Event

Name	Percent Probability of Sustaining Damage					Percent Functionality			
	None	Slight	Moderate	Extensive	Complete	Day 1	Day 7	Day 30	Day 90
Critical Facilities									
Medical	97-99	1-2	0-1	<1	0	97-99	99-100	100	100
Police	97-99	1-2	0-1	<1	<1	97-99	99-100	100	100
Fire	97-100	0-2	0-1	<1	<1	97-100	99-100	100	100
EOC	99.7-99.8	<1	<1	0	0	100	100	100	100
School	99-100	0-1	<1	<1	0	99-100	100	100	100
Utilities									
Potable	99.9-100	<1	<1	0	0	100	100	100	100
Wastewater	99.8-100	<1	<1	0	0	100	100	100	100
Electric	99.8-100	<1	<1	0	0	100	100	100	100
Communication	99.9-100	<1	<1	0	0	100	100	100	100

Source: HAZUS-MH v4.2

Table 4.3.5-14. Estimated Damage and Loss of Functionality for Critical Facilities and Utilities for the 500-Year MRP Earthquake Event

Name	Percent Probability of Sustaining Damage					Percent Functionality			
	None	Slight	Moderate	Extensive	Complete	Day 1	Day 7	Day 30	Day 90
Critical Facilities									
Medical	78-91	6-13	3-7	0-2	<1	78-91	90-97	98-100	99-100
Police	78-90	6-13	3-7	0-2	<1	78-90	90-97	98-100	99-100
Fire	78-96	3-13	1-7	0-2	<1	78-96	91-99	98-100	99-100
EOC	94-96	3-5	1	<1	<1	94-96	98-99	100	100
School	97-99	1-9	0-4	0-1	<1	87-99	96-100	99-100	100
Utilities									

Name	Percent Probability of Sustaining Damage					Percent Functionality			
	None	Slight	Moderate	Extensive	Complete	Day 1	Day 7	Day 30	Day 90
Potable	97-100	0-2	<1	<1	0	99-100	100	100	100
Wastewater	93-100	0-5	0-2	<1	<1	95-100	100	100	100
Electric	93-100	0-5	0-2	<1	<1	98-100	100	100	100
Communication	98-100	0-2	<1	<1	0	100	100	100	100

Source: HAZUS-MH 4.2

Table 4.3.5-15. Estimated Damage and Loss of Functionality for Critical Facilities and Utilities for the 2,500-Year MRP Earthquake Event

Name	Percent Probability of Sustaining Damage					Percent Functionality			
	None	Slight	Moderate	Extensive	Complete	Day 1	Day 7	Day 30	Day 90
Critical Facilities									
Medical	31-65	18-23	12-25	4-13	1-9	31-65	53-83	79-96	85-98
Police	26-65	18-23	12-25	4-13	1-24	26-65	44-89	65-96	71-98
Fire	29-92	11-23	6-25	1-13	0-15	29-92	50-93	74-99	80-99
EOC	60-75	14-19	8-12	2-3	0-7	60-75	79-90	90-98	92-99
School	39-91	7-25	2-21	0-7	0-12	39-91	62-97	81-100	85-100
Utilities									
Potable	61-98	2-14	0-10	0-1	0-18	71-99	84-100	85-100	91-100
Wastewater	36-98	2-16	0-23	0-5	0-21	44-98	75-100	76-100	81-100
Electric	36-98	2-16	0-23	0-5	0-21	58-99	77-100	80-100	95-100
Communication	74-98	2-14	0-11	0-1	0-1	93-100	99-100	99-100	100

Source: HAZUS-MH 4.2

Impact on the Economy

Earthquakes also impact the economy, including loss of business function, damage to inventory (buildings, transportation, and utility systems), relocation costs, wage loss, and rental loss due to repair and replacement of buildings. HAZUS-MH v4.2 estimates building-related economic losses, including income losses (wage, rental, relocation, and capital-related losses) and capital stock losses (structural, non-structural, content, and inventory losses). Economic losses estimated by HAZUS-MH v4.2 are summarized in Table 4.3.5-16.

Table 4.3.5-16. Building-Related Economic Losses from the 100-, 500-, and 2,500-Year MRP Earthquake Events

Level of Severity	Mean Return Period		
	100-year	500-year	2,500-year
Income Losses			
Wage	$297,300	$12,416,500	$145,374,500
Capital Related	$198,700	$8,655,900	$104,781,200
Rental	$395,600	$16,045,600	$172,416,400
Relocation	$647,800	$27,054,000	$305,269,600
Subtotal	**$1,539,400**	**$64,172,000**	**$727,841,700**
Capital Stock Losses			
Structural	$1,571,700	$59,449,300	$698,816,400
Non-Structural	$1,636,500	$174,789,400	$2,473,660,000
Content	$307,800	$64,883,300	$1,001,074,000
Inventory	$13,000	$3,304,300	$46,470,900
Subtotal	**$3,529,000**	**$302,426,300**	**$4,219,994,700**

Source: HAZUS-MH v4.2

Although the HAZUS-MH v4.2 analysis did not compute damage estimates for individual roadway segments and railroad tracks, assumedly these features would undergo damage due to ground failure—resulting in interruptions of regional transportation and of distribution of materials. Losses to the community that would result from damage to lifelines could exceed costs of repair (FEMA 2012).

Earthquake events can significantly affect road bridges, many of which provide the only access to certain neighborhoods. Because softer soils generally follow floodplain boundaries, bridges that cross watercourses should be considered vulnerable. Another key factor in degree of vulnerability is age of facilities and infrastructure, which correlates with standards in place at time of construction. HAZUS-MH v4.2 estimated economic impacts to Hudson County for 15-years after the earthquake event, including impacts to transportation infrastructure. $12.38 million in damages were estimated as a result of a 100-year event and $578.41 million as a result of a 2,500-year event for damages to highways, railways, light rails, buses, ferries, ports, and airports.

HAZUS-MH v4.2 estimates volume of debris that may be generated as a result of an earthquake event to enable the study region to prepare for and rapidly and efficiently manage debris removal and disposal. Debris estimates were divided into two categories: (1) reinforced concrete and steel that require special equipment to break up before transport can occur, and (2) brick, wood, and other debris that can be loaded directly onto trucks by use of bulldozers (HAZUS-MH Earthquake User's Manual).

HAZUS-MH v4.2 estimated the generation of over 3,000 tons of total debris during the 100-year MRP event, over 121,000 tons of debris during the 500-year MRP event, and over 1.3 million tons of debris during the 2,500-year MRP event. Table 4.3.5-17 below lists estimated debris generated by the 100-, 500- and 2,500-year MRP events.

Table 4.3.5-17. Estimated Debris Generated by the 100-, 500-, and 2,500-year MRP Earthquake Events

Municipality	100-Year		500-Year		2,500-Year	
	Brick/Wood (tons)	Concrete/Steel (tons)	Brick/Wood (tons)	Concrete/Steel (tons)	Brick/Wood (tons)	Concrete/Steel (tons)
Bayonne, City of	52	16	6,927	3,630	49,518	55,529
East Newark, Borough of	0	0	925	350	6,383	5,045
Guttenberg, Town of	0	0	1,055	335	6,966	4,317
Harrison, Town of	156	57	3,735	2,251	28,850	39,513
Hoboken, City of	355	115	8,336	4,419	69,630	88,619
Jersey City, City of	777	291	23,343	12,810	181,939	231,127
Kearny, Town of	797	316	12,294	8,298	104,427	164,067
North Bergen, Township of	0	0	6,142	3,390	44,353	52,152
Secaucus, Town of	195	77	9,633	6,331	72,524	103,591
Union City, City of	0	0	2,972	970	18,853	10,147
Weehawken, Township of	0	0	969	402	6,931	6,215
West New York, Town of	30	6	1,703	572	11,315	7,463
Hudson County (Total)	**2,362**	**878**	**78,033**	**43,759**	**601,690**	**767,785**

Source: HAZUS-MH 4.2

Impact on the Environment

According to USGS, earthquakes can cause damage to the surface of the Earth in various forms depending on the magnitude and distribution of the event (USGS 2020). Surface faulting is one of the major seismic components to earthquakes that can create wide ruptures in the ground. Ruptures can have a direct impact on the landscape and natural environment because it can disconnect habitats for miles isolating animal species or tear apart plant roots.

Furthermore, ground failure as a result of soil liquefaction can have an impact on soil pores and retention of water resources (USGS 2020). The greater the seismic activity and liquefaction properties of the soil, the more likely drainage of groundwater can occur which depletes groundwater resources. In areas where there is higher pressure of groundwater retention, the pores can build up more pressure and make soil behave more like a fluid rather than a solid increasing risk of localized flooding and deposition or accumulation of silt (USGS 2020).

Future Changes That May Impact Vulnerability

Understanding future changes that effect vulnerability in the County can assist in planning for future development and ensure establishment of appropriate mitigation, planning, and preparedness measures. The County considered the following factors to examine potential conditions that may affect hazard vulnerability:

- Potential or projected development
- Projected changes in population
- Other identified conditions as relevant and appropriate, including the impacts of climate change

PROJECTED DEVELOPMENT

As discussed in Section 3 (County Profile), areas targeted for future growth and development have been identified across the County. In total, there are 494 new development sites located on NEHRP Class D and E soils. Current building codes require seismic provisions that should render new construction less vulnerable to seismic impacts than older, existing construction that may have been built to lower construction standards.

Specific areas of development are indicated in tabular form in the jurisdictional annexes in Volume II, Section 9 (Jurisdictional Annexes). Please refer to Figure 4.3.5-16 for the potential new development in the County and the NEHRP soil class.

PROJECTED CHANGES IN POPULATION

Factors like increased number of immigrants and a growing number of Millennials and young adults has become a driver for new development. For example, the increasing population has created a need for more school facilities, municipal services, and housing development (Hudson County Planning Board, Re-Examination 2017). Higher density can cause residual impacts on Hudson County when earthquakes occur because older structures that are more vulnerable to ground shaking can be destructive to surrounding newer buildings. Populations that move into Hudson County and choosing to live in these older structures will also be more vulnerable to earthquake impacts. Refer to Section 4.3.1, Population Trends in the County Profile, which includes a discussion on population trends for the County.

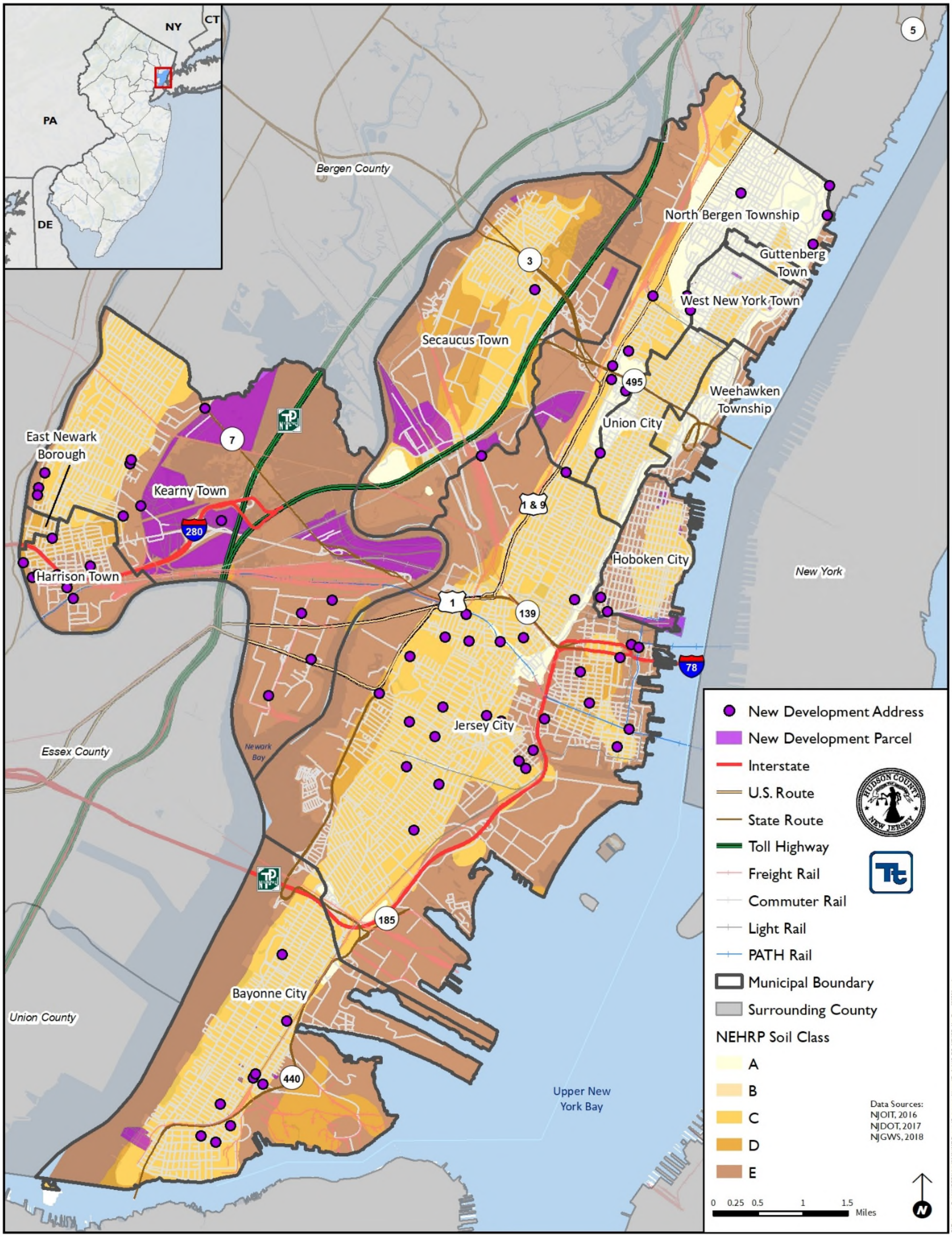
CLIMATE CHANGE

Because the impacts of climate change on the earthquakes are not well understood, a change in the County's vulnerability is difficult to determine. However, climate change has the potential to magnify secondary impacts of earthquakes. As a result of the climate change projections discussed above, the County's assets located on areas of saturated soils and on or at the base of steep slopes, are at a higher risk of landslides/mudslides because of seismic activity. Refer to Section 4.3.8 for additional discussion of the geological hazard. Failure of a dam storing increased volumes of water would result in flooding of the county's assets located in the inundation area.

CHANGE OF VULNERABILITY SINCE 2015 HMP

Several differences exist between the 2015 plan and this update. For the 2020 plan update, an updated general building stock based upon replacement cost value from MODIV tax assessment data and 2019 RS Means, and an updated critical facility inventory were used to assess the County's risk to the hazard areas. In addition, the 2017 American Community Survey population estimates were used and estimated at a structural level in place of the 2010 U.S. Census blocks. Updated hazard areas were used as well; since the 2015 HMP, the NJGWS has released updated NEHRP and liquefaction susceptible soils data. The updated data was used for the exposure analysis and to update HAZUS-MH's default earthquake data.

Figure 4.3.5-16. Potential New Development in Hudson County and NEHRP Soil Types



4.3.6 EXTREME TEMPERATURE

This section provides a profile and vulnerability assessment of the extreme temperature hazard in Hudson County.

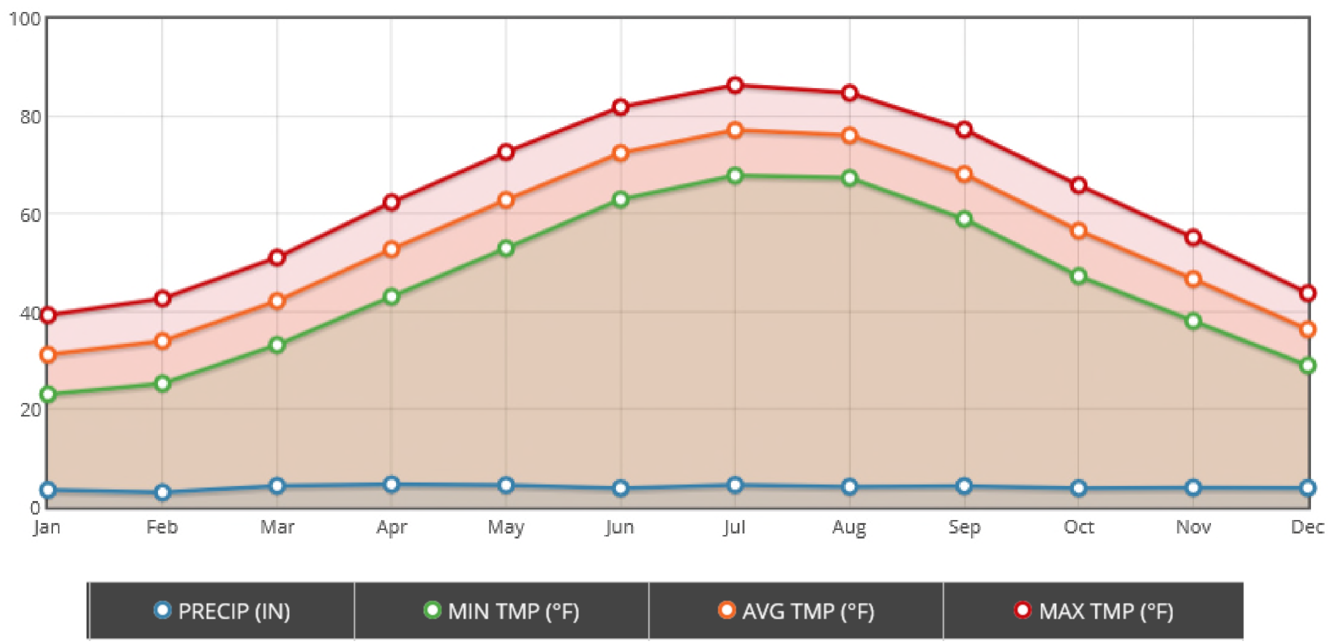
2020 HMP Changes

- New and updated figures from federal and state agencies are incorporated.
- Previous occurrences were updated with events that occurred between 2015 and 2019.
- A social vulnerability assessment was conducted for the extreme temperature hazard using available information.

4.3.6.1 PROFILE

Extreme temperature includes both heat and cold events that can have significant direct impacts to human health and commercial/agricultural businesses and primary and secondary effects on infrastructure (e.g., burst pipes and power failure). Distinguishing characteristics of "extreme cold" or "extreme heat" vary by location, based on the conditions to which the population is accustomed. Figure 4.3.6-1 shows the average low and high temperatures each month at the Harrison station in Hudson County.

Figure 4.3.6-1. Average Temperatures at Harrison Station



Source: NWS 2018a

EXTREME COLD

Extreme cold events are when temperatures drop well below normal in an area. In regions relatively unaccustomed to winter weather, near freezing temperatures are considered "extreme cold." Extreme cold temperatures are generally characterized in temperate zones by the ambient air temperature dropping to approximately 0ºF or below (Centers of Disease Control and Prevention [CDC] 2007). Extremely cold temperatures often accompany a winter storm, which can cause power failures and icy roads. Although staying indoors as much as possible can help reduce the risk of car crashes and falls on the ice, individuals may also face indoor hazards. Many homes will be too cold—either due to a power failure or because the heating system is not adequate for the weather. The use of space heaters and fireplaces to keep warm increases the risk of household fires and carbon monoxide poisoning (CDC 2007).

EXTREME HEAT

Extreme heat is defined as temperatures which hover 10 degrees or more above the average high temperature for a region and that last for several weeks (Centers for Disease Control and Prevention [CDC] 2016). A heat wave is defined as a period of abnormally and uncomfortably hot and unusually humid weather. Typically a heat wave lasts two or more days. (National Weather Service [NWS] 2009). There is no universal definition of a heat wave because the term is relative to the usual weather in a particular area. The term heat wave is applied both to routine weather variations and to extraordinary spells of heat which may occur only once a century (Meehl and Tebaldi 2004).

Urbanized areas and urbanization creates an exacerbated type of risk during an extreme heat event, compared to rural and suburban areas. As defined by the U.S. Census, urban areas are classified as all territory, population, and housing units located within urbanized areas and urban clusters. The term urbanized area denotes an urban area of 50,000 or more people. Urban areas under 50,000 people are called urban clusters. The U.S. Census delineates urbanized area and urban cluster boundaries to encompass densely settled territory, which generally consists of:

- A cluster of one or more block groups or census blocks each of which has a population density of at least 1,000 people per square mile at the time.
- Surrounding block groups and census blocks each of which has a population density of at least 500 people per square mile at the time.
- Less densely settled blocks that form enclaves or indentations or are used to connect discontinuous areas with qualifying densities (U.S. Census 2010).

As these urban areas develop and change, so does the landscape. Buildings, roads, and other infrastructure replace open land and vegetation. Surfaces that were once permeable and moist are now impermeable and dry. These changes cause urban areas to become warmer than the surrounding areas. This forms an ‘island’ of higher temperatures (U.S. EPA 2019).

The term ‘heat island’ describes built up areas that are hotter than nearby rural areas. The annual mean air temperature of a city with more than one million people can be between 1.8 ºF and 5.4ºF warmer than its surrounding areas. In the evening, the difference in air temperatures can be as high as 22ºF. Heat islands occur on the surface and in the atmosphere. On a hot, sunny day, the sun can heat dry, exposed urban surfaces to temperatures 50ºF to 90ºF hotter than the air. Heat islands can affect communities by increasing peak energy demand during the summer, air conditioning costs, air pollution and greenhouse gas emissions, heat-related illness and death, and water quality degradation (U.S. EPA 2019).

EXTENT

EXTREME COLD

The extent (severity or magnitude) of extreme cold temperatures are generally measured through the Wind Chill Temperature (WCT) Index. Wind Chill Temperature is the temperature that people and animals feel when outside and it is based on the rate of heat loss from exposed skin by the effects of wind and cold. As the wind increases, the body is cooled at a faster rate causing the skin’s temperature to drop (NWS 2001).

On November 1, 2001, the NWS implemented a new WCT Index. It was designed to more accurately calculate how cold air feels on human skin. The table below shows the new WCT Index. The WCT Index includes a frostbite indicator, showing points where temperature, wind speed, and exposure time will produce frostbite to humans. Figure 4.3.6-2 shows three shaded areas of frostbite danger. Each shaded area shows how long a person can be exposed before frostbite develops (NWS 2001).

Figure 4.3.6-2. Wind Chill Index Chart

Temperature (°F)

Wind (mph) / Calm	40	35	30	25	20	15	10	5	0	-5	-10	-15	-20	-25	-30	-35	-40	-45
5	36	31	25	19	13	7	1	-5	-11	-16	-22	-28	-34	-40	-46	-52	-57	-63
10	34	27	21	15	9	3	-4	-10	-16	-22	-28	-35	-41	-47	-53	-59	-66	-72
15	32	25	19	13	6	0	-7	-13	-19	-26	-32	-39	-45	-51	-58	-64	-71	-77
20	30	24	17	11	4	-2	-9	-15	-22	-29	-35	-42	-48	-55	-61	-68	-74	-81
25	29	23	16	9	3	-4	-11	-17	-24	-31	-37	-44	-51	-58	-64	-71	-78	-84
30	28	22	15	8	1	-5	-12	-19	-26	-33	-39	-46	-53	-60	-67	-73	-80	-87
35	28	21	14	7	0	-7	-14	-21	-27	-34	-41	-48	-55	-62	-69	-76	-82	-89
40	27	20	13	6	-1	-8	-15	-22	-29	-36	-43	-50	-57	-64	-71	-78	-84	-91
45	26	19	12	5	-2	-9	-16	-23	-30	-37	-44	-51	-58	-65	-72	-79	-86	-93
50	26	19	12	4	-3	-10	-17	-24	-31	-38	-45	-52	-60	-67	-74	-81	-88	-95
55	25	18	11	4	-3	-11	-18	-25	-32	-39	-46	-54	-61	-68	-75	-82	-89	-97
60	25	17	10	3	-4	-11	-19	-26	-33	-40	-48	-55	-62	-69	-76	-84	-91	-98

Frostbite Times: 30 minutes; 10 minutes; 5 minutes

Source: NWS 2016a

The National Weather Service (NWS) provides alerts when Wind Chill indices approach hazardous levels (refer to Table 4.3.6-1).

Table 4.3.6-1. National Weather Service Alerts for Extreme Cold

Alert	Criteria
Wind Chill Advisory	NWS issues a wind chill advisory when seasonably cold wind chill values but not extremely cold values are expected or occurring.
Wind Chill Watch	NWS issues a wind chill watch when dangerously cold wind chill values are possible.
Wind Chill Warning	NWS issues a wind chill warning when dangerously cold wind chill values are expected or occurring.

Source: NWS 2018b

EXTREME HEAT

NOAA's heat alert procedures are based mainly on Heat Index values. The Heat Index is given in degrees Fahrenheit. The Heat Index is a measure of how hot it really feels when relative humidity is factored in with the actual air temperature. To find the Heat Index temperature, the temperature and relative humidity need to be known. Once both values are known, the Heat Index will be the corresponding number with both values (Figure 4.3.6-3). The Heat Index indicated the temperature the body feels. It is important to know that the Heat Index values are devised for shady, light wind conditions. Exposure to full sunshine can increase heat index values by up to 15°F. Strong winds, particularly with very hot dry air, can also be extremely hazardous (NWS 2013).

Figure 4.3.6-3. Heat Index Chart

Temperature (°F)

Relative Humidity (%)	80	82	84	86	88	90	92	94	96	98	100	102	104	106	108	110
40	80	81	83	85	88	91	94	97	101	105	109	114	119	124	130	136
45	80	82	84	87	89	93	96	100	104	109	114	119	124	130	137	
50	81	83	85	88	91	95	99	103	108	113	118	124	131	137		
55	81	84	86	89	93	97	101	106	112	117	124	130	137			
60	82	84	88	91	95	100	105	110	116	123	129	137				
65	82	85	89	93	98	103	108	114	121	128	136					
70	83	86	90	95	100	105	112	119	126	134						
75	84	88	92	97	103	109	116	124	132							
80	84	89	94	100	106	113	121	129								
85	85	90	96	102	110	117	126	135								
90	86	91	98	105	113	122	131									
95	86	93	100	108	117	127										
100	87	95	103	112	121	132										

Likelihood of Heat Disorders with Prolonged Exposure or Strenuous Activity

Caution   Extreme Caution   Danger   Extreme Danger

Source: NWS 2016b

Table 4.3.6-2. National Weather Service Extreme Heat Alerts

Alert	Criteria
Heat Advisory	A Heat Advisory is issued within 12 hours of the onset of extremely dangerous heat conditions. The general rule of thumb for this Advisory is when the maximum heat index temperature is expected to be 100° or higher for at least 2 days, and night time air temperatures will not drop below 75°.
Excessive Heat Watch	Heat watches are issued when conditions are favorable for an excessive heat event in the next 24 to 72 hours. A Watch is used when the risk of a heat wave has increased but its occurrence and timing is still uncertain.
Excessive Heat Warning	An Excessive Heat Warning is issued within 12 hours of the onset of extremely dangerous heat conditions. The general rule of thumb for this Warning is when the maximum heat index temperature is expected to be 105° or higher for at least 2 days and night time air temperatures will not drop below 75°.

Source: NWS 2019

Location

According to the ONJSC, New Jersey has five distinct climate regions. Elevations, latitude, distance from the Atlantic Ocean, and landscape (e.g. urban, sandy soil) produce distinct variations in the daily weather between each of the regions. The five regions include: Northern, Central, Pine Barrens, Southwest, and Coastal (ONJSC Rutgers University, Date Unknown). Hudson County is located within the Central Climate Region.

The Central Region has a northeast to southeast orientation, running from New York Harbor and the Lower Hudson River to the great bend of the Delaware River in the vicinity of Trenton. This region has many urban locations with large amounts of pollutants produced by the high volume of traffic and industrial establishments. The concentration of buildings and impervious surfaces tend to retain more heat; thereby, affecting the local temperatures. The observed nighttime temperatures in heavily developed areas of this region are typically warmer than surrounding suburban and rural areas due to the amount of asphalt, brick, and concrete. The northern edge of the Central Region is often the boundary between freezing and non-freezing precipitation during the winter months. Areas in the southern part of this region tend to have nearly twice as many days with temperatures above 90°F than other locations in the central portion of the State (ONJSC Rutgers University n.d.).

PAST OCCURRENCE

Many sources provided historical information regarding previous occurrences and losses associated with extreme temperatures throughout New Jersey and Hudson County; therefore, the loss and impact information for many events could vary depending on the source. The accuracy of monetary figures discussed is based only on the available information in cited sources.

New Jersey has been experiencing an increase in extreme temperatures across the State. Historically, there has been an increase in temperature during the warmest months in New Jersey, with the majority of the extreme heat months occurring after 1990. Conversely, the months which set records for extreme cold temperatures tended to occur prior to 1930.

FEMA MAJOR DISASTERS AND EMERGENCY DECLARATIONS

Between 1954 and March 15, 2019, neither Hudson County or the State of New Jersey was not included in any major disaster (DR) or emergency (EM) declarations due to extreme temperatures. However, during the same time period, the Federal Emergency Management Agency (FEMA) included Hudson County in five winter storm-related DR or EM declarations classified as one or a combination of the following disaster types: severe winter storm, snowstorm, snow, ice storm, winter storm, and blizzard (Table 4.3.6-3).

Table 4.3.6-3. Extreme Temperature Related Disaster (DR) and Emergency (EM) Declarations 1954-2019

Declaration	Event Date	Declaration Date	Event Description
EM-3106	March 13-17, 1993	March 17, 1993	Snow: Severe Blizzard
DR-1088	January 7-12, 1996	January 13, 1996	Snow: Blizzard of 96 (Severe Snow Storm)
EM-3181	February 16-17, 2003	March 20, 2003	Snow: Snow
EM-1954	December 26-27-2010	February 4, 2011	Snow: Severe Winter Storm and Snowstorm
DR-4264	January 22-24, 2016	March 14, 2016	Severe Storm(s): Severe Winter Storm and Snowstorm

Source: FEMA 2019

U.S. DEPARTMENT OF AGRICULTURE DISASTER DECLARATIONS

The Secretary of Agriculture from the U.S. Department of Agriculture (USDA) is authorized to designate counties as disaster areas to make emergency loans to producers suffering losses in those counties and in counties that are contiguous to a designated county. Between 2015 and 2019, Hudson County was included in the following USDA declaration involving extreme temperatures:

- S34017 - October 2016 – Combined effects of freeze, excessive heat, and drought

EXTREME TEMPERATURE EVENTS

The National Oceanic and Atmospheric Administration (NOAA) National Centers for Environmental Information (NCEI) Storm Events database records and defines extreme temperature events as follows:

- Cold/Wind Chill is reported in the NOAA-NCEI database when a period of low temperatures or wind chill temperatures reach or exceed locally or regionally defined advisory conditions (typical value is -18 °F or colder).
- Excessive Heat is reported in the NOAA-NCEI database whenever heat index values meet or exceed locally or regionally established excessive heat warning thresholds.
- Extreme Cold/Wind Chill is reported in the NOAA-NCEI database when a period of extremely low temperatures or wind chill temperatures reaches or exceeds locally or regionally defined warning criteria (typical value around -35 °F or colder).
- Heat is reported in the NOAA-NCEI database whenever heat index values meet or exceed locally or regionally established advisory thresholds.

Table 4.3.6-4 documents extreme temperature events in Hudson County that have occurred between 2014 and 2019. With extreme temperature documentation for New Jersey and Hudson County being so extensive, not all sources have been identified or researched. Therefore, Table 4.3.6-4 may not include all events that have occurred in the County. Please see Section 9 for detailed information regarding impacts and losses to each municipality.

Table 4.3.6-4. Extreme Temperature Events in Hudson County between 2014 and 2019

Dates of Event	Event Type	Losses/Impacts
August 12-13, 2016	Excessive Heat	High pressure over the western Atlantic Ocean ushered in hot and humid air northward across the area. Hot temperatures along with high humidity resulted in a heat index of 107 at Newark International Airport at 4 pm and 105 degrees at Caldwell Airport on August 12. Hot temperatures along with high humidity resulted in a heat index of 108 at Newark International Airport and 108 degrees at Caldwell Airport on August 13.

Source: NOAA NCEI 2019
Note: Many sources provide historical information regarding previous occurrences and losses associated with drought events throughout New Jersey and Hudson County. Information about losses and impacts resulting from each of many events can vary depending on the source. Notably, monetary amounts cited in this section on drought derive solely from information obtained during research for this HMP.

According to the Storm Events Database, Hudson County has been impacted by 10 extreme temperature events between 1950 and January 2019 (Table 4.3.6-5), which resulted in three deaths. No events resulted in property damage or crop damages. From January 1, 2015 to January 31, 2019, Hudson County was not impacted by extreme temperature events. For events prior to 2015, refer to Appendix E.

Table 4.3.6-5. Extreme Temperature Events in Hudson County 1950 to 2019

Hazard Type	Number of Occurrences Between 1950 and 2018	Total Fatalities	Total Injuries	Total Property Damage ($)	Total Crop Damage ($)
Cold/Wind Chill	1	0	0	$0	$0
Excessive Heat	1	0	0	$0	$0
Extreme Cold/Wind Chill	3	0	0	$0	$0
Heat	5	3	0	$0	$0
TOTAL	**10**	**3**	**0**	**$0**	**$0**

Note: Not all events that have occurred in Hudson County are included due to the extent of documentation and the fact that not all sources have been identified or researched.
Source: NOAA-NCEI 2019

PROBABILITY OF FUTURE OCCURRENCE

It is anticipated that Hudson County will continue to experience extreme temperatures annually that may coincide with or induce secondary hazards such as snow, hail, ice or windstorms, thunderstorms, drought, human health impacts, and utility failures. Table 4.3.6-6 shows the annual number of events, recurrence interval, annual probability, and annual percent chance of occurrence for the hazards associated with extreme temperatures and reported in the NOAA-NCEI Storm Events Database.

Based on these historical records and input from the Steering Committee, the probability of occurrence for extreme temperatures in Hudson County is considered "frequent".

Table 4.3.6-6. Probability of Occurrences of Extreme Temperature Events

Hazard Type	Number of Occurrences Between 1950 and August 2018	Rate of Occurrence or Annual Number of Events (average)	Recurrence Interval (in years)	Probability of event Occurring in Any Given Year	% Chance of Occurring in Any Given Year
Cold/Wind Chill	1	0.01	70.0	0.01	1.4
Excessive Heat	1	0.01	70.0	0.01	1.4
Extreme Cold/Wind Chill	3	0.04	23.3	0.04	4.3
Heat	5	0.07	14.0	0.07	7.1
TOTAL	**10**	**0.14**	**7.0**	**0.14**	**14.3**

Source: NOAA-NCEI 2019
Note: Probability was calculated using the available data provided in the NOAA-NCDC storm events database.

CLIMATE CHANGE IMPACTS

Providing projections of future climate change for a specific region is challenging. Shorter term projections are more closely tied to existing trends making longer term projections even more challenging. The further out a prediction reaches the more subject to changing dynamics it becomes.

Average annual temperatures have increased by 3°F in New Jersey over the past century (NOAA NCEI 2019). Most of this warming has occurred since 1970. The State of New Jersey, for example, has observed an increase in average annual temperatures of 1.2°F between the period of 1971-2000 and the most recent decade of 2001-2010 (CATF 2011). Winter temperatures across the Northeast have seen an increase in average temperature of 4°F since 1970 (Northeast Climate Impacts Assessment [NECIA] 2007). By the 2020s, the average annual temperature in New Jersey is projected to increase by 1.5°F to 3°F above the statewide baseline (1971 to 2000), which was 52.7°F. By 2050, the temperature is projected to increase 3°F to 5°F (Sustainable Jersey Climate Change Adaptation Task Force 2013). According to a recent state-level analysis, by the middle of the 21st century an estimated 70 percent of summers in this region are anticipated to be hotter than what we now recognize as the warmest summer on record (NOAA NCEI 2019).

4.3.6.2 Vulnerability Assessment

To understand risk, a community must evaluate what assets are exposed and vulnerable. For the extreme temperature hazard, the entire County is exposed the following discusses Hudson County's vulnerability, in a qualitative nature, to the extreme temperature hazard.

Impact on Life, Health, and Safety

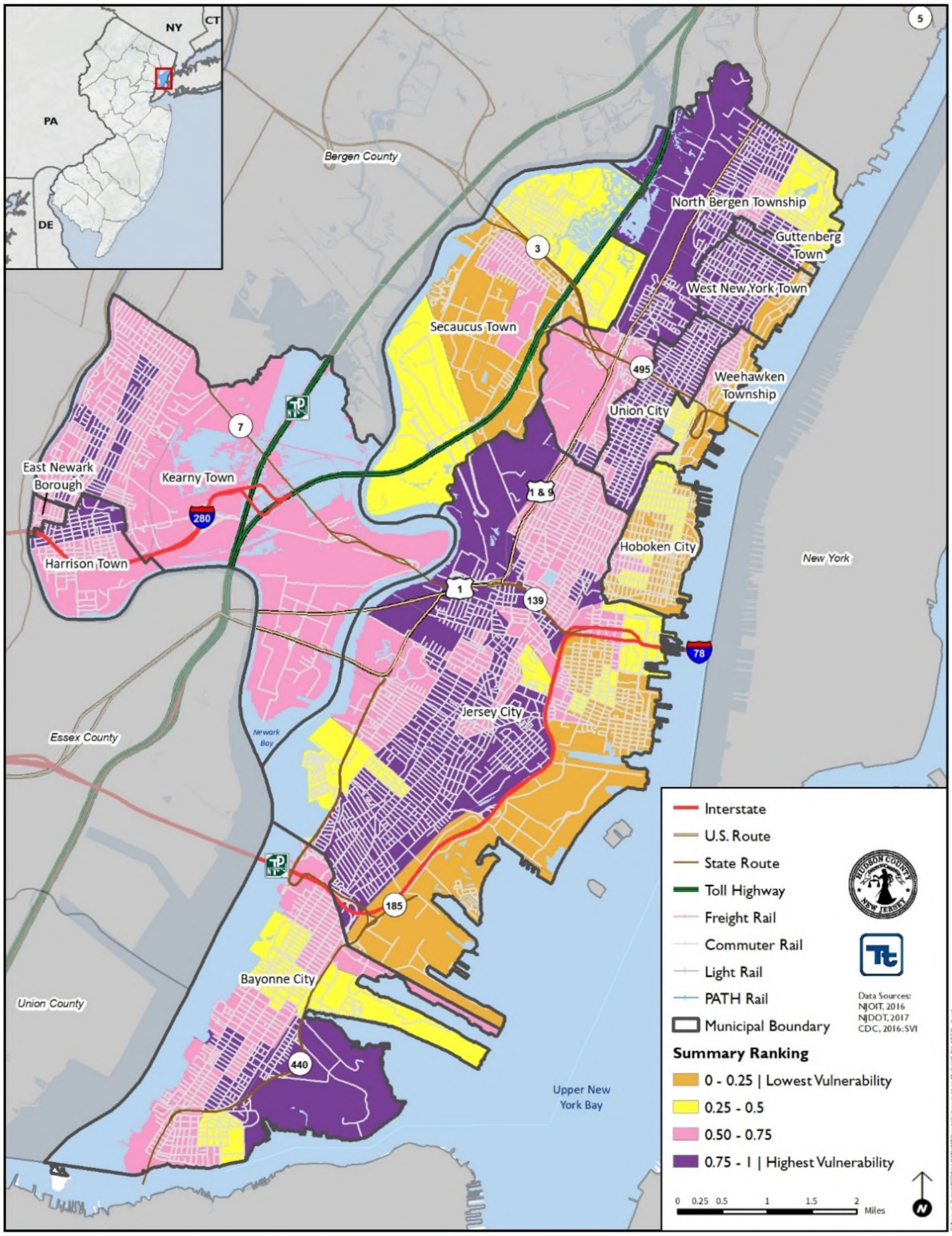
The entire population of Hudson County is exposed to extreme temperature events (population of 679,756 people, according to the 2013-2017 American Community Survey population estimates). Extreme temperature events have potential health impacts including injury and death. According to the Centers for Disease Control and Prevention (CDC), populations most at risk to extreme cold and heat events include the following: 1) the elderly, who are less able to withstand temperatures extremes due to their age, health conditions, and limited mobility to access shelters; 2) infants and children up to four years of age; 3) individuals with chronic medical conditions (e.g., heart disease, high blood pressure), 4) low-income persons that cannot afford proper heating and cooling; and 5) the general public who may overexert during work or exercise during extreme heat events or experience hypothermia during extreme cold events (CDC 2016).

According to the 2017 ACS 5-Year Population Estimate, persons that are most vulnerable to extreme temperature events make up 11.17% of the total population in Hudson County. For example, 75,984 persons within Hudson County are over 65 years in age. Higher concentrations of persons over 65 years in age are found in the Town of Guttenberg and the Town of West New York. Refer to Figure 3.6 in Section 3 (County Profile) that displays the densities of populations over 65 in Hudson County. This suggests that these two communities contain a higher concentration of persons that may be more vulnerable to extreme temperature events.

Furthermore, the homeless and residents below the poverty level might not have access to housing or their housing could be less able to withstand extreme temperatures (e.g., homes with poor insulation and heating supply). In Hudson County, areas with the highest concentration of population below the poverty level, thus most vulnerable communities due to potentially fewer resources to protect against extreme temperatures, are located in Union City and Town of West New York. Refer to Figure 3.6 in Section 3 (County Profile) that displays the densities of low-income populations in Hudson County.

The CDC 2016 Social Vulnerability Index (SVI) ranks U.S. Census tracts on socioeconomic status, household composition and disability, minority status and language, and housing and transportation. Hudson County's overall score is 0.6425, indicating that its communities have moderate to high vulnerability (CDC 2016, refer to Figure 4.3.6-4). This map shows that areas most vulnerable to extreme temperature are located mainly within the interior municipalities of Hudson County.

Figure 4.3.6-4. CDC Social Vulnerability Index Rating for Hudson County



Risk of structural fire in the winter months is elevated with approximately 30 percent of all deaths caused by fire occurring in the winter months. Cooking and heat sources too close to combustible materials are leading factors in winter home fires (U.S. Fire Administration 2018). Often times, power outages occur during extreme cold events. Individuals powering their homes with generators are subjected to carbon monoxide poisoning if proper ventilation procedures are not followed. Improperly connected portable generators are capable of 'back feeding' power lines which may cause injury or death to utility works attempting to restore power and may damage house wiring and/or generators (NJOEM 2019).

Meteorologists can accurately forecast extreme heat and cold event development and the severity of the associated conditions with several days of lead time. These forecasts provide an opportunity for public health and other officials to notify vulnerable populations, implement short-term emergency response actions, and focus on surveillance and relief efforts on those at greatest risk. Adhering to extreme temperature warnings can significantly reduce the risk of temperature-related deaths.

Impact on General Building Stock

All buildings are exposed to the extreme temperature hazard. Refer to Section 3 (County Profile), which summarizes the building inventory in Hudson County. Extreme heat generally does not impact buildings; however, elevated summer temperatures increase the energy demand for cooling. Losses can be associated with the overheating of heating, ventilation, and air conditioning (HVAC) systems. Extreme cold temperature events can damage through freezing/bursting pipes and freeze/thaw cycles, as well as increasing vulnerability to home fires. Additionally, manufactured homes (mobile homes) and antiquated or poorly constructed facilities can have inadequate capabilities to withstand extreme temperatures.

Impact on Critical Facilities

All critical facilities in the County are exposed to the extreme temperature hazard. Impacts to critical facilities that are buildings are the same as described for general building stock. Additionally, it is essential that critical facilities remain operational during natural hazard events. Extreme heat events can sometimes cause short periods of utility failures, commonly referred to as *brown-outs*, due to increased usage from air conditioners and other energy-intensive appliances. Similarly, heavy snowfall and ice storms, associated with extreme cold temperature events, can cause power interruption. Backup power is recommended for critical facilities and infrastructure. Since Superstorm Sandy, Hudson County and municipalities have purchased and installed generators to supply backup power to many critical facilities.

Impact on the Economy

Extreme temperature events also impact the economy, including loss of business function and damage to and loss of inventory. Business-owners can be faced with increased financial burdens due to unexpected repairs caused to the building (e.g., pipes bursting), higher than normal utility bills, or business interruption due to power failure (i.e., loss of electricity, telecommunications). Disruptions in public transportation service will also impact the economy for both commuters and customers alike.

Impact on the Environment

Extreme weather events can have a major impact on the environment. For example, freezing and warming weather patterns create changes in natural processes. An excess amount of snowfall and earlier warming periods may affect natural processes such as flow within water resources (USGS nd). Likewise, rain-on-snow events also exacerbate runoff rates with warming winter weather.

Future Changes That May Impact Vulnerability

Understanding future changes that impact vulnerability in the County can assist in planning for future development and ensuring that appropriate mitigation, planning, and preparedness measures are in place. The County considered the following factors to examine potential conditions that may affect hazard vulnerability:

- Potential or projected development.
- Projected changes in population.
- Other identified conditions as relevant and appropriate, including the impacts of climate change.

PROJECTED DEVELOPMENT AND CHANGE IN POPULATION

The ability of new development to withstand extreme temperature impacts lies in sound land use practices, building design considerations (e.g. Leadership in Energy and Environmental Design [LEED]), and consistent enforcement of codes and regulations for new construction. New development will change the landscape where buildings, roads, and other infrastructure potentially replace open land and vegetation. Surfaces that were once permeable and moist are now impermeable and dry. These changes cause urban areas to become warmer than the surrounding areas forming (heat islands as described above). Specific areas of recent and new development are indicated in tabular form and/or on the hazard maps included in the jurisdictional annexes in Volume II, Section 9 (Jurisdictional Annexes) of this plan.

According to population projections from Hudson County, the area is expected to grow by 29% by 2040. As the population continues to grow, the density of Hudson County will change traffic trends and number of persons on the road. Population increases in less densely populated areas of the County may require utility system upgrades to keep up with utility demands (e.g., water, electric) during extreme temperature events to prevent increased stresses on these systems. Refer to Section 3 (County Profile) for a detailed discussion on population change in Hudson County.

CLIMATE CHANGE

As discussed above, most studies project that the State of New Jersey will see an increase in average annual temperatures. As the climate warms, extreme cold events might decrease in frequency, while extreme heat events might increase in frequency; the shift in temperatures could also result in hotter extreme heat events. With increased temperatures, vulnerable populations could face increased vulnerability to extreme heat and its associated illnesses, such as heatstroke and cardiovascular and kidney disease. Additionally, as temperatures rise, more buildings, facilities, and infrastructure systems may exceed their ability to cope with the heat.

CHANGE OF VULNERABILITY SINCE THE 2015 HMP

Overall, the entire County remains vulnerable to extreme temperatures. As existing development and infrastructure continue to age, they can be at increased risk to failed utility and transportation systems if they are not properly maintained and do not adapt to the changing environment.

4.3.7 FLOOD

This section provides a profile and vulnerability assessment of the flood hazard in Hudson County.

2020 HMP Changes

- Dam and levee failure related flooding has been removed from the flood profile and addressed in a separate profile in Section 5.4.3 (Dam and Levee Failure).
- The discussion on 'shallow flooding' has been updated to 'urban flooding' to align with recent dialogue regarding this topic by the Association of State Floodplain Managers.
- High tide or nuisance flooding has been included in the profile.
- New and updated figures from federal and state agencies are incorporated.
- Previous occurrences were updated with events that occurred between 2015 and 2019.
- Additional analyses conducted include: land cover/land use analysis, social vulnerability analysis, impacts to evacuation routes, and updates to the summary of repetitive loss and severe repetitive loss structures.

4.3.7.1 PROFILE

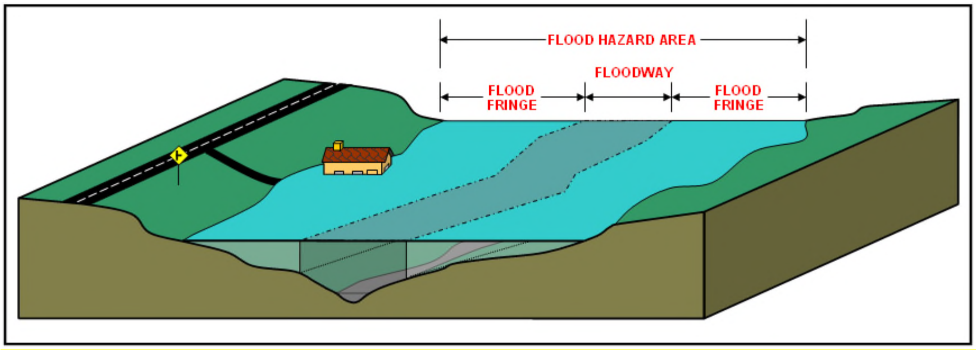
A flood is the inundation of normally dry land resulting from the rising and overflowing of a body of water. They can develop slowly over a period of days or develop quickly, with disastrous effects that can be local (impacting a neighborhood or community) or regional (affecting entire river basins, coastlines, multiple counties, or states) (FEMA 2007). Floods are frequent and costly natural hazards in New Jersey in terms of human hardship and economic loss, particularly to communities that lie within flood-prone areas or floodplains of a major water source.

Flooding in Hudson County is primarily attributed to riverine (inland) and coastal (tidal/surge) flooding from the Hackensack River, Hudson River, Kill Van Kull, Passaic River, and Upper New York Bay (FEMA FIS 2013). In addition, Hudson County also experiences urban flooding, which is the result of precipitation and insufficient drainage.

RIVERINE (INLAND) AND FLASH FLOODING

A floodplain is defined as the land adjoining the channel of a river, stream, ocean, lake, or other watercourse or water body that becomes inundated with water during a flood. In Hudson County, floodplains line the rivers and streams of the County and the coastal areas. The boundaries of the floodplains are altered as a result of changes in land use, the amount of impervious surface, placement of obstructing structures in floodways, changes in precipitation and runoff patterns, improvements in technology for measuring topographic features, and utilization of different hydrologic modeling techniques. Figure 4.3.7-1 depicts the flood hazard area, the flood fringe, and the floodway areas of a riverine floodplain.

Figure 4.3.7-1. Floodplain



Source: NJDEP, Date Unknown

Flash floods are defined by the National Weather Service as: "A flood caused by heavy or excessive rainfall in a short period of time, generally less than 6 hours. Flash floods are usually characterized by raging torrents after heavy rains that rip through riverbeds, urban streets, or mountain canyons sweeping everything before them. They can occur within minutes or a few hours of excessive rainfall. They can also occur even if no rain has fallen, for instance after a levee or dam has failed, or after a sudden release of water by a debris or ice jam." (NWS 2009). Section 4.3.3 (Dam and Levee Failure) provides more information on dam and levee failure.

Coastal Flooding

Coastal floods are the submersion of land areas along the ocean coast and other inland waters caused by seawater over and above normal tide action. Hurricanes and tropical storms, severe storms, and Nor'Easters cause most of the coastal flooding in Hudson County. Coastal flooding can impact structures and infrastructure, similar to riverine flooding, and can cause beach erosion; loss or submergence of wetlands and other coastal ecosystems; saltwater intrusion; high water tables; loss of coastal recreation areas, beaches, protective sand dunes, parks, and open space; and loss of coastal structures (i.e., sea walls, piers, bulkheads, bridges, buildings) (FEMA 2011).

There are several forces that occur with coastal flooding, including the following:

- *Hydrostatic forces* against a structure are created by standing or slowly moving water. Flooding can cause vertical hydrostatic forces, or flotation. These types of forces are one of the main causes of flood damage.
- *Hydrodynamic forces* on buildings are created when coastal floodwaters move at high velocities. These high-velocity flows are capable of destroying solid walls and dislodging buildings with inadequate foundations. High-velocity flows can also move large quantities of sediment and debris that can cause additional damage. In coastal areas, high-velocity flows are typically associated with one or more of the following:
  - Storm surge and wave run-up flowing landward through breaks in sand dunes or across low-lying areas.
  - Tsunamis.
  - Outflow of floodwaters driven into bay or upland areas.
  - Strong currents parallel to the shoreline, driven by waves produced from a storm.
  - High-velocity flows.

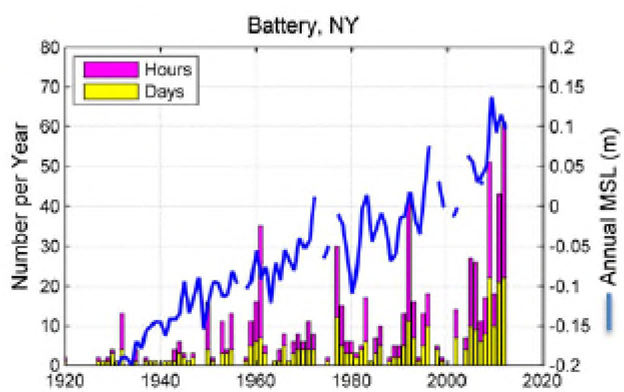
High-velocity flows can be created or exacerbated by the presence of manmade or natural obstructions along the shoreline and by weak points formed by roads and access paths that cross dunes, bridges or canals, channels, or drainage features.

- *Waves* can affect coastal buildings from breaking waves, wave run-up, wave reflection and deflection, and wave uplift. The most severe damage is caused by breaking waves. The force created by these types of waves breaking against a vertical surface is often at least 10 times higher than the force created by high winds during a coastal storm.

- *Flood-borne debris* produced by coastal flooding events and storms typically includes decks, steps, ramps, breakaway wall panels, portions of or entire houses, heating oil and propane tanks, cars, boats, decks and pilings from piers, fences, erosion control structures, and many other types of smaller objects. Debris from floods are capable of destroying unreinforced masonry walls, light wood-frame construction, and small-diameter posts and piles (FEMA 2011).

In addition to coastal flood events that can cause damages, nuisance flooding can impact low-lying areas of Hudson County along tidal waterways. Nuisance flooding, also known as high tide flooding, causes public inconveniences, such as frequent road closures, overwhelmed storm drains, and compromised infrastructure. The threshold for nuisance flooding is site specific based on the regional tidal regime and is established by NOAA. Nuisance flooding has increased in the U.S. on average by about 50 percent over the past 20 years ago and 100 percent over the past 30 years (NOAA 2018). As sea level rises, the number of nuisance flooding days and the severity of nuisance flooding will continue increase. The nearest NOAA tidal gauge to Hudson County is across the Hudson River at the Battery in New York City. Figure 4.3.7-2 shows the hours and days per year that the site has experienced nuisance flooding over time along with the rate of sea level rise.

Figure 4.3.7-2. Frequency of nuisance flooding over time from Hudson River at the Battery, NYC.



Source: NOAA

Urban Flooding

Urban flooding is flooding in a densely populated area that may be caused by a variety of types of inundation (e.g., storm event, infrastructure failure). Regardless of the cause, the increased water runoff due to urban development and inadequate drainage systems has nowhere to go (ASFPM 2020). Drainage systems are designed to remove surface water from developed areas as quickly as possible to prevent localized flooding on streets and other urban areas. The systems make use of a closed conveyance system that channels water away from an urban area to surrounding streams. This bypasses the natural processes of water filtration through the ground, containment, and evaporation of excess water. Because drainage systems reduce the amount of time the surface water takes to reach surrounding streams, flooding in those streams can occur more quickly and reach greater depths than prior to development in that area (Harris 2008).

EXTENT

The frequency and severity of riverine flooding are measured using a discharge probability, which is the probability that a certain river discharge (flow) level will be equaled or exceeded in a given year. Flood studies use historical records to determine the probability of occurrence for the different discharge levels.

Floodplains often are referred to as 100-year floodplains. A 100-year floodplain is not a flood that will occur once every 100 years; the designation indicates a flood that has a 1-percent chance of being equaled or exceeded each year. Thus, the 100-year flood could occur more than once in a relatively short period of time. Due to this misleading term, FEMA has defined it properly as the 1-percent annual chance flood. Similarly, the 500-year floodplain will not occur every 500 years but is an event with a 0.2-percent chance of being equaled or exceeded each year. The “1-percent annual chance flood” is now the standard term used by most federal and state agencies and by the National Flood Insurance Program (NFIP) (FEMA 2003). The 1-percent annual chance floodplain establishes the area that has flood insurance and floodplain management requirements and is referenced as the regulatory floodplain.

The NJDEP is mandated to delineate and regulate flood hazard areas pursuant to N.J.S.A. 58:16A-50 et seq., the Flood Hazard Area Control Act. This Act authorizes the NJDEP to adopt land use regulations for development within the flood hazard areas, to control stream encroachments. and to integrate the flood control activities of the municipal, county, state and federal governments. The state’s Flood Hazard Area delineations are defined by the New Jersey Flood Hazard Area Design Flood, which is equal to a design flood discharge 25 percent greater in flow than the 1-percent annual chance flood. In addition, the floodway shall be based on encroachments that produce no more than a 0.2-foot water surface rise above the 1-percent annual chance flood.

The USGS National Water Information System (NWIS) collects surface water data from more than 850,000 stations across the country. The time-series data describe stream levels, streamflow (discharge), reservoir and lake levels, surface water quality, and rainfall. The data are collected by automatic recorders and manual field measurements at the gage locations. Hudson County currently does not have any active USGS stream gages; however, stream gauges are located upstream in neighboring counties.

In the case of riverine flood hazard, once a river reaches flood stage, the flood extent or severity categories used by the NWS include minor flooding, moderate flooding, and major flooding. Each category has a definition based on property damage and public threat:

- Minor Flooding - minimal or no property damage but possibly some public threat or inconvenience.
- Moderate Flooding - some inundation of structures and roads near streams, some evacuation of people or transfer of property to higher elevations is necessary.
- Major Flooding - extensive inundation of structures and roads, significant evacuation of people or transfer of property to higher elevations (NWS 2011).

The severity of a flood depends not only on the amount of water that accumulates in a period, but also on the land's ability to manage this water. The size of rivers and streams in an area and infiltration rates are significant factors. When it rains, soil acts as a sponge. When the land is saturated or frozen, infiltration rates decrease and any more water that accumulates must flow as runoff (Harris 2008).

The extent of coastal flooding due to coastal storms (hurricanes, tropical storms, and Nor’Easters) is determined by three factors: 1) the nature of the storm with respect to intensity, duration, and path; 2) astronomical tide conditions at the time the storm surge wave reaches the shore; and 3) the physical geometry and bathymetry of a particular area, which affects the time and passage of the surge wave. Similar to riverine flooding, the NWS will issue watches and warnings for minor, moderate, and major coastal flooding.

Currently, there is no measurement used to further define the frequency and severity of urban flooding.

Location

Flooding potential is influenced by climatology, meteorology, and topography. Extensive development, such as that seen in Hudson County, can impact flooding potential because it leaves fewer natural surfaces available to absorb rainwater. Development forces water directly into streams, rivers, and existing drainage systems, swelling them more than when more natural surface buffered the runoff rate.

According to the 2013 preliminary FEMA Flood Insurance Study, flooding in Hudson County is caused primarily by tidal flooding, from such sources as Upper New York Bay, New York Bay, and Kill Van Kull. These sources in turn affect the riverine sources, such as the Hudson River, Hackensack River, and Passaic River. Flooding potential for each type of flooding that affects Hudson County is described in the subsections below. The jurisdictional annexes in Section 9 provide additional information on floodprone areas in each of the County's municipalities.

There are no flood control measures that would alter flood hazards due to coastal flooding within Hudson County (FEMA 2013). However, the following projects are in progress:

- USACE NY & NJ Harbor & Tributaries Focus Area Feasibility Study (HATS)
    - The US Army Corps of Engineers (USACE) is investigating measures to manage future flood risk in ways that support the long-term resilience and sustainability of the coastal ecosystem and surrounding communities, and reduce the economic costs and risks associated with flood and storm events (USACE 2019).
- Hoboken Flood-Resilience Project
    - The U.S. Department of Housing and Urban Development has recently released $230 million for construction of a flood-resistance system to protect Hoboken as well as parts of Weehawken and Jersey City. The project calls for construction of flood structures and stormwater control systems to protect areas vulnerable to flooding. The strategically placed system will utilize natural higher ground to maximize protection and will be designed to blend in seamlessly with the urban streetscape. It will provide protection for critical infrastructure such as the North Hudson Sewerage Authority, as well as public safety facilities such as three fire stations and a hospital.

Floodplains

The Digital Flood Insurance Rate Map (DFIRM) data provided by FEMA for Hudson County show the following flood hazard areas:

- 1-Percent Annual Chance Flood Hazard: Areas subject to inundation by the 1-percent-annual-chance flood event. This includes Zone AE and Zone VE. Mandatory flood insurance requirements and floodplain management standards apply.
- 0.2-Percent Annual Chance Flood Hazard: Area of minimal flood hazard, usually depicted on FIRMs as the 500-year flood level or Shaded X Zone.

The preliminary Hudson County FEMA Digital Flood Insurance Rate Map (DFIRM) dated January 2015 and the preliminary Bergen County FEMA DFIRM dated July 2018 were used to evaluate exposure and determine potential future losses. A depth grid was generated using the preliminary DFIRMs and 1-meter resolution Digital Elevation Model (DEM) provided by the Hudson County Division of Planning and integrated into the HAZUS-MH v4.2 riverine flood model used to estimate potential losses for the 1-percent annual chance flood event. In Hudson County, the flood hazard areas are located along the Hudson River, Newark Bay, the Hackensack River, Pennhorn Creek, and Cromakill Creek. The eastern portion of the Town of Kearny and large portions of Secaucus contain are included in the SFHA.

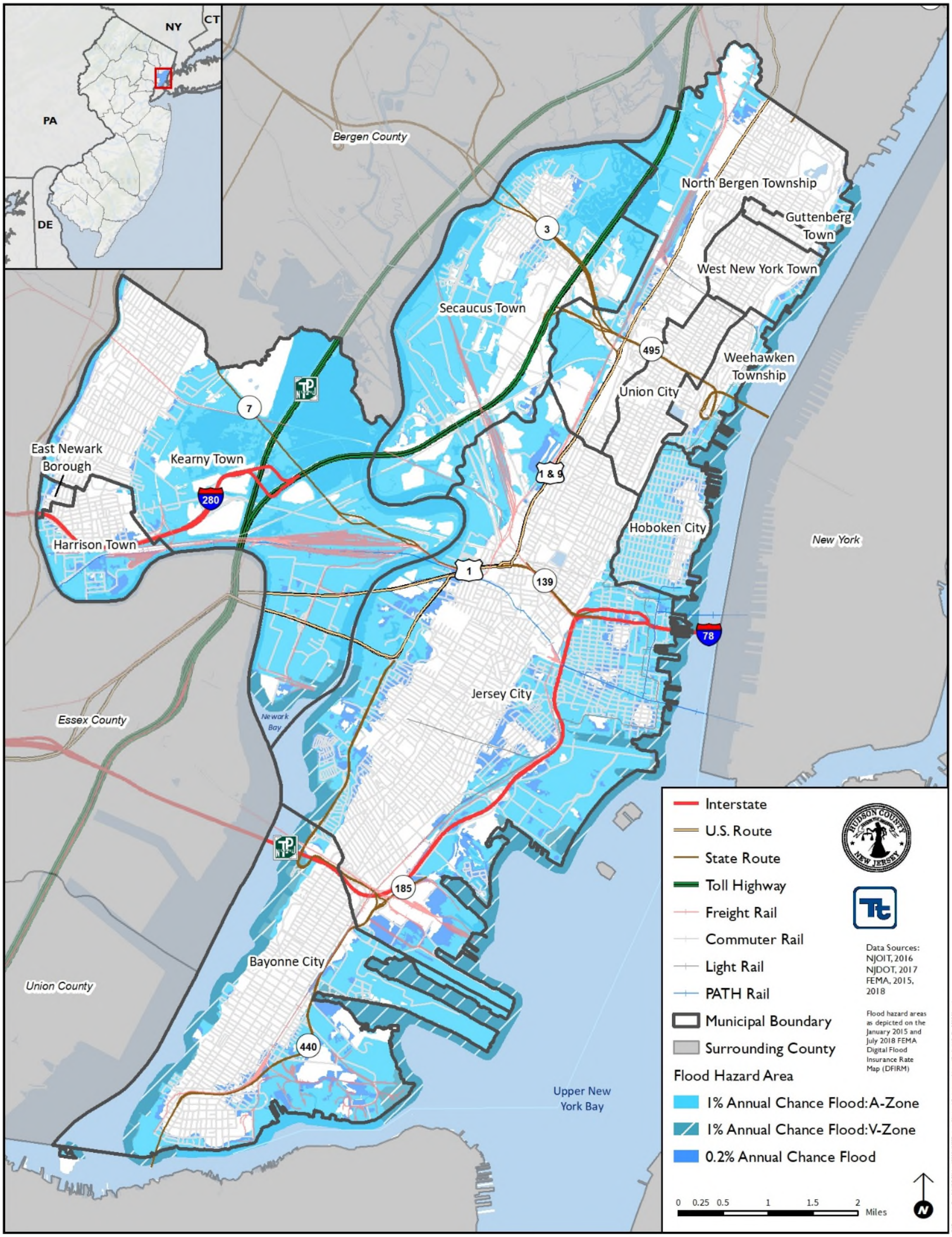
The total land area in the floodplain, inclusive of waterbodies, is summarized in Table 4.3.7-1, and the locations of flood zones in Hudson County as depicted on the FEMA effective DFIRM are illustrated in Figure 4.3.7-3.

Table 4.3.7-1. Total Land Area in the 1-Percent and 0.2-Percent Annual Chance Flood Zones (Acres)

Municipality	Total Land Area	1% Flood Event Hazard Areas		0.2% Flood Event Hazard Areas	
		Area (acres)	Percent (%) of Total	Area (acres)	Percent (%) of Total
Bayonne, City of	4,919	1,945	39.5%	2,227	45.3%
East Newark, Borough of	73	47	65.1%	66	90.4%
Guttenberg, Town of	124	6	4.6%	8	6.5%
Harrison, Town of	848	353	41.6%	458	54.0%
Hoboken, City of	794	578	72.8%	644	81.2%
Jersey City, City of	10,130	3,535	34.9%	5,051	49.9%
Kearny, Town of	6,520	1,662	25.5%	4,372	67.1%
North Bergen, Township of	3,384	191	5.6%	1,238	36.6%
Secaucus, Town of	4,197	48	1.1%	2,732	65.1%
Union City, City of	825	6	0.7%	6	0.7%
Weehawken, Township of	511	169	33.0%	187	36.7%
West New York, Town of	636	54	8.5%	70	11.0%
Hudson County (Total)	32,959	8,593	26.1%	17,059	51.8%

Source: FEMA, 2015/2018

Figure 4.3.7-3. FEMA Flood Hazard Areas in Hudson County



The primary flooding sources in Hudson County are the Hudson River, Passaic River, Hackensack River, Upper New York Bay, Newark Bay, and Kill Van Kull. Section 9 (Jurisdictional Annexes) contains information regarding specific areas of flooding and a map depicting the floodplains for each jurisdiction in Hudson County. The 2013 FEMA preliminary FIS, noted the following principal flood problems in Hudson County:

- ***Weehawken, Guttenburg, West New York*** - Flooding in the Township of Weehawken and Towns of Guttenburg and West New York is caused primarily by tidal flooding of the Hudson River in the low-lying areas along the shore.
- ***Bayonne, Hoboken, Jersey City*** - In the Cities of Bayonne, Hoboken, and Jersey City, the most severe flooding events have been due to hurricanes and related storm surge.
- ***Kearny, Harrison*** - The Towns of Kearney and Harrison are subject to tidal flooding from the Passaic River, which usually occurs when the annual peak rainfall coincides with high tide.
- ***North Bergen*** - In the Township of North Bergen, flooding results from the tidal stages of Newark Bay which affect the Hackensack River, and, in turn, Bellmans Creek, Cromakill Creek, and Penhorn Creek, which wind their way through the Hackensack Estuary. Tidal elevation from the Hackensack River also affects the New Jersey Meadowlands Commission district within the Township of North Bergen.

COASTAL FLOODING

The coastal areas of Hudson County are vulnerable to the damaging impacts of coastal storms. The coastal boundary of New Jersey encompasses the Coastal Area Facility Review Act (CAFRA) area and the New Jersey Meadowlands District. Hudson County is not located in the CAFRA zone; however, four municipalities in the County (Jersey City, Kearny, North Bergen and Secaucus) are located in the Meadowlands.

The Meadowlands are a large ecosystem of wetlands located in northeastern New Jersey. They stretch mainly along the Hackensack and Passaic Rivers as they flow into Newark Bay and include tributaries of the Hackensack River (Sawmill Creek, Berrys Creek, and Overpeck Creek). This area in New Jersey consists of approximately 30.4 square miles of open, undeveloped space, in addition to developed areas. The municipalities of Hudson County located in the New Jersey Meadowlands are prone to flooding during rain events.

The Hackensack Meadowlands Floodplain Management Plan indicated the following problems areas in Hudson County:

- ***Meadowlands Park, Town of Secaucus*** – Flooding has been reported in the vicinity of the Route 3 access ramps from Meadowlands Parkway, which is located in the western section of the Town of Secaucus. It travels in a north-south direction parallel to the Hackensack River. Flooding occurs on both the northbound and southbound shoulders of the roadway near Block 11, Lot 1. Flooding also occurs along the roadway, blocking traffic, and causing significant delays. Flooding is tidally influenced. Heavy rain events cause the Parkway to flood and back up to Tenth Street.
- ***Penhorn Avenue, Town of Secaucus*** – Penhorn Avenue is located in the southern section of the Town of Secaucus. Flooding occurs along this roadway during moderate to severe storm events. It has been reported that each time it rains, the street floods, and with heavy rainfalls, flooding is worse. During rain events, the street is inundated with approximately four feet of water and takes approximately three to four days for the water to drain. In the area of flooding, ground elevation varies from two to eight feet. Penhorn Creek is separated from the Hackensack River, approximately two miles south of Penhorn Avenue.
- ***Fish House Road, Town of Kearny*** – Flooding has been reported in the vicinity of Fish House Road, which is located in the eastern section of the Town of Kearny. Flooding in this area is due primarily to the elevation of the roadway

being at or below extreme high tide. Flooding occurs beneath the PATH and CSX bridges adjacent to the Hackensack River and at the industrial building next to the entrance ramp to Route 7. Flooding also occurs under the Newark Turnpike Causeway where the road can be inundated with water up to four feet. Areas under the Amtrak Bridge flood, and water can reach over a foot in depth. The old cobblestone Newark Turnpike floods, which is now a side street off Route 7. The drainage for this road is tied to the DOT drains by Owens Corning and in the middle of the wide traffic median that eventually drains to the Hackensack River. Two stormwaters catch basins on the Route 7 West exit ramp to Belleville Turnpike are clogged at their outlet.

- ***New Jersey Route 7/Belleville Turnpike, Town of Kearny*** – Route 7/Belleville Turnpike is located in the eastern section of the Town of Kearny. Flooding occurs in the loading docks of several private properties, on the entrance ramp from Belleville Turnpike southbound to Newark-Jersey City Turnpike eastbound, each of the overpasses on Route 7/Belleville Turnpike between Sellers Street and Newark-Jersey City Turnpike, and in front of 720 Route 7/Belleville Turnpike. During heavy rains, tidal blow backs up drains on Belleville Turnpike. The truck yard of the impacted property can be inundated with up to two feet of water, making it difficult for trucks to unload and make deliveries (New Jersey Meadowlands Commission 2005).

Storm surge also contributes to coastal flooding. Storm surges inundate coastal floodplains by tidal elevation rise in inland bays and harbors and backwater flooding through coastal river mouths. Strong winds can increase in tide levels and water-surface elevations. Storm systems generate large waves that run up and flood coastal areas and adjacent low-lying floodplains.

Urban Flooding

Throughout Hudson County, low-lying surface flooding and interior shallow ponding occur as a result of heavy rainfall accompanied by high tides. Inadequate capacity of stormwater systems can cause urban flooding (refer to Figure 4.3.7-4).

Figure 4.3.7-4. Urban Flood Areas in Hudson County

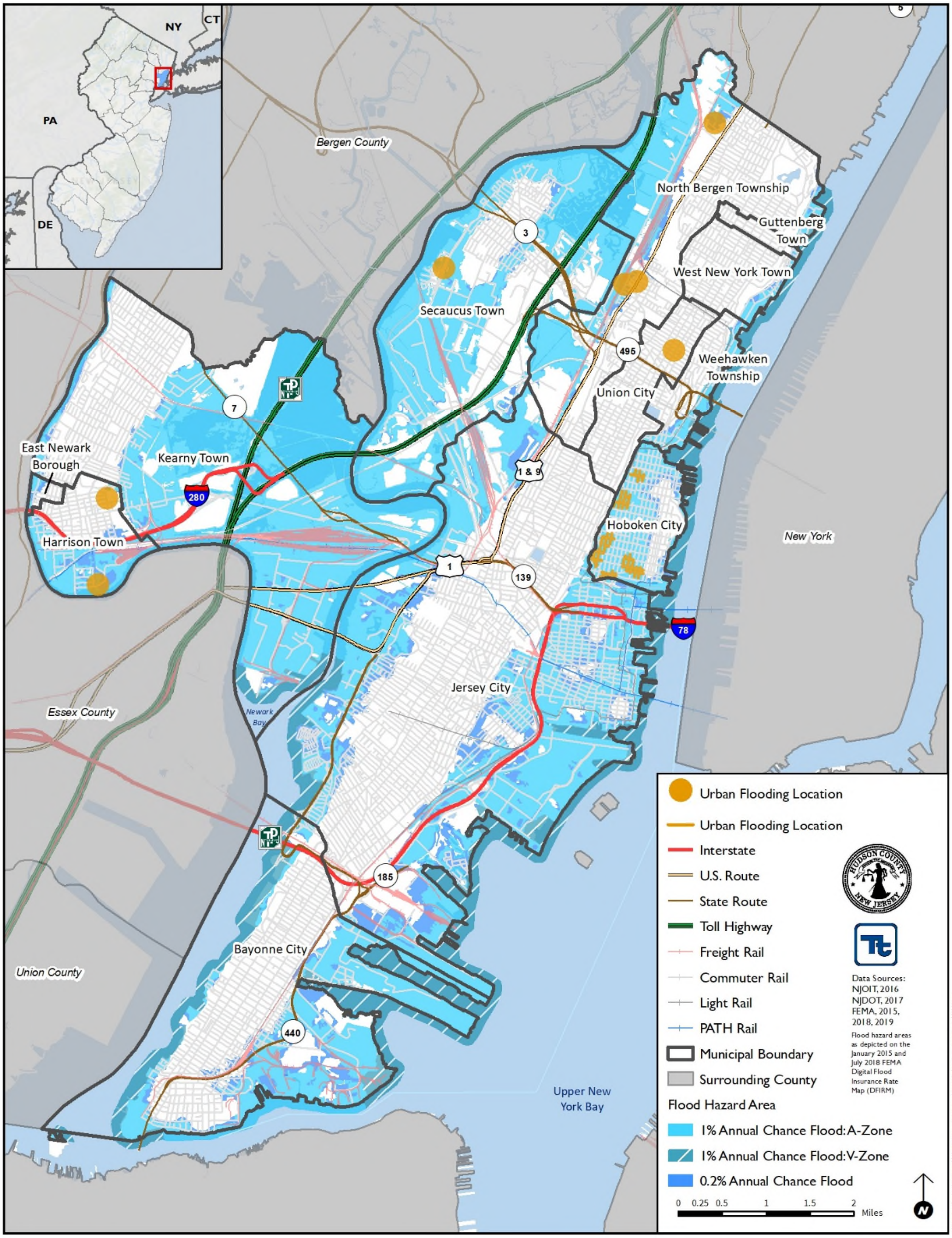
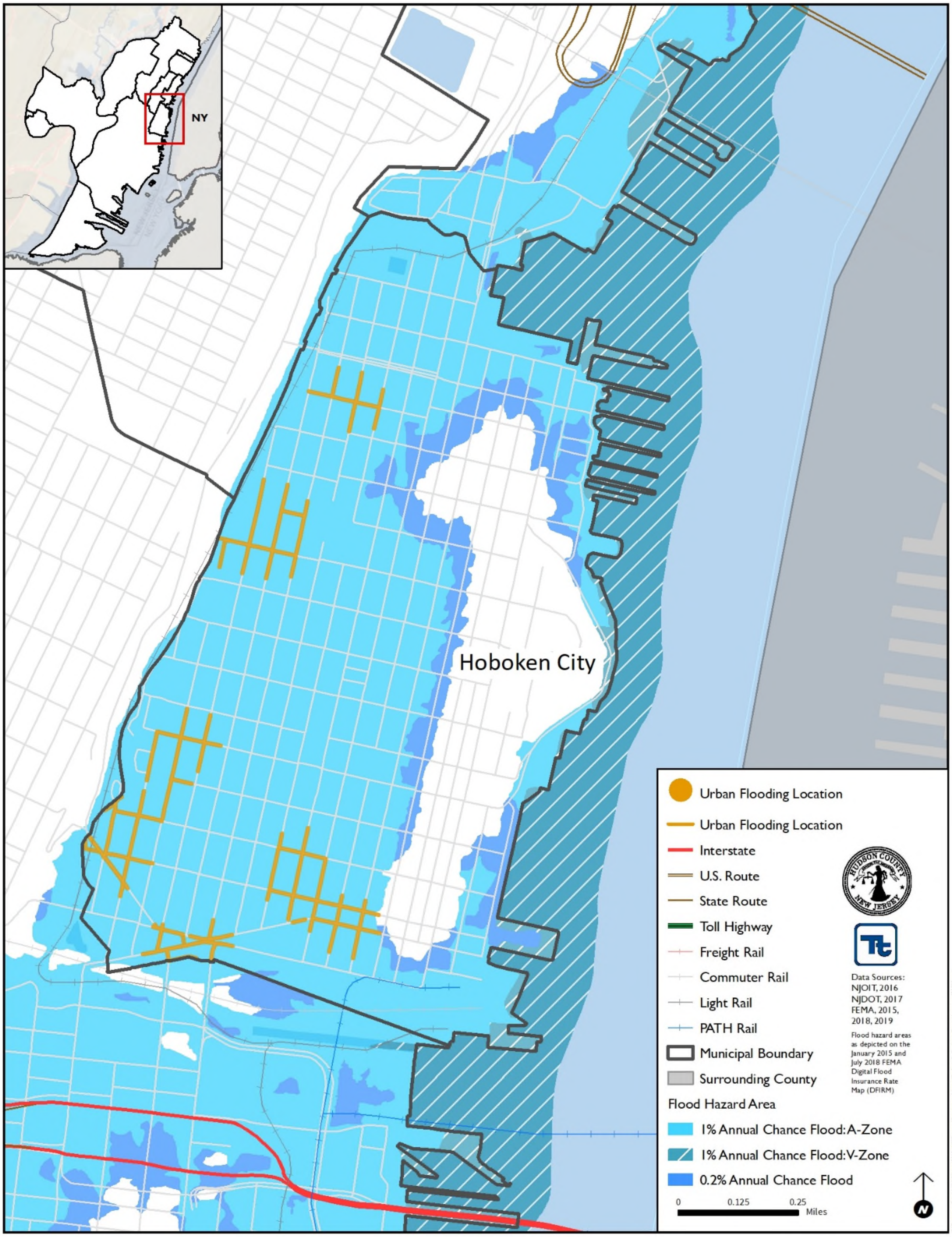


Figure 4.3.7-5. Urban Flood Areas From Rainfall in Hudson County



PAST OCCURRENCE

FEMA MAJOR DISASTERS AND EMERGENCY DECLARATIONS

Between 1954 and 2019, FEMA declared that the State of New Jersey experienced 43 flood-related disasters (DR) or emergencies (EM) classified as one or a combination of the following disaster types: hurricane, tropical storm, Nor'Easter, snowstorm, severe storms, flooding, inland and coastal flooding, coastal storm, high tides, heavy rain, and severe storms. Generally, these disasters cover a wide region of the state; therefore, they might have impacted many counties. Hudson County was included in 14 of these flood-related declarations. Table 4.3.7-2 lists these events.

Table 4.3.7-2. Flood-Related (DR) and Emergency (EM) Declarations (1954-2019)

Declaration	Event Date	Declaration Date	Event Description
DR-310	September 4, 1971	September 4, 1971	Flood: Heavy Rains & Flooding
DR-973	December 10-17, 1992	December 18, 1992	Flood: Coastal Storm, High Tides, Heavy Rain, & Flooding
EM-3106	March 13-17, 1993	March 17, 1993	Snow: Severe Blizzard
DR-1088	January 7-12, 1996	January 13, 1996	Snow: Blizzard of 96 (Severe Snow Storm)
DR-1145	October 18-23, 1996	November 19, 1996	Severe Storm(s): Severe Storms and Flooding
EM-3148	September 16-18, 1999	September 17, 1999	Hurricane: Hurricane Floyd Emergency Declarations
EM-3181	February 16-17, 2003	March 20, 2003	Snow: Snow
DR-1694	April 14-20, 2007	April 26, 2007	Severe Storm(s): Severe Storms and Inland and Coastal Flooding
DR-1954	February 4, 2011	December 26-27, 2010	Snow: Severe Winter Storm and Snowstorm
EM-3332	August 26-September 5, 2011	August 27, 2011	Hurricane: Hurricane Irene
DR-4021	August 27-September 5, 2011	August 31, 2011	Hurricane: Hurricane Irene
EM-3354	October 26-November 8, 2012	October 28, 2012	Hurricane: Hurricane Sandy
DR-4086	October 26-November 8, 2012	October 31, 2012	Hurricane: Hurricane Sandy
DR-4264	January 22-24, 2016	March 14, 2016	Severe Storm(s): Severe Winter Storm and Snowstorm

Source: FEMA 2019

U.S. DEPARTMENT OF AGRICULTURE DISASTER DECLARATIONS

The Secretary of Agriculture from the U.S. Department of Agriculture (USDA) is authorized to designate counties as disaster areas to make emergency loans to producers suffering losses in those counties and in counties that are contiguous to a designated county. Between 2015 and 2019, Hudson County was not included in any USDA declaration involving flooding.

The USDA crop loss data provide another indicator of the severity of previous events. Additionally, crop losses can have a significant impact on the economy by reducing produce sales and purchases. Such impacts may have long-term consequences, particularly if crop yields are low the following years as well. Between 2015 and 2019, Hudson County did not report any crop losses due to flooding.

FLOOD EVENTS

The National Oceanic and Atmospheric Administration (NOAA) National Centers for Environmental Information (NCEI) Storm Events database records and defines flood events as follows:

- Coastal Flood is reported in the NOAA-NCEI database for flooding of coastal areas due to the vertical rise above normal water level caused by strong, persistent onshore wind, high astronomical tide, and/or low atmospheric pressure, resulting in damage, erosion, flooding, fatalities, or injuries. Coastal areas are defined as those portions of coastal land zones (coastal county/parish) adjacent to the waters, bays, and estuaries of the oceans.
- Flash Flood is reported in the NOAA-NCEI database for a life-threatening, rapid rise of water into a normally dry area beginning within minutes to multiple hours of the causative event (e.g., intense rainfall, dam failure, ice jam).
- Flood is reported in the NOAA-NCEI database for any high flow, overflow, or inundation by water which causes damage. In general, this would mean the inundation of a normally dry area caused by an increased water level in an established watercourse, or ponding of water that poses a threat to life or property.

Flood events that have impacted Hudson County between 2015 and January 31, 2019 are identified in Table 4.3.7-3. For events prior to 2015, refer to Appendix E (Risk Assessment Supplement). The annexes in Section 9 provide more detailed information regarding impacts and losses to each plan participant.

Table 4.3.7-3. Flood Events Impacting Hudson County (2015-2019)

Dates of Event	Event Type	FEMA Declaration Number	County Designated?	Location	Losses/Impacts
May 31, 2015	Flash Flood	N/A	N/A	Hoboken, West End	A cold front approaching the area triggered scattered showers and thunderstorms that produced heavy rain leading to flash flooding across northeast New Jersey. Charlottes Circle in Jersey City was closed due to flood waters. Route 7 at Fish House Rd. in Kearny was closed due to flooding.
July 25, 2016	Flash Flood	N/A	N/A	Union City, West End	Showers and thunderstorms developed in a very moist environment ahead of an approaching cold front, resulting in flash flooding across portions of northeast New Jersey. Newark Airport received 1.84 inches of rain. All lanes were closed on US 9/Tonnele Avenue between Secaucus Road and Manhattan Avenue in Jersey City due to flooding.
May 5, 2017	Flash Flood	N/A	N/A	Hoboken, Harrison, Kearny, East Newark	A warm front approaching the area combined with a strong low-level jet ushering in precipitable water values in excess of 1.5 inches, resulted in flash flooding across parts of northeast New Jersey. Newark Airport (3.05 inches) and Teterboro Airport (3.01 inches) received just over 3 inches of rain during the event, with most of that rain falling during a three-hour period. Hourly rainfall rates of up to 1.5 inches were reported at Teterboro, with rates over 1 inch per hour at Newark. Vehicles were stuck in flood waters at the intersection of Montgomery Street and Center Street in Jersey City. Multiple cars were trapped in flood waters on Johnson Avenue in Kearny. Fishburne Avenue in Kearny was closed with water rescues occurring at the intersection of Route 7 and Fishburne Avenue. The fire department responded to motorists trapped in flood waters on Harrison Avenue in Kearny. Cars were trapped with rescues underway on Passaic

Dates of Event	Event Type	FEMA Declaration Number	County Designated?	Location	Losses/Impacts
					Avenue between Central Avenue and East Newark in East Newark.
October 29, 2017	Flood	N/A	N/A	Harrison	A wave of low pressure formed along a slow-moving cold front before rapidly deepening off the Mid Atlantic coast during the evening. With a tropical airmass being entrained into the system, rainfall totals across northeast New Jersey ranged from 2 to 6 inches, with a CWOP site in North Caldwell reporting 5.20 and the ASOS at Newark Airport reporting 4.08 of rain. This resulted in reports of flooding across parts of Hudson and Bergen counties, with water rescues taking place in Hudson County. A water rescue was reported on Passaic Avenue at Bellgrove Drive in Kearny.
April 16, 2018	Flash Flood	N/A	N/A	Harrison, Hoboken	Heavy rainfall developed across the area on the morning of April 16 ahead of a slow-moving warm front. This rain developed in an environment with precipitable water values greater than 1.25 inches, well above normal for mid-April. Rainfall totals generally ranged from 2.5 to 4.5 inches across northeast New Jersey, with most of the rain falling in 3 to 4 hours, resulting in flash flooding across the region. A water rescue was underway at the intersection of Passaic Avenue and Johnston Avenue in Kearny with a car trapped in water up to the window. Multiple roads were closed due to flooding in Hoboken. These roads include Grove Street, Henderson Street, 9th Street between Monroe Street and Madison Street, Madison Street between 8th Street and 10th Street, and the intersections of Clinton Street and 1st Street, Jackson Street and 3rd Street, and Jackson Street and 6th Street.
August 11, 2018	Flash Flood	N/A	N/A	East Newark, Jersey City Airport, Hoboken, Weehawken	A stalled stationary boundary within a very moist airmass provided a focusing mechanism for several rounds of heavy rain that resulted in widespread flash flooding across northeast New Jersey. The Caldwell, NJ ASOS recorded 4.92 inches of rain, and multiple other stations across northeast New Jersey received between 2.5 inches and 4 inches of precipitation. Frank E. Rogers Boulevard was under water near the PATH station in Harrison. Manhole covers were pushed up resulting in flash flooding on Danforth Avenue in Jersey City. Several roads around the City of Hoboken were flooded and impassable.
August 17, 2018	Flash Flood	N/A	N/A	East Newark	Showers and thunderstorms developed in a warm and humid environment ahead of an approaching cold front, resulting in isolated flash flooding across portions of urban northeast New Jersey. These storms brought 1 to 2 inches of rain to the region in a matter of hours, with a cooperative observer in Harrison, NJ recording 1.79 inches of rain during the event. Cars were stuck in flood

Dates of Event	Event Type	FEMA Declaration Number	County Designated?	Location	Losses/Impacts
					waters with water rescues underway on Frank E Rodgers Boulevard at the PATH train station in Harrison.
September 18, 2018	Flash Flood	N/A	N/A	Harrison	A tropical airmass associated with the remnants of Hurricane Florence combined with an approaching cold front to produce waves of showers and thunderstorms that resulted isolated flash flooding in northeast New Jersey. The precipitable water value on the 8 am sounding from Upton, New York was 2.10, which represents a daily maximum value based on the Storm Prediction Center's sounding climatology. The intersection of Passaic Avenue and Johnston Avenue in Kearny was closed due to flooding.
September 25, 2018	Flash Flood	N/A	N/A	Communipaw, Granton Junction, Union City, Jersey City Airport, Greenville, West End, Hoboken	Rain developed across the area ahead of an approaching warm front, consolidating into a slow-moving band of heavy rain across northeast New Jersey by late morning. Precipitable water values increased from 1.84 on the morning sounding from Upton, NY to 2.13 by evening. Both of these values are above the 90th percentile based on a sounding climatology, with the 2.13 precipitable water value on the evening of the 25th a record for the date. Rainfall amounts generally ranged from 3 to 5 inches, with one CoCoRaHS observer reporting 5.56 inches of rain in Palisades Park. Cars were stuck in flood waters on Route 440 southbound near Port Jersey Boulevard in Bayonne. New Jersey Route 3 flooded westbound in the area of the eastern spur of the New Jersey Turnpike in Secaucus. All lanes were closed in both directions due to flooding on the US Route 1 & 9 truck route approaching NJ 440 in West Bergen. Portions of Central Avenue in Kearny were impassable due to 3 to 4 feet of standing water. A ramp was closed due to flooding on the New Jersey Turnpike-Hudson County Extension outside interchange 14A (NJ 440A/Bayonne Bridge) in Bayonne. All lanes were closed due to flooding on NJ 7 eastbound approaching Charlotte Circle in Marion.

Source: NOAA-NCEI 2019, FEMA 2019
Note: Not all events that have occurred in Hudson County are included in the table due to the extent of documentation and not all sources have been identified or researched. Loss and impact information for many events can vary depending on the source. Therefore, the accuracy of damages and monetary figures is based only on the available information identified during research for this HMP.

According to the Storm Events Database, Hudson County has been impacted by 80 flood events between 1950 and January 2019 (Table 4.3.7-4). These events resulted in one fatality and $4.10 million in property damages. There were no events categorized as urban flood events to calculate a probability.

Table 4.3.7-4. Severe Weather Events in Hudson County 1950 to 2019

Hazard Type	Number of Occurrences Between 1950 and 2019	Total Fatalities	Total Injuries	Total Property Damage ($)	Total Crop Damage ($)
Coastal Flood	15	0	0	$0	$0
Flash Flood	44	0	0	$400K	$0
Flood	21	1	0	$3.70M	$0
TOTAL	**80**	**1**	**0**	**$4.10M**	**$0**

Source: NOAA-NCEI 2019
Note: Not all events that have occurred in Hudson County are included due to the extent of documentation and the fact that not all sources have been identified or researched.
K: Thousand
M: Million

PROBABILITY OF FUTURE OCCURRENCE

Hudson County is expected to continue experiencing direct and indirect impacts of flooding in the future. As the climate continues to change, population and development increases this continues to be a concern for Hudson County. However, several jurisdictions are identifying and implementing large-scale projects to mitigate future impacts as discussed throughout Section 9.

Table 4.3.7-5 summarizes data regarding the probability of occurrences of flood events in Hudson County based on the historic record. The information used to calculate the probability of occurrences is based solely on NOAA-NCEI storm events database results.

Table 4.3.7-5. Flood Events in Hudson County 1950 to 2019

Hazard Type	Number of Occurrences Between 1950 and 2019	Rate of Occurrence	Recurrence Interval (in years)	Probability of Event Occurring in Any Given Year	Percent (%) Chance of Occurring in Any Given Year
Coastal Flood	15	0.22	4.7	0.21	21.4%
Flash Flood	44	0.64	1.6	0.63	62.9%
Flood	21	0.30	3.3	0.30	30.0%
TOTAL	**80**	**1.2**	**0.88**	**1**	**100%**

Source: NOAA-NCEI 2019
Note: Not all events that have occurred in Hudson County are included due to the extent of documentation and the fact that not all sources have been identified or researched.
K: Thousand
M: Million

In Section 4.4, the identified hazards of concern for Hudson County are ranked using a variety of parameters. The probability of occurrence, or likelihood of the event, is one parameter used for hazard rankings. Based on historical records and input from the Planning Partnership, the probability of occurrence for flood in the County is considered "frequent" (likely to occur within 25 years, as presented in Table 4.3.7-5).

CLIMATE CHANGE

New Jersey has become wetter over the past century. Northern New Jersey's 1971-2000 precipitation average was over 5 inches (12-percent) greater than the average from 1895-1970 (CATF 2011). The heaviest 1 percent of daily rainfalls have increased by approximately 70 percent between 1958 and 2011 in the Northeast (Horton et al. 2015). Average annual precipitation is projected to increase in the region by 4 to 11-percent by the 2050s and 5 to 13-percent by the 2080s (NPCC 2015). Increased rainfall and heavy rainfalls increase the risk of flooding events.

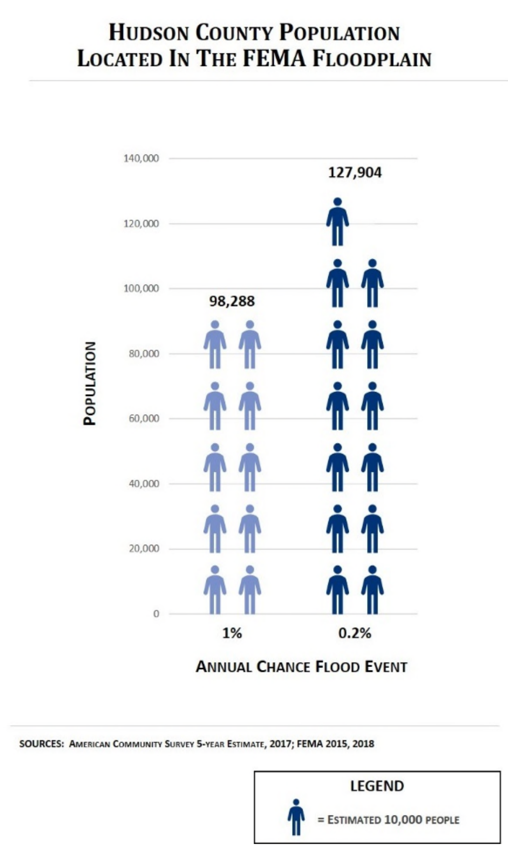
Annual precipitation for New Jersey has been about 8 percent above average over the last 10 years. The number of extreme precipitation events has also been above average over the last 10 years. During 2010–2014, the state experienced the largest number of extreme precipitation events (days with more than 2 inches) compared to any other 5-year period, about 50 percent above the long-term average. Winter and spring precipitation is projected to increase for the 21st century; extreme precipitation is also projected to increase. The projections of increasing precipitation are characteristic of a large area of the Northern Hemisphere in the northern middle latitudes, as well as increases in heavy precipitation events. This may result in increased coastal and inland flooding risks throughout the state (NCEI 2019).

Sea level rise increases the risks coastal communities face from coastal flooding. Sea level along the New Jersey Coast has risen by more than 16 inches since 1911, double the global average (NOAA NCEI 2019). The historical rate of sea level rise along the New Jersey coast over the past 50 years was 0.12 to 0.16 inches per year. Future rates are predicted to increase to 0.5 inches/year (Miller and Kopp 2013). As sea level rises, the impact of storm surge events will increase as the combination of storm surge and increased sea level will increase the frequency and severity of coastal flooding. Section 4.3.1 (Coastal Erosion and Sea Level Rise) provides more information on sea level rise impacts.

4.3.7.2 Vulnerability Assessment

To assess Hudson County's risk to the flood hazard, a spatial analysis was conducted using the best available spatially-delineated flood hazard areas. The 1- and 0.2-percent annual chance flood events were examined to determine the assets located in the hazard areas and to estimate potential loss using the FEMA HAZUS-MH v4.2 model. These results are summarized below. Refer to Section 4.2 (Methodology and Tools) for additional details on the methodology used to assess flood risk.

Figure 4.3.7-1. Number of Persons Exposed to Flood Hazard Areas



Impact on Life, Health, and Safety

The impact of flooding on life, health and safety is dependent upon several factors including the severity of the event and whether adequate warning time is provided to residents. Exposure represents the population living in or near floodplain areas that could be impacted should a flood event occur. However, exposure is not limited to persons who reside in a defined hazard zone, but includes all individuals who may be affected by the effects of a hazard event (e.g., people are at risk while traveling in flooded areas, or their access to emergency services is compromised during an event). The degree of that impact will vary and is not strictly measurable.

Based on the spatial analysis, there are an estimated 98,288 people living in the Special Flood Hazard Area (SFHA, or 1-percent annual chance event floodplain) and an estimated 127,904 people located in the 0.2-percent annual chance flood event floodplain (refer to Table 4.3.7-6 and Figure 4.3.7-6). These residents may be displaced due to their homes flooding, requiring them to seek temporary shelter with friends and family or in emergency shelters. The City of Hoboken has the greatest percentage of its population located in the floodplain; approximately 64-percent and 78-percent for the 1-percent chance event and 0.2-percent chance event, respectively. The City of Jersey City has the greatest number of residents located in the floodplain; approximately 48,082 and 64,516 people located in the 1-percent chance event and 0.2-percent chance event floodplain boundaries, respectively. For this project, the potential population exposed is used as a guide for planning purposes.

Table 4.3.7-6. Estimated Population Living in the Flood Hazard Area

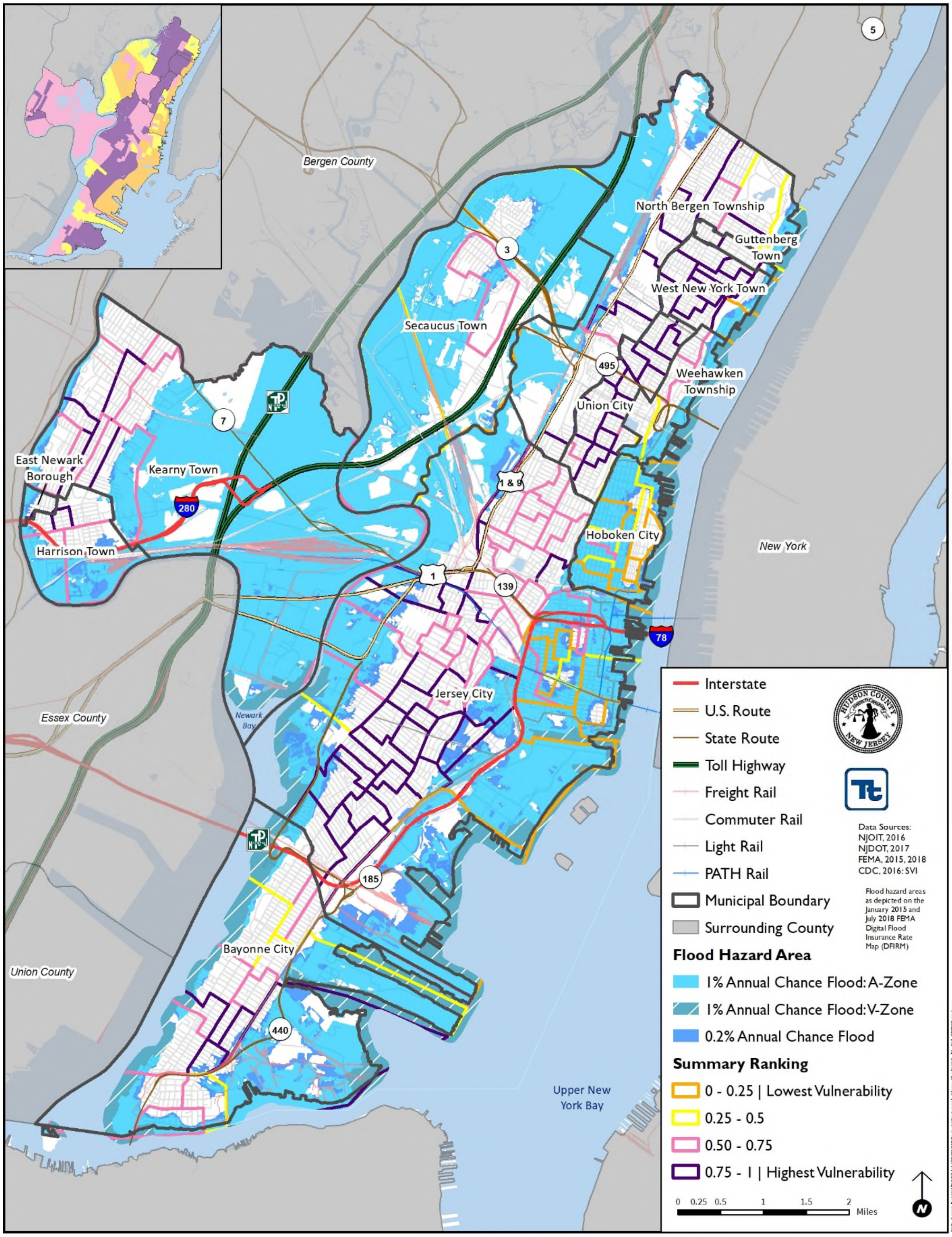
Municipality	Total Population	1-percent Annual Chance Flood Event		0.2-percent Annual Chance Flood Event	
		Number	% of Total	Number	% of Total
Bayonne, City of	66,719	3,882	5.8%	6,393	9.6%
East Newark, Borough of	2,725	0	0.0%	50	1.9%
Guttenberg, Town of	11,733	0	0.0%	0	0.0%
Harrison, Town of	15,898	1,095	6.9%	1,570	9.9%
Hoboken, City of	54,117	34,465	63.7%	42,285	78.1%
Jersey City, City of	265,932	48,082	18.1%	64,516	24.3%
Kearny, Town of	42,487	1,205	2.8%	1,442	3.4%
North Bergen, Township of	63,438	479	0.8%	753	1.2%
Secaucus, Town of	19,279	5,057	26.2%	5,660	29.4%
Union City, City of	69,815	0	0.0%	0	0.0%
Weehawken, Township of	14,268	787	5.5%	810	5.7%
West New York, Town of	53,345	3,237	6.1%	4,424	8.3%
Hudson County (Total)	**679,756**	**98,288**	**14.5%**	**127,904**	**18.8%**

Sources: American Community Survey 5-year Estimate, 2017; FEMA, 2015/2018

Research has shown that some populations, while they may not have more hazard exposure, may experience exacerbated impacts and prolonged recovery if/when impacted. This is due to many factors including their physical and financial ability to react or respond during a hazard. Of the population exposed, the most vulnerable include the economically disadvantaged and the population over age 65. Economically disadvantaged populations may be more vulnerable because they are likely to evaluate their risk and make decisions to evacuate based on net economic impacts on their families. The population over age 65 is also more vulnerable because they are more likely to seek or need medical attention that may not be available due to isolation during a flood event, and they may have more difficulty evacuating. Within the 1-percent annual chance event, there are approximately 7,452 people over the age of 65 and 10,548 people below the poverty level. These populations are all located within the SFHA. As for the 0.2-percent chance event, there are approximately 10,191 people over the age 65 and 13,600 people below the poverty level.

The CDC 2016 Social Vulnerability Index (SVI) ranks U.S. Census tracts on socioeconomic status, household composition and disability, minority status and language, and housing and transportation. Hudson County's overall score is 0.6425, indicating that its communities have moderate to high vulnerability (CDC 2016). Refer to Figure 4.3.7-6 which illustrates a majority of the socially vulnerable areas in the County are located outside the floodplain.

Figure 4.3.7-7. CDC Social Vulnerability Index Rating for Hudson County and Flood Hazard Areas



Using 2010 U.S. Census data, HAZUS-MH v4.2 estimates the potential sheltering needs as a result of a 1-percent annual chance flood event. For the 1-percent flood event, HAZUS-MH v4.2 estimates 97,426 households will be displaced, and 9,417 people will seek short-term sheltering. These statistics, by municipality, are presented in Table 4.3.7-7. The estimated displaced population and number of persons seeking short-term sheltering differs from the number of persons exposed to the 1-percent annual chance flood, because the displaced population numbers take into consideration that not all residents will be significantly impacted enough to be displaced or to require short-term sheltering during a flood event (refer to Figure 4.3.7-8).

Figure 4.3.7-2. Households Displaced by 1-Percent Flood Event

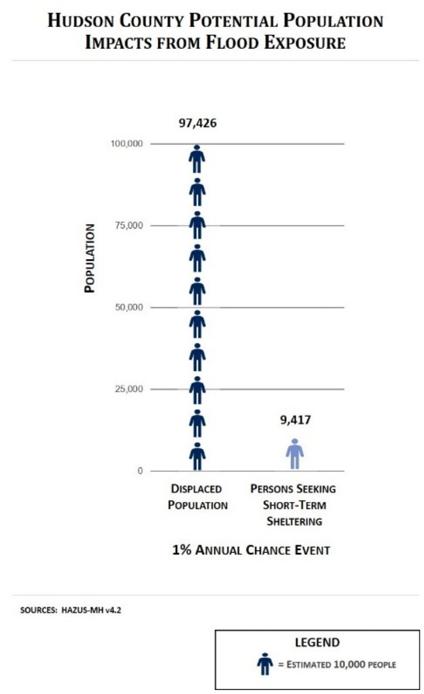


Table 4.3.7-7. Estimated Population Displaced or Seeking Short-Term Shelter from the 1-Percent Annual Chance Flood Event

Municipality	U.S. Census 2010 Population	1-Percent Annual Chance Event	
		Displaced Households	Persons Seeking Short-Term Sheltering
Bayonne, City of	66,719	4,635	397
East Newark, Borough of	2,725	15	-
Guttenberg, Town of	11,733	200	12
Harrison, Town of	15,898	863	55
Hoboken, City of	54,117	33,286	3,529
Jersey City, City of	265,932	45,432	4,532
Kearny, Town of	42,487	3,256	146
North Bergen, Township of	63,438	1,400	112
Secaucus, Town of	19,279	6,285	509
Union City, City of	69,815	73	4
Weehawken, Township of	14,268	1,053	63
West New York, Town of	53,345	928	58
Hudson County (Total)	**679,756**	**97,426**	**9,417**

Sources: HAZUS-MH v4.2

Total number of injuries and casualties resulting from typical riverine and tidal flooding are generally limited based on advance weather forecasting, blockades, and warnings. Injuries and deaths generally are not anticipated if proper warning and precautions occur. In contrast, warning time for flash flooding is limited. These events are frequently associated with other natural hazard events such as earthquakes, landslides, or severe weather, which limits their predictability and compounds the hazard. Populations without adequate warning of the event are highly vulnerable to this hazard.

Cascading impacts may also include exposure to pathogens such as mold. After flood events, excess moisture and standing water contribute to the growth of mold in buildings. Mold may present a health risk to building occupants, especially those with already compromised immune systems such as infants, children, the elderly and pregnant women. The degree of impact will vary and is not strictly measurable. Mold spores can grow in as short a period as 24-48 hours in wet and damaged areas of buildings that have not been properly cleaned. Very small mold spores can easily be inhaled, creating the potential for allergic reactions, asthma episodes, and other respiratory problems. Buildings should be properly cleaned and dried out to safely prevent mold growth (CDC 2019).

Molds and mildews are not the only public health risk associated with flooding. Floodwaters can be contaminated by pollutants such as sewage, human and animal feces, pesticides, fertilizers, oil, asbestos, and rusting building materials. Common public health risks associated with flood events also include:

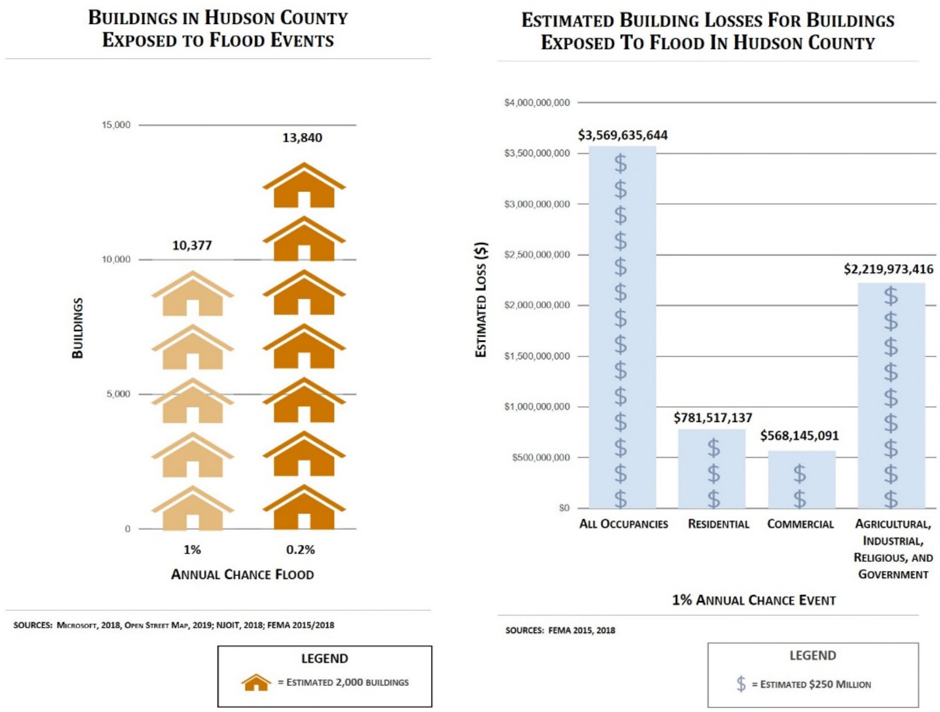
- Unsafe food
- Contaminated drinking and washing water and poor sanitation
- Mosquitos and animals
- Carbon monoxide poisoning
- Secondary hazards associated with re-entering/cleaning flooded structures
- Mental stress and fatigue

Current loss estimation models such as HAZUS-MH are not equipped to measure public health impacts. The best level of mitigation for these impacts is to be aware that they can occur, educate the public on prevention, and be prepared to deal with these vulnerabilities in responding to flood events.

Impact on General Building Stock

Exposure to the flood hazard includes those buildings located in the flood zone (refer to Figure 4.3.7-9 and Figure 4.3.7-10). Potential damage is the modeled loss that could occur to the exposed inventory measured by the structural and content replacement cost value. There are an estimated 10,377 buildings located in the SFHA with a value of approximately $25.95 billion of building and contents (based on replacement cost value). This represents approximately 34.3-percent of the County's total general building stock inventory replacement cost value (approximately $75.7 billion).

Figure 4.3.7-3. Buildings Exposed and Estimated Losses to Flood Hazard Events



There are 13,840 buildings located in the 0.2-percent annual chance flood boundary with approximately $32.3 billion of building/contents in replacement cost value (or 42.7-percent of the County's total replacement cost value). The City of Hoboken has the greatest proportion of its buildings located in the floodplain; approximately 61.1-percent and 74.2-percent for the 1-percent chance event and 0.2-percent chance event, respectively. The City of Jersey City has the greatest number of buildings located in the floodplain; approximately 4,342 and 6,413 located in the 1-percent chance event and 0.2-percent chance event boundaries, respectively. Refer to Table 4.3.7-8 and Table 4.3.7-9 for the building flood exposure analysis results by municipality.

HAZUS-MH estimates $3.56 billion in building and content damage as a result of the 1-percent annual chance flood event (or 7.1-percent of the total building stock replacement cost value). Of the $3.56 billion in potential loss, $781 million is estimated to residential structures. Refer to Table 4.3.7-10 for the potential losses estimated by HAZUS-MH v4.2 by municipality.

Figure 4.3.7-4. Population Exposed to Flood Hazard Events

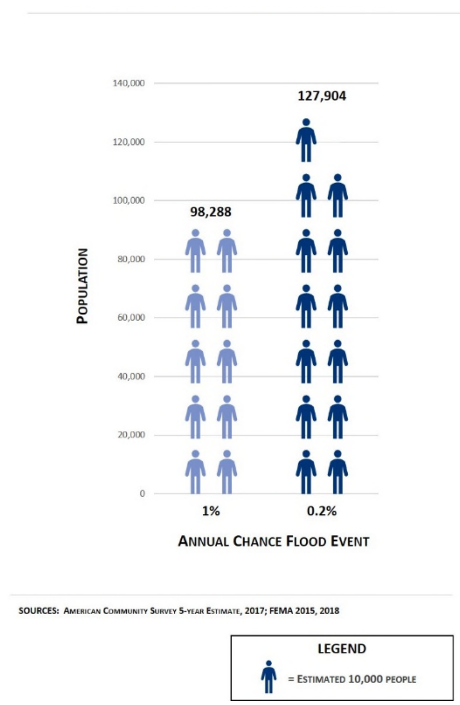


Table 4.3.7-8. Estimated General Building Stock Exposure to the 1-Percent Annual Chance Flood Event – All Occupancies

Municipality	Total # Buildings	Total Replacement Cost Value (RCV)	Estimated Building Stock Exposed			
			Number of Buildings - 1-percent Annual Chance Flood	% of Total	RCV - 1-percent Annual Chance Flood	% of Total
Bayonne, City of	6,802	$8,856,079,105	1124	16.5%	$2,718,352,128	30.7%
East Newark, Borough of	403	$240,888,451	7	1.7%	$31,248,036	13.0%
Guttenberg, Town of	1,227	$651,507,569	6	0.5%	$16,240,680	2.5%
Harrison, Town of	2,537	$2,398,975,757	187	7.4%	$891,632,993	37.2%
Hoboken, City of	4,470	$3,910,202,233	2745	61.4%	$2,790,836,828	71.4%
Jersey City, City of	35894	$25,693,921,967	4342	12.1%	$6,785,947,189	26.4%
Kearny, Town of	7,209	$7,874,466,790	681	9.4%	$4,414,659,830	56.1%
North Bergen, Township of	6,005	$8,393,144,641	138	2.3%	$2,108,652,012	25.1%
Secaucus, Town of	3,845	$9,593,262,762	969	25.2%	$5,529,684,968	57.6%
Union City, City of	1,729	$3,742,882,384	0	0.0%	$0	0.0%
Weehawken, Township of	2,113	$1,510,119,929	160	7.6%	$516,846,041	34.2%
West New York, Town of	4,594	$2,825,012,673	18	0.4%	$150,017,138	5.3%
Hudson County (Total)	**76,828**	**$75,690,464,261**	**10,377**	**13.5%**	**$25,954,117,843**	**34.3%**

Sources: Microsoft, 2018, Open Street Map, 2019; NJOIT, 2018; FEMA 2015/2018

Table 4.3.7-9. Estimated General Building Stock Exposure to the 0.2-Percent Annual Chance Flood Event – All Occupancies

Municipality	Total # Buildings	Total Replacement Cost Value (RCV)	Estimated Building Stock Exposed			
			Number of Buildings - 0.2-percent Annual Chance Flood	% of Total	RCV - 0.2-percent Annual Chance Flood	% of Total
Bayonne, City of	6,802	$8,856,079,105	1478	21.7%	$3,427,105,853	38.7%
East Newark, Borough of	403	$240,888,451	24	6.0%	$68,495,039	28.4%
Guttenberg, Town of	1,227	$651,507,569	12	1.0%	$37,354,230	5.7%
Harrison, Town of	2,537	$2,398,975,757	293	11.5%	$1,226,703,166	51.1%
Hoboken, City of	4,470	$3,910,202,233	3316	74.2%	$3,168,777,668	81.0%
Jersey City, City of	35894	$25,693,921,967	6413	17.9%	$10,605,720,401	41.3%
Kearny, Town of	7,209	$7,874,466,790	758	10.5%	$4,542,832,166	57.7%
North Bergen, Township of	6,005	$8,393,144,641	196	3.3%	$2,422,095,603	28.9%
Secaucus, Town of	3,845	$9,593,262,762	1143	29.7%	$5,998,309,201	62.5%
Union City, City of	1,729	$3,742,882,384	0	0.0%	$0	0.0%
Weehawken, Township of	2,113	$1,510,119,929	175	8.3%	$545,153,715	36.1%
West New York, Town of	4,594	$2,825,012,673	32	0.7%	$244,799,443	8.7%
Hudson County (Total)	**76,828**	**$75,690,464,261**	**13,840**	**18.0%**	**$32,287,346,486**	**42.7%**

Sources: Microsoft, 2018, Open Street Map, 2019; NJOIT, 2018; FEMA 2015/2018

Table 4.3.7-10. Estimated General Building Stock Potential Loss to the 1-Percent Annual Chance Flood Event

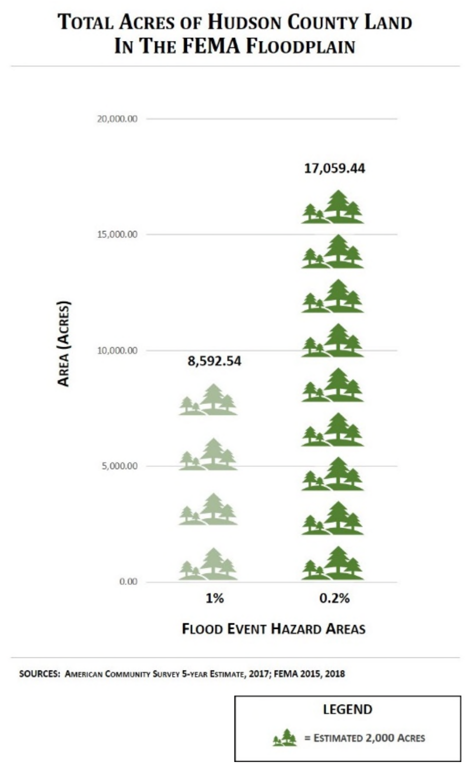
Municipality	Total Replacement Cost Value	1-Percent Annual Chance Event							
		All Occupancies		Residential		Commercial		Agricultural, Industrial, Religious, Education and Government	
		Estimated Loss	% of Total	Estimated Loss	% of Total	Estimated Loss	% of Total	Estimated Loss	% of Total
Bayonne, City of	$4,483,250,138	$505,471,218	11.3%	$16,150,403	0.4%	$85,690,867	1.9%	$403,629,949	9.0%
East Newark, Borough of	$6,021,089,887	$738,537	0.0%	$0	0.0%	$0	0.0%	$738,537	0.0%
Guttenberg, Town of	$1,183,204,981	$112,839	0.0%	$0	0.0%	$0	0.0%	$112,838.92	0.0%
Harrison, Town of	$3,008,045,785	$91,581,730	3.0%	$26,367,282	0.9%	$1,838,537	0.1%	$63,375,910	2.1%
Hoboken, City of	$6,090,766,912	$818,818,508	13.4%	$366,863,194	6.0%	$172,861,558	2.8%	$279,093,755.90	4.6%
Jersey City, City of	$527,629,662	$1,083,767,531	205.4%	$230,748,439	43.7%	$215,106,438	40.8%	$637,912,654	120.9%
Kearny, Town of	$6,082,819,367	$664,022,538	10.9%	$15,760,667	0.3%	$7,245,713	0.1%	$641,016,158.54	10.5%
North Bergen, Township of	$1,095,474,263	$139,481,307	12.7%	$21,661,553	2.0%	$22,340,354	2.0%	$95,479,399	8.7%
Secaucus, Town of	$5,384,838,816	$112,934,210	2.1%	$45,361,039	0.8%	$4,248,393	0.1%	$63,324,777.32	1.2%
Union City, City of	$7,691,376,811	$0	0.0%	$0	0.0%	$0	0.0%	$0	0.0%
Weehawken, Township of	$3,575,395,600	$140,900,724	3.9%	$47,853,574	1.3%	$58,777,689	1.6%	$34,269,461.07	1.0%
West New York, Town of	$5,241,567,136	$11,806,503	0.2%	$10,750,987	0.2%	$35,542	0.0%	$1,019,975	0.0%
Hudson County (Total)	**$50,385,459,357**	**$3,569,635,644**	**7.1%**	**$781,517,137**	**1.6%**	**$568,145,091**	**1.1%**	**$2,219,973,416**	**4.4%**

Source: HAZUS-MH v4.2

Impact on Land Uses

An exposure analysis was completed to determine the residential and non-residential parcels located in the flood hazard areas. To estimate the land use exposure to the 1- and 0.2-percent flood events, the floodplain boundaries were overlaid upon the 2018 parcel data in GIS (2018 New Jersey Geographic Information Network) and used to calculate the estimated number and area of residential and non-residential parcels exposed to this hazard. Refer to Figure 4.3.7-12 and Figure 4.3.7-13 which illustrate the residential and non-residential parcels that intersect the floodplain. A summary of total acres located in the flood hazard areas are illustrated in Figure 4.3.7-11.

Figure 4.3.7-5. Total Acres of Land Exposed to Flood Hazard Events



The analysis shows a majority of the residential parcels in Jersey City are located in the flood hazard area (refer to Table 4.3.7-11). Across Hudson County, approximately 11-percent of all structures and approximately 6-percent of the total residential land use area are within the 1-percent annual chance of flooding flood hazard area. Furthermore, approximately 15-percent of all parcels and 6-percent of residential land use area in the County are within the 0.2-percent annual chance of flooding flood hazard area. Out of all the Hudson County municipalities, the City of Hoboken has the highest proportion of its residential parcels exposed to the 1-percent and 0.2-percent annual chance flood hazard areas.

The analysis also shows approximately 5-percent of the total acreage of non-residential parcels and 2-percent of the non-residential land use area in the County are vulnerable to flooding (refer to Table 4.3.7-12). Out of the municipalities within Hudson County, the City of Bayonne and the City of Hoboken have the greatest number of non-residential land and non-residential parcels in the 1-percent annual chance flood hazard area.

Figure 4.3.7-12. Residential Parcels that Intersect the Flood Hazard Areas

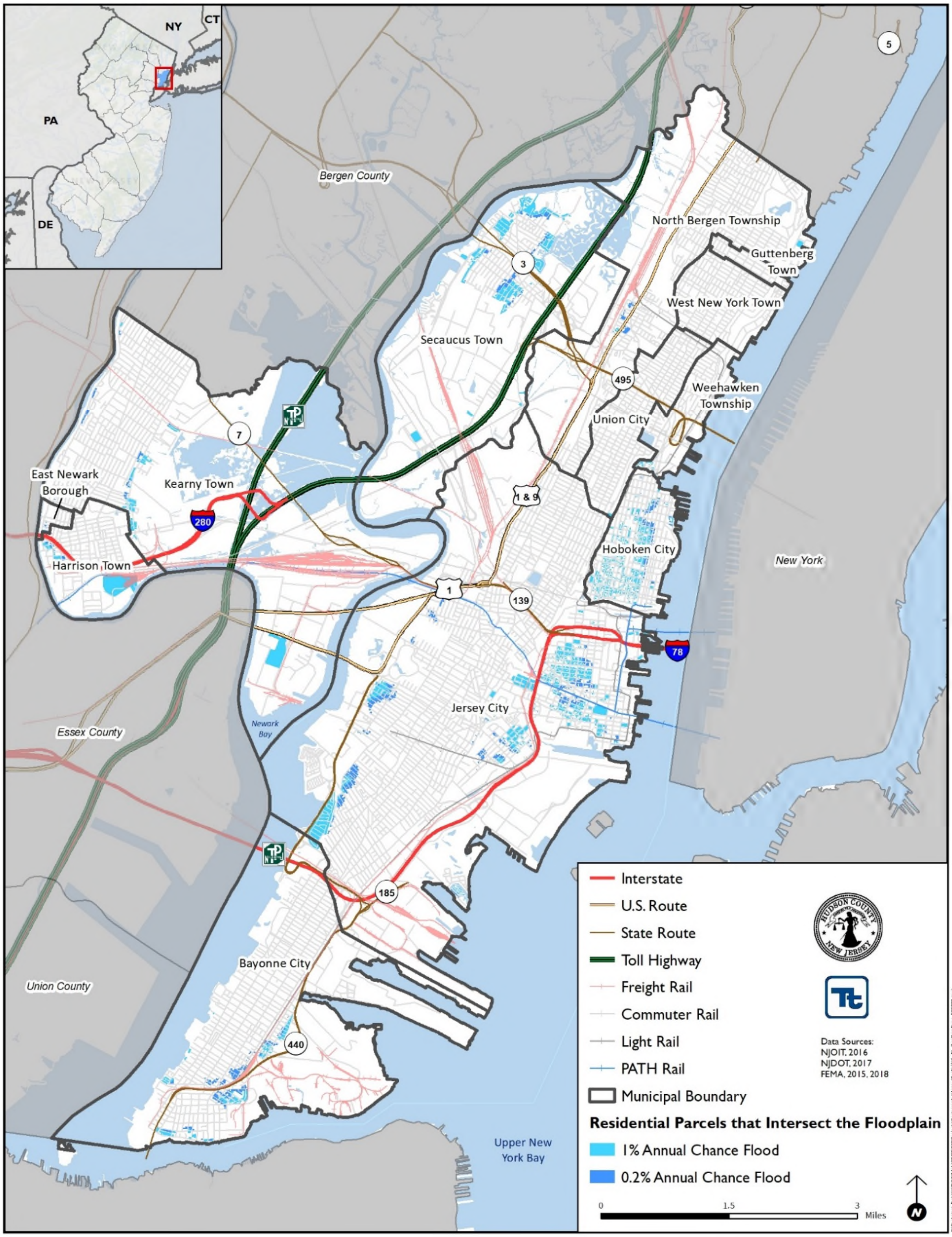


Table 4.3.7-11. Residential Land Use Exposure to the 1-Percent and 0.2-Percent Annual Chance Flood Events

Municipality	Total Residential Land Use Area (acres)	Total Number of Residential Parcels	1% Flood Event Hazard Area				0.2% Flood Event Hazard Area			
			Number of Residential Parcels in A and V-Zone	% of Total	Residential Land Use Area in A and V-Zone (acres)	% of Total	Number of Residential Parcels in 0.2%	% of Total	Residential Land Use Area in 0.2% (acres)	% of Total
Bayonne, City of	1,194	5,171	303	5.9%	51	1.0%	492	0	56	1.1%
East Newark, Borough of	29	352	0	0.0%	0	0.0%	6	0	0	0.0%
Guttenberg, Town of	94	990	0	0.0%	0	0.0%	0	0	0	0.0%
Harrison, Town of	200	2,075	124	6.0%	17	0.8%	185	0	18	0.9%
Hoboken, City of	411	3,424	2,164	63.2%	845	24.7%	2,644	1	884	25.8%
Jersey City, City of	3,012	30,273	3,255	10.8%	2,757	9.1%	4,889	0	2,878	9.5%
Kearny, Town of	945	6,241	193	3.1%	25	0.4%	230	0	26	0.4%
North Bergen, Township of	862	5,126	16	0.3%	2	0.0%	37	0	2	0.1%
Secaucus, Town of	551	3,280	717	21.9%	9	0.3%	857	0	10	0.3%
Union City, City of	447	1,252	0	0.0%	0	0.0%	0	0	0	0.0%
Weehawken, Township of	217	1,926	113	5.9%	38	2.0%	117	0	38	2.0%
West New York, Town of	339	3,583	11	0.3%	1	0.0%	22	0	1	0.0%
Hudson County (Total)	**8,302**	**63,693**	**6,896**	**10.8%**	**3,744**	**5.9%**	**9,479**	**0**	**3,913**	**6.1%**

Source: FEMA 2015, 2018
Note: % = Percent

Figure 4.3.7-13. Non-Residential Parcels that Intersect the Flood Hazard Areas

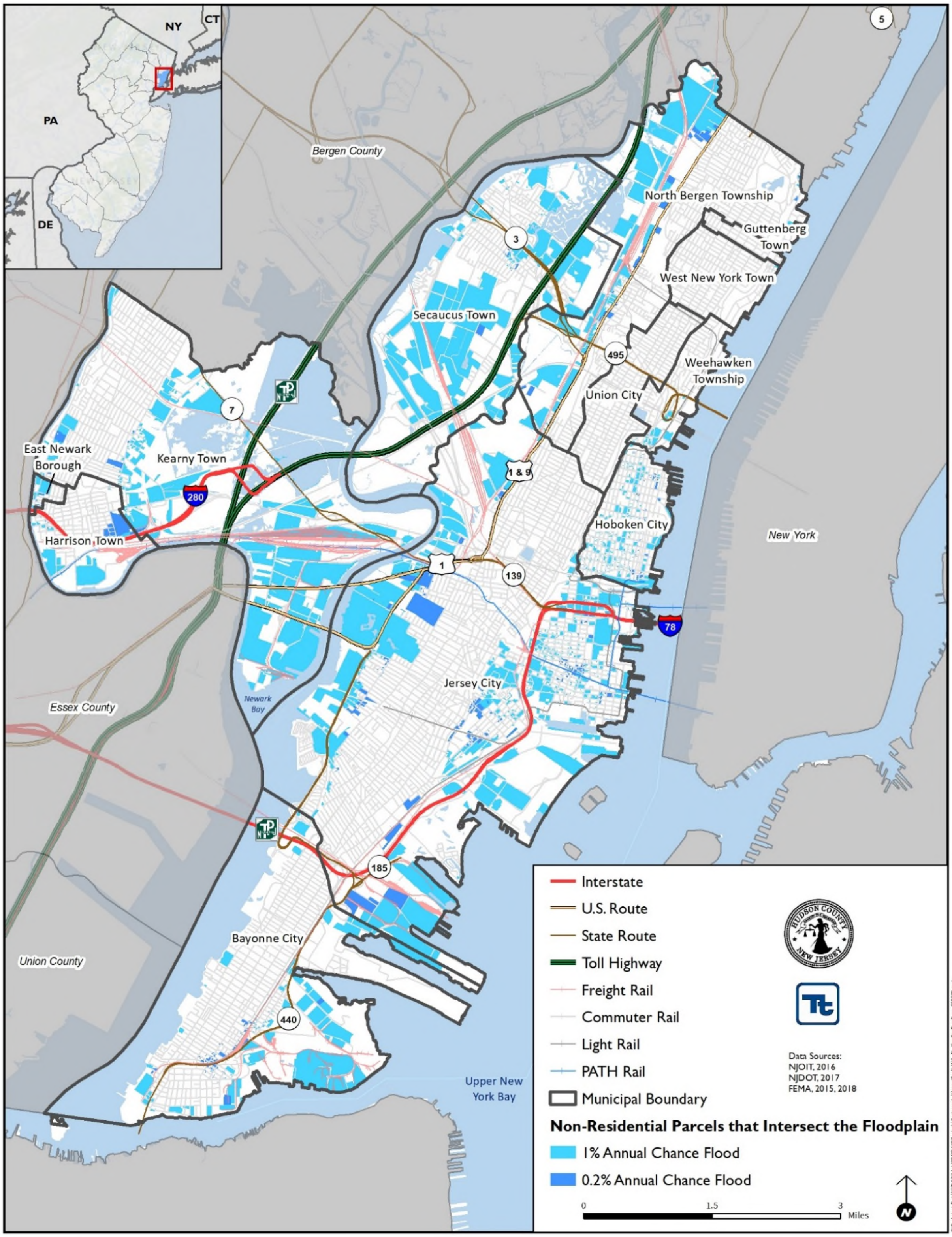


Table 4.3.7-12. Non-Residential Land Use Exposure to the 1-Percent and 0.2 Percent Annual Chance Flood Events

Municipality	Total Non- Res Land Use Area (acres)	Total Number of Non-Res Parcels	1% Flood Event Hazard Area				0.2% Flood Event Hazard Area			
			Number of Non-Res Parcels in A and V-Zone	% of Total	Non-Res Land Use Area in A and V-Zone (acres)	% of Total	Number of Non-Res Prarcels in 0.2%	% of Total	Non-Res Land Use Area in 0.2% (acres)	% of Total
Bayonne, City of	3,725	5,171	821	15.9%	167	3.2%	986	19.1%	172	3.3%
East Newark, Borough of	43	352	7	2.0%	3	0.9%	18	5.1%	3	1.0%
Guttenberg, Town of	30	990	6	0.6%	0	0.0%	12	1.2%	0	0.0%
Harrison, Town of	648	2,075	63	3.0%	25	1.2%	108	5.2%	27	1.3%
Hoboken, City of	383	3,424	581	17.0%	155	4.5%	672	19.6%	159	4.6%
Jersey City, City of	7,118	30,273	1,087	3.6%	736	2.4%	1,524	5.0%	773	2.6%
Kearny, Town of	5,575	6,241	488	7.8%	283	4.5%	528	8.5%	283	4.5%
North Bergen, Township of	2,521	5,126	122	2.4%	4	0.1%	159	3.1%	4	0.1%
Secaucus, Town of	3,645	3,280	252	7.7%	2	0.1%	286	8.7%	3	0.1%
Union City, City of	378	1,252	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Weehawken, Township of	294	1,926	47	2.4%	10	0.5%	58	3.0%	10	0.5%
West New York, Town of	297	3,583	7	0.2%	0	0.0%	10	0.3%	0	0.0%
Hudson County (Total)	24,657	63,693	3,481	5.5%	1,385	2.2%	4,361	6.9%	1,433	2.3%

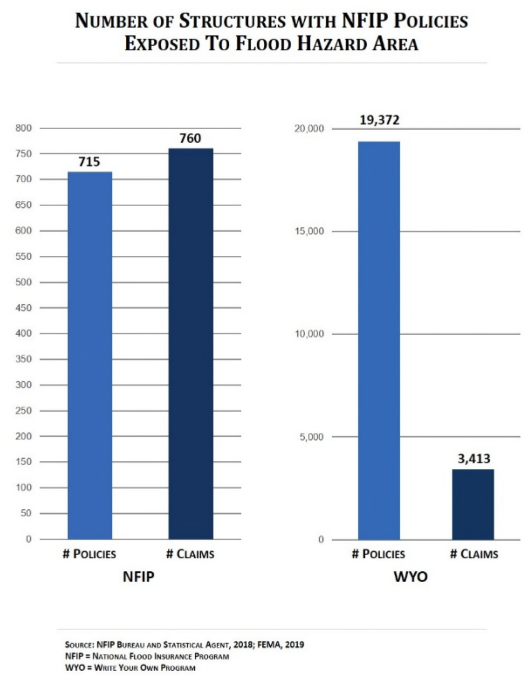
Source: FEMA 2015, 2018
Note: % = Percent
Non-Res = Non-residential
The area presented includes the area of inland waterways and excludes bays or oceans.

NFIP STATISTICS

FEMA Region 2 provided a list of NFIP policies, past claims, repetitive loss properties (RL), and severe repetitive loss properties (SRL) in Hudson County. According to FEMA, a RL property is a NFIP-insured structure that has had at least two paid flood losses of more than $1,000 in any 10-year period since 1978. A SRL property is a NFIP-insured structure that has had four or more separate claim payments made under a standard flood insurance policy, with the amount of each claim exceeding $5,000 and with the cumulative amount of such claims payments exceeding $20,000; or at least two separate claims payments made under a standard flood insurance policy with the cumulative amount of such claim payments exceed the fair market value of the insured building on the day before each loss (FEMA 2018). Figure 4.3.7-14 shows that there are more NFIP claims than policies in Hudson County reported for 2018/2019. This is likely because there are over 400 repetitive loss structures in the County that submitted multiple flood loss claims under their NFIP policy.

Table 4.3.7-13 through Table 4.3.7-15 and Figure 4.3.7-14 and Figure 4.3.7-9 summarize the NFIP policies, claims and repetitive loss statistics for Hudson County. Table 4.3.7-13 and Table 4.3.7-14 summarize the occupancy classes of the repetitive loss and severe repetitive loss properties in the County. Of the occupancy classes represented, two to four family properties account for 45% of the RL properties and 60% of the SRL properties. This information is current as of April 2019.

Figure 4.3.7-6. Number of Policies, Claims and Repetitive Loss Structures for Flood Loss Reported in 2018/2019 for Hudson County



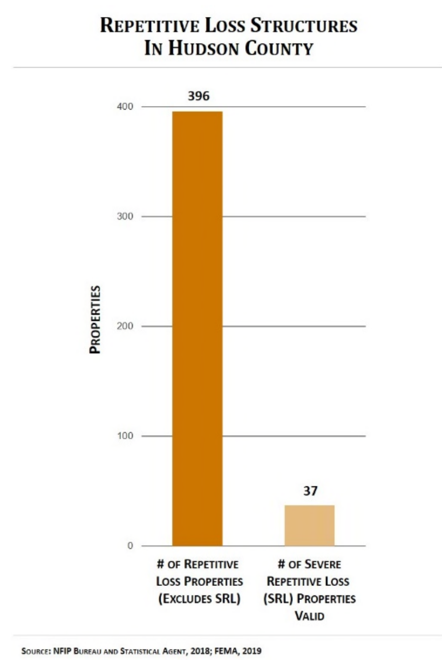


Table 4.3.7-13. Occupancy Class of Repetitive Loss Structures in Hudson County

Occupancy Class	Total Number of Repetitive Loss Properties (excludes SRL)	Total Number of Severe Repetitive Loss Properties (Valid only)	Total
Single Family	86	6	92
Condo	2	0	2
2-4 Family	175	16	191
Other Residential	103	7	110
Non-Residential	31	8	39
Hudson County	**397**	**37**	**434**

Source: FEMA Region 2 2019
Note: Repetitive loss and severe repetitive loss statistics provided by FEMA Region 2 and are current as of April 26, 2019.
The total number of repetitive loss properties does not include the severe repetitive loss properties. The severe repetitive loss property totals only include validated properties.

Table 4.3.7-14. Occupancy Class of Repetitive Loss Structures in Hudson County, by Municipality

Municipality	Repetitive Loss Properties (excludes SRL)					Severe Repetitive Loss Properties (valid only)				
	Single Family	Assumed Condo	2-4 Family	Other Residential	Non-Residential	Single Family	Assumed Condo	2-4 Family	Other Residential	Non-Residential
Bayonne, City of	6	0	1	0	1	0	0	0	0	0
East Newark, Borough of	0	0	0	0	0	0	0	0	0	0
Guttenberg, Town of	0	0	0	0	0	0	0	0	0	0
Harrison, Town of	0	0	3	0	0	0	0	0	0	0
Hoboken, City of	19	1	66	83	8	2	0	5	7	0
Jersey City, City of	50	1	98	20	10	3	0	11	0	3
Kearny, Town of	0	0	0	0	6	0	0	0	0	2
North Bergen, Township of	4	0	2	0	2	1	0	0	0	3
Secaucus, Town of	7	0	2	0	2	0	0	0	0	0
Union City, City of	0	0	0	0	0	0	0	0	0	0
Weehawken, Township of	0	0	2	0	0	0	0	0	0	0
West New York, Town of	0	0	1	0	1	0	0	0	0	0
Hudson County (Total)	**86**	**2**	**175**	**103**	**30**	**6**	**0**	**16**	**7**	**8**

Source: *FEMA Region 2 2019*

Note: *Repetitive loss and severe repetitive loss statistics provided by FEMA Region 2 and are current as of April 26, 2019.*

The total number of repetitive loss properties does not include the severe repetitive loss properties. The severe repetitive loss property totals only include validated properties.

Table 4.3.7-15. NFIP Policies, Claims, and Repetitive Loss Statistics

Municipality	NFIP # Policies	WYO # Policies	Total Policies	NFIP # Claims	WYO # Claims	# Claims	NFIP Payments	WYO Payments	Total Loss Payments	# Rep. Loss Prop (Excludes SRL)	# Severe Rep. Loss (SRL)Prop. Valid	# Severe Rep. Loss (SRL)Prop. *Pending*	Total RL + SRL (RL + Valid SRL)	Mitigated (Yes/No)
Bayonne, City of (1)	32	290	322	33	74	107	$286,125	$1,776,210	$2,062,334	8	0	0	8	Yes (0) / No (8)
East Newark, Borough of	0	1	1	0	1	1	$0	$22,488	$22,488	0	0	0		N/A
Guttenberg, Town of (2)	0	17	17	1	3	4	$0	$50,936	$50,936	0	0	0	0	N/A
Harrison, Town of (3)	7	233	240	2	32	34	$340,374	$4,952,709	$5,293,083	3	0	0	3	Yes (0) / No (3)
Hoboken, City of (4)	404	9,280	9,684	177	1,702	1,879	$3,587,664	$45,723,952	$49,311,616	177	14	0	191	Yes (0) / No (187)
Jersey City, City of (5)	244	7,185	7,429	275	1,281	1,556	$4,225,928	$45,063,691	$49,289,619	179	17	0	196	Yes (0) / No (200)
Kearny, Town of (6)	2	117	119	156	105	261	$7,247,804	$21,480,366	$28,728,170	6	2	1	8	Yes (1) / No (9)
North Bergen, Township of (7)	5	503	508	65	63	128	$942,419	$4,243,832	$5,186,251	8	4	1	12	Yes (0) / No (14)
Secaucus, Town of (8)	3	34	37	34	53	87	$121,181	$897,463	$1,018,644	11	0	0	11	Yes (0) / No (11)
Union City, City of	0	0	0	0	0	0	$0	$0	$0	0	0	0	0	N/A
Weehawken, Township of (9)	17	747	764	11	90	101	$610,597	$6,905,484	$7,516,081	2	0	0	2	Yes (0) / No (2)
West New York, Town of (10)	1	965	966	6	9	15	$14,841	$2,470,399	$2,485,240	2	0	0	2	Yes (0) / No (1)
Hudson County (Total)	**715**	**19,372**	**20,087**	**760**	**3,413**	**4,173**	**$17,376,934**	**$133,587,528**	**$150,964,462**	**396**	**37**	**2**	**433**	**Yes (1) / No (435)**

Source: FEMA Region 2 2019; NFIP Bureau of Statistical Agency 2018

Rep. = Repetitive

NFIP = National Flood Insurance Policy

WYO = Write your own policy

BSA = NFIP Bureau and Statistical Agency

(1) Please note data differences from BSA, which indicates there is a total of 347 policies, 104 claims, and $1,892,178 of losses reported in the City of Bayonne.

(2) Please note data differences from BSA, which indicates there is a total of 147 policies in the Town of Guttenberg.

(3) Please note data differences from BSA, which indicates there is a total of 241 policies, 35 claims, and $5,358,554 losses reported in the Town of Harrison.

(4) Please note data differences from BSA, which indicates there is a total of 9,650 policies, 1,888 claims, and $51,117,220 losses reported in the City of Hoboken.

(5) Please note data differences from BSA, which indicates there is a total of 7,385 policies, 1,560 claims, and $49,271,909 losses reported in the City of Jersey City. There are also multiple Jersey Cities reported in the HUDEX data table that have the same community number, but varying number of policy counts and losses

(6) Please note data differences from BSA, which indicates there is a total of 128 policies, 265 claims, and $29,426,008 losses reported in the Town of Kearny. There are also multiple Towns of Kearny reported in the HUDEX data table that have the same community number, but varying number of policy counts and losses.

(7) Please note data differences from BSA, which indicates there is a total of 506 policies, 139 claims, and $5,182,882 losses reported in the Township of North Bergen. There are also multiple Townships of North Bergen reported in the HUDEX data table that have the same community number, but varying number of policy counts and losses

(8) Please note data differences from BSA, which indicates there is a total of 36 policies and $1,017,887 losses reported in the Town of Secaucus.

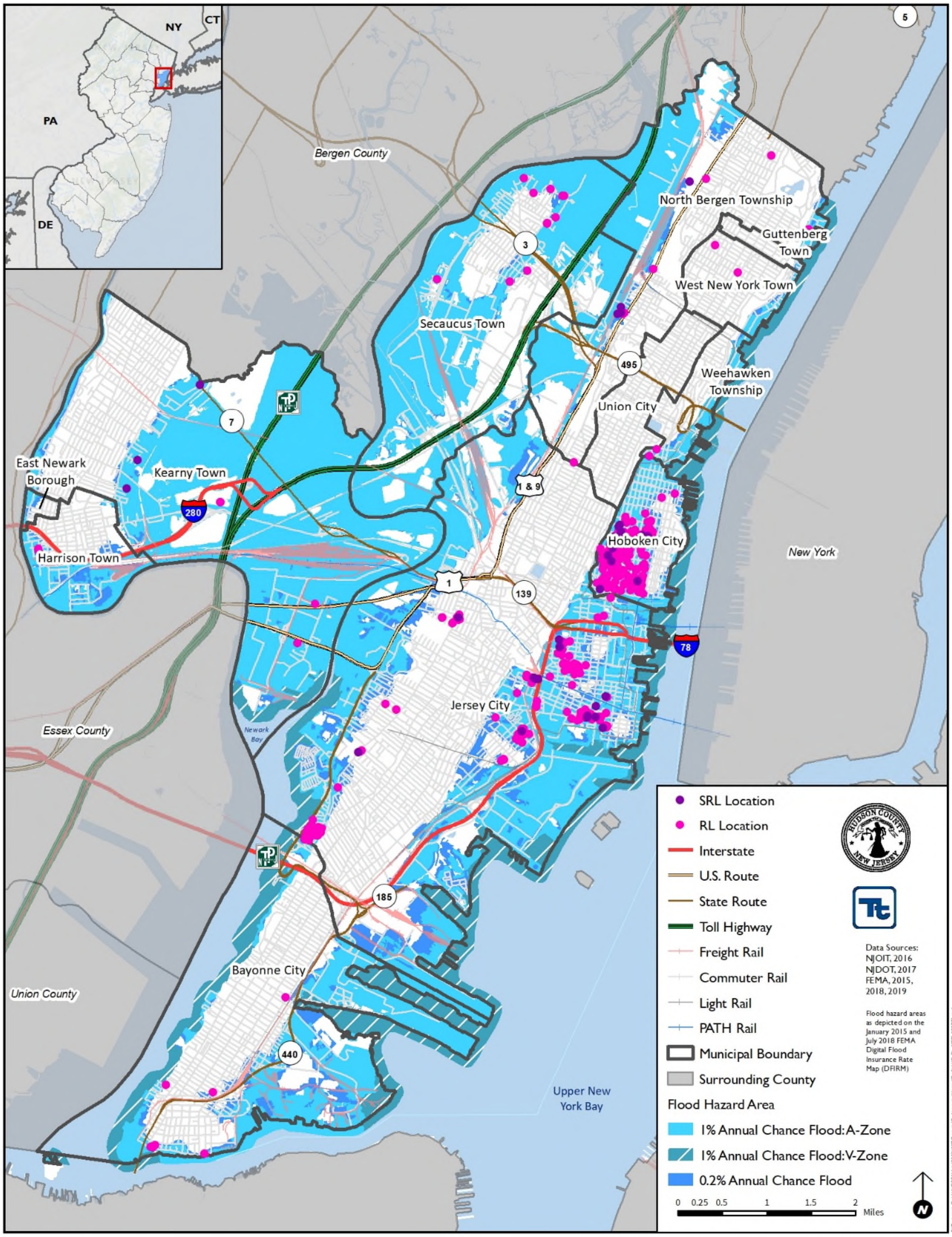
(9) Please note data differences from BSA, which indicates there is a total of 758 policies in the Township of Weehawken.

(10) Please note data differences from BSA, which indicates there is a total of 1,282 policies in the Town of West New York.

(11) Repetitive loss and severe repetitive loss statistics provided by FEMA Region 2 and are current as of 4/26/2019; Policies and claims are current as of July 2019. The total number of repetitive loss properties does not include the severe repetitive loss properties. The severe repetitive loss property totals only include validated properties.

(12) Total building and content losses from the claims file provided by FEMA Region 2

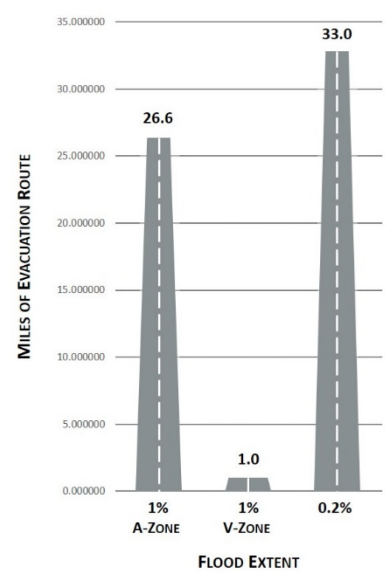
Figure 4.3.7-15. NFIP Repetitive Loss and Severe Repetitive Loss Properties in Hudson County



IMPACT ON CRITICAL FACILITIES

Figure 4.3.7-7. Evacuation Route Exposure to Flood Hazard Areas

TOTAL MILES OF EVACUATION ROUTE IN HUDSON COUNTY EXPOSED TO FLOOD HAZARD AREAS



SOURCES: HOMELAND INFRASTRUCTURE FOUNDATION-LEVEL DATA. 2007. HURRICANE EVACUATION ROUTES. ON-LINE ADDRESS: HTTPS://HIFLD-GEOPLATFORM.OPENDATA.ARCGIS.COM/DATASETS/HURRICANE-EVACUATION-ROUTES.
A-ZONE: A ZONE, AE ZONE, AO ZONE
V-ZONE: VE ZONE
0.2-PERCENT: INCLUDES ENTIRE 1-PERCENT FLOOD EXTENT, PLUS ADDITIONAL EXTENT OF 0.2-PERCENT BOUNDARY

It is important to determine the critical facilities and infrastructure that may be at risk to flooding, and who may be impacted should damage occur. Critical services during and after a flood event may not be available if critical facilities are directly damaged or transportation routes to access these critical facilities are impacted. Roads that are blocked or damaged can isolate residents and can prevent access throughout the planning area to many service providers needing to reach vulnerable populations or to make repairs.

Critical facility exposure to the flood hazard was examined. In addition, HAZUS-MH v4.2 was used to estimate the flood loss potential to critical facilities located in the FEMA mapped floodplains. Table 4.3.7-16 summarizes these results. Figure 4.3.7-18 and Figure 4.3.7-19 display the distribution of critical facilities in the 1- and 0.2-percent annual chance flood event boundaries. Of the 353 critical facilities located in the 1-percent annual chance flood event boundary, 67 were identified as childcare facilities. Figure 4.3.7-17 displays the major roadways that may be impacted by the 1-percent annual chance flood event. These include Interstate 78, Interstate 280, US Route 1&9, State Route 139, State Route 495, State Route 3, and the New Jersey Toll Road. Further analysis found that 26.6 miles, 0.96 miles, and 33.0 miles of major evacuation routes in Hudson County are exposed to the 1-percent A-zone, 1-Percent V-zone, and 0.2-Percent flood hazard extents (also refer to Figure 4.3.7-16). Bridges washed out or blocked by floods or debris also can cause isolation. This can be an issue for the commuter community that relies on these transportation routes to enter or leave the County after work.

Further, critical facilities that are near an area where frequent urban flooding occurs are also vulnerable to the flood hazard. Urban flooding is defined by FEMA as flooding caused by rain that falls on densely populated areas that have increased amounts of impervious surfaces, which overwhelms the capacity of drainage systems (Natural Resources Defense Council 2019). This type of flooding can be exacerbated by riverine and coastal flooding within the County.

Debris from flood events may also affect culverts and sewer systems by creating bottlenecks in the wastewater system, which could not only cause or exacerbate localized urban flooding, but also cause wastewater to spill into homes and neighborhoods or contaminate local rivers and streams.

Figure 4.3.7-17. Major Roadways Located in the 1-percent Annual Chance Floodplain

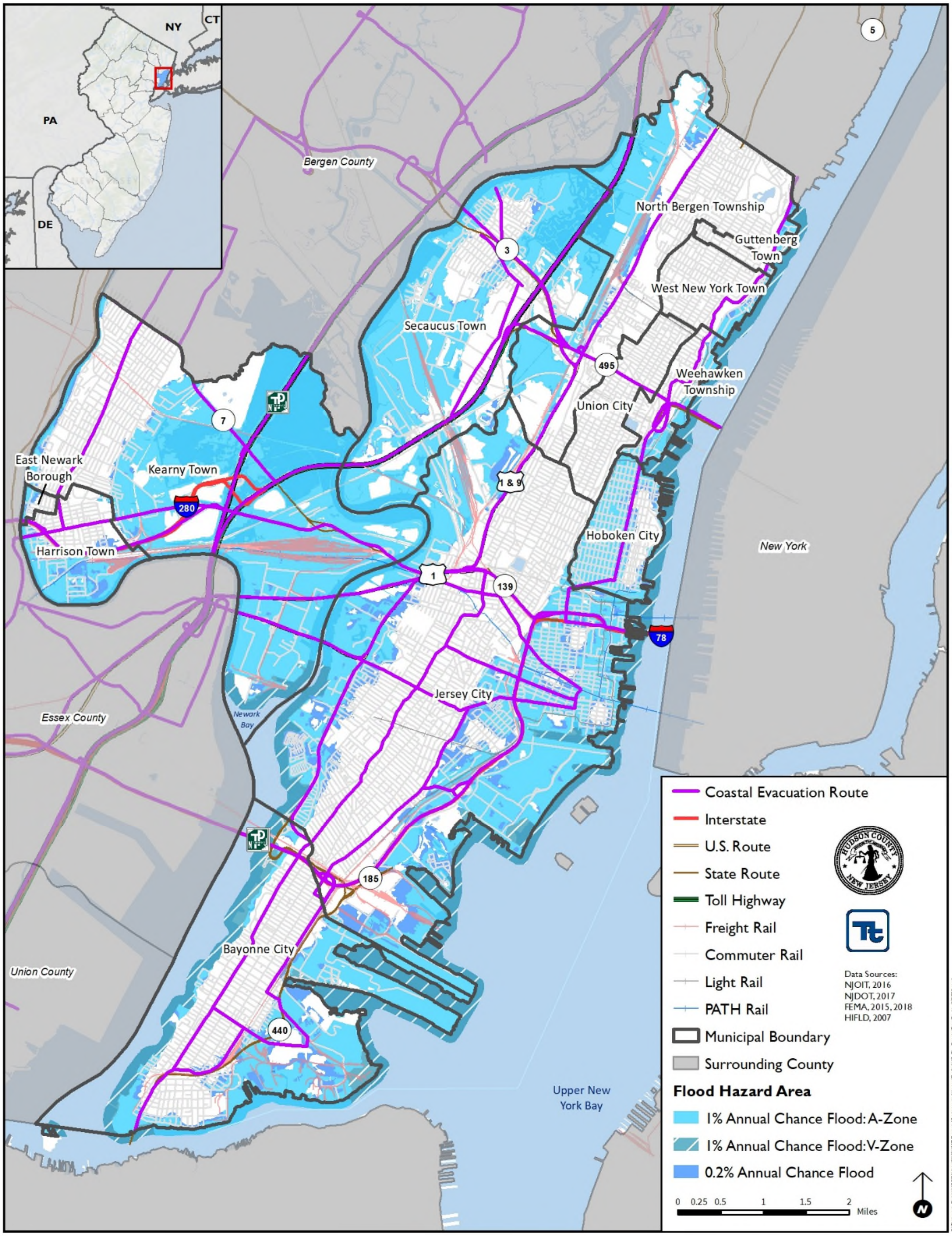
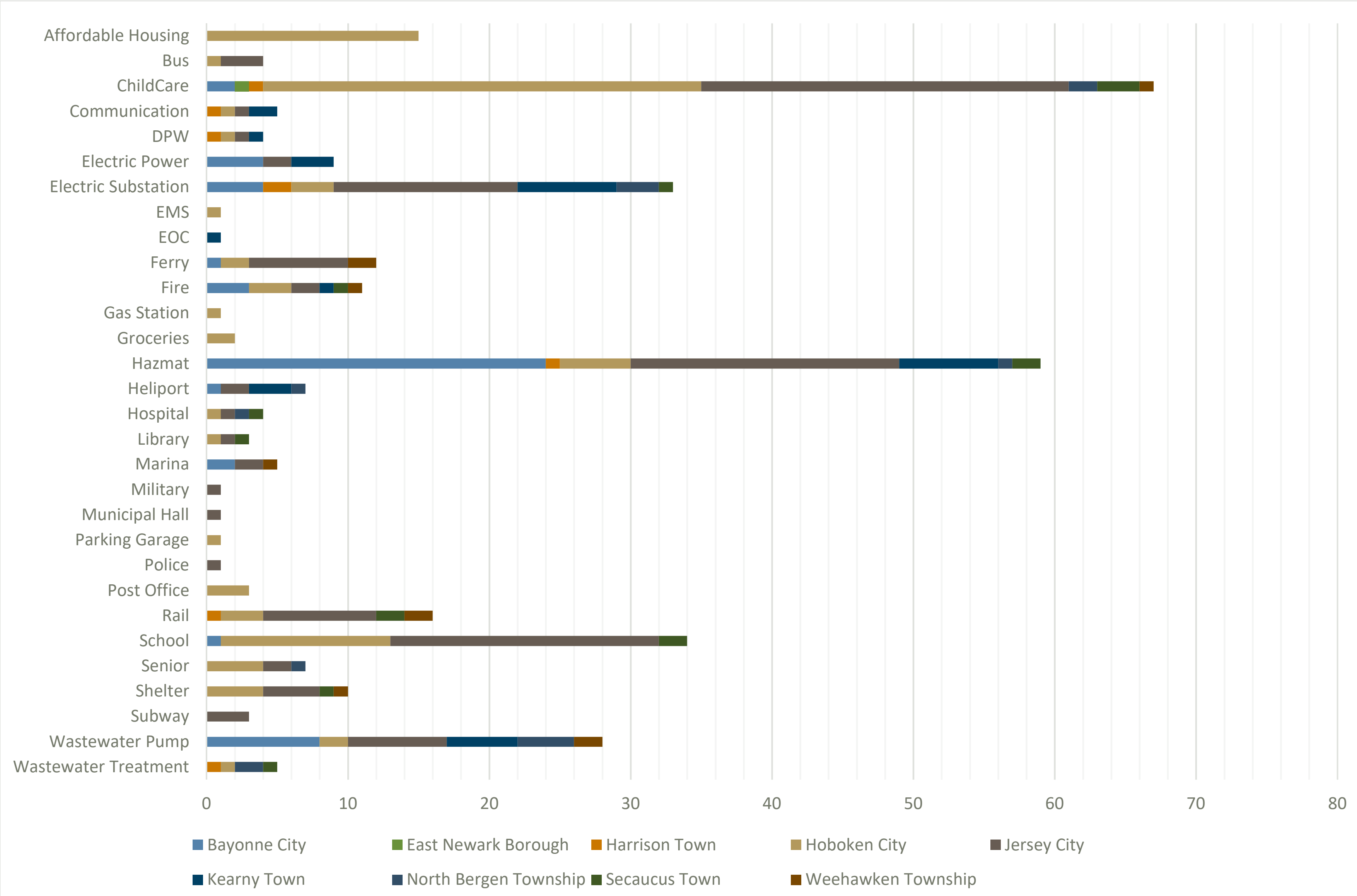


Table 4.3.7-16. Critical Facilities Located in the 1- and 0.2-Percent Annual Chance Event Floodplains

Facility Type	Number of Critical Facilities Located in the 1-Percent Annual Chance Event Floodplain	Number of Critical Facilities Located in the 0.2-Percent Annual Chance Event Floodplain
Affordable Housing	15	17
Backup data centers	0	1
Bus	4	5
Child Care	67	89
Communication	5	5
Dam	0	0
DPW	4	4
Electric Power	9	9
Electric Substation	33	36
EMS	1	1
EOC	1	1
Equipment Staging Location	0	0
Ferry	12	12
Fire	11	13
Gas Station	1	1
Government Building	0	0
Groceries	2	2
Hazmat	59	60
Heliport	7	8
Hospital	4	4
Library	3	5
Marina	5	5
Medical	0	0
Military	1	1
Municipal Hall	1	1
Oil Facility	0	1
Parking Garage	1	1
Pharmacy	0	0
Police	1	1
Post Office	3	4
Potable Water	0	0
Public Health	0	0
Rail	16	20
School	34	43
Senior	7	8
Shelter	10	10
Subway	3	3
Wastewater Pump	28	38
Wastewater Treatment	5	6
Total	**353**	**415**

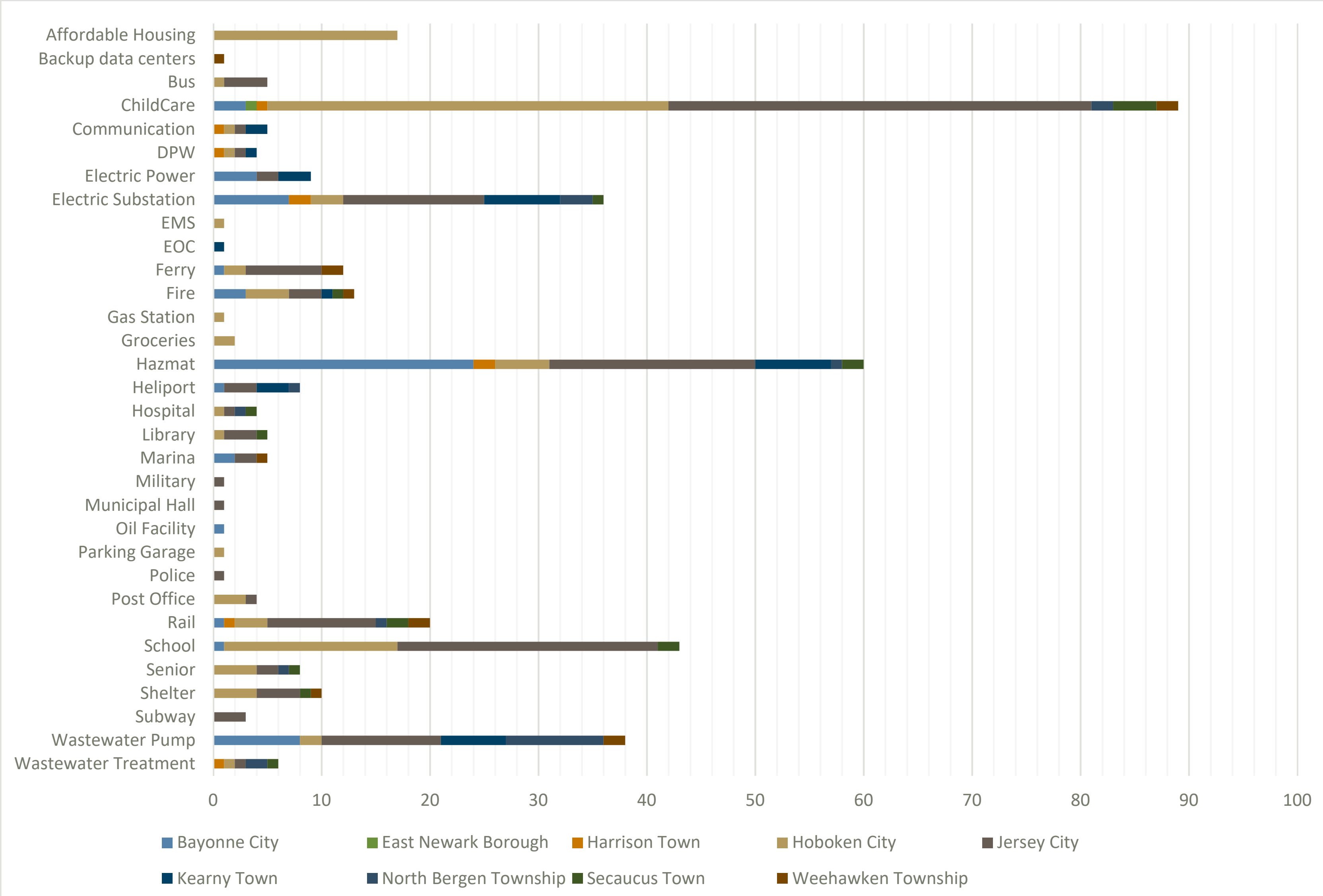
Source: Hudson County, 2019; FEMA 2015/2018; HAZUS-MH v4.2
** Only one facility was estimated to have structure and contents losses*
EMS = Emergency Medical Services
EOC = Emergency Operations Center

Figure 4.3.7-18. Distribution of Critical Facilities in the 1-Percent Annual Chance Flood Event Floodplain by Type and Municipality



Sources: FEMA 2015/2018; Hudson County, 2019

Figure 4.3.7-19. Distribution of Critical Facilities in the 0.2-Percent Annual Chance Flood Event Floodplain by Type and Municipality



Sources: FEMA 2015/2018; Hudson County, 2019

Impact on the Economy

Flood events can significantly impact the local and regional economy. This includes but is not limited to general building stock damages and associated tax loss, impacts to utilities and infrastructure, business interruption, and impacts on tourism. In areas that are directly flooded, renovations of commercial and industrial buildings may be necessary, disrupting associated services. Refer to the 'Impact on Buildings' subsection earlier which discusses direct impacts to buildings in Hudson County.

Flooding can cause extensive damage to public utilities and disruptions to delivery of services. Loss of power and communications may occur and drinking water and wastewater treatment facilities may be temporarily out of operation. As presented in Table 4.3.7-16, 353 critical facilities are exposed and potentially vulnerable to the 1-percent annual chance flood event.

Debris management may also be a large expense after a flood event. HAZUS-MH v4.2 estimates the amount of structural debris generated during a flood event. The model breaks down debris into three categories: (1) finishes (dry wall, insulation, etc.); (2) structural (wood, brick, etc.); and (3) foundations (concrete slab and block, rebar, etc.). These distinctions are necessary because of the different types of equipment needed to handle debris. Table 4.3.7-17 and Figure 4.3.7-20 summarize the HAZUS-MH v4.2 countywide debris estimates for the 1-percent annual chance flood event. This table only estimates structural debris generated by flooding and does not include non-structural debris or additional potential damage and debris possibly generated by wind that may be associated with a flood event or storm that causes flooding.

Figure 4.3.7-8. Estimated Debris Created by the 1-Percent Flood Hazard Event

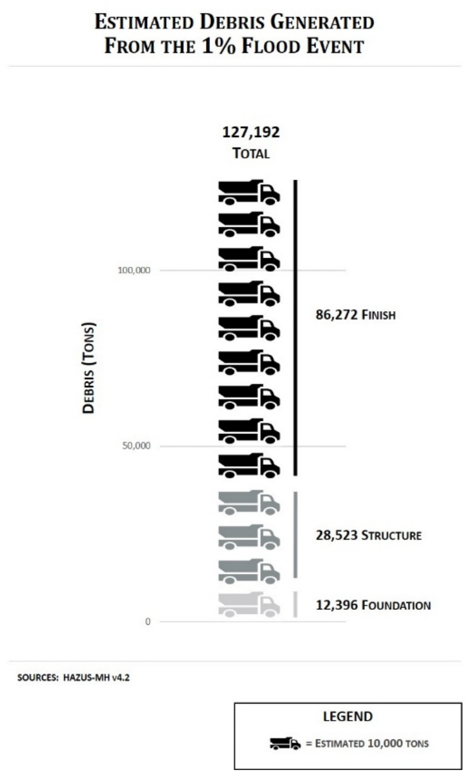


Table 4.3.7-17. Estimated Debris Generated from the 1-Percent Flood Event

Municipality	1% Flood Event			
	Total (tons)	Finish (tons)	Structure (tons)	Foundation (tons)
Bayonne, City of	18,561	7,747	7,034	3,781
East Newark, Borough of	5	5	0	0
Guttenberg, Town of	218	185	19	13
Harrison, Town of	1,151	393	402	356
Hoboken, City of	43,290	35,763	5,788	1,739
Jersey City, City of	48,269	29,611	13,403	5,254
Kearny, Town of	1,423	1,422	1	1
North Bergen, Township of	5,679	4,151	936	593
Secaucus, Town of	3,198	2,635	345	218
Union City, City of	58	58	0	0
Weehawken, Township of	3,863	3,339	313	210

Municipality	1% Flood Event			
	Total (tons)	Finish (tons)	Structure (tons)	Foundation (tons)
West New York, Town of	1,476	962	282	232
Hudson County (Total)	**127,192**	**86,272**	**28,523**	**12,396**

Source: HAZUS-MH v4.2

Impact on the Environment

As Hudson County and communities in Watershed Management Areas 4 and 5 grow (refer to Figure 3-2 in Section 3), flood events may increase in frequency and/or severity as land use changes, more structures are built, and impervious surfaces expand. Furthermore, flood extents for the 1-percent and 0.2-percent annual flood events will continue to evolve alongside natural occurrences such as sea level rise, climate change, and/or severity of coastal storms. These flood events will inevitably impact Hudson County's natural and local environment.

Overall, the acreage of natural land is a small percentage compared to the rest of the land area in each municipality (refer to Table 4.3.7-18). Severe flooding cannot only influence the habitat of these natural land areas, it can be disruptive to species that reside in these natural habitats.

Table 4.3.7-18. Natural Land Area By Municipality

Municipality	Total Land Area (Acres)	Natural Land Area (Acres) (1)	Percent of Total Land Area (Acres)
Bayonne, City of	4,919	140	2.8%
East Newark, Borough of	73	0	0.0%
Guttenberg, Town of	124	0	0.2%
Harrison, Town of	848	19	2.3%
Hoboken, City of	794	-	0.0%
Jersey City, City of	10,130	754	7.4%
Kearny, Town of	6,520	689	10.6%
North Bergen, Township of	3,384	509	15.0%
Secaucus, Town of	4,197	726	17.3%
Union City, City of	825	21	2.6%
Weehawken, Township of	511	40	7.9%
West New York, Town of	636	24	3.8%
Hudson County (Total)	**32,959**	**2,922**	**8.9%**

Source: NJDEP, OIRM, BGIS, 2015

1) *Assumed Natural Land to include coniferous brush/shrubland, deciduous brush/shrubland, deciduous forest (>50% crown closure), deciduous forest (10-50% crown closure), deciduous scrub/shrub wetlands, deciduous wooded wetlands, herbaceous wetlands, beaches, mixed deciduous/coniferous brush/shrubland, mixed forest (>50% coniferous with 10-50% crown closure), mixed scrub/shrub wetlands (deciduous dom.), natural lakes, old field (<25% brush covered), phragmites dominate coastal wetlands, phragmites dominate interior wetlands, phragmites dominate old field, phragmites dominate urban area, saline marsh (high marsh), saline marsh (low marsh), wetlands right of way, upland right of way (undeveloped) from NJDEP, OIRM, and BGIS land use land cover data.*

Table 4.3.7-19 shows the amount of natural landcover, including area classified with endangered species, within Hudson County that falls within the 1-percent and 0.2-percent annual chance floodplains.

Table 4.3.7-19. Natural Environment Area Within the 1-percent and 0.2-percent Annual Chance Floodplain.

Wetlands	Area in the 1-Percent Annual Chance Floodplain (acres)	Area in the 0.2-Percent Annual Chance Floodplain (acres)
Wetlands	1,291	1,307
Forest	827	880
Endangered Species	5,266	5,314

Source: NJDEP 2017, NJDEP 2015, FEMA 2015/2018

Furthermore, impacts from changes in climate such as the frequency and intensity of weather events have an impact on the flood extents in Hudson County. Both globally and at the local scale, climate change has the potential to alter the prevalence and severity of extremes such as flood events. While predicting changes of flood events under a changing climate is difficult, understanding vulnerabilities to potential changes is a critical part of estimating future climate change impacts on human health, society and the environment (U.S. Environmental Protection Agency [EPA], 2006). Refer to Section 4.3.2 (Coastal Storm) for detailed information regarding sea level rise and the vulnerability assessment conducted for Hudson County.

Future Changes That May Impact Vulnerability

Understanding future changes that affect vulnerability can assist in planning for future development and ensure establishment of appropriate mitigation, planning, and preparedness measures. Several factors are examined in this section to assess hazard vulnerability.

Hudson County falls within the North Atlantic Coast Comprehensive Study (NACCS) area, which established a plan to identify risk management strategies to mitigate future flood risks (USACE 2015). The NACCS was established shortly after Hurricane Sandy struck the north Atlantic states. As a result, a New York-New Jersey Harbor and Tributaries Coastal Storm Risk Management Report was created for vulnerable communities to address concerns identified by the NACCS (USACE 2019). This risk management report reviews different case studies to determine future risk and potential mitigation based on flood management designs for the New York Metropolitan Area and the six largest cities in New Jersey, which encompasses Hudson County. The designs range from no action to shoreline stabilization and storm surge barriers strategies (refer to Figure 4.3.7-21). USACE is reviewing these alternatives to determine the best management strategy for reducing future flood risks. The outcome of the selected alternative may impact future development, changes in the population, and effects from climate change.

Table 4.3.7-20. Alternatives Suggested in the New York-New Jersey Harbor and Tributaries Coastal Storm Risk Management Report

Alt	Areas Benefited by Alternative	Areas Not Benefiting from Alternative	Main Environmental Concerns	Notes
1	None	Entire study area.	Entire study area remains as vulnerable as it will be with the currently ongoing efforts to coastal flooding impacts.	Assumes all ongoing studies/projects by USACE and funded efforts by others (e.g., RBD) are implemented to extent currently considered feasible/actionable.

Alt	Areas Benefited by Alternative	Areas Not Benefiting from Alternative	Main Environmental Concerns	Notes
2	Nearly all of the study area	Part of the eastern shorelines Bronx & Westchester Counties.	Tidal exchange in Hudson River Estuary, migration of estuary resources through Bight and Long Island Sound, cultural resources impacts.	Fewest number of alternative features (see Table 11).
3.a	Much of the study area	Shorelines around Raritan, Sandy Hook, and Lower Bay.	Tidal exchange in Hudson River Estuary, migration of estuary resources through Bight and LIS.	Addresses severe coastal storm risk in nearly all of NYC, inner NJ, and Hudson River. Relatively few alternative features.
3.b	Inland NJ areas (including port, oil terminals and Newark airport) and backside of SI by barrier, high risk areas of NJ & upstate NY along HR & NYC	Segments of NY (including NYC) and NJ (along HR) that initially appear to not have high risk/exposure.	Tidal exchange in Kills/Newark Bay, migration of estuary resources to Newark Bay, impacts to CERCLA-listed sites, impacts to cultural and social resources from perimeter measures in NJ along HR and NYC.	Only relatively higher risk areas in NY (including NYC) and NJ (along HR) have alternative features (Table 11).
4	Only relatively higher risk sections of shoreline or smaller tributary basins in study area.	Relatively moderate and low risk areas.	Tidal exchange in Hackensack River, Gowanus Canal, and Newtown Creek; CERCLA-listed sites; impacts to cultural and social resources from perimeter measures in NJ along HR and NYC.	Only relatively higher risk areas in NY (including NYC) and NJ have features. Major port facilities (incl. oil terminals, etc.), Newark and LaGuardia airports remain at risk. Many alternative features (Table 11).
5	Only relatively higher risk sections of shoreline or smaller tributary basins in study area.	Relatively moderate and low risk areas.	Coastal zone and wetland impacts to cultural and social resources from perimeter measures in NJ, upstate Hudson in NY, and NYC.	Only relatively higher risk areas in NY (including NYC) and NJ have features when feasible without in-water measures. Major facilities (including oil terminals etc.), Newark and LaGuardia airports remain at risk. Several alternative features (Table 11).

Source: USACE 2015 (Table 12)

PROJECTED DEVELOPMENT

As discussed in Section 3 (County Profile), areas targeted for future growth and development have been identified across the County. Any areas of growth could be potentially impacted by the flood hazard if located within the floodplain and mitigation measures are not considered. It is the intention of the County and all participating municipalities to discourage development in vulnerable areas or to encourage higher regulatory standards at the local level.

The municipalities have reviewed areas of recent and proposed development in their community. Development that could be located using an address or Parcel ID were geocoded and overlain with the FEMA DFIRM boundaries to determine exposure to the flood hazard. There are 464 and 485 recent, proposed, and future developments vulnerable to the 1-percent flood hazard and 0.2-percent flood hazard areas. Refer to Section 3 (County Profile), and Volume II Section 9 (Jurisdictional Annexes) for more detailed information on potential new development areas in Hudson County. Figure 4.3.7-22 illustrates the proposed new development and the FEMA DFIRM boundaries for Hudson County.

Projected Changes in Population

Factors such as increased number of immigrants and a growing number of Millennials and young adults has become a driver for new development in Hudson County. For example, the increasing population has created a need for more school facilities, municipal services, and housing development (Hudson County 2017). Higher density can, not only create issues for local residents during evacuation of a natural hazard event, but can also impact commuters that travel to or through Hudson County for work. Historically, flood and storm events with associated surge have severely impacted transportation corridors as well as infrastructure. Refer to Section 3.2.3, Population Trends in the County Profile, which includes a discussion on population trends for the County.

Climate Change

As discussed above, most studies project that the State of New Jersey will see an increase in average annual temperatures and precipitation. Annual precipitation amounts in the region are projected to increase, primarily in the form of heavy rainfalls, which have the potential to increase the risk to flash flooding and riverine flooding, and flood critical transportation corridors and infrastructure. Increases in precipitation may alter and expand the floodplain boundaries and runoff patterns, resulting in the exposure of populations, buildings, and critical facilities and infrastructure that were previously outside the floodplain. This increase in exposure would result in an increased risk to life and health, an increase in structural losses, a diversion of additional resources to response and recovery efforts, and an increase in business closures affected by future flooding events due to loss of service or access.

The North Jersey Transportation Planning Authority (NJTPA) recently completed the Passaic River Basin Climate Resilience Planning Study (2019) which assessed the potential for increasingly severe and frequent storm and heat events along with rising sea levels in the Passaic River Basin. The riverine and coastal spatial data generated as a result of this study (25- and 100-year precipitation events for today and planning horizons 2045 and 2080) were used to help understand the change in building exposure as the climate changes. Table 4.3.7-21 through Table 4.3.7-23 summarizes the number of buildings, critical facilities, and population exposed to future projected flood inundation extents, respectively. It is important to note that not the entire 1-percent annual chance floodplain was included in this analysis; only the existing 100-year precipitation event in the Passaic River Basin. As summarized in the table, the climate models anticipate an increase in flood inundation extents in 2045 and 2080 for the 25- and 100-year precipitation events, respectively, leading to an increase in number of buildings and persons exposed.

Table 4.3.7-21. Estimated General Building Stock Exposure to the Existing and Projected 25- and 100-year Precipitation Events

Municipality	25-year Event		100-year	
	Current	2045	Current	2045
East Newark Borough	6	13	15	0
Harrison Town	180	240	255	0
Kearny Town	117	141	143	2
Building Count Total	**303**	**394**	**413**	**2**

Source: NJTPA 2019

**The all representative concentration pathway scenario was used for this analysis.*

Table 4.3.7-22. Estimated Critical Facility Exposure to the Existing and Projected 25- and 100-year Precipitation Events

Municipality	25-year				100-year			
	Current	Current Lifeline	2045	2045 Lifeline	Current	Current Lifeline	2080	2080 Lifeline
East Newark Borough	1	0	1	0	1	0	1	0
Harrison Town	8	4	8	4	8	4	8	4
Kearny Town	11	8	13	10	14	11	15	12
Critical Facilities Total	**20**	**12**	**22**	**14**	**23**	**15**	**24**	**16**

Table 4.3.7-23. Estimated Population Exposed to the Existing and Projected 25- and 100-year Precipitation Events

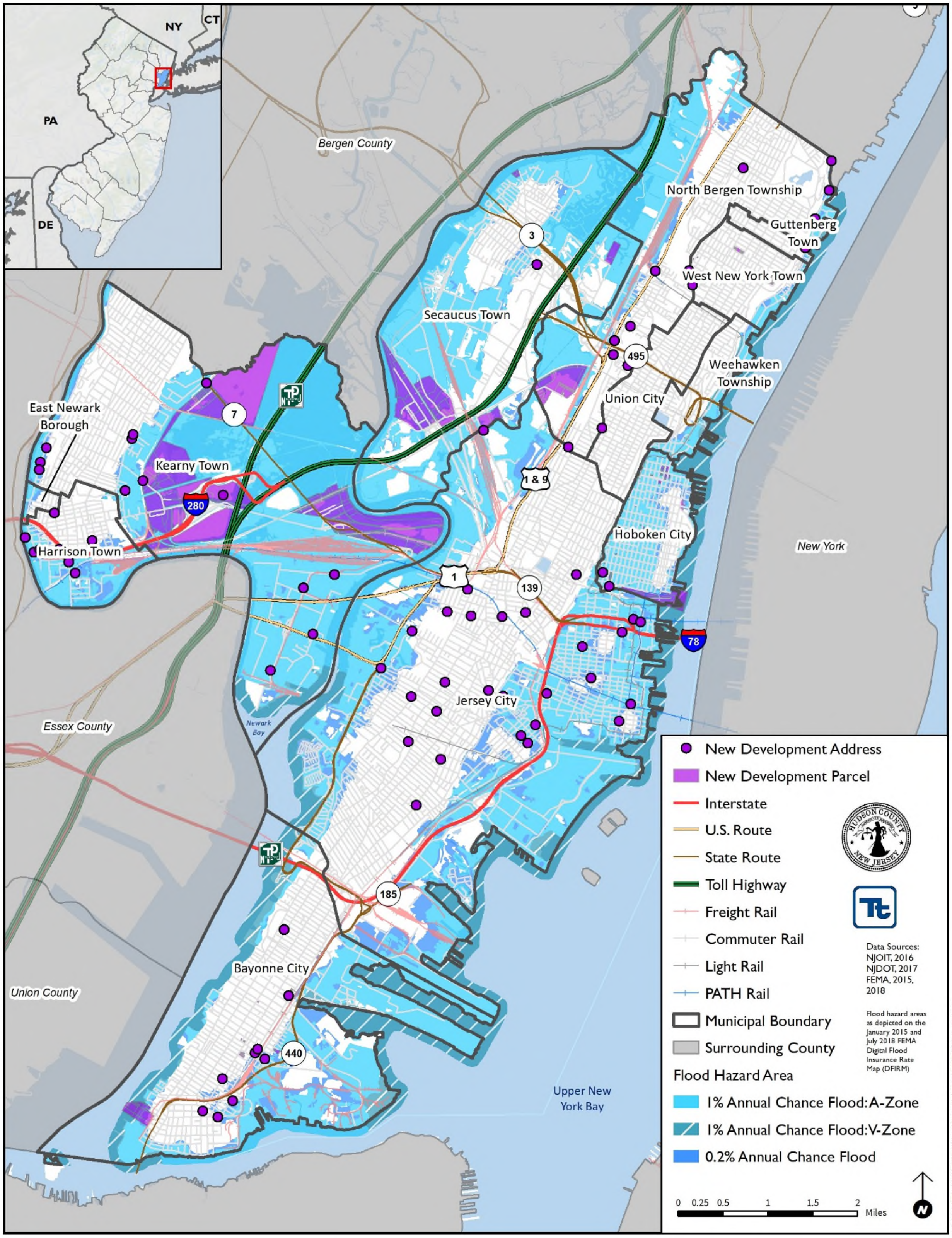
Municipality	25-year		100-year	
	Current	2045	Current	2080
East Newark Borough	0	1	2	48
Harrison Town	117	149	159	217
Kearny Town	3	3	3	5
Population Count Total	**120**	**153**	**164**	**270**

Change of Vulnerability Since 2015 HMP

Since the 2015 analysis, population statistics have been updated using the 2013-2017 American Community Survey. The general building stock was also updated using RS Means 2019 building valuations that estimated replacement cost value for each building in the inventory. This provides an up-to-date look at the entire building stock for Hudson County and gives more accurate results for the exposure and loss estimation analysis.

In addition, a preliminary DFIRM was released for most of Hudson County in January 2015, but this area did not include the Meadowlands. Therefore, the flood data used for this analysis included the preliminary DFIRM from 2015 and incorporated the effective DFIRM for Bergen County that was published in July 2018. These data layers were incorporated into the spatial analyses for damage and exposure assessments. Further, an updated version of FEMA's HAZUS-MH flood module (version 4.2) and updated 1-percent annual chance flood event depth grid were used to estimate potential losses for the 1-percent annual chance flood event.

Figure 4.3.7-21. Potential New Development and Flood Boundaries



4.3.8 GEOLOGIC

This section provides a profile and vulnerability assessment of the geologic hazard in Hudson County.

2020 HMP Changes

- New and updated figures from federal and state agencies are incorporated.
- Previous occurrences were updated with events that occurred between 2015 and 2019.
- Additional analyses were included: social vulnerability analysis, impacts to major transit routes

4.3.8.1 PROFILE

Geological hazards are any geological or hydrological processes that pose a threat to human lives and natural lands. These types of hazards can include earthquakes, landslides and other slope failures, mudflows, sinkholes, and flooding. For the purpose of this HMP update, landslides and land subsidence/sinkholes will be discussed in this hazard profile. Earthquakes and flooding are addressed in separate sections of this plan, Section 4.3.5 (Earthquake) and Section 4.3.7 (Flood), respectively.

LANDSLIDES

According to the U.S. Geological Survey (USGS), the term landslide includes a wide range of ground movement, such as rock falls, deep failure of slopes, and shallow debris flows. Although gravity acting on an over steepened slope is the primary reason for a landslide, there are other contributing factors (USGS 2013). Among the contributing factors are: (1) erosion by rivers, glaciers, or ocean waves which create over-steepened slopes; (2) rock and soil slopes weakened through saturation by snowmelt or heavy rains; (3) earthquakes which create stresses making weak slopes fail; and (4) excess weight from rain/snow accumulation, rock/ore stockpiling, waste piles, or man-made structures. Scientists from the USGS also monitor stream flow, noting changes in sediment load in rivers and streams that may result from landslides. All of these types of landslides are considered aggregately in USGS landslide mapping.

In New Jersey, there are four main types of landslides: slumps, debris flows, rockfalls, and rockslides. Slumps are coherent masses that move downslope by rotational slip on surfaces that underlie and penetrate the landslide deposit (Briggs et al 1975). A debris flow, also known as a mudslide, is a form of rapid mass movement in which loose soil, rock, organic matter, air, and water mobilize as slurry that flows downslope. Debris flows are often caused by intense surface water from heavy precipitation or rapid snow melt. This precipitation loosens surface matter, thus triggering the slide. Rockfalls are common on roadway cuts and steep cliffs. These landslides are abrupt movements of geological material such as rocks and boulders. Rockfalls happen when these materials become detached. Rockslides are the movement of newly detached segments of bedrock sliding on bedrock, joint, or fault surfaces (Delano and Wilshusen 2001).

Although gravity acting on an over-steepened slope is the primary reason for a landslide, there are other contributing factors that include:

- Erosion by rivers, glaciers, or ocean waves create over-steepened slopes
- Rock and soil slopes are weakened through saturation by snowmelt or heavy rains
- Earthquakes create stresses that make weak slopes fail
- Earthquakes of magnitude 4.0 and greater have been known to trigger landslides
- Volcanic eruptions produce loose ash deposits, heavy rain, and debris flows

- Excess weight from accumulation of rain or snow or stockpiling of rock or ore, from waste piles or man-made structures may stress weak slopes to failure (USGS 2016).

Landslides may be triggered by both natural and human-caused changes in the environment, including heavy rain, rapid snow melt, steepening of slopes caused by construction or erosion, earthquakes, and changes in groundwater levels. Areas generally prone to landslide hazards include previous landslide areas, bases of steep slopes, bases of drainage channels, developed hillsides, and areas recently burned by forest and brush fires (NYS DHSES 2014). Human activities that contribute to slope failure include altering the natural slope gradient, increasing soil water content, and removing vegetation cover. Warning signs for landslide activity include:

- Springs, seeps, or saturated ground in areas that have not typically been wet before
- New cracks or unusual bulges in the ground, street pavement, or sidewalk
- Soil moving away from foundations
- Ancillary structures, such as decks and patios, tilting and moving relative to the main house
- Tilting or cracking of concrete floors and foundations
- Broken water lines and other underground utilities
- Leaning telephone poles, trees, retaining walls, or fences
- Offset fence lines
- Sunken or down-dropped road beds
- Rapid increase in creek water levels, possibly accompanied by increased turbidity
- Sudden increase in creek water levels while rain is still falling or just recently ended
- Sticking doors and windows, and visible open spaces indicating jambs and frames out of plumb
- A faint rumbling sound that increases in volume as the landslide nears
- Unusual sounds, such as trees cracking or boulders knocking together (USGS 2013).

SUBSIDENCE/SINKHOLES

Land subsidence can be defined as the sudden sinking or gradual downward settling of the earth's surface with little or no horizontal motion, owing to the subsurface movement of earth materials (USGS 2000). Subsidence often occurs through the loss of subsurface support in karst terrain, which may result from a number of natural- and human-caused occurrences. Karst describes a distinctive topography that indicates dissolution of underlying carbonate rocks (limestone and dolomite) by surface water or groundwater over time. The dissolution process causes surface depressions and the development of sinkholes, sinking stream, enlarged bedrock fractures, caves, and underground streams (New Jersey State HMP 2014).

Sinkholes, the type of subsidence most frequently seen in the New Jersey, are a natural and common geologic feature in areas with underlying limestone, carbonate rock, salt beds, or other rocks that are soluble in water. Over periods of time, measured in thousands of years, the carbonate bedrock can be dissolved through acidic rainwater moving in fractures or cracks in the bedrock. This creates larger openings in the rock through which water and overlying soil materials will travel. Over time the voids will enlarge until the roof over the void is unable to support the land above will collapse forming a sinkhole. In this example the sinkhole occurs naturally, but in other cases the root causes of a sinkhole are anthropogenic. These anthropogenic causes can include those that involve changes to the water balance of an area such as: over-withdrawal of groundwater; diverting surface water from a large area and concentrating it in a single point; artificially creating ponds of surface water; and drilling new water wells. These actions can serve to accelerate the natural processes of creation of soil voids, which can have a direct impact on sinkhole creation (New Jersey State HMP 2014).

Both natural and man-made sinkholes can occur without warning. Slumping or falling fence posts, trees, or foundations, sudden formation of small ponds, wilting vegetation, discolored well water, and/or structural cracks in walls and floors, are all specific signs that a sinkhole is forming. Sinkholes can range in form from steep-walled holes, to bowl, or cone-shaped depressions. When sinkholes occur in developed areas, they can cause severe property damage, disruption of utilities, damage to roadways, injury, and loss of life (New Jersey State HMP 2014).

EXTENT

LANDSLIDE

To determine the extent of a landslide hazard, the affected areas need to be identified and the probability of the landslide occurring within some time period needs to be assessed. Natural variables that contribute to the overall extent of potential landslide activity in any particular area include soil properties, topographic position and slope, and historical incidence. Predicting a landslide is difficult, even under ideal conditions and with reliable information. As a result, the landslide hazard is often represented by landslide incidence and/or susceptibility, as defined below:

- Landslide incidence is the number of landslides that have occurred in a given geographic area. High incidence means greater than 15% of a given area has been involved in landsliding; medium incidence means that 1.5 to 15% of an area has been involved; and low incidence means that less than 1.5% of an area has been involved (Geological Hazards Program Date Unknown).

- Landslide susceptibility is defined as the probable degree of response of geologic formations to natural or artificial cutting, to loading of slopes, or to unusually high precipitation. It can be assumed that unusually high precipitation or changes in existing conditions can initiate landslide movement in areas where rocks and soils have experienced numerous landslides in the past. Landslide susceptibility depends on slope angle and the geologic material underlying the slope. Landslide susceptibility only identifies areas potentially affected and does not imply a time frame when a landslide might occur. High, medium, and low susceptibility are delimited by the same percentages used for classifying the incidence of landsliding (Geological Hazards Program Date Unknown, OAS 1991).

SUBSIDENCE/SINKHOLE

Subsidence and sinkholes occur slowly and continuously over time or abruptly for various reasons. Subsidence and sinkholes can occur due to either natural processes (karst sinkholes in areas underlain by soluble bedrock) or as a result of human activities. Subsidence in the U.S. has directly affected more than 17,000 square miles in 45 states, and associated annual costs are estimated to be approximately $125 million. The principal causes of subsidence are aquifer-system compaction, drainage of organic soils, underground mining, hydrocompaction, natural compaction, sinkholes, and thawing permafrost (Galloway et al. 2000). There are several methods used to measure land subsidence. Global Positioning System (GPS) is a method used to monitor subsidence on a regional scale. Benchmarks (geodetic stations) are commonly space around four miles apart (State of California 2014).

Another method which is becoming increasingly popular is Interferometric Synthetic Aperture Radar (InSAR). InSAR is a remote sensing technique that uses radar signals to interpolate land surface elevation changes. It is a cost-effective solution for measuring land surface deformation for a region while offering a high degree of spatial detail and resolution (State of California 2014).

LOCATION

LANDSLIDES

According to the USGS, Hudson County has moderate potential to landslides (USGS 2005). For a figure displaying the landslide potential of the conterminous United States, please refer to http://pubs.usgs.gov/fs/2005/3156/2005-3156.pdf.

Landslides are common in New Jersey, primarily in the northern region of the State. As noted in the previous occurrences section, New Jersey has an extensive history of landslides, and the landslides occur for a variety of reasons. Figure 4.3.8-1 illustrates the historic landslides in Hudson County. According to this figure, most of the landslide events have occurred in the northeastern section of the County.

The New Jersey Geologic Survey (currently known as the New Jersey Geological and Water Survey) determined landslide susceptibility for nine counties in New Jersey (Bergen, Essex, Hudson, Middlesex, Monmouth, Morris, Passaic, Somerset, and Union). Areas within these counties are classified into Class A, B, and C landslide susceptible classes, and several subclasses within the main classifications. These classes are consistent with HAZUS User Manual Table 9.2. Class A areas in New Jersey include classes AII, AIV, AVI which is strongly cemented rock at varying slope angles; Class B includes classes BIII, BIV, BV, and BVI which includes weakly cemented rock and soil at varying slope angles; and Class C includes classes CV, CVI, CVII, CIX, and CX which includes shale and clayey soil at varying slope angles.

Figure 4.3.8-2 shows the landslide susceptibility in Hudson County. There are small areas in the northeast region of the County that are susceptible to landslide events (Class AI, AII, AIV and BIV). Table 4.3.8-1 summarizes the area within each class. According to the figure and table, the largest area of susceptibility is a long corridor that stretches approximately 6.5 miles from the northeast corner of North Bergen to the northern portion of Jersey City. In total, only about 0.73% or 0.38 sq. mi., of the County has landslide susceptibility.

Figure 4.3.8-1. Historic Landslide Locations in Hudson County, 1903 – June 2014

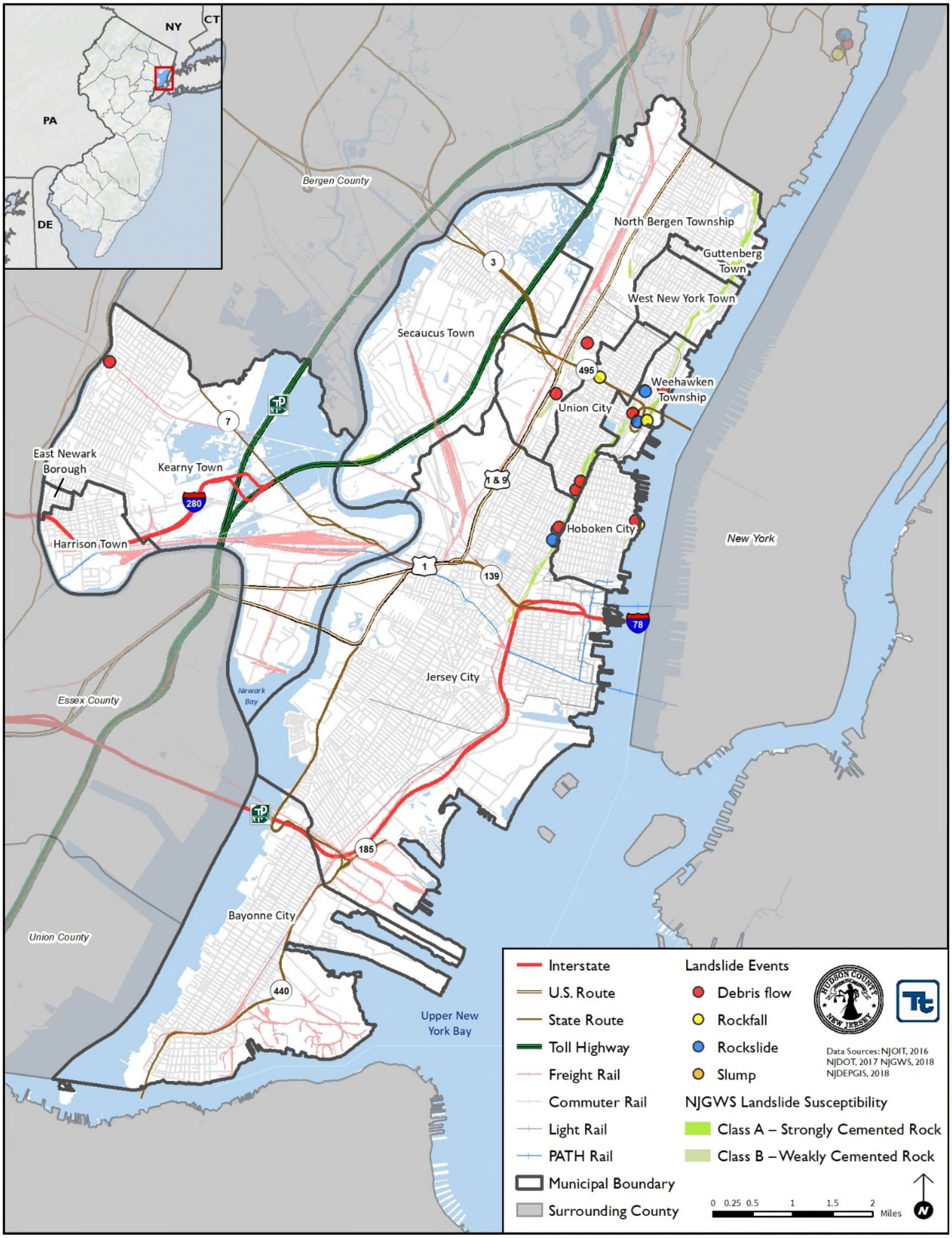


Figure 4.3.8-2. Landslide Susceptibility in Hudson County

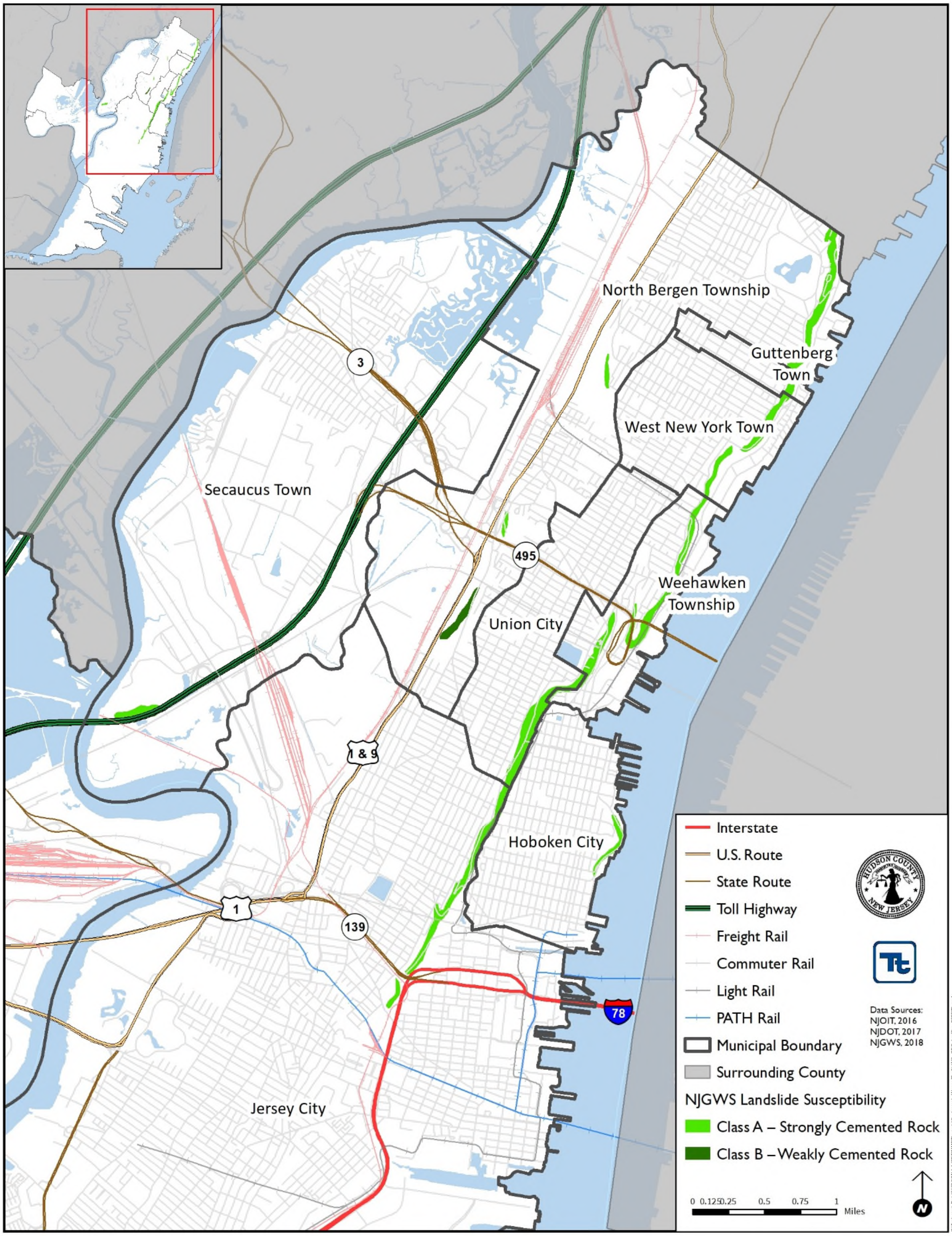


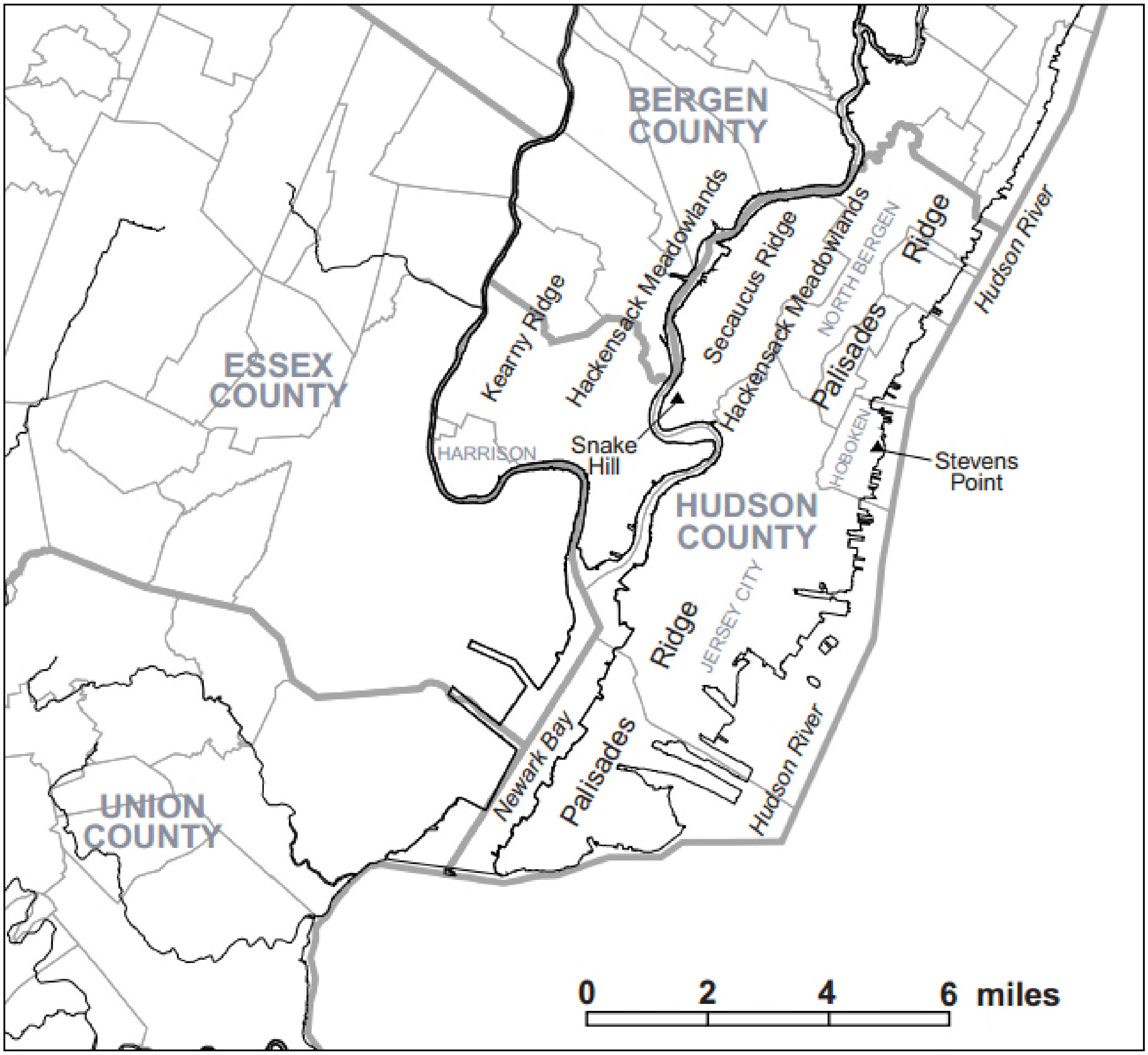
Table 4.3.8-1. Total Land Area Located in the Landslide Susceptible Areas

Municipality	Total Area (sq mi)	Classification			
		Class A	% Total	Class B	% Total
Bayonne, City of	7.7	0.0000	0%	0	0%
East Newark, Borough of	0.1	0.0000	0%	0	0%
Guttenberg, Town of	0.2	0.0083	4.29%	0	0%
Harrison, Town of	1.3	0.0000	0%	0	0%
Hoboken, City of	1.2	0.0192	1.54%	0	
Jersey City, City of	15.9	0.0743	<1%	0	0%
Kearny, Town of	10.2	0.0000	0%	0	0%
North Bergen, Township of	5.3	0.0695	1.31%	0.019251	<1%
Secaucus, Town of	6.6	0.0214	<1%	0	0%
Union City, City of	1.3	0.0620	4.81%	0	0%
Weehawken, Township of	0.8	0.0886	11.09%	0	0%
West New York, Town of	1.0	0.0374	3.76%	0	0%
Hudson County (Total)	**51.5**	**0.3806**	**<1%**	**0**	**0%**

Source: *NJGWS 2015*
Notes: *Class A includes classes AII, AIV, AVI which is strongly cemented rock at varying slope angles. Class B includes classes BIII, BIV, BV, and BVI which includes weakly cemented rock and soil at varying slope angles. According to this source, no Class C soils types are identified in Hudson County.*
Total area includes land and water.
% *percent*
sq mi *square miles*
NJGWS *New Jersey Geological Water Survey*

Surficial materials in Hudson County include glacial till, glacial-lake sand and gravel deposits, glacial-lake silt and clay deposits, postglacial river sand, peat and organic silt deposited in estuaries and salt marshes, and outcropping bedrock. For detailed information regarding surficial materials found in Hudson County, refer to the 1999 *Earthquake Loss Estimation Study for Hudson County, New Jersey: Geological Component* found at: http://www.state.nj.us/dep/njgs/enviroed/freedwn/hudson_hazus.pdf. According to this document, areas of potential landsliding in Hudson County include cliffs and steep slopes in diabase bedrock on the east slope of the Palisades Ridge north of Jersey City, several small areas of steep slope on the west slope of the Palisades Ridge, bluffs in serpentinite bedrock at Stevens Point in Hoboken, and the cliffs in diabase on Snake Hill in Secaucus (NJGS, 1999). Figure 4.3.8-3 illustrates the geological features of Hudson County.

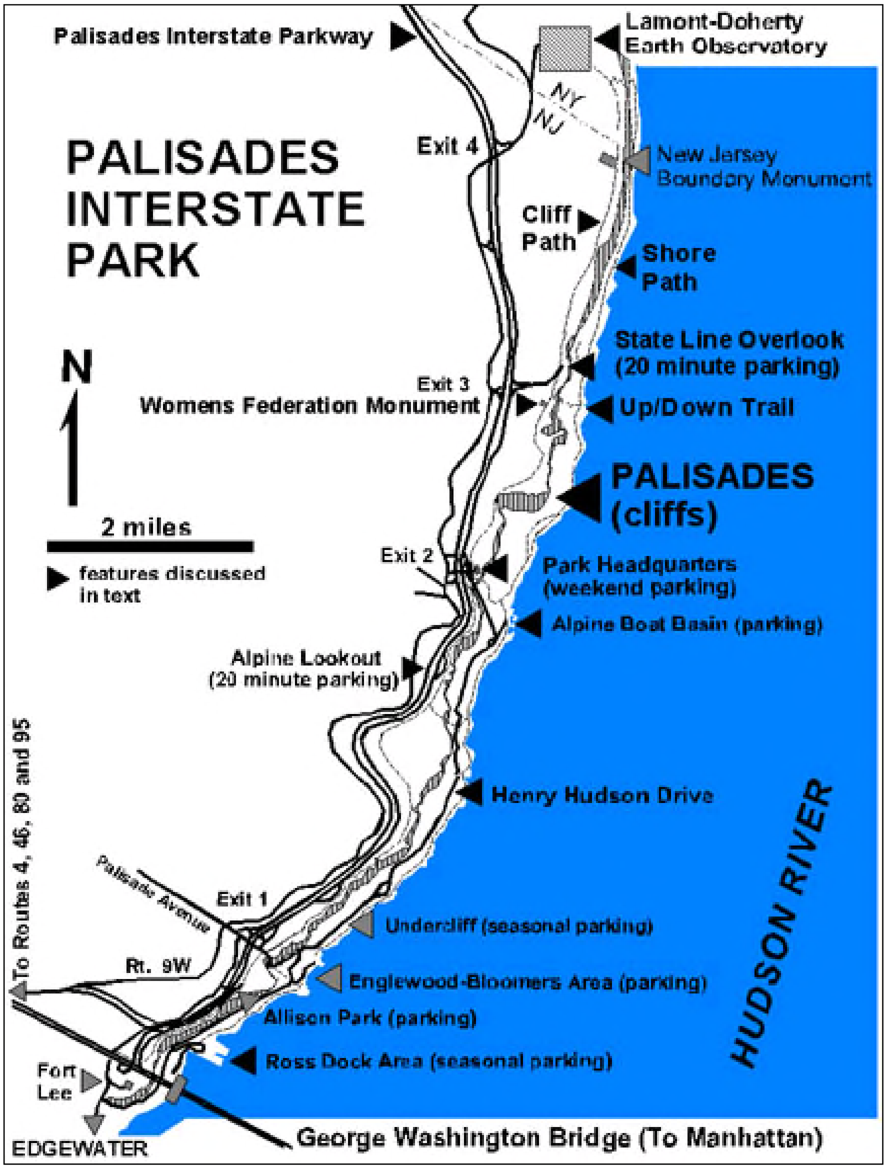
Figure 4.3.8-3. Geological Features in Hudson County



Source: NJGS 1999

According to the New Jersey Geological Survey (NJGS), the Palisades are the most active area for landslides in New Jersey (refer to Figure 4.3.8-4). The Palisades are cliffs that line the western margin of the Hudson River, from Jersey City to the south, to northward of the Tappan Zee Bridge. The cliffs and forested talus slopes rise more than 600 feet above the river (Pallis 2009). In this region, large rockfalls and rockslides occur along the high cliffs bordering the Hudson River. These landslides are most common in the winter and spring months after freeze-thaw cycles occur and loosen pieces of rock along joints and fractures. Surface water also seeps into joints and cracks along the rock, increasing the weight of the rocks and causing the expansion of joints when it freezes, thus prying blocks away from the main cliff (Hansen 2001).

Figure 4.3.8-4. New Jersey Palisades



Source: USGS 2003

SUBSIDENCE/SINKHOLES

New Jersey is susceptible to the effects of subsidence and sinkholes, primarily in the northern region of the State. Land subsidence and sinkholes have been known to occur as a result of natural geologic phenomenon or as a result of human alteration of surface and underground geology.

Naturally occurring subsidence and sinkholes in New Jersey occur within bands of carbonate bedrock. In northern New Jersey, there are more than 225 square miles that are underlain by limestone, dolomite, and marble. In some areas, no sinkholes have appeared, while in others, sinkholes are common. In southern New Jersey, there are approximately 100 miles which are locally underlain by a lime sand with thin limestone layers. No collapse sinkholes have been identified; however, there are some features which could be either very shallow solution depressions or wind blowout features. Sinkholes in New Jersey are generally concentrated in the northwestern part of the state.

Areas underlain by carbonate rock may contain surface depressions and open drainage passages making such areas unstable and susceptible to subsidence and surface collapse. As a result, the alteration of drainage patterns, placement of impervious coverage, grade changes or increased loads can result in land subsidence and sinkhole formation (Piefer 2006). Hudson County does not contain carbonate rock formations.

The State's susceptibility to subsidence is also due in part to the number of abandoned mines throughout New Jersey. The State historically was an iron-producing state and the first mines in New Jersey were drilled in the early 1700s, with operations continuing until 1986 when the last active mine was closed. Although mines have closed in New Jersey, continued development in the northern part of the State has been problematic because of the extensive mining there which has caused widespread subsidence. However, the data from NJGWS and the figure indicate that Hudson County does have any abandoned mines (NJGWS 2006).

Past Occurrence

Many sources provided historical information regarding previous occurrences and losses associated with severe storms throughout the State of New Jersey and Hudson County; therefore, the loss and impact information for many events varies depending on the source. The accuracy of monetary figures discussed is based only on the available information in cited sources.

Between 1954 and 2019, FEMA issued a disaster (DR) or emergency (EM) declaration for the State of New Jersey for one geological hazard-related event, classified as a mudslide. Of those events, Hudson County has not been included any declarations (EM and DR) (FEMA 2014).

For this 2020 HMP update, known geologic events that have impacted Hudson County between 2015 and 2019 were identified. For events prior to 2015, refer to Appendix X. No geologic events were identified occurring between 2015 and 2019.

Probability of Future Occurrence

Based upon risk factors for and past occurrences, it is likely that geological hazards will occur in Hudson County in the future. It is estimated that the County will continue to experience direct and indirect impacts of geological hazards and its impacts on occasion, with the secondary effects causing potential disruption or damage to communities.

In Section 4.4, the identified hazards of concern for Hudson County were ranked. The probability of occurrence, or likelihood of the event, is one parameter used for hazard rankings. Based on historical records and input from the Planning Committee, the probability of occurrence for geological hazards in the County is considered 'occasional' (likely to occur within 100 years, as presented in Table 4.4-4).

Climate Change Impacts

Providing projections of future climate change for a specific region is challenging. Shorter term projections are more closely tied to existing trends making longer term projections even more challenging. The further out a prediction reaches the more subject to changing dynamics it becomes. Future climate change may impact storm patterns, increasing the probability of more frequent, intense storms with varying duration. Increase in global temperature could affect the snowpack and its ability to hold and store water. Warming temperatures also could increase the occurrence and duration of droughts, which could increase the probability of wildfire, reducing the vegetation that helps to support steep slopes. All of these factors could increase the probability for landslide occurrences.

LANDSLIDES

Both northern and southern New Jersey have become wetter over the past century. Northern New Jersey's 1971-2000 precipitation average was over five inches (12%) greater than the average from 1895-1970. Southern New Jersey became two inches (5%) wetter late in the 20th century (Office of New Jersey State Climatologist).

Climate change may impact storm patterns, increasing the probability of more frequent, intense storms with varying duration. Increase in global temperature could affect the snowpack and its ability to hold and store water. Warming temperatures also could increase the occurrence and duration of droughts, which would increase the probability of wildfire, reducing the vegetation that helps to support steep slopes. All of these factors would increase the probability for landslide occurrences.

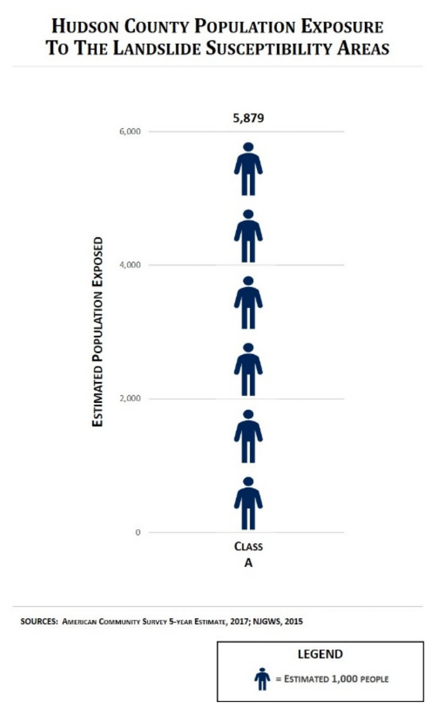
SUBSIDENCE/SINKHOLES

Similar to landslides, climate change will affect subsidence and sinkholes in New Jersey. As discussed throughout this profile, one of the triggers for subsidence and sinkholes is an abundance of moisture which has the potential to permeate the bedrock causing an event. Climatologists expect an increase in annual precipitation amounts. This increase will coincide with an increased risk in subsidence and sinkholes in vulnerable areas.

4.3.8.2 Vulnerability Assessment

For geological hazards, NJGWS landslide susceptibility areas have been identified as the hazard area. Due to the lack of spatially delineated subsidence hazard areas in the County, a spatial analysis was not conducted for this geologic hazard. The following text summarizes the potential impact of geological hazards on the County. Refer to Section 4.2 (Methodology and Tools) for additional details on the methodology used to assess geological hazard risk.

Figure 4.3.8-5. Population Exposed to Class A Landslide Soils



Impact on Life, Health, and Safety

Generally, a landslide or subsidence event is an isolated incidence and impact the populations within the immediate area of the incident. Specifically, the population located downslope of the landslide hazard areas are particularly vulnerable. In addition to causing damages to residential buildings and displacing residents, landslides and subsidence events can block off or damage major roadways and inhibit travel for emergency responders or populations trying to evacuate the area.

Table 4.3.8-2 and Figure 4.3.8-5 summarize the population located in Class A landslide susceptibility area. The spatial analysis indicates that there are zero persons residing in the Class B landslide susceptible area. The Town of Guttenberg has the greatest percent of its population located in the Class A hazard area (i.e., 14.1-percent), whereas the Township of North Bergen has the greatest number of persons located in the Class A hazard area (i.e., 2,387 persons).

Research has shown that some populations, while they may not have more hazard exposure, may experience exacerbated impacts and prolonged recovery if/when impacted. Within Class A areas, there are approximately 1,083 people over the age of 65 and 581 people below the poverty level.

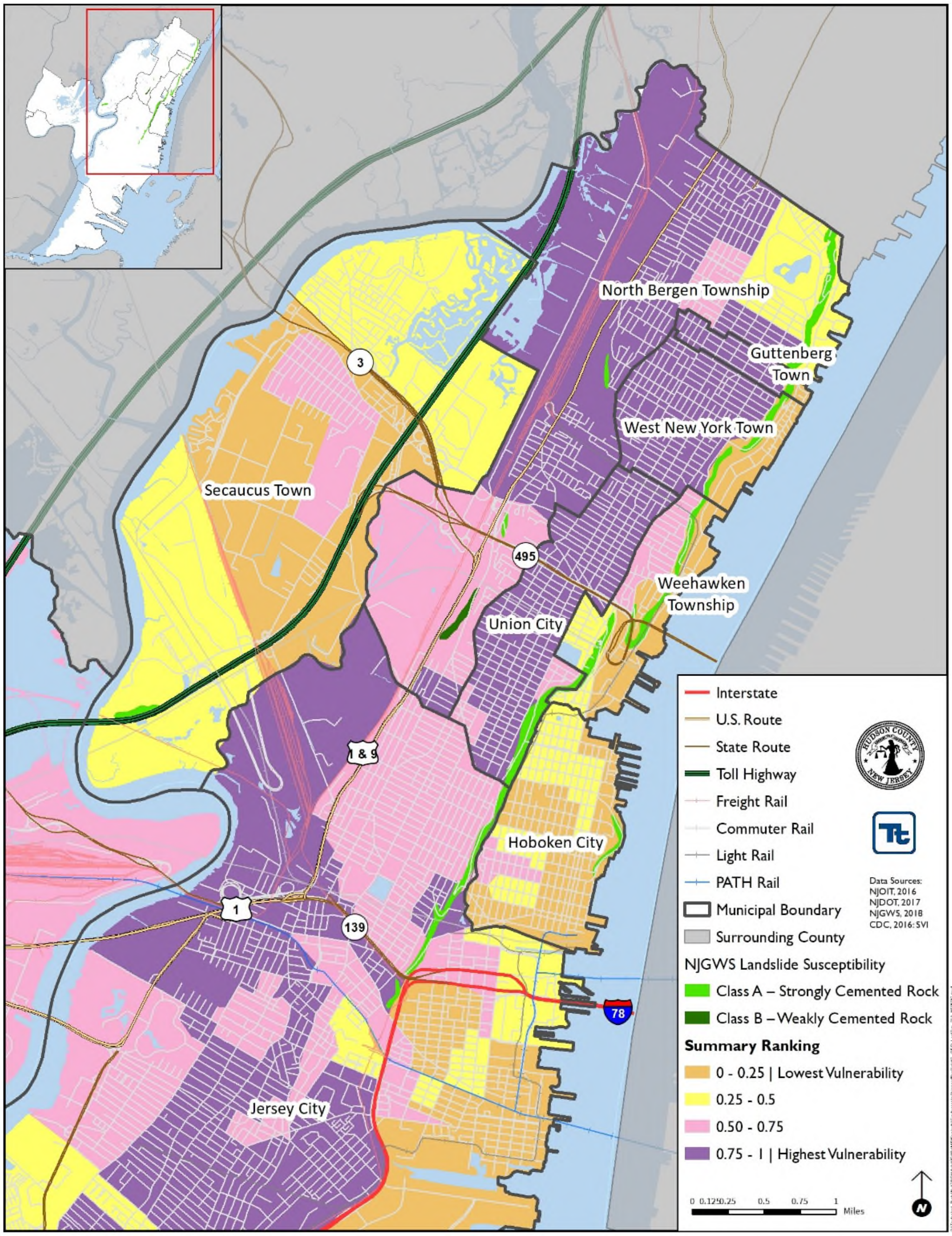
Table 4.3.8-2. Estimated Population Located in the Landslide Hazard Area

Municipality	American Community Survey (2013-2017) Population	Estimated Population Exposed	
		Class A	% of Total
Bayonne, City of	66,719	0	0.0%
East Newark, Borough of	2,725	0	0.0%
Guttenberg, Town of	11,733	1,659	14.1%
Harrison, Town of	15,898	0	0.0%
Hoboken, City of	54,117	29	0.1%
Jersey City, City of	265,932	37	0.0%
Kearny, Town of	42,487	0	0.0%
North Bergen, Township of	63,438	2,387	3.8%
Secaucus, Town of	19,279	0	0.0%
Union City, City of	69,815	805	1.2%
Weehawken, Township of	14,268	654	4.6%
West New York, Town of	53,345	307	0.6%
Hudson County (Total)	**679,756**	**5,879**	**0.9%**

Sources: American Community Survey 5-year Estimate, 2017; NJGWS, 2015
Note: Class A includes classes AII, AIV, AVI which is strongly cemented rock at varying slope angles. Class B includes classes BIII, BIV, BV, and BVI which includes weakly cemented rock and soil at varying slope angles. No Class C soils were identified in Hudson County.
NJGWS New Jersey Geological Water Survey

Furthermore, the Centers for Disease Control and Prevention's (CDC) 2016 Social Vulnerability Index (SVI) ranks U.S. Census tracts on socioeconomic status, household composition and disability, minority status and language, and housing and transportation. Hudson County's overall score is 0.6425, indicating that its communities have moderate to high vulnerability (CDC 2016). Figure 4.3.8-6 shows that areas within the moderate to high SVI are exposed to the landslide hazard.

Figure 4.3.8-6. CDC Social Vulnerability Index Rating for Hudson County



Impact on General Building Stock

In general, the built environment located in the high landslide susceptibility area and the population, structures and infrastructure located downslope are vulnerable to this hazard. Landslides may destabilize the foundation of structures resulting in monetary losses to businesses and residents. There are 243 buildings with a replacement cost value of $290 million located in the Class A landslide susceptibility areas countywide (refer to Figure 4.3.8-7). The Township of Weehawken has the greatest number of buildings located in Class A areas; 120 buildings (5.7-percent of its total) with an estimated replacement cost of $52 million. There are only 2 buildings located in the Class B areas countywide. These two structures are located in the Township of North Bergen and have an estimated replacement cost of $4.9 million. Table 4.3.8-3 summarizes the exposed building stock located in Class A landslide susceptibility areas by municipality.

Figure 4.3.8-7. Building Exposure to Class A Landslide Soil

Table 4.3.8-3. Number of Buildings in the Landslide Hazard Area by Municipality

Municipality	Number of Buildings	Total Replacement Cost Value (RCV)	Estimated Building Stock Exposed			
			Number of Buildings - Class A	% of Total	RCV - Class A	% of Total
Bayonne, City of	6,802	$8,856,079,105	0	0.0%	$0	0.0%
East Newark, Borough of	403	$240,888,451	0	0.0%	$0	0.0%
Guttenberg, Town of	1,227	$651,507,569	4	0.3%	$47,379,965	7.3%
Harrison, Town of	2,537	$2,398,975,757	0	0.0%	$0	0.0%
Hoboken, City of	4,470	$3,910,202,233	4	0.1%	$6,718,336	0.2%
Jersey City, City of	35894	$25,693,921,967	9	0.0%	$34,576,791	0.1%
Kearny, Town of	7,209	$7,874,466,790	0	0.0%	$0	0.0%
North Bergen, Township of	6,005	$8,393,144,641	73	1.2%	$61,500,461	0.7%
Secaucus, Town of	3,845	$9,593,262,762	0	0.0%	$0	0.0%
Union City, City of	1,729	$3,742,882,384	22	1.3%	$56,956,433	1.5%
Weehawken, Township of	2,113	$1,510,119,929	120	5.7%	$52,111,612	3.5%
West New York, Town of	4,594	$2,825,012,673	11	0.2%	$30,888,113	1.1%
Hudson County (Total)	**76,828**	**$75,690,464,261**	**243**	**0.3%**	**$290,131,710**	**0.4%**

Sources: Microsoft, 2018, Open Street Map, 2019; NJOIT, 2018; NJGWS, 2016
Note: NJGWS New Jersey Geological Water Survey

RCV Replacement Cost Value
Class A includes classes AII, AIV, AVI which is strongly cemented rock at varying slope angles. Class B includes classes BIII, BIV, BV, and BVI which includes weakly cemented rock and soil at varying slope angles. No Class C soils were identified in Hudson County.

Impact on Critical Facilities

The spatial analysis indicates there are six critical facilities located in the Class A hazard area. One is located in Hoboken City, two are located in Jersey City, two are located in Union City, and one is located in Weehawken Township. Two of the critical facilities are wastewater pumps and the others are a rail line, shelter, childcare, and electric substation facility. In addition to critical facilities, a significant amount of infrastructure can be exposed to mass movements of geological material:

- *Roads*—Access to major roads is crucial to life-safety after a disaster event and to response and recovery operations. Landslides can block egress and ingress on roads, causing isolation for neighborhoods, traffic problems, and delays for public and private transportation. This can result in economic losses for businesses.
- *Bridges*—Landslides can significantly impact road bridges. Mass movements can knock out bridge abutments or significantly weaken the soil supporting them, making them hazardous for use.
- *Power Lines*—Power lines are generally elevated above steep slopes; but the towers supporting them can be subject to landslides. A landslide could trigger failure of the soil underneath a tower, causing it to collapse and ripping down the lines. Power and communication failures due to landslides can create problems for vulnerable populations and businesses.
- *Rail Lines* – Similar to roads, rail lines are important for response and recovery operations after a disaster. Landslides can block travel along the rail lines, which would become especially troublesome, because it would not be as easy to detour a rail line as it is on a local road or highway. Many residents rely on public transport to get to work around the county and into Philadelphia and New York City, and a landslide event could prevent travel to and from work.

Impact on the Economy

Geologic hazards can impose direct and indirect impacts on society. Direct costs include the actual damage sustained by buildings, property and infrastructure. Indirect costs, such as clean-up costs, business interruption, loss of tax revenues, reduced property values, and loss of productivity are difficult to measure. Additionally, ground failure threatens transportation corridors, fuel and energy conduits, and communication lines (USGS 2005). Estimated potential damages to general building stock can be quantified as discussed above. For the purposes of this analysis, general building stock damages are discussed further.

According to the New Jersey Geological Survey (NJGS), the Palisades are the most active area for landslides in New Jersey (refer to Figure 4.3.8-4). The Palisades are cliffs that line the western margin of the Hudson River, from Jersey City to the south, to northward of the Tappan Zee Bridge. The Class A hazard area also lines major transit routes, such as 495 and JF Kennedy Blvd. The hazard area also crosses over the Lincoln Tunnel Reversible Lane that connects New Jersey and New York border. This latter coverage is especially concerning for the commuter community that travels into and out of New Jersey and New York. Should a landslide event occur, this will damage the landscape and key infrastructure. Infrastructure losses can have a major impact on Hudson County's tax base and local economy.

Impact on the Environment

Landslides can cause major damage to the built and natural environment. For example, changes in topography can damage or destroy vegetation and wildlife habitats. Landslides may cause massive wasting and erosion of natural surfaces (USGS 2001). Habitats can be stripped of fertile soils which delays growth of new vegetation post-landslide event.

Furthermore, soil and sediment runoff can accumulate downslope potentially blocking waterways and roadways and impacting quality of streams and other water bodies. Mudflows that erode into downstream waterways can threaten the life of freshwater and/or coastal species (USGS 2001). The impacts of eroded landscape can travel for miles downstream into adjacent waterways and create issues for surrounding watersheds.

Future Changes That May Impact Vulnerability

Understanding future changes that effect vulnerability in the County can assist in planning for future development and ensure establishment of appropriate mitigation, planning, and preparedness measures. The County considered the following factors to examine potential conditions that may affect hazard vulnerability:

- Potential or projected development
- Projected changes in population
- Other identified conditions as relevant and appropriate, including the impacts of climate change

PROJECTED DEVELOPMENT

Any areas of growth could be potentially impacted by the geologic hazard if located within the identified hazard areas or downslope. In general, development of slopes is not recommended due to the increased risk of erosion, stormwater runoff and flooding potential. The additional runoff results in sedimentation of down slope surface waters, which damages habitat and has the potential to damage property. The sloping land increases the rate of runoff, which reduces the rate of groundwater infiltration.

Each municipality identified areas of recent development and proposed development in their community. Several municipalities have steep slope ordinances with requirements for developing in certain locations that may be susceptible to this hazard. Developments that could be located using an address or Parcel ID were geocoded and overlain with the landslide hazard areas to determine vulnerability to flooding. No identified new development is located in a landslide susceptible area. Refer to Section 3 (County Profile), and Volume II Section 9 (Jurisdictional Annexes) for potential new development and landslide hazard areas in Hudson County and Figure 4.3.8-8 which illustrates the proposed new development and the landslide hazard areas in Hudson County.

PROJECTED CHANGES IN POPULATION

Since 2010, Hudson County has experienced a 4.2% increase in total number of persons living in its jurisdictional boundary. As discussed above, 495, JF Kennedy Blvd, and the Lincoln Tunnel Reversible Lane that connects New Jersey and New York border are exposed to the landslide hazard areas, and an increasing population will result in a greater vulnerability as more people are using these roadways on a daily basis. Refer to Section 4.3.1, Population Trends in the County Profile, includes a discussion on population trends for the county.

CLIMATE CHANGE

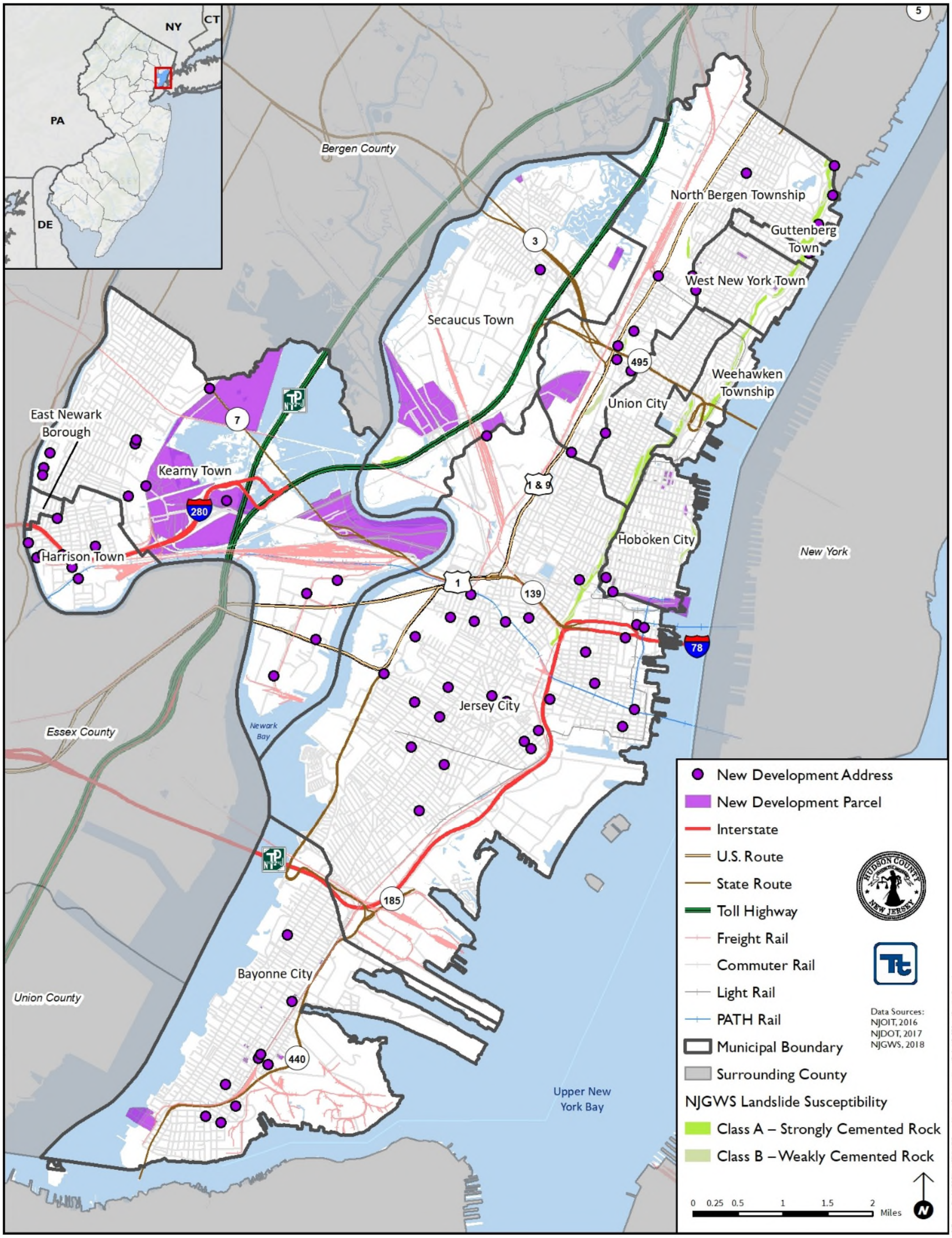
A direct impact of climate change on landslides is difficult to determine. Multiple secondary effects of climate change have the potential to increase the likelihood of landslides. Warming temperatures resulting in wildfires would reduce vegetative cover along steep slopes and destabilize the soils due to destruction of the root system; increased intensity of rainfall events would increase saturation of soils on steep slopes. Under these future conditions, the County's assets located on or at the base of these steep slopes will have an increased risk to landslides. Roadways and other transportation infrastructure located in these areas will also be at an increased risk of closure, which would impact the County's risk as described above .

Higher temperatures and the possibility of more intense, less frequent summer rainfall may lead to changes in water resource availability. The projection in the increase of average temperatures may lead to an increase in the frequency of droughts. Sinkhole activity intensifies in some karst areas increases during periods of drought. With an increase in drought periods, the number of sinkholes can increase (Linares et al. 2016). Additionally, changes to the water balance of an area including over-withdrawal of groundwater, diverting surface water from a large area and concentrating it in a single point, artificially creating ponds of surface water, and drilling new water wells will cause sinkholes. These actions can also serve to accelerate the natural processes of bedrock degradation, which can have a direct impact on sinkhole creation.

Change of Vulnerability Since 2015 HMP

The entire County continues to be vulnerable to the landslide hazard. Several differences exist between the 2015 HMP and this HMP update including updated hazard data and asset inventory data. As discussed in Section 4.2 (Methodology and Tools), an updated general building stock based upon replacement cost value from MODIV tax assessment data and 2019 RS Means, and an updated critical facility inventory were used to assess the County's risk to the identified hazards of concern. In addition, the 2017 American Community Survey population estimates were used and estimated at a structural level in place of the 2010 U.S. Census blocks. Updated hazard areas were used as well; since the 2015 HMP, the NJGWS has released updated landslide susceptibility data. The updated data was used for the exposure analysis and to update HAZUS-MH's default earthquake data. Overall, the hazard area delineations remained unchanged, so any signification increase in vulnerability would be attributed to population growth and new development.

Figure 4.3.8-8. Potential New Development and Landslide Hazard Areas



4.3.9 SEVERE WEATHER

This section provides a profile and vulnerability assessment of the severe weather hazard in Hudson County.

2020 HMP Changes

- New and updated figures from federal and state agencies are incorporated.
- Previous occurrences were updated with events that occurred between 2015 and 2019.
- Additional analyses were added to this section including: social vulnerability analysis and review of historical structural damages to predict future damages

4.3.9.1 PROFILE

For the purpose of this HMP update and as deemed appropriated by Hudson County, the severe weather hazard includes thunderstorms, lightning, hailstorms, windstorms, and tornadoes which are defined in the sections below. Nor'easters, hurricanes and tropical storms are discussed in Section 4.3.2 Coastal Storm.

THUNDERSTORMS

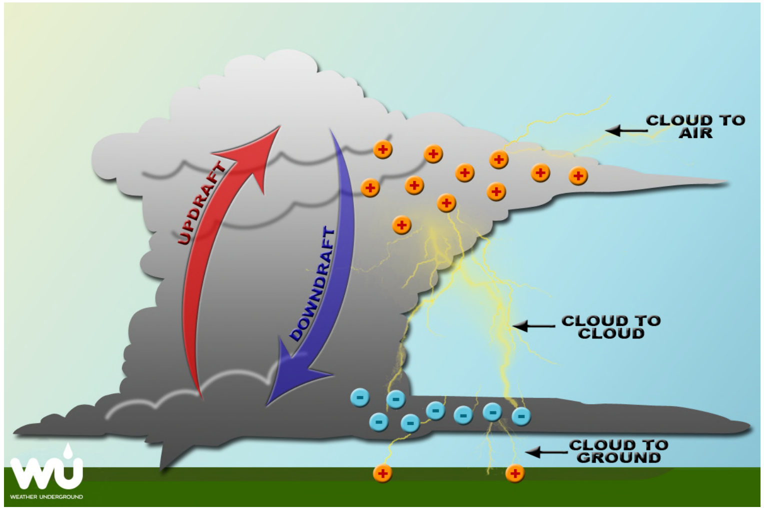
A thunderstorm is a local storm produced by a cumulonimbus cloud and accompanied by lightning and thunder (National Weather Service [NWS] 2009). A thunderstorm forms from a combination of moisture; rapidly rising warm air; and a force capable of lifting air, such as a warm front, cold front, a sea breeze, or a mountain. Thunderstorms form from the equator to as far north as Alaska. Although thunderstorms generally affect a small area when they occur, they have the potential to become dangerous due to their ability to generate tornadoes, hailstorms, strong winds, flash flooding, and lightning.

Thunderstorms can lead to heavy rain induced flooding, landslides, strong winds, and lightning. Roads may become impassable from flooding, downed trees or power lines, or a landslide. Downed power lines can lead to loss of utility services, such as water, phone, and electricity. Typical thunderstorms are 15 miles in diameter and last an average of 30 minutes. During the summer, thunderstorms are responsible for most of the rainfall.

LIGHTNING

Lighting is a bright flash of electrical energy produced by a thunderstorm. The resulting clap of thunder is the result of a shock wave created by the rapid heating and cooling of the air in the lightning channel. All thunderstorms produce lightning and are very dangerous. Lightning ranks as one of the top weather killers in the United States, killing approximately 50 people and injuring hundreds each year. Lightning can occur anywhere there is a thunderstorm. Lightning can be cloud to air, cloud to cloud, and cloud to ground. Figure 4.3.9-1 demonstrates the variety of lightning types.

Figure 4.3.9-1. Types of Lightning

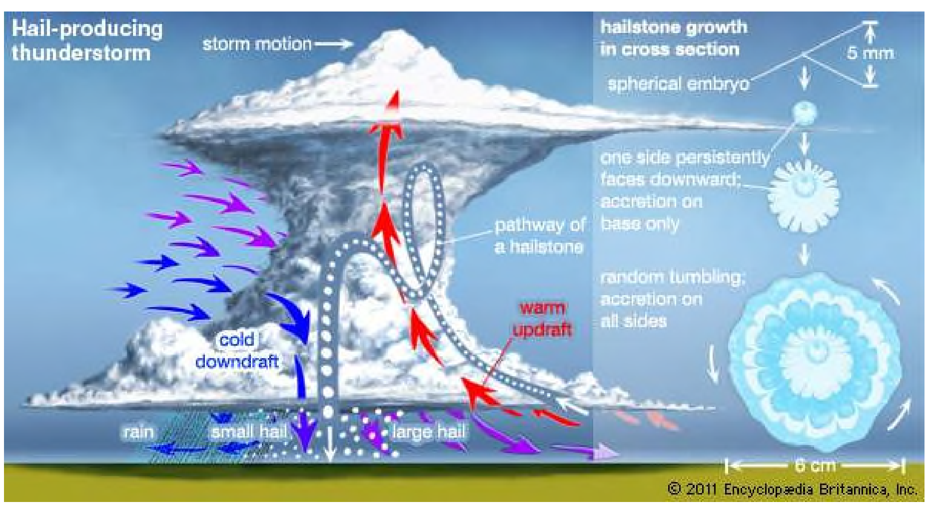


Source: Weather Underground date unknown

HAILSTORMS

Hail forms inside a thunderstorm or other storms with strong updrafts of warm air and downdrafts of cold water. If a water droplet is picked up by the updrafts, it can be carried well above the freezing level. Water droplets freeze when temperatures reach 32 degrees Fahrenheit (°F) or colder. As the frozen droplet begins to fall, it may thaw as it moves into warmer air toward the bottom of the thunderstorm. However, the droplet may be picked up again by another updraft and carried back into the cold air and re-freeze. With each trip above and below the freezing level, the frozen droplet adds another layer of ice. The frozen droplet, with many layers of ice, falls to the ground as hail. Most hail is small and typically less than (2 inches in diameter (NWS 2010). Figure 4.3.9-2 shows how hail is formed within thunderstorms.

Figure 4.3.9-2. Hail Formation in Thunderstorms



Source: Encyclopedia Britannica 2011

WINDSTORMS

Wind begins with differences in air pressures and occurs through rough horizontal movement of air caused by uneven heating of the earth's surface. Wind occurs at all scales, from local breezes lasting a few minutes to global winds resulting from solar heating of the earth. High winds are often associated with other severe weather events such as thunderstorms, tornadoes, nor'easters, hurricanes, and tropical storms (discussed further in this section or in Section 4.3.2 Coastal Storms).

TORNADOES

A tornado appears as a rotating, funnel-shaped cloud that extends from a thunderstorm to the ground with whirling winds that can reach 250 miles per hour (mph). Damage paths can be greater than 1 mile wide and 50 miles long. Tornadoes typically develop from either a severe thunderstorm or hurricane as cool air rapidly overrides a layer of warm air. Tornadoes typically move at speeds between 30 and 125 mph and can generate combined wind speeds (forward motion and speed of the whirling winds) exceeding 300 mph. The lifespan of a tornado rarely is longer than 30 minutes (FEMA 1997). Tornadoes can occur at any time of the year, with peak seasons at different times for different states (National Severe Storms Laboratory [NSSL] 2013).

EXTENT

The extent (severity or magnitude) of a severe storm is largely dependent upon the most damaging aspects of each type of severe weather. This section describes the extent of thunderstorms, lighting, hail, windstorms, and tornadoes in Hudson County. Historical data presented in Table 4.3.9-1 shows the most powerful severe weather records in Hudson County.

Table 4.3.9-1. Severe Storm Extent in Hudson County (1950 – 2019)

Extent of Severe Storms in Hudson County	
Largest Hailstone on Record	1.75 inches
Strongest Tornado on Record	F-1
Highest Wind Speed on Record	90 knots

Source: NOAA-NCEI 2019

Thunderstorms

NWS considers a thunderstorm severe if it produces damaging wind gusts of 58 mph or higher, hail 1 inch (quarter size) in diameter or larger, or tornadoes (NWS 2010). Severe thunderstorm watches and warnings are issued by the local NWS office and NOAA's Storm Prediction Center (SPC). NWS and SPC will update the watches and warnings and will notify the public when they are no longer in effect. Watches and warnings for thunderstorms in New Jersey are defined as follows:

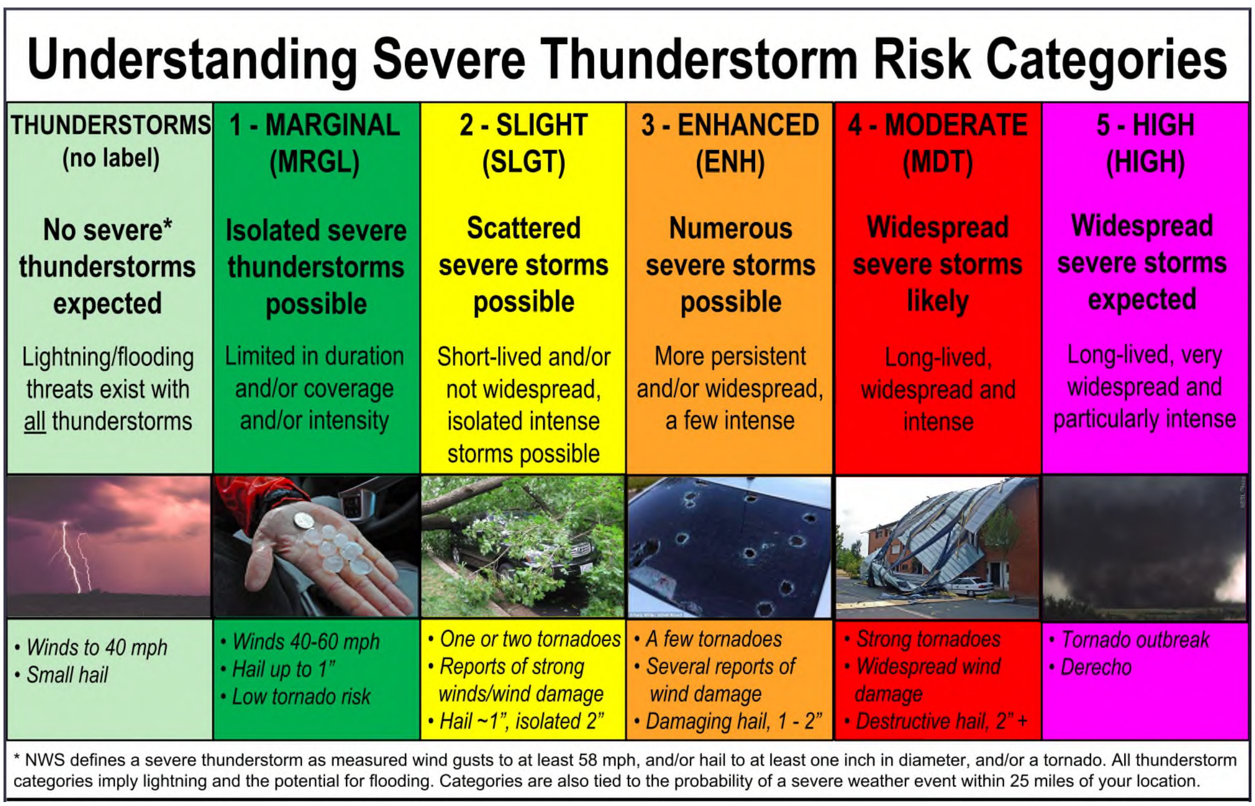
- *Severe Thunderstorm Warnings* are issued when there is evidence based on radar or a reliable spotter report that a thunderstorm is producing (or is forecast to produce) wind gusts of 58 mph or greater, structural wind damage, and hail 1 inch in diameter or greater. A warning will include the location of the storm, the municipalities that are expected to be impacted, and the primary threat associated with the severe thunderstorm warning. After it has been issued, the NWS office will follow up periodically with Severe

Weather Statements, which contain updated information on the severe thunderstorm and will let the public know when the warning is no longer in effect (NWS 2010).

- *Severe Thunderstorm Watches* are issued by the SPC when conditions are favorable for the development of severe thunderstorms over a larger-scale region for a duration of at least 3 hours. Tornadoes are not expected in such situations, but isolated tornado development may also occur. Watches are normally issued well in advance of the actual occurrence of severe weather. During the watch, NWS will keep the public informed on developments happening in the watch area and will also notify the public when the watch has expired or been cancelled (NWS 2010).
- *Special Weather State for Near Severe Thunderstorms* bulletins are issued for strong thunderstorms that are below severe levels, but still may have some adverse impacts. Usually, they are issued for the threat of wind gusts of 40 to 58 mph or small hail less than one (1) inch in diameter (NWS 2010).

In addition, the SPC issues severe thunderstorm risk maps based on the likelihood of different severities of thunderstorms. Figure 4.3.9-3 shows the SPC's severe thunderstorm risk categories.

Figure 4.3.9-3. Severe Thunderstorm Risk Categories



Source: NOAA SPC 2017

LIGHTNING

Lightning is most often associated with moderate to severe thunderstorms. The severity of lightning refers to the frequency of lightning strikes during a storm. Multiple devices are available to track and monitor the frequency of lightning.

HAIL

The severity of a hailstorm is measured by duration, hail size, and geographic extent. Most hail stones from hailstorms are made up of variety of sizes. The size of hail is estimated by comparing it to a known object. Table 4.3.9-2 describes the different sizes of hail as compared to real-world objects and lists approximate measurements.

Table 4.3.9-2. Hail Size

Description	Diameter (in inches)	Description	Diameter (in inches)
Pea	0.25	Golf ball	1.75
Marble or mothball	0.50	Hen's egg	2.00
Penny or dime	0.75	Tennis ball	2.5
Nickel	0.88	Baseball	2.75
Quarter	1.00	Teacup	3.00
Half dollar	1.25	Grapefruit	4.00
Walnut or ping pong ball	1.50	Softball	4.50

Source: NOAA 2012

WINDSTORMS

Table 4.3.9-3 provides the NWS descriptions of winds during wind-producing events.

Table 4.3.9-3. NWS Wind Descriptions

Descriptive Term	Sustained Wind Speed (mph)
Strong, dangerous, or damaging	≥40
Very windy	30-40
Windy	20-30
Breezy, brisk, or blustery	15-25
None	5-15 or 10-20
Light or light and variable wind	0-5

Source: NWS 2015

NWS issues advisories and warnings for winds, which are normally site-specific. High wind advisories, watches, and warnings are issued by the NWS when wind speeds may pose a hazard or may be life threatening. The criterion for each of these varies from state to state. Wind warnings and advisories for New Jersey are as follows:

- *High Wind Warnings* are issued when sustained winds of 40 mph or greater are forecast for 1 hour or longer, or wind gusts of 58 mph or greater are forecast for any duration.
- *Wind Advisories* are issued when sustained winds of 30 to 39 mph are forecast for one 1 hour or longer, or wind gusts of 46 to 57 mph are forecast for any duration (NWS 2015).

TORNADO

The magnitude or severity of a tornado is categorized using the Enhanced Fujita Tornado Intensity Scale (EF Scale). Figure 4.3.9-4 illustrates the relationship between EF ratings, wind speed, and expected tornado damage.

Figure 4.3.9-4. Enhanced Fujita Tornado Intensity Scale Ratings, Wind Speeds, and Expected Damage

EF Rating	Wind Speeds	Expected Damage		
EF-0	65-85 mph	'Minor' damage: shingles blown off or parts of a roof peeled off, damage to gutters/siding, branches broken off trees, shallow rooted trees toppled.		
EF-1	86-110 mph	'Moderate' damage: more significant roof damage, windows broken, exterior doors damaged or lost, mobile homes overturned or badly damaged.		
EF-2	111-135 mph	'Considerable' damage: roofs torn off well constructed homes, homes shifted off their foundation, mobile homes completely destroyed, large trees snapped or uprooted, cars can be tossed.		
EF-3	136-165 mph	'Severe' damage: entire stories of well constructed homes destroyed, significant damage done to large buildings, homes with weak foundations can be blown away, trees begin to lose their bark.		
EF-4	166-200 mph	'Extreme' damage: Well constructed homes are leveled, cars are thrown significant distances, top story exterior walls of masonry buildings would likely collapse.		
EF-5	> 200 mph	'Massive/incredible' damage: Well constructed homes are swept away, steel-reinforced concrete structures are critically damaged, high-rise buildings sustain severe structural damage, trees are usually completely debarked, stripped of branches and snapped.		

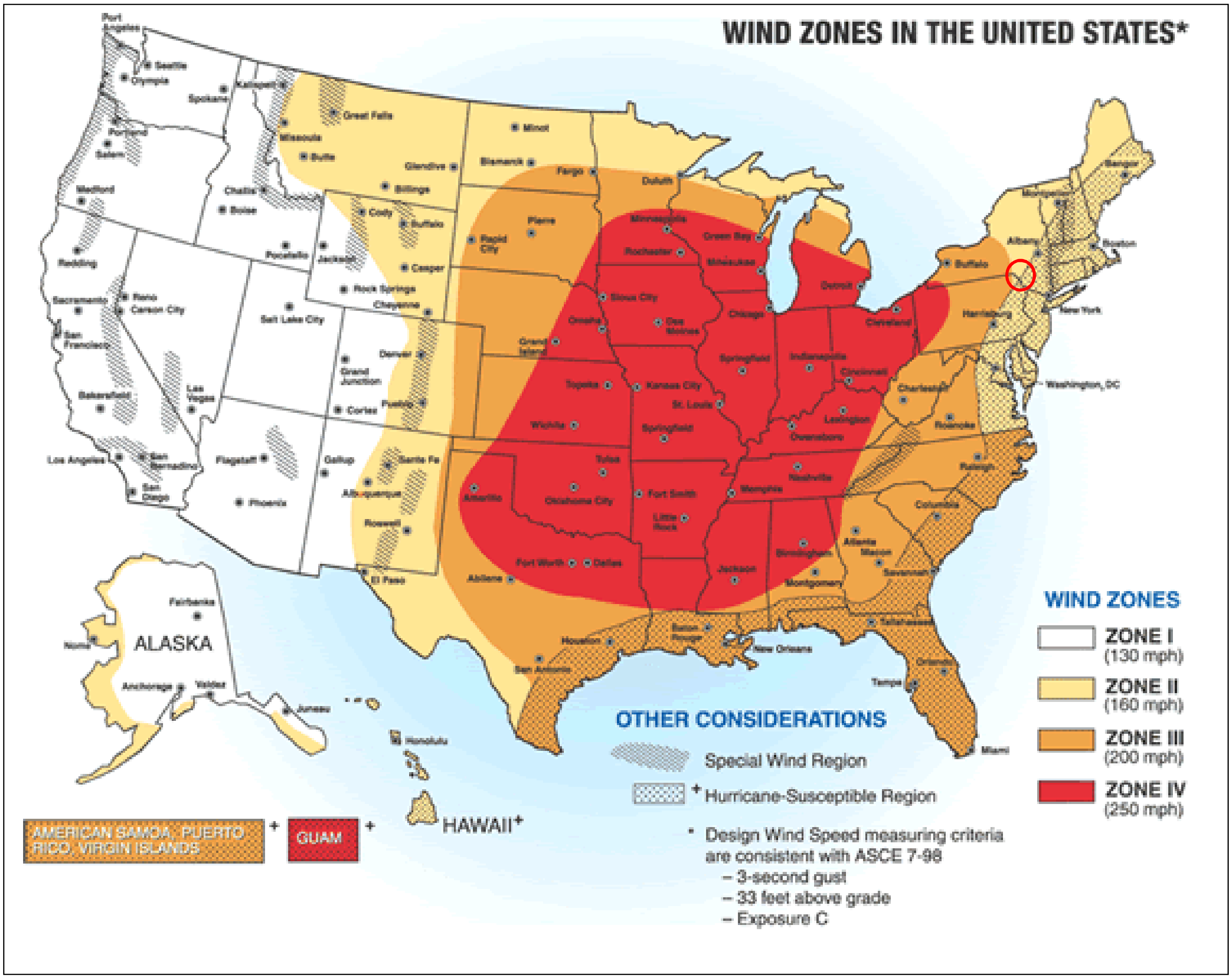
Source: NWS 2018

Tornado watches and warning are issued by the local NWS office. A tornado watch is released when tornadoes are possible in an area. A tornado warning means a tornado has been sighted or indicated by weather radar. The current average lead time for tornado warnings is 13 minutes. Occasionally, tornadoes develop so rapidly, that little, if any, advance warning is possible (NOAA 2011).

Location

All of Hudson County is exposed to hail, lightning, windstorms and high wind, thunderstorms, and tornadoes and all of the County is subject to high winds from severe weather events. According to the FEMA Winds Zones of the United States map, Hudson County is located in Wind Zone II, where wind speeds can reach up to 160 mph and is part of the hurricane susceptible region. Hurricanes are covered in Section 4.3.2 Coastal Storms. Figure 4.3.9-5 illustrates wind zones across the United States, which indicate the impacts of the strength and frequency of wind activity per region. The information on the figure is based on 40 years of tornado data and 100 years of hurricane data collected by FEMA.

Figure 4.3.9-5. Wind Zones in the United States



Source: FEMA 2012
Note: The red circle indicates the approximate location of Hudson County.

PAST OCCURRENCE

Many sources provided historical information regarding previous occurrences and losses associated with severe storms throughout the State of New Jersey and Hudson County; therefore, the loss and impact information for many events varies depending on the source. The accuracy of monetary figures discussed is based only on the available information in cited sources.

FEMA MAJOR DISASTERS AND EMERGENCY DECLARATIONS

Between 1954 and January 2019, Hudson County has been included in 10 declarations for severe storm-related events classified as one or a combination of the following disaster types: severe storm, straight-line winds, tornado, or hurricane (FEMA 2019). Table 4.3.9-4 lists these events.

Table 4.3.9-4. Severe Weather-Related Disaster (DR) and Emergency (EM) Declarations 1954-2019

Declaration	Event Date	Declaration Date	Event Description
DR-310	September 4, 1971	September 4, 1971	Flood: Heavy Rains & Flooding
DR-973	December 10-17, 1992	December 18, 1992	Flood: Coastal Storm, High Tides, Heavy Rain, & Flooding
DR-1145	October 18-23, 1996	November 19, 1996	Severe Storm(s): Severe Storms and Flooding
EM-3148	September 16-18, 1999	September 17, 1999	Hurricane: Hurricane Floyd Emergency Declarations
DR-1694	April 14-20, 2007	April 26, 2007	Severe Storm(s): Severe Storms and Inland and Coastal Flooding
EM-3332	August 26-September 5, 2011	August 27, 2011	Hurricane: Hurricane Irene
DR-4021	August 27-September 5, 2011	August 31, 2011	Hurricane: Hurricane Irene
EM-3354	October 26-November 8, 2012	October 28, 2012	Hurricane: Hurricane Sandy
DR-4086	October 26-November 8, 2012	October 31, 2012	Hurricane: Hurricane Sandy
DR-4264	January 22-24, 2016	March 14, 2016	Severe Storm(s): Severe Winter Storm and Snowstorm

Source: FEMA 2019

U.S. DEPARTMENT OF AGRICULTURE DISASTER DECLARATIONS

The Secretary of Agriculture from the U.S. Department of Agriculture (USDA) is authorized to designate counties as disaster areas to make emergency loans to producers suffering losses in those counties and in counties that are contiguous to a designated county. Between 2015 and 2019, Hudson County was not included in any USDA declaration involving severe storms.

The USDA crop loss data provide another indicator of the severity of previous events. Additionally, crop losses can have a significant impact on the economy by reducing produce sales and purchases. Such impacts may have long-term consequences, particularly if crop yields are low the following years as well. Between 2015 and 2019, Hudson County did not report any crop losses due to severe storms.

SEVERE STORM EVENTS

The National Oceanic and Atmospheric Administration (NOAA) National Centers for Environmental Information (NCEI) Storm Events database records and defines severe storm events as follows:

- Funnel cloud is reported in the NOAA-NCEI database for a rotating, visible extension of a cloud pendant from a convective cloud with circulation not reaching the ground. The funnel cloud should be large, noteworthy, or create strong public or media interest to be entered.
- Hail is reported in the NOAA-NCEI database for frozen precipitation in the form of balls or irregular lumps of ice. Hail 3/4 of an inch or larger in diameter are entered. Hail accumulations of smaller size, which cause property and/or crop damage or casualties, are also entered.
- Heavy rain is reported in the NOAA-NCEI database for unusually large amounts of rain which does not cause a Flash Flood or Flood event, but causes damage, e.g., roof collapse or other human/economic impact.
- High wind is reported in the NOAA-NCEI database for sustained non-convective winds of 35 knots (40 mph) or greater lasting for 1 hour or longer, or gusts of 50 knots (58 mph) or greater for any duration (or otherwise locally/regionally defined).
- Lightning is reported in the NOAA-NCEI database for sudden electrical discharges from a thunderstorm, resulting in a fatality, injury, and/or damage.

- Strong wind is reported in the NOAA-NCEI database for non-convective winds gusting less than 50 knots (58 mph), or sustained winds less than 35 knots (40 mph), resulting in a fatality, injury, or damage.
- Thunderstorm wind is reported in the NOAA-NCEI database for winds, arising from convection (occurring within 30 minutes of lightning being observed or detected), with speeds of at least 50 knots (58 mph), or winds of any speed (non-severe thunderstorm winds below 50 knots) producing a fatality, injury, or damage.
- Tornado is reported in the NOAA-NCEI database for a violently rotating column of air, extending to or from a cumuliform cloud or underneath a cumuliform cloud, to the ground, and often (but not always) visible as a condensation funnel.

For this 2020 HMP update, known severe storm events that have impacted Hudson County between 2015 and 2019 are identified in Table 4.3.9-5. For events prior to 2015, refer to Appendix E.

Table 4.3.9-5. Severe Storm Events Impacting Hudson County between 2015 and 2019

Dates of Event	Event Type	FEMA Declaration Number	County Designated?	Location	Losses/Impacts
July 1, 2015	Thunderstorm Wind	N/A	N/A	Constable Hook, Communipaw, Bayonne	A passing warm front triggered isolated severe thunderstorms which impacted Northeastern New Jersey. A tree was reported down on a car at 7 Lord Avenue in Bayonne. $7.5K in property damages were reported. A tree was reported down on a car at the intersection of West 58th Street and Avenue B in Bayonne. $7.5K in property damages were reported.
April 3, 2016	High Wind	N/A	N/A	Hudson County, Jersey City	Deep low pressure tracked just to the east of the area. The public reported a tree down on to a car on Summit Avenue in Jersey City. This occurred at 10 am. $50K in property damages were reported.
July 18, 2016	Thunderstorm Wind	N/A	N/A	Communipaw	A passing cold front triggered a couple of severe thunderstorms over Union County. A gust of 70 mph was measured at the National Ocean Service site at Robbins Reef.
January 23, 2017	Strong Wind	N/A	N/A	Hudson County, Harrison	A deep area of low pressure passed just south and east of Long Island. A CO-OP observer at Harrison measured a wind gust up to 55 mph. $10K in property damages were reported.
February 13, 2017	Strong Wind	N/A	N/A	Hudson County, Harrison, Jersey City, North Bergen	Low pressure passed to the east and rapidly deepened. In Harrison, a wind gust up to 52 mph was measured, and a wind gust up to 57 mph was measured at the Red Bull Arena, elevation 100 feet. In Jersey City, a gust to 50 mph was measured. In North Bergen, a public school mesonet reported a gust to 52 mph. $10K in property damages were reported.
March 2, 2017	Strong Wind	N/A	N/A	Hudson County, Bayonne	Gusty northwest winds occurred behind a strong cold front. The mesonet station in Bayonne reported a wind gust up to 56 mph. $10K in property damages were reported.
March 22, 2017	Strong Wind	N/A	N/A	Hudson County, Weehawken	Gusty northwest winds occurred behind deep low pressure and a strong cold front. A mesonet station measured sustained winds of 38 mph in Weehawken. $10K in property damages were reported.
May 2, 2017	Strong Wind	N/A	N/A	Hudson County, Harrison	Strong winds occurred behind a cold front. A co-op observer reported that a tree fell down on a house on Davis Avenue in Harrison. The weather station at

Dates of Event	Event Type	FEMA Declaration Number	County Designated?	Location	Losses/Impacts
					Harrison measured a wind gust up to 55 mph. $100K in property damages were reported.
October 29, 2017	Strong Wind	N/A	N/A	Hudson County, Harrison	A low pressure system rapidly intensified as it moved north, passing west of the local area. Law enforcement reported a tree down on South 3rd Street in Harrison. $50K in property damages were reported.
May 15, 2017	Thunderstorm Wind	N/A	N/A	East Newark	An approaching cold front triggered numerous severe thunderstorms over northeastern New Jersey. A fallen tree limb resulted in one injury in West Hudson Park.
July 17, 2018	Thunderstorm Wind	N/A	N/A	Weehawken	A cold front approached from the west and brought a line of with an isolated strong thunderstorm through Hudson County. A tree was reported down on utility lines on Clinton Street between 1st Street and 2nd Street. $3K in property damages were reported.
July 22, 2018	Strong Wind	N/A	N/A	Hudson County, Harrison	Low pressure approached from the south, and gusty easterly winds were observed ahead of it. Emergency management reported a tree down on power lines on Hamilton Street in the Town of Harrison. $50K in property damages were reported.

Source: *NOAA-NCEI 2019*
Note: *Not all events that have occurred in Hudson County are included due to the extent of documentation and the fact that not all sources have been identified or researched.*
K: Thousand

According to the Storm Events Database, Hudson County has been impacted by 137 severe weather events between 1950 and January 2019 (Table 4.3.9-6). These events resulted in two fatalities, three total injuries, and $2.014 million in property damages.

Table 4.3.9-6. Severe Weather Events in Hudson County 1950 to 2019

Hazard Type	Number of Occurrences Between 1950 and 2019	Total Fatalities	Total Injuries	Total Property Damage ($)	Total Crop Damage ($)
Funnel cloud	2	0	0	$0	$0
Hail	14	0	0	$0	$0
Heavy rain	30	0	0	$0	$0
High wind	22	0	0	$1.35M	$0
Lightning	5	0	0	$28.50K	$0
Strong wind	14	1	0	$227.00K	$0
Thunderstorm wind	49	1	3	$158.50K	$0
Tornado	1	0	0	$250.00K	$0
TOTAL	**137**	**2**	**3**	**$2.014M**	**$0**

Source: *NOAA-NCEI 2019*
Note: *Not all events that have occurred in Hudson County are included due to the extent of documentation and the fact that not all sources have been identified or researched.*
K: Thousand
M: Million

Probability of Future Occurrence

Hudson County is expected to continue experiencing direct and indirect impacts of severe weather annually. These storms may induce secondary hazards such as flooding and utility failure.

Table 4.3.9-7 summarizes data regarding the probability of occurrences of severe storm events in Hudson County. Based on historic occurrences, thunderstorm events are the most common in Hudson County, followed by hail events. The information used to calculate the probability of occurrences is based solely on NOAA-NCEI storm events database results.

Table 4.3.9-7. Probability of Severe Weather Events in Hudson County

Hazard Type	Number of Occurrences Between 1950 and 2018	Rate of Occurrence	Recurrence Interval (in years)	Probability of Event Occurring in Any Given Year	% Chance of Occurring in Any Given Year
Funnel cloud	2	0.03	35.00	0.03	2.86
Hail	14	0.20	5.00	0.20	20.00
Heavy rain	30	0.43	2.33	0.43	42.86
High wind	22	0.32	3.18	0.31	31.43
Lightning	5	0.07	14.00	0.07	7.14
Strong wind	14	0.20	5.00	0.20	20.00
Thunderstorm wind	49	0.71	1.43	0.70	70.00
Tornado	1	0.01	70.00	0.01	1.43
TOTAL	**137**	**1.99**	**0.51**	**1.96**	**100%**

Source: NOAA-NCEI 2019
Note: Not all events that have occurred in Hudson County are included due to the extent of documentation and the fact that not all sources have been identified or researched.
K: Thousand
M: Million

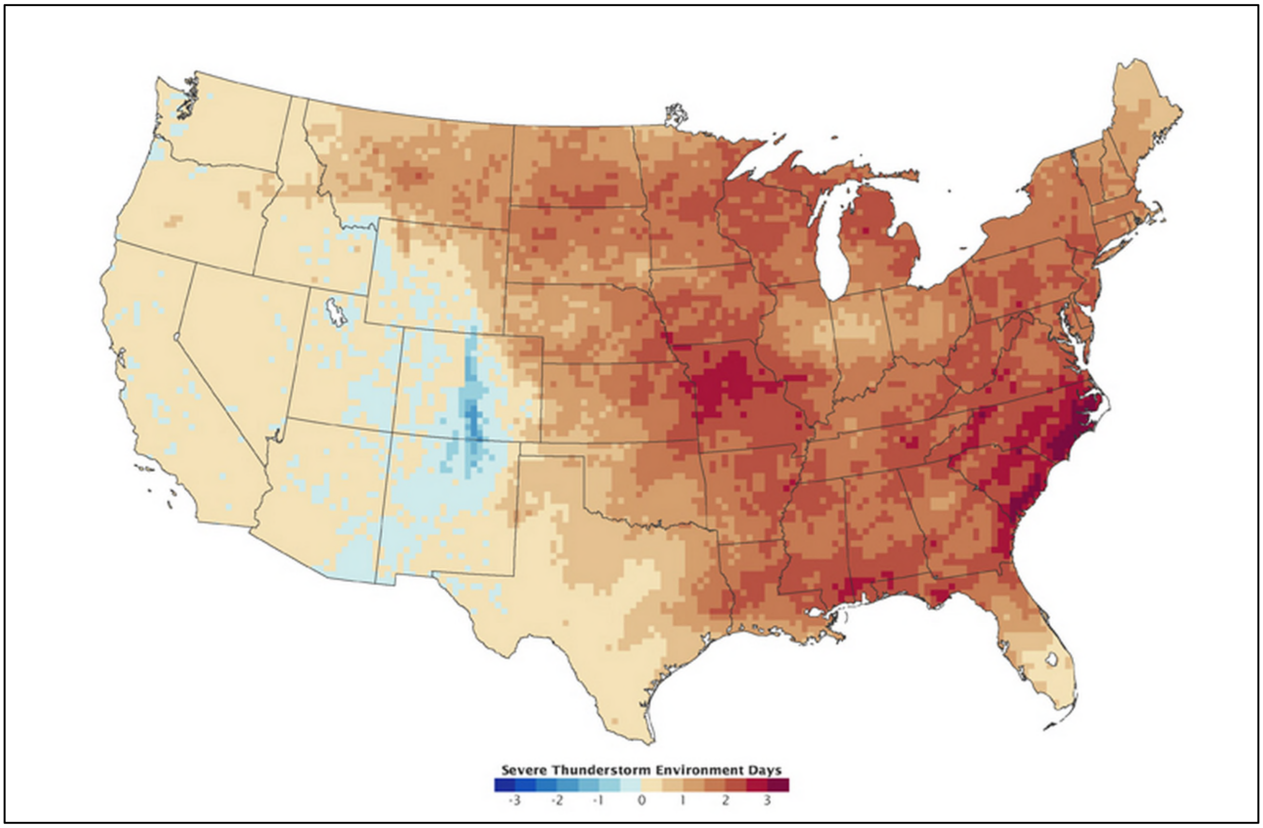
In Section 4.4, the identified hazards of concern for Hudson County are ranked using a variety of parameters. The probability of occurrence, or likelihood of the event, is one parameter used for hazard rankings. Based on historical records and input from the Planning Partnership, the probability of occurrence for severe weather in the County is considered “frequent”.

Climate Change Impacts

New Jersey have become wetter over the past century. Northern New Jersey’s 1971-2000 precipitation average was over five inches (12-percent) greater than the average from 1895-1970 (Sustainable Jersey Climate Change Adaptation Task Force [CATF] 2011). The heaviest 1% of daily rainfalls have increased by approximately 70% between 1958 and 2011 in the Northeast (Horton et al. 2015). Average annual precipitation is projected to increase in the region by four to 11-percent by the 2050s and five to 13-percent by the 2080s (New York City Panel on Climate Change [NPCC] 2015).

As the climate changes, temperatures and the amount of moisture in the air will both increase, thus leading to an increase in the severity of thunderstorms which can lead to derechos and tornadoes. Studies have shown that an increase in greenhouse gases in the atmosphere would significantly increase the number of days that severe thunderstorms occur in the southern and eastern United States (National Aeronautics and Space Administration [NASA] 2005).

Figure 4.3.9-6. Predicted Change in Severe Thunderstorm Environment Days from the 1962-1989 Period to the 2072-2099 Period



Source: Trapp et. al. 2007

Average annual temperatures have increased by 3°F in New Jersey over the past century (NOAA NCEI 2019). Most of this warming has occurred since 1970. The State of New Jersey, for example, has observed an increase in average annual temperatures of 1.2°F between the period of 1971-2000 and the most recent decade of 2001-2010 (CATF 2011). Winter temperatures across the Northeast have seen an increase in average temperature of 4°F since 1970 (Northeast Climate Impacts Assessment [NECIA] 2007). By the 2020s, the average annual temperature in New Jersey is projected to increase by 1.5°F to 3°F above the statewide baseline (1971 to 2000), which was 52.7°F. By 2050, the temperature is projected to increase 3°F to 5°F (Sustainable Jersey Climate Change Adaptation Task Force 2011.

4.3.9.2 Vulnerability Assessment

A qualitative assessment was conducted to analyze the severe weather hazard for Hudson County. Wind-related vulnerability data was generated using a HAZUS-MH v4.2 analysis for the wind hazard. A probabilistic assessment was conducted for the 100- and 500-year MRPs to analyze the severe storm hazard and provide a range of loss estimates. These estimates are detailed in Section 4.3.2 (Coastal Storm).

Impact on Life, Health, and Safety

The impact of severe storms on life, health, and safety is dependent upon several factors including the severity of the event and whether adequate warning time was provided to residents. The entire population of Hudson County (679,756) is exposed to this hazard (2013-2017 American Community Survey 5-Year Population Estimate).

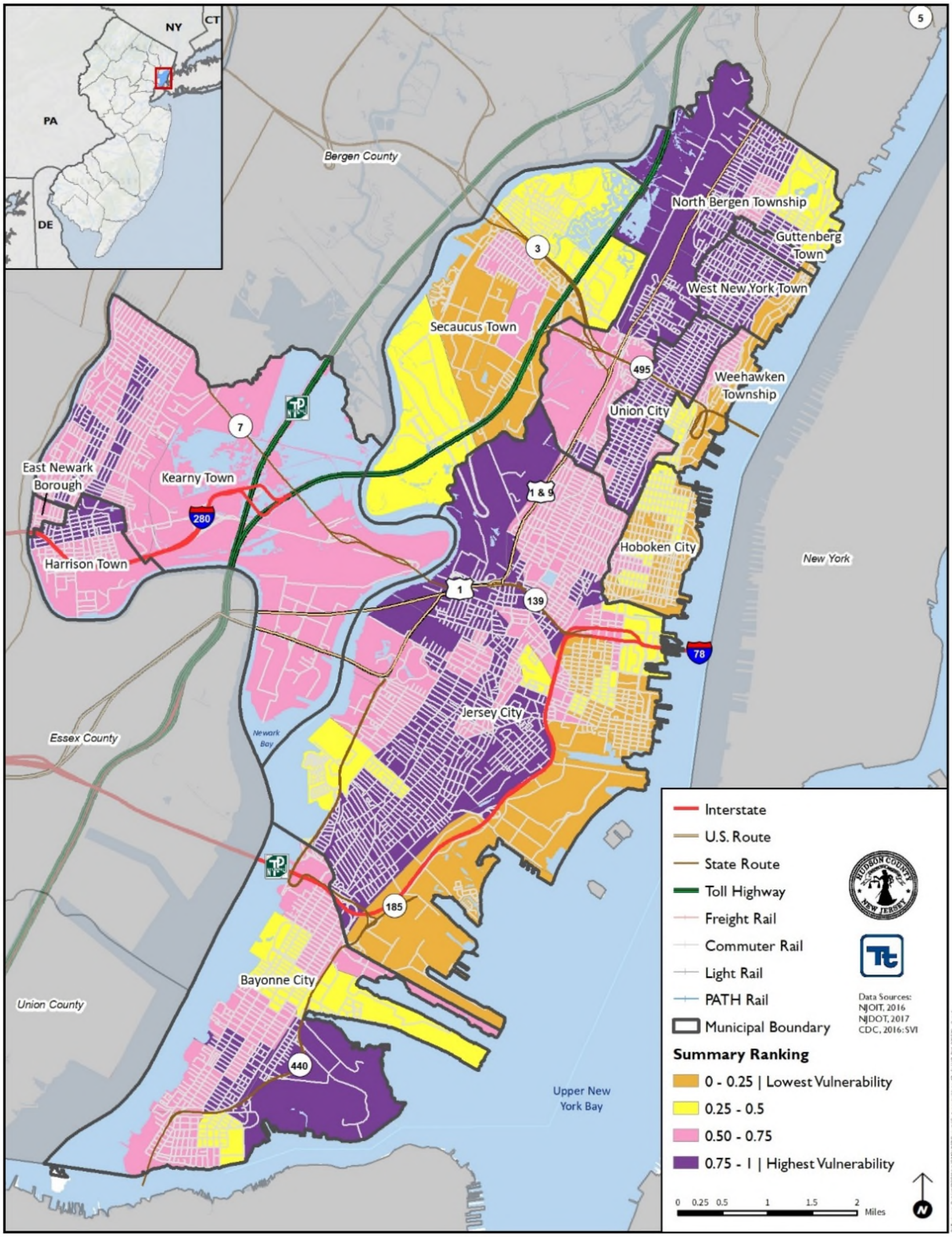
Lightning can be responsible for deaths, injuries, and property damage. Lightning-based deaths and injuries typically involve heart damage, inflated lungs, or brain damage, as well as loss of consciousness, amnesia, paralysis, and burns, depending on the severity of the strike. Additionally, most people struck by lightning survive, although they may have severe burns and internal damage. People located outdoors (i.e., recreational activities and farming) are considered most vulnerable to hailstorms, thunderstorms, and tornadoes because there is little to no warning, and shelter might not be available. Moving to a lower risk location will decrease a person's vulnerability.

As a result of severe storm events, residents can be displaced or require temporary to long-term sheltering. In addition, downed trees, damaged buildings, and debris carried by high winds from hurricanes, tropical storms, or tornadoes can lead to injury or loss of life. Socially vulnerable populations are most susceptible, based on several factors, including their physical and financial ability to react or respond during a hazard and the location and construction quality of their housing.

Economically disadvantaged populations are more vulnerable because they often evaluate evacuation needs and make decisions based on the economic impact to their family. The population over the age of 65 (75,984) is also vulnerable, can physically have difficulty evacuating, and are more likely to seek or need medical attention, which may not be available due to isolation during a storm event (2013-2017 American Community Survey 5-Year Population Estimate). Furthermore, the Centers for Disease Control and Prevention's (CDC) 2016 Social Vulnerability Index (SVI) ranks U.S. Census tracts on socioeconomic status, household composition and disability, minority status and language, and housing and transportation. Hudson County's overall score is 0.6425, indicating that its communities have moderate to high vulnerability (CDC 2016, refer to Figure 4.3.9-7).

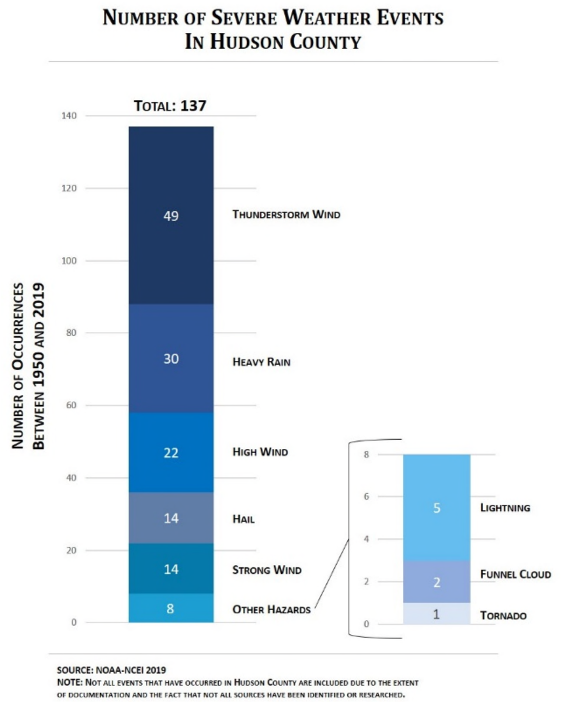
Section 3 (County Profile) provides for the statistics for these populations in Hudson County. Refer to Section 4.3.2 (Coastal Storm) for more details regarding wind-related impacts on Hudson County's population.

Figure 4.3.9-7. CDC Social Vulnerability Index Rating for Hudson County



Impact on General Building Stock

Figure 4.3.9-1. Number and Type of Severe Weather Events That Occurred Between 1950 and 2019



Damage to buildings depends on several factors, including the type of event, wind speed, presence and size of hail, storm duration, path of the storm track or tornado, and distance from the tornado funnel. Historically, greatest number of severe weather events reported for Hudson County are thunderstorm wind (refer to Figure 4.3.9-8 and Figure 4.3.9-9 for a summary of event types and damages, respectively). Further, the last and only tornado recorded to occur in Hudson County between 1950 and 2019 took place in July 1976 with property damages valued at $250,000 (NOAA 2020).

Lightning can spark wildfires or building fires, especially if structures are not protected by surge protectors on critical electronic, lighting, or information technology systems. Five separate lightning events have been recorded to occur in Hudson County between 1950 and 2019 (NOAA 2020). Four out of five of these events caused property damage that was less than $10,000, equaling a total damage value of $28,500. While significant damage to the building stock is possible as a result of lightning and hail, they do not appear to have as wide of an impact as a high wind or tornado event as shown in Table 4.3.9-6. Refer to Section 4.3.2 (Coastal Storm) for more details regarding wind-related impacts on Hudson County's building stock and critical facilities.

Impact on Critical Facilities

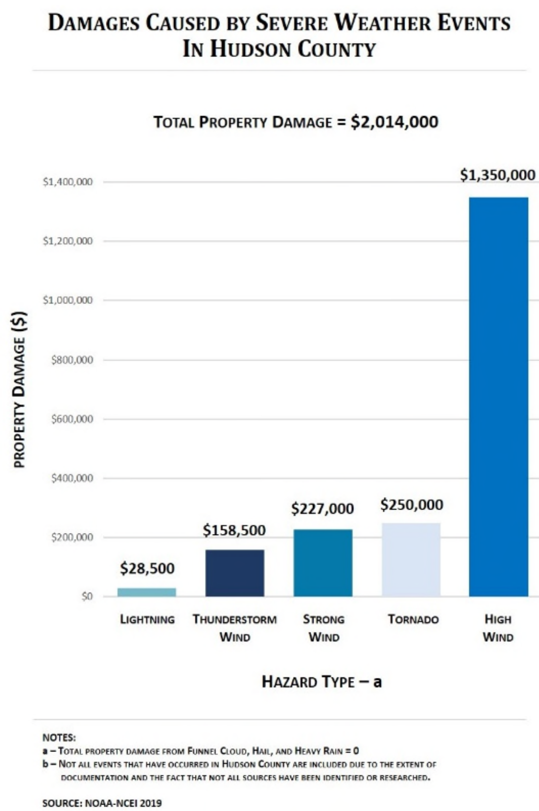
Utility infrastructure could suffer damage from high winds associated with falling tree limbs or other debris, resulting in the loss of power or other utility service. Loss of service can impact residents, critical facilities, and business operations alike. Interruptions in heating or cooling utilities can affect populations, such the young and elderly, who are particularly vulnerable to temperature-related health impacts. Loss of power can also impact other public utilities, including potable water, wastewater treatment, and communications. Lack of power to emergency facilities, including police, fire, EMS, and hospitals, will inhibit a community's ability to effectively respond to an event and maintain the safety of its residents.

Impact on the Economy

As discussed, severe storm events can impact structures and the economy (refer to Figure 4.3.9-9). Impacts to transportation lifelines affect both short-term (e.g., evacuation activities) and long-term (e.g., day-to-day commuting and goods transport) transportation needs. Evacuation routes within the County may be impacted where severe weather causes an excessive amount of debris or infrastructure destruction. Utility infrastructure (power lines, gas lines, electrical systems) could suffer damage and impacts can result in the loss of power, which can impact business operations and can impact heating or cooling provision to the population.

The cost of these severe weather impacts can strain the local economy. Even though New Jersey is estimated to experience an average of two hailstorm events per year, the outcome of these events could be detrimental depending on the cost it would take for the community to respond to damages. Likewise, these costs can add up for other severe weather events such as tornados destroying key infrastructure and level local businesses, or extreme rain events flooding out shopping centers or transportation hubs. As highlighted in Table 4.3.9-5, several severe weather events have historically caused tens of thousands to hundreds of thousands of dollars in damages. Refer to the Section 4.3.2 (Coastal Storm) for additional impacts on the economy as a result of severe weather events.

Figure 4.3.9-2. Historical Severe Weather Damages



Impact on the Environment

The impact of severe weather events on the environment varies, but researchers are finding that the long-term impacts of more severe weather can be destructive to the natural and local environment. National organizations such as USGS and NOAA have been studying and monitoring the impacts of extreme weather phenomena as it impacts on streamflow, river levels, reservoir elevations, rainfall, floods, landslides, erosion, etc. (USGS 2017). These organizations have found that coastal communities are particularly vulnerable to changes in the local environment due to severe weather events (NOAA 2013c). Researchers are predicting that landscapes will continue to extensively transform, changing the natural habitat. For example, severe weather that creates longer periods of rainfall can erode natural coastlines and degrade soil stability for terrestrial species. Tornadoes can tear apart habitats causing fragmentation across ecosystems. Researchers also believe that a greater number of diseases will spread across ecosystems because of impacts that severe weather and climate change will have on water supplies (NOAA 2013c). Overall, as the physical environment becomes more altered, species will begin to contract or migrate in response, which may cause additional stressors to the entire ecosystem within Hudson County.

Future Changes That May Impact Vulnerability

Understanding future changes that effect vulnerability in the County can assist in planning for future development and ensure establishment of appropriate mitigation, planning, and preparedness measures. The County considered the following factors to examine potential conditions that may affect hazard vulnerability:

- Potential or projected development.
- Projected changes in population.
- Other identified conditions as relevant and appropriate, including the impacts of climate change.

PROJECTED DEVELOPMENT

As discussed in Section 3 (County Profile), areas targeted for future growth and development have been identified across Hudson County. Any areas of growth could be potentially impacted by the severe storm hazard because the entire County is exposed and vulnerable. However, due to increased standards and codes, new development may be less vulnerable to the severe storm hazard compared with the aging building stock in the County.

PROJECTED CHANGES IN POPULATION

According to population projections, Hudson County expects an increase in population by 29% by 2040 (Hudson County 2017). Refer to Section 3 (County Profile) which includes a discussion on population trends for the County. As the population continues to grow, more residents will be exposed to the severe weather hazard. Man-made alterations to the landscape will continue to have an impact on the natural environment's ability to mitigate severe weather residual impacts such as flooding off impervious surfaces or wind tunnels created by higher density urban strips. A reduction in natural land surfaces or trees to increase the number of schools or homes needed to support a growing urban area can exacerbate these severe weather hazards.

CLIMATE CHANGE

As discussed above, most studies project that the State of New Jersey will see an increase in average annual temperatures and precipitation. An increase in temperatures may also lead to an increase in the frequency and intensity of coastal storms. More frequent and severe storms will increase the County's vulnerability to each of the identified severe storm hazards. Section 4.3.7 (Flood) provides a discussion related to the impact of climate change due to increases in rainfall resulting from severe storms. In addition to the impacts of increasing temperatures and precipitation, sea level rise will increase the County's vulnerability to coastal storms. Increases in mean sea level will lead to subsequent increases in storm surge inundation depths.

CHANGE OF VULNERABILITY

Overall, the County's vulnerability to severe weather has not changed, and the entire County will continue to be exposed and vulnerable to severe weather events. Changes regarding wind and flood-related losses are discussed in Sections 4.3.2 and 4.3.7, respectively.

4.3.10 SEVERE WINTER STORM

This section provides a profile and vulnerability assessment of the severe winter storm hazard in Hudson County.

2020 HMP Changes

- New and updated figures from federal and state agencies are incorporated.
- Previous occurrences were updated with events that occurred between 2015 and 2019.
- A vulnerability assessment was conducted for the severe winter weather hazard using default HAZUS-MH population and general building stock data to support an evaluation of assets exposed to this hazard and the potential impacts associated with this hazard.

4.3.10.2 PROFILE

A winter storm is considered a storm with significant snowfall, ice, and/or freezing rain. The quantity of precipitation varies by elevation. Heavy snowfall in non-mountainous areas is four inches or more in a 12-hour period, or six inches or more in a 24-hour period. In mountainous areas, heavy snowfall is considered 12 inches or more in a 12-hour period or 18 inches or more in a 24-hour period. Blizzards are storms with considerable falling and/or blowing snow combined with sustained winds or frequent wind gusts of 35 mph or greater that frequently reduce visibility to less than 0.25 mile for at least three hours.

Some winter storms are large enough to immobilize an entire region while others may only affect a single community. Winter storms are typically accompanied by low temperatures, high winds, freezing rain or sleet, and heavy snowfall. The aftermath of a winter storm can have an impact on a community or region for days, weeks, or even months; potentially causing cold temperatures, flooding, storm surge, closed and/or blocked roadways, downed utility lines, and power outages. In Hudson County, winter storms include blizzards, snow storms, Nor'Easters and ice storms. Nor'Easters are also a common type of storm that may occur during winter months within the State of New Jersey; however, given the frequency of these types of storms in the State and their severe potential impact, Nor'Easters are considered by the Planning Committee as a separate hazard and are further discussed in Section 4.3.2 (Coastal Storms) within this plan. Extreme cold temperatures and wind chills are also associated with winter storms; however, based on input from the Planning Committee, these events are further discussed in this Plan in Section 4.3.6 (Extreme Temperatures).

HEAVY SNOW

According to the National Snow and Ice Data Center (NSIDC), snow is precipitation in the form of ice crystals. It originates in clouds when temperatures are below the freezing point (32 degrees Fahrenheit [°F]), when water vapor in the atmosphere condenses directly into ice without going through the liquid stage. Once an ice crystal has formed, it absorbs and freezes additional water vapor from the surrounding air, growing into snow crystals or snow pellets, which then fall to the earth. Snow falls in different forms, such as snowflakes, snow pellets, or sleet. Snowflakes are clusters of ice crystals that form from a cloud. Snow pellets are opaque ice particles in the atmosphere. They form as ice crystals fall through super-cooled cloud droplets that are below freezing but remain a liquid. The cloud droplets then freeze to the crystals. A heavy snowstorm is defined as a snowstorm with accumulations of 4 inches or more of snow in a 6-hour period, or 6 inches of snow in a 12-hour period (NWS 2009).

BLIZZARDS

A blizzard is a winter snowstorm with sustained or frequent wind gusts of 35 miles per hour (mph) or more, accompanied by falling or blowing snow reducing visibility to or below 0.25 mile. These conditions must be predominant over a 3-hour period to be considered a blizzard. Extremely cold temperatures are often associated with blizzard conditions, but are not a formal part of the definition. The hazard created by the combination of snow, wind, and low visibility significantly increases with temperatures below 20°F. A severe blizzard is categorized as having temperatures near or below 10°F, winds exceeding 45 mph, and visibility reduced by snow to near 0 miles. Storm systems powerful enough to cause blizzards usually form when the jet stream dips far to the south, allowing cold air from the north to clash with warm air from the south. Blizzard conditions often develop on the northwest side of an intense storm system. The difference between the lower pressure in the storm and the higher pressure to the west creates a tight pressure gradient, resulting in strong winds and extreme conditions caused by the blowing snow (The Weather Channel 2012).

SLEET

Sleet is made up of drops of rain that freeze into ice as they fall. They are usually smaller than 0.30 inch in diameter (NSIDC 2013). A sleet storm involves significant accumulations of solid pellets, which form from the freezing of raindrops or partially melted snowflakes causing slippery surfaces, posing a hazard to pedestrians and motorists (NWS 2009).

FREEZING RAIN

Freezing rain occurs when rain falls into areas that are below freezing. In order for this to occur, ground-level temperatures must be colder than temperatures aloft. Freezing rain can also occur when the air temperature is slightly above freezing but the surface that the rain lands upon is still below freezing from prior cold air temperatures (NWS 2009).

ICE STORMS

An ice storm is an event caused by damaging accumulations of ice during freezing rain events. An ice storm involves significant accumulation of rain or drizzle freezing on objects (trees, power lines, roadways, etc.) as it strikes them, causing slippery surfaces and damage from sheer weight of ice accumulations (NWS 2009). Significant ice accumulations are typically 0.25 inch or greater (National Weather Service [NWS] 2013).

EXTENT

The magnitude or severity of a severe winter storm depends on several factors, including a region's climatological susceptibility to snowstorms, snowfall amounts, snowfall rates, wind speeds, temperatures, visibility, storm duration, topography, time of occurrence during the day (for example, weekday versus weekend), and time of season. While sleet accumulation is measured and tracked in a method similar to snow events, the extent or severity of freezing rain or an ice storm requires a different and sometimes more challenging process. According to NWS, ice accumulation does not coat the surface of an object evenly, as gravity typically forces rainwater to the underside of an object before it freezes. Wind can also force rainwater downward prior to freezing, resulting in a thicker coating of ice on one side of the object than the other side. Ice mass is then determined by taking the average from the thickest and thinnest portions of ice on the sample used for measurement.

The National Oceanic and Atmospheric Administration's (NOAA) National Climatic Data Center (NCDC) produces the Regional Snowfall Index (RSI) for significant snowstorms that impact the eastern two-thirds of the United States. The RSI ranks snowstorm impacts on a scale from Category 1 to 5, which is similar to the Enhanced Fujita scale for tornadoes or the Saffir-Simpson scale for hurricanes. RSI is based on the spatial extent of the storm, the amount of snowfall, and the combination of the extent and snowfall totals with population (based on the 2000 Census). The NCDC has analyzed and assigned RSI values to over 500 storms since 1900 (NOAA-NCDC 2018). Table 4.3.10-1 explains the five RSI ranking categories.

Table 4.3.10-1. Regional Snowfall Index Ranking Categories

Category	Description
1	Notable
2	Significant
3	Major
4	Crippling
5	Extreme

Source: NOAA-NCDC 2018

NWS operates a widespread network of observation systems, such as geostationary satellites, Doppler radars, and automated surface observing systems that feed into the current state-of-the-art numerical computer models to provide a look into future weather, ranging from hours to days. The models are then analyzed by NWS meteorologists who then write and disseminate forecasts (NWS 2013). While winter weather is normal during the winter season for Hudson County, the NWS uses winter weather watches, warnings, and advisories to help people anticipate what to expect in the days and hours prior to an approaching storm.

- A ***winter storm watch*** is issued when severe winter conditions (heavy snow, ice, etc.) may affect a certain area, but its occurrence, location, and timing are uncertain. A watch is issued to provide 24 to 72 hours of notice of the possibility of severe winter weather.
- A ***winter storm warning*** is issued when hazardous winter weather, in the form of heavy snow, heavy freezing rain, or heavy sleet, is imminent or occurring. A warning is usually issued 12 to 24 hours before the event is expected to begin.
- A ***winter weather advisory*** is issued when a hazardous winter weather event is occurring, is imminent, or has a greater than 80 percent chance of occurrence. Advisories are used to inform people that winter weather conditions are expected to cause significant inconveniences and that conditions may be hazardous. These conditions may refer to sleet, freezing rain, or ice storms, in addition to snow events.
- NWS may also issue a ***blizzard warning*** when snow and strong winds combine to produce the potential for blinding snow, deep drifts, and wind chill (NWS n.d.).

LOCATION

SNOW AND BLIZZARDS

The trajectory of the storm center—whether it passes close to the New Jersey coast or at a distance—largely determines both the intensity and the duration of the snowfall over the State. Winter storms tend to have the heaviest snowfall within a 150-mile wide swath to the northwest of what are generally southwest to northeast moving storms. Depending on whether all or a portion of New Jersey falls within this swath, the trajectory determines which portion of the State (or all of the State) receives the heaviest amount of snow. According to the ONJSC, Hudson County's normal seasonal snowfall is approximately 30-35 inches.

ICE STORMS

All regions of New Jersey are subject to ice storms. The distribution of ice storms often coincides with general distribution of snow within several zones in the State. A cold rain may be falling over the southern portion of the State, freezing rain over the central region, and snow over the northern counties as a coastal storm moves northeastward offshore. A locality's distance to the passing storm center is often the crucial factor in determining the temperature and type of precipitation during a winter storm. Based on data from 1948–2000, Hudson County can anticipate 2-4 days with freezing rain per year (Changnon & Karl 2003). Based on data from 1932–2001, the County can anticipate 6-9 total hours of freezing rain per year (Changnon 2004).

IMPACTS OF WINTER WEATHER IN URBAN AREAS

Winter weather can create havoc on an urban area, delaying or shutting down all airline, railway, shipping and roadway transportation systems, creating increased health and safety concerns, stranding commuters, stopping the flow of supplies, disrupting medical and emergency services, damaging or disrupting communication and utility services and creating significant economic loss of businesses. With larger populations of people, more buildings, roadways, bridges and various forms of transportation and utilities services; urban and metropolitan areas become much more susceptible to greater impacts and losses during winter weather events (Hudson County HMP 2015).

Various urban and metropolitan regions consist of complex infrastructure of highways, city streets, bridges, tunnels and local roads. These conditions create a challenge to the Department of Transportation, state agencies, and municipal governments when hazardous winter weather conditions threaten our ability to maintain safe transit conditions for the public and the flow of commerce. Also, the congested streets provide parking to residents, visitors and commercial suppliers, which can become a danger and a nuisance during a winter weather event. During winter storms, traffic congestion and street parking make the snow and ice plowing efforts very difficult and result in plowed-in vehicles, amongst other problems. During such events, federal assistance requests have been made by various states to assist with the clearing of streets and removal of stranded cars along the highways and other major roadways impacted by the (Hudson County HMP 2015).

While severe winter weather can be debilitating and pose a serious threat to safety anywhere in the U.S., winter storms can have a particularly devastating impact to the economy in heavily populated and highly industrialized areas, particularly in the northeastern United States, from Virginia to Maine. For example, the aviation industry can be economically affected by causing widespread delays, airport closings and occasionally contributing to serious airline accidents. Another example, the snowstorm of January 7-8, 1996 crippled air transportation on the East Coast (New York, Washington, Boston, Philadelphia), causing an estimated $50 to $100 million in losses to the airlines industry. During the February 12, 2006 snowstorm, airlines cancelled 2,500 flights in the New York City area alone (Hudson County HMP 2015).

With the Northeast region, from Virginia to Maine, being so heavily populated and highly industrialized, devastating losses can occur to the local, regional and national economy in the event of a winter weather event. The densely populated northeastern metropolitan centers of Washington, Baltimore, Philadelphia, New York, and Boston are home to an abundance of resources, commercial and industrial suppliers, and domestic and international transportation systems that all become directly or indirectly impacted during winter weather conditions. Snowstorms have had their greatest impact on transportation, being especially disruptive to automotive travel, trucking, and aviation (Hudson County HMP 2015).

Hudson County is located within the New York City metropolitan area, which includes all of New York City, northern New Jersey, and Long Island (Hudson County, 2007). The county is a major transportation hub for the metropolitan area, which includes the New Jersey Turnpike, I-280, and U.S. Route 1 and 9. These roads have become dangerous during winter storms, especially to commuters and plowing crews. Stranded motorists often abandoned their cars along highways, causing difficulties to those who try to clear the roads. During severe winter storms, states often have to request federal assistance to clear streets and removed stranded cars on the highways (Hudson County HMP 2015).

PAST OCCURRENCE

Many sources provided historical information regarding previous occurrences and losses associated with extreme temperatures throughout New Jersey and Hudson County; therefore, the loss and impact information for many events could vary depending on the source. The accuracy of monetary figures discussed is based only on the available information in cited sources.

FEMA MAJOR DISASTERS AND EMERGENCY DECLARATIONS

Between 1954 and March 15, 2019, the Federal Emergency Management Agency (FEMA) included Hudson County in five winter storm-related DR or EM declarations classified as one or a combination of the following disaster types: severe winter storm, snowstorm, snow, ice storm, winter storm, and blizzard (Table 4.3.10-2).

Table 4.3.10-2. Winter Storm Related Disaster (DR) and Emergency (EM) Declarations 1954-2019

Declaration	Event Date	Declaration Date	Event Description
EM-3106	March 13-17, 1993	March 17, 1993	Snow: Severe Blizzard
DR-1088	January 7-12, 1996	January 13, 1996	Snow: Blizzard of 96 (Severe Snow Storm)
EM-3181	February 16-17, 2003	March 20, 2003	Snow: Snow
EM-1954	December 26-27-2010	February 4, 2011	Snow: Severe Winter Storm and Snowstorm
DR-4264	January 22-24, 2016	March 14, 2016	Severe Storm(s): Severe Winter Storm and Snowstorm

Source: FEMA 2019

U.S. DEPARTMENT OF AGRICULTURE DISASTER DECLARATIONS

The Secretary of Agriculture from the U.S. Department of Agriculture (USDA) is authorized to designate counties as disaster areas to make emergency loans to producers suffering losses in those counties and in counties that are contiguous to a designated county. Between 2015 and 2019, Hudson County was not included in any USDA declaration involving winter storms.

SEVERE WINTER STORM EVENTS

The National Oceanic and Atmospheric Administration (NOAA) National Centers for Environmental Information (NCEI) Storm Events database records and defines severe winter storm events as follows:

- Blizzard is reported in the NOAA-NCEI database when a winter storm which produces the following conditions for 3 consecutive hours or longer: (1) sustained winds or frequent gusts 30 knots (35 mph) or greater, and (2) falling and/or blowing snow reducing visibility frequently to less than 1/4 mile.

- Heavy snow is reported in the NOAA-NCEI database whenever snow accumulation meet or exceed locally/regionally defined 12 and/or 24 hour warning criteria.
- Ice storm is reported in the NOAA-NCEI database when ice accretion meet or exceed locally/regionally defined warning criteria (typical value is 1/4 or 1/2 inch or more).
- Sleet is reported in the NOAA-NCEI database whenever sleet accumulations meet or exceed locally/regionally defined warning criteria (typical value is ½ inch or more).
- Winter storm is reported in the NOAA-NCEI database whenever a winter weather event has more than one significant hazard (i.e., heavy snow and blowing snow; snow and ice; snow and sleet; sleet and ice; or snow, sleet and ice) and meets or exceeds locally/regionally defined 12 and/or 24 hour warning criteria for at least one of the precipitation elements.
- Winter weather is reported in the NOAA-NCEI database when a winter precipitation event causes a death, injury, or a significant impact to commerce or transportation, but does not meet locally/regionally defined warning criteria.

For this 2020 HMP Update, known major winter storm events that have impacted Hudson County between 2015 and 2019 are identified in . For events prior to 2015, refer to Appendix X.

Table 4.3.10-3. Severe Winter Storm Events Impacting Hudson County between 2015 and 2019

Dates of Event	Event Type	FEMA Declaration Number	County Designated?	Losses/Impacts
January 18, 2015	Winter Weather	N/A	N/A	Warm air overriding a stationary front along the coast, while a shallow Arctic air mass remained entrenched over land, led to light freezing rain through the day, and also into the evening in the higher interior elevations. Freezing rain continued even as air temperatures warmed above freezing due to very cold ground temperatures. A trained spotter in Harrison reported freezing rain accumulation of 0.2 inch. The freezing rain led to widespread motor vehicle accidents, and numerous falls and injuries. NJ Transit suspended bus service, and police issued closures on many roadways, including the Bayonne Bridge.
January 26, 2015	Winter Storm	N/A	N/A	A potent Alberta Clipper low moved from southwestern Canada on January 24th to the Plains states and Ohio Valley on the 25th. The low then redeveloped off the Mid Atlantic coast on the 26th and rapidly intensified into a strong nor'easter, bringing heavy snow and strong winds to parts of northeast New Jersey just west of New York City. Trained spotters and the public reported snowfall of 8 to 9 inches. North winds gusted up to 33 mph at nearby Newark Liberty Airport, with blowing and drifting of snow.
February 1, 2015	Winter Storm	N/A	N/A	An area of low pressure tracked east from the Ohio Valley the night of February 1 to just south of Long Island the afternoon of February 2. The close proximity of the low with arctic air to the north resulted in snow at the onset, which transitioned to a wintry mix during the morning hours before going back to snow by early afternoon. Northeast New Jersey received 5 to 12 inches of snowfall and up to a third of an inch of ice. Snowfall amounts averaged around 5 inches, along with a third of an inch of ice. Harrison reported 4.5 inches with North Bergen reporting 0.32 inches of ice.
March 5, 2015	Heavy Snow	N/A	N/A	Rain associated with a wave of low pressure moving along a cold front to the south changed to snow before sunrise on March 5, and became heavy across portions of Northeast New Jersey. A

Dates of Event	Event Type	FEMA Declaration Number	County Designated?	Losses/Impacts
				cooperative observer in Harrison measured 6.5 inches of snow. Trained spotters elsewhere also measured 7 to 8 inches of snow.
January 22-23, 2016	Winter Storm, Blizzard	DR-4264	Yes	Low pressure moving across the deep South on Thursday January 21st and Friday January 22nd intensified and moved off the Mid Atlantic coast on Saturday January 23rd, bringing heavy snow and strong winds to northeast New Jersey, and blizzard conditions to the urban corridor and some nearby areas. Governor Chris Christie declared a state of emergency for New Jersey on Friday January 22nd. New Jersey Transit stopped running trains, buses and light rail at 2 AM Saturday January 23rd. Bridges and tunnels from New York City into New Jersey were shut down by mid-afternoon Saturday. Travel in and out of airports lagged through Monday January 25th as airlines pre-emptively cut hundreds of flights. More than 1,000 flights out of area airports were cancelled, and Teterboro Airport were shuttered due to whiteout conditions. Trained spotters and an NWS cooperative observer in Harrison reported snowfall of 25 to 27 inches. Nearby Central Park and Newark Airport ASOS observations showed blizzard conditions, with visibility less than one quarter mile in heavy snow and frequent wind gusts over 35 mph through the day and into the early evening on Saturday January 23rd.
January 7, 2017	Winter Weather	N/A	N/A	Low pressure developed across the southeast coast early on January 7, 2017 and deepened as it tracked off the coast. Despite the low tracking farther to the east, the Tri-State area was located in the right entrance region of a strong upper level jet streak. This allowed for snow to expand well to the northwest of the low bringing locally heavy snow to portions of northeast New Jersey. The COOP Observer in Harrison reported 4.8 inches of snowfall. A trained spotter in Hoboken reported 5.6 inches of snowfall.
February 9, 2017	Winter Storm	N/A	N/A	Low pressure developed along a cold front over the Middle Atlantic early Thursday, February 9th. The low rapidly intensified as it moved off the Delmarva coast in the morning and then to the south and east of Long Island late morning into the afternoon. The low brought heavy snow and strong winds to portions of Northeast New Jersey. Numerous flights were cancelled or delayed at Newark Airport. A trained spotter reported 6 inches of snow in Harrison. Winds also gusted to 42 mph in Bayonne at 12:09 pm.
March 14, 2017	Winter Storm	N/A	N/A	Rapidly deepening low pressure tracked up the eastern seaboard on Tuesday March, 14 bringing blizzard conditions to Western Passaic county. Heavy snow and sleet along with strong winds occurred across the rest of Northeast New Jersey. The storm cancelled numerous flights at Newark airport with some mass transit services suspended. Large trees fell onto homes in Bergen county and approximately 4,500 power outages resulted from the strong winds and heavy snow. A COOP Observer reported 7.2 inches of snow and sleet in Harrison. A trained spotter reported 8.1 inches of snow and sleet in Hoboken.
December 9, 2017	Winter Storm	N/A	N/A	Low pressure along a slow moving cold front off the eastern seaboard brought locally heavy snow to portions of northeast New Jersey. A strong upper jet stream enhanced the snow across

Dates of Event	Event Type	FEMA Declaration Number	County Designated?	Losses/Impacts
				the Tri-State as the low pressure passed well offshore. The COOP observer in Harrison measured 5 inches of snow.
March 7, 2018	Winter Weather	DR-4368	No	A strong low pressure system developed along the Middle Atlantic coast during the morning of Wednesday, March 7, 2018. The low tracked along the coast through the early morning hours on Thursday, March 8, 2018. The storm brought heavy wet snow, strong gusty winds, and even some thundersnow across northeast New Jersey. Snowfall rates ranged from 1 to 3 inches per hour at times in the heaviest snow bands. Trained spotters and the public reported 6 inches of snowfall. Strong winds in combination with heavy, wet snow also brought down tree limbs and a few power lines. A COOP observer reported 9 inches of snow in Harrison. An Emergency Manager in Hoboken reported 8.7 inches of snow. Although several neighboring counties received a disaster declaration, Hudson was not included as damages did not meet designation threshold.
March 21, 2018	Heavy Snow	N/A	N/A	A large and slow moving low pressure developed along the Middle Atlantic coast on Wednesday, March 21st and moved slowly north and east along the coast through Thursday, March 22nd. Moderate to occasionally heavy snow bands moved across portions of northeast New Jersey. A COOP observer reported 9 inches of snow in Harrison. An Emergency Manager in Hoboken reported 8.7 inches of snow.
April 2, 2018	Heavy Snow	N/A	N/A	Waves of low pressure moved along a stalled frontal boundary across the Middle Atlantic. Moderate to heavy snow fell during the morning commute across northeast New Jersey. Snowfall rates reached 1 inch per hour at times. A daily record snowfall for April 2nd of 5 inches was set at Newark, NJ. An NWS COOP observer in Harrison reported 6.5 inches of snowfall. A trained spotter in Kearny reported 6.8 inches of snowfall.
November 15, 2018	Winter Storm	N/A	N/A	A wave of low pressure developed along the Middle Atlantic coast during Thursday November 15, 2018. The low was associated with a closed upper level trough across the Midwest. As the trough translated eastward into Friday November 16, 2018, the low pressure moved up the northeast coast. The antecedent air mass ahead of the low was cold and dry for the middle of November with temperatures during the morning and afternoon of November in the upper 20s and low 30s. The moisture associated with the trough and low pressure was able to produce moderate to heavy bands of snow as the precipitation began across the entire Tri-State area due to the cold air in place. Once the low drew warmer air from the south, the precipitation gradually changed to a wintry mix and then plain rain, especially for the New York City metro and Long Island. The moderate to heavy wet snowfall significantly impacted the evening rush hour with 1-2 inch per hour snowfall rates. Hundreds of trees, tree limbs, and branches were brought down by the weight of the snow, which caused many power outages. Numerous accidents were reported and many motorists were stranded on roads until the early morning hours the next day. There were over 1,000 flights cancelled at the New York City metro airports (Kennedy, La Guardia, and Newark). A COOP observer reported 5.8 inches of snow. The public reported 6 inches of snow in Kearny. Impacts were widely felt across Hudson county with major disruption to the evening

Dates of Event	Event Type	FEMA Declaration Number	County Designated?	Losses/Impacts
				commute. Trees branches and limbs were downed due to the weight of the heavy wet snow. One tree brought down power lines in 7th street and Willow Avenue in Hoboken. Nearby Newark airport reported 1-2 inch per hour snowfall rates at times during the evening commute.
January 30, 2019	Winter Weather	N/A	N/A	A strong cold front initiated a broken line of snow squalls to the region. The snow squalls quickly moved across northeast New Jersey in the afternoon and early portion of the evening commute. Traffic was brought to a standstill during the squalls and created life-threatening travel. Snow squalls quickly moved through bringing whiteout conditions, strong winds, and dangerous driving conditions. A trained spotter in Harrison reported 0.5 inches of snow.

Source: NOAA-NCEI 2019

According to the Storm Events Database, Hudson County has been impacted by 59 severe winter storm events between 1950 and January 2019 (Table 4.3.10-4). No events resulted in injuries, deaths, property damages, or crop damages.

Table 4.3.10-4. Severe Winter Storm Events in Hudson County 1950 to 2019

Hazard Type	Number of Occurrences Between 1950 and 2018	Total Fatalities	Total Injuries	Total Property Damage ($)	Total Crop Damage ($)
Blizzard	3	0	0	$0	$0
Heavy Snow	29	0	0	$0	$0
Ice Storm	0	0	0	$0	$0
Sleet	0	0	0	$0	$0
Winter Storm	19	0	0	$0	$0
Winter Weather	8	0	0	$0	$0
TOTAL	**59**	**0**	**0**	**$0**	**$0**

Note: Not all events that have occurred in Hudson County are included due to the extent of documentation and the fact that not all sources have been identified or researched.
Source: NOAA-NCEI 2019

PROBABILITY OF FUTURE OCCURRENCE

Hudson County is estimated to continue experiencing direct and indirect impacts of severe winter storms annually.

Table 4.3.10-5 provides the probability of occurrences of severe winter storm events. However, the information used to calculate the probability of occurrences is only based on NOAA-NCEI storm events database results.

Table 4.3.10-5. Severe Winter Storm Events in Hudson County 1950 to 2019 and Probability of Occurrences

Hazard Type	Number of Occurrences Between 1950 and 2018	Number of Occurrences Between 1950 and 2018	Rate of Occurrence	Recurrence Interval (in years)	Probability of Event Occurring in Any Given Year
Blizzard	3	0.04	23.33	0.04	4.29
Heavy Snow	29	0.42	2.41	0.41	41.43
Ice Storm	0	0.00	0	0	0
Sleet	0	0.00	0	0	0

Hazard Type	Number of Occurrences Between 1950 and 2018	Number of Occurrences Between 1950 and 2018	Rate of Occurrence	Recurrence Interval (in years)	Probability of Event Occurring in Any Given Year
Winter Storm	19	0.28	3.68	0.27	27.14
Winter Weather	8	0.12	8.75	0.11	11.43
TOTAL	**59**	**0.86**	**1.19**	**0.84**	**84.29**

Note: *Not all events that have occurred in Hudson County are included due to the extent of documentation and the fact that not all sources have been identified or researched.*
Source: *NOAA-NCEI 2019*

In Section 4.4, the identified hazards of concern for Hudson County are ranked using a variety of parameters. The probability of occurrence, or likelihood of the event, is one parameter used for hazard rankings. Based on historical records and input from the Planning Partnership, the probability of occurrence for severe winter storms in the County is considered "frequent" (likely to occur within 25 years, as presented in Table 4.4-4).

Climate Change Impacts

In terms of snowfall and ice storms, there is a lack of quantitative data to predict how future climate change will affect this hazard. It is likely that the number of winter weather events may decrease, and the winter weather season may shorten; however, it is also possible that the intensity of winter storms may increase. The exact effect on winter weather is still highly uncertain (Sustainable Jersey Climate Change Adaptation Task Force 2011).

Average annual temperatures have increased by 3°F in New Jersey over the past century (NOAA NCEI 2019). Most of this warming has occurred since 1970. The State of New Jersey has observed an increase in average annual temperatures of 1.2°F between the period of 1971-2000 and the most recent decade of 2001-2010 (ONJSC, 2011). Winter temperatures across the Northeast have seen an increase in average temperature of 4°F since 1970 (Northeast Climate Impacts Assessment [NECIA] 2007). By the 2020s, the average annual temperature in New Jersey is projected to increase by 1.5°F to 3°F above the statewide baseline (1971 to 2000), which was 52.7°F. By 2050, the temperature is projected to increase 3°F to 5°F (Sustainable Jersey Climate Change Adaptation Task Force 2013). Due to the increase in temperature, snow cover and sea ice extent are predicted to likely decrease over the next century and the snow season length is very likely to decrease over North America. However, warming of the lower atmosphere could potentially lead to more ice storms by allowing snow to more frequently melt as it falls and then refreeze near or at surface (NPCC 2009).

4.3.10.3 Vulnerability Assessment

All of Hudson County is exposed to the severe winter storm hazard; therefore, all assets in the County (population, structures, critical facilities, and lifelines), as described in the County Profile (Section 4), are potentially vulnerable to a severe winter storm event. The following subsections discuss Hudson County's vulnerability, in a qualitative nature, to the severe winter weather hazard.

Impact on Life, Health, and Safety

The entire population of Hudson County is exposed to severe winter weather events (population of 679,756 people, according to the 2013-2017 American Community Survey population estimates). The homeless and elderly are considered most susceptible to this hazard; the homeless due to their lack of shelter and the elderly due to their increased risk of injuries and death from falls and overexertion or hypothermia from attempts to clear snow and ice.

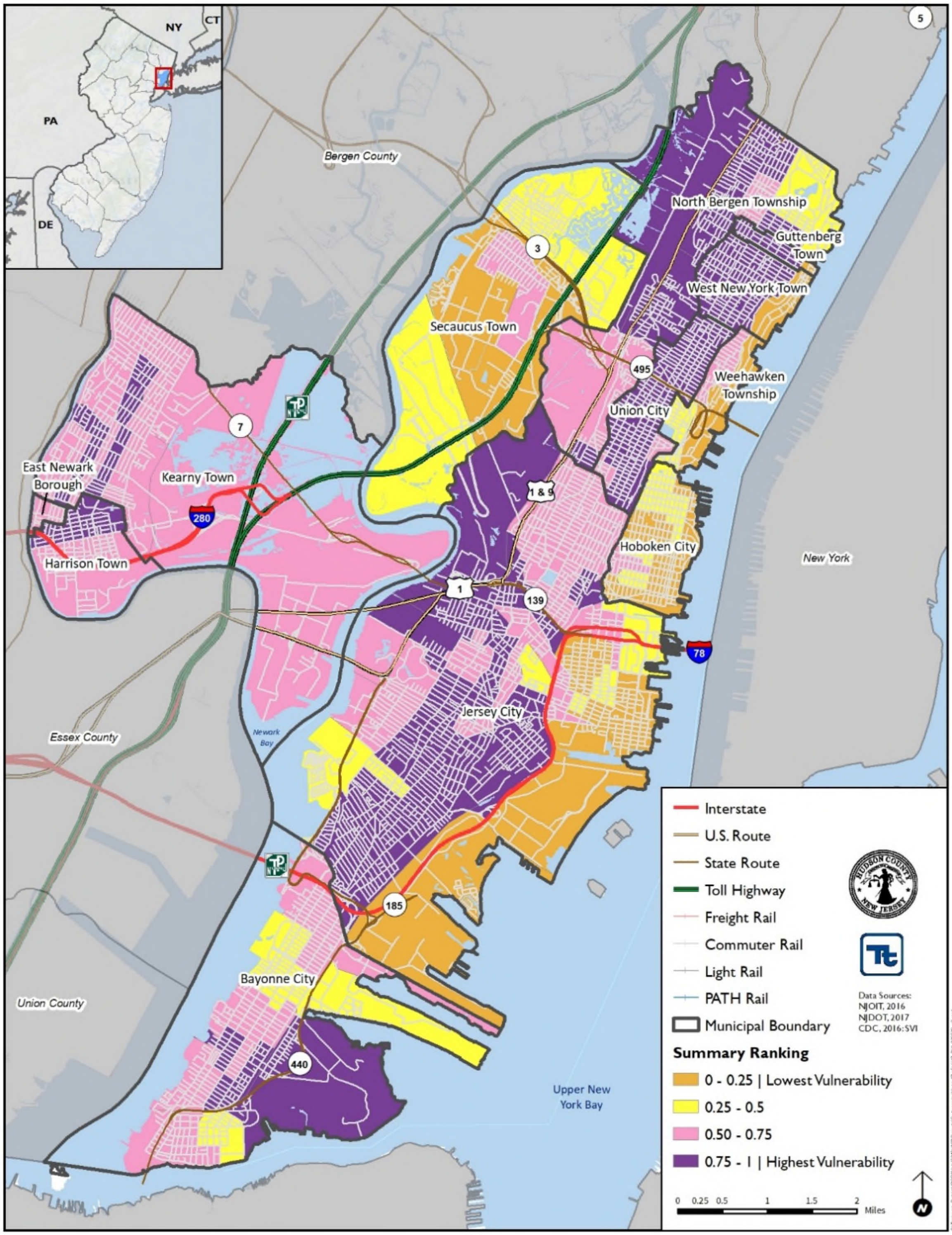
According to the 2017 ACS 5-Year Population Estimate, 75,984 persons within Hudson County are over 65 years in age. Severe winter storm events can reduce the ability of these populations to access emergency services. According to the Census Reporter, approximately 16% of persons over 65 years in age in Hudson County are also in poverty (Census Reporter 2018). Higher concentrations of persons over 65 years in age reside in the Town of Guttenberg and the Town of West New York. Refer to Figure 3-6 in Section 3 (County Profile) that displays the densities of populations over 65 in Hudson County.

The homeless and residents below the poverty level might not have access to housing or their housing could be less able to withstand cold temperatures (e.g., homes with poor insulation and heating supply). Residents with low incomes might not have access to housing or their housing can be less able to withstand cold temperatures (e.g., homes with poor insulation and heating supply). In Hudson County, areas with the highest concentration of population below the poverty level are located in Union City and Town of West New York. Refer to Figure 3.6 in Section 3 (County Profile) that displays the densities of low-income populations in Hudson County.

The Centers for Disease Control and Prevention's (CDC) 2016 Social Vulnerability Index (SVI) ranks U.S. Census tracts on socioeconomic status, household composition and disability, minority status and language, and housing and transportation. Hudson County's overall score is 0.6425, indicating that its communities have moderate to high vulnerability (CDC 2016). Jersey City, Union City, and North Bergen Township are communities ranked with the greatest vulnerability (0.75 – 1). Figure 4.3.10-1 below displays the CDC 2016 SVI.

According to the NOAA National Severe Storms Laboratory (NSSL); every year, winter weather indirectly and deceptively kills hundreds of people in the U.S., primarily from automobile accidents, overexertion and exposure. Winter storms are often accompanied by strong winds creating blizzard conditions with blinding wind-driven snow, drifting snow and extreme cold temperatures and dangerous wind chill. They are considered deceptive killers because most deaths and other impacts or losses are indirectly related to the storm. People can die in traffic accidents on icy roads, heart attacks while shoveling snow, or of hypothermia from prolonged exposure to cold. Heavy accumulations of ice can bring down trees and power lines, disabling electric power and communications for days or weeks. Heavy snow can immobilize a region and paralyze a city, shutting down all air and rail transportation and disrupting medical and emergency services. Storms near the coast can cause coastal flooding and beach erosion as well as sink ships at sea. The economic impact of winter weather each year is huge, with costs for snow removal, damage and loss of business in the millions (NSSL, 2018).

Figure 4.3.10-1. CDC's Social Vulnerability Index 2016



IMPACT ON GENERAL BUILDING STOCK

All buildings in Hudson County are exposed to the severe winter storm hazard; however, properties in poor condition may be more vulnerable to impacts. In general, structural impacts include damage to roofs and building frames rather than building content. Current modeling tools are not available to estimate specific losses for this hazard. As an alternate approach, the percent damage to structures that could result from severe winter storm conditions is considered. This allows planners and emergency managers to select a range of potential economic impact based on an estimate of the percent of damage to the general building stock. Table 4.3.10-6 summarizes the estimated loss to structures because of 1-, 5-, and 10-percent loss (also refer to Figure 4.3.10-2). Given professional knowledge and the currently available information, the potential loss for this hazard is considered to be overestimated because of varying factors (building structure type, age, load distribution, building codes in place). Therefore, this should be used as estimates only for planning purposes with the knowledge that the associated losses for severe winter storm events vary greatly.

Figure 4.3.10-2. Estimated Impacts to General Building Stock in Hudson County from Severe Winter Weather Events

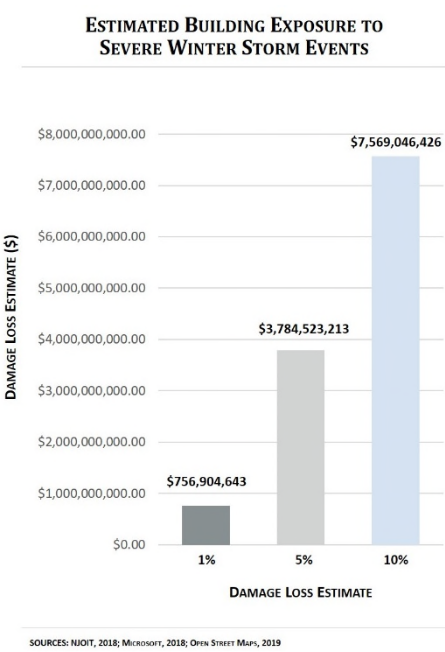


Table 4.3.10-6. General Building Stock Exposure and Estimated Losses from Severe Winter Storm Events

Municipality	Number of Buildings Total (All Occupancies)	1% Damage Loss Estimate	5% Damage Loss Estimate	10% Damage Loss Estimate
Bayonne, City of	6,802	$88,560,791	$442,803,955	$885,607,911
East Newark, Borough of	403	$2,408,885	$12,044,423	$24,088,845
Guttenberg, Town of	1,227	$6,515,076	$32,575,378	$65,150,757
Harrison, Town of	2,537	$23,989,758	$119,948,788	$239,897,576
Hoboken, City of	4,470	$39,102,022	$195,510,112	$391,020,223
Jersey City, City of	35,894	$256,939,220	$1,284,696,098	$2,569,392,197
Kearny, Town of	7,209	$78,744,668	$393,723,340	$787,446,679
North Bergen, Township of	6,005	$83,931,446	$419,657,232	$839,314,464
Secaucus, Town of	3,845	$95,932,628	$479,663,138	$959,326,276
Union City, City of	1,729	$37,428,824	$187,144,119	$374,288,238
Weehawken, Township of	2,113	$15,101,199	$75,505,996	$151,011,993
West New York, Town of	4,594	$28,250,127	$141,250,634	$282,501,267
Hudson County (Total)	**76,828**	**$756,904,643**	**$3,784,523,213**	**$7,569,046,426**

Source: NJOIT, 2018; Microsoft, 2018; Open Street Maps, 2019

A specific area that is vulnerable to the severe winter storm hazard is the floodplain. Severe winter storms can cause flooding through blockage of streams or through snow melt. At-risk residential infrastructures are presented in Section 4.3.7 (Flood). Generally, losses resulting from flooding associated with severe winter storms should be less than that associated with a 1-percent annual chance flood event. In addition, coastal areas are at high risk during winter storm events that involve high winds, as presented in Section 4.3.2 (Coastal Storms) for losses resulting from wind.

Impact on Critical Facilities

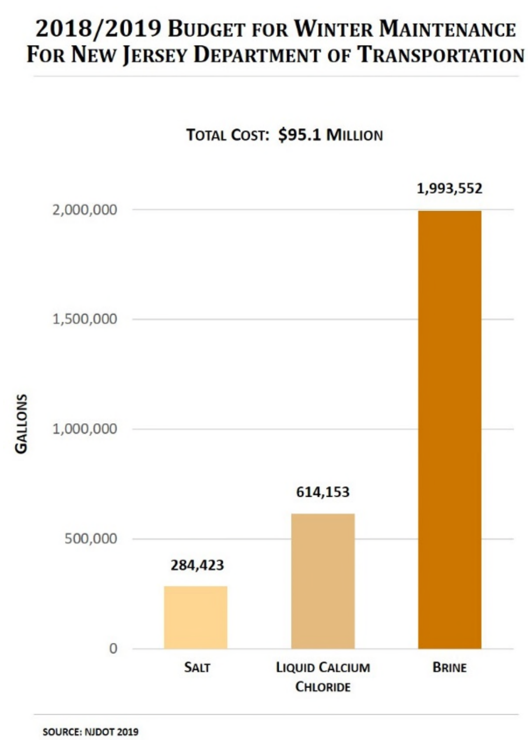
Full functionality of critical facilities such as police, fire and medical facilities is essential for response during and after a severe winter storm event. These critical facility structures are largely constructed of concrete and masonry; therefore, they should only suffer minimal structural damage from severe winter storm events. Because power interruption can occur, backup power is recommended. Infrastructure at risk for this hazard includes roadways that could be damaged due to the application of salt and intermittent freezing and warming conditions that can damage roads over time. Severe snowfall requires the clearing roadways and alerting citizens to dangerous conditions; following the winter season, resources for road maintenance and repair are required.

Access to evacuation routes may also become impaired during a severe winter storm. Snow pack and ice can make these roads unsafe for persons within the County. If emergency personnel are unable to clear these roads quickly, households can become stranded until the roads clear. Access to grocery stores or hospitals will be limited or unavailable.

Impact on the Economy

The cost of snow and ice removal and repair of roads from the freeze/thaw process can drain local financial resources. Impacts on the economy also include commuter difficulties into or out of the area for work or school. The loss of power and closure of roads prevent commuters from traveling within the County. In 2016, 23 states within the US spent over $1.1 billion in winter maintenance costs (The Weather Channel 2016). Figure 4.3.10-3 shows during the 2018-2019 winter season, the State of New Jersey Department of Transportation has budgeted winter maintenance expenditures at $95.1 million, which includes costs for salt (284,423 tons), liquid calcium chloride (614,153 gallons), and brine (1,993,552 gallons) (NJDOT 2019).

Figure 4.3.10-3. Winter Maintenance Budget for State of New Jersey



Impact on the Environment

Severe winter weather can have a major impact on the environment. Not only does winter weather create changes in natural processes, the residual impacts of a community's methods to maintain its infrastructure through winter weather maintenance may also have an impact on the environment. For example, an excess amount of snowfall and earlier warming periods may affect natural processes such as flow within water resources (USGS nd). Rain-on-snow events can also exacerbate runoff rates with warming winter weather. Consequentially, these flow rates and excess volumes of water can erode banks, tear apart habitat along the banks and coastline, and disrupt terrestrial plants and animals.

Furthermore, chemically-based winter maintenance practices have its own effect on the natural environment. Melting snow and ice that carry deicing chemicals onto vegetation and into soils can contaminate the local waterways (The Environmental Literacy Council 2015). Elevated salt levels may hinder vegetation from absorbing nutrients, slowing plant growth. Another instance may be that the salted roadways and sidewalks will attract more animals to high traffic locations, making them more vulnerable to vehicular accidents (The Environmental Literacy Council 2015).

FUTURE CHANGES THAT MAY IMPACT VULNERABILITY

Understanding future changes that impact vulnerability in the County can assist in planning for future development and ensure that appropriate mitigation, planning, and preparedness measures are in place. The County considered the following factors to examine potential conditions that can affect hazard vulnerability:

- Potential or projected development.
- Projected changes in population.
- Other identified conditions as relevant and appropriate, including the impacts of climate change.

PROJECTED DEVELOPMENT

Areas targeted for future growth and development have been identified across Hudson County (refer to Sections 3 and 9). Any areas of growth could be potentially impacted by the severe winter storm hazard because the entire planning area is exposed and vulnerable. However, due to increased standards and codes, new structures are anticipated to be less vulnerable to the severe winter weather hazard compared with the aging building stock in the County.

PROJECTED CHANGES IN POPULATION

According to population projections from Hudson County, the area is expected to grow by 29% by 2040 (Hudson County Planning Board, Re-Examination 2017). As the population continues to grow, the density of Hudson County will change traffic trends and number of persons on the road. While this won’t necessarily change winter weather maintenance for the County, it will impact the rate of infrastructure degradation with the combination of increased roadway activity, salt and chemical application, and the freezing and thawing of roadways over the winter season. Furthermore, persons in poverty may become displaced into older neighborhoods that will be less effective at protection from winter elements. These persons may become more vulnerable to severe winter weather events as result of gentrification and population growth trends.

CLIMATE CHANGE

As discussed earlier, it is uncertain how climate change will influence extreme winter storm events. An increase in the frequency and severity of severe winter storms could result in an increase of snow loads on the County’s building stock and infrastructure, putting each building at risk to structural damage. More frequent and severe events also will result in increased resources spent to prepare for and clean-up after an event. However, as winter temperatures continue to rise, climate projections indicate the increase in precipitation is likely to occur during the winter months as rain. Increased rain on snowpack or frozen or saturated soils can lead to increased flooding and related impacts on the County’s assets.

Change of Vulnerability

Overall, the County's exposure and vulnerability have not changed, and the entire County will continue to be exposed and vulnerable to severe winter storm events.

4.3.11 WILDFIRE

This section provides a profile and vulnerability assessment of the wildfire hazard in Hudson County.

2020 HMP Changes

- Previous occurrences were updated with events that occurred between 2015 and 2019.
- The vulnerability assessment was conducted using updated population, building and critical facility/lifeline spatial data to determine exposure to the wildfire hazard. In addition, hazard exposure was conducted using the social vulnerability index, evacuation routes and new development.

4.3.11.1 PROFILE

A wildland fire can be defined as any non-structural fire that occurs in the wildland. Three distinct types of wildland fires have been defined and include: naturally occurring wildfire, human-caused wildfire, and prescribed fire. Many of these are highly destructive and can be difficult to control. They occur in forested, semi-forested, or less developed areas. Wildland fires can be caused by lightning, human carelessness, and arson. Most frequently, wildland fires in the State of New Jersey are caused by humans. Wildfires result in the uncontrolled destruction of forests, brush, field crops, grasslands, real estate, and personal property, and have secondary impacts on other hazards such as flooding, by removing vegetation and destroying watersheds.

Wildfires can increase the probability of other natural disasters, specifically floods and mudflows. Wildfires, particularly large-scale fires, can dramatically alter the terrain and ground conditions, making land already devastated by fire susceptible to floods. Lands impacted by wildfire increase the risk of flooding and mudflow in those areas impacted by wildfire. Normally, vegetation absorbs rainfall, reducing runoff. However, wildfires leave the ground charred, barren, and unable to absorb water; thus, creating conditions perfect for flash flooding and mudflows. Flood risk in these impacted areas remain significantly higher until vegetation is restored, which can take up to five years after a wildfire (FEMA 2019).

Flooding after a wildfire is often more severe, as debris and ash left from the fire can form mudflows. During and after a rain event, as water moves across charred and denuded ground, it can also pick up soil and sediment and carry it in a stream of floodwaters. These mudflows have the potential to cause significant damage to impacted areas. Areas directly affected by fires and those located below or downstream of burn areas are most at risk for flooding (FEMA 2013). For detailed information regarding flooding, see Section 4.3.7 (Flood).

The height of wildland fire season in New Jersey is typically in spring (March through May) and culminates in early May, corresponding with the driest live fuel moisture periods of the year. Although the spring months are the most severe, the summer and fall months may also experience extensive fires in the state. While the spring season is historically the period in which wildfire danger is the highest, wildland fires can occur every month of the year. Drought, snow pack, and local weather conditions can expand the length of the fire season. The early and late shoulders of the fire season usually are associated with human-caused fires. Lightning generally is the cause of most fires in the peak season.

In the State of New Jersey, each year, an average of 1,500 wildfires damage or destroy 7,000 acres of the state's forests. Wildfires not only damage woodlands but threaten homeowners who live within or are adjacent to forest environments. From January 1, 2018, to August 12, 2018, there were 552 wildfires in New Jersey that burned over

1,300 acres. In contrast, during this same period in 2017, the State experienced 588 fires, which burned over 5,024 acres (NJFFS 2018). Details regarding the number of fires in Hudson County were not included in these overall statistics.

EXTENT

The extent (that is, magnitude or severity) of wildfires depends on weather (dryness/drought) and human activity. To determine the potential for wildfires, the NJFFS uses two indices to measure and monitor the dryness of forest fuels and the possibility of fire ignitions becoming wildfires. This includes the National Fire Danger Rating Systems Buildup Index and the Keetch-Byram Drought Index. Both are used for fire preparedness planning, which includes the following initiatives: campfire and burning restrictions, fire patrol assignments, staffing of fire lookout towers, and readiness status for both observation and firefighting aircraft.

- The ***Buildup Index*** is a number that reflects the combined cumulative effects of daily drying and precipitation fuels with a 10-day time lag constant. It is a rating of the total amount of fuel available for combustion.
- The ***Keetch-Byram Drought Index*** (KBDI) is an index used to determining forest fire potential. The drought index is based on a daily water balance, where a drought factor is balanced with precipitation and soil moisture (assumed to have a maximum storage capacity of 8-inches) and is expressed in hundredths of an inch of soil moisture depletion.

In addition to the two indices, the NJFFS uses the National Fire Danger Rating System (NFDRS) to provide a measure of relative seriousness of burning conditions and threat of fire in the State. It allows the NJFFS to estimate the daily fire danger for a given area. The NFDRS uses a five-color coded system to help the public understand fire potential. The NJFFS slightly adapted the color system for their purposes (refer to Table 4.3.11-1). The NFDRS, with the NFFS color scheme, is as follows:

Table 4.3.11-1 Fire Danger Rating and Color Code

Fire Danger Rating and Color Code	Description
Low (Green)	Fuels do not ignite readily from small firebrands although a more intense heat source, such as lightning, may start fires in duff or punky wood. Fires in open cured grasslands may burn freely a few hours after rain, but woods fires spread slowly by creeping or smoldering, and burn in irregular fingers. There is little danger of spotting.
Moderate (Blue)	Fires can start from most accidental causes, but with the exception of lightning fires in some areas, the number of starts is generally low. Fires in open cured grasslands will burn briskly and spread rapidly on windy days. Timber fires spread slowly to moderately fast. The average fire is of moderate intensity, although heavy concentrations of fuel, especially draped fuel, may burn hot. Short-distance spotting may occur, but is not persistent. Fires are not likely to become serious and control is relatively easy.
High (Yellow)	All fine dead fuels ignite readily, and fires start easily from most causes. Unattended brush and campfires are likely to escape. Fires spread rapidly and short-distance spotting is common. High intensity burning may develop on slopes or in concentrations of fine fuels. Fires may become serious and their control difficult unless they are attacked successfully while small.
Very High (Orange)	Fires start easily from all causes and, immediately after ignition, spread rapidly and increase quickly in intensity. Spot fires are a constant danger. Fires burning in light fuels may quickly develop high intensity characteristics such as long-distance spotting and fire whirlwinds when they bum into heavier fuels.
Extreme (Red)	Fires start quickly, spread furiously, and burn intensely. All fires are potentially serious. Development into high intensity burning will usually be faster and occur from smaller fires than in the very high fire danger class. Direct attack is rarely possible and may be dangerous except immediately after ignition. Fires that develop headway in heavy slash or in conifer stands may be unmanageable while the extreme burning condition lasts. Under these conditions the only

Fire Danger Rating and Color Code	Description
	effective and safe control action is on the flanks until the weather changes or the fuel supply lessens.

Source: NJFFS 2018

LOCATION

According to the U.S. Fire Administration (USFA), the fire problem in the U.S. varies from region to region. This often is a result of climate, poverty, education, demographics, and other causal factors (USFA, 2012). Wildfires occur in virtually all of the U.S. The western portion of the U.S. is subject to more frequent wildfires, due to their more arid climate and prevalent conifer and brush fuel types. Wildfires have proven to be the most destructive in California but have become an increasingly frequent and damaging phenomenon nationwide (FEMA, 1997). States with a large amount of wooded, brush, and grassy areas, such as California, Colorado, New Mexico, Montana, Kansas, Mississippi, Louisiana, Georgia, Florida, North and South Carolina, Tennessee, Massachusetts, and the national forests of the western U.S. are at highest risk for wildfires (University of Florida, 1998). In Hudson County, wildfires have the potential to occur anywhere in the County.

NJFFS, a division of the New Jersey Department of Environmental Protection (NJDEP), is responsible for protecting the 3.15 million acres of wildland in the State. NJFFS is under the direction of the State firewarden and is headquartered in Trenton. NJFFS has 85 full-time employees that provide an array of services including staffing the State's 21 fire towers, which are operational during the months of March, April, May, October, and November.

NJFFS divides the State into three regions (Northern, Central, Southern) each totaling about 1,250,000 acres. There are 29,125,000 acre sections with a dedicated forest fire warden in each; and 269 districts each consisting of 15,000-20,000 acres In total, 29 section forest fire wardens, 269 district forest fire wardens and 2,000 trained crew members respond to fires on an as-needed basis (NJFFS 2013). Hudson County is located in the NJFFS Division A (Northern NJ).

WILDFIRE FUEL HAZARD AREAS

NJFFS developed Wildfire Fuel Hazard data for the entire state based on NJDEP data. For details on the information that was developed, refer to: https://www.state.nj.us/dep/gis/njfh.html. Figure 4.3.11-1 and Figure 4.3.11-2 illustrate the wildfire fuel hazard and wildfire risk for Hudson County. A majority of the County has low fuel hazard and low risk. Very small areas throughout the County are identified as having extreme fuel hazards. These areas include the Meadowlands and areas along the Hackensack River in Secaucus, Liberty State Park in Jersey City, and parts of Kearny near the marshland. Table 4.3.11-2 indicates the amount of land in each of the wildfire fuel hazard ranking zones for Hudson County. Table 4.3.11-3 summarizes the area within each hazard ranked area, specific to Hudson County jurisdictions.

Table 4.3.11-2. Area in the Wildfire Fuel Hazard Ranking Zones in Hudson County

Hazard Area	Area (Square Miles)
Extreme	0.008
Very High	1.105
High	3.697
Moderate	5.348
Low	2.635

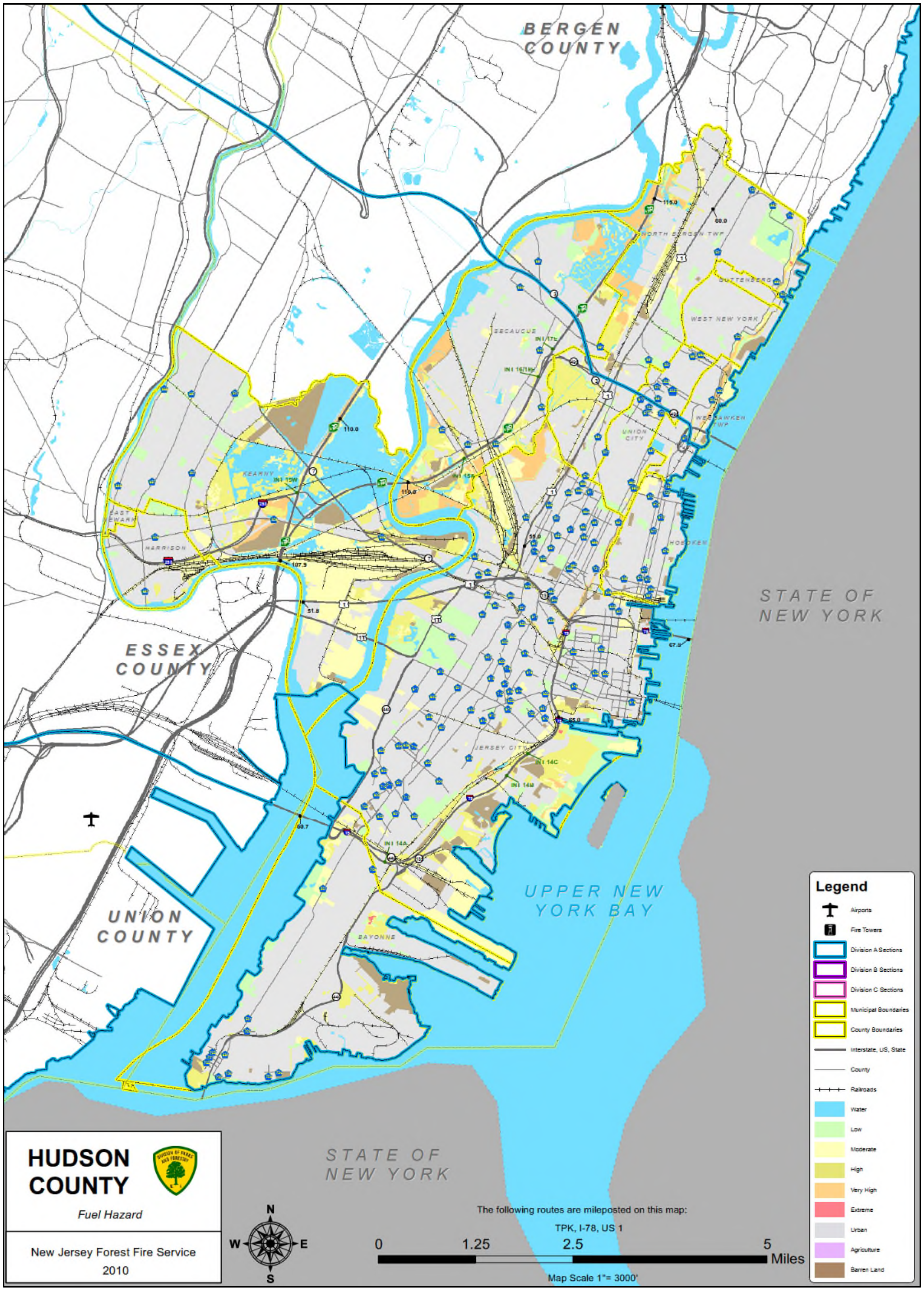
Source: NJFFS 2013

Table 4.3.11-3. Approximate Area in Wildfire Fuel Hazard Ranking Zones in Hudson County

Municipality	Total Area (Square Miles)	NJ Forest Service Risk Areas			
		Low to Moderate	% in Hazard Area	High to Extreme	% in Hazard Area
City of Bayonne	7.7	0.6	8.3%	0.3	4.4%
Borough of East Newark	0.1	0.0	1.1%	0.0	0.03%
Town of Guttenberg	0.2	0.0	0.8%	0.0	0.2%
Town of Harrison	1.3	0.2	15.1%	0.1	4.7%
City of Hoboken	1.2	0.2	14.2%	0.0	0.002%
City of Jersey City	15.9	3.0	18.9%	1.4	8.6%
Town of Kearny	10.2	2.2	21.3%	1.1	10.8%
Township of North Bergen	5.3	0.9	16.9%	0.6	12.3%
Town of Secaucus	6.6	0.7	10.2%	1.2	17.9%
City of Union City	1.3	0.1	6.2%	0.0	2.4%
Township of Weehawken	0.8	0.1	12.7%	0.1	7.3%
Town of West New York	1.0	0.1	6.3%	0.0	3.9%
Hudson County (Total)	51.5	8.0	15.5%	4.8	**9.3%**

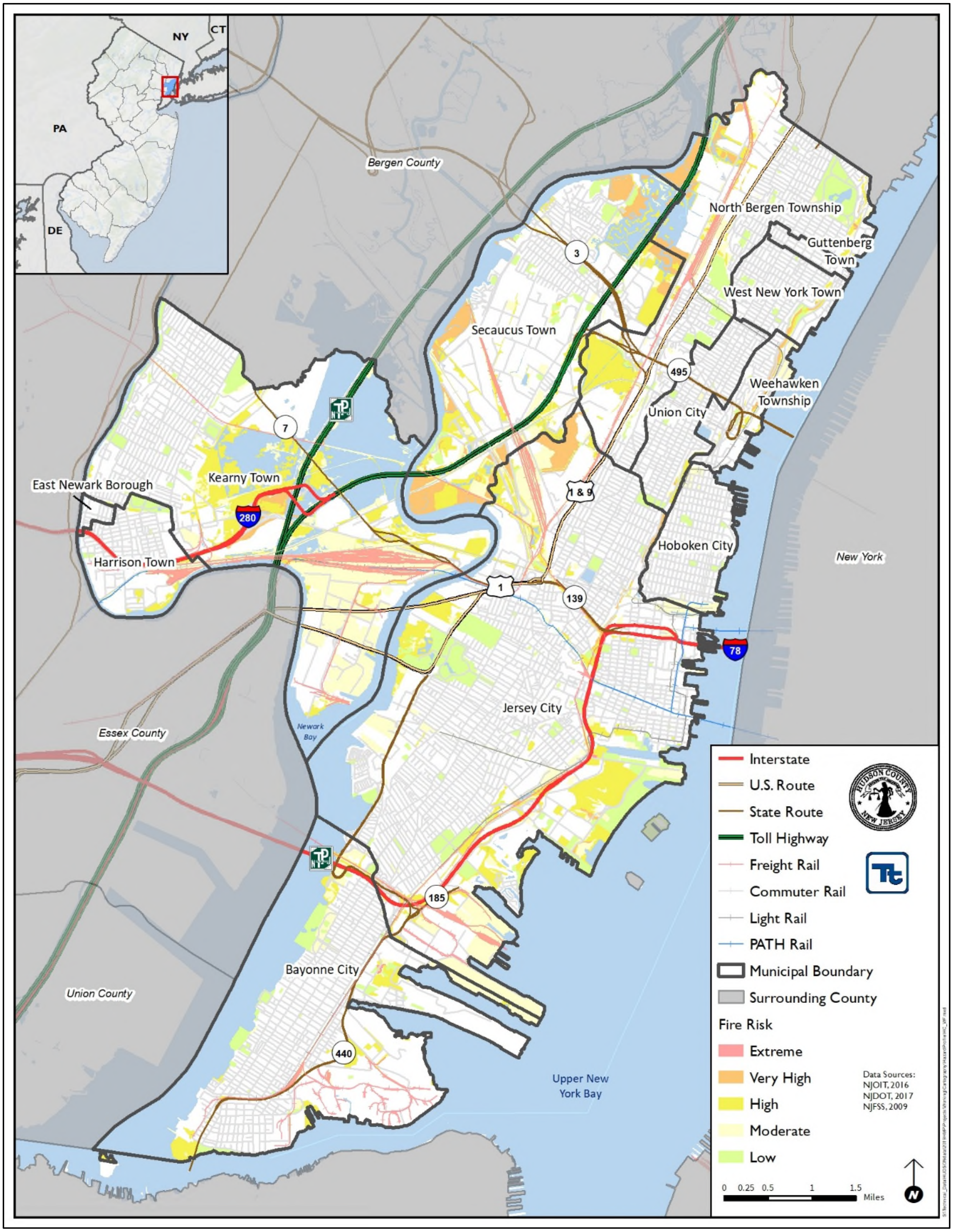
Source: NJFFS 2013

Figure 4.3.11-1. Wildfire Fuel Hazard for Hudson County



Source: *New Jersey Forest Fire Service 2010*

Figure 4.3.11-2. Wildfire Risk for Hudson County



Past Occurrence

Many sources provided wildfire information regarding previous occurrences and losses associated with wildfire throughout New Jersey and Burlington County. With so many sources reviewed for the purpose of this HMP Update, loss and impact information for many events could vary depending on the source. Therefore, the accuracy of monetary figures discussed is based only on the available information identified during research for this HMP update.

Between 1954 and 2018, New Jersey was included in two FEMA fire management assistance (FMA) declarations. Generally, these disasters cover a wide range of the State; therefore, the disaster may have impacted many counties. Hudson County was not included in any FEMA FMA declarations.

For this 2020 HMP Update, known wildfire events that have impacted Hudson County between 2015 and 2019 were identified. For events prior to 2015, refer to Appendix X. No major wildfire events were identified occurring between 2015 and 2019.

Probability of Future Occurrence

Estimating the approximate number of urban fires and wildfires to occur in Hudson County is difficult to predict in a probabilistic manner. This is because a number of variable factors impact the potential for a fire to occur and because some conditions (for example, ongoing land use development patterns, location, fuel sources, and construction sites) exert increasing pressure on the WUI zone. Based on available data, urban fires and wildfires will continue to present a risk to Hudson County. Given the numerous factors that can impact urban fire and wildfire potential, the likelihood of a fire event starting and sustaining itself should be gauged by professional fire managers on a daily basis.

In Section 4.4, the identified hazards of concern for Hudson County were ranked. The probability of occurrence, or likelihood of the event, is one parameter used for ranking hazards. Based on historical records and input from the Planning Committee, the probability of occurrence for wildfire in the County is considered 'frequent'.

Climate Change Impacts

A gradual change in temperatures will alter the growing environment of many tree species throughout the United States and New Jersey, reducing the growth of some trees and increasing the growth of others. Tree growth and regeneration may be affected more by extreme weather events and climatic conditions than by gradual changes in temperature or precipitation. Warmer temperatures may lead to longer dry seasons and multi-year droughts, creating triggers for wildfires, insects, and invasive species. Increased temperature and change in precipitation will also affect fuel moisture during wildfire season and the length of time wildfires can burn in a given year (U.S. Department of Agriculture [USDA] 2012). Climate change may also increase the frequency of lightning strikes. A warmer atmosphere holds more moisture which is one of the key items for triggering a lightning strike. Lightning strikes cause approximately half the wildfires in the United States. If the frequency of lightning strikes increases, the potential for wildfires from these strikes also increases (Lee 2014). Wildfire incidents are predicted to increase throughout the United States due to climate change, causing at least a doubling of areas burned within the next century (USDA 2012).

Average annual temperatures have increased by 3°F in New Jersey over the past century (NOAA NCEI 2019). By the 2020s, the average annual temperature in New Jersey is projected to increase by 1.5°F to 3°F above the statewide baseline (1971 to 2000), which was 52.7°F. By 2050, the temperature is projected to increase 3°F to 5°F (Sustainable Jersey Climate Change Adaptation Task Force 2011). As for precipitation, Northern New Jersey's 1971-2000 precipitation average was over five inches (12%) greater than the average from 1895-1970 (Office of New Jersey State

Climatologist). Average annual precipitation is projected to increase in the region up to 10% by the 2020s and up to 15% by the 2050s. Most of the additional precipitation is expected to come during the winter months (New York City Panel on Climate Change [NPCC] 2013).

As stated above, according to the temperature projections for Northern New Jersey, including Burlington County, this area can expect warmer and drier conditions which may increase the frequency and intensity of wildfires. Higher temperatures are expected to increase the amount of moisture that evaporates from land and water. These changes have the potential to lead to more frequent and severe droughts, which, in turn, increases the likelihood of wildfires (U.S. EPA 2009).

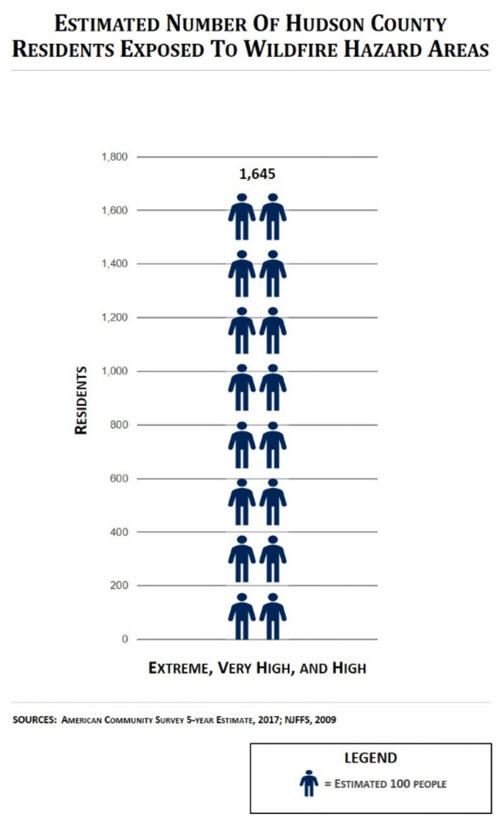
4.3.11.2 Vulnerability Assessment

A spatial analysis was conducted using the NJFFS Wildfire Fuel Hazard spatial layer. For the purposes of the assessment, an asset (population, structures, critical facilities, and lifelines) is considered exposed and potentially vulnerable to the wildfire hazard if it is located in the 'extreme', 'very high' and 'high' wildfire fuel hazard areas. Refer to Section 4.2 for additional details on the methodology used to assess wildfire risk.

Impact on Life, Health, and Safety

As demonstrated by historic wildfire events in New Jersey and other parts of the country, potential losses include impacts to human health and life of residents and responders, structures, infrastructure and natural resources. In addition, wildfire events can have major economic impacts on a community from the initial loss of structures and the subsequent loss of revenue from destroyed businesses and a decrease in tourism. The most vulnerable populations include emergency responders and those within a short distance of the interface between the built environment and the wildland environment. First responders are exposed to the dangers from the initial incident and after-effects from smoke inhalation and heat stroke. Table 4.3.11-4 summarizes the estimated population exposed by municipality.

Figure 4.3.11-3. Number of Persons Exposed to Extreme, Very High, and High Wildfire Hazard Areas



Based on the spatial analysis, an estimated 1,645 people, or 0.2-percent of the County's population, is located in the high, very high and extreme wildfire hazard areas (refer to Figure 4.3.11-3). Overall, the Town of Secaucus has the greatest number of populations located in the extreme, very high, and high hazard areas (1,325 people) and the greatest percent of its population exposed (6.9-percent of total municipal population).

Of the population exposed, the most vulnerable include the economically disadvantaged and the population over age 65. Economically disadvantaged populations are more vulnerable because they are likely to evaluate their risk and make decisions to evacuate based on net economic impacts on their families. The population over age 65 is also more vulnerable because they are more likely to seek or need medical attention that may not be available due to isolation during a wildfire event, and they may have more difficulty evacuating. In the high/very high/extreme NJFFS fuel hazard boundaries, there are approximately 159 people over the age of 65 and 376 people below the poverty level.

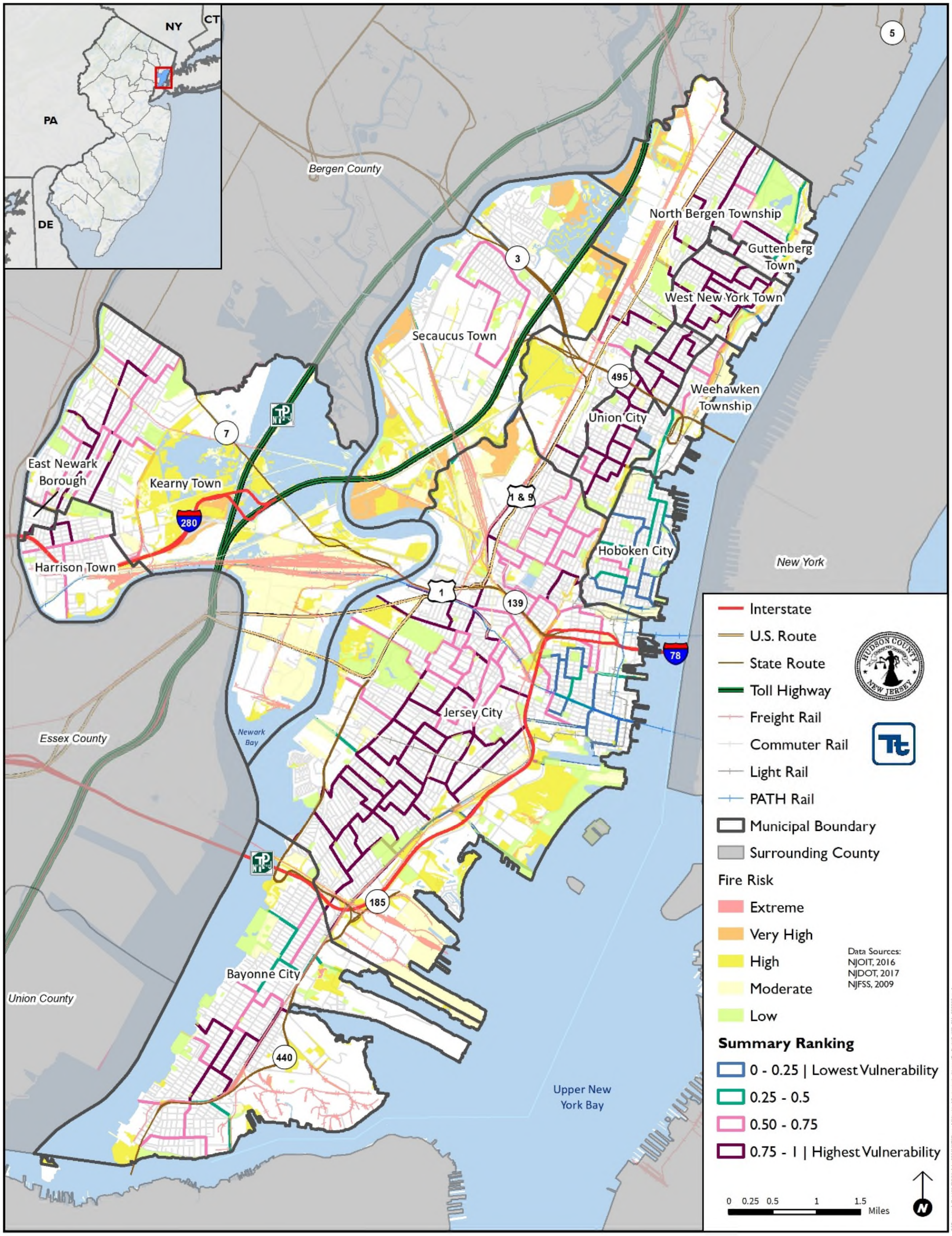
Table 4.3.11-4. Estimated Vulnerable Population

Municipality	American Community Survey (2013-2017) Population	Estimated Population Exposed	
		Extreme, Very High, and High	% of Total
Bayonne, City of	66,719	77	0.1%
East Newark, Borough of	2,725	0	0.0%
Guttenberg, Town of	11,733	0	0.0%
Harrison, Town of	15,898	0	0.0%
Hoboken, City of	54,117	0	0.0%
Jersey City, City of	265,932	208	0.1%
Kearny, Town of	42,487	0	0.0%
North Bergen, Township of	63,438	29	0.0%
Secaucus, Town of	19,279	1,325	6.9%
Union City, City of	69,815	0	0.0%
Weehawken, Township of	14,268	6	0.0%
West New York, Town of	53,345	0	0.0%
Hudson County (Total)	**679,756**	**1,645**	**0.2%**

Sources: American Community Survey 5-year Estimate, 2017; NJFFS, 2009

Furthermore, the Centers for Disease Control and Prevention's (CDC) 2016 Social Vulnerability Index (SVI) ranks U.S. Census tracts on socioeconomic status, household composition and disability, minority status and language, and housing and transportation. Hudson County's overall score is 0.6425, indicating that its communities have moderate to high vulnerability (CDC 2016, refer to Figure 4.3.11-4). This figure shows that the highest risk communities of impacts from wildfire (i.e., Secaucus and Jersey City), have mid to high social vulnerability rankings. The majority of Jersey City is ranked very high in social vulnerability, whereas Secaucus ranks from 0.25 – 0.75.

Figure 4.3.11-4. CDC Social Vulnerability Index Rating for Hudson County



Impact on General Building Stock

Buildings located within the NJFFS identified extreme, very high or high fuel hazard areas are exposed and considered vulnerable to the wildfire hazard (refer to Figure 4.3.11-5). Buildings constructed of wood or vinyl siding are generally more likely to be impacted by the fire hazard than buildings constructed of brick or concrete. Table 4.3.11-6 summarizes the estimated building stock inventory located in the hazard area by municipality. 1.3-percent ($976 million) of the County's replacement cost value is located in the extreme/very high/high hazard area. The Town of Secaucus has the greatest number of buildings in the wildfire hazard area (52 structures – 1.4-percent of its total), while Jersey City has the greatest replacement cost value located in the hazard area ($424 million – 1.7-percent of its total).

Figure 4.3.11-5. Building Exposure to Extreme, Very High, and High Wildfire Hazard Areas

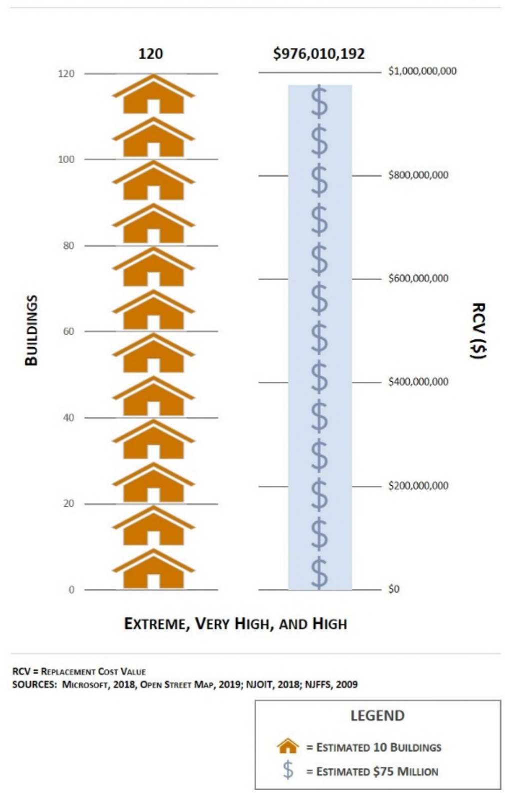


Table 4.3.11-5. Building Stock Replacement Value Located in Wildfire Fuel Hazard Ranking Zones

Municipality	Number of Buildings	Total Replacement Cost Value (RCV)	Estimated Building Stock Exposed			
			Number of Buildings - Extreme, Very High, and High	% of Total	RCV - Extreme, Very High, and High	% of Total
Bayonne, City of	6,802	$8,856,079,105	16	0.2%	$110,767,153	1.3%
East Newark, Borough of	403	$240,888,451	0	0.0%	$0	0.0%
Guttenberg, Town of	1,227	$651,507,569	0	0.0%	$0	0.0%
Harrison, Town of	2,537	$2,398,975,757	0	0.0%	$0	0.0%
Hoboken, City of	4,470	$3,910,202,233	0	0.0%	$0	0.0%
Jersey City, City of	35894	$25,693,921,967	30	0.1%	$424,285,619	1.7%
Kearny, Town of	7,209	$7,874,466,790	11	0.2%	$6,762,355	0.1%
North Bergen, Township of	6,005	$8,393,144,641	6	0.1%	$57,910,523	0.7%
Secaucus, Town of	3,845	$9,593,262,762	52	1.4%	$368,288,416	3.8%
Union City, City of	1,729	$3,742,882,384	0	0.0%	$0	0.0%

Municipality	Number of Buildings	Total Replacement Cost Value (RCV)	Estimated Building Stock Exposed			
			Number of Buildings - Extreme, Very High, and High	% of Total	RCV - Extreme, Very High, and High	% of Total
Weehawken, Township of	2,113	$1,510,119,929	2	0.1%	$3,432,614	0.2%
West New York, Town of	4,594	$2,825,012,673	3	0.1%	$4,563,513	0.2%
Hudson County (Total)	**76,828**	**$75,690,464,261**	**120**	**0.2%**	**$976,010,192**	**1.3%**

Sources: Microsoft, 2018, Open Street Map, 2019; NJOIT, 2018; NJFFS, 2009

Impact on Critical Facilities

In Hudson County, there are 10 critical facilities located in the wildfire hazard area. Six out of the 10 critical facilities are wastewater pump stations. As mentioned previously, wildfires can have an impact on the water supplies throughout the County because of residual pollutants like char or debris landing in water resources which can clog wastewater pipes, culverts, etc. Two out of the 10 facilities are centralized around persons within the County (i.e., shelter and childcare facility). Jersey City contains the greatest number of critical facilities impacted by the wildfire hazard area (i.e., 4 out of 10).

The risk of wildfire impacting evacuation routes is another issue Hudson County may encounter (refer to Figure 4.3.11-6 and Figure 4.3.11-7). Routes near the New Jersey Meadowlands such as the Turnpike and Highway 3 may be more vulnerable to risk of impacts of wildfire events since wetland species have a greater chance of erupting in flames during times of drought and high temperature events as discussed above. A spatial analysis found that a total of 16.84 miles of evacuation routes in Hudson County are exposed to the wildfire hazard area.

Figure 4.3.11-6. Evacuation Routes Exposed to Wildfire Hazard Areas

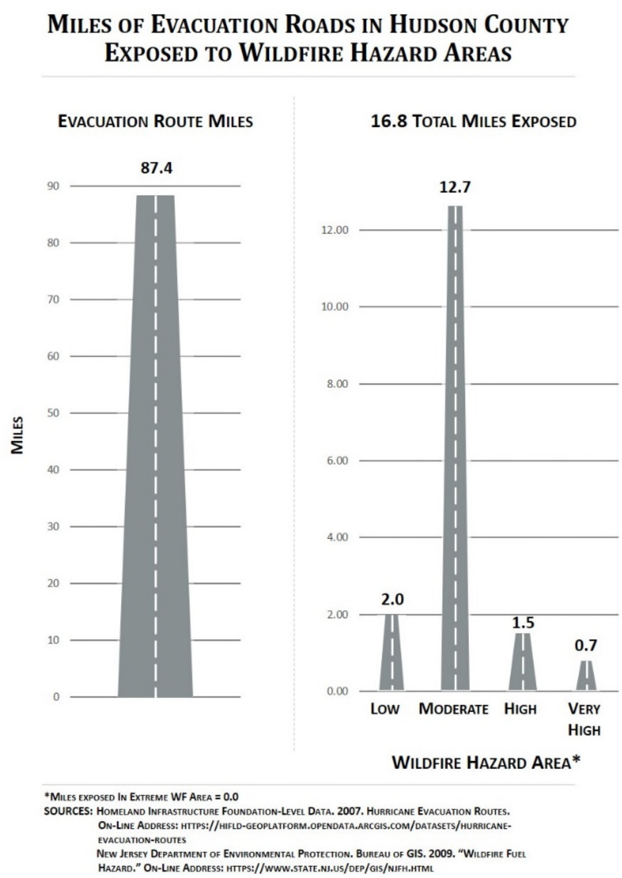
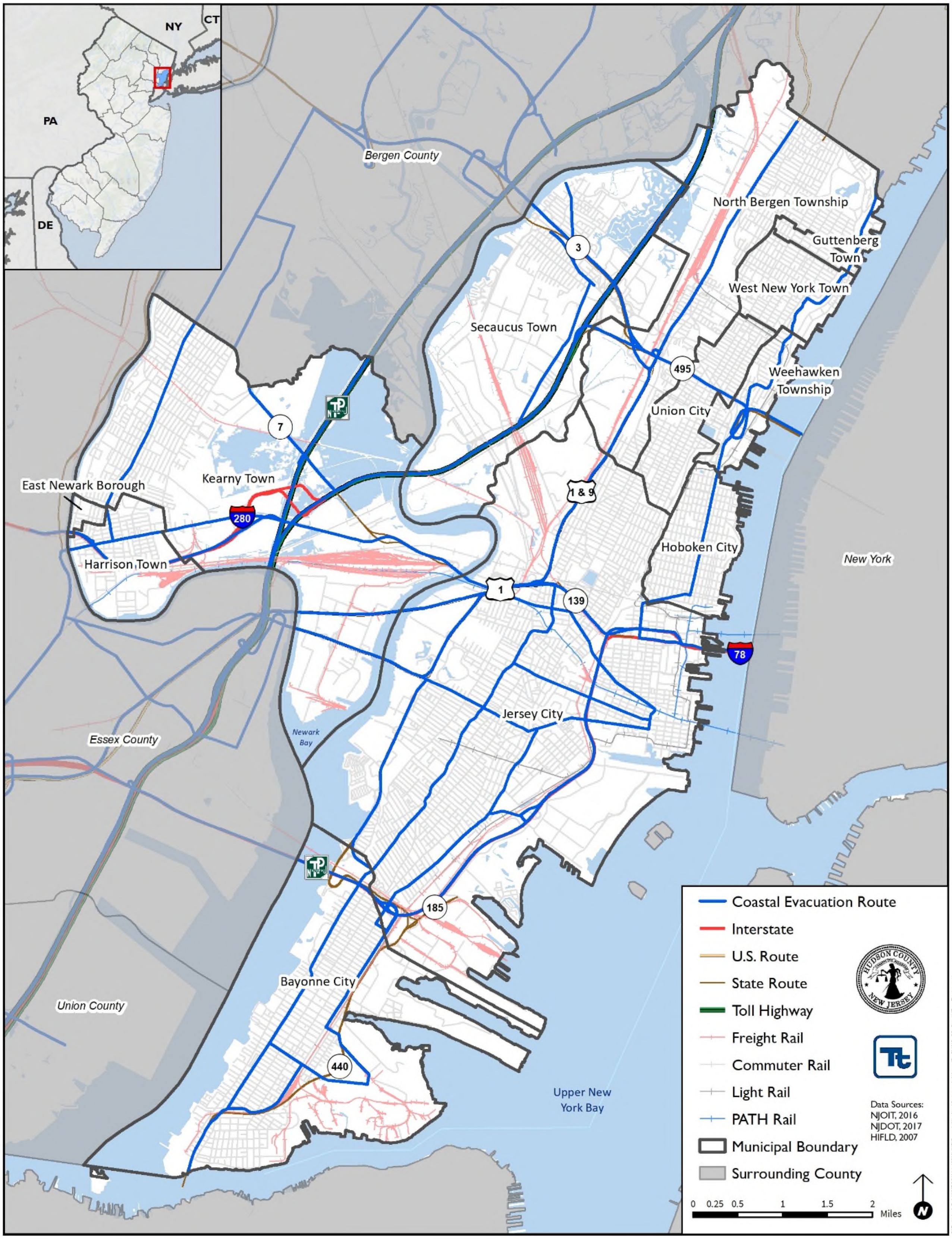


Figure 4.3.11-7. Coastal Evacuation Routes of Hudson County



Impact on the Economy

Wildfire events can have major economic impacts on a community from the initial loss of structures and the subsequent loss of revenue from destroyed business. Wildfires can cost thousands of taxpayer dollars to suppress and control and involve hundreds of operating hours on fire apparatus and thousands of volunteer man hours from the volunteer firefighters. There are also many direct and indirect costs to local businesses that excuse volunteers from working to fight these fires.

Wildfire can also severely impact roads and infrastructure. Interstate 280, Interstate 78, the NJ Toll Road, State Highway 1, and State Highway 440 are exposed to portions of the wildfire hazard area through Hudson County. These routes are especially important for the commuter population that travels between New Jersey and New York, or for those who travel into and out of Hudson County for work. In general, roads and bridges surrounding the areas of fire risk are important because they provide ingress and egress to large areas and, in some cases, to isolated neighborhoods. Fires can create conditions that block or prevent access and can isolate residents and emergency service providers.

Due to a lack of data regarding past structural and economic losses specific to Hudson County or its municipalities, it is not possible to estimate future losses due to wildfire events currently.

Impact on the Environment

According to the USGS, post-fire runoff polluted with debris and contaminates can be extremely harmful to ecosystem and aquatic life (USGS 2018). Studies show that urban fires in particular are more harmful to the environment compared to forest fires (USGS 2018). The age and density of the infrastructure within Hudson County implies that a fire can have exacerbated consequences on the environment because of the increased amount of chemicals and contaminates that would be released from burning infrastructure. These chemicals, such as iron lead, and zinc, may leach into the storm water, contaminate nearby streams, and impair aquatic life.

Future Changes That May Impact Vulnerability

Understanding future changes that affect vulnerability can assist in planning for future development and ensure establishment of appropriate mitigation, planning, and preparedness measures. The County considered the following factors to examine potential conditions that may affect hazard vulnerability:

- Potential or projected development
- Projected changes in population
- Other identified conditions as relevant and appropriate, including the impacts of climate change

PROJECTED DEVELOPMENT

As discussed in Section 3 (County Profile), areas targeted for future growth and development have been identified across the County. It is anticipated that any new development and new residents in the extreme, very high or high fuel hazard areas will be exposed to the wildfire hazard.

New development could be affected by the wildfire hazard if located in the identified hazard areas and mitigation measures are not considered during design, development and maintenance of the property. Each municipality identified areas of recent development and proposed development in their community. Developments that could be located using an address or Parcel ID were geocoded and overlain with the NJFFS high, very high, and extreme wildfire hazard areas to determine exposure to wildfire. There are 110 recent and proposed developments vulnerable to the wildfire hazard; Refer to Section 3 (County Profile), and Volume II Section 9 for potential new development in Hudson County; and Figure 4.3.11-8 for a map of proposed new development and the NJFFS boundaries for Hudson County.

PROJECTED CHANGES IN POPULATION

According to population projections from Hudson County, the area is expected to grow by 29% by 2040 (Hudson County 2017). This change in population growth for Hudson County is noteworthy because the community had been experiencing six decades of population decline (Hudson County 2017). Factors like increased number of immigrants and a growing number of Millennials and young adults has become a driver for new development. For example, the increasing population has created a need for more school facilities, municipal services, and housing development (Hudson County 2017). As population grows, people may expand out towards areas adjacent to or within the wildfire hazard area. The mix of additional structures, ornamental vegetation, and wildland fuels may cause erratic fire behavior, and could potentially increase risk to life, property, and economic welfare in vulnerable areas throughout the County. Refer to Section 3 (County Profile) which includes a discussion on population trends for the County.

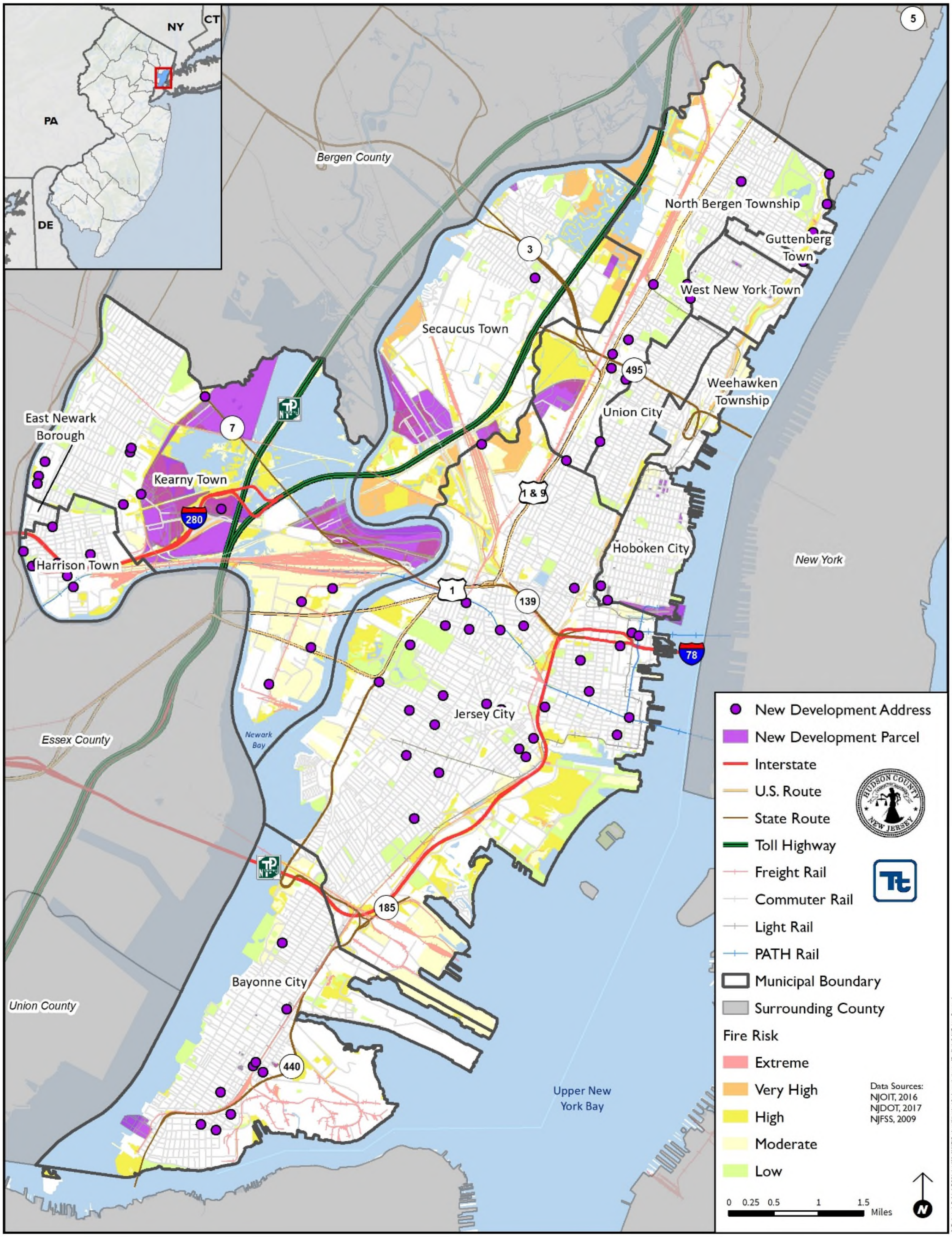
CLIMATE CHANGE

As discussed earlier, temperatures are anticipated to increase, therefore, suitability of habitats for specific types of trees potentially changes, altering the fire regime and resulting in more frequent fire events and changes in intensity. Prolonged and more frequent heat waves have the potential to increase the likelihood of a wildfire. The increased potential combined with stronger winds can increase the County's vulnerability. If stronger winds occur near a wildfire and emergency services are unable to initially contain the event, the fast-moving fire can spread to nearby developments. This can directly impact the County's population and built environment in the vicinity of the fire, and also indirectly affect those served by utility infrastructure that can be damaged by a fire.

CHANGE OF VULNERABILITY SINCE 2015 HMP

Several differences exist between the 2015 HMP and this update. For this plan update, an updated general building stock based upon replacement cost value from MODIV tax assessment data and 2019 RS Means, and an updated critical facility inventory were used to assess the County's risk to the hazard areas; further lifelines were identified. In addition, the 2017 American Community Survey population estimates were used and estimated at a structural level as compared to the 2015 plan which evaluated exposure using 2010 U.S. Census blocks. The NJFFS Wildfire Fuel Hazard spatial layer has not been updated since the last HMP. Changes in exposure are attributed to increases in population and new development.

Figure 4.3.11-8. Wildfire Risk and New Development for Hudson County



4.4 Hazard Ranking

2020 HMP CHANGES

- The 2020 update hazard ranking methodology was expanded to include adaptive capacity and climate change.
- The probability of occurrence category was adjusted to include the benchmark value 'unlikely', and modifications to the remaining categories so that 'frequent' aligned with an event that has an annual probability.
- The MUAs conducted a hazard ranking exercise utilizing the results from the municipalities in which their assets are located as well as assessing impacts within their jurisdiction.
- Flood increased to a high ranked hazard for the 2020 HMP update.

A comprehensive range of hazards that pose a significant risk to Hudson County were selected and considered during the development of this plan; see Section 4.1 (Identification of Hazards of Concern). However, each jurisdiction has differing levels of exposure and vulnerability to each of these hazards. It is important for each jurisdiction participating in this plan to recognize those hazards that pose the greatest risk to their jurisdiction and direct their attention and resources accordingly to most effectively and efficiently manage risk and reduce losses. The hazard ranking for the county and each participating jurisdiction can be found in their jurisdictional annexes in Volume II, Section 9 of this plan.

To this end, a hazard risk ranking process was conducted for Hudson County and its municipalities using the method described below. This method includes four risk assessment categories—probability of occurrence, impact (population, property and economy), adaptive capacity, and climate change. Each was assigned a weighting factor to calculate an overall ranking value for each hazard of concern. Depending on the calculation, each hazard was assigned a high, medium, or low ranking. Details regarding each of these categories is described below.

4.4.1 HAZARD RANKING METHODOLOGY

The methodology used to rank the hazards of concern for Hudson County is described below. Estimates of risk for the County were developed using methodologies promoted by FEMA's hazard mitigation planning guidance, generated by FEMA's HAZUS-MH risk assessment tool, and input from Hudson County and participating jurisdictions.

As described in Section 4.2 (Methodology), three different levels of analysis were used to estimate potential impacts: 1) historic loss/qualitative analysis; 2) exposure analysis; and 3) loss estimation. All three levels of analysis are suitable for planning purposes; however, with any risk analysis, there is underlying uncertainty resulting from assumptions used to describe and assess vulnerability and the methodologies available to model impacts. Impacts from any hazard event within the County will vary from the analysis presented here based on the factors described for each hazard of concern; namely location, extent, warning time, and mitigation measures in place at the time of an event.

The hazard ranking methodology for some hazards of concern is based on a scenario event, while others are based on the potential vulnerability to the County as a whole. In order to account for these differences, the quantitative hazard ranking methodology was adjusted using professional judgement and subject-matter input; assumptions are included, as appropriate, in the following subsections. The limitations of this analysis are recognized given the all scenarios do not have the same likelihood of occurrence; nonetheless, there is value in summarizing and comparing the hazards using a standardized approach to evaluate relative risk. The following categories were considered when evaluating the relative risk of the hazards of concern.

- **Probability of Occurrence**—The probability of occurrence of the scenario evaluated was estimated by examining the historic record and/or calculating the likelihood of annual occurrence. When no scenario was assessed, an examination of the historic record and judgement was used to estimate the probability of occurrence of an event that will impact the County.
- **Impact**—The following three hazard impact subcategories were considered: impact to people; impact to assets and the economy; and impact to environmental resources and cultural assets. The results of the updated risk assessment and/or professional judgement were used to assign the numeric values for these three impact subcategories. A factor was applied to each subcategory, giving impact on population the greatest weight.
    - Population—Numeric value x 3
    - Buildings—Numeric value x 2
    - Economy—Numeric value x 1
- **Adaptive Capacity**—Adaptive capacity describes a jurisdiction's current ability to protect from or withstand a hazard event. This includes capabilities and capacity in the following areas: administrative, technical, planning/regulatory and financial. Mitigation measures already in place increases a jurisdiction's capacity to withstand and rebound from events (e.g. codes/ordinances with higher standards to withstand hazards due to design or location; deployable resources; or plans and procedures in place to respond to an event). In other words, assigning 'low' for adaptive capacity means the jurisdiction does not have the capability to effectively respond, which increases vulnerability; whereas 'high' adaptive capacity means the jurisdiction does have the capability to effectively respond, which decreases vulnerability. These ratings were assigned using the results of the core capability assessment with subject-matter input from each jurisdiction.
- **Climate Change** (Changing Future Conditions) - Current climate change projections were considered as part of the hazard ranking to ensure the potential for an increase in severity/frequency of the hazard was included. This was important to Hudson County to include because the hazard ranking helps guide and prioritize the mitigation strategy development, which should have a long-term future vision to mitigate the hazards of concern. The potential impacts climate change may have on each hazard of concern is discussed in Sections 4.3.1 through 4.3.11. The benchmark values in the methodology are similar to confidence levels outlined in the National Climate Assessment 2017.

The relative hazard risk score was calculated for each hazard using the following formula. Table 4.4-1 summarizes the categories, benchmark values, and weights used to calculate the risk factor for each hazard.

Example Hazard Ranking Equation

Hazard Ranking = [Probability of Occurrence x .40] +
[(Impact on Population x 3) + (Impact on Property x 2) + (Impact on Economy x 1) x .40] +
[Adaptive Capacity x .10] + [Climate Change x .10]

Using the weighting applied, the highest possible risk factor value is 6.75. The higher the number, the greater the relative risk. Based on the total for each hazard, a priority ranking is assigned to each hazard of concern (high, medium, or low). The rankings were categorized as follows: Low = Values less than or equal to 3.8; Medium = Values between 3.9 and 4.9; High = Values greater than or equal to 5.0.

Table 4.4-1. Summary of Hazard Ranking Approach

<table>
<tr><th colspan="2">Category</th><th>Level / Category</th><th>Degree of Risk / Benchmark Value</th><th>Numeric Value</th><th>Weighted Value</th></tr>
<tr><td colspan="2" rowspan="4">Probability of Occurrence</td><td>Unlikely</td><td>A hazard event is not likely to occur or is unlikely to occur with less than a 1% annual chance probability.</td><td>0</td><td rowspan="4">40%</td></tr>
<tr><td>Rare</td><td>Between 1 and 10% annual probability of a hazard event occurring.</td><td>1</td></tr>
<tr><td>Occasional</td><td>Between 10 and 100% annual probability of a hazard event occurring.</td><td>2</td></tr>
<tr><td>Frequent</td><td>100% annual probability; a hazard event may occur multiple times per year.</td><td>3</td></tr>
<tr><td rowspan="9">Impact (Sum of all 3)</td><td rowspan="3">Population (Numeric Value x 3)</td><td>Low</td><td>14% or less of your population is exposed to a hazard with potential for measurable life safety impact, due to its extent and location.</td><td>1</td><td rowspan="9">40%</td></tr>
<tr><td>Medium</td><td>15% to 29% of your population is exposed to a hazard with potential for measurable life safety impact, due to its extent and location.</td><td>2</td></tr>
<tr><td>High</td><td>30% or more of your population is exposed to a hazard with potential for measurable life safety impact, due to its extent and location.</td><td>3</td></tr>
<tr><td rowspan="3">Property (Numeric Value x 2)</td><td>Low</td><td>Property exposure is 14% or less of the total number of structures for your community.</td><td>1</td></tr>
<tr><td>Medium</td><td>Property exposure is 15% to 29% of the total number of structures for your community.</td><td>2</td></tr>
<tr><td>High</td><td>Property exposure is 30% or more of the total number of structures for your community.</td><td>3</td></tr>
<tr><td rowspan="3">Economy (Numeric Value x 1)</td><td>Low</td><td>Loss estimate is 9% or less of the total replacement cost for your community.</td><td>1</td></tr>
<tr><td>Medium</td><td>Loss estimate is 10% to 19% of the total replacement cost for your community.</td><td>2</td></tr>
<tr><td>High</td><td>Loss estimate is 20% or more of the total replacement cost for your community.</td><td>3</td></tr>
<tr><td colspan="2" rowspan="3">Adaptive Capacity</td><td>Low</td><td>Weak/outdated/inconsistent plans, policies, codes/ordinances in place; no redundancies; limited to no deployable resources; limited capabilities to respond; long recovery.</td><td>3</td><td rowspan="3">10%</td></tr>
<tr><td>Medium</td><td>Plans, policies, codes/ordinances in place and meet minimum requirements; mitigation strategies identified but not implemented on a widespread scale; county/jurisdiction can recover but needs outside resources; moderate county/Jurisdiction capabilities.</td><td>2</td></tr>
<tr><td>High</td><td>Plans, policies, codes/ordinances in place and exceed minimum requirements; mitigation/protective measures in place; county/jurisdiction has ability to recover quickly because resources are readily available, and capabilities are high.</td><td>1</td></tr>
<tr><td colspan="2" rowspan="2">Climate Change</td><td>Low</td><td>No local data is available; modeling projections are uncertain on whether there is increased future risk; confidence level is low (inconclusive evidence).</td><td>1</td><td rowspan="2">10%</td></tr>
<tr><td>Medium</td><td>Studies and modeling projections indicate a potential for exacerbated conditions due to climate change; confidence level is medium to high (suggestive to moderate evidence).</td><td>2</td></tr>
</table>

Category	Level / Category	Degree of Risk / Benchmark Value	Numeric Value	Weighted Value
	High	Studies and modeling projections indicate exacerbated conditions/increased future risk due to climate change; very high confidence level (strong evidence, well documented and acceptable methods).	3	

Note: A numerical value of zero is assigned if there is no impact.

**For the purposes of this exercise, "impacted" means exposed for population and property and estimated loss for economy.*

To summarize the confidence level regarding the input utilized to populate the hazard ranking, a gradient of certainty was developed. A certainty factor of high, medium or low was selected and assigned to each hazard to provide a level of transparency and increased understanding of the data utilized to support the resulting ranking. The following scale was used to assign a certainty factor to each hazard:

- High—Defined scenario/event to evaluate; probability calculated; evidenced-based/quantitative assessment to estimate potential impacts through hazard modeling.
- Moderate—Defined scenario/event or only a hazard area to evaluate; estimated probability; combination of quantitative (exposure analysis, no hazard modeling) and qualitative data to estimate potential impacts.
- Low—Scenario or hazard area is undefined; there is a degree of uncertainty regarding event probability; majority of potential impacts are qualitative.

Table 4.4-2 summarizes the hazard scenario or hazard area evaluated; highlights key impacts to population, buildings/critical assets and the economy; and lists the associated certainty factor assigned for each hazard to convey the level of confidence in the data used. This table is not intended to be a complete and comprehensive list of all hazard impacts determined in the risk assessment and considered for the hazard ranking exercise. Refer to Sections 4.3.1 to 4.3.11 for a complete summary of all estimated impacts for each hazard.

Table 4.4-2. Overview of the Hazard Scenario and Associated Estimated Impacts Considered in the Hazard Ranking

Hazard	Category				Certainty Factor
	Hazard Scenario/ Area Evaluated	Estimated Countywide Impacts			
		Population	Buildings/Critical Facilities and Lifelines	Economy[a]	
Coastal Erosion and Sea Level Rise	Coastal Erosion: CEHA Sea Level Rise: NOAA +1ft and +3ft rise	Coastal Erosion: 3,667 people +1ft Rise: 227 people +3ft Rise: 736 people	Coastal Erosion (# located in CEHA): 380 buildings 19 critical facilities 6 lifelines +1ft Rise (# lost): 65 buildings 8 critical facilities 1 lifeline +3ft Rise (# lost): 260 buildings 13 critical facilities 4 lifelines	Coastal Erosion ($ building RCV located in CEHA): $714 million +1ft Rise ($ RCV lost): $290 million +3ft Rise ($ RCV lost): $1.8 billion	High
Coastal Storm	100-year MRP	Entire County population exposed 94,006 residents located in Category 1 storm surge inundation area	9,468 buildings ($22 million RCV) located in Category 1 storm surge inundation area	$88 million building RCV damage due to wind	High
Dam and Levee Failure	Dam failure at the Hackensack Reservoir #2 Dam in Weehawken	TBD	TBD	TBD	TBD
Drought	Drought event	Entire County population exposed; impacts to health and safety of individuals are estimated to be minimal.	Critical facility functionality may be impacted (e.g., water source for fire services); overall impacts to structures are low.	4 farms in County	Low
Earthquake	100-Year Mean Return Period Event	Entire population exposed 5 displaced household 120,450 residents located on earthquake-vulnerable soils	Located on Vulnerable Soils (NEHRP Soils D&E; high liquefaction susceptibility): $35 billion building RCV 395 critical facilities 145 lifelines	$3.5 million RCV building damages 3,240 tons of building debris $1.5 million income loss	High
Extreme Temperature	Extreme temperature	Entire County population exposed;	Critical facility functionality may be impacted if without backup power source	4 farms in County; 2 farm operators report	Low

Hazard	Category				Certainty Factor
	Hazard Scenario/ Area Evaluated	Estimated Countywide Impacts			
		Population	Buildings/Critical Facilities and Lifelines	Economy[a]	
	event (heat or cold)	Vulnerable populations: elderly, youth, individuals with chronic medical conditions; low income		farming as primary occupation	
Flood	100-Year Mean Return Period Event	98,288 residents living in the SFHA	Located in the SFHA: 10,377 buildings 103 critical facilities 53 lifelines	$3.6 billion in estimated RCV loss	High
Geological	High Landslide Susceptibility Areas	5,879 residents located in Class A and B susceptibility areas	245 buildings located in Class A and B susceptibility areas 6 critical facilities 4 lifelines	$295 million building RCV located in Class A and B susceptibility areas	Moderate
Severe Weather	Severe Weather Event	Entire population exposed	All buildings exposed	Event-dependent	Low
Severe Winter Weather	Severe Winter Weather Event	Entire population exposed	All buildings exposed	Event-dependent	Low
Wildfire	Wildfire Fuel Hazard areas (High, Very High, Extreme)	1,645 residents located in high, very high, and extreme wildfire hazard area	120 buildings located in wildfire hazard area 8 critical facility 7 lifelines	$976 million building RCV located in wildfire hazard area	Moderate

Notes:
Building values are based on structure replacement cost for sea level rise losses do not include land value.
a Estimated loss in replacement cost values as available from HAZUS-MH.
Exposed = This refers to the number of assets located in the hazard area; all of which may not incur losses as a result of the event.
SFHA = Special flood hazard area (1-percent annual chance flood event)
RCV = Replacement cost value based on 2019 RSMeans

Table 4.4-3 summarizes the projected changes in hazard event occurrences in terms of location, extent or intensity and frequency and/or duration. In addition, it lists the associated value assigned to each hazard in the risk factor calculation (i.e., confidence in changing future conditions). Refer to Sections 4.3.1 to 4.3.11 for a more detailed discussion of all factors of change discussed for each hazard of concern.

Table 4.4-3. Overview of Projected Future Changes for each Hazard of Concern

Hazard	Projected Change			Confidence in Changing Future Conditions [a]
	Location	Extent/ Intensity	Frequency/ Duration	
Coastal Erosion and Sea Level Rise	↑	↑	↑	Highly Likely
Coastal Storm	↑	↑	↑	Highly Likely
Dam and Levee Failure	↑	↑	↑	Likely
Drought	—	—	↑	Likely
Earthquake	—	—	—	Uncertain
Extreme Temperature	↑	↑	↑	Highly Likely
Flood	↑	↑	↑	Highly Likely
Geological Hazards	—	—	—	Uncertain
Severe Weather	↑	↑	↑	Highly Likely
Severe Winter Weather	—	↓	↓	Likely
Wildfire	↑	↑	↑	Likely

Notes:
Arrow direction indicates a projected increase or decrease based on literature review as described in Sections 4.3.1 through 4.3.11
— *Straight line indicates uncertain and/or no change known at this time.*
a Similar to confidence levels outlined in the National Climate Assessment 2017

Highly Likely = Studies and modeling projections indicate exacerbated conditions/increased future risk due to climate change; very high confidence level (strong evidence, well documented and acceptable methods).
Likely = Studies and modeling projections indicate a potential for exacerbated conditions due to climate change; confidence level is medium to high (suggestive to moderate evidence).
Uncertain = No local data is available; modeling projects are uncertain on whether there is increased future risk; confidence level is low (inconclusive evidence).
No Change = Studies and modeling projections indicate there is no evidence at this time to indicate conditions may change in the future.

4.4.2 HAZARD RANKING RESULTS

Using the process described above, the risk ranking for the identified hazards of concern was determined for Hudson County. The hazard ranking is detailed in the subsequent tables that present the step-wise process for the ranking. The countywide risk ranking includes the entire planning area and may not reflect the highest risk indicated for any of the participating jurisdictions. The resulting ranks of each municipality indicate the differing degrees of risk exposure and vulnerability. The results support the appropriate selection and prioritization of initiatives to reduce the highest levels of risk for each municipality. Both the county and the participating jurisdictions have applied the same methodology to develop the countywide risk and local rankings to ensure consistency in the overall ranking of risk; jurisdictions had the ability to alter rankings based on local knowledge and experience in handling each hazard.

This hazard ranking exercise serves four purposes: 1) to describe the probability of occurrence for each hazard; 2) to describe the impact each would have on the people, property, and economy; 3) to evaluate the capabilities a community has with regards to natural hazards; and 4) to consider changing future conditions (i.e., climate change) in Hudson County. Estimates of risk for Hudson County were developed using methodologies promoted by FEMA's hazard mitigation planning guidance, generated by FEMA's HAZUS-MH risk assessment tool and input from the county and participating municipalities.

Table 4.4-4. Ranking for Hazards of Concern for Hudson County

Hazard of Concern	Probability		Impact										Adaptive Capacity	Climate Change
			Population			Property			Economy			Total Impact Value		
	Impact	Numeric Value	Impact	Numeric Value	Weighted Value (x3)	Impact	Numeric Value	Weighted Value (x2)	Impact	Numeric Value	Weighted Value (x1)			
Coastal Erosion and Sea Level Rise	Occasional	2	Low	1	1 x 3 = 3	Low	1	1 x 2 = 2	Medium	2	2 x 1 = 2	7	2	3
Coastal Storm	Occasional	2	Medium	2	2 x 3 = 6	Medium	2	2 x 2 = 4	High	3	3 x 1 = 3	13	2	3
Dam and Levee Failure	Occasional	2	Low	1	1 x 3 = 3	Low	1	1 x 2 = 2	Low	1	1 x 1 = 1	6	2	2
Drought	Occasional	2	Medium	2	2 x 3 = 6	Low	1	1 x 2 = 2	Low	1	1 x 1 = 1	9	2	2
Earthquake	Rare	1	Medium	2	2 x 3 = 6	Low	2	1 x 2 = 2	Low	1	1 x 1 = 1	9	2	1
Extreme Temperature	Frequent	3	Low	1	1 x 3 = 3	Low	1	1 x 2 = 2	Low	1	1 x 1 = 1	9	2	3
Flood	Frequent	3	Medium	2	2 x 3 = 6	Medium	2	1 x 2 = 4	Medium	2	2 x 1 = 1	12	2	3
Geological Hazards	Occasional	2	Low	1	1 x 3 = 3	Low	1	1 x 2 = 2	Low	1	1 x 1 = 1	6	2	1
Severe Weather	Frequent	3	High	3	3 x 3 = 9	High	3	3 x 2 = 6	Low	1	1 x 1 = 1	16	2	3
Severe Winter Weather	Frequent	3	High	3	3 x 3 = 9	High	3	3 x 2 = 6	Low	1	1 x 1 = 1	16	1	2
Wildfire	Frequent	3	Low	1	1 x 3 = 3	Low	1	1 x 2 = 2	Low	1	1 x 1 = 1	6	2	2

Table 4.4-5 presents the total calculations for each hazard ranking value for the hazards of concern. The rankings were categorized and assigned a color as follows: Low = Values less than or equal to 3.8 (yellow); Medium = Values between 3.9 and 4.9 (orange); High = Values greater than or equal to 5.0 (red).

Table 4.4-5. Total Hazard Ranking Values for the Hazards of Concern for Hudson County

Hazard of Concern	Probability x 40%	Total Impact x 40%	Adaptive Capacity x 10%	Changing Future Conditions x 10%	Total Hazard Ranking Value
Coastal Erosion and Sea Level Rise	0.8	2.8	0.2	0.3	4.1
Coastal Storm	0.8	5.2	0.2	0.3	6.5
Dam and Levee Failure	0.8	2.4	0.2	0.2	3.6
Drought	0.8	3.6	0.2	0.2	4.8
Earthquake	0.4	3.6	0.2	0.1	4.3
Extreme Temperature	1.2	2.4	0.2	0.3	4.1
Flood	1.2	4.8	0.2	0.3	6.5
Geological Hazards	0.8	2.4	0.2	0.1	3.5
Severe Weather	1.2	6.4	0.2	0.3	8.1
Severe Winter Weather	1.2	6.4	0.1	0.2	7.9
Wildfire	1.2	2.4	0.2	0.2	4.0

Low = Values less than or equal to 3.8; Medium = Values between 3.9 and 4.9; High = Values greater than or equal 5.0.

These rankings have been used as one of the bases for identifying the jurisdictional hazard mitigation strategies included in Section 9 (Jurisdictional Annexes) of this plan. The summary rankings for the county reflect the results of the vulnerability analysis for each hazard of concern and vary from the specific results of each jurisdiction. For example, the severe storm hazard may be ranked low in one jurisdiction, but due to the exposure and impact countywide, it is ranked as a high hazard and is addressed in the county mitigation strategy accordingly. Jurisdictional ranking results are presented in each local annex in Section 9 (Jurisdictional Annexes) of this plan.

SECTION 5. CAPABILITY ASSESSMENT

2020 HMP CHANGES

- In the 2015 HMP, the capability assessment section was presented in Section 6 as part of the mitigation strategy. For the 2020 HMP update, the capability assessment was expanded and presented in Section 5 as a stand-alone section with capabilities expanded in each jurisdictional annex as well (Section 9 [Jurisdictional Annexes]).

According to FEMA's *Mitigation Planning How-To Guide #3*, a capability assessment is an inventory of a community's missions, programs, and policies and an analysis of its capacity to carry them out. Each jurisdiction has a unique set of capabilities available to accomplish mitigation and reduce long-term vulnerable to future hazard events. Capabilities include authorities, policies, programs, staff, and funding. Reviewing existing capabilities helps identify capabilities that currently implement mitigation and leads to loss reductions or that have the potential to be implemented in the future.

This assessment is an integral part of the planning process. The assessment process enables identification, review, and analysis of current federal, state, and local programs, policies, regulations, funding, and practices that could either facilitate or hinder mitigation.

During the original planning process, Hudson County and participating jurisdictions identified and assessed their capabilities in the areas of existing programs, policies, and technical documents. By completing this assessment, each jurisdiction learned how or whether they would be able to implement certain mitigation actions by determining the following:

- Limitations that could exist on undertaking actions.
- The range of local and state administrative, programmatic, regulatory, financial, and technical resources available to assist in implementing their mitigation actions.
- Actions deemed infeasible, as they are currently outside the scope of capabilities.
- Types of mitigation actions that could be technically, legally (regulatory), administratively, politically, or fiscally challenging or infeasible.
- Opportunities to enhance local capabilities to support long term mitigation and risk reduction.

During the plan update process, all participating jurisdictions were tasked with developing or updating their capability assessment, paying particular attention to evaluating the effectiveness of these capabilities in supporting hazard mitigation and identifying opportunities to enhance local capabilities to integrate hazard mitigation into their plans, programs, and day-to-day operations.

County and municipal capabilities in the Planning and Regulatory, Administrative and Technical, and Fiscal subjects can be found in the Capability Assessment section of each jurisdictional annex in Section 9 (Jurisdictional Annexes).

5.1 Update Process Summary

The purpose of the capability assessment is to understand the planning, regulatory, administrative, technical, and financial capabilities present in Hudson County. This assessment helps the County and its jurisdictions identify strengths and opportunities that can be used to reduce losses from hazard events and reduce risks throughout Hudson County.

To complete the capability assessment, the contracted consultant met with Hudson County and each municipality one-on-one to review the capability assessment from the 2015 HMP and update accordingly. In addition to in-person meetings, the consultant reviewed plans and codes/ordinances to enhance the information provided by the jurisdictions.

A summary of the various federal and state capabilities available to promote and support mitigation and reduce risk in Hudson County are presented below. Information provided by the County and municipalities are presented in Volume II, Section 9 (Jurisdictional Annexes) of this plan update.

5.2 Planning and Regulatory Capability

Planning and regulatory capabilities are based on the implementation of ordinances, policies, local laws and state statutes, and plans and programs that relate to guiding and management growth and development. Planning and regulatory capabilities refer not only to the current plans and regulations, but also to the jurisdiction's ability to change and improve those plans and regulations as needed. The following provides the planning and regulatory capabilities for Hudson County.

5.2.1 PLANNING AND REGULATORY CAPABILITIES – FEDERAL AND STATE

Table 5-1. Planning and Regulatory Capabilities – Federal and State

Capability		
Disaster Mitigation Act (DMA)	**Description:**	The DMA is the current federal legislation addressing hazard mitigation planning. It emphasizes planning for disasters before they occur. It specifically addresses planning at the local level, requiring plans to be in place before Hazard Mitigation Assistance grant funds are available to communities. This plan is designed to meet the requirements of DMA, improving eligibility for future hazard mitigation funds.
	Responsible Agency:	FEMA
	Provides Funding for Mitigation:	HMPs designed to meet the requirements of DMA will remain eligible for future FEMA Hazard Mitigation Assistance funds
	Hazard:	All-natural hazards
National Flood Insurance Program (NFIP)	**Description:**	The NFIP is a federal program enabling property owners in participating communities to purchase insurance as a protection against flood losses in exchange for state and community floodplain management regulations that reduce future flood damages. The Flood Hazard Profile in Section 4.3.6 (Flood) provides information on recent legislation related to reforms to the NFIP. All municipalities in Hudson County actively participate in the NFIP. As of September 30, 2018, there were 4,221 NFIP policies in Hudson County. There have been 4,752 claims made, totaling over $110.3 million for damages to structures and contents. There are 450 NFIP Repetitive Loss properties and 62 Severe Repetitive Loss properties in the county.

Capability		
	Responsible Agency:	FEMA
	Provides Funding for Mitigation:	Full compliance and good standing under the NFIP are application prerequisites for all FEMA grant programs for which participating jurisdictions are eligible under this plan.
	Hazard:	Flood
NFIP Community Rating System (CRS)	**Description:**	As an additional component of the NFIP, CRS is a voluntary incentive program that recognizes and encourages community floodplain management activities that exceed the minimum NFIP requirements. As a result, flood insurance premium rates are discounted to reflect the reduced flood risk resulting from the community actions meeting the three goals of the CRS: (1) reduce flood losses, (2) facilitate accurate insurance rating, and (3) promote the awareness of flood insurance. Municipalities, and the county as a whole, could expect significant cost savings on premiums if enrolled in the CRS program. As of April 2019, the New Jersey Sports Exposition Authority is actively participating in the CRS program (Class 7). Other communities in Hudson County noted they explored the possibility of participating.
	Responsible Agency:	FEMA
	Provides Funding for Mitigation:	CRS premium discounts on flood insurance range from 5 percent for Class 9 communities up to 45 percent for Class 1 communities.
	Hazard:	Flood
Municipal Land Use Law	**Description:**	The State of New Jersey Municipal Land Use Law (L.1975, c. 291, s. 1, effective August 1, 1976) is the legislative foundation for the land use process in the State of New Jersey, including decisions by Planning Boards and Zoning Boards of Adjustment. It defines the powers and responsibilities of boards and is essential to their functions and decisions. It also provides the required components of a municipal master plan. Every municipal agency must adopt and can amend reasonable rules and regulations, consistent with this act or with any applicable ordinance, for the administration of its functions, powers, and duties. These plans help jurisdictions review their land use plans and policies with public participation. The Municipal Land Use Law requires that each municipality prepare a comprehensive plan and update that plan every 10 years. The New Jersey Exposition Authority (NJSEA) holds zoning jurisdiction over the portions of each municipality within its borders. The Consolidation Act allows municipalities to administer the majority of the zoning requirements of the NJSEA, upon adoption of an 'opt-out' resolution agreeing to follow the land use provisions of the Meadowlands zoning regulations. To date, the Towns of Secaucus and Kearny have become 'opt-out' municipalities (NJSEA 2019).
	Responsible Agency:	State of New Jersey
	Provides Funding for Mitigation:	No
	Hazard:	All
State of New Jersey Hazard Mitigation Plan (2019 Update)	**Description:**	The State of New Jersey HMP includes an evaluation of the state's overall pre- and post-hazard mitigation policies, programs, and capabilities; the policies related to development in hazard-prone areas; and the state's funding capabilities. The State of New Jersey HMP thoroughly describes the federal and state programs available to Hudson County to promote mitigation. The State of New Jersey HMP was used as a resource in developing Hudson County's HMP update.
	Responsible Agency:	NJOEM
	Provides Funding for Mitigation:	No
	Hazard:	All (natural and non-natural)

Capability		
Critical Area Protection Policy	**Description:**	The following NJDEP programs both protect critical natural resources, and provide funding for the State, municipalities, and counties to purchase land for open-space preservation and recreation, which may directly or indirectly support hazard mitigation efforts: Green Acres Program Blue Acres Program Historical Preservation Program Farmland Preservation Wetlands Act of 1970 (N.J.S.A. 13:9A) Soil and Erosion and Sediment Control Act (N.J.S.A. 4:24) The Wetlands Act of 1970 (N.J.S.A. 13:9A) provide rules and regulations governing development in wetland areas of New Jersey. New Jersey has 15 soil conservation districts, following county boundaries that implement the New Jersey Soil Erosion and Sediment Control Act (N.J.S.A. 4:24), which governs certain aspects of new development. The County of Hudson established a County Recreation and Open Space Trust Fund (Ord No. O-2007-00032) pursuant to P.L. 1997, Chapter 24, which shall be funded through the collection of property tac at a rate not to exceed $0.015 per $100 of total County equalized real property valuation. (N.J.S.A. 40:12-15.1 et seq.
	Responsible Agency:	NJDEP, Hudson County Open Space Trust Fund Advisory Board
	Provides Funding for Mitigation:	Yes – the various programs (Green Acres, Blue Acres) provide funding to jurisdictions to acquire land and properties and turn into open space. The Hudson County Open Space Trust Fund can be used to acquire land and to maintain the properties.
	Hazard:	Coastal Storm, Flood, Severe Weather
Uniform Construction Code (UCC)	**Description:**	Building codes mandate best practices and technology, much of which is designed to reduce or prevent damage from occurring when structures are under stress. The UCC adopts up-to-date building codes as its Building Subcode and One- and Two-Family Subcode. These Subcodes contain requirements that address construction in both A and V flood zones. Also, all new construction is required to comply with the UCC for flood zone construction. New Jersey has enacted legislation directing the Department of Community Affairs (NJ DCA) to adopt a radon hazard code or revise the state building code to establish "adequate and appropriate standards to ensure that schools and residential buildings within tier one areas [as defined by the state] ... are constructed in a manner that minimizes radon gas and radon progeny entry and facilitates any subsequent remediation that might prove necessary." See N.J. Stat. Ann. 52:27D-123a. The Department then adopted a radon hazard sub-code which does not reference existing model standards or guidance, but which sets forth the basic requirements for a passive sub-slab or sub-membrane depressurization system. See N.J. Admin. Code 5:23-10.4. The radon control standards and procedures apply to new residential construction (and school construction) in "tier one" areas, as defined by the state, and Appendix 10-A of the sub-code lists the specific municipalities that are designated as tier one areas.
	Responsible Agency:	NJ DCA
	Provides Funding for Mitigation:	No
	Hazard:	All
Floodplain Management Policy	**Description:**	New Jersey State Law Flood Hazard Area Control Act (NJSA 58:16A-52): The Act and regulations attempts to minimize damage to life and property from flooding caused by development within fluvial and tidal flood hazard areas, to preserve the quality of surface waters, and to protect the wildlife and vegetation that

Capability		
		exist within and depend upon such areas for sustenance and habitat. While it does not require local adoption, as it is enforced by the NJDEP, the floodplain ordinances of each municipality need to be reviewed to be in compliance with this new regulation.
	Responsible Agency:	New Jersey Department of Environmental Protection (NJDEP)
	Provides Funding for Mitigation:	No
	Hazard:	Flood
Growth Management Policy	**Description:**	Land preservation and recreation comprise one of the cornerstones of New Jersey's smart growth policy. The New Jersey Statewide Comprehensive Outdoor Recreation Plan provides Statewide policy direction to the State, local governments, and conservation organizations in the preservation of open space and the provision of public recreation opportunities. The State Plan was prepared and adopted by the State Planning Commission according to the requirements of the State Planning Act of 1985 as amended (NJSA 52:18A-196 et seq.) to serve as an instrument of State policy to guide State agencies and local government in the exercise of governmental powers regarding planning, infrastructure investment and other public actions and initiatives that affect and support economic growth and development in the State. Green Acres Program, Open Space Tax Program, and Development and Redevelopment Plan. The State Planning Act has enhanced the traditionally limited role of county land-use planning and control. Also provides tools for municipalities when preparing their master land use plans and better opportunity for a comprehensive approach to planning so not to harm or be in conflict with neighboring Municipalities' plans.
	Responsible Agency:	
	Provides Funding for Mitigation:	No
	Hazard:	All
U.S. Army Corps of Engineers	**Description:**	The U.S. Army Corps of Engineers recently completed a report detailing the results of a two-year study to address coastal storm and flood risk to vulnerable populations, property, ecosystems, and infrastructure affected by Hurricane Sandy in the United States' North Atlantic region. This, the North Atlantic Coast Comprehensive Study, is designed to help local communities better understand changing flood risks associated with climate change and to provide tools to help those communities better prepare for future flood risks. It builds on lessons learned from Hurricane Sandy and attempts to bring to bear the latest scientific information available for state, local, and tribal planners. The New York New Jersey Harbor and Tributaries focus area feasibility study, which will include a tiered Environmental Impact Statement, is evaluating five initial alternatives, which currently are comprised of measures that address severe coastal storm risks for specific geographic regions within the study area, in addition to the no action alternative. These five alternatives encompass a variety of water- and land-based measures identified throughout the estuary at areas of high projected coastal storm risk and include combinations of shoreline structures, such as beach nourishment, levees, floodwalls and seawalls, and storm-surge barriers. This initial range of alternatives was developed in part from the analysis provided in the North Atlantic Coast Comprehensive Study, as well as coordination with the States of New York and New Jersey and the City of New York. The alternatives are taking into account other ongoing and planned actions being taken within the study area by the Corps, other federal agencies, both states and New York City, and other municipalities.

Capability		
		The feasibility study will develop information to distinguish between alternatives so that ultimately a recommended plan can be identified. Based upon available information and analyses, a draft report describing the alternatives, their benefits, costs and environmental and social impacts is scheduled to be available for agency and public review in late summer of 2020. The Corps will then review the comments received as part of the agency and public review to determine what, if any, additional analyses, may be warranted to refine the alternatives and possibly add further measures that may be justified on a building-to-building basis (e.g., non-structural measures) or that may address areas that suffer from more frequent (and typically less severe) coastal storm risks (e.g., natural and nature-based features). Additional analyses may result the preparation of a subsequent draft prior to the completion of the final report and the selection of a recommended plan. As project details are developed during Preconstruction Engineering and Design, consideration of environmental and social impacts will continue to be evaluated.
	Responsible Agency:	U.S. Army Corps of Engineers, partners include NJDEP
	Provides Funding for Mitigation:	Yes
	Hazard:	Coastal Storm, Flood
New Jersey Department of Health	**Description:**	The State performed a Risk Based Funding Hazard and Vulnerability Assessment under a Centers for Disease Control and Prevention (CDC) grant focusing upon health-related effects.
	Responsible Agency:	Department of Health
	Provides Funding for Mitigation:	No
	Hazard:	Pandemic, Power Failure, Foodborne Infectious Disease Outbreak, Extreme Weather Emergencies (excluding flood), Hazardous Materials Incident with Evacuation, Flood, Nuclear Power Generating Facility Incidents with Off-site Radiation Release and Terrorism. Although the non-natural hazards were not an evaluated as hazard of concern for this plan, Hudson County is noting that these hazards are covered in this State-level planning document.

5.2.2 PLANNING AND REGULATORY CAPABILITIES – COUNTY AND LOCAL

Detailed information regarding these capabilities can be found in each jurisdictional annex found in Volume II, Section 9 (Jurisdictional Annexes).

5.3 Administrative and Technical Capability

Administrative and technical capabilities refer to the jurisdiction's staff and their skills and tools that can be used for mitigation planning and implementation. It also refers to the ability to access and coordinate the resources effectively. The following provides the administrative and technical capabilities for Hudson County.

5.3.1 ADMINISTRATIVE AND TECHNICAL CAPABILITY – FEDERAL AND STATE

Table 5-2. Administrative and Technical Capability – Federal and State

Capability		
FEMA Risk MAP	**Description:**	A Coastal Restudy is in progress for New York/New Jersey as a result of issues raised during the previous coastal map appeal process. The Coastal Restudy will affect the following communities in Hudson County: 1. Bayonne 2. East Newark 3. Guttenberg 4. Harrison 5. Hoboken 6. Jersey City 7. Kearny 8. North Bergen 9. Secaucus 10. Union City 11. Weehawken 12. West New York
	Responsible Agency:	FEMA
	Provides Funding for Mitigation:	No
	Hazard:	Flood
Recovery Bureau	**Description:**	The Chief of the Recovery Bureau supervises the Mitigation, Public Assistance, and Finance Units. The Mitigation Unit undertakes hazard mitigation planning and the review of mitigation projects in advance of potential disasters and is also activated during and immediately after disasters to evaluate existing and proposed mitigation measures in the affected areas.
	Responsible Agency:	NJOEM
	Provides Funding for Mitigation:	No
	Hazard:	All
Mitigation Unit	**Description:**	The Mitigation Unit, within the Emergency Management Section, has the mission of enhancing state, county, and municipal risk reduction through the development and implementation of mitigation strategies. Hazard mitigation, by definition, is any sustained action that prevents or reduces the loss of property or human life from recurring hazards. The Mitigation Unit accomplishes this task by implementing and administering several grant-based programs in conjunction with FEMA.
	Responsible Agency:	NJOEM
	Provides Funding for Mitigation:	Yes
	Hazard:	All
Preparedness Bureau	**Description:**	The Preparedness Unit in the Preparedness Bureau is responsible for disseminating preparedness information in advance of a disaster or potential disaster. The Preparedness Unit maintains an extensive library of natural disaster preparedness and recovery information on its Plan and Prepare website (http://ready.nj.gov/plan-prepare/index.shtml). The disaster preparedness and

Capability		
		recovery information featured prominently on the New Jersey State Police and NJOEM website home pages (http://njsp.org/ and http://ready.nj.gov/index.shtml) is a critical part of New Jersey's efforts to protect public health and safety and to minimize loss of life and property in the event of a disaster.
	Responsible Agency:	NJOEM
	Provides Funding for Mitigation:	No
	Hazard:	All
Hazard Mitigation Grant Program Administrative Plan	**Description:**	In the event that an active disaster declaration has necessitated a FEMA-approved Hazard Mitigation Grant Program (HMGP) Administrative Plan, the plan is reviewed to ensure compliance with the prevailing guidance and to set forth the administrative procedures, organization, and requirements for administering the HMGP in New Jersey. The HMGP Administrative Plan is developed by the state and details the process for prioritizing post-disaster mitigation funding of local mitigation projects.
	Responsible Agency:	NJOEM
	Provides Funding for Mitigation:	Yes
	Hazard:	All
Bureau of Dam Safety & Flood Control	**Description:**	The Bureau of Dam Safety & Flood Control leads the state's efforts filling the State NFIP Coordinator position and providing Community Rating System (CRS) support. In addition, the section's responsibilities include the funding of construction and operation of federal, state, and local flood control mitigation projects throughout the state. The section has also taken a lead role on the development and adoption of NJ Flood Hazard Area mapping, as well as an active partnership with FEMA on their Map Modernization Program efforts. The bureau assists communities participating in the NFIP and interested in joining CRS through the NJDEP Community Assistance Program Unit.
	Responsible Agency:	NJDEP
	Provides Funding for Mitigation:	Yes
	Hazard:	Flood, Severe Weather, Coastal Storms
Dam Safety Section	**Description:**	The NJDEP Dam Safety Section under the Bureau of Dam Safety & Flood Control has responsibility for overseeing dam safety in the state. The primary goal of the program is to ensure the safety and integrity of dams in New Jersey, and thereby protect people and property from the consequences of dam failures. The section also coordinates with the Division of State Police, local and county emergency management officials in the preparations and approval of emergency action plans. The Dam Safety Section reviews plans and specifications for the construction of new dams or for the alteration, repair, or removal of existing dams. The section must grant approval before the owner can proceed with construction. Engineers from the Dam Safety Section evaluate each project, investigate site conditions, and check recommended construction materials. During construction, engineers identify conditions that may require design changes, check for compliance with approved plans and specifications, and approve foundations before material is placed. Existing dams are periodically inspected to assure that they are adequately maintained, and owners are directed to correct any deficiencies found. The regulations require the owner to obtain a professional engineer to inspect their dams on a regular basis. These investigations include a comprehensive review of all pertinent material contained in the Section's files, a visual inspection, technical studies when necessary, and preparation of a comprehensive report.
	Responsible Agency:	NJDEP

Capability		
	Provides Funding for Mitigation:	Yes
	Hazard:	Flood, Severe Weather, Coastal Storms
Division of Water Supply and Geoscience	**Description:**	This Division works to ensure adequate, reliable, and safe water supply is available for the future. This goal is accomplished through the regulation of ground and surface water diversions, permitting of wells, permitting of drinking water infrastructure, monitoring of drinking water quality, and technical support for water systems to achieve compliance with all federal and state standards. Water Supply staff provides technical assistance to assist water systems during water supply emergencies, as needed to re-establish safe and adequate public water supplies, and to address routine non-compliance from significant deficiencies or poor water quality test results. The Drinking Water State Revolving Fund (DWSRF) program assists water systems in financing the cost of infrastructure through the use of federal and New Jersey Environmental Infrastructure Trust (NJEIT) funds. Additionally, Water Supply provides operator licensing and training support as well as financial assistance through the DWSRF program.
	Responsible Agency:	NJDEP
	Provides Funding for Mitigation:	Yes
	Hazard:	All
New Jersey Geological and Water Survey	**Description:**	The New Jersey Geological and Water Survey evaluates geologic, hydrogeologic and water quality data to manage and protect water resources, to identify natural hazards and contaminants, and to provide mineral resources including offshore sands for beach nourishment. Information provided by the survey includes GIS data and maps of geology, topography, groundwater, and aquifer recharge. In addition, the data tracks wellhead protection areas, aquifer thicknesses, properties and depths, groundwater quality, drought, geologic resources, and hazards such as earthquakes, abandoned mines, karst-influenced sinkholes, and landslides.
	Responsible Agency:	NJDEP
	Provides Funding for Mitigation:	No
	Hazard:	Drought, Earthquake, Geological
Office of Planning Advocacy	**Description:**	The New Jersey Office of Planning Advocacy (OPA) supports and coordinates planning throughout the state to protect the environment, mitigate development hazards and guide future growth into compact, mixed use development and redevelopment while fostering a robust long-term economy. The OPA implements the goals of the State Development and Redevelopment Plan to achieve comprehensive, long-term planning; and integrates that planning with programmatic and regulatory land use decisions at all levels of government and the private sector.
	Responsible Agency:	New Jersey Department of the State
	Provides Funding for Mitigation:	No
	Hazard:	Natural Hazards
Office of the State Climatologist	**Description:**	The Office of the New Jersey's State Climatologist (ONJSC) generates and archives climate data. Generated data are from the New Jersey Weather and Climate Network (NJWxNet), which is an assemblage of 55 automated weather stations situated throughout the state. A decade or more of hourly observations are available from some of the stations, while others have shorter records. Since fall 2012 observations are available on a five-minute basis. Along with these records, ONJSC archives or has ready access to National Weather Service Cooperative Weather Station data. These are daily

Capability		
		observations from several dozen stations at any given time over the past century. Individual stations have as many as 120 years of data while other stations have started or ceased operating since the late 1800s. Another source of generated data is the Community Collaborative Rain, Hail and Snow Network (CoCoRaHS), which includes daily observations of rain and snow from as many as several hundred volunteers throughout the state.
	Responsible Agency:	Rutgers University
	Provides Funding for Mitigation:	No
	Hazard:	Natural Hazards
New Jersey Climate Adaptation Alliance (NJADAPT)	**Description:**	NJADAPT focuses on climate change preparedness for New Jersey in key impact sectors (public health; watersheds, rivers and coastal communities; built infrastructure; agriculture; and natural resources). NJADAPT is a collaborative effort of scientists and data managers in academia, government, the private sector and non-governmental organization community who have developed a strategic plan for a New Jersey platform to host and apply climate science impacts and data. The NJADAPT website (http://www.njadapt.org/) includes a flood exposure profile for community discussions about hazard impacts; NJ Flood Mapper (which is a tool for flooding hazards and sea level rise); and Getting to Resilience (a tool used to help communities reduce vulnerability and increase preparedness).
	Responsible Agency:	Rutgers University
	Provides Funding for Mitigation:	No
	Hazard:	Flood, Coastal Storm, Severe Weather
New Jersey Sports Exposition Authority	**Description:**	Zoning authority is discussed in the previous section. The NJSEA maintains several vehicles to help District municipalities address flooding and sewer-line issues, among other concerns. Vehicles include a vac-truck, root cutter, two portable automatic self-priming pump systems and a trailer-mounted light tower. They are staffed by the NJSEA and are available to towns free of charge. The GIS group provides data and technical capabilities for District municipalities. 1. The Geographic Information Systems (GIS) group uses state-of-the-art technology to create, maintain and update comprehensive, web-based digital maps and mapping tools for every property in the District. The maps are also a useful, time-saving tool for municipal officials who use property data to manage municipal assets and plan for infrastructure and other improvements. Emergency responders and municipal officials are kept informed of new capabilities and upgrades to the program through GIS' comprehensive training programs, technical support and refresher seminars 2. Maintains a water level alert system and flood maps to first responders and the public. The email and text-based alerts for Meadowlands District towns are sent when water levels reach 5.5 feet and continue to be relayed as the levels rise. The interactive, web-based flood prediction maps include the parts of Meadowlands District municipalities that may flood from sea surge levels of 4 to 8 feet.
	Responsible Agency:	New Jersey Sports Exposition Authority
	Provides Funding for Mitigation:	Yes – See Meadowlands Conservation Trust below
	Hazard:	All

5.3.2 ADMINISTRATIVE AND TECHNICAL CAPABILITY – COUNTY AND LOCAL

Table 5-3 summarizes the administrative and technical capabilities in Hudson County. Detailed information regarding administrative and technical capabilities in the County and the municipalities can be found in each jurisdictional annex found in Volume II, Section 9 (Jurisdictional Annexes).

Table 5-3. Administrative and Technical Capability – County and Local

Capability		
Hudson County Office of Emergency Management	**Description:**	The mission of the Hudson County Office of Emergency Management (HCOEM) is to maintain the highest possible level of preparedness to protect the lives and property of the Hudson County citizenry before, during and after a natural or man-made disaster. The HCOEM works with all emergency responders, public and private agencies, business communities, the Urban Area Security Initiative (UASI), the Regional Catastrophic Planning Group (RCPG) and volunteer organizations to meet this mission. HCOEM works, along with our partners in local, state and federal government, to assist local municipalities within the county in preparing for all of the hazards that pose a threat to our communities. HCOEM strives to lessen the negative effects of disasters on our neighborhoods through hazard mitigation planning and creating partnerships with volunteer, business and community groups. They employ the following four phases of comprehensive emergency management: ▪ Mitigation: Actions taken to eliminate or reduce the degree of long-term risk to human life and property from natural and technological hazards. ▪ Preparedness: Actions taken in advance of an emergency to develop operational capabilities and facilitate an effective response in the event an emergency occurs. ▪ Response: Actions taken immediately before, during, or directly after an emergency occurs, to save lives, minimize damage to property and enhance the effectiveness of recovery. ▪ Recovery: Activity to return vital life support systems to minimal operating standards and long-term activity designed to return life to normal or improved levels. HCOEM provides funding for emergency preparedness for all municipalities through Office of Homeland Security and Preparedness (OHSP) grants and Urban Area Security Initiative (UASI) funds. Police, Fire, EMS and local hospitals are given funding for training to better prepare for upcoming emergencies. HCOEM is leading the 2020 Hudson County HMP update and hosting information about the HMP on their website (http://www.hudsoncountynj.org/hudson-county-hazard-mitigation-planning-hmp-page/) including links to the citizen survey and informational brochure.
	Responsible Agency:	Hudson County Office of Emergency Management
	Provides Funding for Mitigation:	No
	Hazard:	All
Hudson County Division of Planning	**Description:**	The Hudson County Division of Planning provides information and recommendations for the orderly and proper development of the County. The Division provides staff support and technical assistance to the Hudson County Planning Board, the Hudson County Open Space Trust Fund Advisory Board and the Comprehensive Economic Development Strategy "CEDS" Committee. As the manager of the County's Planning Board, the Division of Planning plays a vital role in reviewing all subdivision applications in the County and site plan

Capability		
		applications for development along County roads that may affect traffic and drainage facilities. The Planning Board promotes sustainability and environmentally friendly development through their Land Development Regulations. The Division of Planning serves as the GIS data warehouse for 12 municipalities (excluding Jersey City), all of which rely on the County's GIS software or trained personnel. The Division of Planning is supporting our municipalities as they prepare for the vitally important 2020 Census. The Department supported the update of the 2020 Hudson County HMP, is the primary point of contact for the Hudson County annex, is a member of the Steering Committee and reviewed and contributed to the plan.
	Responsible Agency:	Hudson County Department of Parks and Community Services
	Provides Funding for Mitigation:	Open Space, Recreation and Historic Trust Fund
	Hazard:	All
Hudson County Planning Board	**Description:**	The Hudson County Planning Board was established by a resolution of the Hudson County Board of Chosen Freeholders on September 27, 1962. The Hudson County Planning Board is a semi-autonomous, quasi-judicial body organized under the County Planning Act (N.J.S.A. 40:27-1 et seq.). The Planning Board has jurisdiction over all subdivisions and site plans for development and redevelopment along county roads or affecting county drainage facilities. Hudson County was the first Planning Board in the State to incorporate a Green Infrastructure Technique Checklist in its application to promote sustainability in building and site design. All site plans must meet the minimum requirements of two green techniques outlined by the County's Best Management Practices list (e.g., porous pavers, green roofs). The Planning Board has a shade tree requirement where one street tree shall be provided for every 30 feet of street frontage along a County road. The County has a Low Impact Development Checklist which encourages the use of nonstructural stormwater management strategies and provides guidance in their incorporation in land development projects. The Checklist complements the NJDEP Stormwater Management Rules with additional oversight on vegetation, circulation, pollution prevention and consistency with the Hudson County Master Plan.
	Responsible Agency:	Hudson County Board of Chosen Freeholders
	Provides Funding for Mitigation:	No
	Hazard:	All
Hudson County Division of Engineering	**Description:**	<u>Pre-Disaster</u> • Conduct initial evaluation of traffic routes and county facilities for emergency access routes. • Inspect critical infrastructure and coordinate with any pre-disaster preparation activities • Conduct or assist in operations necessary to reduce the imminent threat of danger, or support other operations directly intended to prevent or minimize injury or illness to the impacted population • Participate in OEM disaster drills, coordination meetings, and any OEM pre-disaster meetings.

Capability		
		• Provide technical support as needed for OEM operations being conducted by Hudson County, or by neighboring OEM jurisdictions, when necessary <u>Post-Disaster</u> • The Hudson County Engineer's office will provide damage assessment of its facilities including structural evaluations. The data will include damage impact, problems and dollar estimates of damage • Engage contractors and professional consultants as necessary under emergency contract to restore damaged county facilities. • The Hudson County Engineer will collect data, inspection reports, bills and any required documentation from County or municipal emergency management coordinators and submit reports to the State OEM or FHWA • Provide maps, plans and assessments of County owned operated facilities as necessary to coordinating agencies as needed. • Record on Post Disaster activities as required by State OEM, FEMA and/or FHWA including, photographs, video, sketches, reports, etc. The County Engineer supported the update of the 2020 Hudson County HMP and sat on the Steering Committee for the planning process.
	Responsible Agency:	
	Provides Funding for Mitigation:	No
	Hazard:	All hazards
Hudson County Division of Housing and Community Development	**Description:**	The Hudson County Division of Housing and Community Development works to end homelessness and promote the development of affordable housing and sound community development activities in Hudson County with the use of federal and local resources. The Hudson County Division of Housing and Community Development (HCD) is responsible for administering Hudson County's annual appropriation of Community Development Block Grant (CDBG), HOME Investment Partnerships Act (HOME) and Emergency Solutions Grant funds (ESG) from the United State Department of Housing and Urban Development (HUD). The Hudson County CDBG Program includes the municipalities of East Newark, Guttenberg, Harrison, Hoboken, Kearny, Secaucus, Weehawken and West New York. The Hudson County ESG Program includes all municipalities with regard to homeless programs participating in the Jersey City-Hudson County Continuum of Care Strategy. The Hudson County Consortium (the "Consortium") for the HOME Program includes the eight communities in the Urban Hudson County, Entitlement municipalities of Bayonne and Union City, and the Township of North Bergen. The Division provides a comprehensive and flexible source of funding for municipalities, non-profits, businesses and families to address a myriad of community, housing and economic development needs. Predominantly serving low and moderate income neighborhoods and families, its programs serve as valuable tools to empower people to create viable urban communities as well as safe, affordable and decent housing opportunities.
	Responsible Agency:	
	Provides Funding for Mitigation:	No, administers U.S. HUD CDBG
	Hazard:	All
Hudson County Department of Roads and Public Property	**Description:**	The Department of Roads and Public Property is committed in its mission to improve the ability to become more resilient throughout Hudson County. They are upgrading pumping capacity on the roads in flood zones. This upgraded capacity will improve outflow on major roads, reduce rerouting of commuters and will result in less down time for law enforcement deployed at the flooded intersections. The Department is constantly cleaning catch basins and culverts

Capability		
		to improve drainage. They are completing an energy allocation grant to provide backup generator power at a critical building. The building provides offices for key administration and financial personnel that must keep the continuity of government going. They have performed mitigation strategies at many of their buildings. They raised all plumbing heating and electrical infrastructure at the Correctional facility which is in a flood prone area. They have also performed the same strategy of raising all utilities in the Emergency Operations Center to allow resiliency during any emergency. The Department of Roads and Public Property is continually finding ways to make improvements in their building stock and roads to make them more resilient for the residents that they serve in Hudson County.
	Responsible Agency:	Department of Roads and Public Property
	Provides Funding for Mitigation:	No
	Hazard:	All
Hudson County Economic Development Corporation	**Description:**	The Hudson County Economic Development Corporation (HCEDC) is focused on job creation and economic development through business attraction and retention. The HCEDC provide leadership, financial assistance and guidance to County businesses by collaboration with local, state and federal partners. Their focus is to cultivate new investments and job growth through programs that assist all communities with environmental issues to create a sustainable, robust and healthy economy for the future of Hudson County. The success of the Hudson County Brownfields programs has resulted in billions of investments in properties that have added to the vitality of our communities and the overall health of our residence.
	Responsible Agency:	
	Provides Funding for Mitigation:	No
	Hazard:	All
Hudson County Municipal Utility Authorities	**Description:**	***Jersey City MUA*** – The Jersey City MUA (JCMUA) operates both the sewerage and water systems of Jersey City. They ensure that all wastewater and stormwater flow to the treatment plan and that fresh water reaches the residents of the City. The mission statement of the JCMUA is: "The Jersey City Municipal Utilities Authority pledges to operate and maintain its sewerage and water facilities in a fashion that will protect the public health and environment of all its constituents. It will always strive to accomplish this goal in the most competent, economical and compassionate manner possible." The JCMUA owns more than 230 miles of sewers and 5,000 catch basins. There are 21 combined sewer overflow points throughout the City that keep raw wastewater from discharging into the rivers. The drinking water in the city flows from the Boonton Reservoir in Boonton, NJ through 26 miles of pipe. There are 240 miles of water pipes throughout the City. ***North Bergen MUA*** – The North Bergen MUA provides wastewater collection and treatment services as well as solid waste and recycling services in order to protect the public safety, welfare, and health of residents within its assigned areas. The wastewater department is responsible for the collection of wastewater from the Townships of North Bergen, Guttenberg and a small portion of Union City. The solid waste department is responsible for the collection and transport of household waste and recyclable materials for the township of North Bergen. ***North Hudson Sewage Authority*** - The North Hudson Sewage Authority dedicates itself to the highest standards of performance. To that end, it has committed itself to developing a private-sector culture within its operations.

Capability		
		The hallmarks of this approach are: rewarding creativity and productivity inside the organization and valuing our ratepayers' interests as stakeholders in the Authority's enterprise. By fostering a culture in which dedication to excellence is paramount, the Board of Commissioners imposes upon itself the discipline to manage its business cost-effectively, to fulfill its obligations with honesty and integrity, to maintain the highest ethical standards throughout the organization, and to discharge its most important responsibility as a protector of one of the most important waterways in the world, the Hudson River. ***Secaucus MUA*** - The Secaucus MUA is responsible for processing all of the wastewater generated within the Township of Secaucus. The Authority owns and operates seven pumping stations that vary in capacity from approximately 30,000 gallons per day to over two million gallons per day. Additionally, the Authority maintains approximately 10 miles of collection system piping. This collection system is maintained in conjunction with the Department of Public Works and preventative maintenance is routinely performed. The wastewater treatment facility currently processes 3,100,000 gallons per day. ***Kearny MUA*** - The Kearny MUA (KMUA) was created by the mayor and council of the Town of Kearny in May 1988. KMUA is responsible for the collection of stormwater and wastewater from portions of Meadowlands and the South Kearny sections of the Town. It is also responsible for removing solids from the wastewater and pumping it to the Passaic Valley Sewerage Commission in Newark for final treatment. The KMUA maintains one 17.5 million gallon per day capacity pumping station in South Kearny and three smaller pumping stations in the Kearny Meadowlands.
	Responsible Agency:	Each individual MUA
	Provides Funding for Mitigation:	
	Hazard:	All
Hudson County Parks	**Responsible Agency:**	The Hudson County Division of Parks oversees, maintains and regularly improves our outstanding County Park System. The system encompasses 616 total acres of active and passive recreation space.
	Provides Funding for Mitigation:	No
	Hazard:	All
	Responsible Agency:	Hudson County Department of Parks and Community Services
Hudson County Regional Health Commission	**Responsible Agency:**	Hudson County Regional Health Commission oversees the following programs: 1. Environmental Health 2. Public Health Emergency Preparedness 3. Mosquito Control 4. Childhood Lead Exposure Prevention The Public Health Emergency Preparedness program strives to protect Hudson County residents from natural and manmade public health emergencies and threats through education, planning and exercising. They work closing with Hudson County OEM as well as municipal emergency management coordinators to ensure a coordinated response to emergencies countywide. Hudson County participates in the Health Alert Network. In addition, Hudson County Regional Health coordinates the Medical Reserve Corps, Health Alert Network and Points of Distribution. Hudson County Regional Health Commission Public Health Officer served on the Steering Committee, attended meetings and contributed to the 2020 HMP update.
	Provides Funding for Mitigation:	No

Capability		
	Hazard:	All
	Responsible Agency:	NJDEP delegated authority to the Commission to implement environmental health programs and the Worker and Community Right to Know.
Hudson Essex Passaic Soil Conservation District	**Description:**	The Hudson Essex Passaic Soil Conservation District, serving three counties, is a special purpose subdivision of the State of New Jersey Dept of Ag: Division of Ag & Natural Resources. HEPSCD is one of 15 soil conservation districts in New Jersey empowered to conserve and manage soil and water resources in cooperation with the State Soil Conservation Committee. The District addresses stormwater, soil erosion and sedimentation issues that result from land disturbance activities (primarily construction). District certification of plans for qualifying projects is a prerequisite to local construction permits. The mission of the New Jersey Conservation Partnership is to provide leadership in the planning and implementation of natural resource management programs for the agricultural and development communities and the general public through a locally based delivery system in coordination with local, state and federal partners.
	Responsible Agency:	State of New Jersey Dept of Agriculture
	Provides Funding for Mitigation:	No
	Hazard:	All
Sustainable Jersey	**Description:**	Sustainable Jersey is a nonprofit organization that provides tools, training and financial incentives to support communities as they pursue sustainability programs. By supporting community efforts to reduce waste, cut greenhouse gas emissions, and improve environmental equity, Sustainable Jersey aims to empower communities to build a better world for future generations. The organization also offers a certification program. Sustainable Jersey certification is a designation for municipal governments in New Jersey. All actions taken by municipalities to score points toward certification must be accompanied by documentary evidence and is reviewed. The certification is free and completely voluntary.
	Responsible Agency:	Hudson County Environmental Commission
	Provides Funding for Mitigation:	No
	Hazard:	All
Sustainable Hudson Alliance (SEA)	**Description:**	Regional hubs have formed across New Jersey and are comprised of municipal and schools green team and environmental commission members, municipal and county representatives, and business, community and nonprofit leaders. The hub in Hudson County is called the Sustainable Hudson Alliance (SEA) is a coalition of local municipal green teams and sustainability organizations working together to create solutions for local environments and economies. The Alliance is currently pursuing a renewable community energy aggregation program to provide residents of Hudson County with the option of 100% green energy. The Alliance has also initiated the NJ Home Performance with ENERGYSTAR™ Program and Comfort Partners Program that offer rebates and financing for energy efficiency upgrades, insulation, and helpful assessments to reduce bills and environmental impact. Participating communities include: Belleville, Bloomfield, Caldwell, Cedar Grove, East Orange, Hudson Fells, Fairfield, Glen Ridge, Irvington, Livingston, Maplewood, Millburn, Montclair, Newark, North Caldwell, Nutley, Orange, Roseland, South Orange, Verona, West Caldwell, and West Orange.
	Responsible Agency:	Sustainable Jersey
	Provides Funding for Mitigation:	No
	Hazard:	All

Capability		
County and Municipal Emergency Management Coordinators	**Description:**	According to NJSA Appendix A:9-33 et seq. (Chapter 251 P.L. 1942, as amended by Chapter 438, P.L. 1953) each municipality appoints a Municipal Emergency Management, serving a term of three years, and is responsible for planning, activating, coordinating and conducting emergency management operations within the municipality. The County holds regular meetings and Coordinators attend training/exercises. For example, the UASCI region provided funding to Kean University Fire Safety to provide training on the utilization of tenders in community. Several Hudson County municipalities attended including: Belleville, Cedar Grove, Montclair and North Caldwell https://www.keanfiresafety.com/uasi/
	Responsible Agency:	Municipalities
	Provides Funding for Mitigation:	No
	Hazard:	All
Regional Marine Vessels Memorandum of Understanding	**Description:**	The New Jersey side of the Port of New York /New Jersey covers 50 miles with no central control since it is divided into 13 distinct municipalities. A Memorandum of Understanding among the 13 New Jersey cities (Regional Marine Vessel group) was proposed to coordinate and cooperate with each other on the response and/or sharing of resources that is critical to an effective regional response. The following parties in the MOU within Hudson County are: 1. North Hudson Regional Fire and Rescue; 2. Jersey City Fire Department; 3. Hoboken Fire Department; 4. Bayonne Fire Department; 5. Kearny Fire Department; 6. Secaucus Fire Department
	Responsible Agency:	Port of New York and New Jersey
	Provides Funding for Mitigation:	No
	Hazard:	All

5.4 Fiscal Capabilities

Fiscal capabilities are the resources that a jurisdiction has access to or is eligible to use to fund mitigation actions. The table below provides a list of programs, descriptions, and links for those jurisdictions seeking funding sources. This table is not intended to be a comprehensive list, but rather a tool to help begin identifying potential sources of funding.

Table 5-4. Fiscal Capabilities

Capability		
Federal		
Hazard Mitigation Grant Program	**Description:**	The HMGP is a post-disaster mitigation program. FEMA makes these grants available to states by after each federal disaster declaration. The HMGP can provide up to 75 percent funding for hazard mitigation measures and can be used to fund cost-effective projects that will protect public or private property or that will reduce the likely damage from future disasters in an area covered by a federal disaster declaration. Examples of projects include acquisition and demolition of structures in hazard prone areas, flood-proofing or elevation to reduce future damage, minor structural improvements, and development of state or local standards. Projects must fit into an overall mitigation strategy for the area identified as part of a local planning effort. All applicants must have a FEMA-approved HMP (this plan). Additional information regarding the HMGP is available on the FEMA website: https://www.fema.gov/hazard-mitigation-grant-program Hudson County has received HMGP funding, including funding to purchase generators to provide continuity of operations during utility failures.

Capability		
	Responsible Agency:	FEMA
	Provides Funding for Mitigation:	Yes
	Hazard:	All
Flood Mitigation Assistance Program	**Description:**	The FMA program combines the previous Repetitive Flood Claims and Severe Repetitive Loss Grants into one grant program. The FMA provides funding to assist states and communities in implementing measures to reduce or eliminate the long-term risk of flood damage to buildings, manufactured homes, and other structures insurable under the NFIP. The FMA is funded annually; no federal disaster declaration is required. Only NFIP insured homes and businesses are eligible for mitigation in this program. Funding for FMA is very limited and, as with the HMGP, individuals cannot apply directly for the program. Applications must come from local governments or other eligible organizations. The federal cost share for an FMA project is at least 75 percent. For the nom-federal share, at most 25 percent of the total eligible costs must be provided by a non-federal source; of this 25 percent, no more than half can be provided as in-kind contributions from third parties. At minimum, a FEMA-approved local flood mitigation plan is required before a project can be approved. The FMA funds are distributed from FEMA to the state. NJOEM serves as the grantee and program administrator for the FMA program. The FMA program is detailed on the FEMA website: https://www.fema.gov/flood-mitigation-assistance-grant-program.
	Responsible Agency:	FEMA
	Provides Funding for Mitigation:	Yes
	Hazard:	Flood, Severe Weather, Coastal Storms
Pre-Disaster Mitigation Program	**Description:**	The PDM program is an annually funded, nationwide, competitive grant program. No disaster declaration is required. Federal funds will cover 75 percent of a project's cost up to $3 million. As with the HMGP and FMA, a FEMA-approved local HMP is required to be approved for funding under the PDM program. The PDM program is detailed on the FEMA website: https://www.fema.gov/pre-disaster-mitigation-grant-program. Hudson County used the PDM program to fund this 2020 HMP update.
	Responsible Agency:	FEMA
	Provides Funding for Mitigation:	Yes
	Hazard:	All
Individual Assistance	**Description:**	Individual Assistance (IA) provides help for homeowners, renters, businesses, and some non-profit entities after disasters occur. This program is largely funded by the U.S. Small Business Administration. For homeowners and renters, those who suffered uninsured or underinsured losses could be eligible for a Home Disaster Loan to repair or replace damaged real estate or personal property. Renters are eligible for loans to cover personal property losses. Individuals are allowed to borrow up to $200,000 to repair or replace real estate, $40,000 to cover losses to personal property, and an additional 20 percent for mitigation. For businesses, loans could be made to repair or replace disaster damages to property owned by the business, including real estate, machinery and equipment, inventory, and supplies. Businesses of any size are eligible. Non-profit organizations, such as charities, churches, and private universities are eligible. An Economic Injury Disaster Loan provides necessary working capital until normal operations resume after a physical disaster but are restricted by law to small businesses only. IA is detailed on the FEMA website: https://www.fema.gov/individual-disaster-assistance.

Capability		
	Responsible Agency:	FEMA
	Provides Funding for Mitigation:	Yes
	Hazard:	All
Public Assistance	**Description:**	Public Assistance (PA) provides cost reimbursement aid to local governments (state, county, local, municipal authorities, and school districts) and certain non-profit agencies that were involved in disaster response and recovery programs or that suffered loss or damage to facilities or property used to deliver government-like services. This program is largely funded by FEMA with both local and state matching contributions required. PA is detailed on the FEMA website: https://www.fema.gov/public-assistance-local-state-tribal-and-non-profit.
	Responsible Agency:	FEMA
	Provides Funding for Mitigation:	Yes
	Hazard:	All
Department of Homeland Security Grant Program	**Description:**	The Homeland Security Grant Program (HSGP) plays an important role in the implementation of the National Preparedness System by supporting the building, sustainment, and delivery of core capabilities essential to achieving the National Preparedness Goal of a secure and resilient nation. In FY 2019, the total amount of funds available under HSGP was $1.095 billion. HSGP is comprised of three interconnected grant programs including the State Homeland Security Program, Urban Areas Security Initiative (UASI), and the Operation Stonegarden. Together, these grant programs fund a range of preparedness activities, including planning, organization, equipment purchase, training, exercises, and management and administration. Hudson County is part of the Jersey City/Newark UASI region. The UASI program provides funding to address the unique multi-discipline planning, operations, equipment, and training and exercise needs of high-threat, high-density urban areas and to assist in building and sustaining capabilities related to terrorism prevention, protection, mitigation, response, and recovery. Additional information regarding HSGP is available on the website: https://www.fema.gov/homeland-security-grant-program.
	Responsible Agency:	FEMA
	Provides Funding for Mitigation:	Yes
	Hazard:	All
Fire Management Assistance Grant Program	**Description:**	Assistance for the mitigation, management, and control of fires on publicly or privately-owned forests or grasslands that threaten such destruction as would constitute a major disaster. Provides a 75% federal cost share and the state pays the remaining 25% for actual cost. Information on this program is available on the website: https://www.fema.gov/fire-management-assistance-grant-program.
	Responsible Agency:	FEMA
	Provides Funding for Mitigation:	Yes
	Hazard:	Wildfire
	Description:	The primary goal of the Assistance to Firefighters Grants is to enhance the safety of the public and firefighters with respect to fire-related hazards by providing direct financial assistance to eligible fire

Capability		
Assistance to Firefighters Grant Program		departments, nonaffiliated Emergency Medical Services organizations, and State Fire Training Academies. This funding is for critically needed resources to equip and train emergency personnel to recognized standards, enhance operations efficiencies, foster interoperability, and support community resilience. Information regarding this grant program is available on the website: https://www.fema.gov/welcome-assistance-firefighters-grant-program.
	Responsible Agency:	FEMA
	Provides Funding for Mitigation:	Yes
	Hazard:	-
High Hazard Potential Dams Grant Program	**Description:**	The Rehabilitation of High Hazard Potential Dams Grant Program provides technical, planning, design, and construction assistance in the form of grants to non-Federal governmental organizations or nonprofit organizations for rehabilitation of eligible high hazard potential dams. Information regarding this program is available on the website: https://www.grants.gov/web/grants/view-opportunity.html?oppId=316238.
	Responsible Agency:	FEMA
	Provides Funding for Mitigation:	Yes
	Hazard:	Dam Failure
Small Business Administration Loan	**Description:**	The Small Business Administration (SBA) provides low-interest disaster loans to homeowners, renters, business of all sizes, and most private nonprofit organizations. SBA disaster loans can be used to repair or replace the following items damaged or destroyed in a declared disaster: real estate, personal property, machinery and equipment, and inventory and business assets. Homeowners could apply for up to $200,000 to replace or repair their primary residence. Renters and homeowners could borrow up to $40,000 to replace or repair personal property-such as clothing, furniture, cars, and appliances that were damaged or destroyed in a disaster. Physical disaster loans of up to $2 million are available to qualified businesses or most private nonprofit organizations. Additional information regarding SBA loans is available on the SBA website: https://www.sba.gov/managing-business/running-business/emergency-preparedness/disaster-assistance.
	Responsible Agency:	SBA
	Provides Funding for Mitigation:	Yes
	Hazard:	All
Community Development Block Grant Program	**Description:**	CDBG are federal funds intended to provide low and moderate-income households with viable communities, including decent housing, a suitable living environment, and expanded economic opportunities. Eligible activities include community facilities and improvements, roads and infrastructure, housing rehabilitation and preservation, development activities, public services, economic development, and planning and administration. Public improvements could include flood and drainage improvements. In limited instances and during the times of “urgent need” (e.g., post disaster) as defined by the CDBG National Objectives, CDBG funding could be used to acquire a property located in a floodplain that was severely damaged by a recent flood, demolish a structure severely damaged by an earthquake, or repair a public facility severely damaged by a hazard event. Additional information regarding CDBG is available on the website: https://www.hudexchange.info/programs/cdbg-entitlement/.

Capability		
	Responsible Agency:	HUD
	Provides Funding for Mitigation:	Yes
	Hazard:	All
Federal Highway Administration-Emergency Relief	**Description:**	The Federal Highway Administration (FHWA) Emergency Relief is a grant program through the U.S. Department of Transportation (DOT) that can be used for repair or reconstruction of federal-aid highways and roads on federal lands that have suffered serious damage as a result of a disaster. New Jersey Department of Transportation serves as the liaison between local municipalities and FHWA. Additional information regarding the FHWA Emergency Relief Program is available on the website: https://www.fhwa.dot.gov/programadmin/erelief.cfm.
	Responsible Agency:	U.S. DOT
	Provides Funding for Mitigation:	Yes
	Hazard:	All
Federal Transit Administration - Emergency Relief	**Description:**	The Federal Transit Authority (FTA) Emergency Relief is a grant program that funds capital projects to protect, repair, reconstruct, or replace equipment and facilities of public transportation systems. Administered by the Federal Transit Authority at the U.S. DOT and directly allocated to Metropolitan Transit Authority (MTA) and Port Authority, this transportation-specific fund was created as an alternative to FEMA PA. Currently, a total of $5.2 billion has been allocated to New Jersey-related entities. Additional information regarding the FTA Emergency Relief Program is available on the website: https://www.transit.dot.gov/funding/grant-programs/emergency-relief-program/emergency-relief-program.
	Responsible Agency:	U.S. DOT
	Provides Funding for Mitigation:	Yes
	Hazard:	All
Disaster Housing Program	**Description:**	Emergency assistance for housing, including minor repair of home to establish livable conditions, mortgage and rental assistance available through the U.S. Department of Housing and Urban Development (HUD). Information on this program is available on the website: https://www.hud.gov/program_offices/public_indian_housing/publications/dhap.
	Responsible Agency:	HUD
	Provides Funding for Mitigation:	Yes
	Hazard:	All
HOME Investment Partnerships Program	**Description:**	Grants to local and state government and consortia for permanent and transitional housing, (including financial support for property acquisition and rehabilitation for low income persons). Information on this program is available on the website: https://www.hud.gov/program_offices/comm_planning/affordablehousing/programs/home/.
	Responsible Agency:	HUD
	Provides Funding for Mitigation:	Yes

Capability		
	Hazard:	-
HUD Disaster Recovery Assistance	**Description:**	Grants to fund gaps in available recovery assistance after disasters (including mitigation). Information on this program is available on the website: https://www.hud.gov/info/disasterresources.
	Responsible Agency:	HUD
	Provides Funding for Mitigation:	Yes
	Hazard:	All
Section 108 Loan Guarantee	**Description:**	Enables states and local governments participating in the CDBG program to obtain federally guaranteed loans for disaster-distressed areas. Information on this program is available on the website: https://www.hudexchange.info/programs/section-108/.
	Responsible Agency:	HUD
	Provides Funding for Mitigation:	Yes
	Hazard:	All
Smart Growth Implementation Assistance program	**Description:**	The Smart Growth Implementation Assistance (SGIA) program through the U.S. Environmental Protection Agency (EPA) focuses on complex or cutting-edge issues, such as stormwater management, code revision, transit-oriented development, affordable housing, infill development, corridor planning, green building, and climate change. Applicants can submit proposals under 4 categories: community resilience to disasters, job creation, the role of manufactured homes in sustainable neighborhood design, or medical and social service facilities siting. Information on this program is available on the website: https://www.epa.gov/smartgrowth.
	Responsible Agency:	EPA
	Provides Funding for Mitigation:	Yes
	Hazard:	-
Partners for Fish and Wildlife	**Description:**	Financial and technical assistance to private landowners interested in pursuing restoration projects affecting wetlands and riparian habitats. Information on this program is available on the website: https://www.fws.gov/partners/.
	Responsible Agency:	U.S. Fish and Wildlife Service
	Provides Funding for Mitigation:	Yes
	Hazard:	-
Transportation Investment Generating Economic Recovery (TIGER)	**Description:**	Investing in critical road, rail, transit and port projects across the nation. Information on this program is available on the website: https://www.transportation.gov/tags/tiger-grants.
	Responsible Agency:	U.S. DOT
	Provides Funding for Mitigation:	Yes
	Hazard:	-

Capability		
Community Facilities Direct Loan & Grant Program	**Description:**	This program provides affordable funding to develop essential community facilities in rural areas. An essential community facility is defined as a facility that provides an essential service to the local community for the orderly development of the community in a primarily rural area, and does not include private, commercial or business undertakings. Information on this program is available on the website: https://www.rd.usda.gov/programs-services/community-facilities-direct-loan-grant-program.
	Responsible Agency:	USDA
	Provides Funding for Mitigation:	Yes
	Hazard:	-
Emergency Loan Program	**Description:**	USDA's Farm Service Agency provides emergency loans to help producers recover from production and physical losses due to drought, flooding, other natural disasters or quarantine. Information on this program is available on the website: https://www.fsa.usda.gov/programs-and-services/farm-loan-programs/emergency-farm-loans/index.
	Responsible Agency:	USDA
	Provides Funding for Mitigation:	Yes
	Hazard:	All natural hazards
Emergency Watershed Protection program	**Description:**	The Emergency Watershed Protection (EWP) program provides assistance to relieve imminent hazards to life and property caused by floods, fires, drought, windstorms, and other natural occurrences through the Natural Resources Conservation Service. Information on this program is available on the website: https://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/landscape/ewpp/.
	Responsible Agency:	USDA
	Provides Funding for Mitigation:	Yes
	Hazard:	All-natural hazards
Financial Assistance	**Description:**	Financial assistance to help plan and implement conservation practices that address natural resource concerns or opportunities to help save energy, improve soil, water, plant, air, animal and related resources on agricultural lands and non-industrial private forest land. Information on this program is available on the website: https://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/financial/.
	Responsible Agency:	NRCS
	Provides Funding for Mitigation:	Yes
	Hazard:	-
Emergency Management Performance Grants (EMPG) Program	**Description:**	Assist local, tribal, territorial, and state governments in enhancing and sustaining all-hazards emergency management capabilities. Information on this program is available on the website: https://www.fema.gov/emergency-management-performance-grant-program
	Responsible Agency:	U.S. DHS

Capability		
	Provides Funding for Mitigation:	Yes
	Hazard:	All
Reimbursement for Firefighting on Federal Property	**Description:**	Provides reimbursement only for direct costs and losses over and above normal operating costs. Information on this program is available on the website: https://www.usfa.fema.gov/grants/firefighting_federal_property.html.
	Responsible Agency:	U.S. DHS
	Provides Funding for Mitigation:	Yes
	Hazard:	Fire
Land & Water Conservation Fund	**Description:**	Matching grants to states and local governments for the acquisition and development of public outdoor recreation areas and facilities (as well as funding for shared federal land acquisition and conservation strategies). Information on this program is available on the website: https://www.nps.gov/subjects/lwcf/index.htm.
	Responsible Agency:	National Park Service
	Provides Funding for Mitigation:	Yes
	Hazard:	-
State		
New Jersey Clean Energy Program	**Description:**	New Jersey's Clean Energy Program (NJCEP) promotes increased energy efficiency and the use of clean, renewable sources of energy including solar, wind, geothermal, and sustainable biomass. The results for New Jersey are a stronger economy, less pollution, lower costs, and reduced demand for electricity. NJCEP offers financial incentives, programs, and services for residential, commercial, and municipal customers. Refer to https://www.njcleanenergy.com/main/about-njcep/about-njcep for additional details on NJCEP. The program also offers a Community Energy Plan Grant for government entities (e.g. municipality, county, Green Team or environmental commission, or other Sustainable Jersey organization within a community or county). The grant will provide funding for an entity to create a Community Energy Master Plan to align local communities with the State Energy Master Plan
	Responsible Agency:	New Jersey Board of Public Utilities
	Provides Funding for Mitigation:	Yes
	Hazard:	Hazards impacted by climate change
Grant and Loan Programs	**Description:**	NJDEP offers a wide variety of funding opportunities for local governments and other types of organizations to fund numerous environmentally based projects. This includes funding for: air quality, energy, and sustainability; compliance and enforcement; engineering and construction; land use management; local government assistance; natural and historic resources; site remediation and waste management programs; and water resource management. Information on each of the programs can be found on the NJDEP website: https://www.nj.gov/dep/grantandloanprograms/.
	Responsible Agency:	NJDEP
	Provides Funding for Mitigation:	Yes

Capability		
	Hazard:	All
Green Acres Program	**Description:**	Green Acres was created to meet New Jersey's growing recreation and conservation needs. This program has helped preserve over 1.2 million acres of land in New Jersey. Not only are state Green Acres funding available, but Hudson County enacted its own county green acres tax to provide funding for the state program match, as well as for other recreation and open space programs (see below). Hudson County has used the Green Acres Program to acquire open space, with a majority of land being municipal- or county-owned. Green Acres open space exists in: Belleville, Bloomfield, Caldwell, Cedar Grove, East Orange, Hudson Fells, Fairfield, Glen Ridge, Irvington, Livingston, Maplewood, South Orange, Millburn, Montclair, Newark, North Caldwell, Nutley, Orange, Roseland, South Orange, Verona, West Caldwell, and West Orange.
	Responsible Agency:	NJDEP
	Provides Funding for Mitigation:	Yes
	Hazard:	-
Blue Acres Program	**Description:**	Blue Acres provides funding for acquisition of land in floodways of the Delaware River, Passaic River, and Raritan River and their respective tributaries, for recreation and conservation purposes. Properties (including structures) that have been damaged by, or may be prone to incurring damage caused by, storms or storm-related flooding, or that may buffer or protect other lands from such damage, are eligible for acquisition. The Blue Acres Program is active in 16 municipalities currently, including Newark in Hudson County.
	Responsible Agency:	NJDEP
	Provides Funding for Mitigation:	Yes
	Hazard:	Flood, Severe Weather, Coastal Storm
New Jersey Water Bank	**Description:**	The New Jersey Water Bank (NJWB) is a partnership between the NJDEP and the NJEIT to provide low cost financing for the design, construction, and implementation of projects that help protect and improve water quality and help ensure safe and adequate drinking water. The NJWB finances projects by utilizing two funding sources. The Trust issues revenue bonds which are used in combination with zero percent interest funds to provide very low interest loans for water infrastructure improvements. The NJDEP administers a combination of Federal State Revolving Fund capitalization grants, as well as the State's matching funds, loan repayments, State appropriations and interest earned on such funds.
	Responsible Agency:	NJDEP and New Jersey Environmental Infrastructure Trust
	Provides Funding for Mitigation:	Yes
	Hazard:	Flood, Severe Weather
New Jersey Redevelopment Authority	**Description:**	The New Jersey Redevelopment Authority (NJRA) is an independent state financing authority committed exclusively to the redevelopment of New Jersey's urban areas. NJRA offers several financing resources including site acquisition funding, predevelopment assistance, several development assistance resources, and technical assistance.
	Responsible Agency:	-
	Provides Funding for Mitigation:	Yes
	Hazard:	-

Capability		
New Jersey Department of Community Affairs	**Description:**	The New Jersey Department of Community Affairs (NJDCA) is a state agency created to provide administrative guidance, financial support, and technical assistance to local governments, community development organizations, businesses, and individuals to improve the quality of life in New Jersey. NJDCA offers a wide range of programs, funding, and services that respond to issues of public concern including fire and building safety, housing production, community planning and development, and local government management and finance. Among other funding sources, NJDCA administers CDBG funding and is typically the CDBG-Disaster Relief funding recipient for the State of New Jersey.
	Responsible Agency:	-
	Provides Funding for Mitigation:	Yes
	Hazard:	-
New Jersey Board of Public Utilities	**Description:**	The New Jersey Board of Public Utilities (BPU) works with private utility companies to provide analysis of natural hazard information affecting the provision of electric power, telecommunications, public water, sewage collection and treatment, and other regulated public utilities. The data are used during response and recovery efforts in the event of emergency or disaster and is also used to analyze impact of mitigation plans and projects. BPU also provides technical assistance for the Energy Resiliency Program
	Responsible Agency:	BPU
	Provides Funding for Mitigation:	Yes
	Hazard:	All
Environmental Infrastructure Financing Program	**Description:**	Qualified borrowers receive loans in two equal parts: Approximately one half to three quarters comes from a 0-interest State Revolving Fund maintained by the NJDEP. The other portion comes from proceeds of highly rated tax-exempt revenue bonds sold by the Trust. Combining these two funds results in a loan that is 50 to 75% lower than traditional loan rates.
	Responsible Agency:	NJDEP
	Provides Funding for Mitigation:	Yes
	Hazard:	-
New Jersey Small Cities Communities Development Block Grants	**Description:**	The New Jersey Small Cities Communities Development Block Grants provide funds for economic development, housing rehabilitation, community revitalization, and public facilities designated to benefit people with low and moderate incomes, or to address recent local needs for which no other source of funding is available to non-entitlement counties and municipalities. Information on the program is available on the website: https://www.nj.gov/dca/divisions/dhcr/offices/neighborhood.html.
	Responsible Agency:	NJDCA
	Provides Funding for Mitigation:	Yes
	Hazard:	-
New Jersey Conservation Foundation	**Description:**	The New Jersey Conservation Foundation (NJCF) is a private, not-for-profit organization. Through acquisition and stewardship, NJCF protects strategic lands, promotes strong land use policies, and forges partnerships to achieve conservation goals. Grants to help fund preservation activities. Information on the program is available on the website: https://www.njconservation.org/what-we-do/.
	Responsible Agency:	NJCF

Capability		
	Provides Funding for Mitigation:	Yes
	Hazard:	-
The New Jersey Infrastructure Bank	**Description:**	Two programs provide and administer low interest rate loans to qualified municipalities, counties, regional authorities, and water purveyors in New Jersey. Approximately $350 million is awarded annually. 1. NJEIT for the purpose of financing water quality infrastructure projects that enhance ground and surface water resources, ensure the safety of drinking water supplies, protect the public health and make possible responsible and sustainable economic development. 2. The New Jersey Transportation Infrastructure Bank (NJTIB) is an independent State Financing Authority responsible for providing and administering low interest rate loans to qualified municipalities, counties, and regional authorities in New Jersey for the purpose of financing transportation quality infrastructure projects. Information on the program is available on the website: https://www.njib.gov/.
	Responsible Agency:	NJDEP
	Provides Funding for Mitigation:	Yes
	Hazard:	-
Drinking Water State Revolving Fund	**Description:**	The DWSRF program assists water systems in financing the cost of infrastructure through the use of federal and New Jersey Infrastructure Trust funds. Additionally, the Water Supply program provides operator licensing and training support as well as financial assistance through the DWSRF program. Information on the program is available on the website: https://www.state.nj.us/dep/watersupply/dws_loans.html.
	Responsible Agency:	NJDEP
	Provides Funding for Mitigation:	Yes
	Hazard:	-
New Jersey Department of Transportation (NJDOT)	**Description:**	Funding of the Program is typically federal through the Federal Highway Administration or State through the Transportation Trust Fund. Information on the program is available on the website: https://www.state.nj.us/transportation/business/localaid/funding.shtm.
	Responsible Agency:	NJDOT
	Provides Funding for Mitigation:	Yes
	Hazard:	-
Meadowlands Conservation Trust	**Description:**	Established by an act of the New Jersey State Legislature in 1999 and empowered to obtain land through fee simple acquisitions and conservation easements for the purpose of permanently preserving wetlands, waterways, woodlands and other environmentally sensitive open space in the New Jersey portion of the Hackensack River Watershed which includes Hudson County.
	Responsible Agency:	New Jersey Sports Exposition Authority
	Provides Funding for Mitigation:	Yes
	Hazard:	Flood, storm surge, storms, climate change
Energy Efficiency Incentives	**Description:**	The NJSEA promotes the use of renewable and sustainable energy systems and other energy efficiency measures by offering incentives to companies and developers whose projects include

Capability		
		aspects of sustainable building practices, such as solar power, recycled materials and energy-efficient heating and lighting systems.
	Responsible Agency:	New Jersey Sports Exposition Authority
	Provides Funding for Mitigation:	Benefits include reduced fees for zoning certificate and plan review applications as well as priority reviews.
	Hazard:	
Local		
Transportation Alternatives Set Aside Program	**Description:**	Funded through the FHWA's Federal Aid Program and administered by the New Jersey DOT, in partnership with the North Jersey Transportation Planning Authority, Transportation Alternatives Set Aside Program (TAP) provides federal funds for community based "non-traditional" projects designed to strengthen the cultural, aesthetic, and environmental aspects of the nation's intermodal system. TAP was established by Congress in 2012 under MAP-21 and is funded through a set-aside of the Federal-aid Highway Program.
	Responsible Agency:	Hudson County Division of Planning
	Provides Funding for Mitigation:	No
	Hazard:	Flood
Hudson County Open Space, Recreation and Historic Preservation Trust Fund	**Description:**	The Hudson County Open Space, Recreation and Historic Preservation Trust Fund was established in 2003 after approval by a two-to-one majority of County voter participants. The Board of Chosen Freeholders annually approves the property tax rate which funds the Trust Fund. Recreation and Open Space Trust Fund shall be used for any or all of the following purposes or any combination thereof as determined by the governing body: A. Acquisition of lands for recreation and conservation purposes. B. Development of lands acquired for recreation and conservation purposes. C. Maintenance of lands acquired for recreation and conservation purposes. D. Acquisition of farmland for farmland preservation purposes. E. Historic preservation of historic properties, structures, facilities, sites, areas or objects, and the acquisition of such properties, structures, facilities, sites, areas or objects for historic preservation purposes. F. Payment of debt service on indebtedness issued or incurred by the County of Hudson for any of the above purposes, except for Subsection C above.
	Responsible Agency:	Hudson County Recreation and Open Space Trust Fund Advisory Board
	Provides Funding for Mitigation:	No
	Hazard:	All

5.5 Plan Integration

Described earlier in this section and within each annex, participating jurisdictions identified integration of hazard risk management into their existing planning, regulatory, and operational/administrative framework ("integration capabilities") and intended integration promotion (integration actions). Volume II, Section 9 (Jurisdictional Annexes) provides details on how each jurisdiction integrates hazard mitigation into their existing capabilities.

5.5.1 INTEGRATION PROCESS

Hazard mitigation is a sustained action taken to reduce or eliminate the long-term risk to human life and property from hazards. Integrating hazard mitigation into a community's existing plans, policies, codes, and programs leads to development patterns that do not increase risk from known hazards or leads to redevelopment that reduces risk from known hazards. The Hudson County Planning Partnership was tasked with identifying how hazard mitigation is integrated into existing planning mechanisms. Section 9 (Jurisdictional Annexes) details how this is done for each participating municipality and the County. During this process, many municipalities recognized the importance and benefits of incorporating hazard mitigation into future municipal planning and regulatory processes and have added new mitigation actions to support this effort.

The Planning Partnership representatives will continue to incorporate mitigation planning as an integral component of daily government operations. Planning Partnership representatives will continue to work with local government officials to integrate the newly adopted hazard mitigation goals and actions into the general operations of government and partner organizations. Further, the sample adoption resolution presented in Appendix A (Plan Adoption) includes a resolution item stating the intent of the local governing body to incorporate mitigation planning as an integral component of government and partner operations. By doing so, the Planning Partnership anticipates that:

1. Hazard mitigation planning will be formally recognized as an integral part of overall planning and emergency management efforts.
2. The Hazard Mitigation Plan, Comprehensive Plans, Emergency Management Plans, and other relevant planning mechanisms will become mutually supportive documents that work in concert to meet the goals and needs of County residents.

Section 7 (Plan Maintenance) provides for additional information on the implementation of the mitigation plan through existing programs.

SECTION 6. MITIGATION STRATEGY

This section presents the process by which Hudson County will reduce or eliminate potential losses from the natural hazards identified in Section 4.2 (Hazard Identification) of this HMP. The mitigation strategy focuses on existing and potential future mitigation actions to alleviate the effects of hazards on Hudson County's population, economy, environment and general building stock.

The Steering Committee reviewed the results of the risk assessment and capability assessment to identify and develop mitigation actions, which are presented herein. This section includes:

1. Background and Past Mitigation Accomplishments
2. General Planning Approach
3. Review and Update of Mission Statement, Mitigation Goals and Objectives
4. Mitigation Strategy Development

Hazard mitigation reduces the potential impacts of, and costs associated with, emergency and disaster-related events. Mitigation actions address a range of impacts, including impacts on the population, property, the economy, and the environment.

Mitigation actions can include activities such as: revisions to land-use planning, training and education, and structural and nonstructural safety measures.

2020 HMP Changes

- The mission statement, goals and objectives were updated to align with County and local priorities.
- The capability assessment was moved to Section 5.
- A Strengths, Weaknesses, Obstacles and Opportunities exercise was conducted for the high-ranked hazards to inform the updated mitigation strategy.
- A stakeholder workshop was held to obtain a comprehensive understanding of capabilities and problem areas to inform the updated mitigation strategy.

6.1 BACKGROUND AND PAST MITIGATION ACCOMPLISHMENTS

In accordance with the requirements of the DMA 2000, a discussion regarding past mitigation activities and an overview of past efforts is provided as a foundation for understanding the mitigation goals, objectives, and activities outlined in this plan update. Hudson County, through previous and ongoing hazard mitigation activities, has demonstrated that it is proactive in protecting its physical assets and citizens against losses from natural hazards. Examples of previous and ongoing County actions and projects include the following. Refer to Section 9 (Jurisdictional Annexes) for progress on municipal and MUA previous actions.

- Installation of generators at critical facilities in the County (e.g., Jersey City Campus Shelter, Hudson County School of Technology; County property 830 Bergen Avenue) (DR-4086).
- A Fire Boat Task Force was established in the region to increase capacity to fight fires.
- Water Tender training was hosted at Keane University and attended by municipalities in the County.
- Hudson County OEM and Hudson Regional Health participated in a State emergency exercise that focused on the emergency delivery of medicine for distribution.
- Lincoln Park West Wetland Restoration – Restored approximately 34 acres of wetlands and 11 acres of wetland transition area along the Hackensack River in Jersey City; funded by NOAA, Harbor Spill Restoration Committee and

Office of Natural Resource Restoration. The project was a partnership with NJDEP, NOAA, USACE, Hudson County Parks Department, Hudson County Improvement Authority, Port Authority NY/ NJ and US Fish and Wildfire. has restored the area's native salt marsh community to enhance the overall ecological health of the Hackensack River ecosystem, improving the tidal hydrology and increasing public access and recreation to a restored urban ecological oasis.

- Hudson County OEM is participating in a trans-Hudson evacuation exercise Spring 2020 to cooperation with the Coast Guard and New York.
- Passaic River Basin Climate Resilience Planning Study (June 27, 2019): The North Jersey Transportation Planning Authority (NJTPA) developed this study to evaluate the vulnerability of the Passaic River Basin transportation assets to climate change events and identify adaptation strategies for agencies and municipalities to integrate resiliency into their transportation networks. The study area included Hudson County and the County was part of their Task Force. Adaptation strategies were identified for highly vulnerable and critical transportation assets in the County.
- Hudson County initiated a coordinated evacuation plan with FEMA and the State to be used in the event of an evacuation of all, or a significant portion of, Hudson County. This plan is currently in progress.

6.2 General Mitigation Planning Approach

The overall approach used to update the County and local hazard mitigation strategies are based on FEMA and State of New Jersey regulations and guidance regarding local mitigation plan development, including the following:

- DMA 2000 regulations, specifically 44 CFR 201.6 (local mitigation planning).
- FEMA *Local Mitigation Planning Handbook*, March 2013.
- FEMA *Local Mitigation Plan Review Guide*, October 1, 2011.
- FEMA *Integrating Hazard Mitigation into Local Planning*, March 1, 2013.
- FEMA *Plan Integration: Linking Local Planning Efforts*, July 2015.
- FEMA *Mitigation Planning How-To Guide #3, Identifying Mitigation Actions and Implementing Strategies* (FEMA 386-3), February 2013.
- FEMA *Mitigation Ideas: A Resource for Reducing Risk to Natural Hazards*, January 2013.

The mitigation strategy update approach includes the following steps that are further detailed in later subsections of this section:

- Section 6.3 – Strengths, Weaknesses, Obstacles and Opportunities (SWOO) exercise
- Section 6.4 – Stakeholder Workshop
- Section 6.5 – Review and update the mission statement, mitigation goals and objectives
- Section 6.6 – Prepare an implementation strategy, including:
    - Identification of progress on previous County and local mitigation strategies
    - Development of updated County and local mitigation strategies, and
    - Prioritization projects and initiatives in the updated mitigation strategy

6.3 Strengths, Weaknesses, Obstacles and Opportunities Exercise

The Steering and Planning Committees participated in a facilitated SWOO session to identify strengths, weakness or challenges, obstacles and opportunities in hazard mitigation for the County's high-ranked hazards. Each of these hazards was discussed during the October 2019 session and each jurisdiction was asked to complete a SWOO worksheet to document strengths, weaknesses, obstacles and opportunities relevant to their jurisdiction for their high-ranked hazards. SWOO results were recorded to assist with the update to the County's mitigation strategy. The discussion of each hazard began with identifying County, local jurisdiction and stakeholder strengths to mitigate the risk and potential future impacts of these hazards. Next, the weaknesses, challenges and obstacles the planning area faces to reduce each hazard's risk were identified. To conclude the discussion of each high-ranked hazard, the meeting attendees were asked to identify potential opportunities for enhanced mitigation. The following summarizes the five general categories of potential opportunities identified during the session. Refer to Appendix B (Participation Documentation) which provides the information captured for each hazard during the SWOO session.

- Address challenges with financial resources
- Address challenges with staffing resources (both employed or contracted, and volunteer)
- Increase public awareness
- Increase and enhance local capabilities
- Reduce vulnerability

6.4 Stakeholder Workshop

As discussed in Section 2 (Planning Process), the County hosted a regional stakeholder workshop on February 19, 2020 to gather input from invited stakeholders, along with the Steering and Planning Committee members. The goal of the workshop was to identify:

- Capabilities that contribute to the reduction of risk such as plans, ordinances, administrations, and projects;
- Problem areas that represent vulnerabilities/gaps/challenges within the County; and
- Potential actions or projects that could be undertaken to increase the County's resilience and decrease the County's risk to future hazard events.

In addition, a survey was distributed to gather a comprehensive knowledge-base of capabilities, problems and potential mitigation actions. Information gathered during this session was shared with all plan participants and used to inform the updated mitigation strategy development. Refer to Appendix C (Meeting Documentation) for a complete listing of stakeholder invitees, attendees and meeting notes.

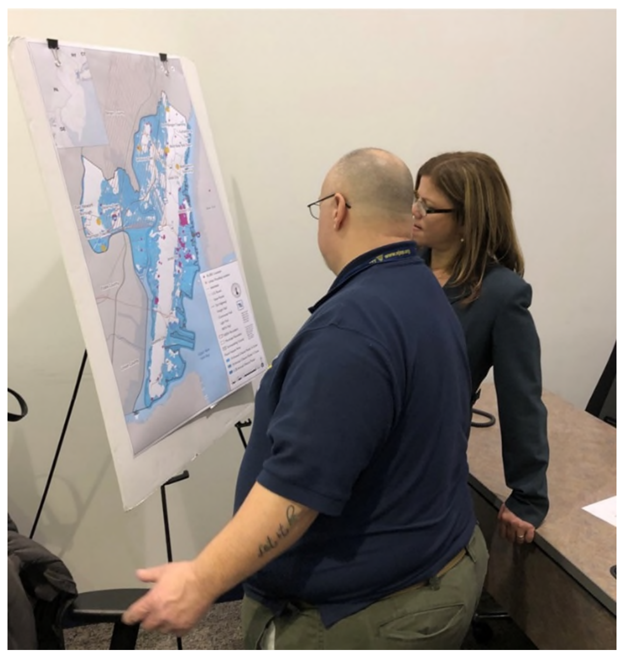


Figure 6-1. Stakeholder Workshop Map Exercise [NJDOT Representatives]

6.5 Review and Update of Mission Statement, Mitigation Goals and Objectives

This section documents the County's efforts to develop hazard mitigation goals and objectives that are established to reduce or avoid long-term vulnerabilities to the identified hazards.

6.5.1 MISSION STATEMENT

Per FEMA guidance (386-1), a mission statement or guiding principle describes the overall duty and purpose of the planning process and serves to identify the principle message of the plan. It focuses or constrains the range of goals and objectives identified. This is not a goal because it does not describe outcomes. Hudson County's mission statement is broad in scope and provides a direction for the HMP.

The 2015 HMP mitigation strategy, inclusive of the 2015-identified mission statement was first examined at the April 2019 Steering Committee kickoff meeting and then discussed at the May 2019 Planning Partnership meeting. During the 2020 HMP update planning process, the Planning Partnership were provided the opportunity to comment on the mission statement as well as the goals, objectives and provide a status update on the mitigation actions. The 2020 HMP mission statement remains the same as in the 2015 plan:

The mission of the Hudson County Hazard Mitigation Plan is to identify and minimize, through cost-effective and sustainable mitigation efforts, the vulnerability to natural hazards in order to protect the health, safety, property, quality of life, environment and economy within Hudson County.

6.5.2 GOALS AND OBJECTIVES

According to CFR 201.6(c)(3)(i): "The hazard mitigation strategy shall include a description of mitigation goals to reduce or avoid long-term vulnerabilities to the identified hazards." The mitigation goals were developed based on the risk assessment results, discussions, research, and input from the Steering and Planning Committees, existing authorities, polices, programs, resources, stakeholders, and the public.

As previously noted, the Steering and Planning Committees reviewed and updated the goals and objectives in April and May at the kickoff meetings in consideration of the hazard events and losses since the 2015 plan, the goals and objectives established in the updated State HMP, county and local risk management plans, as well as direct input on how the Steering Committee (representing the County and participating jurisdictions) recognized the need to move forward to best manage their hazard risk.

For the purposes of this plan, goals and objectives are defined as follows:

FEMA defines ***Goals*** as general guidelines that explain what should be achieved. Goals are usually broad, long-term, policy statements, and represent a global vision.

FEMA defines ***Objectives*** as strategies or implementation steps to attain mitigation goals. Unlike goals, objectives are specific and measurable, where feasible.

FEMA defines ***Mitigation Actions*** as specific actions that help to achieve the mitigation goals and objectives.

Goals are general guidelines that explain what is to be achieved. They are broad, long-term, policy-type statements that represent global visions. Goals help define the benefits that the plan is trying to achieve. The success of the plan, once implemented, should be measured by the degree to which its goals have been met (that is, by the actual benefits in terms of hazard mitigation).

Objectives are short-term aims, which when combined form a strategy or course of action to meet a goal. Unlike goals, objectives are specific and measurable.

The goals and objectives update provides clear guidelines for how the County and all jurisdictions can move forward to best manage their hazard risk. Amendments include additions and edits to goals and objectives to express the plan participants' interests in integrating this plan with other planning mechanisms/programs and to support mitigation through the protection and preservation of natural systems, incorporate resilience of lifelines, and integrate green infrastructure.

As a result of this review process, the goals and objectives for the 2020 update were amended, as presented in Table 6-1. *Italicized* text indicates the updates made to the goals and objectives. Appendix F presents the 2015 mission statement, goals and objectives and the evaluation feedback from the Steering Committee.

Table 6-1. Hudson County Mitigation Goals and Objectives

Goal	Objective
Goal 1: Protect life	1.1: Develop, enhance and protect early warning and emergency communications systems
	1.2: Improve and support Comprehensive Regional Evacuation Plan
	1.3: Strengthen County and local planning, building codes, ordinances and enforcement
	1.4: Identify the need for, and acquire, any special emergency services, training, and equipment to enhance response capabilities for specific hazards.
	1.5: Enhance sheltering capabilities at the local level (NEW)
Goal 2: Protect property	2.1: *Protect, maintain and i*ncrease resilience of infrastructure and critical facilities
	2.2: Reduce repetitive and severe repetitive losses
	2.3: Assure coordination between communities and encourage shared services in acquiring, maintaining and providing emergency services
	2.4: Reduce the risk of utility failure
	2.5: Review existing local laws and ordinances, safety inspection procedures, and applicable rules to help ensure that they employ the most recent and generally accepted standards for the protection of buildings and environmental resources
Goal 3: Promote a sustainable economy	3.1: Identify and pursue funding opportunities to develop and implement local and county mitigation activities.
	3.2: Provide/Improve flood protection with flood control structures, and drainage maintenance plans
	3.3: Enhance stakeholder education and training *about hazard risks and mitigation*
Goal 4: Protect the environment	4.1: Review and incorporate updated hazard data into the County Hazard Mitigation Plan and other county and local planning mechanisms
	4.2: Increase support for the development of local mitigation planning and projects *that provide co-benefits and support a healthy and equitable environment*
	4.3: Better characterize flood/stormwater hazard events by conducting additional hazard studies and identify inadequate stormwater facilities and poorly drained areas
	4.4: Prevent (or discourage) new development in hazardous areas or ensure that if building occurs in high-risk areas that it is done in such a way as to minimize risk
	4.5: Strengthen understanding of, and adaptation to, a changing climate (NEW)
Goal 5: Increase public awareness	5.1: Educate the public on the risk from natural and man-made hazards and increase personal hazard preparation, mitigation, response, and recovery activities *for socially vulnerable populations.*
	5.2: Encourage and support additional related training and education of public officials

	5.3: Integrate the recommendations of this plan into existing local plans/programs.
Goal 6: Support continuity of operations pre-, during and post-hazard events	6.1: Ensure continuity of government operations, emergency services and essential facilities during and immediately after disaster and hazard events
	6.2: Increase resiliency by facilitating rapid disaster recovery
	6.3: Support and encourage the implementation of alternative energy source
	6.4: Implement mitigation measures that promote the reliability of lifeline systems (NEW)

6.6 Mitigation Strategy Development and Update

6.6.1 REVIEW OF 2015 HMP MITIGATION ACTION PLAN

To evaluate progress on local mitigation actions, the planning consultant met with each participant to discuss the status of the mitigation actions identified in the 2015 plan. For each action, jurisdictions were asked to provide the status of each action (*No Progress, In Progress, Ongoing Capability, Discontinue, or Completed*) and provide review comments on each. Jurisdictions were requested to quantify the extent of progress and provide reasons for the level of progress or why actions were being discontinued. Each jurisdictional annex in Section 9 (Jurisdictional Annexes) provides a table identifying the jurisdiction's prior mitigation strategy, the status of those actions and initiatives, and their disposition within their updated strategy.

Local mitigation actions identified as *Complete*, and those actions identified as *Discontinued*, were removed from the updated strategies. Local mitigation actions identified as an *Ongoing Capability* were incorporated into the capability assessment of each jurisdictional annex. Those actions identified as *No Progress* or *In Progress* that remain a priority for the jurisdiction, have been carried forward into the updated mitigation strategy.

Beginning in June 2019, the planning consultant worked directly with each jurisdiction (phone, email, local support meetings) to assist with the development and update of their annex and include mitigation strategies, focusing on identifying well-defined, implementable projects with a careful consideration of benefits (risk reduction, losses avoided), costs, and possible funding sources (including mitigation grant programs).

At the May 2019 kickoff meeting and during subsequent local-level planning meetings, all participating jurisdictions were further surveyed to identify mitigation activities completed, ongoing, and potential/proposed. As new potential mitigation actions, projects, or initiatives became evident during the plan update process, including as part of the risk assessment update and as identified through the public and stakeholder outreach process detailed in Section 2 (Planning Process), jurisdictions were made aware of these either through direct communication (local meetings, email, phone), at Steering and Planning Committee meetings, or via their draft jurisdictional annexes.

6.6.2 IDENTIFICATION AND ANALYSIS OF MITIGATION TECHNIQUES

Concerted efforts were made to assure that the jurisdictions develop updated mitigation strategies that included activities and initiatives covering the range of mitigation action types described in recent FEMA planning guidance (FEMA *Local Mitigation Planning Handbook* March 2013), specifically:

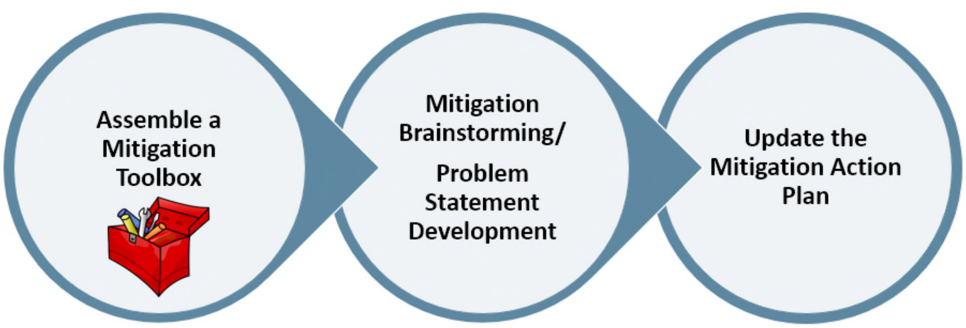
- Local Plans and Regulations—These actions include government authorities, policies, or codes that influence the way land and buildings are being developed and built.

- Structure and Infrastructure Projects—These actions involve modifying existing structures and infrastructure to protect them from a hazard or remove them from a hazard area. This could apply to public or private structures, as well as critical facilities and infrastructure. This type of action involves projects to construct manmade structures to reduce the impact of hazards.
- Natural Systems Protection—These are actions that minimize damage and losses and preserve or restore the functions of natural systems.
- Education and Awareness Programs—These are actions to inform and educate citizens, elected officials, and property owners about hazards and potential ways to mitigate them. These actions could include participation in national programs, such as the National Flood Insurance Program and Community Rating System, StormReady (NOAA), and Firewise (NFPA) Communities.

6.6.3 2020 HMP MITIGATION ACTION PLAN

To help support the selection of an appropriate, risk-based mitigation strategy, each annex was updated to provide a summary of hazard vulnerabilities identified during the plan update process, either directly by local representatives or through review of available County and local plans and reports, and through the hazard profiling and vulnerability assessment process.

A mitigation strategy workshop was conducted by the contracted planning consultant on January 9, 2020, for all participating jurisdictions to support the development of the updated mitigation strategy. To assist with the identification of implementable and action-oriented mitigation actions, a three-step process was followed for the 2020 HMP update: 1) Assemble a 'mitigation toolbox'; 2) Identify problem statements through 'mitigation brainstorming' and 3) Update the mitigation action plan. This section describes the process followed by the County and the jurisdictions to develop the 2020 updated mitigation action plan.



The concept of a 'mitigation toolbox' was introduced to the Planning Partnership at the October 2019 risk assessment meeting. A mitigation toolbox contains numerous resources available to the County and participating jurisdictions to assist with the development of an updated mitigation action plan. This toolbox was referred to throughout the 2020 HMP mitigation strategy update and will continue to serve as a resource over the plan performance period. The toolbox contains, but is not limited, to the following and will be continuously added to over time:

- 2020 HMP mission statement, goals and objectives
- 2015 HMP Mitigation Strategy
- Risk assessment results

- Capability assessment results
- Outcomes of the SWOO
- Outcomes of the Stakeholder Workshop
- Mitigation Catalog
- Subject-matter expertise
- Stakeholder and public input (e.g., citizen survey results, survey results from Senior Wellness event)
- Existing plans/policies/programs
- FEMA resources (e.g., Mitigation Ideas).

As discussed in Section 2 (Planning Process) and earlier in this section, the October 2019 risk assessment meeting and individual jurisdiction meetings were focused on understanding risk and capabilities and identify gaps in capabilities, challenges and opportunities. This provided context for the next steps in the update of the mitigation strategy and inform the Planning Partnership of the available resources in their 'toolbox.'

At the January 2020 mitigation strategy workshop, the Planning Partnership focused problem statements based on the impacts of hazards in the County. The results of the updated risk assessment, challenges and opportunities identified during the capability assessment update and SWOO sessions, and information gathered from the citizen survey were used to inform problem statement development. At the workshop, the Planning Partnership broke up into small groups and round-table discussions took place so jurisdictions could understand each other's problem statements and share either what others have done to address the problem or help brainstorm what the best mitigation action is to address. Information gathered from the stakeholder workshop in February 2020 was shared with the Planning Partnership via email to further inform the updated mitigation strategy development.

As a result, problem statement worksheets were developed to detail the problems/challenges/gaps/identified vulnerabilities the jurisdiction faces, then mitigation alternatives evaluated to best reduce future risk and address the identified problem. These problem statements were intended to provide a detailed description of the problem area, including impacts to the jurisdiction, past damages, and loss of service. These problem statements helped form a bridge between the hazard risk assessment, which quantifies impacts to each community, with the development of achievable mitigation strategies.

A strong effort has been made to better focus local mitigation strategies to clearly defined, readily implementable projects and initiatives that meet the definition or characteristics of mitigation. Broadly defined mitigation actions were eliminated from the updated strategy unless accompanied by discrete actions, projects, or initiatives.

Certain continuous or ongoing strategies that represent programs that are fully integrated into the normal operational and administrative framework of the community have been identified within the capabilities section of each annex and removed from the updated mitigation strategy.

Jurisdictions included mitigation actions to address vulnerable critical facilities located within the floodplain. For those facilities, each jurisdiction was asked to identify the status of mitigation: already mitigated and how/to what flood level, reason for not mitigating (e.g. do not have the jurisdiction to mitigate), or the proposed mitigation number included in the proposed mitigation action table in each annex. It is recognized, however, that in the case of projects being funded through federal mitigation programs, the level of protection can be influenced by cost-effectiveness, as determined through a formal benefit-cost analysis. In the case of "self-funded" projects, jurisdiction discretion must be recognized.

Further, the County and jurisdictions have limited authority over privately-owned critical facility owners regarding mitigation at any level of protection.

Throughout the course of the plan update process, additional regional and county-level mitigation actions were identified by the following processes:

- Review of the results and findings of the updated risk assessment.
- Review of available regional and county plans reports and studies;
- Direct input from county departments and other county and regional agencies, including:
    - Hudson County Office of Emergency Management
    - Hudson County Roads and Real Property
    - Hudson County Planning
    - Hudson County Regional Health Commission
    - Hudson County Department of Corrections
- Input received through the public and stakeholder outreach process.

6.7 Mitigation Best Practices

Catalogs of hazard mitigation best practices were developed that present a broad range of alternatives to be considered for use in Hudson County, in compliance with 44 CFR Section 201.6(c)(3)(ii). One catalog was developed for each natural hazard of concern evaluated in this plan; referred to as the Mitigation Catalog (Appendix F). The catalogs present alternatives that are categorized in two ways:

- By whom would have responsibility for implementation:
    - Individuals – personal scale
    - Businesses – corporate scale
    - Government – government scale
- By what each of the alternatives would do:
    - Manipulate the hazard
    - Reduce exposure to the hazard
    - Reduce vulnerability to the hazard
    - Build local capacity to respond to or be prepared for the hazard

The alternatives presented include actions that will mitigate current risk from hazards and actions that will help reduce risk from changes in the impacts of these hazards resulting from climate change. Hazard mitigation actions recommended in this plan were selected from among the alternatives presented in the catalog, as well as other resources made available to all jurisdictions (i.e., FEMA's Mitigation Ideas). The catalog provides a baseline of mitigation alternatives that are backed by a planning process, are consistent with the established goals and objectives, and are within the capabilities of the planning partners to implement. Some of these actions may not be feasible based on the selection criteria identified for this plan. The purpose of the catalog was to provide a list of what could be considered to reduce risk from natural hazards within the planning area. Actions in the catalog that are not included for the partnership's action plan were not selected for one or more of the following reasons:

- The action is not feasible
- The action is already being implemented

- There is an apparently more cost-effective alternative
- The action does not have public or political support.

6.8 Mitigation Strategy Evaluation and Prioritization

Section 201.c.3.iii of 44 CFR requires an action plan describing how mitigation actions identified will be prioritized. The County and participating jurisdictions utilized a modified STAPLEE (Social, Technical, Administrative, Political, Legal, Economic, and Environmental) mitigation action evaluation methodology based on a set of evaluation criteria suited to the purposes of hazard mitigation strategy evaluation. This method provides a systematic approach that considers the opportunities and constraints of implementing a specific mitigation action.

The Steering Committee applied an action evaluation methodology, which includes an expanded set of 14 criteria to include the consideration of cost-effectiveness, availability of funding, anticipated timeline, and if the action addresses multiple hazards. The 14 evaluation/prioritization criteria used in the 2020 update process is the same used in the 2015 plan:

1. Life Safety—How effective will the action be at protecting lives and preventing injuries?
2. Property Protection—How significant will the action be at eliminating or reducing damage to structures and infrastructure?
3. Cost-Effectiveness—Are the costs to implement the project or initiative commensurate with the benefits achieved?
4. Technical—Is the mitigation action technically feasible? Is it a long-term solution? Eliminate actions that, from a technical standpoint, will not meet the goals.
5. Political—Is there overall public support for the mitigation action? Is there the political will to support it?
6. Legal—Does the jurisdiction have the authority to implement the action?
7. Fiscal—Can the project be funded under existing program budgets (i.e., is this initiative currently budgeted for)? Would it require a new budget authorization or funding from another source such as grants?
8. Environmental–What are the potential environmental impacts of the action? Will it comply with environmental regulations?
9. Social—Will the proposed action adversely affect one segment of the population? Will the action disrupt established neighborhoods, break up voting districts, or cause the relocation of lower income people?
10. Administrative—Does the jurisdiction have the personnel and administrative capabilities to implement the action and maintain it? Will outside help be necessary?
11. Multi-hazard—Does the action reduce the risk to multiple hazards?
12. Timeline—Can the action be completed in less than 5 years (within our planning horizon)?
13. Local Champion—Is there a strong advocate for the action or project among the jurisdiction's staff, governing body, or committees that will support the action's implementation?
14. Other Local Objectives—Does the action advance other local objectives, such as capital improvements, economic development, environmental quality, or open space preservation? Does it support the policies of other plans and programs?

Participating jurisdictions were asked to use these criteria to assist them in evaluating and prioritizing mitigation actions identified in the 2020 update. Specifically, for each mitigation action, the jurisdictions were asked to assign a numeric rank (-1, 0, or 1) for each of the 14 evaluation criteria, defined as follows:

- 1 = Highly effective or feasible

- 0 = Neutral
- -1 = Ineffective or not feasible

Further, jurisdictions were asked to provide a summary of the rationale behind the numeric rankings assigned, as applicable. The numerical results were totaled and then used by each jurisdiction to help prioritize the action or strategy as *Low*, *Medium*, or *High*. Actions that had a numerical value between 0 and 4 were categorized as *low*; actions with numerical values between 5 and 9 were categorized as *medium*; and actions with numerical values between 10 and 14 were categorized as *high*. While this provided a consistent, systematic methodology to support the evaluation and prioritization of mitigation actions, jurisdictions might have additional considerations that could influence their overall prioritization of mitigation actions.

For the plan update there has been an effort to develop more clearly defined and action-oriented mitigation strategies. These local strategies include projects and initiatives that are seen by the community as the most effective approaches to advance their local mitigation goals and objectives within their capabilities. In addition, each jurisdiction was asked to develop problem statements. With this process, participating jurisdictions were able to develop action-oriented and achievable mitigation strategies.

6.9 Benefit/Cost Review

Section 201.6.c.3iii of 44 CFR requires the prioritization of the action plan to emphasize the extent to which benefits are maximized according to a cost/benefit review of the proposed projects and their associated costs. Stated otherwise, cost-effectiveness is one of the criteria that must be applied during the evaluation and prioritization of all actions comprising the overall mitigation strategy.

The benefit/cost review applied in for the evaluation and prioritization of projects and initiatives in this plan update process was qualitative; that is, it does not include the level of detail required by FEMA for project grant eligibility under the Hazard Mitigation Assistance (HMA) grant programs. For all actions identified in the local strategies, jurisdictions have identified both the costs and benefits associated with project, action or initiative.

Costs are the total cost for the action or project, and could include administrative costs, construction costs (including engineering, design and permitting), and maintenance costs.

Benefits are the savings from losses avoided attributed to the implementation of the project, and could include life-safety, structure and infrastructure damages, loss of service or function, and economic and environmental damage and losses.

When possible, jurisdictions were asked to identify the actual or estimated dollar costs and associated benefits. Often numerical costs and/or benefits were not identified and may be impossible to quantify. In this case, jurisdictions were asked to evaluate project cost-effectiveness using *high*, *medium*, and *low* ratings. Where estimates of costs and benefits were available, the ratings were defined as the following:

Low <= $10,000   Medium = $10,000 to $100,000   High >=$100,000

Where quantitative estimates of costs and/or benefits were not available, qualitative ratings using the following definitions were used:

Table 6-2 Qualitative Cost and Benefit Ratings

Costs	
High	Existing funding levels are not adequate to cover the costs of the proposed project, and implementation would require an increase in revenue through an alternative source (e.g., bonds, grants, and fee increases).
Medium	The project could be implemented with existing funding but would require a re-apportionment of the budget or a budget amendment, or the cost of the project would have to be spread over multiple years.
Low	The project could be funded under the existing budget. The project is part of or can be part of an existing, ongoing program.
Benefits	
High	Project will have an immediate impact on the reduction of risk exposure to life and property.
Medium	Project will have a long-term impact on the reduction of risk exposure to life and property or will provide an immediate reduction in the risk exposure to property.
Low	Long-term benefits of the project are difficult to quantify in the short term.

Using this approach, projects with positive benefit versus cost ratios (such as high over high, high over medium, medium over low) are considered cost-effective. For some of the Hudson County initiatives identified, the planning partnership might seek financial assistance under FEMA's HMA programs. These programs require detailed benefit/cost analysis as part of the application process. These analyses will be performed when funding applications are prepared, using the FEMA benefit/cost analysis model process. The planning partnership is committed to implementing mitigation strategies with benefits that exceed costs. For projects not seeking financial assistance from grant programs that require this sort of analysis, the planning partnership reserves the right to define "benefits" according to parameters that meet its needs and the goals and objectives of this plan.

SECTION 7. PLAN MAINTENANCE

2020 HMP Changes

- In this update the maintenance process has been more clearly outlined to provide a roadmap for the annual monitoring of the plan. This includes a summary plan maintenance matrix that provides an overview of the planning partner responsibilities for monitoring, evaluation, and update of the plan.
- Specific discussion of ongoing or proposed integration actions including those to support incorporation of mitigation planning as an integral component of daily government operations is included in Section 5 (Capability Assessment) rather than summarized in this section of the plan,

This section details the formal process that will ensure that the HMP remains an active and relevant document and that the Planning Partnership maintains their eligibility for applicable funding sources. The plan maintenance process includes a schedule for monitoring and evaluating the plan annually and producing an updated plan every five years. In addition, this section describes how public participation will be integrated throughout the plan maintenance and implementation process. It explains how the mitigation strategies outlined in this plan update will be incorporated into existing planning mechanisms and programs, such as comprehensive land use planning processes, capital improvement planning, and building code enforcement and implementation. The plan's format allows sections to be reviewed and updated when new data become available, resulting in a plan that will remain current and relevant.

The plan maintenance matrix shown in Table 7-1 provides a synopsis of responsibilities for plan monitoring, evaluation, and update, which are discussed in further detail in the sections below.

Table 7-1. Plan Maintenance Matrix

Task	Approach	Timeline	Lead Responsibility	Support Responsibility
Monitoring	Preparation of status updates and action implementation tracking as part of submission for Annual Progress Report.	August or upon major update to Comprehensive Plan or major disaster	Jurisdictional points of contact identified in Section 8 (Planning Partnership) and Section 9 (Jurisdictional Annexes)	Jurisdictional implementation lead identified in Section 8 (Planning Partnership) and Section 9 (Jurisdictional Annexes)
Integration	In order for integration of mitigation principles action to become an organic part of the ongoing county and local activities, the county will incorporate the distribution of the safe growth worksheet (see 7.1.2 below) for annual review and update by all participating jurisdictions.	August each year with interim email reminders to address integration in county, municipal and MUA activities.	HMP Coordinator and jurisdictional points of contact identified in Section 8 (Planning Partnership) and Section 9 (Jurisdictional Annexes)	HMP Coordinator
Evaluation	Review the status of previous actions as submitted by the monitoring task lead and support to assess the effectiveness of the plan; compile and finalize the Annual Progress Report	Finalized progress report completed by October 14 of each year	Steering Committee; Plan Maintenance element	Jurisdictional points of contacts identified in Section 9 (Jurisdictional Annexes)

Task	Approach	Timeline	Lead Responsibility	Support Responsibility
Update	Reconvene the planning partners, at a minimum, every 5 years to guide a comprehensive update to review and revise the plan.	Every 5 years or upon major update to Comprehensive Plan or major disaster	Hudson County HMP Coordinator	Jurisdictional points of contacts identified in Section 9 (Jurisdictional Annexes)

7.1 Monitoring, Evaluating and Updating the Plan

The procedures for monitoring, evaluating, and updating the plan are provided below.

The HMP Coordinator is assigned to manage the maintenance and update of the plan during its performance period. The HMP Coordinator will chair the Steering Committee and be the prime point of contact for questions regarding the plan and its implementation as well as to coordinate incorporation of additional information into the plan.

The Planning Committee shall fulfill the monitoring, evaluation and updating responsibilities identified in this section which is comprised of a representative from each participating jurisdiction. Each jurisdiction is expected to maintain a representative on the Planning Committee throughout the plan performance period (five years from the date of plan adoption). As of the date of this plan, primary and secondary mitigation planning representatives (points-of-contact) are identified in each jurisdictional annex in Section 9 (Jurisdictional Annexes).

Regarding the composition of the committee, it is recognized that individual commitments change over time, and it shall be the responsibility of each jurisdiction and its representatives to inform the HMP Coordinator of any changes in representation. The HMP Coordinator will strive to keep the committee makeup as a uniform representation of planning partners and stakeholders within the planning area.

Currently, the Hudson County HMP Coordinator is designated as:

Name: James Woods, OEM County Coordinator
Email Address: jwoods@hcnj.us

7.1.1 MONITORING

The Planning Committee shall be responsible for monitoring progress on, and evaluating the effectiveness of, the plan, and documenting annual progress. Each year, beginning one year after plan development, Hudson County and local Planning Partnership representatives will collect and process information from the departments, agencies and organizations involved in implementing mitigation projects or activities identified in their jurisdictional annexes (Section 9) of this plan, by contacting persons responsible for initiating and/or overseeing the mitigation projects.

In the first year of the performance period, this will be accomplished by utilizing an online performance progress reporting system, the BATool^{SM} which will enable municipal, MUA and county representatives of directly access mitigation initiatives to easily update the status of each project, document successes or obstacles to implementation, add or delete projects to maintain mitigation project implementation. It is anticipated that all participating partners will be prompted by the tool to update progress annually, providing an incentive for participants to refresh their mitigation strategies and to continue implementation of projects. It is expected that this reporting system will support the submittal of an increased number of project grant fund applications due to the functionality of the system which facilitates the sorting and prioritization of projects.

In addition to progress on the implementation of mitigation actions, including efforts to obtain outside funding; and obstacles or impediments to implementation of actions, the information that Planning Partnership representatives shall be expected to document, as needed and appropriate include:

- Any grant applications filed on behalf of any of the participating jurisdictions
- Hazard events and losses occurring in their jurisdiction
- Additional mitigation actions believed to be appropriate and feasible
- Public and stakeholder input
- Plan monitoring for years 2 through 4 of the plan performance periods will be similarly addressed via the BATool[SM] or manually.

7.1.2 INTEGRATION PROCESS OF THE HMP INTO LOCAL PLANNING MECHANISMS

As discussed in Section 5 (Capability Assessment), integrating hazard mitigation into a jurisdiction's existing plans, policies, codes, and programs leads to development patterns designed to not increase risk from known hazards or to lead to redevelopment that reduces risk from known hazards. The Hudson County Planning Partnership was tasked with identifying how hazard mitigation is integrated into existing planning mechanisms. Refer to Section 9 (Jurisdictional Annexes) for how this is done for each participating jurisdiction. During this process, many jurisdictions recognized the importance and benefits of incorporating hazard mitigation into future local planning and regulatory processes.

During the HMP annual review process, each participating jurisdiction will be asked to document how they are utilizing and incorporating the Hudson County HMP into their day-to-day operations and planning and regulatory processes. Additionally, each jurisdiction will identify additional policies, programs, practices, and procedures that could be modified to accommodate hazard mitigation actions and include these findings and recommendations in the Annual HMP Progress Report. The following checklist was adapted from FEMA's Local Mitigation Handbook (2013), Appendix A, Worksheet 4.2. This checklist will help a community analyze how hazard mitigation is integrated into local plans, ordinances, regulations, ordinances, and policies. By completing the checklist, it will help jurisdictions identify areas that integrate hazard mitigation currently and where to make improvements and reduce vulnerability to future development. In this manner, the integration of mitigation into municipal and MUA activities will evolve into an ongoing culture within the county and its jurisdictions.

Table 7-2. Safe Growth Check List

Planning Mechanisms	Do you Do This?		Notes: How is it being done or how will this be utilized in the future?
	Yes	No	
Operating, Local and Capital Improvement Program Budgets			
• When constructing upcoming budgets, hazard mitigation actions will be funded as budget allows. Construction projects will be evaluated to see if they meet the hazard mitigation goals.			

Planning Mechanisms	Do you Do This?		Notes: How is it being done or how will this be utilized in the future?
	Yes	No	
• Annually, during adoption process, the jurisdiction will review mitigation actions when allocating funding.			
• Do budgets limit expenditures on projects that would encourage development in areas vulnerable to natural hazards?			
• Do infrastructure policies limit extension of existing facilities and services that would encourage development in areas vulnerable to natural hazards?			
• Do budgets provide funding for hazard mitigation projects identified in the County HMP?			
Human Resource Manual			
• Do any job descriptions specifically include identifying and/or implementing mitigation projects/actions or other efforts to reduce natural hazard risk?			
Building and Zoning Ordinances			
• Prior to, zoning changes, or development permitting, the jurisdiction will review the hazard mitigation plan and other hazard analyses to ensure consistent and compatible land use.			
• Does the zoning ordinance discourage development or redevelopment within natural areas including wetlands, floodways, and floodplains?			
• Does it contain natural overlay zones that set conditions			
• Does the ordinance require developers to take additional actions to mitigate natural hazard risk?			
• Do rezoning procedures recognize natural hazard areas as limits on zoning changes that allow greater intensity or density of use?			
• Do the ordinances prohibit development within, of filling of, wetlands, floodways, and floodplains?			
Subdivision Regulations			

Planning Mechanisms	Do you Do This? Yes	No	Notes: How is it being done or how will this be utilized in the future?
• Do the subdivision regulations restrict the subdivision of land within or adjacent to natural hazard areas?			
• Do the subdivision regulations restrict the subdivision of land within or adjacent to natural hazard areas?			
• Do the regulations provide for conservation subdivisions or cluster subdivisions in order to conserve environmental resources?			
• Do the regulations allow density transfers where hazard areas exist?			
Master Plan			
• Are the goals and policies of the plan related to those of the County HMP?			
• Does the future land use map clearly identify natural hazard areas?			
• Do the land use policies discourage development or redevelopment with natural hazard areas?			
• Does the plan provide adequate space for expected future growth in areas located outside natural hazard areas?			
Land Use			
• Does the future land use map clearly identify natural hazard areas?			
• Do the land use policies discourage development or redevelopment with natural hazard areas?			
• Does the plan provide adequate space for expected future growth in areas located outside natural hazard areas?			
Transportation Plan			
• Does the transportation plan limit access to hazard areas?			
• Is transportation policy used to guide growth to safe locations?			
• Are transportation systems designed to function under disaster conditions (e.g. evacuation)?			
Environmental Management			
• Are environmental systems that protect development from hazards identified and mapped?			
• Do environmental policies maintain and restore protective ecosystems?			

Planning Mechanisms	Do you Do This?		Notes: How is it being done or how will this be utilized in the future?
	Yes	No	
• Do environmental policies provide incentives to development that is located outside protective ecosystems?			
Grant Applications			
• Data and maps will be used as supporting documentation in grant applications.			
Local Ordinances			
• When updating ordinances, hazard mitigation will be a priority			
Economic Development			
• Local economic development group will take into account information regarding identified hazard areas when assisting new businesses in finding a location.			
Public Education and Outreach			
• Does the jurisdiction have any public outreach mechanisms / programs in place to inform citizens on natural hazards, risk, and ways to protect themselves during such events?			

7.1.3 EVALUATING

The evaluation of the mitigation plan is an assessment of whether the planning process and actions have been effective, if the HMP goals are being achieved, and whether changes are needed. The HMP will be evaluated on an annual basis to determine the effectiveness of the programs, and to reflect changes that could affect mitigation priorities or available funding.

The status of the HMP will be discussed and documented at an annual plan review meeting of the Steering and Planning Committees (Planning Partnership), to be held either in person or via teleconference approximately one year from the date of local adoption of this update, and successively thereafter. At least two weeks before the annual plan review meeting, the Hudson County HMP Coordinator will advise the Planning Partnership of the meeting date, agenda and expectations of the members.

The Hudson County HMP Coordinator will be responsible for calling and coordinating the annual plan review meeting and soliciting input regarding progress toward meeting plan goals and objectives. These evaluations will assess whether:

- Goals and objectives address current and expected conditions.
- The nature or magnitude of the risks has changed.
- Current resources are appropriate for implementing the HMP and if different or additional resources are now available.
- Actions were cost effective.
- Schedules and budgets are feasible.
- Implementation problems, such as technical, political, legal or coordination issues with other agencies are presents.
- Outcomes have occurred as expected.
- Changes in county, municipal or MUA resources impacted plan implementation (e.g., funding, personnel, and equipment)
- New agencies/departments/staff should be included, including other local governments as defined under 44 CFR 201.6.

Specifically, the Planning Partnership will review the mitigation goals, objectives, and activities using performance-based indicators, including:

- New agencies/departments
- Project completion
- Under/overspending
- Achievement of the goals and objectives
- Resource allocation
- Timeframes
- Budgets
- Lead/support agency commitment
- Resources
- Feasibility

Finally, the Planning Partnership will evaluate how other programs and policies have conflicted or augmented planned or implemented measures, and shall identify policies, programs, practices, and procedures that could be modified to accommodate hazard mitigation actions ("Implementation of Mitigation Plan through Existing Programs" subsection later in this section discusses this process). Other programs and policies can include those that address:

- Economic development
- Environmental preservation
- Historic preservation
- Redevelopment
- Health and/or safety
- Recreation
- Land use/zoning
- Public education and outreach
- Transportation

The Planning Partnership should refer to the evaluation forms, Worksheets #2 and #4 in the FEMA 386-4 guidance document, to assist in the evaluation process (see Appendix G – Plan Review Tools). Further, the Planning Partnership should refer to any process and plan review deliverables developed by the County or participating jurisdictions as a part of the plan review processes established for prior or existing local HMPs within the County.

The Hudson County HMP Coordinator shall be responsible for preparing an Annual HMP Progress Report for each year of the performance period, based on the information provided by the Planning Partnership, information presented at the annual meeting, and other information as appropriate and relevant. These annual reports will provide data for the five-year update of this HMP and will assist in pinpointing any implementation challenges. By monitoring the implementation of the HMP on an annual basis, the Planning Partnership will be able to assess which projects are completed, which are no longer feasible, and what projects should require additional funding.

The Annual HMP Progress Report shall be posted on the Hudson County Office of Emergency Management website to keep the public apprised of the plan's implementation (Office of Emergency Management (OEM) | Hudson County Hazard Mitigation Planning (HMP) Page). Additionally, the website provides details on the HMP update planning process. For communities who might choose to join the NFIP CRS program, this report will also be provided to each CRS participating community in order to meet annual CRS recertification requirements. To meet this recertification timeline, the Planning partnership will strive to complete the review process and prepare an Annual HMP Progress Report by May of each year.

The HMP will also be evaluated and revised following any major disasters, to determine if the recommended actions remain relevant and appropriate. The risk assessment will also be revisited to see if any changes are necessary based on the pattern of disaster damages or if data listed in the Section 4.3 of this plan has been collected to facilitate the risk assessment. This is an opportunity to increase the community's disaster resistance and build a better and stronger community.

7.1.4 UPDATING

44 CFR 201.6.d.3 requires that local hazard mitigation plans be reviewed, revised as appropriate, and resubmitted for approval in order to remain eligible for benefits awarded under the DMA 2000. It is the intent of Hudson County to update this plan on a five-year cycle from the date of initial plan adoption.

To facilitate the update process, the Hudson County HMP Coordinator, with support of the Planning Partnership, shall use the second annual meeting to develop and commence the implementation of a detailed plan update program. The Hudson County HMP Coordinator shall invite representatives from NJOEM to this meeting to provide guidance on plan update procedures. This program shall, at a minimum, establish who shall be responsible for managing and completing the plan update effort, what needs to be included in the updated plan, and a detailed timeline with milestones to assure that the update is completed according to regulatory requirements.

At this meeting, the Planning Partnership shall determine what resources will be needed to complete the update. The Hudson County HMP Coordinator shall be responsible for assuring that needed resources are secured.

Following each five-year update of the mitigation plan, the updated plan will be distributed for public comment. After all comments are addressed, the HMP will be revised and distributed to all planning group members and the New Jersey State Hazard Mitigation Officer.

7.2 Grant Monitoring and Coordination

Hudson County recognizes the importance of having an annual coordination period that helps each planning partner become aware of upcoming mitigation grant opportunities identifies multi-jurisdiction projects to pursue. Grant monitoring will be the responsibility of each local partner as part of their annual progress reporting". The Hudson County HMP Coordinator will keep the planning partners apprised of FEMA Hazard Mitigation Assistance grant openings and assist in developing letters of intent for grant opportunities when practicable.

Hudson County intends to be a resource to the planning partnership in the support of project grant writing and development. The degree of this support will depend on the level of assistance requested by the partnership during open windows for grant applications. As part of grant monitoring and coordination, Hudson County intends to provide the following:

- Notification to planning partners about impending grant opportunities.
- A current list of eligible, jurisdiction-specific projects for funding pursuit consideration.
- Notification about mitigation priorities for the fiscal year to assist the planning partners in the selection of appropriate projects.

Grant monitoring and coordination will be integrated into the annual progress report or as needed based on the availability of non-HMA or post-disaster funding opportunities.

7.3 Implementation of Mitigation Plan through Existing Programs

Effective mitigation is achieved when hazard awareness and risk management approaches and strategies become an integral part of public activities and decision-making. Within the County there are many existing plans and programs that support hazard risk management, and thus it is critical that this hazard mitigation plan integrate and coordinate with, and complement, those existing plans and programs.

Section 5 (Capability Assessment) provides a summary and description of the existing plans, programs and regulatory mechanisms at all levels of government (federal, state, county and local) that support hazard mitigation within the

County. Within each jurisdictional annex in Section 9 (Jurisdictional Annexes), the County and each participating jurisdiction identified how they have integrated hazard risk management into their existing planning, regulatory and operational/administrative framework ("existing integration"), and how they intend to promote this integration ("opportunities for future integration").

As discussed in Section 5 (Capability Assessment), it is the intention of Planning Partnership representatives to continue to incorporate mitigation planning as an integral component of daily government operations. The Planning Partnership representatives will work with local government officials to integrate the newly adopted hazard mitigation goals and actions into the general operations of government and partner organizations. Further, the sample adoption resolution (Appendix A) includes a resolution item stating the intent of the local governing body to incorporate mitigation planning as an integral component of government and partner operations. By doing so, the Planning Committee anticipates that:

1) Hazard mitigation planning will be formally recognized as an integral part of overall emergency management efforts;
2) The Hazard Mitigation Plan, Comprehensive Plans, Emergency Management Plans and other relevant planning mechanisms will become mutually supportive documents that work in concert to meet the goals and needs of county residents.

Other planning processes and programs to be coordinated with the recommendations of the hazard mitigation plan include the following:

- Emergency response plans
- Training and exercise of emergency response plans
- Debris management plans
- Recovery plans
- Capital improvement programs
- Municipal codes
- Community design guidelines
- Water-efficient landscape design guidelines
- Stormwater management programs
- Water system vulnerability assessments
- Community Wildfire Protection Plans
- Comprehensive Flood Hazard Management Plans
- Resiliency plans
- Community Development Block Grant-Disaster Recovery action plans
- Public information/education plans

Some action items do not need to be implemented through regulation. Instead, these items can be implemented through the creation of new educational programs, continued interagency coordination, or improved public participation.

During the annual plan evaluation process, the Planning Partnership representatives will identify additional policies, programs, practices, and procedures that could be modified to accommodate hazard mitigation actions and include these findings and recommendations in the Annual HMP Progress Report.

7.4 Continued Public Involvement

Hudson County and participating jurisdictions are committed to the continued involvement of the public in the hazard mitigation process. This HMP update will continue to be posted on-line (http://www.hudsoncountynj.org/hudson-county-hazard-mitigation-planning-hmp-page/). In addition, public outreach and dissemination of the HMP will include:

- Links to the plan on municipal websites of each jurisdiction with capability.
- Continued utilization of existing social media outlets (Facebook, Twitter) to inform the public of natural hazard events, such as floods and severe storms. Educate the public via the jurisdictional websites on how these applications can be used in an emergency situation.
- Development of annual articles or workshops on flood hazards to educate the public and keep them aware of the dangers of flooding.

Planning Committee representatives and the Hudson County HMP Coordinator will be responsible for receiving, tracking, and filing public comments regarding this HMP. The public will have an opportunity to comment on the plan via the hazard mitigation website at any time. The HMP Coordinator will maintain this website, posting new information and maintaining an active link to collect public comments.

The public can also provide input at the annual review meeting for the HMP and during the next five-year plan update. The Hudson County HMP Coordinator is responsible for coordinating the plan evaluation portion of the meeting, soliciting feedback, collecting and reviewing the comments, and ensuring their incorporation in the five-year plan update as appropriate. Additional meetings might also be held as deemed necessary by the planning group. The purpose of these meeting would be to provide the public an opportunity to express concerns, opinions, and ideas about the mitigation plan.

The Planning Committee representatives shall be responsible to assure that:

- Public comment and input on the plan, and hazard mitigation in general, are recorded and addressed, as appropriate.
- Copies of the latest approved plan (or draft in the case that the five-year update effort is underway) are available for review, along with instructions to facilitate public input and comment on the HMP.
- Appropriate links to the Hudson County Hazard Mitigation Plan website are included on municipal websites.
- Public notices are made as appropriate to inform the public of the availability of the plan, particularly during HMP update cycles.

The Hudson County HMP Coordinator shall be responsible to assure that:

- Public and stakeholder comment and input on the plan, and hazard mitigation in general, are recorded and addressed, as appropriate.
- The Hudson County HMP website is maintained and updated as appropriate.
- Copies of the latest approved plan are available for review at appropriate county facilities along with instructions to facilitate public input and comment on the plan.
- Public notices, including media releases, are made as appropriate to inform the public of the availability of the plan, particularly during plan update cycles.

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Section 7. Plan Maintenance Procedures

FEMA. 2013. "Local Mitigation Planning Handbook." On-Line Address: https://www.fema.gov/media-library-data/20130726-1910-25045-9160/fema_local_mitigation_handbook.pdf

Section 8. Planning Partnership

Section 322 of the Robert T. Stafford Disaster Relief and Emergency Assistance Act (Stafford Act), as amended, 42 U.S.C. 5165, and the National Flood Insurance Act of 1968, as amended, 42 U.S.C. 4001 et seq., 44 Code of Federal Regulations (CFR) Part 201.

ACRONYMS AND ABBREVIATIONS

%	Percent
ACOE	Army Corps of Engineers
ACS	American Community Survey
ADA	Americans with Disabilities Act
AICP	American Institute of Certified Planners
ANSS	Advanced National Seismic System
APA	Approval Pending Adoption
ARC	American Red Cross
ASCE	American Society of Civil Engineers
B	Borough
BCA	Benefit Cost Analysis
BCEGS	Building Code Effectiveness Grading Schedule
BFE	Base Flood Elevation
BOCA	Building Officials Code Administration
C	City
CAV	Community Assistance Visit
CDBG	Community Development Block Grant
CDBG-DR	Community Development Block Grant Disaster Recovery
CDC	Centers for Disease Control and Prevention
CDMS	Comprehensive Data Management System
CEDS	Comprehensive Economic Development Strategy
CFR	Code of Federal Regulations
CIP	Capital Improvement Plan
COOP/COG	Continuity of Operations/Continuity of Government
CPC	Climate Prediction Center
CRS	Community Rating System
DFIRM	Digital Flood Insurance Rate Map
DHS	Department of Homeland Security
DMA 2000	Disaster Mitigation Act of 2000
DOT	Department of Transportation
DPW	Department of Public Works

DR	Major Disaster Declaration (FEMA)
EF	Enhanced Fujita Scale
EM	Emergency Declaration (FEMA)
EM	Emergency Management
EMS	Emergency Medical Services
EOC	Emergency Operation Center
EOP	Emergency Operation Plan
EPA	Environmental Protection Agency
ESF	Emergency Support Function
ESRI	Environmental Systems Research Institute
FEMA	Federal Emergency Management Agency
FHWA	Federal Highway Administration
FIRM	Flood Insurance Rate Map
FIA	Flood Insurance Administration
FIS	Flood Insurance Study
FMA	Flood Mitigation Assistance
FPA	Floodplain Administrator
FY	Fiscal Year
GIS	Geographic Information System
HAZMAT	Hazardous Materials
HAZUS-MH	Hazards U.S. Multi-Hazard
HMA	Hazard Mitigation Assistance
HMGP	Hazard Mitigation Grant Program
HMP	Hazard Mitigation Plan
HUC	Hydrologic Unit
HUD	U.S. Department of Housing and Urban Development
HVAC	Heating, Ventilation, and Air Conditioning
I	Interstate
IA	Individual Assistance
ICS	National Incident Command System
ISO	Insurance Service Organization
IT	Information Technology
LEPC	Local Emergency Planning Committee

LOMR	Letter of Map Revision
LOIP	Letter of Intent to Participate
MGD	Million Gallons per Day
Mi	Mile
MMI	Modified Mercalli Intensity Scale
Mph	Miles per Hour
MRP	Mean Return Period
N/A	Not Applicable
NA	Not Available
NASA	National Aeronautics and Space Administration
NCDC	National Climate Data Center
NCEI	National Centers for Environmental Information
NDMC	National Drought Mitigation Center
NEHRP	National Earthquake Hazard Reductions Program
NESIS	Northeast Snowfall Impact Scale
NFIP	National Flood Insurance Program
NFPA	National Fire Protection Association
NGVD	National Geodetic Vertical Datum
NHC	National Hurricane Center
NID	National Inventory of Dams
NIMS	National Incident Management System
NJ	New Jersey
NJDEP	New Jersey Department of Environmental Protection
NJGS	New Jersey Geological Survey
NJOEM	New Jersey Office of Emergency Management
NJTPA	North Jersey Transportation Planning Authority
NOAA	National Oceanic and Atmospheric Administration
NPDP	National Performance of Dams Program
NPL	National Priorities List
NRCC	Northeast Regional Climate Center
NRCS	Natural Resources Conservation Service
NSIDC	National Snow and Ice Data Center
NSSL	National Severe Storms Library

NWIS	National Water Information System
NWS	National Weather Service
OEM	Office of Emergency Management
ONJSC	Office of the New Jersey State Climatologist
PA	Public Assistance
PC	Planning Committee
PCII	Protected Critical Infrastructure Information
PD	Police Department
PDM	Pre-Disaster Mitigation Program
PDSI	Palmer Drought Severity Index
PE	Professional Engineer
PGA	Peak Ground Acceleration
POC	Point of Contact
RCV	Replacement Cost Value
RL	Repetitive Loss
RSI	Regional Snowfall Index
RTE	Route
SBA	Small Business Administration
SC	Steering Committee
SF	Square Feet
SFHA	Special Flood Hazard Area
SPC	Storm Prediction Center
Sq. Mi.	Square mile
SRL	Severe Repetitive Loss
STAPLEE	Social, Technical, Administrative, Political, Legal, Economic, Environmental
SWCD	Soil and Water Conservation District
SWMP	Storm Water Management Plan
SWOO	Strengths, Weaknesses, Obstacles and Opportunities
T	Township or Town
TBD	To Be Determined
TS	Tropical Storm
UASI	Urban Areas Security Initiative
USACE	U.S. Army Corps of Engineers

USD	U.S. Dollar
USDA	U.S. Department of Agriculture
USDM	U.S. Drought Monitor
USDOT	U.S. Department of Transportation
USEDA	U.S. Economic Development Administration
USEPA	U.S. Environmental Protection Agency
USFS	U.S. Forest Service
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geologic Survey
VA	Vulnerability Assessment
WMA	Watershed Management Area
WUI	Wildland Urban Interface