SECTION 1. INTRODUCTION

2019 HMP UPDATE CHANGES

- Section 1, Introduction, was updated to reflect the organization of the 2019 Hazard Mitigation Plan (HMP) update.

1.1 BACKGROUND

A Hazard Mitigation Plan (HMP) is a living document that communities use to reduce their vulnerability to hazards. It forms the foundation for a community's long-term strategy to reduce disaster losses and creates a framework for decision making to reduce damages to lives, property, and the economy from future disasters. Examples of mitigation projects include home acquisitions or elevations to remove structures from high risk areas, upgrades to critical public facilities, and infrastructure improvements. Ultimately, these actions reduce vulnerability, and communities are able to recover more quickly from disasters.

In response to the requirements of the Disaster Mitigation Act of 2000 (DMA 2000), Burlington County, and the cities, townships, and boroughs located therein, have developed this multi-jurisdictional HMP, which is an update of the 2014 *Burlington County New Jersey Multi-Jurisdictional All Hazards Mitigation Plan*. 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) 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.

Burlington County has been included in 26 FEMA (major and emergency) declarations since 1954.

Specifically, the DMA 2000 requires that states, with support from local governmental agencies, 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 will better enable local and state governments to articulate accurate needs for mitigation, resulting in faster allocation of funding and more effective risk reduction projects.

1.1.1 DMA 2000 Origins -The Robert T. Stafford Disaster Relief and Emergency Assistance Act

In the early 1990s, a new federal policy regarding disasters began to evolve. Rather than simply 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 simply 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, other costs associated with disasters are minimized, 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). This section

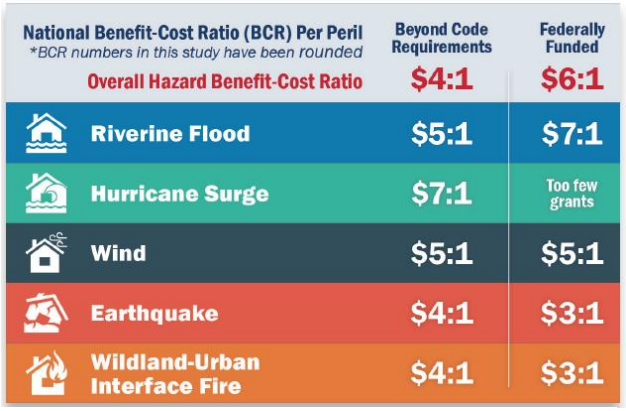
sets forth the requirements that communities evaluate natural hazards within their respective jurisdictions and develop an appropriate plan of action to mitigate those hazards, while emphasizing the need for state, tribal, and local governments to closely coordinate mitigation planning and implementation 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 can be taken by the community to mitigate those hazards—before disaster strikes. For communities to remain eligible for hazard mitigation assistance from the federal government, they 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.

1.1.2 Benefits of Mitigation Planning

The planning process will help prepare citizens and government agencies to better respond when disasters occur. In addition, mitigation planning allows Burlington County as a whole, as well as the participating municipalities, 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:



Natural hazard mitigation saves $6 on average for every $1 spent on federal mitigation grants (FEMA 2018).

- An increased understanding of hazards faced by Burlington County and its communities;
- Building a more sustainable and disaster-resistant county;
- Increasing education and awareness of hazards and their threats, as well as their risks;
- Building relationships by involving residents, organizations, and businesses;
- 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; and
- Reduced long-term impacts and damages to human health and structures and reduced repair costs.

1.1.3 Organizations Involved in the Mitigation Planning Effort

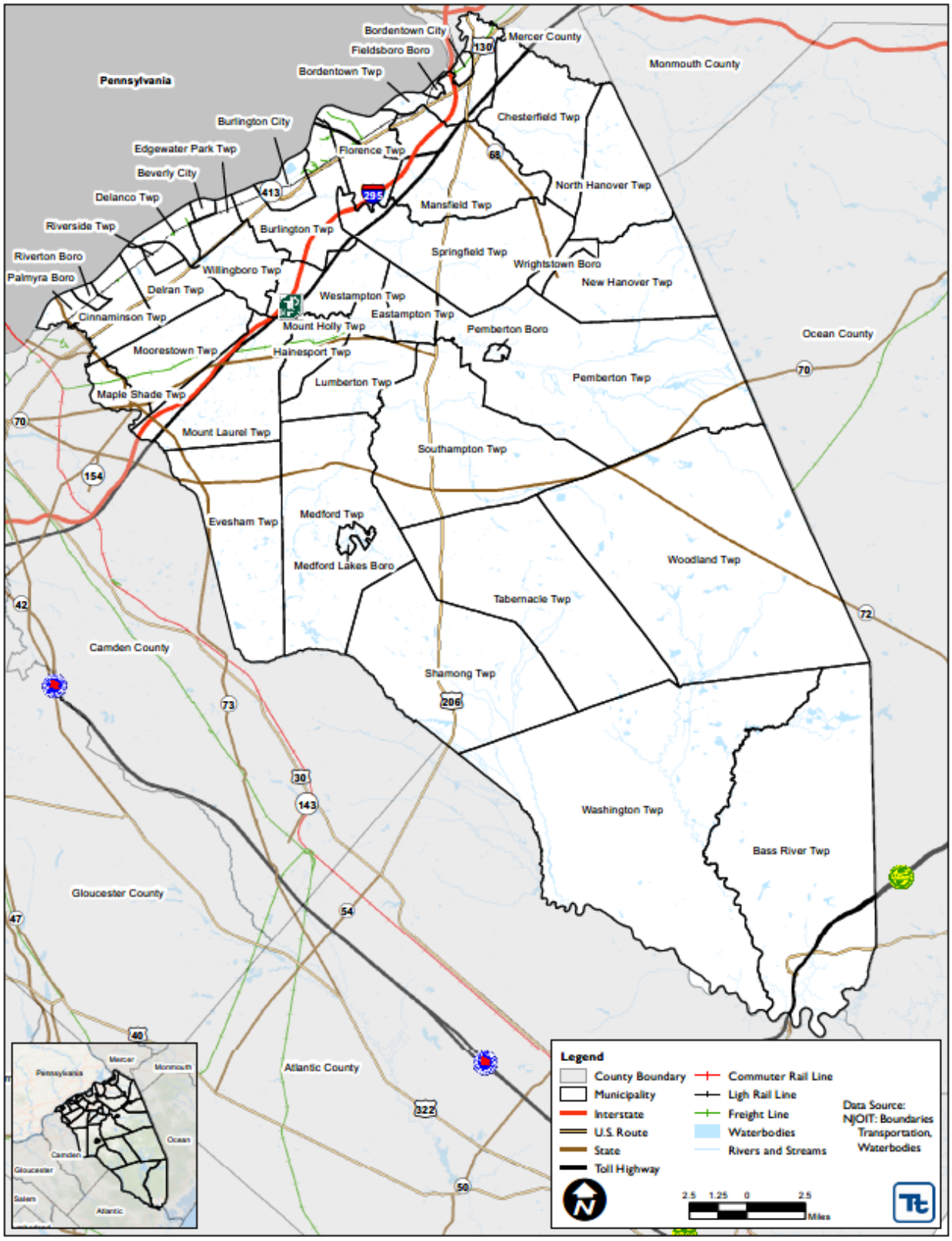
Burlington County and the participating jurisdictions intend to implement this HMP with full coordination and participation of county and local departments, organizations and groups, as well as by coordinating with relevant state and federal entities. Coordination helps to ensure that stakeholders have established communication channels and relationships necessary to support mitigation planning and mitigation actions included in Section 6 (Mitigation Strategy) and Section 9 (Jurisdictional Annexes). In addition to Burlington County, all municipalities have participated in the planning process (Table 1-1 and Figure 1-1).

Table 1-1. Participating Jurisdictions in Burlington County

Jurisdictions		
City of Beverly	Township of Florence	Township of Southampton

Jurisdictions		
City of Bordentown	Township of Hainesport	Township of Springfield
City of Burlington	Township of Lumberton	Township of Tabernacle
Township of Bass River	Township of Mansfield	Township of Washington
Township of Bordentown	Township of Maple Shade	Township of Westampton
Township of Burlington	Township of Medford	Township of Willingboro
Township of Chesterfield	Township of Moorestown	Township of Woodland
Township of Cinnaminson	Township of Mount Holly	Borough of Fieldsboro
Township of Delanco	Township of Mount Laurel	Borough of Medford Lakes
Township of Delran	Township of New Hanover	Borough of Palmyra
Township of Eastampton	Township of North Hanover	Borough of Pemberton
Township of Edgewater Park	Township of Pemberton	Borough of Riverton
Township of Evesham	Township of Riverside	Borough of Wrightstown
	Township of Shamong	

Figure 1-1. Burlington County, New Jersey Mitigation Plan Area



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 and guidance to local jurisdictions. In addition, FEMA provides grants, tools, guidance, and training to support mitigation planning.

Additional input and support for this planning effort was obtained from a range of agencies and through public involvement, as discussed in Section 3 (Planning Process). Under the project management of the Burlington County Office of Emergency Management (Burlington OEM), oversight for the preparation of this HMP was provided by the Burlington County Hazard Mitigation Steering and Planning Committees. Details regarding the roles and responsibilities of the Steering and Planning Committees are also further discussed in Section 3. The Steering Committee, consisting of representatives from county departments, has been formed to plan, guide, expedite, and implement the planning process. A list of Steering Committee and Planning Committee members is provided in Section 3.

This HMP update 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 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

Table 1-2 summarizes the requirements outlined in the DMA 2000 Interim Final Rule and where each of these requirements is addressed in this HMP.

Table 1-2. FEMA Local Mitigation Plan Review Tool

Plan Criteria	Primary Location in the 2019 HMP
Prerequisites	
Adoption by the Local Governing Body: §201.6(c)(5)	Volume I, Section 2.0; Appendix A
Planning Process	
Documentation of the Planning Process: §201.6(b) and §201.6(c)(1)	Volume I, Section 3.0
Risk Assessment	
Identifying Hazards: §201.6(c)(2)(i)	Volume I, Section 5.2
Profiling Hazards: §201.6(c)(2)(i)	Volume I, Section 5.4
Assessing Vulnerability: Overview: §201.6(c)(2)(ii)	Volume I, Section 5.4
Assessing Vulnerability: Identifying Structures: §201.6(c)(2)(ii)(A)	Volume I, Section 4.0 Volume I Section 5.4
Assessing Vulnerability: Estimating Potential Losses: §201.6(c)(2)(ii)(B)	Volume I, Section 5.4

Plan Criteria	Primary Location in the 2019 HMP
Assessing Vulnerability: Analyzing Development Trends: §201.6(c)(2)(ii)(C)	Volume I, Section 4.0; Volume II, Section 9 Annexes
Mitigation Strategy	
Local Hazard Mitigation Goals: §201.6(c)(3)(i)	Volume I, Section 6.0; Volume II, Section 9 Annexes
Identification and Analysis of Mitigation Actions: §201.6(c)(3)(ii)	Volume I, Section 6.0; Volume II, Section 9 Annexes
Implementation of Mitigation Actions: §201.6(c)(3)(iii)	Volume I, Section 6.0; Volume II, Section 9 Annexes
Multi-Jurisdictional Mitigation Actions: §201.6(c)(3)(iv)	Volume I, Section 6.0; Volume II, Section 9 Annexes
Plan Maintenance Process	
Monitoring, Evaluating, and Updating the Plan: §201.6(c)(4)(i)	Volume I, Section 7.0
Incorporation into Existing Planning Mechanisms: §201.6(c)(4)(ii)	Volume I, Section 7.0; Volume II, Section 9 Annexes
Continued Public Involvement: §201.6(c)(4)(iii)	Volume I, Section 7.0

1.1.4 Organization

The Burlington County HMP update is organized as a two-volume plan to facilitate use of this plan as a resource for each participant. Volume I provides information on the overall planning process, and the natural hazard profiling and vulnerability assessments which served as a basis for the understanding of risk and identification of appropriate mitigation actions. As such, Volume I is intended for use as a resource for on-going mitigation analysis. Volume II consists of an annex dedicated to each participating jurisdiction. Each annex summarizes the jurisdiction's legal, regulatory, and fiscal capabilities; vulnerabilities to natural hazards; status of past mitigation actions; and provides an individualized mitigation strategy. The annexes are intended to provide an expedient 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.

Goals and Objectives

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

The six goals of the Burlington County HMP:

- Goal 1: Protect Life
- Goal 2: Protect Property
- Goal 3: Promote a Sustainable Economy
- Goal 4: Protect the Environment
- Goal 5: Increase Public Awareness
- Goal 6: Support Continuity of Operations

Hazards of Concern

Burlington County and participating jurisdictions reviewed the natural hazards that caused measurable impacts in the planning area and updated the list of hazards of concern based on events, losses, and information available since the 2014 HMP. Burlington County and participating jurisdictions evaluated the risk and vulnerability due to each of the hazards of concern on the assets of each participating jurisdiction. Although the resulting hazard risk rankings varied for each jurisdiction, the summary risk rankings corresponded with that of Burlington County and are indicated in each jurisdictional annex. The hazard risk ranks were used to focus and prioritize individual jurisdictional mitigation strategies.

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 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 HMP integrate and coordinate with, and complement, those mechanisms.

The *Capability Assessment* in Section 6 (Mitigation Strategy) 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 Burlington County. Within each jurisdictional annex (Section 9), Burlington County and each participating jurisdiction identified how they have 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 9 (Jurisdictional Annexes).

1.1.5 Implementation of the 2014 Hazard Mitigation Plan

Section 6 (Mitigation Strategy) and Section 9 (Jurisdictional Annexes) of the plan present the status of the mitigation projects identified in the 2014 Burlington County HMP. Numerous projects and programs have been implemented that have reduced hazard vulnerability to assets in the planning area. The county and municipal annexes, and plan maintenance procedures in Section 7 (Plan Maintenance), have been developed to encourage specific activities such as review of the HMP during update of codes, ordinances, zoning, and development to ensure that a more thorough integration, with its related benefits, will be completed within the upcoming five-year planning period.

1.1.6 Implementation of the Planning Process

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

- Developed a Steering Committee and Planning Committee
- Reviewed the 2014 *Burlington County HMP*
- Identified/reviewed hazards that are of greatest concern to the county (hazards of concern) to be included in the update
- Profiled these hazards
- Estimated the assets at risk and potential losses associated with these hazards
- Reviewed and updated the mitigation goals and added objective
- Reviewed the 2014 mitigation strategy and actions to indicate progress

- Developed new mitigation actions to address reduction of vulnerability of hazards of concern
- Involved a wide range of stakeholders and the public in the HMP update process
- Updated mitigation plan maintenance procedures to be executed after obtaining approval of the plan from NJOEM and FEMA

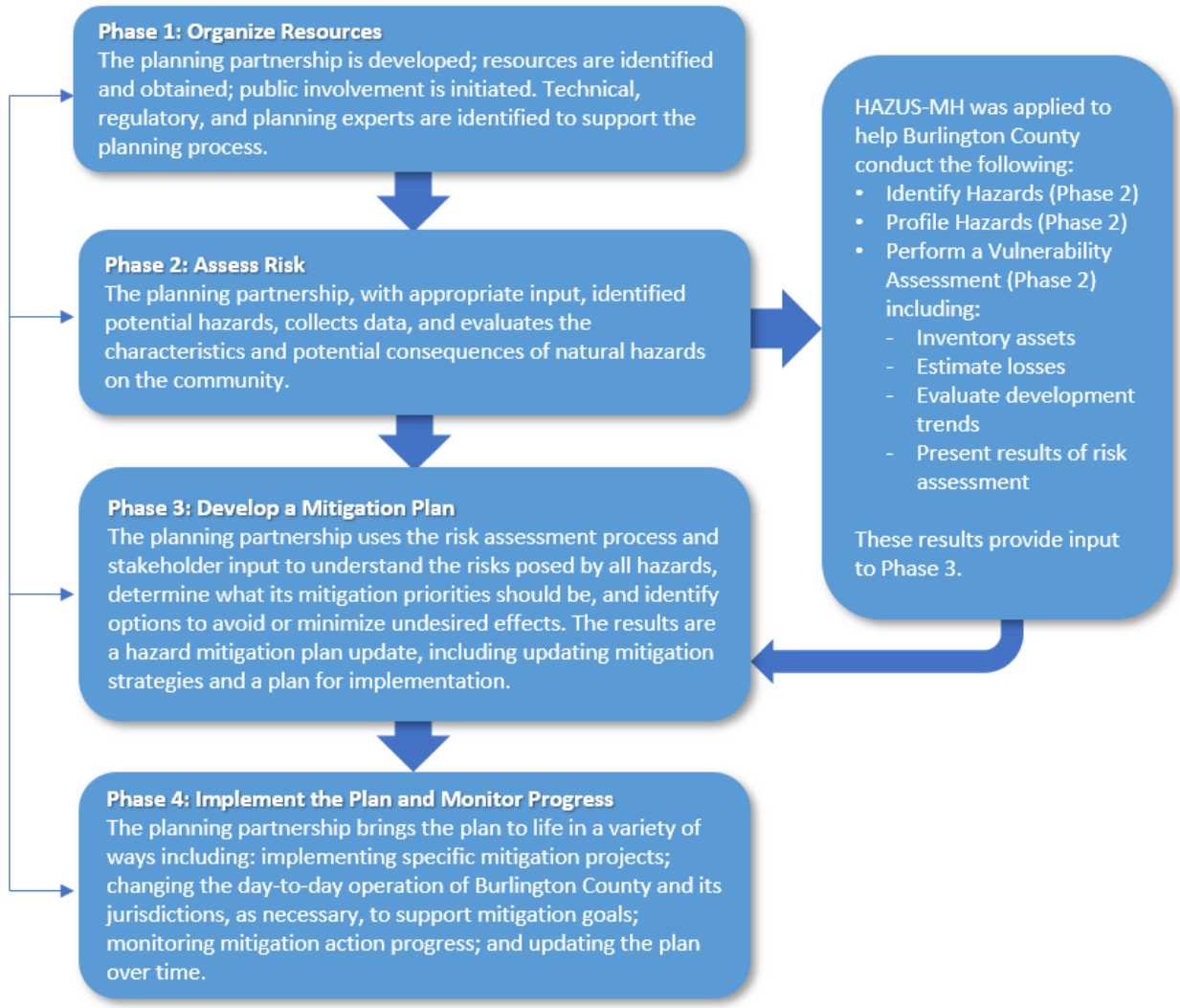
As required by the DMA 2000, Burlington County and participating jurisdictions have informed the public on the planning process and provided opportunities for public comment and input. In addition, numerous agencies and stakeholders have participated as core or support members, providing input and expertise throughout the planning process.

This HMP update documents the process and outcomes of Burlington County and the jurisdictions' efforts. Section 2 (Plan Adoption) includes documentation that the prerequisites for plan approval have been met. Section 3 (Planning Process) includes additional information on the process to develop this plan update.

1.1.7 Organization of this Mitigation Plan

This HMP update was organized in accordance with FEMA and NJOEM guidance. The structure of this HMP update follows the four-phase planning process recommended by FEMA and is summarized in Figure 1-2.

Figure 1-2. Burlington County Hazard Mitigation Planning Process



As noted earlier, the HMP is organized into two volumes: Volume I includes all information that applies to the entire planning area (Burlington County); and Volume II includes participating jurisdiction-specific information.

Volume I of this HMP includes the following sections:

Section 1: Introduction: Overview of participants and planning process.

Section 2: Plan Adoption: Information regarding the adoption of the HMP update by Burlington County and each participating jurisdiction.

Section 3: Planning Process: A description of the HMP update methodology and development process; Steering Committee, Planning Committee, and stakeholder involvement efforts; and a description of how this HMP update will be incorporated into existing programs.

Section 4: County Profile: An overview of Burlington County, including: (1) general information, (2) economy, (3) land use trends, (4) population and demographics, (5) general building stock inventory and (6) critical facilities.

Section 5: 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 and health; general building stock; critical facilities; and the economy). Description of the status of local data and planned steps to improve local data to support mitigation planning.

Section 6: Mitigation Strategy: Information regarding the updated mitigation goals and objectives identified by Burlington County; capability assessment; and mitigation strategy development and update are included in this section.

Section 7: Plan Maintenance: The system established by Burlington County 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, and jurisdictional annexes.

Section 9: Jurisdictional Annexes: A jurisdiction-specific annex for each participating municipality and Burlington County containing their hazards of concern, hazard risk ranking, capability assessments, new/updated mitigation actions, action prioritization specific only to Burlington County or that jurisdiction, progress on 2014 mitigation actions, and an overview of plan integration into local planning processes.

Appendices include:

Appendix A: Resolutions of HMP Adoption: Resolutions from the county and each jurisdiction will be included as they formally adopt the HMP update.

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

Appendix C: Participation Matrix: A matrix is presented to give a broad overview of who attended meetings and when input was provided to the HMP update.

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 update process.

Appendix E: Mitigation action worksheet template, instructions.

Appendix F: FEMA 386-4 Guidance Worksheets: Examples of plan review templates available to support annual plan review.

Appendix G: FEMA Plan Review Tools: Examples of plan review templates available to support annual plan review.

1.2 THE PLAN UPDATE – WHAT IS DIFFERENT?

Burlington County's initial HMP was approved by FEMA and adopted by participating jurisdictions in 2008. The plan was subsequently updated, approved by FEMA, and adopted by participating jurisdictions in 2014. The 2019 update builds on the 2014 plan and specifically includes the following changes or enhancements. This plan differs from its predecessor for a variety of reasons:

- Updated data and tools provided for a more detailed and accurate risk assessment. The risk assessment was prepared to better support future grant applications by providing risk and vulnerability information that would directly support the measurement of "cost-effectiveness" required under FEMA mitigation grant programs.
- The plan identified implementable actions rather than strategies, with enough information to serve as the basis for policy and funding decisions and represent measurable impacts on resiliency and mitigation progress. Strategies provide direction, but actions are fundable under grant programs.

Table 1-3. Plan Changes Crosswalk

44 CFR Requirement	2014 Plan	2019 Updated Plan
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 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.*	The 2014 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. • Use of a public information survey. Stakeholders were identified and coordinated with throughout the process. A comprehensive review of relevant plans and programs was performed by the planning team.	Building upon the success of the 2014 plan, the 2019 planning effort deployed the same public engagement methodology. The plan included the following enhancements: • Using social media. • Web-deployed survey. As with the 2014 plan, the 2019 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 2014 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 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 2019 plan update.
§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 2014 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. • Impact on people, property, and critical facilities.	The same format, using new and updated data, was used for the 2019 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 the State of New Jersey. • Vulnerability assessment includes: impact on life, safety, and health, general building stock, critical facilities, and the

44 CFR Requirement	2014 Plan	2019 Updated Plan
	• Future growth and development. • Additional data and next steps. • Overall vulnerability assessment.	economy, as well as future changes that could impact vulnerability. • The vulnerability assessment also includes changes in vulnerability since the 2014 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 computer model was used for the severe 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 model. HAZUS-MH outputs were generated for other hazards by applying an estimated damage function to an asset inventory extracted from HAZUS-MH-MH.	The same methodology was deployed for the 2019 plan update, using new and updated data.
§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 and the identification of repetitive and severe repetitive loss properties in each jurisdiction was included in the plan.	The same methodology was deployed for the 2019 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 profile provides a discussion on future development trends.	The same methodology was deployed for the 2019 plan update using new and updated data.
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 for the severe 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 2019 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 2019 plan update using new and updated data.
§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	The 2014 plan contained a mission statement, goals, objectives and actions. The mission statement, goals and objectives were regional and covered all planning partners. Each planning partner identified actions that could be implemented within their	The same methodology for setting goals, objectives, and actions was applied to the 2019 plan update. The Steering Committee reviewed and reconfirmed the mission statement, goals, and objectives for the plan. Each planning partner used the

44 CFR Requirement	2014 Plan	2019 Updated Plan
ability to expand on and improve these existing tools.]	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 planning, regulatory, technical, and financial capabilities.	progress reporting from the plan maintenance and evaluated the status of actions identified in the 2014 plan. Actions that were completed or no longer considered to be feasible were removed. The balance of the actions was carried over to the 2019 plan, and in some cases, new actions were added to the action plan. Those actions identified as ongoing capabilities were incorporated into the capability assessment of each jurisdictional annex.
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 a mission statement, goals, and objectives targeted specifically for this hazard mitigation plan. These planning components supported the actions identified in the plan.	The same methodology for setting goals, objectives, and actions was applied to the 2019 plan update. The Steering Committee reviewed and updated the mission statement, goals, and objectives for the plan to include a focus on increased resiliency. This resulted in the finalization of six goals and nine objectives to frame the plan.
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 2014 plan includes a hazard mitigation catalog that was developed through a facilitated process. This catalog identifies actions that manipulate the hazard, reduce exposure to the hazard, reduce vulnerability, or increase mitigation capability. The catalog further segregates actions by scale of implementation. A table in the action plan section analyzes each action by mitigation type to illustrate the range of actions selected.	The mitigation catalog was reviewed and updated by the Steering Committee for the 2019 update. As with the 2014 plan, the catalog has been included in the 2019 plan to represent the comprehensive range of alternatives considered by each planning partner. The table with the analysis of mitigation actions was used in jurisdictional annexes to the plan.
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 NFIP identified an action stating their commitment to maintain compliance and good standing under the program.	Ongoing participation in the NFIP for municipalities was included in ongoing capabilities for each participating municipality.
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 qualitative methodology based on the objectives the project will meet, the timeline for completion, how the project will be funded, the impact of the project, the benefits of the project, and the costs of the project.	A revised methodology based on the STAPLEE criteria and using new and updated data was used for the 2019 plan update.
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 2014 plan detailed a plan maintenance strategy.	The 2014 plan maintenance strategy was carried over to the 2019 plan.

44 CFR Requirement	2014 Plan	2019 Updated Plan
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 2014 plan details recommendations for incorporating the plan into other planning mechanisms.	The 2019 plan details recommendations for incorporating the plan into other planning mechanisms such as the following: • Master Plan • Capital Improvement and Municipal Budget • Municipal Codes and Ordinances
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 2014 plan details a strategy for continuing public involvement.	The 2014 plan maintenance strategy was carried over to the 2019 plan. In addition, the county will use a proprietary online tool to support the annual progress reporting of mitigation actions.
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).	40 planning partners participated in the 2014 planning process.	The 2019 plan achieves DMA compliance for 40 planning partners. Resolutions for each partner adopting the plan can be found in Appendix A of this volume.

SECTION 2. PLAN ADOPTION

2019 HMP UPDATE CHANGES

- The resolutions issued to support adoption of the HMP update by each jurisdiction are included in Appendix A.

2.1 OVERVIEW

This section contains information regarding adoption of the HMP update by Burlington County and each participating jurisdiction.

2.1.1 Plan Adoption by Local Governing Bodies

A hazard mitigation plan must document that it has been formally adopted by the governing bodies of the jurisdictions requesting federal approval of the plan. For multi-jurisdictional plans, each jurisdiction requesting approval must document that is has been formally adopted. Adoption by the local governing bodies demonstrates the commitment of Burlington County and each participating jurisdiction to fulfill the mitigation goals and strategies outlined in the plan. Adoption legitimizes the HMP and authorizes responsible agencies to execute their responsibilities

This plan will be submitted for a pre-adoption review to NJOEM and FEMA Region 2. Once FEMA provides conditional approval of this HMP update, known as Approval Pending Adoption (APA), the county and participating jurisdictions will proceed with formal adoption proceedings.

Following adoption or formal action on the plan, the jurisdiction must submit a copy of the resolution or other legal instrument showing formal adoption (acceptance) of the plan to the Burlington County Hazard Mitigation Coordinator. Burlington County will forward the executed resolutions to NJOEM after which they will be forwarded to FEMA for record. The jurisdictions understand that FEMA will transmit acknowledgement of verification of formal plan adoption and the official approval of the plan to the Burlington County Hazard Mitigation Coordinator.

The resolutions issued by each jurisdiction to support adoption of the plan will be included in Appendix A (Plan Adoption).

In addition to being required by DMA 2000, adoption of the plan is necessary because:

- It lends authority to the plan to serve as a guiding document for all local and state government officials;
- It gives legal status to the plan in the event it is challenged in court;
- It certifies the program and grant administrators that the plan's recommendations have been properly considered and approved by the governing authority and jurisdictions' citizens; and
- It helps to ensure the continuity of mitigation programs and policies over time because elected officials, staff, and other community decision-makers can refer to the official document when making decisions about the community's future.

Source: FEMA. 2003. "How to Series"-*Bringing the Plan to Life* (FEMA 386-4).

Resolution # _____

WHEREAS the **XXXXXX**, New Jersey, has experienced natural hazards that result in public safety hazards and damage to private and public property;

WHEREAS the hazard mitigation planning process set forth by the State of New Jersey and the Federal Emergency Management Agency offers the opportunity to consider natural hazards and risks, and to identify mitigation actions to reduce future risk;

WHEREAS the New Jersey Office of Emergency Management is providing federal mitigation funds to support development of the mitigation plan;

WHEREAS a *Hazard Mitigation Plan* (HMP) has been developed by the Mitigation Steering and Planning Committees;

WHEREAS the *Hazard Mitigation Plan* includes a prioritized list of mitigation actions including activities that, over time, will help minimize and reduce safety threats and damage to private and public property, and

WHEREAS the draft plan was provided to each participating jurisdiction and was posted on the Burlington County website so as to introduce the planning concept and to solicit questions and comments; and to present the Plan and request comments, as required by law, and

NOW THEREFORE BE IT RESOLVED by the **XXXX** of the **XXXX**:

1. The *Burlington County Multi-Jurisdictional All Hazards Mitigation Plan, as submitted to the New Jersey Office of Emergency Management and the Federal Emergency Management Agency on **XXXX*** by the Burlington County Department of Public Safety/Office of Emergency Management is hereby adopted as an official plan of the **XXXXX**; minor revisions recommended by the Federal Emergency Management Agency and/or the New Jersey Office of Emergency Management may be incorporated without further action.

2. The **XXXXX** departments identified in the HMP are hereby directed to pursue implementation of the recommended high priority activities that are assigned to their departments.

3. Any action proposed by the HMP shall be subject to and contingent upon budget approval, if required, which shall be at the discretion of the **XXXX**, and this resolution shall not be interpreted so as to mandate any such appropriations.

4. The Burlington County Office of Emergency Management Coordinator is designated to coordinate with other offices and shall periodically report on the activities, accomplishments, and progress, and shall prepare an annual progress report to be submitted to the Burlington County Department of Public Safety/Office of Emergency Management. The status reports shall be submitted on a yearly basis by a predetermined date as agreed upon by all stakeholders.

PASSED by the **XXXX** of the **XXXXXX,** this _____ day of _____, 2019.

SECTION 3. PLANNING PROCESS

2019 HMP Update Changes

- All aspects of the Planning Process were updated for the 2019 HMP.

3.1 INTRODUCTION

This section includes a description of the planning process used to update the 2014 Burlington County HMP, including how it was prepared, who was involved in the process, and how the public was involved. To ensure that the HMP met the requirements of DMA 2000, as well as to support the long-term goal of having all jurisdictions in the county covered under a comprehensive and cohesive county-wide DMA 2000 plan, an approach to the planning process and plan documentation was developed to achieve the following:

- The HMP will be multi-jurisdictional and consider natural hazards facing Burlington County, thereby satisfying the natural hazards mitigation planning requirements specified in DMA 2000. Burlington County invited all municipalities in the county to join with them in the preparation of the Burlington County HMP update. Burlington County and all its municipalities participated in the HMP as indicated in Table 3-1 below. The plan will consider all-natural hazards of concern facing the area, thereby satisfying the natural hazards mitigation planning requirements specified in DMA 2000.

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

Table 3-1. Participating Burlington County Jurisdictions

Jurisdictions		
City of Beverly	Township of Florence	Township of Southampton
City of Bordentown	Township of Hainesport	Township of Springfield
City of Burlington	Township of Lumberton	Township of Tabernacle
Township of Bass River	Township of Mansfield	Township of Washington
Township of Bordentown	Township of Maple Shade	Township of Westampton
Township of Burlington	Township of Medford	Township of Willingboro
Township of Chesterfield	Township of Moorestown	Township of Woodland
Township of Cinnaminson	Township of Mount Holly	Borough of Fieldsboro
Township of Delanco	Township of Mount Laurel	Borough of Medford Lakes
Township of Delran	Township of New Hanover	Borough of Palmyra
Township of Eastampton	Township of North Hanover	Borough of Pemberton
Township of Edgewater Park	Township of Pemberton	Borough of Riverton
Township of Evesham	Township of Riverside	Borough of Wrightstown
	Township of Shamong	

The Burlington 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 municipal 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 solicited information from local agencies and individuals with specific knowledge of certain natural 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 of the HMP describes the mitigation planning process, including (1) Planning Partnership – Organization and Activity; (2) Stakeholder Outreach and Involvement; (3) Public Participation – Citizen Involvement; (4) Integration and Coordination with Existing Mitigation Efforts and Programs; and (5) Continued Public and Stakeholder Involvement.

3.2 PLANNING PARTNERSHIP - ORGANIZATION AND ACTIVITY

Many parties supported the preparation of this HMP update: the Steering Committee, Planning Committee, stakeholders and planning consultant. This planning process does not represent the start of hazard risk management in the 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 an historical perspective of the county and local activities implemented to reduce vulnerability to hazards in the planning area.

This subsection 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.

3.2.1 Organization of Planning Partnership

Recognizing the need to manage risk within the county, and to meet the requirements of the DMA 2000, the Burlington County Office of Emergency Management led the update to the 2014 Burlington County HMP. Burlington County applied for and was awarded a multi-jurisdictional planning grant under the FEMA Pre-Disaster Mitigation program (PDMC-PL-02-NJ-2015-02), which has supported the development of the update of the Burlington County HMP.

Project management and grant administration has been the responsibility of the Burlington County Office of Emergency Management. A contract consultant (Tetra Tech, Inc.) was selected to guide the County and participating jurisdictions through the HMP update process. A contract between Tetra Tech, Inc. (Tetra Tech) and Burlington County was executed on August 9, 2017. Specifically, Tetra Tech, the "contract consultant", was tasked with:

- Assisting with the organization of a Steering 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; and
- Authoring of the draft and final HMP documents.

In September 2017, Burlington County notified all 40 municipalities within the county of the pending planning process and invited them to formally participate. Municipalities 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) and to identify a planning point of contact to serve on a Planning Committee and represent the interests of their respective community. All 40 municipalities returned their Letter of Intent to Participate (refer to Appendix C – Participation Matrix).

To facilitate HMP development, with support from their contract planning consultant, Burlington County developed a Steering Committee to provide guidance and direction to the planning effort, and to ensure the resulting document will be embraced both politically and by the constituency within the planning area. All municipalities participating in the plan update authorized the Steering Committee to perform certain activities on their behalf, via the Letter of Intent to participate (FEMA mitigation planning "combination model"). Steering Committee members are identified in Table 3-2. The Steering Committee was charged with:

- 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:
    - Reviewing and updating the hazards of concern;
    - Developing a public and stakeholder outreach program;
    - Assuring the data and information used in the plan update process is best available;
    - Reviewing and updating the hazard mitigation planning goals and objectives;
    - Identifying and screening of appropriate mitigation strategies and activities;
    - Reviewing and updating plan maintenance procedures; and
- Reviewing and commenting on plan documents prior to submission to NJOEM and FEMA.

A Planning Committee was assembled to represent each of the municipalities participating in the HMP update, with one primary representative and an alternate point of contact from each of the 40 participating municipalities. Each municipality received a copy of the "Planning Partner Expectations" which outlined the responsibilities of the participants and the agreement of the partners to authorize a Steering Committee to represent the jurisdiction in the completion of certain planning elements. Table 3-2 lists the current municipal members of the Planning Committee at the time of this HMP's publication. Please note that the Steering Committee members are also part of the overall project Planning Committee, fulfilling these responsibilities on behalf of Burlington County. This 'planning partnership' (Steering and Planning Committees) were 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, etc.);
- 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; and
- Adopt, implement and maintain the plan update.

Table 3-2. Burlington County Hazard Mitigation Planning Partnership

Organization	Name	Title	Municipal POC Primary POC	Municipal POC Alternate POC
Burlington County Office of Emergency Management	Kevin Shoppas	Coordinator	Steering Committee	
	Wayne Comegno	Deputy Coordinator	Steering Committee	
	David Rickert	GIS	Steering Committee	
	Justin Wright	Planner	Steering Committee	
	Colleen Ekey	Planning Aide	Steering Committee	
Burlington County Roads and Bridges	John Janis Jr.	Road Supervisor	Steering Committee	
Burlington County Engineering	Joe Brickley	County Engineer	Steering Committee	
Burlington County Parks	John Smith	Superintendent of Parks	Steering Committee	
Burlington County Department of Resource Conservation	Mary Pat Robbie	Director (Acting)	Steering Committee	
Burlington County Freeholders Office	Todd Wirth	Administration	Steering Committee	
	Christine Brown	Assistant PIO	Steering Committee	
Burlington County Public Safety	John Drinkard	Director (Acting)	Steering Committee	
	Howard Black	Deputy Director (Acting)	Steering Committee	
	Laura Murray	Administrative Assistant	Steering Committee	
Burlington County Health Department	Holly Cucuzzella	Director	Steering Committee	
	Jessica Czepeil	Public Health Nurse	Steering Committee	
	Lauren Ernst	Public Health Planner	Steering Committee	
Township of Bass River	Sally Bourguignon	OEM Coordinator	X	
	Amanda Somes	Municipal Clerk		X
City of Beverly	Kevin Richards	OEM Coordinator	X	
	Rich Wolbert	Public Safety Director		X
City of Bordentown	James Lynch, Jr.	Mayor / EMC	X	
	Brian Maugeri, Sr.	Deputy EMC		X
Township of Bordentown	Sgt. Salvatore Guido	OEM Coordinator	X	
	Michael Theokas	Administrator		X
City of Burlington	Frank Caruso	EMC	X	
	Kenneth Shine, Assoc. DBIA, CFM	Project Manager		X
Township of Burlington	Dave Ekelburg	OEM Coordinator	X	
	Scott Hatfield	Township Engineer		X
Township of Chesterfield	Chief Kyle Wilson	Police Department / OEM	X	
	Glenn Riccardi	Construction Code Official		X
Township of Cinnaminson	Danny Norman	Director of OEM	X	
	Todd Day	Township Engineer		X

Organization	Name	Title	Municipal POC Primary POC	Municipal POC Alternate POC
Township of Delanco	Janice Lohr	Assistant Administrator / Municipal Clerk	X	
	Michael Templeton	Twp. Committeeman		X
Township of Delran	Walter Bauer	EMC	X	
	Joseph Cunningham	Deputy Fire Chief		X
Township of Eastampton	David Shaw	EMC	X	
	Eric Schubiger	Township Manager		X
Township of Edgewater Park	Patrick Daly	OEM Coordinator	X	
	Chief Gene Di Filippo	Police Chief/Acting Twp. Administrator		X
Township of Evesham	Chief Carl Bittenbender	Fire Chief / OEM Coordinator	X	
	Nancy Jamanow	Community Development Director		X
Borough of Fieldsboro	David R. Hansell	Mayor	X	
	Patrice Hansell	Municipal Clerk		X
Township of Florence	Philip Drangula	OEM	X	
	Richard Brook	Administrator		X
Township of Hainesport	William Boettcher	OEM Coordinator	X	
	William Challenger	Deputy OEM Coordinator		X
Township of Lumberton	Daniel Januseski	OEM Coordinator	X	
	Brandon Umba	Administrator		X
Township of Mansfield	Douglas Borgstrom	Fire Official/EMC	X	
	Linda Semus	Municipal Clerk/Registrar		X
Township of Maple Shade	Joseph Andl	Township Manager	X	
	Kevin Rijs, P.P., AICP	Community Development Director		X
Township of Medford	Robert Dovi	Lt. EMC	X	
	Thomas Thorn	Chief Deputy EMC		X
Borough of Medford Lakes	Dr. Robert Burton	Borough Manager	X	
	Mark McIntosh	Borough Clerk		X
Township of Moorestown	Chief Lee Lieber	Police Chief / OEM Coordinator	X	
	Jason Witkowski	Patrolman, Deputy OEM		X
Township of Mount Holly	Joshua Brown	Township Manager	X	
	Ryan Donnelly	OEM Coordinator		X
Township of Mount Laurel	Ronald Devlin	EMC	X	
	John Colucci	Fire Chief/Deputy EMC		X
Township of New Hanover	Pat Murphy	OEM Coordinator	X	
	Kyle Tuliano	Deputy OEM		X
Township of North Hanover	Richard Mellor	EMC/Police	X	
	Alexandra DeGood	Zoning Officer/Construction		X
Borough of Palmyra	Tracy Kilmer	Deputy OEM Coordinator	X	
	Richard Dreby	OEM Executive Coordinator		X
Borough of Pemberton	Chad Bozoski	EMC / Fire Chief	X	

Organization	Name	Title	Municipal POC Primary POC	Municipal POC Alternate POC
	Donna Mull	Borough Administrator / Clerk		X
Township of Pemberton	Craig Augustoni	OEM Coordinator	X	
	Dennis Gonzalez	Business Administrator		X
Township of Riverside	Meghan Jack	Township Administrator	X	
	Susan Dydek	Clerk		X
Borough of Riverton	Scott Reed	Fire Chief / OEM	X	
	Michelle Hack	Borough Clerk		X
Township of Shamong	John Lyons	OEM Coordinator	X	
	Susan Onorato	Administrator		X
Township of Southampton	Kathleen Hoffman	Administrator/Township Clerk	X	
	Charles Oatman	Director of Public Works		X
Township of Springfield	Eric Trout	Chief of Police / OEM Coordinator	X	
	J. Paul Keller	Manager/Administrative		X
Township of Tabernacle	Robert Sunbury	OEM Coordinator	X	
	Douglas Cramer, CPWM	Township Administrator		X
Township of Washington	David Simpson	OEM Coordinator	X	
	To be determined	To be determined		X
Township of Westhampton	Daryl Caulfield	OEM Coordinator	X	
	Chief Craig Farnsworth	Emergency Services		X
Township of Willingboro	John Carroll	EMC	X	
	Richard Brevogel	Acting Twp. Manager		X
Township of Woodland	Shawn Viscardi	OEM Coordinator	X	
	Tom Toth	Deputy OEM Coordinator		X
Borough of Wrightstown	James Ingling	Deputy OEM Coordinator	X	
	William Bird	OEM Coordinator		X

Notes: POC = Point of Contact;

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. It is recognized that the jurisdictions in Burlington County have differing levels of capabilities and resources available to apply to the planning process, and further have differing exposure and vulnerability to the natural hazard risks being considered in this HMP. It was Burlington County's intent to encourage participation by all-inclusive jurisdictions, and to accommodate their specific needs and limitations while still meeting the intents and purpose of 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 update (Section 9) wherein the jurisdiction has 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 HMP update via resolution.

Appendix C (Participation Matrix) identifies those individuals who represented their municipalities 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, Jurisdictional Annex Workshop and FEMA/NJOEM Mitigation Workshop. During the planning process the planning consultant contacted each participant to offer support, explain the process, and to facilitate the submittal and review of critical documents.

It is noted that all municipalities actively participate in the National Flood Insurance Program (NFIP), and have a designated NFIP Floodplain Administrator (FPA). All known FPAs were informed of the planning process, reviewed the plan documents, and provided 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).

3.2.2 Planning Partnership 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 planning partnership had the opportunity to review the draft plan and supported interaction with other stakeholders, and assisted with public involvement efforts.

A summary of Planning and Steering Committee meetings held and key milestones met during the development of the HMP update is included in Table 3-3. It also identifies which DMA 2000 requirements the activities satisfy. Documentation of meetings (agendas, sign-in sheets, and minutes where available) may be found in Appendix B (Meeting Documentation). Table 3-3 identifies only the formal meetings held during plan development, and does not reflect the planning activities conducted by individuals and groups throughout the planning process. In addition to these meetings there was a great deal of communication between Planning 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 (Steering and Planning Committees) as described in Section 7 (Plan Maintenance). The planning partnership is responsible for reviewing the HMP, soliciting and considering public comment as part of the five year HMP update.

Table 3-3. Summary of Planning Outreach

Date	Activity/ DMA 2000 Requirement	Key Outcomes/Purpose	Participants
August 9, 2017	1b, 2	Burlington County resolution to select contract planning consultant to update Multi-Jurisdictional Mitigation Plan	Board of Chosen Freeholders
September 22, 2017	1b, 1c, 2, 3a, 4a	Pre-Kick Off Meeting #1: Meeting with Burlington County Department of Public Safety/OEM to discuss the hazard mitigation planning process, municipal participation expectations, schedule, Steering Committee, and upcoming meetings.	Burlington County Department of Public Safety/OEM and GIS: Public Safety: J. Drinkard, H. Blank; OEM: S. King, W. Comegno: GIS: D. Rickert; Tetra Tech: Paul Miller
November 8, 2017	1b, 1c, 2, 3a, 4a	Steering Committee Meeting #1: The Steering Committee guidelines were addressed, hazards of concern exercise conducted, public/stakeholder outreach was discussed and	Refer to Appendix B (Meeting Documentation).

Table 3-3. Summary of Planning Outreach

Date	Activity/ DMA 2000 Requirement	Key Outcomes/Purpose	Participants
		data collection (spatial data and planning data) initiated. Goals and objectives were reviewed and discussed and a new goal was added to this update.	
November 30, 2017	1c, 2, 3a-c, 3e, 4a, 4b	Planning Committee Meeting #1 / Municipal Kick-Off Meetings (two meetings 2PM and 7PM): Presentation and discussion on the planning process, and discussion regarding municipal participation expectations. Initial data and information gathering conducted including distribution of worksheets on a CD for each municipality to complete.	Refer to Appendix B (Meeting Documentation).
December 7, 2017	1c, 2, 3a-c, 3e, 4a, 4b	Planning Committee Meeting #1 Make Up - Conference Call: A conference call was conducted for municipalities who were unable to attend the November 30 planning meetings. Attendees were provided all materials including the CD prior to this conference call. All participants received similar information that was presented at the November 30th meeting	Refer to Appendix B (Meeting Documentation).
January 25, 2018	3a, 4b	Steering Committee Meeting #2: The following topics were discussed during this committee meeting: municipal participation; progress on 2014 HMP mitigation actions; public outreach; upcoming meetings confirmation.	Refer to Appendix B (Meeting Documentation).
January 25, 2018	1b	Webinar: Stormwater Management: There are commonalities between data gathered for the Burlington County Hazard Mitigation Plan and the requirements of a municipal stormwater program. This webinar addressed how a municipality can take advantage of these efficiencies to improve water quality, reduce flooding, and comply with NJ permit and stormwater regulations.	Voluntary webinar offered to all municipalities.
March 1, 2018	2, 3d, 4a, 4b, 5a, 5b	Annex Workshop and FEMA/NJOEM Mitigation Strategy Meeting: The updated goals and objectives were presented to the Planning Committee for review. Worksheet #7 - New Action Worksheet was provided to all participants. NJOEM and FEMA Region 2 presented on mitigation strategy development, plan maintenance, and plan integration. Additional tools and resources were distributed (e.g., mitigation catalog). This meeting encouraged participants to identify and prioritize a comprehensive range of mitigation alternatives as a result of historic losses; and discuss integration of mitigation. Continued public outreach and promotion of the Citizen Survey was encouraged to all participants.	Refer to Appendix B (Meeting Documentation).
March 15, 2018	3b, 3c, 4b, 4c	Results of the risk assessment were distributed to plan participants to assist with the identification of new mitigation actions.	Participating municipalities
March 29, 2018	2, 4b	A Strengths, Weaknesses, Opportunities and Obstacles (SWOO) exercise and mitigation strategy workshop was conducted. Tools and resources were distributed. The workshop guided participants on how to identify and prioritize a comprehensive range of mitigation alternatives as a result of historic losses, current risk; and discuss integration of mitigation.	Refer to Appendix B (Meeting Documentation).
May 1, 2018	4b, 4c	Jurisdictional Annex Workshop Conference Call	Refer to Appendix B (Meeting Documentation).
August 2018 through November 2018	2, 3b, 3c, 3e, 4a, 4b	Municipal Outreach and Guidance: contact was made with each participating municipality to review their draft annex and provide support in finalizing the annex.	Participating municipalities
March 4, 2019	5a, 5b, 5c	Steering Committee Meeting: discussed HMP title, annex progress, plan maintenance and Draft HMP	Burlington County Department of Public Safety/OEM: K. Shoppas, J.

Table 3-3. Summary of Planning Outreach

Date	Activity/ DMA 2000 Requirement	Key Outcomes/Purpose	Participants
			Wright, W. Comegno, C. Ekey; Tetra Tech: P. Miller, H. Apgar
March 8, 2019	1b	Draft sections of the HMP posted to County website (as available) for participant, stakeholder and public review.	Public and all plan participants
September 2019	2	HMP submitted to NJOEM and FEMA Region II	NJOEM and FEMA Region II
Upon plan approval by FEMA	1a	HMP adoption by resolution by the governing bodies of the County and all participating municipalities	All plan participants

Each number in column 2 identifies specific DMA 2000 requirements, as follows:
1a – Prerequisite – Adoption by the Local Governing Body
1b – 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

3.3 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. This section presents (1) municipal involvement, (2) state and regional agency involvement, (3) public participation – citizen involvement, and outreach to business, utility, educational, transportation, human services, and other stakeholders.

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 Committee. Stakeholder outreach was performed early on, and continually throughout the planning process. Information and input provided by these stakeholders has been included throughout this HMP update where appropriate, as identified in the references.

The following is a list of the various stakeholders that were invited to participate in the development of this plan, along with a summary of how these stakeholders participated and contributed. This summary listing does not represent the total of stakeholders that were aware of and 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.

3.3.1 Federal Agencies

FEMA Region II: Provided updated planning guidance; provided summary and detailed NFIP data for planning area; presented at the March 2018 Mitigation Strategy workshop; conducted plan review.

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

- National Centers for Environmental Information (NCEI)
- 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. Environmental Protection Agency (USEPA)
- U.S. Geological Survey (USGS)

3.3.2 State Agencies

New Jersey Office of Emergency Management (NJOEM): Administered planning grant; provided updated planning guidance; attended meetings including presenting at the March 2018 Mitigation Strategy workshop; offered technical assistance; provided review of the draft HMP update.

New Jersey Department of Environmental Protection (NJDEP): Provided data and information.

3.3.3 Burlington County Departments

Several county departments were represented on the Steering Committee and involved in the HMP update planning process. Please see Appendix C (Participation Matrix) for further details regarding regional and local stakeholder agencies. All responses to the stakeholder surveys may be found in Appendix D (Public and Stakeholder Outreach).



Burlington County Office of Emergency Management (OEM): The Burlington County OEM coordinated the development of the HMP update, reaching out to all municipalities and county departments to solicit involvement in the planning process. The Burlington County OEM has been identified as the ongoing Burlington County Hazard Mitigation Plan Coordinator (see Section 7 – Plan Maintenance) and served in this role throughout the update planning process. In addition to the OEM Director, individuals from OEM served on the Steering Committee. The HMP Coordinator ensured broad outreach and involvement from numerous Burlington County departments including regular communications regarding the HMP and its status. The Burlington County OEM provided data, reviewed sections, contributed to the mitigation strategy, coordinated efforts with the municipalities to ensure their full participation, and were notified and/or took the stakeholder survey.

The HMP was discussed at several Local Emergency Planning Committee (LEPC) meetings held by OEM. This included:

- Burlington County LEPC meeting on March 30, 2017
- Burlington County LEPC meeting on June 30, 2017

- Burlington County LEPC meeting on August 30, 2017
- Burlington County LEPC meeting on March 29, 2018
- Municipal LEPC meeting at Delanco Township on April 30, 2018
- Municipal LEPC meeting at Riverside Township on June 4, 2018
- Burlington County LEPC meeting on June 20, 2018
- Municipal LEPC meeting at Moorestown Township on September 12, 2018
- Municipal LEPC meeting at Burlington (city) on October 2, 2018
- Burlington County LEPC meeting on October 4, 2018
- Municipal LEPC meeting at Mt. Laurel Township on November 1, 2018
- Municipal LEPC meeting at Medford Township on December 4, 2018
- Burlington County LEPC meeting on December 8, 2018

Burlington County Division of Roads and Bridges: The County Division of Roads and Bridges, part of the Department of Public Works, had one representative on the Steering Committee. In addition to their role as Steering Committee member, the Division provided information and data, contributed to the County Profile (Section 4), and updated the following: capability assessment, previous mitigation strategy, and updated mitigation strategy. The Division also reviewed draft sections of the HMP prior to public review.

Burlington County Division of Parks: The Superintendent of the Burlington County Division of Parks was a member of the Steering Committee. In addition, the superintendent provided information and data, contributed to the County Profile (Section 4), and updated the following: capability assessment, previous mitigation strategy, and updated mitigation strategy. The Division also reviewed draft sections of the HMP prior to public review.

Burlington County Department of Resource Conservation: The Director of the Department of Resource Conservation was a member of the Steering Committee. In addition, the director provided information and data, contributed to the County Profile (Section 4), and updated the following: capability assessment, previous mitigation strategy, and updated mitigation strategy. The Division also reviewed draft sections of the HMP prior to public review.

Burlington County Freeholders Office: The Public Information Officer (PIO) from the Freeholder's Office was a member of the Steering Committee. In addition, the PIO provided information and data, contributed to the County Profile (Section 4), and updated the following: capability assessment, previous mitigation strategy, and updated mitigation strategy.

Burlington County Department of Public Safety: The Director and Deputy Director of Public Safety were members of the Steering Committee. In addition, the Department provided information and data, contributed to the County Profile (Section 4), and updated the following: capability assessment, previous mitigation strategy, and updated mitigation strategy. The Department also reviewed draft sections of the HMP prior to public review.

Burlington County Health Department: The Director of the County Health Department was a member of the Steering Committee. In addition, the Department provided information and data, contributed to the County Profile (Section 4), and updated the following: capability assessment, previous mitigation strategy, and updated mitigation strategy. The Department also reviewed draft sections of the HMP prior to public review.

3.3.4 Regional, County, and Local Stakeholders

Please see Appendix C (Participation Matrix) for further details regarding regional and local stakeholder agencies. The stakeholders listed below were directly contacted by Burlington County to take a stakeholder survey which included the identification of specific mitigation actions/projects and/or review the draft HMP. Results of the surveys can be found in Appendix D (Public and Stakeholder Outreach).

Academia

All school districts in the county were provided the academic stakeholder survey and were invited to provide input and notified of the draft HMP review period, however no responses have been received to date.

Ambulance/Emergency Medical Services

All ambulance and emergency medical service providers in the county were provided the Emergency Medical Services stakeholder survey and invited to provide input; however, no responses have been received to date.

Fire Departments

All fire departments in the county were provided the fire department stakeholder survey and invited to provide input; however, no responses have been received to date.

Hospitals and Health Care Facilities

All hospitals and health care facilities in the county were provided the hospitals and health care facilities stakeholder survey and invited to provide input; however, no responses have been received to date.

Highway and Public Works

All highway and public works departments in the county were provided the highway and public works stakeholder survey and invited to provide input; however, no responses have been received to date.

Law Enforcement

All law enforcement agencies in the county were provided the law enforcement stakeholder survey and invited to provide input; however, no responses have been received to date.

Utilities

All utility providers in the county were provided the utilities stakeholder survey and invited to provide input; however, no responses have been received to date.

Business and Commercial Interests

Businesses and commercial interests in the county were provided the Business and Commerce Stakeholder survey and invited to provide input, however no responses have been received to date.

Other

Burlington County Bridge Commission: The Burlington County Bridge Commission was invited to review draft sections of the HMP.

Delaware Valley Regional Planning Commission (DVRPC): While the DVRPC did not sit on the Steering Committee for the plan update, the results of their Coastal Vulnerability Assessments for several Burlington County municipalities were reviewed and incorporated into the HMP as appropriate.

3.3.5 Adjacent Counties

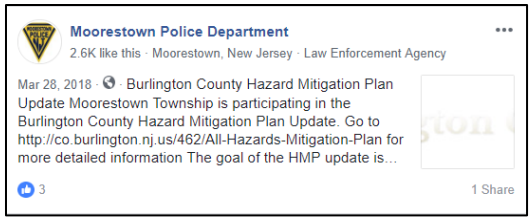
Burlington County has made an effort to keep surrounding counties and municipalities appraised of the project and allowed the opportunity to provide input to this planning process. Specifically, the following adjoining and nearby county representatives were contacted in March 2019 to inform them about the availability of the project website, draft plan documents and surveys, and invited to provide input to the planning process. No formal comments were received from adjacent counties as of the date of the plan update.

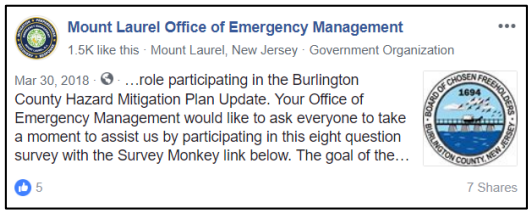
- Camden County, NJ
- Atlantic County, NJ
- Ocean County, NJ
- Monmouth County, NJ
- Mercer County, NJ

3.4 PUBLIC PARTICIPATION - CITIZEN INVOLVEMENT

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

- The Burlington County OEM created a dedicated webpage to hazard mitigation during the 2014 HMP planning process. The public website was maintained through the last five years and updated in late 2017 to reflect the 2019 HMP update planning process as a way to facilitate communication between the Steering Committee, Planning Committee, and county residents. The website can be found here: http://www.co.burlington.nj.us/462/All-Hazards-Mitigation-Plan
- The public website contains a project overview, a discussion as to why the county is updating the plan, project announcements, frequently asked questions, draft documents for review and comment, and a link to the county resident and stakeholder surveys. See Figure 3-1 for a screenshot of this public website.
- The Burlington County OEM posted a link on the county home page under 'All Hazard Mitigation Plan' directing visitors to the draft HMP update. Further, a press release was posted to announce the open public review period. The press release is located in Appendix D (Public and Stakeholder Outreach).
- All municipalities with a public website were requested to post a link to the Burlington County HMP website to provide ongoing public outreach. In addition, all participating municipalities 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).





    - On March 28, 2018, the Moorsetown Police Department created a Facebook post about the update, providing links to the county's HMP webpage and a link to the citizen survey.
    - On March 30, 2018, the Mount Laurel Office of Emergency Management created a Facebook post about the update, providing links to the county's HMP webpage and a link to the citizen survey.
    - On April 3, 2018, the Mount Laurel Sun posted an article the plan update process for Mount Laurel Township and encouraged residents to complete the citizen survey.
- An on-line hazards preparedness citizen survey was developed to gauge household preparedness that may impact the county and to assess the level of knowledge of tools and techniques to assist in reducing risk and loss of those hazards (https://www.surveymonkey.com/r/BurlingtonCounty2018HMPUpdate). The questionnaire asked quantifiable questions about citizen perception of risk, knowledge of mitigation, and support of community programs; and also asked several demographic questions to help analyze trends. Reponses were collected and provided back to plan participants for consideration in

the mitigation action development. Appendix D (Public and Stakeholder Outreach) summarizes public input received through the website, the online survey, and other sources.

- In March and April 2018, a link to the survey was published in the Beverly Bee newspaper and a social media campaign asking citizens to complete the survey was done via Nixle, Facebook posts, and Twitter. Screenshots of these posts can be found in Appendix D (Public and Stakeholder Outreach).
- The county and participating municipalities were requested to use their social media accounts to announce and encourage plan participation through surveys. For example, on March 19, 2018, the County OEM issued a notification through NIXLE informing residents of the plan update and advising them to complete the citizen survey. Screenshots of the social media public outreach efforts are presented in Appendix D (Public and Stakeholder Outreach).
- Starting in September 2019, draft sections of the plan were posted on the project website for public review and comment prior to submittal to NJOEM and FEMA. A news release was distributed on the Burlington County website announcing the availability of the draft HMP for public review and comment. In addition, links were provided to the participating jurisdictions to post on their respective websites.

Screenshots and pictures of public outreach efforts are presented in Appendix D (Public and Stakeholder Outreach). Public comments that have been received to date are documented in Appendix D (Public and Stakeholder Outreach) as well.

Figure 3-1. Screenshot of the Burlington County Hazard Mitigation Webpage



Source: Burlington County Office of Emergency Management 2018

3.5 INCORPORATION OF EXISTING PLANS, STUDIES, REPORTS AND TECHNICAL INFORMATION

The Burlington County HMP update strived to use the best available technical information, plans, studies and reports throughout the plan 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 is presented in the County Profile (Section 4). Details of the source of this data, along with technical information on how the data was used to develop the risk and vulnerability assessment, is presented in the Hazard Profiling and Risk Assessment Section (Section 5), specifically within Section 5.3 (Data and Methodology), as well as throughout the hazard profiles in Section 5.4. Further, the source of technical data and information used may be found within the References section.

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. Burlington County and participating jurisdictions were tasked with updating the inventory of their Planning and Regulatory capabilities (see Capability Assessment section of each jurisdictional annex in Section 9), and providing relevant planning and regulatory documents as applicable. Relevant documents, including plans, reports, and ordinances were reviewed to identify:

- Date of most recent adoption;
- Existing 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 during the development of the overall Goals [and Objectives] (see Section 6);
- 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 plan process in an effort to develop mitigation planning goals, objectives and mitigation strategies that are consistent across local and regional planning and regulatory mechanisms; and thus develop complementary and mutually supportive plans, including:

- Comprehensive/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
- State of New Jersey 2014 State Hazard Mitigation Plan Update

The "Legal and Regulatory" capability assessment of each participating jurisdiction is included in Section 9, Jurisdictional Annexes, and provides a listing of the local codes, ordinances, regulations, and planning mechanisms available in the jurisdictions and reviewed during this planning process.

A partial listing of the plans, reports, and technical documents reviewed in the preparation of this plan is included in Table 3-4.

Table 3-4. Record of the Review of Existing Programs, Policies, and Technical Documents for Participating Jurisdictions

Existing Plan, Program or Technical Document	Date	Jurisdictional Applicability
Pinelands Comprehensive Management Plan	September 2, 2014	Bass River (Twp.), Evesham (Twp.), Medford Lakes (B), Medford (Twp.), New Hanover (Twp.), North Hanover (Twp.), Pemberton (Twp.), Shamong (Twp.), Southampton (Twp.), Washington (Twp.), Woodland (Twp.), and Wrightstown (B)
Bass River Township Municipal Stormwater Management Plan	April 2010	Bass River (Twp.)
City of Beverly 2014 Master Plan Reexamination Report	2014	Beverly (C)
City of Beverly Master Plan Green Buildings and Environmental Sustainability Element	March 22, 2017	Beverly (C)
Bordentown Township Master Plan Reexamination Report	December 2008	Bordentown (Twp.)
Environmental Resource Inventory for the Township of Bordentown	August 2013	Bordentown (Twp.)
City of Burlington 2010 Master Plan	June 2010	Burlington (C)
Township of Burlington Comprehensive Master Plan	July 10, 2008	Burlington (Twp.)
2017 Reexamination Report and Master Plan Amendment for Chesterfield Township	August 15, 2017	Chesterfield (Twp.)
Township of Chesterfield Municipal Stormwater Management Plan	July 21, 2006	Chesterfield (Twp.)
Eastampton Township 2016 Master Plan Reexamination Report	January 20, 2016	Eastampton (Twp.)
Open Space and Recreation Plan for the Township of Evesham	December 2012	Evesham (Twp.)
Evesham Township Redevelopment Plan	October 2013	Evesham (Twp.)
Florence Township Master Plan	April 2007	Florence (Twp.)
Reexamination Report Florence Township	2007	Florence (Twp.)
Hainesport Housing Plan Element and Fair Share Plan	December 3, 2008	Hainesport (Twp.)
Hainesport Township Reexamination of Master Plan and Development Regulations	December 3, 2008	Hainesport (Twp.)
Lumberton Township Master Plan	2009	Lumberton (Twp.)
Township of Maple Shade 2016 Master Plan Reexamination Report and Master Plan Amendment	April 27, 2016	Maple Shade (Twp.)
Master Plan Reexamination Report - Route 70 Corridor	November 11, 2014	Medford (Twp.)
Master Plan Reexamination Report & PPE Zoning Districts	December 18, 2017	Medford (Twp.)
Circulation Plan Element Township of Moorestown	April 3, 2014	Moorestown (Twp.)
2013 Master Plan Conservation Element	August 1, 2013	Moorestown (Twp.)
2009 Master Plan Open Space and Recreation Plan Element	December 3, 2009	Moorestown (Twp.)
Housing Element of the Master Plan and Fair Share Plan	December 29, 2008	Moorestown (Twp.)
Reexamination Report of the Master Plan	June 26, 2008	Moorestown (Twp.)
Master Plan Township of Moorestown	June 27, 2002	Moorestown (Twp.)

Existing Plan, Program or Technical Document	Date	Jurisdictional Applicability
Master Plan Mount Laurel	April 20, 2006	Mount Laurel (Twp.)
General Reexamination of the Master Plan and Master Plan Amendment	October 23, 2017	Mount Laurel (Twp.)
Master Plan Township of Shamong	September 25, 2013	Shamong (Twp.)
Route 206 Area - Area in Need of Redevelopment without Condemnation and Rehabilitation Investigation Study	October 1, 2015	Shamong (Twp.)
Washington Township Master Plan	January 2007	Washington (Twp.)
2000 Master Plan and Development Regulations Reexamination Report for Westampton Township	August 17, 2000	Westampton (Twp.)
2006 Master Plan and Development Regulations Reexamination Report for Westampton Township	September 6, 2006	Westampton (Twp.)
Housing Plan Element and Fair Share Plan 2004-2014 2012 Amendments	February 1, 2012	Westampton (Twp.)
2015 Master Plan and Development Regulations Reexamination Report for Westampton Township	April 1, 2015	Westampton (Twp.)
2002 Circulation Plan Element	April 2002	Westampton (Twp.)
Environmental Resource Inventory for the Township of Westampton	February 2011	Westampton (Twp.)
Housing Plan Element and Fair Share Plan 2004-2014 2014 Amendments	December 3, 2014	Westampton (Twp.)
Housing Plan Element and Fair Share Plan 2015-2025	October 25, 2015	Westampton (Twp.)
Open Space, Recreation and Farmland Preservation Plan	July 1, 2009	Westampton (Twp.)
2014 New Jersey State Hazard Mitigation Plan	2014	Statewide
Flood Insurance Study for Burlington County, New Jersey	December 22, 2017	Countywide

3.6 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 Burlington 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.

The Capability Assessment section of Section 6 (Mitigation Strategy) 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).

3.7 CONTINUED PUBLIC INVOLVEMENT

Burlington County and 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.co.burlington.nj.us/462/All-

Hazards-Mitigation-Plan and municipalities will be encouraged to maintain links to the plan website. Further, the county will hard copies of the HMP 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 Planning Partnership's annual evaluation and posted on the public website at http://www.co.burlington.nj.us/462/All-Hazards-Mitigation-Plan.

Each jurisdiction's governing body shall be responsible for receiving, tracking, and filing public comments regarding this plan.

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. Kevin Shoppas, County Emergency Management 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 5-year plan update as appropriate; however, members of the Planning Committee will assist the HMP Coordinator. Additional meetings may also be held as deemed necessary by the Planning Committee. 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 HMP update, implementation and ongoing maintenance will continue to be a function of the Planning Committee. The Planning Committee 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. Kevin Shoppas has been identified as the ongoing County Hazard Mitigation Plan Coordinator (see Section 7), and is responsible for receiving, tracking, and filing public comments regarding this HMP update. Contact information is:

Mailing Address: Public Safety Building County of Burlington, 1 Academy Drive, Westampton, NJ 08060
Contact Name: Kevin Shoppas
Email Address: kshoppas@co.burlington.nj.us

SECTION 4. COUNTY PROFILE

2019 HMP Update Changes

- The County Profile contains updated information regarding the county's physical setting, population and demographics and trends, general building stock, land use and trends, and critical facilities. Additionally, it includes future development trends in the county.

This profile describes the general information of the County (physical setting, population and demographics, general building stock, and land use and population trends) and critical facilities located within Burlington County. In Section 5, specific profile information is presented and analyzed to develop an understanding of the study area, including the economic, structural, and population assets at risk and the particular concerns that may be present related to hazards analyzed (for example, a high percentage of vulnerable persons in an area).

4.1 GENERAL INFORMATION

Burlington County is located in the center of New Jersey, bordered to the north by Mercer and Monmouth County, east by Ocean County, to the south by Atlantic County, to the southwest by Camden County, and to the northwest by the Delaware River and Pennsylvania. According to the 2010 U.S. Census, the total population of the County is 448,734 and has a total land area of 820 square miles. The County is 43 miles long and has an average width of 20 miles. Burlington County ranks first in area and 11th in population among New Jersey's 21 counties. Figure 4-1 illustrates an overview of Burlington County.

The Lenni-Lenape Indians were the original aboriginal owners of Burlington County. In October 1677, a group of English debarked from the ship Kent and founded the Town of Burlington. Burlington County was later incorporated on May 17, 1694. The American Indians sold more and more of their lands to the new settlers until finally, in 1801, there remained less than 100 adult American Indians on the Indian Mills reservation, which was the first American Indian reservation in the U.S. and the American Indian's last dwelling place in Burlington County (Burlington County HMP 2014).

The County's waterways were a principal factor in the early and successful seating of Burlington County. These transportation systems were vital at the time to trade, travel and provincial existence. Consequently, the earliest homes and the earliest settlements were on the waterways. Burlington, thriving at its river location, was the port of entry. Several of its early inhabitants moved on to establish farms in the fertile valleys, being generally careful to choose creek-valleys where a landing and a waterway insured easy transport to Burlington or Philadelphia (Burlington County HMP 2014).

According to the 2010 U.S. Census data, the County's population was 448,734. Burlington County is the 11th most populated county in New Jersey (U.S. Census Bureau, 2010).

4.2 MAJOR PAST HAZARD EVENTS

Presidential disaster declarations are typically issued for hazard events that cause more damage than state and local governments can handle without assistance from the federal government, although no specific dollar loss threshold has been established for these declarations. A presidential disaster declaration puts federal recovery programs into motion to help disaster victims, businesses, and public entities. Some of the programs are matched by state programs. Review of presidential disaster declarations helps establish the probability of reoccurrence for each hazard and identify targets for risk reduction. Table 4-1 shows FEMA disaster declarations that included Burlington County through 2018 (records date back to 1954).

Table 4-1. History of FEMA Declarations in Burlington County, New Jersey

Disaster Number	Event Date	Declaration Date	Incident Type	Title
DR-205	August 18, 1965	August 18, 1965	Drought	Water Shortage
DR-310	September 4, 1971	September 4, 1971	Flood	Heavy Rains & Flooding
DR-477	July 23, 1975	July 23, 1975	Flood	Heavy Rains, High Winds, Hail & Tornadoes
DR-528	February 8, 1977	February 8, 1977	Severe Ice Storm	Ice Conditions
EM-3083	October 19, 1980	October 19, 1980	Drought	Water Shortage
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-3148	September 16-18, 1999	September 17, 1999	Hurricane	Hurricane Floyd Emergency Declarations
EM-3156	May 30-November 1, 2000	November 1, 2000	Other	West Nile Virus
EM-3169	September 11, 2001	September 19, 2001	Fire	Fires and Explosions
EM-3181	February 16-17, 2003	March 20, 2003	Snow	Snow
DR-1530	July 12-23, 2004	July 16, 2004	Severe Storm(s)	Severe Storms and Flooding
EM-3257	August 29-October 1, 2005	September 19, 2005	Hurricane	Hurricane Katrina Evacuation
DR-1694	April 14-20, 2007	April 26, 2007	Severe Storm(s)	Severe Storms and Inland and Coastal Flooding
FM-2695	May 15, 2007	May 16, 2007	Fire	Warren Grove Fire
DR-1873	December 19-20, 2009	February 5, 2010	Snow	Snowstorm
DR-1889	February 5-6, 2010	March 23, 2010	Snow	Severe Winter Storm and Snowstorm
DR-1897	March 12-April 15, 2010	April 2, 2010	Severe Storm(s)	Severe Storms and Flooding
DR-1954	December 26-27, 2010	February 4, 2011	Snow	Severe Winter Storm and Snowstorm
DR-4021	August 27-September 5, 2011	August 31, 2011	Hurricane	Hurricane Irene
DR-4086	October 26-November 8, 2012	October 30, 2012	Hurricane	Hurricane Irene
DR-4231	June 23, 2015	July 22, 2015	Hurricane	Hurricane Sandy
DR-4264	January 22-24, 2016	March 14, 2016	Hurricane	Hurricane Sandy
DR-4368	March 6-7, 2018	June 8, 2018	Severe Storm(s)	Severe Storm

Source: FEMA 2019

4.3 PHYSICAL SETTING

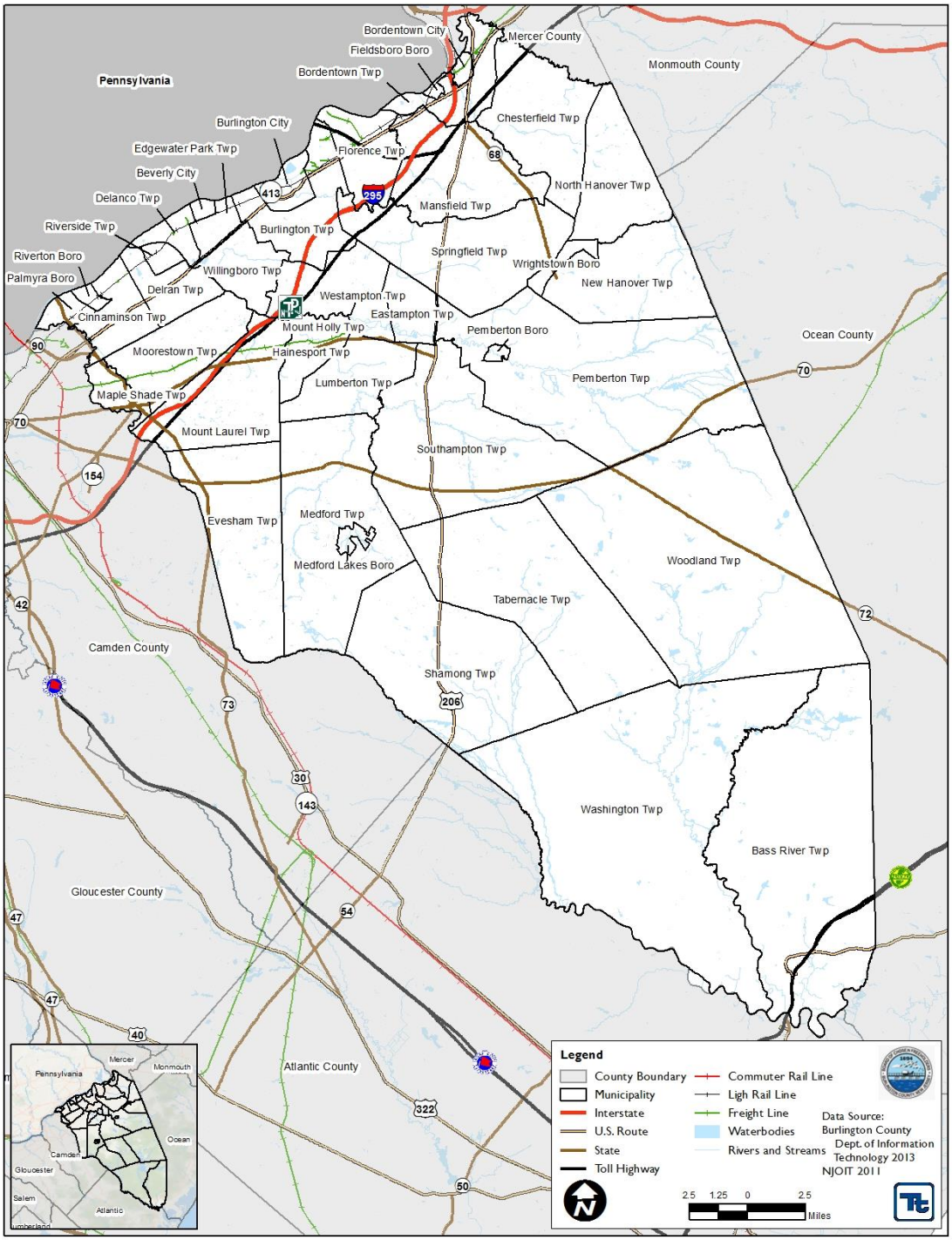
This section presents the physical setting of the County, including: location, hydrography and hydrology, topography and geology, climate, and land use/land cover.

4.3.1 Location

Burlington County is the largest county in New Jersey, covering 827 square miles, and extends from the Delaware River to the Great Bay. Burlington County is bordered to the north by Mercer County, to the northeast by Monmouth County, to the east by Ocean County, to the southwest by Atlantic County and to the west by Camden County. The Delaware River separates Burlington County from Pennsylvania to the west. The County has a total area of 529,351 acres including 5,191 acres of water (Burlington County, 2014). Figure 4-1 illustrates Burlington County and its surrounding area.

Forty municipalities exist within the County, consisting of three cities, six boroughs and 31 townships. The county seat is located in Mount Holly (Burlington County, 2013). Burlington County is located within the Philadelphia-Camden-Wilmington Metropolitan Statistical Area (MSA). Burlington County features a variety of land uses including densely populated urban development to preserved open space and military use.

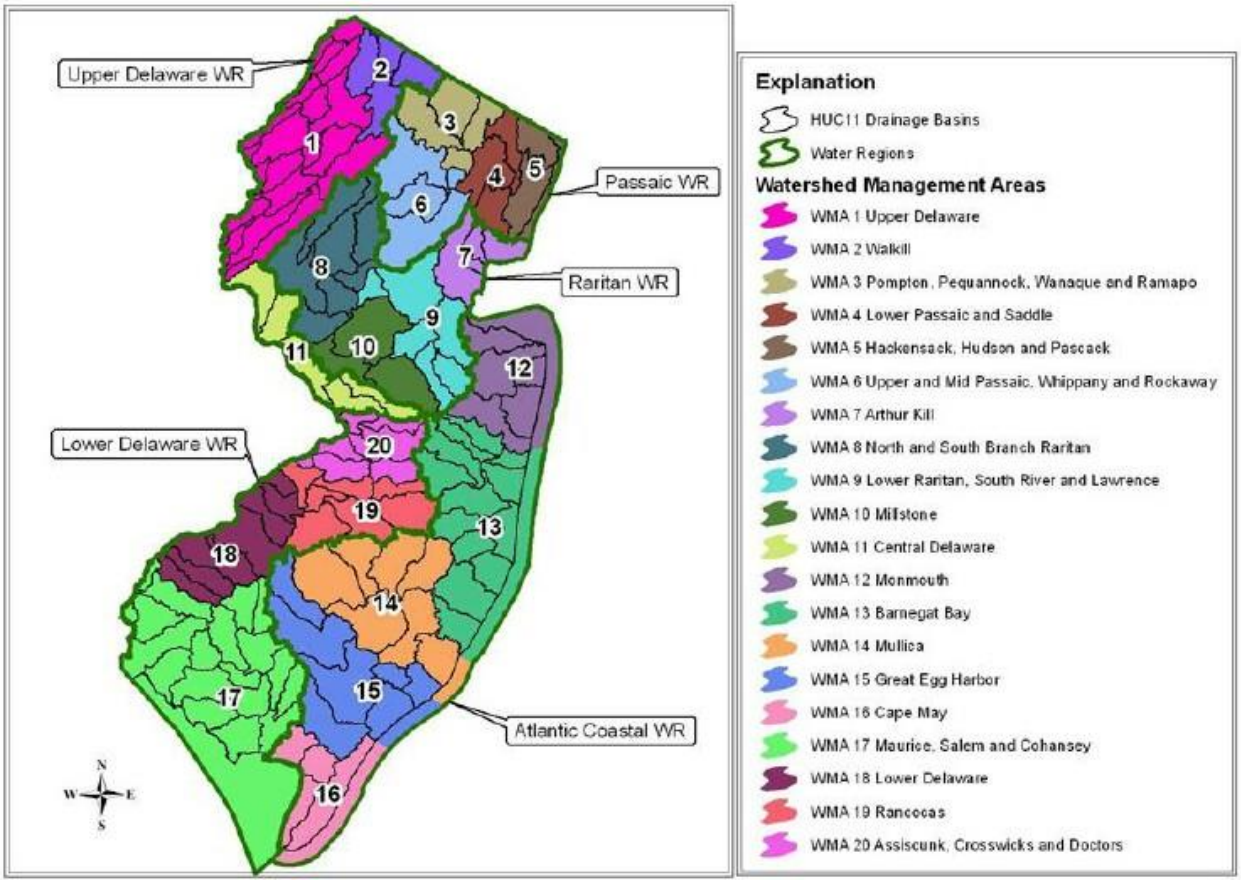
Figure 4-1. Burlington County, New Jersey



4.3.2 Hydrography and Hydrology

A watershed is the area of land that drains into a body of water such as a river, lake, stream, or bay. It is separated from other systems by high points in the area such as hills or slopes. It includes not only the waterway itself but also the entire land area that drains to it. Drainage basins generally refer to large watersheds that encompass the watersheds of many smaller rivers and streams. In New Jersey, the State is divided into 20 Watershed Management Areas (WMA), which are made up of smaller watersheds. Figure 4-2 depicts the 20 Watershed Management Areas (WMAs) and drainage basins found in New Jersey.

Figure 4-2. Watershed Management Areas of New Jersey



Source: New Jersey Geological and Water Survey, 2007

According to the figure above and to Figure 4-3, Burlington County is located in five WMAs: WMA 13 (Barnegat Bay), WMA 14 (Mullica), WMA 18 (Lower Delaware), WMA 19 (Rancocas), and WMA 20 (Assiscunk, Crosswicks, Doctors).

WMA 13, Barnegat Bay, includes watersheds that drain the central Atlantic drainage of New Jersey. The Barnegat Bay Watershed is a 660 square mile area encompassing all of the land and water in Ocean County, as well as parts of Monmouth County. The area lies mostly in Ocean County and includes the Barnegat Bay as well as the following subwatersheds: Metedeconk River, Toms River, Forked River, Cedar Creek (NJDEP 2012a).

WMA 14, Mullica, includes watersheds draining portions of the Pinelands of New Jersey. It is approximately 561 square miles in size and approximately 80% of this watershed consists of state parks and forests. Major rivers include the Mullica, Wading River, Nochescatauxin Brook, Atsion Creek, Bass River, Batsto River, Nescochaque

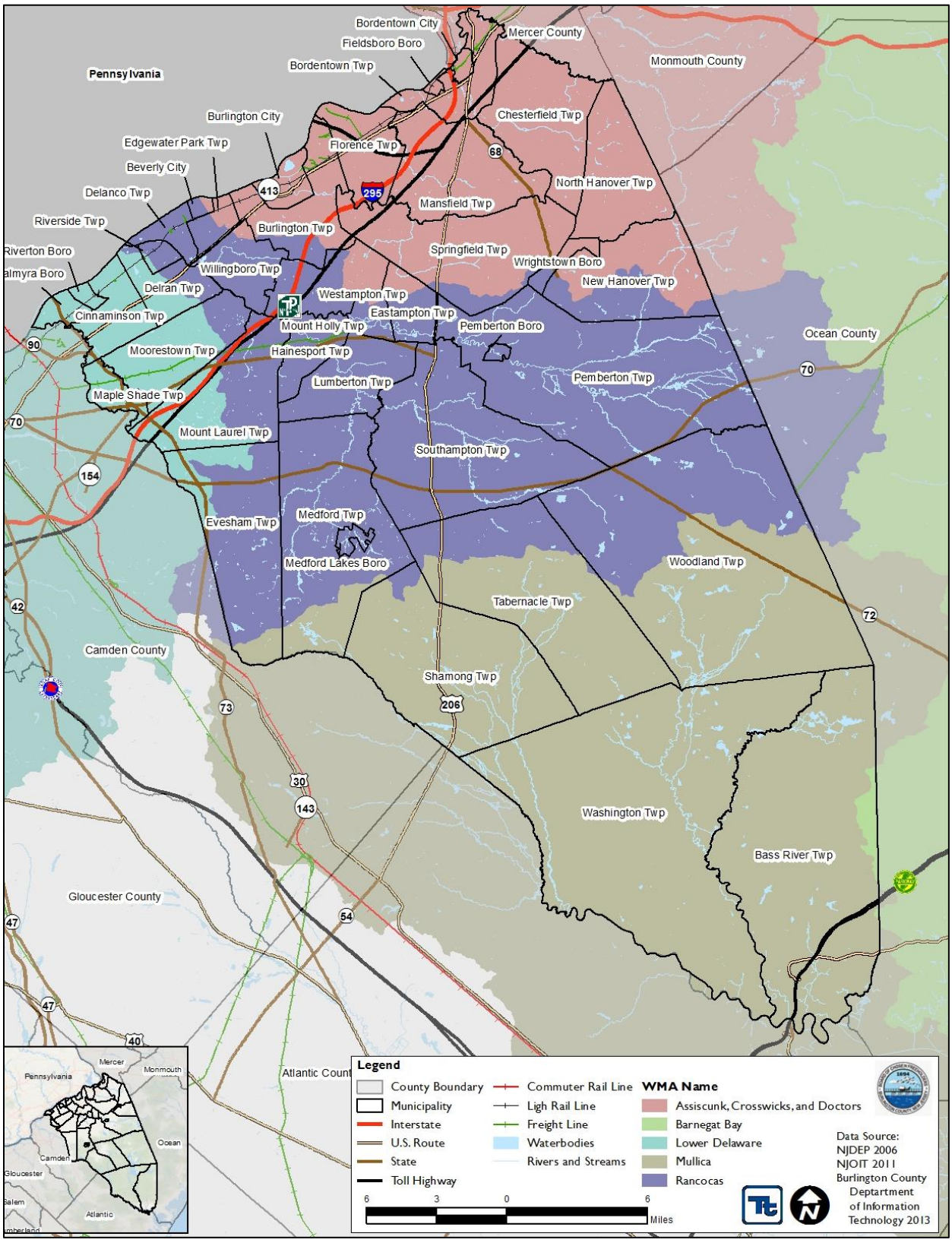
Creek, Landing Creek, Hammonton Creek and the Oswego River. This Management Area lies in Burlington, Atlantic and Ocean Counties and includes the watersheds of Mullica River, Mechescatauxin Creek, Wading River, Atsion Creek, Batsto River, and Doughty Creek. The Mullica River and its tributaries are considered the primary drainage system for the Pinelands (NJDEP 2012b).

WMA 18, Lower Delaware, includes the Cooper River, Big Timber, Mantua, Newton, Oldmans, Pennsauken, Pompeston, Raccoon, Repaupo and Woodbury Creeks, as well as Baldwin Run, Swede Run and Maple Swamp. This management area covers all or parts of Burlington, Camden and Gloucester counties, including 68 municipalities encompassing 391 square miles (NJDEP 2012c).

WMA 19, Rancocas, is the largest watershed in south-central New Jersey and is made up of the North and South Branch and the Main stem of the Rancocas Creek, including Mill Creek. Portions of Burlington, Camden and Ocean Counties and approximately 33 municipalities make up this management area and cover an area of 360 square miles. Of its total area, the North Branch drains 167 square miles and the South Branch drains 144 square miles. The North Branch is 31 miles long and is fed by the Greenwood Branch, McDonalads Branch and Mount Misery Brook. The major tributaries to the South Branch include the Southwest Branch Rancocas Creek; Stop the Jade Run, Haynes Creek and Friendship Creek (NJDEP 2012d).

WMA 20, Assiscunk, Crosswicks, Doctors, includes the Assiscunk, Blacks, Crafts, Crosswicks, Doctors, Duck and Mill Creeks. This management area includes 26 municipalities spanning four counties: Burlington, Mercer, Monmouth and Ocean encompassing 253 square miles. Crosswicks Creek is 25 miles long and drains an area of 146 square miles to the Delaware River at Bordentown. Major tributaries include Jumping Brook, Lahaway Creek, North Run and Doctors Creek. Tides affect this stream up to the Crosswicks Mill Dam. Allentown Lake, Oakford Lake, Prospertown Lake and Imlaystown Lake are major impoundments in the Crosswicks Creek Watershed (NJDEP 2012e).

Figure 4-3. Watersheds of Burlington County



Delaware River Basin

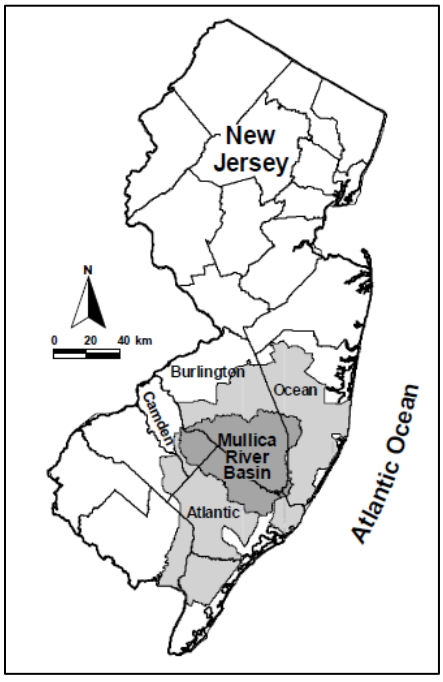
The Delaware River is the longest un-dammed river in the United States east of the Mississippi River. The Delaware extends 330 miles from the confluence of its East and West branches at Hancock, New York to the mouth of the Delaware Bay where it meets with the Atlantic Ocean. The Delaware River is fed by 216 tributaries, with the largest being the Schuylkill and Lehigh Rivers in Pennsylvania. Overall, the Delaware River Basin contains over 13,000 square miles and drains portions of Pennsylvania, New York State, New Jersey, and Delaware. Over 15 million people rely on the waters of the Delaware River Basin for drinking, agricultural use and industrial use. New York City gets roughly half its water from three large reservoirs located on tributaries to the Delaware River (Delaware River Basin Commission 2017).

Three reaches of the Delaware River are included in the National Wild and Scenic Rivers System. One section extends 73 miles from the confluence of the River's East and West branches at Hancock, New York downstream to Millrift, Pennsylvania; the second stretches 40 miles just south of Port Jervis, New York downstream to the Delaware Water Gap near Stroudsburg, Pennsylvania. The Lower Delaware Wild and Scenic Rivers Act, signed into law on November 1, 2000, added a 38.9-mile section of the main stem Delaware (and about 28 miles of selected tributaries) to the national system, linking the Delaware Water Gap and Washington Crossing, Pennsylvania, just upstream of Trenton, New Jersey. Three-quarters of the non-tidal Delaware River is now included in the National Wild and Scenic Rivers System (Delaware River Basin Commission 2017).

Mullica River Basin

The 1,474 square km Mullica River Basin drains 23 municipalities in Atlantic, Burlington, Camden, and Ocean Counties. The unconfined Kirkwood-Cohanset aquifer system underlies the basin. The Basin is dominated by undeveloped forest land, much of which is designated as state owned or wildlife management areas. The entire Basin lies within the Pinelands National Reserve. The Mullica River and its tributaries are renowned for their high-water quality and largely undisturbed ecosystems (Zampella et al., 2001).

Figure 4-4. Regional Location of the Mullica River Basin in the Pinelands National Reserve

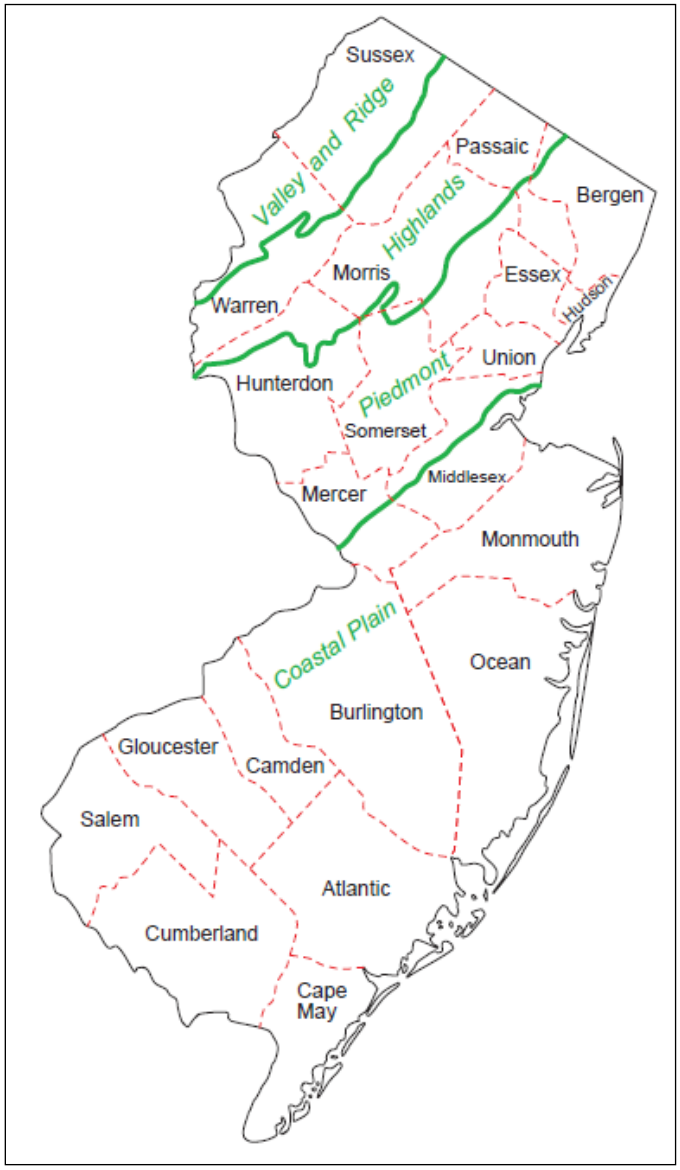


Source: Zampella et al., 2001

4.3.3 Topography and Geology

Burlington County lies within the Atlantic Coastal Plain. The lowest part of the County is sea level at the Delaware River and the highest point is Arneys Mount, located in the Township of Springfield, at an elevation of approximately 260 feet above sea level (FEMA FIS, 2010). The Atlantic Coastal Plain is one of the four major physiographic regions of New Jersey (Figure 4-5). The unconsolidated deposits of the Coastal Plain dip gently to the southeast and range in age from the upper Cretaceous to Minocene (90 to 10 million years old) (Dalton, 2003).

Figure 4-5. Physiographic Provinces in Burlington County



Source: Dalton, 2003

According to the New Jersey Geological Survey (NJGS), the Coastal Plain begins with a broad trough that extends along the southern border of the Piedmont Province from the Raritan Bay to Trenton. Near Monmouth Junction the trough floor forms a saddle and it reaches an elevation of about 80 feet. East of that depression is a drainage divide between the Delaware River and Atlantic Ocean. The maximum elevation of the Coastal Plain, located at Crawford Hill, is 391 feet. The streams that flow northwest to the Delaware have narrow valleys, are shorter and

have steeper gradients than streams that flow northwest to the Delaware which are shorter and have steeper gradients than the streams that flow southeast. The Highlands of Navesink at 266 feet above sea level is the highest point directly on the coast (Dalton, 2003).

Like New Jersey, Burlington County has distinct geological regions within the County. The Coastal Plain is divided into three subdivisions including the inner lowland, the inner upland, and the outer lowland. In Burlington County the inner lowland is the area bordering the Delaware River, where elevations rarely exceed 100 feet above sea level. Streams in this inner lowland area drain to the Delaware River (Lucey, 2001).

The inner upland forms the drainage divide in the county and is a narrow, slightly dissected cuesta with some elevations up to 200 feet. Erosional remnants for the prominent hills of Mount Holly, Juliustown, and Arney's Mount. The sands and gravel in these hills, in addition to having been protected by capping gravels, have frequently been partially cemented by iron-oxide precipitated by water percolating down through the ground (Lucey, 2001).

Southern Burlington County lies within the outer lowland where elevations rarely exceed 50 feet. Streams within this subprovince empty into the Atlantic Ocean. Sloping gently towards the sea, the flat terrain of this area has been slightly modified by the Mullica, Wading, and Bass Rivers (Lucey, 2001).

4.3.4 Climate

New Jersey is located about halfway between the equator and the North Pole, on the eastern coast of the U.S. Due to its geographic location, New Jersey is influenced by wet, dry, hot, and cold airstreams, creating a highly variable climate (ONJSC, Date Unknown). Five climate zones make up New Jersey – North, Central, Southwest, Pine Barrens, and Coastal. Figure 4-6 illustrates the climate zones of New Jersey.

As shown of Figure 4-6, Burlington County primarily located within the Pine Barrens zone, with the southeastern tip of the County located in the Coastal zone and the north and northwest portions in the central and southwest climate regions. Details regarding these climate zones are described below.

- Pine Barrens Climate Zone - Scrub pine and oak forests dominate the interior southern portion of New Jersey, hence the name, Pine Barrens. Sandy soils, which are porous and not very fertile, have a major effect on the climate of this region. On clear nights, solar radiation absorbed during the day is quickly radiated back into space, resulting in surprisingly low minimum temperatures. Atlantic City Airport, which is surrounded by sandy soil, can be 15-20 degrees cooler than the Atlantic City Marina on the bay, which is only about thirteen miles away.

  The porous soil permits any precipitation to rapidly infiltrate and leave surfaces quite dry. Drier conditions allow for a wider range between the daily maximum and minimum temperatures, and make the area vulnerable to forest fires.

- Southwest Climate Zone - lies between sea level and approximately 100 feet above sea level. The close proximity to Delaware Bay adds a maritime influence to the climate of this region. The Southwest has the highest average daily temperatures in the state and without sandy soils, tends to have higher nighttime minimum temperatures than in the neighboring Pine Barrens (ONJSC, Date Unknown).

  This region receives less precipitation than the Northern and Central regions of the state as there are no orographic features and, it is farther away from the Great Lakes-St. Lawrence storm track. It is also far enough inland to be away from the heavier rains from some coastal storms, thus it receives less precipitation than the Coastal Zone (ONJSC, Date Unknown).

  Prevailing winds are from the southwest, except in winter when west to northwest winds dominate. High humidity and moderate temperatures prevail when winds flow from the south or east. The moderating effect of the water also allows for a longer growing season. Autumn frosts usually occur about four weeks

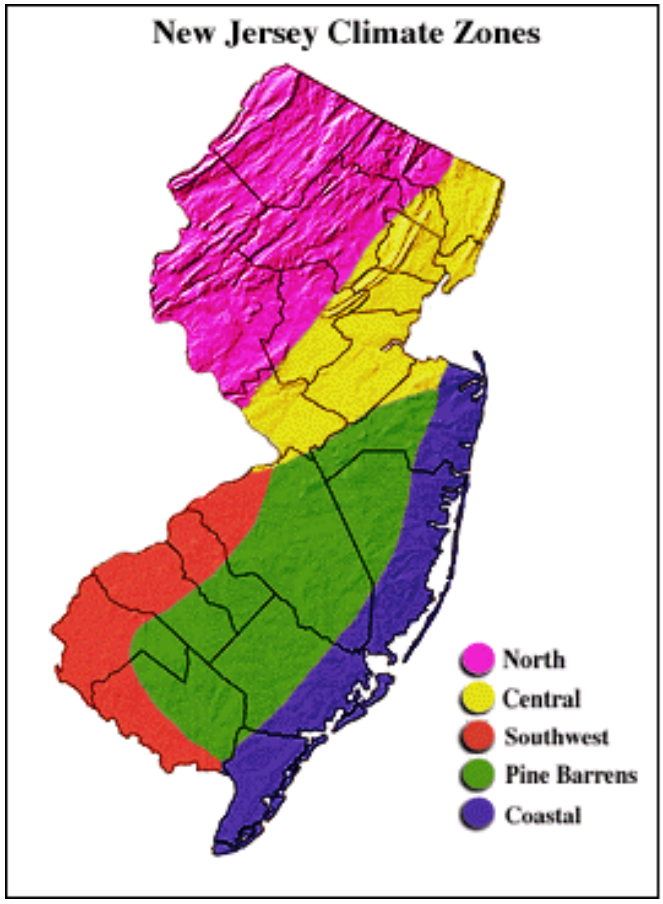
later here than in the North and the last spring frosts are about four weeks earlier, giving this region the longest growing season in New Jersey (ONJSC, Date Unknown).

- Coastal Climate Zone - In autumn and early winter, when the ocean is warmer than the land surface, the Coastal Zone will experience warmer temperatures than interior regions of the state. In the spring months, ocean breezes keep temperatures along the coast cooler. Being adjacent to the Atlantic Ocean, with its high heat capacity (compared to land), seasonal temperature fluctuations tend to be more gradual and less prone to extremes.

  Sea breezes play a major role in the coastal climate. When the land is warmed by the sun, heated air rises, allowing cooler air at the ocean surface to spread inland. Sea breezes often penetrate 5-10 miles inland, but under more favorable conditions, can affect locations 25-40 miles inland. They are most common in spring and summer.

Burlington County has a temperate climate with warm summers and moderate winters. The annual precipitation averages approximately 43 inches, which is generally distributed evenly throughout the year (FEMA FIS, 2010).

Figure 4-6. Climate Zones in New Jersey



Source, ONJSC, Date Unknown.

4.3.5 Land Use and Land Cover

Burlington County's land area is occupied and utilized in several different ways. This includes agricultural land, barren land, forested land, urban land, and wetlands. In 2007, 20.46 percent of the land in Burlington County was used for residential, industrial, transportation, and recreational purposes. Compared to the 2012 figures which indicate that 20.89 percent of the County was developed for these purposes. Also, in 2007 35.39 percent was

forested land; 10.42 percent was agricultural land; 30.17 percent was wetlands; and 0.75 percent was barren land. When compared with the land use land cover data set from 2012, there has been a decrease in agricultural land to 10.22 percent, barren land decreased to 0.71 percent, forest decreased to 35.26 percent and wetlands decreased to 30.12 percent with an increase in urban land use to 20.9 percent. Refer to Table 4-2 and Figure 4-7 below.

Table 4-2. Land Use Summary for Burlington County, 2007 and 2012

Land Use Category	2007 Data		2012 Data	
	Acreage	Percent of Burlington County	Acreage	Percent of Burlington County
Agriculture	54,625.00	10.42%	53,580.41	10.22%
Barren	3,951.09	0.75%	3,725.75	0.71%
Forest	185,524.84	35.39%	184,855.05	35.26%
Urban	107,260.49	20.46%	109,499.22	20.89%
Wetlands	158,140.19	30.17%	157,867.93	30.12%

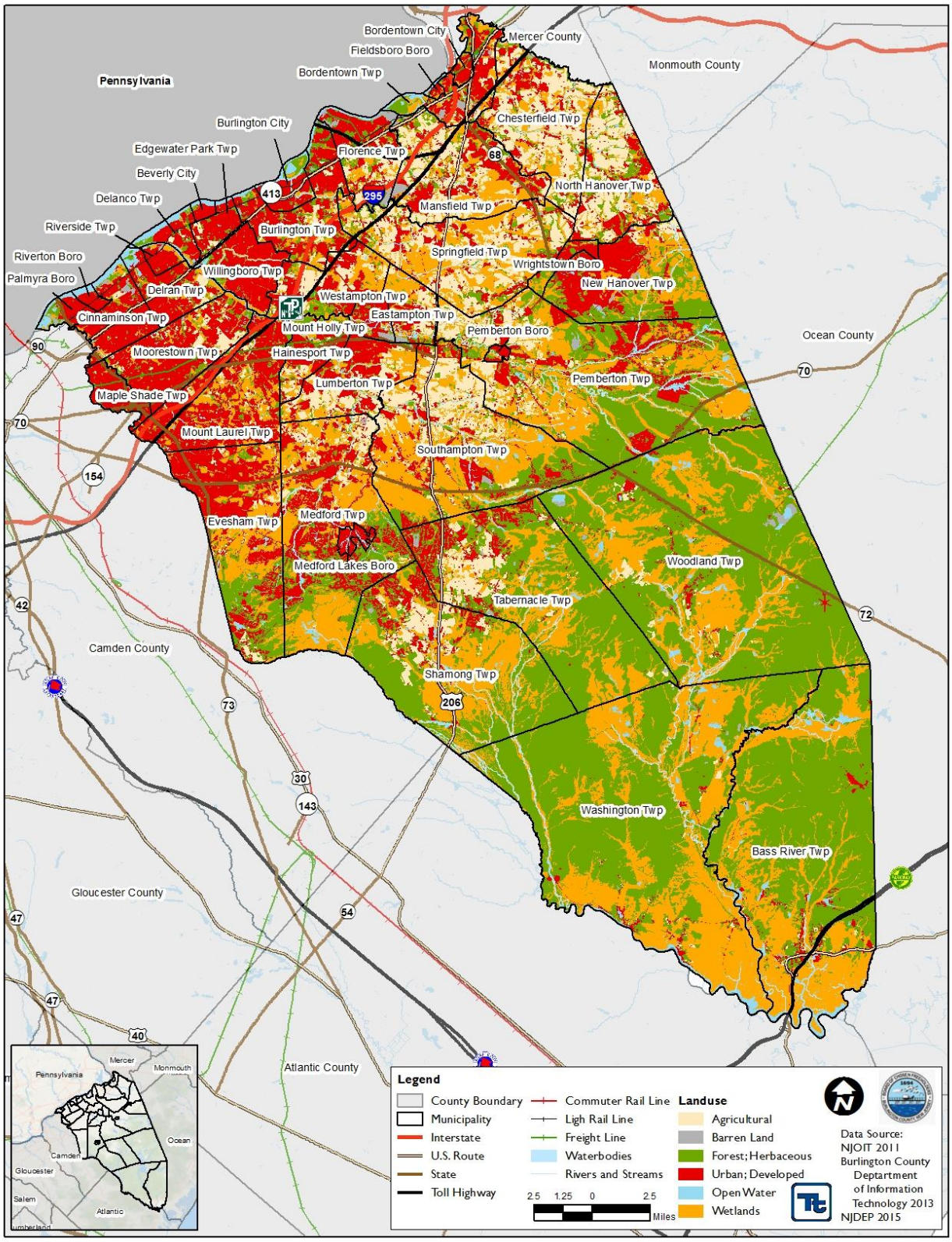
Source: NJDEP (2007, 2012 LULC)
Note: Urban land includes residential, industrial, transportation, and recreational land. Water is excluded from the table above. Percentages were calculated as a percentage of total county area including water.

Land Use Trends

Local zoning and planning authority is provided for under the New Jersey Municipal Land Use Law, which gives municipalities zoning and planning authority. DMA 2000 requires that communities consider land use trends, which can impact the need for, and priority of, mitigation options over time. Land use trends significantly impact exposure and vulnerability to various hazards. For example, significant development in a hazard area increases the building stock and population exposed to that hazard.

This plan provides a general overview of population and land use and types of development occurring within the study area. An understanding of these development trends can assist in planning for further development and ensuring that appropriate mitigation, planning, and preparedness measures are in place to protect human health and community infrastructure.

Figure 4-7. 2012 Land Use Land Cover for Burlington County



Agriculture

New Jersey is the most densely populated state in the nation. Farmland is disappearing at an average rate of 10,000 acres a year. Fields where dairy cows once grazed and peach trees once blossomed are now home to shopping malls, houses and highways (State of New Jersey, 2006).

Agriculture in Burlington County predates the arrival of European settlers. Native Americans farmed in the region, originally named Matinicunk, at the time British Quakers arrived in the New World in the early 1600s. Native Americans cultivated a number of crops and, understanding the limitations of soils, rotated fields in order to prevent the depletion of soils. As early European settlers arrived, they were able to begin cultivation on small fields utilized by Native Americans immediately rather than having to clear forested lands. An abundance of good agricultural soils and proximity to major urban centers contributed significantly to the development of the county's early agricultural industry (Burlington County Agricultural Development Board, 2008).

Agricultural land is used primarily for the production of food and fiber. This includes cropland, pastureland, and orchards. According to the NJDEP, agricultural land includes pasturelands and grazing lands associated with horse or cattle raising operations, orchards, vineyards, nurseries and other horticultural areas. Other lands used in support of agricultural activities, such as farmsteads, associated barns, stables, and corrals, are also included (NJDEP, 2007).

Agriculture is an integral part of the natural landscapes that comprise the County. Burlington County's natural and agricultural landscapes are attractive to many farmers. According to the 2012 Census of Agriculture, there were 95,899 acres of farmland in the County, or approximately 18.3% of the total lands in the County. This is significantly more than the 2007 survey which indicated that there were 85,790 acres of farmland or 16.3% of the total lands in the County. In 2012, there were 838 active farms in the County. The number of farms is down from 2007 when there were 922. Table 4-3 outlines the number of farms, average farm size and total acreage of farms in Burlington County from 1900 to 2012.

Table 4-3. Farms in Burlington County, 1900 to 2007

Year	Number of Farms	Average Farm Size (acre)	Total Acreage
1900	2,549	135	343,096
1910	2,389	121	287,816
1920	2,172	125	271,235
1925	2,132	86	183,940
1930	1,948	94	182,740
1935	2,122	103	219,273
1940	1,847	171	314,825
1945	1,629	108	176,242
1950	1,905	111	211,588
1954	1,835	113	207,618
1959	1,351	137	184,727
1964	1,070	154	164,835
1969	857	166	142,132
1974	708	202	142,751
1978	717	181	129,747
1982	743	152	112,689
1987	834	124	103,224
1992	816	119	97,186
1997	857	121	103,667
2002	906	123	111,237

Year	Number of Farms	Average Farm Size (acre)	Total Acreage
2007	922	93	85,790
2012	838	114	95,899

Source(s): U.S. Department of Agriculture National Agricultural Statistics Service, 2007; Burlington County Comprehensive Farmland Preservation Plan, 2008, USDA 2012.

Table 4-4 outlines the top crop items grown in Burlington County, along with the number of acres devoted to these crops. The table indicates that soybeans for beans are the predominant crop in the County and ranks second in the State for total acres of soybeans.

Table 4-4. Burlington County Farmland by Crop (Acres): 2007 and 2012

Crop Type	2007	2012
Soybeans for beans	18,589	19,288
Corn for grain	8,342	7,557
Forage - land used for all hay and haylage, grass silage, and greenchop	6,035	4,663
Land in berries	4,912	4,974
Vegetables harvested for sale	4,309	5,071

Source: USDA, 2012

With active agriculture extending from the Pinelands throughout northern Burlington County, the County has always been one of the leading agricultural counties in the nation. The largest blueberries in the world were developed and raised in Burlington County and the County is ranked as the second largest blueberry-producing and third largest cranberry-producing county in the U.S. There are more acres devoted to farming than any county in the state, primarily in vegetable, fruit and timber production (Burlington County HMP, 2013).

Burlington County has adopted a Comprehensive Farmland Preservation Plan which lays out a strategy for preservation of this vital resource. Over 26,500 acres have been permanently protected from conversion to nonagricultural uses through permanent deed-restrictions. In addition, roughly 23,000 acres of land in agricultural planning areas of the state-regulated New Jersey Pinelands have been deed-restricted through the Pinelands Development Credit Program. In total, nearly 50,000 acres (roughly 45 percent of the existing agricultural land base) have been protected from conversion to non-agricultural uses (Burlington County Agricultural Development Board, 2008).

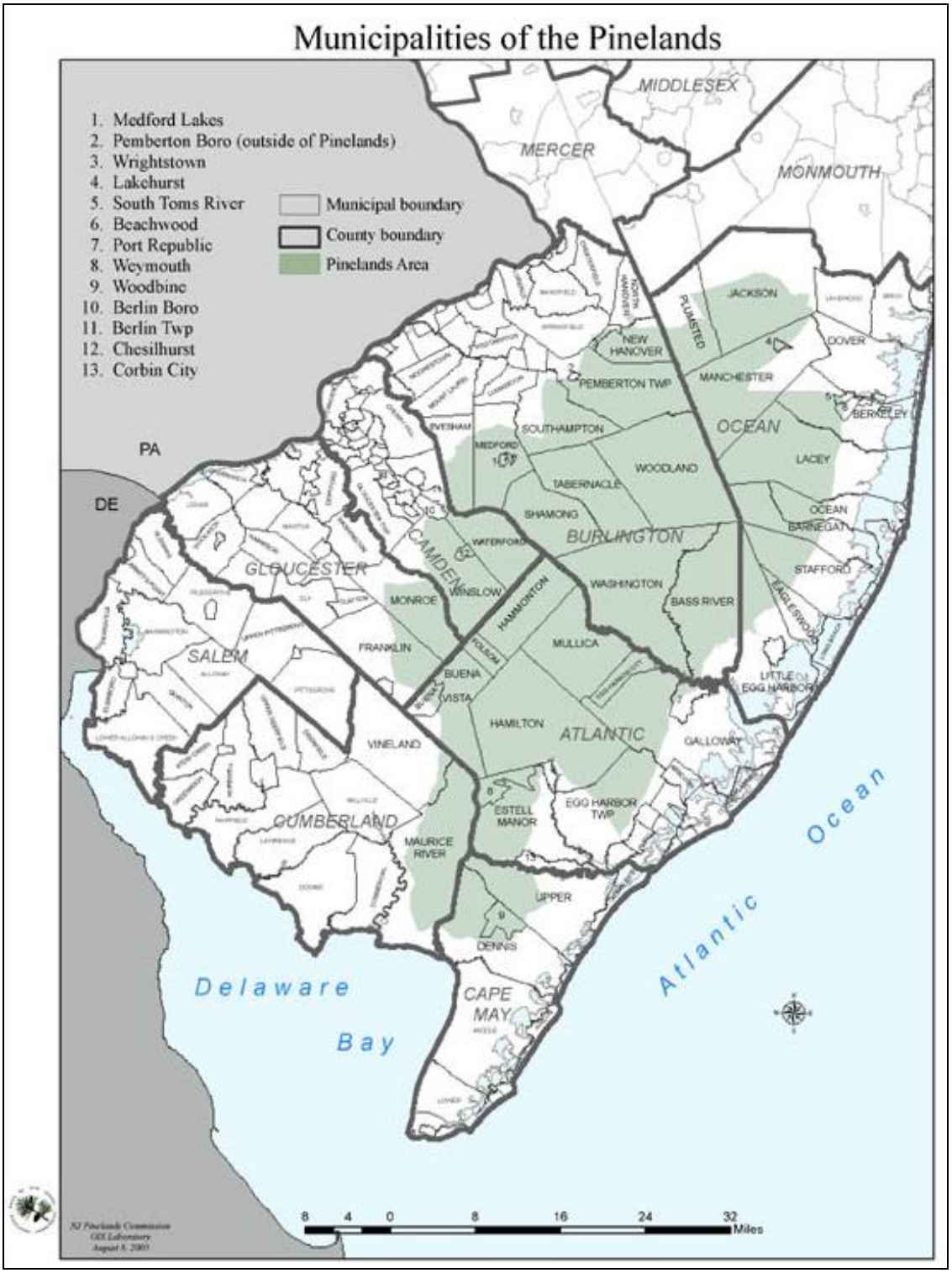
Pinelands National Reserve

The Pinelands National Reserve (PNR) was created by Congress under the National Parks and Recreation Act of 1978. The PNR is the first National Reserve in the nation. The PNR encompasses approximately 1.1 million acres covering portions of seven counties and all or parts of 56 municipalities (NJ Pinelands Commission, 2013).

This internationally important ecological region is 1.1 million acres in size and occupies 22% of New Jersey's land area. It is the largest body of open space on the Mid-Atlantic seaboard between Richmond and Boston and is underlain by aquifers containing 17 trillion gallons of some of the purest water in the land (NJ Pinelands Commission, 2013).

Approximately 64 percent of Burlington County's land area is under the jurisdiction of the New Jersey Pinelands Commission. Fourteen of Burlington County's 40 municipalities have area within the Pinelands. In its 2017 long-term economic monitoring report, the Pinelands Commission estimated that 21.5 percent of the county's population, according to 2010 U.S. Census estimates were located within the Pinelands (New Jersey Pinelands Commission, 2017). Figure 4-8 illustrates the location of and municipalities within the Pinelands.

Figure 4-8. Municipalities within the New Jersey Pinelands



Source: Piney Power, 2013

Barren Land

Barren land is composed of rock or rock faces or lacks vegetation for other reasons. Burlington County has very limited barren land, amounting to less than 1% of the County's land cover.

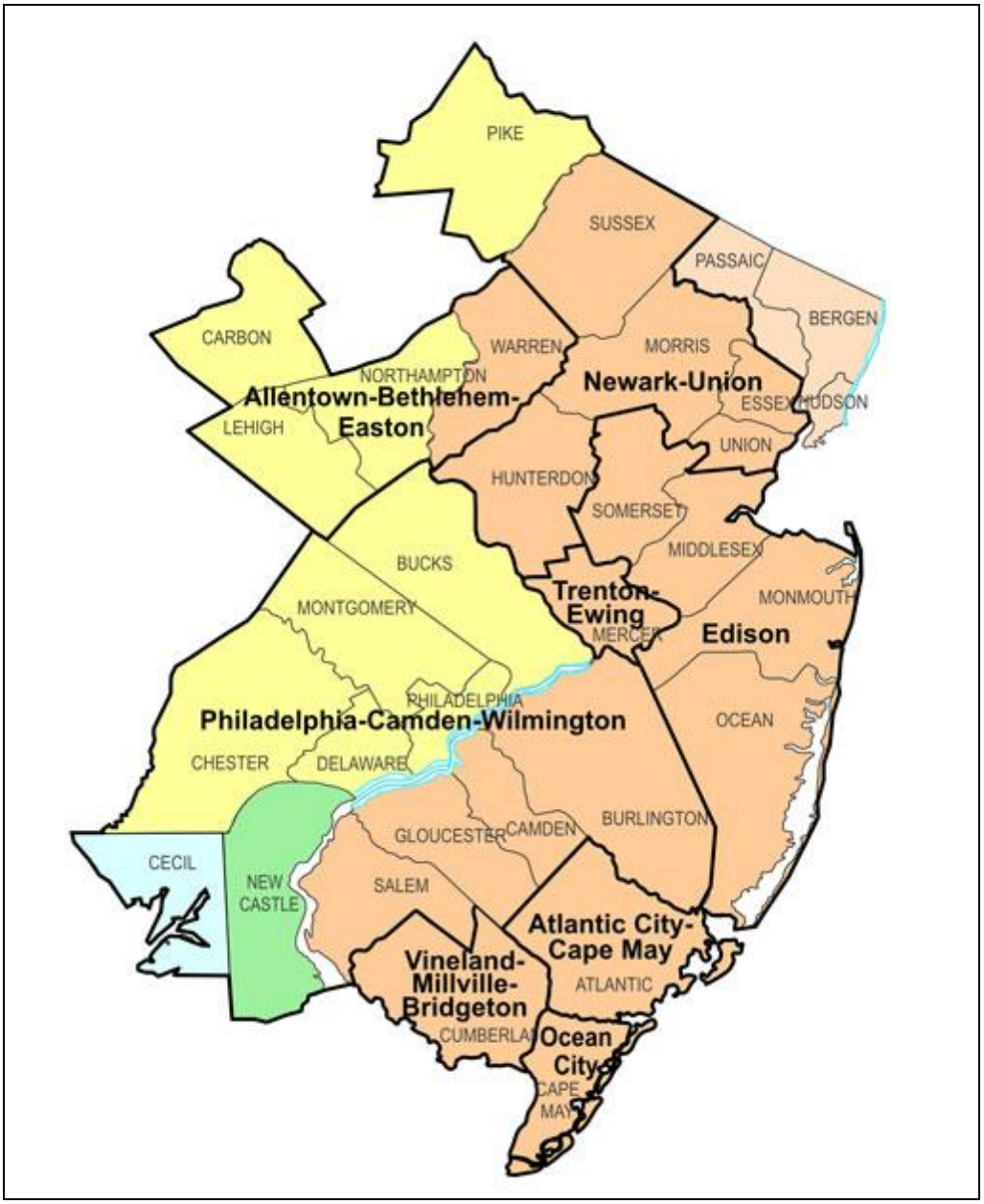
Metropolitan/Urban Area

The Census Bureau classifies 'urban' as all territory, population, and housing units located within an urbanized area (UA) or an urban cluster (UC). It delineates UA and UC boundaries to encompass densely settled territory, which consist of core census block groups or blocks that have a population density of at least 1,000 people per square mile; and surrounding census blocks that over an overall density of at least 500 people per square mile.

An urbanized area is defined as "A statistical geographic entity consisting of a densely settled core created from census tracts or blocks and contiguous qualifying territory that together have a minimum population of at least 50,000 persons." (U.S. Census Bureau, 2011). An urban cluster is defined as "A statistical geographic entity consisting of a densely settled core created from census tracts or blocks and contiguous qualifying territory that together have at least 2,500 persons but fewer than 50,000 persons."(U.S. Census Bureau, 2011). With a population of over 448,000 and a population density of approximately 500 people per square mile, Burlington County is not considered an urban area.

Burlington County is one of the 12 counties within the Philadelphia-Camden-Wilmington Metropolitan Statistical Area, which is the sixth most populous metropolitan area in the United States. The MSA has a 2010 population of 5,965,343, which includes Burlington County. The MSA also has approximately 4,377 square miles of land. (U.S. Census Bureau). This metropolitan area is made up of 5 divisions as indicated in Figure 4-9.

Figure 4-9. Philadelphia-Camden-Wilmington Metropolitan Statistical Area, PA-NJ-DE-MD Metropolitan Statistical Area



Water

Numerous ponds, lakes, creeks, and rivers make up the waterscape of Burlington County, which lie within two drainage basins (Lower Delaware Basin and New Jersey Coastal Basin) and three sub-basins (Crosswicks-Neshaminy, Lower Delaware, and Mullica-Toms) (NJDEP, 2012; USEPA, 2013). A description of the drainage basins is discussed earlier in this section.

The major bodies of water and waterways within the County include: Delaware River, Oswego River, Bass River, Batsto River, Mullica River, Wading River, West Branch Wading River, Rancocas Creek, North Branch Rancocas Creek, South Branch Rancocas Creek, Southwest Branch Rancocas Creek, Crosswicks Creek, Big Timber Creek,

South Branch Mount Misery Brook, Shoal Branch, Greenwood Branch, and Great Bay (National Atlas, 2013). The county has numerous manmade small lakes and ponds created through modifying streams and creeks including Oswego Lake, Harrisville Lake, and Lake Absegami.

Wetlands

In classifying land cover, wetlands are defined as all freshwater wetlands larger than one acre and all linear freshwater wetlands wider than 10 feet. Wetlands are lands that are inundated or saturated by surface or ground waters at a frequency and duration sufficient to support vegetation. Included in this category are natural vegetation swamps, marshes, bogs, and savannas. Wetlands make up a significant portion of Burlington County (~30%) and are found along many of the County's rivers, streams, and creeks.

Open Space and Parkland

Open space is defined as a portion of a site which is permanently set aside for public or private use and will not be developed. The space may be used for passive or active recreation, or may be reserved to protect or buffer natural areas. The Burlington County Park System has more than 1,000 acres of developed parkland, 3,500 acres of land slated for park development, and a regional trail system that will provide a link between parks in the future (Burlington County Parks Department 2019). Burlington County Freeholders have focused on expanding the parks system to include:

- Regional Parks
- Recreation Areas
- Natural Resource Areas
- Special Use Areas

Connectivity will be a high priority in park planning and design. Pathway facilities and linkages in the Burlington County Parks System will include:

- Park trails
- Connector trails
- Bikeways
- Water or canoe trails
- All terrain bike trails
- Cross-country ski trails
- Equestrian trails

The Burlington County Park System consists of 12 county parks and historic sites. Table 4-6 outlines locations included in the County park system, as well as State parks in the County. These parks range from small to large and feature aquatic features and hiking trails.

Table 4-5. County and State Parks in Burlington County

Park	Total Acreage
Amico Island Park	55
Amphitheater	Unknown
Bass River State Forest	29,147
Batsto Natural Area	9,449
Boundary Creek Natural Resource Area	34
Brendan T. Byrne State Forest	37,242
Burlington County Community Agricultural Center	Unknown
Cedar Swamp Natural Area	30,000

Park	Total Acreage
County Fairgrounds	61
Crystal Lake Park	370+
Laurel Run Park	120
Long Bridge Park	115
Oswego River Natural Area	1,927
Penn State Forest	3,366
Pennington Park	140
Smithville Park	312
Smithville Lake	22
Rancocas Nature Center	210
Rancocas State Park (Hainesport)	1,252
Willingboro Lakes Park	105
Wharton State Forest	122,880

Source: Burlington County, 2013

4.4 POPULATION AND DEMOGRAPHICS

Knowledge of the population composition, 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 following sections discuss general population characteristics, vulnerable populations and population trends in Burlington County.

4.4.1 General Population Characteristics

According to the 2010 U.S. Census, Burlington County had a population of 448,734 people. Table 4-2 presents the 2000 and 2010 U.S. Census population statistics for Burlington County by municipality. Figure 4-9 shows the distribution of the general population density (persons per square mile) by Census block. For the purposes of this plan update, 2010 Census data available in HAZUS-MH are used to assess risk. This data is considered appropriate given the relatively small population increase between 2000 and 2010.

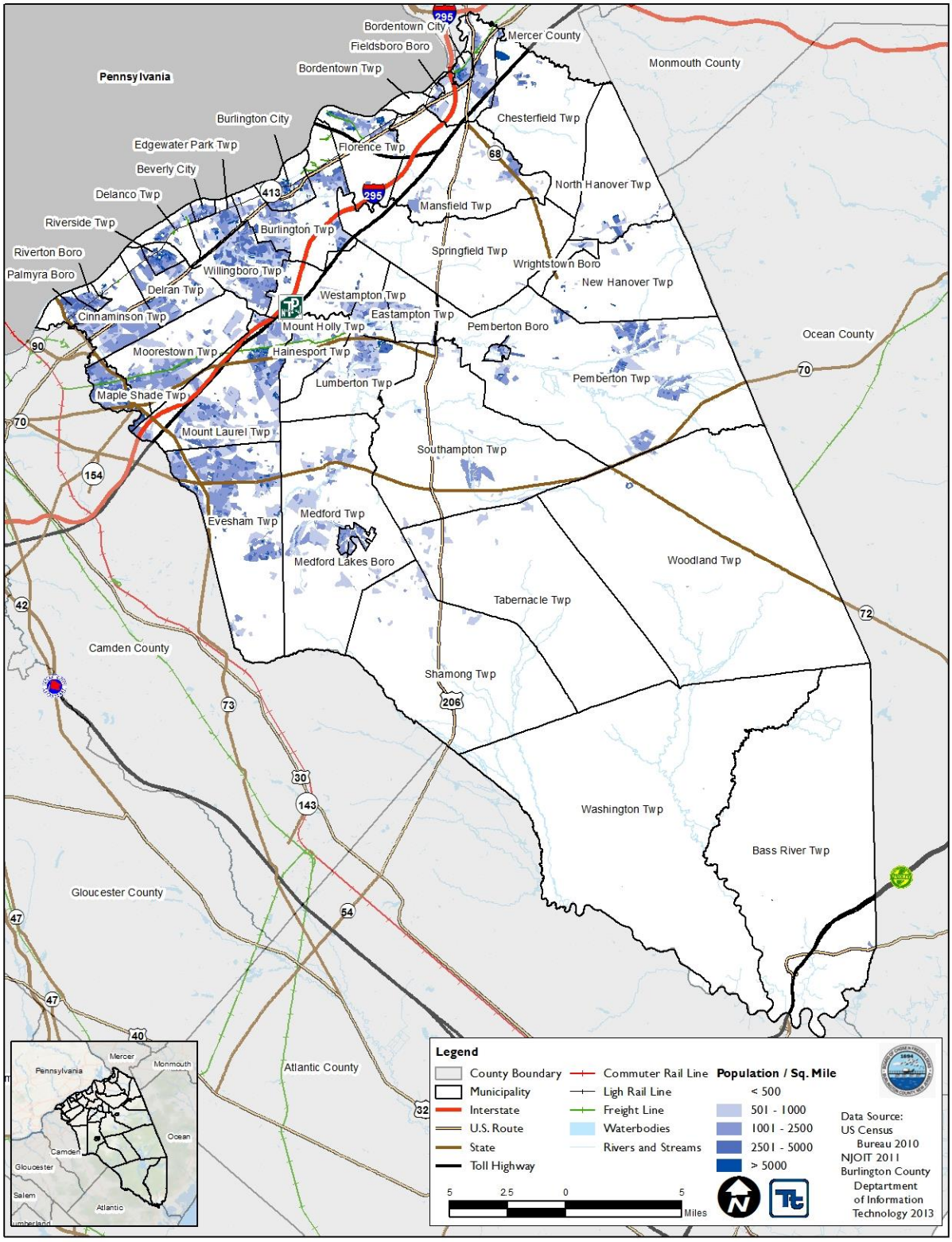
Table 4-6. Burlington County Population Statistics (2010 U.S. Census)

Municipality	Census 2000 Total Pop.	Census 2010 Total Pop.	Population 65+ Census 2010 Total	Population 65+ Census 2010 % of Total	Population 65+ Census 2000 Total	Population 65+ Census 2000 % of Total	Low-Income Population ** Census 2000 Total	Low-Income Population ** Census 2000 % of Total
Bass River, Township of	1,510	1,443	187	13	178	11.8	129	8.5
Beverly, City of	2,661	2,577	292	11.3	312	11.7	271	10.2
Bordentown, City of	3,969	3,924	528	13.5	547	13.8	520	13.1
Bordentown, Township of	8,380	11,367	1,207	10.6	986	11.8	564	6.7
Burlington, City of	9,736	9,920	1,556	15.7	1,678	17.2	1,269	13.0
Burlington, Township of	20,294	22,594	2,719	12.0	2,603	12.8	1,537	7.6
Chesterfield, Township of	5,955	7,699	415	5.4	283	4.8	72	1.2
Cinnaminson, Township of	14,595	15,569	2,839	18.2	2,787	19.1	726	5.0
Delanco, Township of	3,237	4,283	689	16.1	421	13.0	332	10.3
Delran, Township of	15,536	16,896	2,009	11.9	1,678	10.8	1,185	7.6
Eastampton, Township of	6,202	6,069	283	4.7	452	7.3	423	6.8
Edgewater Park, Township of	7,864	8,881	1,403	15.8	1,014	12.9	876	11.1
Evesham, Township of	42,275	45,538	5,961	13.1	3,795	9.0	2,134	5.0
Fieldsboro, Borough of	522	540	57	10.6	39	7.5	18	3.4

Municipality	Census 2000 Total Pop.	Census 2010 Total Pop.	Population 65+ Census 2010 Total	Population 65+ Census 2010 % of Total	Population 65+ Census 2000 Total	Population 65+ Census 2000 % of Total	Low-Income Population ** Census 2000 Total	Low-Income Population ** Census 2000 % of Total
Florence, Township of	10,746	12,109	1,534	12.7	1,277	11.9	956	8.9
Hainesport, Township of	4,126	6,110	874	14.3	499	12.1	233	5.6
Lumberton, Township of	10,461	12,559	1,312	10.4	1,106	10.6	952	9.1
Mansfield, Township of	5,090	8,544	2,382	27.9	1,566	30.8	501	9.8
Maple Shade, Township of	19,079	19,131	2,530	13.2	2,894	15.2	2,321	12.2
Medford Lakes, Borough of	4,173	4,146	611	14.7	513	12.3	122	2.9
Medford, Township of	22,253	23,033	3,212	13.9	2,295	10.3	835	3.8
Moorestown, Township of	19,017	20,726	3,360	16.2	3,123	16.4	1,126	5.9
Mount Laurel, Township of	40,221	41,864	6,723	16.1	1,312	12.2	1,204	11.2
Mt. Holly, Township of	10,728	9,536	1,054	11.1	6,001	14.9	2,873	7.1
New Hanover, Township of	9,744	7,385	276	3.7	91	0.9	258	2.6
North Hanover, Township of	7,347	7,678	648	8.4	443	6.0	834	11.4
Palmyra, Borough of	7,091	7,398	973	13.2	937	13.2	677	9.5
Pemberton, Borough of	1,210	1,409	187	13.3	104	8.6	142	11.7
Pemberton, Township of	28,691	27,912	3,257	11.7	2,736	9.5	2,535	8.8
Riverside, Township of	7,911	8,079	850	10.5	1,082	13.7	881	11.1
Riverton, Borough of	2,759	2,779	498	17.9	537	19.5	214	7.8
Shamong, Township of	6,462	6,490	636	9.8	376	5.8	301	4.7
Southampton, Township of	10,388	10,464	3,347	32.0	3,498	33.7	1,509	14.5
Springfield, Township of	3,227	3,414	453	13.3	346	10.7	116	3.6
Tabernacle, Township of	7,170	6,949	777	11.2	489	6.8	319	4.4
Washington, Township of	621	687	N/A	N/A	133	21.4	53	8.5
Westampton, Township of	7,217	8,813	914	10.4	656	9.1	331	4.6
Willingboro, Township of	33,008	31,629	5,037	15.9	4,210	12.8	1,657	5.0
Woodland, Township of	1,170	1,788	187	10.5	94	8.0	50	4.3
Wrightstown, Borough of	746	802	63	0.07	66	8.8	164	21.9
Burlington County	**423,394**	**448,734**	**26,231**	**5.8**	**53,157**	**12.6**	**31,220**	**7.4**

Source: *Census 2010 (U.S. Census Bureau); HAZUS-MH 4.0*
Note: *Pop. = population*
** Individuals below poverty level (2017 Census poverty threshold for a 3-person family unit is $19,173)*
*** Households with an income of less than $20,000 are reported*
**** 2010 Census Data not available*

Figure 4-10. Distribution of General Population for Burlington County, New Jersey



4.4.2 Vulnerable Populations

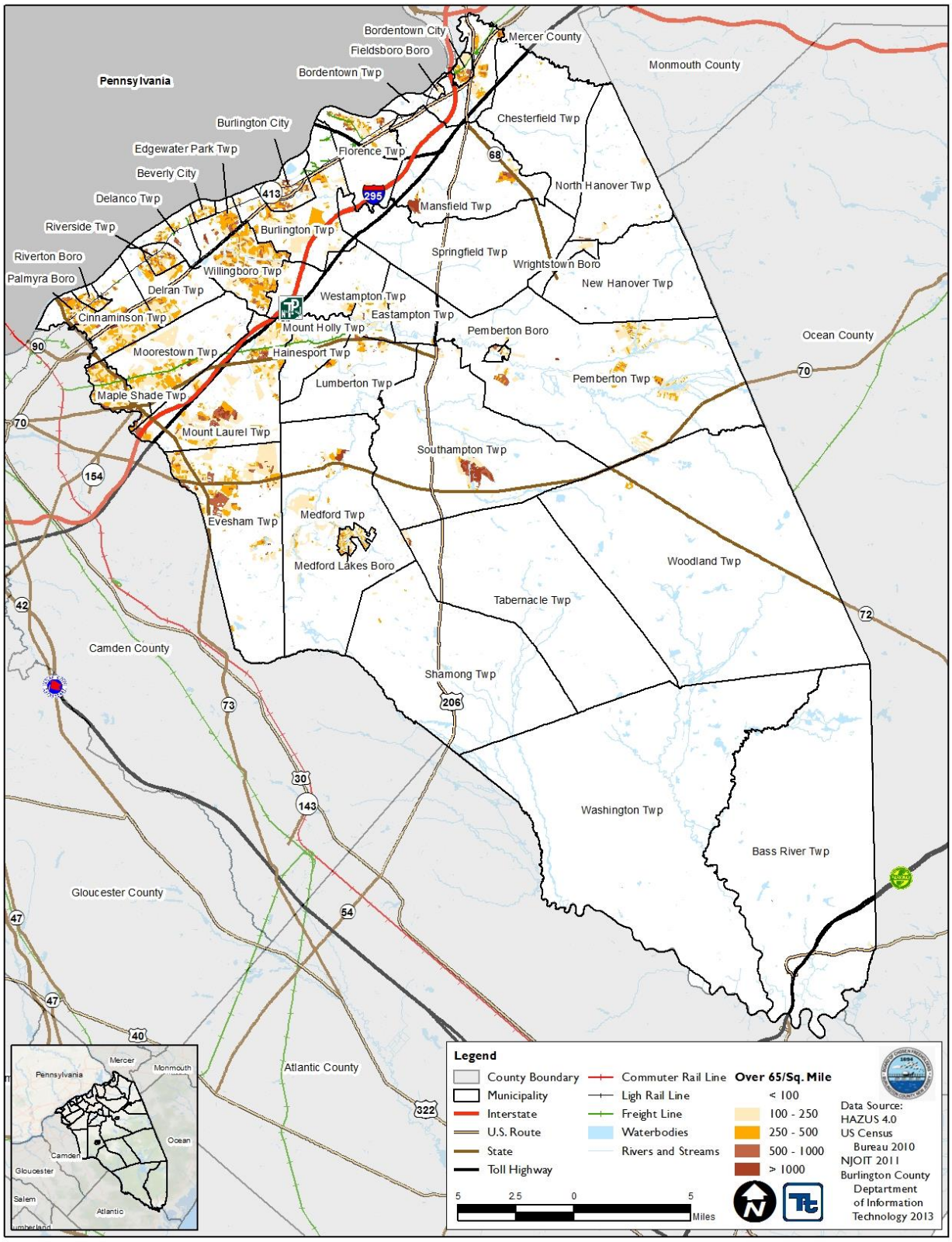
Identifying concentrations of vulnerable populations can assist communities in targeting preparedness, response and mitigation actions. Populations with a higher level of vulnerability may be more seriously affected during the course of an emergency or disaster. Vulnerable populations have unique needs which need to be taken into consideration by public officials to help ensure the safety of demographics with a higher level of risk. For the purposes of this planning process, vulnerable populations in Burlington County include children, elderly, low-income, the physically or mentally disabled, non-English speakers and the medically or chemically dependent.

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 are more apt to lack the physical and economic resources necessary for response to hazard events and are more likely to suffer health-related consequences. Those living on their own may have more difficulty evacuating their homes. The elderly are also more likely to live in senior care and living facilities (described in Section 4.4.1) where emergency preparedness occurs at the discretion of facility operators.

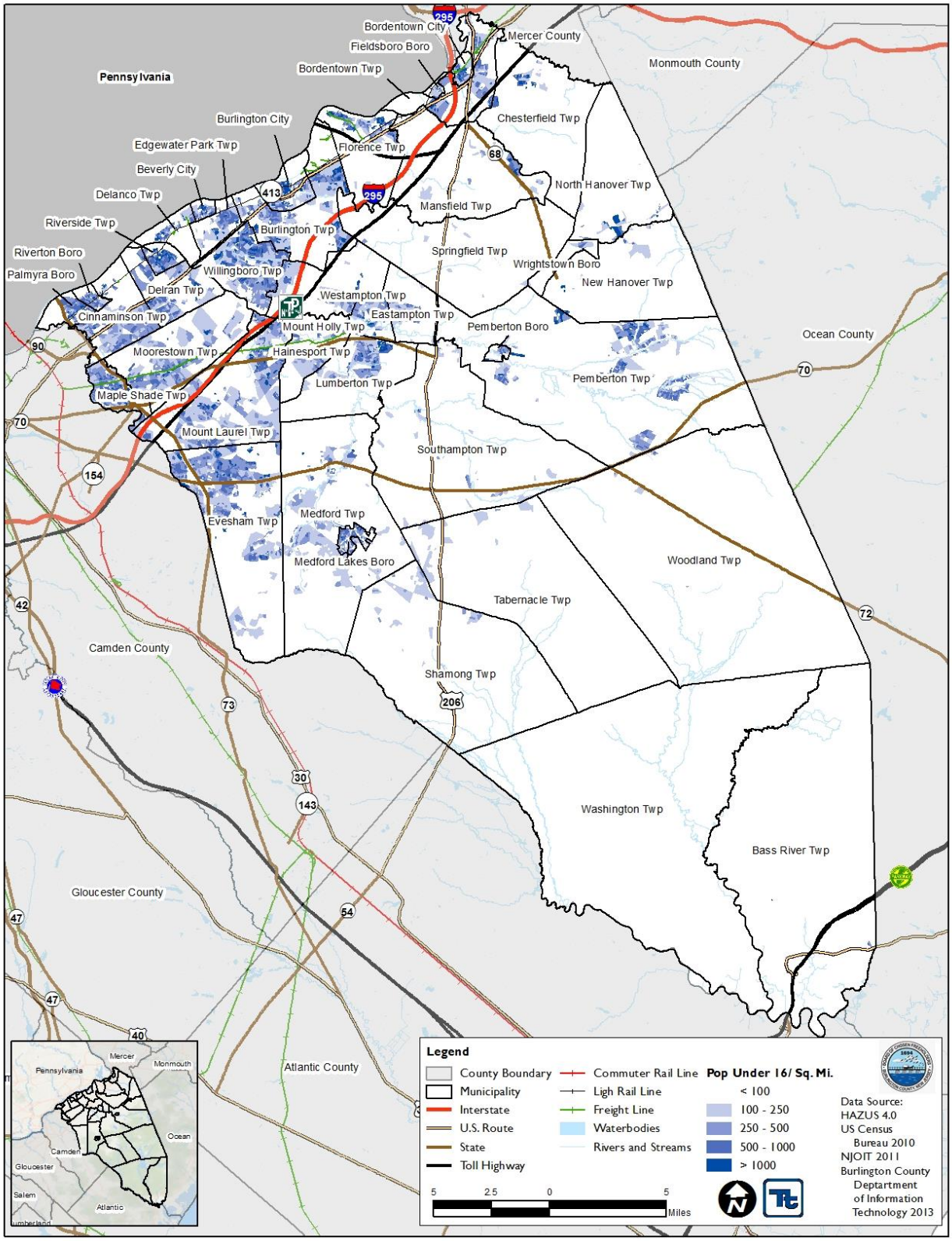
According to the 2012-2016 American Community Survey 5-Year Estimates, the median age in Burlington County was 41.3 years. HAZUS-MH reports 23.2 percent of the 2010 Burlington County population is under the age 16. Of the 2016 population, 15.5 percent of the County's population is age 65 and older. Figure 4-7 shows the distribution of persons over age 65 and Figure 4-8 shows the distribution of persons under the age of 16 and in Burlington County.

Figure 4-11. Distribution of Persons Over the Age of 65 in Burlington County, New Jersey



Note: The figure indicates distribution based on Census Block designations.

Figure 4-12. Distribution of Children under Age of 16 in Burlington County, New Jersey

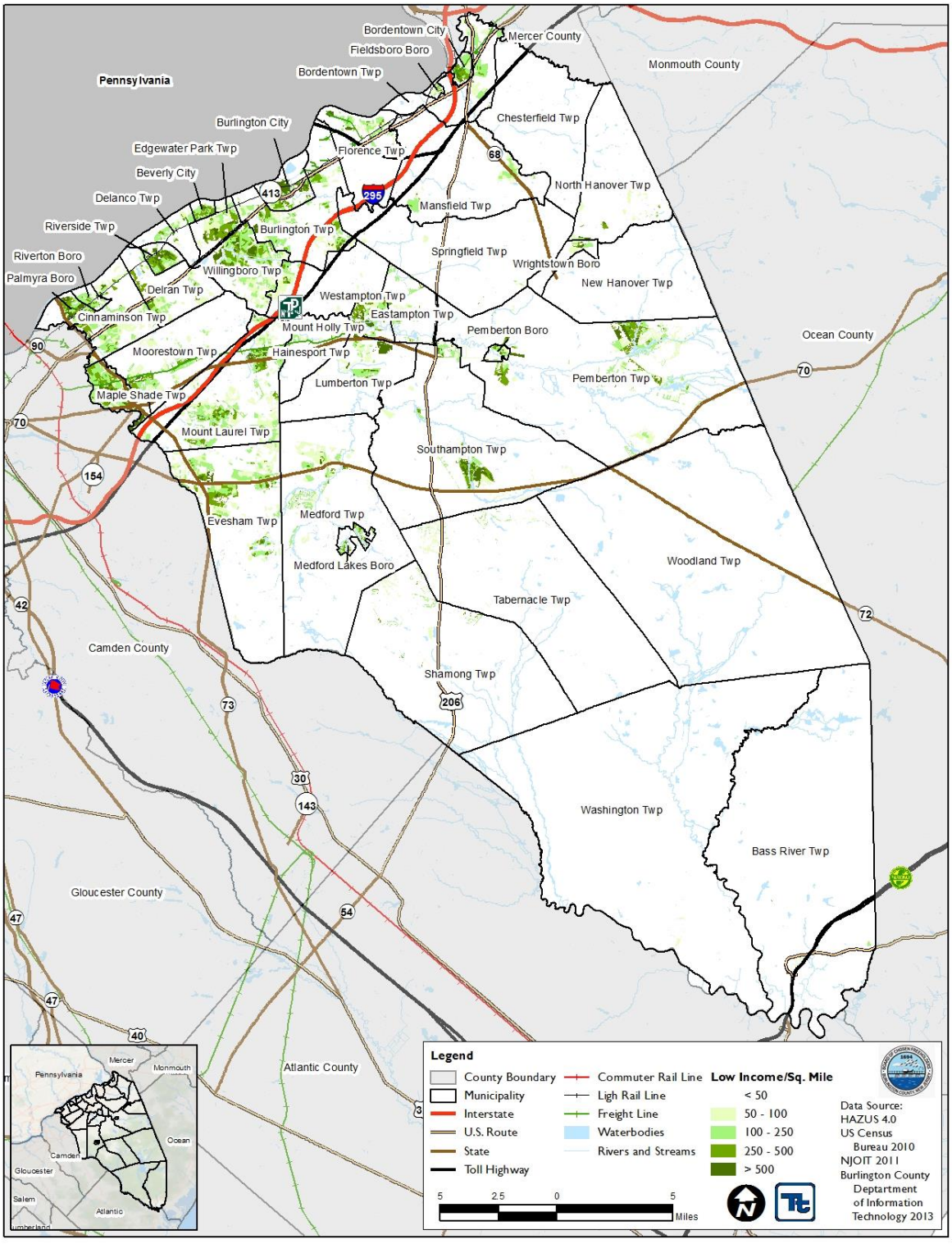


Income

The 2012-2016 American Community Survey 5-Year Estimates find that the median household income in Burlington County was $80,034, and the per capita income was $38,137. The U.S. Census Bureau identifies households with two adults and two children with an annual household income below $24,339 per year as "low income" (U.S. Census 2016). The 2012-2016 American Community Survey 5-Year Estimates indicates a total of 6.5 percent persons below the poverty level.

It is noted that the spatial U.S. 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 2016 U.S. Census Bureau data. This difference is not believed to be significant for the purposes of this planning effort; therefore, for the exposure and loss estimations in the risk assessment, the 2010 U.S. Census data in HAZUS-MH is reported. Refer to Figure 4-13 below which illustrates the low-income population density in Burlington County.

Figure 4-13. Distribution of Low-Income Population in Burlington County, New Jersey

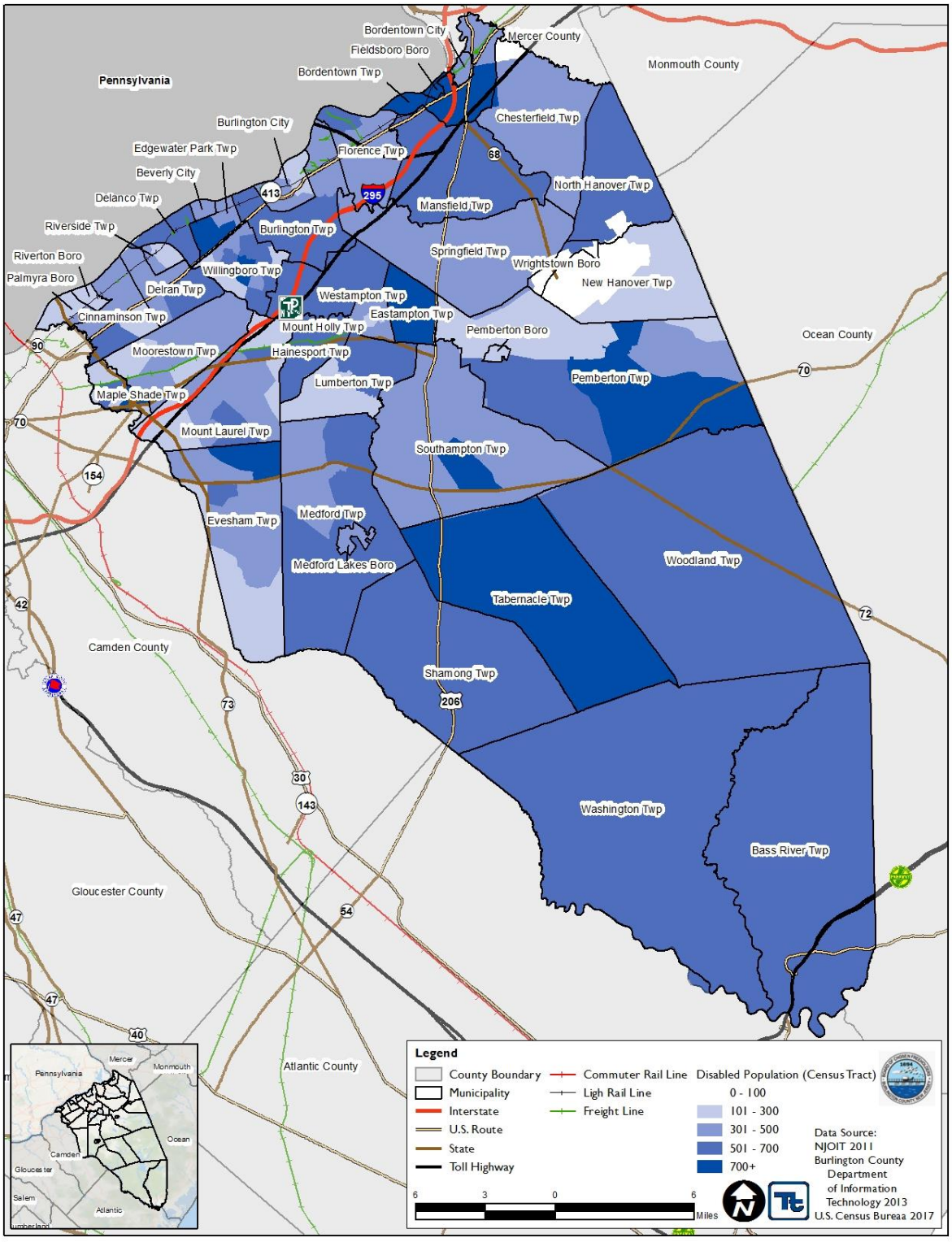


Note: The figure indicates distribution based on Census Block designations using the HAZUS-MH household income of <$20,000 per year.

Physically or Mentally Disabled

"Persons with a disability include those who have physical, sensory, or cognitive impairment that might limit a major life activity (Center for Disease Control, 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 2012-2016 American Community Survey, 11.2 percent of residents in Burlington County are living with a disability. The figure below shows the geographic distribution of disabled individuals throughout Burlington County, it includes individuals with: hearing, vision, cognitive, ambulatory, self-care, and independent living difficulties.

Figure 4-14. Distribution of Persons with a Disability in Burlington County, New Jersey

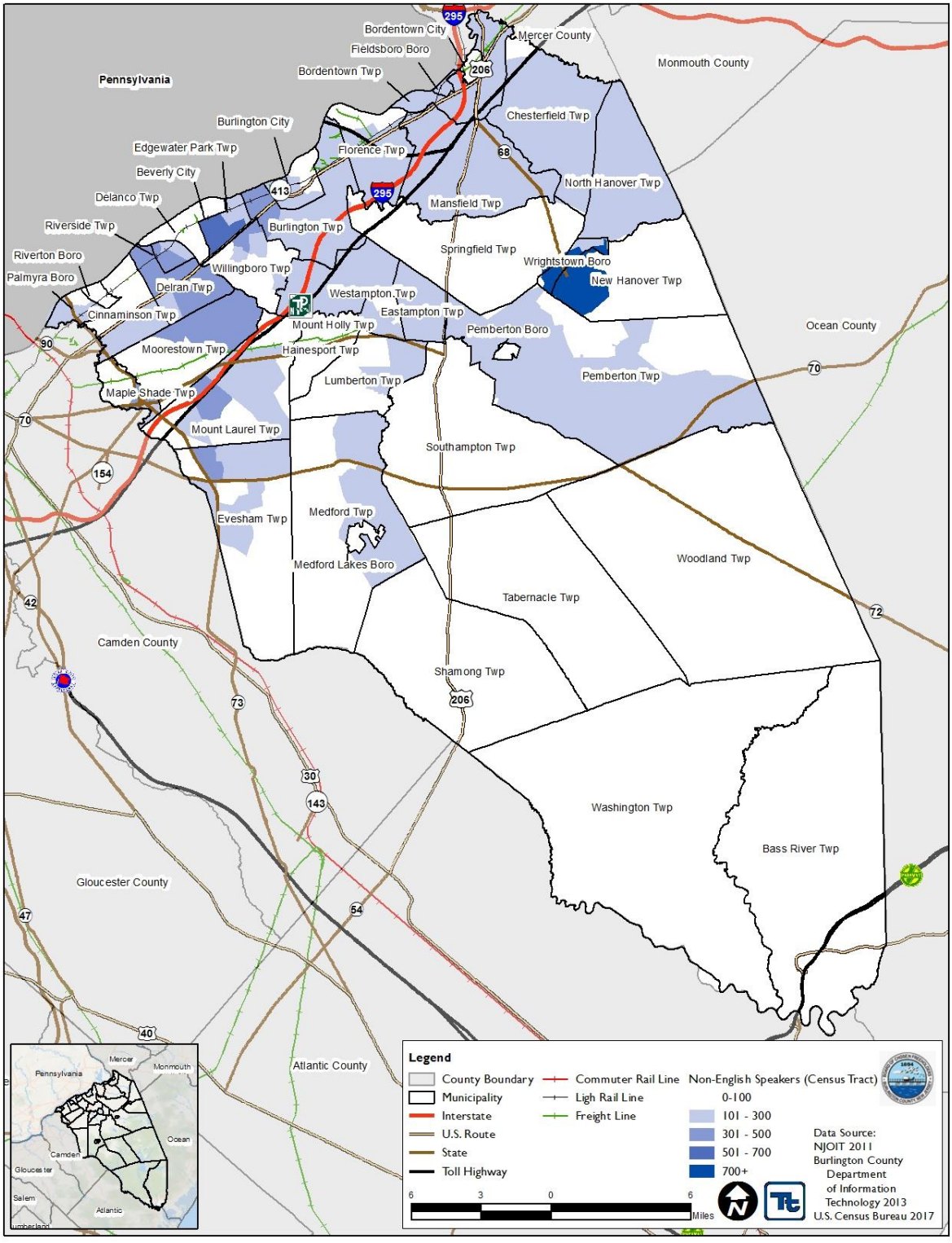


Source: United States Census Bureau, 2012-2016 American Community Survey; Burlington County Department of Information Technology, 2013
Note: The figure indicates distribution based on Census Tract designations.

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, 2015). According to the 2012-2016 American Community Survey, 16.9 percent of the County's population over the age of 5 primarily speaks a language other than English at home; this is significantly less than the State average of 30.7 percent. Of the County's population, 7.3 percent speak Spanish and 7.6 percent speak other Indo-European languages. The figure below shows the geographic distribution of individuals who speaker a language other than English.

Figure 4-15. Distribution of Persons Who Speak English Less Than "Very Well" in Burlington County, New Jersey



Source: United States Census Bureau, 2012-2016 American Community Survey; Burlington County Department of Information Technology, 2013
Note: The figure indicates distribution based on Census Tract designations.

4.4.3 Population Trends

This section discusses population trends to use as a basis for estimating future changes 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.

According to the U.S. Census Bureau Burlington County's 2010 population was 448,734 persons, which is a six-percent increase from the 2000 Census population of 423,394. From 1900 to 2010, the County has experienced a constant growth in population. The largest increase was seen between the years 1950 to 1960, when the County experienced a 65.2 percent (88,589 persons) population increase. From 1890 – 1900 the population decreased 0.5 percent (-287). Table 4-7 displays the population and population differences from 1900 to 2010 in Burlington County. Table 4-8 displays the population of the County's municipalities from 1940 to 2010. Figure 4-16 depicts the past, current, and projected population statistics/trends for the County.

Table 4-7. Burlington County Population Trends, 1900 to 2010

Year	Population	Change in Population	Percent (%) Population Change
1900	58,241	-	-
1910	66,565	8,324	14.3
1920	81,770	15,205	22.8
1930	93,541	11,771	14.4
1940	97,013	3,472	3.7
1950	135,910	38,897	40.1
1960	224,499	88,589	65.2
1970	323,132	98,633	43.9
1980	362,542	39,410	12.2
1990	395,066	32,524	9.0
2000	423,394	28,328	7.2
2010	448,734	25,340	6.0

Source: U.S. Census Bureau, 2010
Note: Change in population and percent in population change was calculated from available data

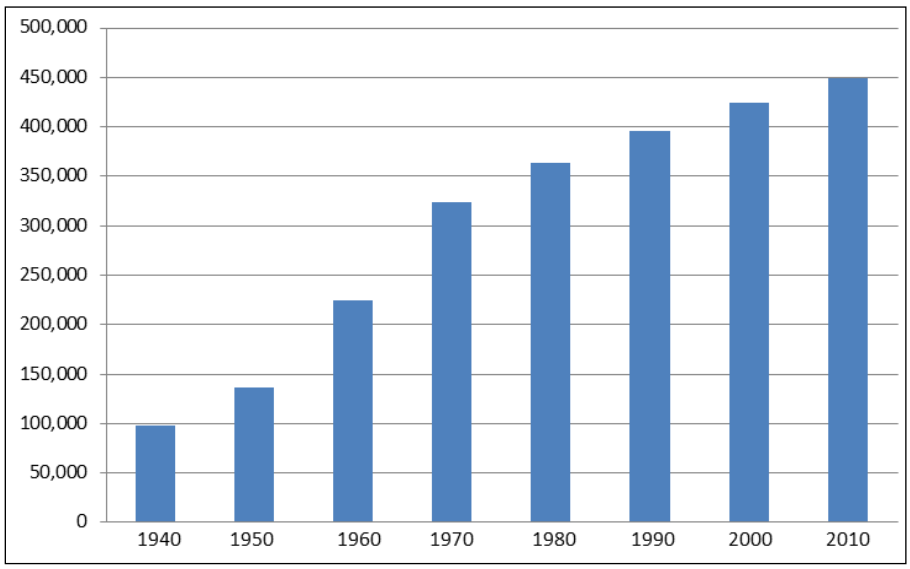
Table 4-8. Burlington County Resident Population by Municipality: 1940-2010

Municipality	1940	1950	1960	1970	1980	1990	2000	2010	Percent Change 2000 - 2010
Bass River, Township of	599	688	737	815	1,344	1,580	1,510	1,443	-4%
Beverly, City of	2,691	3,084	3,400	3,105	2,919	2,973	2,661	2,577	-3%
Bordentown, City of	4,223	5,497	4,974	4,490	4,441	4,341	3,969	3,924	-1%
Bordentown, Township of	1,095	2,033	5,936	7,303	7,170	7,683	8,380	11,367	36%
Burlington, City of	10,905	12,051	12,687	12,010	10,246	9,835	9,736	9,920	2%
Burlington, Township of	2,520	3,441	6,291	10,621	11,527	12,454	20,294	22,594	11%
Chesterfield, Township of	1,766	2,020	2,519	3,190	3,867	5,152	5,955	7,699	29%
Cinnaminson, Township of	2,504	3,144	8,302	16,962	16,072	14,583	14,595	15,569	7%
Delanco, Township of	2,383	2,805	4,011	4,157	3,730	3,316	3,237	4,283	32%

Municipality	1940	1950	1960	1970	1980	1990	2000	2010	Percent Change 2000 - 2010
Delran, Township of	5,327	10,065	14,811	13,178	15,536	13,178	15,536	16,896	9%
Eastampton, Township of	498	692	1,402	2,284	3,814	4,962	6,202	6,069	-2%
Edgewater Park, Township of	1,171	1,279	2,866	7,412	9,273	8,388	7,864	8,881	13%
Evesham, Township of	1,655	2,121	4,548	13,477	21,508	35,309	42,275	45,538	8%
Fieldsboro, Borough of	537	589	583	615	597	579	522	540	3%
Florence, Township of	7,229	7,455	8,127	8,560	9,084	10,266	10,746	12,109	13%
Hainesport, Township of	858	1,793	3,271	2,990	3,236	3,249	4,126	6,110	48%
Lumberton, Township of	1,007	1,325	2,833	3,945	5,236	6,705	10,461	12,559	20%
Mansfield, Township of	1,907	1,907	2,084	2,597	2,523	3,874	5,090	8,544	68%
Maple Shade, Township of	5,535	6,560	12,947	16,464	20,525	19,211	19,079	19,131	0%
Medford Lakes, Borough of	137	461	2,876	4,792	4,958	4,462	4,173	4,146	-1%
Medford, Township of	2,237	2,836	4,844	8,292	17,622	20,526	22,253	23,033	4%
Moorestown, Township of	7,749	9,123	12,497	15,577	15,596	16,116	19,017	20,726	9%
Mount Laurel, Township of	2,189	2,817	5,249	11,221	17,614	30,270	40,221	41,864	4%
Mt. Holly, Township of	6,892	8,206	13,271	12,713	10,818	10,639	10,728	9,536	-11%
New Hanover, Township of	983	18,168	28,528	27,410	14,258	9,546	9,744	7,385	-24%
North Hanover, Township of	731	1,155	2,796	9,858	9,050	9,994	7,347	7,678	5%
Palmyra, Borough of	5,178	5,802	7,036	6,969	7,085	7,056	7,091	7,398	4%
Pemberton, Borough of	906	1,194	1,250	1,344	1,198	1,367	1,210	1,409	16%
Pemberton, Township of	2,386	4,751	13,726	19,754	29,720	31,342	28,691	27,912	-3%
Riverside, Township of	7,072	7,199	8,474	8,591	7,941	7,974	7,911	8,079	2%
Riverton, Borough of	2,354	2,761	3,324	3,412	3,068	2,775	2,759	2,779	1%
Shamong, Township of	505	712	774	1,318	4,537	5,765	6,462	6,490	0%
Southampton, Township of	1,813	2,341	3,166	4,982	8,808	10,202	10,388	10,464	1%
Springfield, Township of	1,299	1,562	1,956	2,244	2,691	3,028	3,227	3,414	6%
Tabernacle, Township of	490	1,034	1,621	2,103	6,236	7,360	7,170	6,949	-3%
Washington, Township of	518	566	541	673	808	805	621	687	11%
Westampton, Township of	573	716	1,114	2,680	3,383	6,004	7,217	8,813	22%
Willingboro, Township of	642	852	11,861	43,386	39,912	36,291	33,008	31,629	-4%
Woodland, Township of	1,374	1,524	1,904	2,032	2,285	2,063	1,170	1,788	53%
Wrightstown, Borough of	241	1,199	4,846	2,719	3,031	3,843	746	802	8%

Source: U.S. Census of Population and Housing, Date Unknown.

Figure 4-16. Burlington County Population Trends, 1940 – 2010



Source: U.S. Census Bureau, 2010

Between 1990 and 2010, nine of the 40 municipalities experienced an overall decrease in their population all other of the municipalities saw an increase in their populations from 2000 to 2010. The municipalities which experienced population decreases were the Townships of Bass River, Easthampton, Mount Holly, New Hanover, Pemberton, and Willingboro, the Cities of Beverly and Bordentown, and the Borough of Medford Lakes. The Township of New Hanover experienced the greatest loss of population, losing 24% of its population from 2000. The Township of Woodland Township experienced a population increase of 53%.

Table 4-9 displays the 2010 Census population for the ten largest municipalities by population in Burlington County. According to the Delaware Valley Regional Planning Commission's 2040 population estimates, the County population is expected to reach 457,126 by 2020, and 494,732 by 2040. This is an increase of 45,998 persons by 2040. (DVRPC 2012) With the predicted population increase, urban (residential) land use will increase, while other land uses, such as agriculture and forested land, may decrease over time.

Table 4-9. Ten Largest Municipalities in Burlington County

Rank	Municipality	Population
1	Evesham, Township of	45,538
2	Mount Laurel, Township of	41,864
3	Willingboro, Township of	31,629
4	Pemberton, Township of	27,912
5	Medford, Township of	23,033
6	Burlington, Township of	22,594
7	Moorestown, Township of	20,726
8	Maple Shade, Township of	19,131
9	Delran, Township of	16,896
10	Cinnaminson, Township of	15,569

Source: 2010 U.S. Census

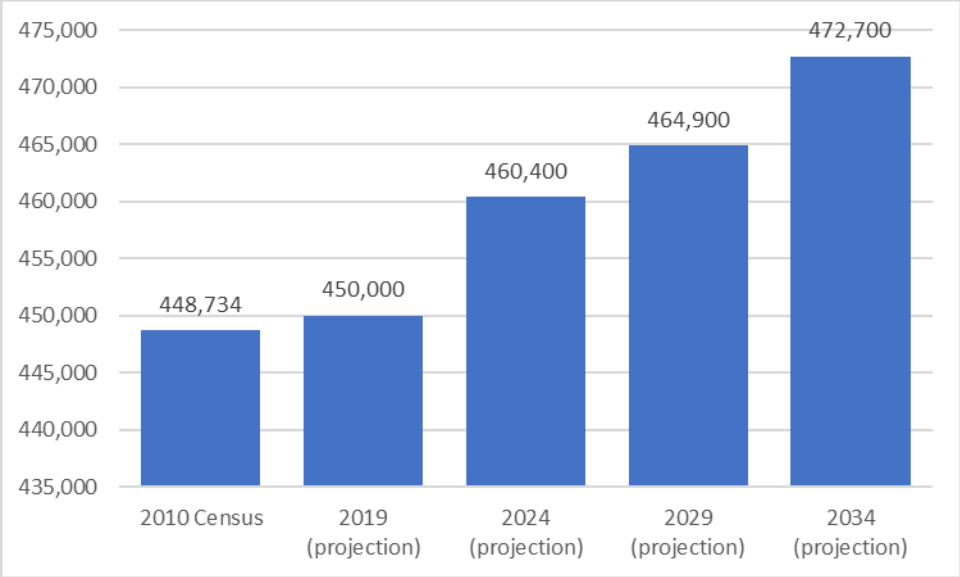
Over the next 15 years, from 2019 to 2034, Burlington County has a projected population growth of 5.3-percent. Based on New Jersey Department of Labor population projections, the county population is expected to reach 460,400 by 2024 and 472,700 by 2034 (Figure 4-17).

Table 4-10. Burlington County Population Projections, 2019 to 2034

Year	Population	Change in Population
2010 Census	448,734	-
2019 (projection)	450,000	0.28%
2024 (projection)	460,400	2.31%
2029 (projection)	464,900	0.98%
2034 (projection	472,700	1.68%

Source: New Jersey Department of Labor and Workforce Development 2014

Figure 4-17. Burlington County Population Projections, 2010 to 2034



Source: New Jersey Department of Labor and Workforce Development 2014

4.5 GENERAL BUILDING STOCK

The 2010 U.S. Census data identifies 165,727 households in Burlington County. The U.S. Census data identified 175,615 housing units in Burlington County in 2010. U.S. Census defines household as all the persons who occupy a housing unit, and a housing unit as a house, an apartment, a mobile home, a group of rooms, or a single room that is occupied (or if vacant, is intended for occupancy) as separate living quarters. Therefore, you may have more than one household per housing unit. The median price of a single family home in Burlington County was estimated at $266,200 in 2010 (U.S. Census, 2010).

For this update, the default general building stock in HAZUS-MH v4.2 was updated and replaced with a custom building inventory for Burlington County both at the aggregate and structure level. The updated building inventory

was built using detailed the building footprints, parcels and structure-specific building attributes. Burlington County has a total building replacement value (structure and content) of greater than $165 billion. The Residential value makes up approximately 66.7 percent of the total replacement value. Table 4-3 presents replacement value statistics by occupancy class for Burlington County.

Table 4-11. Replacement Value by Occupancy Class

Municipality	All Occupancies				Residential		Commercial		Industrial	
	Count	Structural Value	Estimated Contents	Total Replacement Cost (Structural + Contents)	Count	Total Replacement Cost (Structural + Contents)	Count	Total Replacement Cost (Structural + Contents)	Count	Total Replacement Cost (Structural + Contents)
Bass River, Township of	1,863	$592,479,667	$435,437,463	$1,027,917,130	1,023	$471,126,613	484	$209,674,207	9	$11,665,684
Beverly, City of	964	$307,500,140	$163,986,998	$471,487,138	935	$430,539,426	8	$6,853,816	2	$5,148,790
Bordentown, City of	1,219	$744,949,381	$500,046,523	$1,244,995,904	1,053	$734,708,572	81	$146,484,909	13	$195,580,818
Bordentown, Township of	3,113	$1,674,099,210	$1,145,942,037	$2,820,041,247	2,524	$1,584,471,520	289	$543,431,173	109	$241,559,435
Burlington, City of	3,644	$1,962,644,603	$1,252,588,489	$3,215,233,092	3,216	$2,130,168,343	193	$309,202,528	39	$70,780,909
Burlington, Township of	7,757	$5,000,155,300	$3,013,104,371	$8,013,259,672	7,031	$5,961,152,787	205	$533,519,273	124	$614,236,873
Chesterfield, Township of	2,093	$1,400,485,206	$1,042,809,213	$2,443,294,418	1,357	$1,073,027,978	56	$67,128,717	6	$3,869,219
Cinnaminson, Township of	6,358	$3,443,136,617	$2,260,759,135	$5,703,895,752	5,709	$3,547,132,446	236	$494,179,648	218	$627,214,410
Delanco, Township of	1,562	$918,559,858	$503,641,621	$1,422,201,479	1,458	$1,244,754,710	42	$40,614,401	6	$87,628,606
Delran, Township of	5,191	$3,217,120,782	$1,928,501,814	$5,145,622,596	4,767	$3,865,856,904	213	$308,925,108	34	$231,693,686
Eastampton, Township of	2,499	$1,060,270,313	$626,747,199	$1,687,017,512	2,030	$1,300,569,343	225	$125,347,418	16	$16,022,117
Edgewater Park, Township of	2,567	$1,457,974,255	$849,310,960	$2,307,285,215	2,364	$1,825,989,884	74	$162,098,732	34	$117,725,858
Evesham, Township of	14,319	$9,168,653,192	$5,497,429,231	$14,666,082,424	12,839	$11,013,671,882	518	$1,526,787,429	46	$234,436,899
Fieldsboro, Borough of	242	$84,982,564	$54,388,563	$139,371,126	193	$91,782,003	10	$6,613,341	28	$27,791,285
Florence, Township of	2,522	$1,673,982,403	$1,113,281,204	$2,787,263,607	2,044	$1,682,103,599	78	$81,114,272	52	$115,275,168
Hainesport, Township of	2,747	$2,080,207,178	$1,367,001,557	$3,447,208,735	2,174	$2,139,616,863	138	$228,412,051	105	$415,818,773
Lumberton, Township of	4,009	$3,424,896,916	$2,034,660,341	$5,459,557,257	3,405	$4,170,709,726	178	$312,145,320	48	$145,386,902
Mansfield, Township of	2,798	$2,285,414,884	$1,771,086,705	$4,056,501,589	1,874	$1,542,984,536	136	$305,587,252	4	$41,805,982
Maple Shade, Township of	6,006	$2,679,790,126	$1,705,710,787	$4,385,500,913	5,458	$2,922,238,018	348	$684,855,771	56	$115,090,171
Medford Lakes, Borough of	1,909	$837,422,542	$442,628,329	$1,280,050,871	1,846	$1,184,382,640	30	$36,912,107	12	$10,947,073
Medford, Township of	10,627	$7,999,936,346	$4,845,971,148	$12,845,907,494	9,206	$9,461,895,592	386	$563,064,071	66	$170,312,318
Moorestown, Township of	8,736	$6,109,599,449	$3,999,202,177	$10,108,801,626	7,741	$6,331,191,815	438	$1,192,836,317	109	$984,189,569
Mount Holly, Township of	4,573	$2,150,068,863	$1,348,284,133	$3,498,352,996	4,048	$2,405,354,190	169	$351,810,788	32	$108,699,679

Municipality	All Occupancies				Residential		Commercial		Industrial	
	Count	Structural Value	Estimated Contents	Total Replacement Cost (Structural + Contents)	Count	Total Replacement Cost (Structural + Contents)	Count	Total Replacement Cost (Structural + Contents)	Count	Total Replacement Cost (Structural + Contents)
Mount Laurel, Township of	12,900	$9,343,991,534	$5,309,809,270	$14,653,800,804	11,771	$12,102,546,790	338	$1,084,708,230	60	$184,048,295
New Hanover, Township of	1,964	$1,546,232,618	$1,476,602,868	$3,022,835,486	361	$208,889,250	38	$43,058,752	0	$0
North Hanover, Township of	2,901	$1,729,559,019	$1,350,319,968	$3,079,878,987	1,905	$1,137,717,154	120	$118,656,465	1	$3,207,479
Palmyra, Borough of	2,713	$1,106,819,144	$681,579,412	$1,788,398,557	2,516	$1,275,719,196	90	$134,518,987	22	$83,146,192
Pemberton, Borough of	514	$207,432,867	$138,437,039	$345,869,906	411	$206,987,484	49	$53,490,261	4	$1,949,827
Pemberton, Township of	13,511	$5,772,021,833	$3,602,892,846	$9,374,914,679	11,953	$6,507,386,961	192	$215,385,866	12	$5,768,438
Riverside, Township of	2,868	$1,276,520,301	$762,619,650	$2,039,139,951	2,615	$1,541,701,954	132	$146,343,852	18	$133,048,415
Riverton, Borough of	1,274	$585,858,006	$330,576,784	$916,434,789	1,218	$765,843,666	22	$32,219,835	5	$13,100,109
Shamong, Township of	3,623	$1,696,218,832	$1,042,165,601	$2,738,384,433	3,055	$1,962,159,694	60	$57,533,711	10	$12,409,999
Southampton, Township of	7,982	$3,975,061,802	$2,747,285,971	$6,722,347,774	5,865	$3,683,327,494	1,015	$809,156,809	36	$36,000,792
Springfield, Township of	2,876	$2,223,461,090	$1,630,053,819	$3,853,514,909	1,909	$1,780,221,814	128	$440,472,485	32	$33,600,051
Tabernacle, Township of	4,452	$2,175,794,267	$1,443,246,498	$3,619,040,765	3,661	$2,197,643,307	328	$158,507,585	7	$5,656,451
Washington, Township of	939	$357,333,022	$240,093,911	$597,426,933	718	$351,717,333	44	$11,686,204	11	$20,091,603
Westampton, Township of	3,006	$2,487,347,035	$1,782,086,372	$4,269,433,407	2,400	$2,115,781,988	218	$380,964,430	47	$493,085,138
Willingboro, Township of	12,395	$5,281,247,833	$2,978,499,580	$8,259,747,413	11,991	$6,908,244,760	117	$149,803,840	35	$91,999,183
Woodland, Township of	1,323	$888,068,601	$768,679,645	$1,656,748,246	746	$358,166,869	33	$19,806,031	45	$32,504,921
Wrightstown, Borough of	485	$223,368,035	$188,595,000	$411,963,035	167	$104,319,107	41	$79,264,094	7	$4,964,834
Burlington County	**173,044**	**$101,150,665,635**	**$64,376,064,232**	**$165,526,729,867**	**147,557**	**$110,323,804,210**	**7,500**	**$12,173,176,085**	**1,520**	**$5,747,461,950**

Source: Burlington County, NJ Department of the Treasury, 2017

The 2012-2016 American Community Survey for Burlington County identified that there are 177,623 housing units in Burlington County. The median property value is $245,000. The 2010 Census data identify that the majority of housing units (65.0 percent) in Burlington County are single-family detached units. The 2016 U.S. Census Bureau's County Business Patterns data identified 38,883 business establishments employing 182,219 people in Burlington County. The industry with the greatest number of employees (27,533) is the health care and social assistance industry, followed by the retail trade industry (25,043).

Figure 4-12 through Figure 4-14 show the distribution and exposure density of residential, commercial and industrial buildings in Burlington County. Exposure density is the dollar value of structures per unit area, including building content value. Generally, contents for residential structures are valued at about 50 percent of the building's value. For commercial facilities, the value of the content is generally about equal to the building's structural value. Actual content value various widely depending on the usage of the structure. The densities are shown in units of $1,000,000 ($M) per square mile.

Viewing exposure distribution maps, such as Figures 4-12 through 4-14, can assist communities in visualizing areas of high exposure and in evaluating aspects of the study area in relation to the specific hazard risks.

Figure 4-18. Distribution of Residential Building Stock Replacement Cost Value in Burlington County

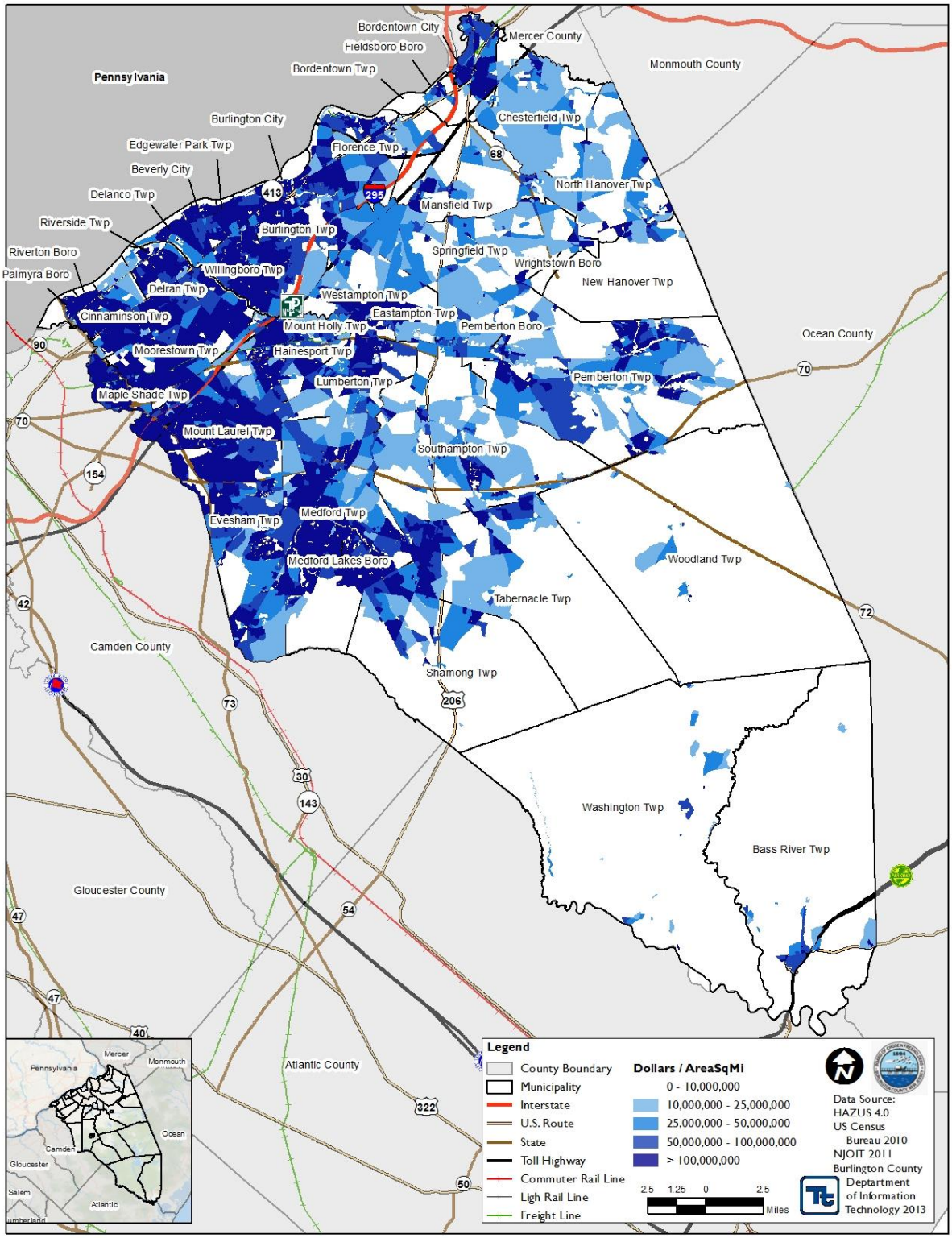


Figure 4-19. Distribution of Commercial Building Stock Replacement Value in Burlington County

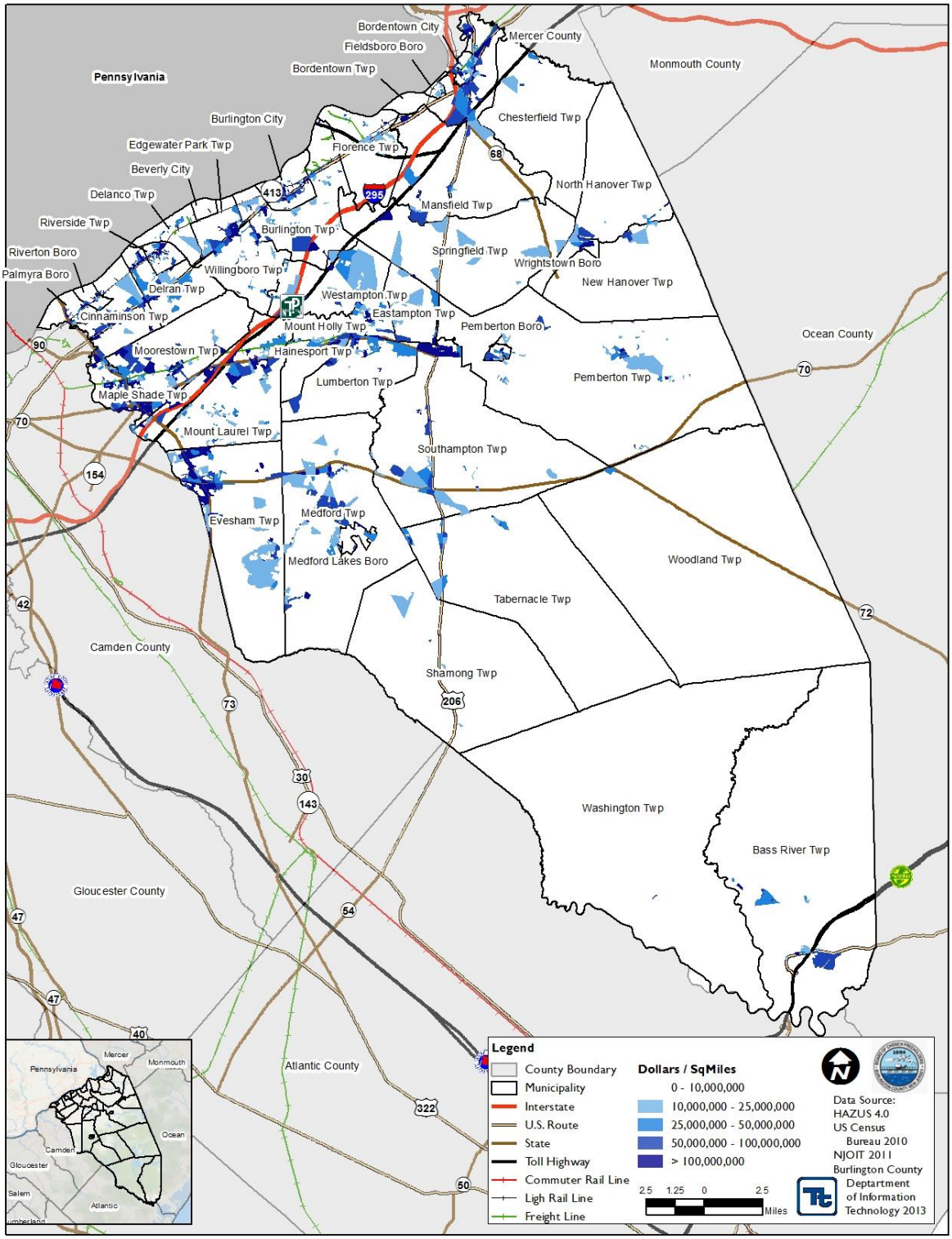
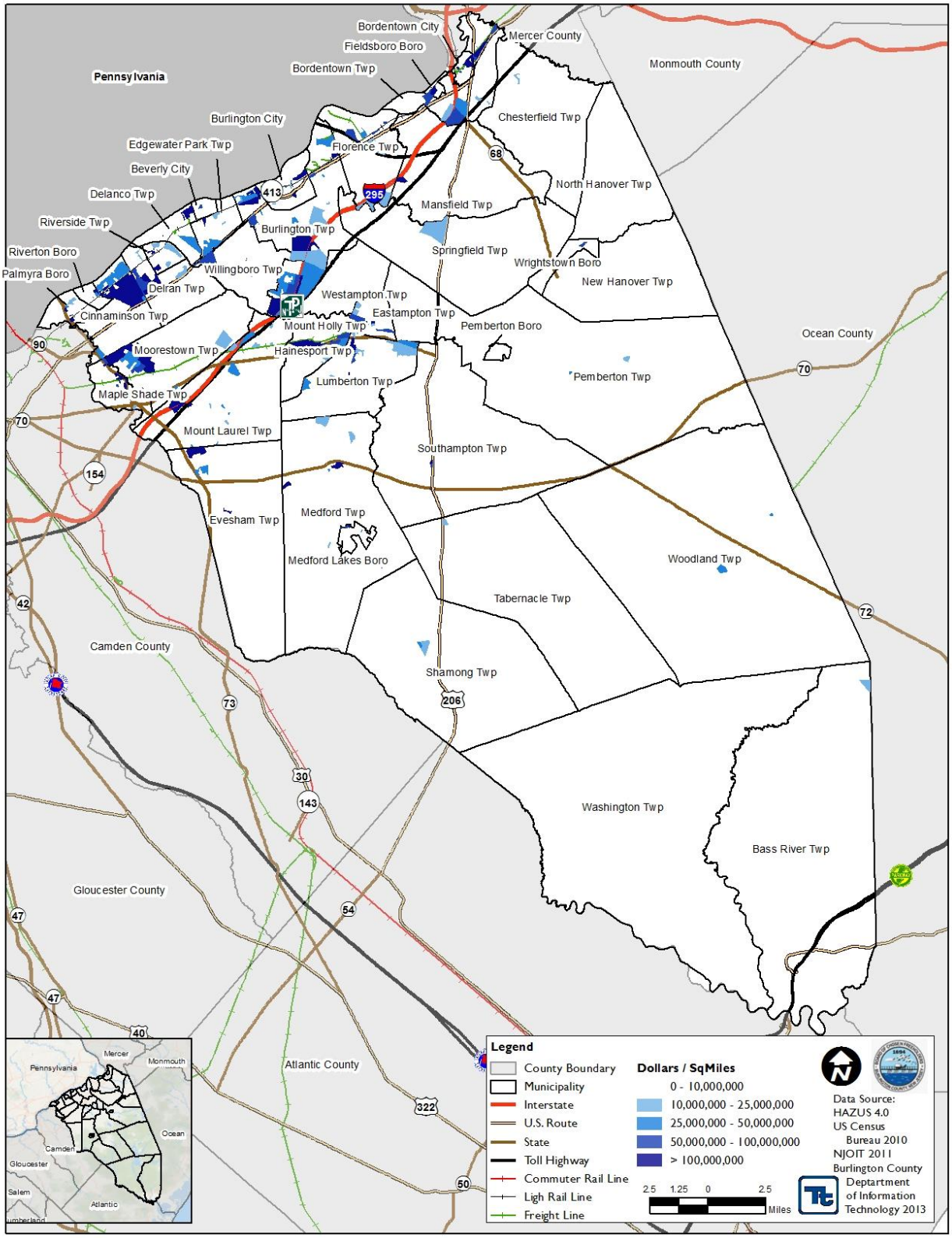


Figure 4-20. Distribution of Industrial Building Replacement Cost Value in Burlington County

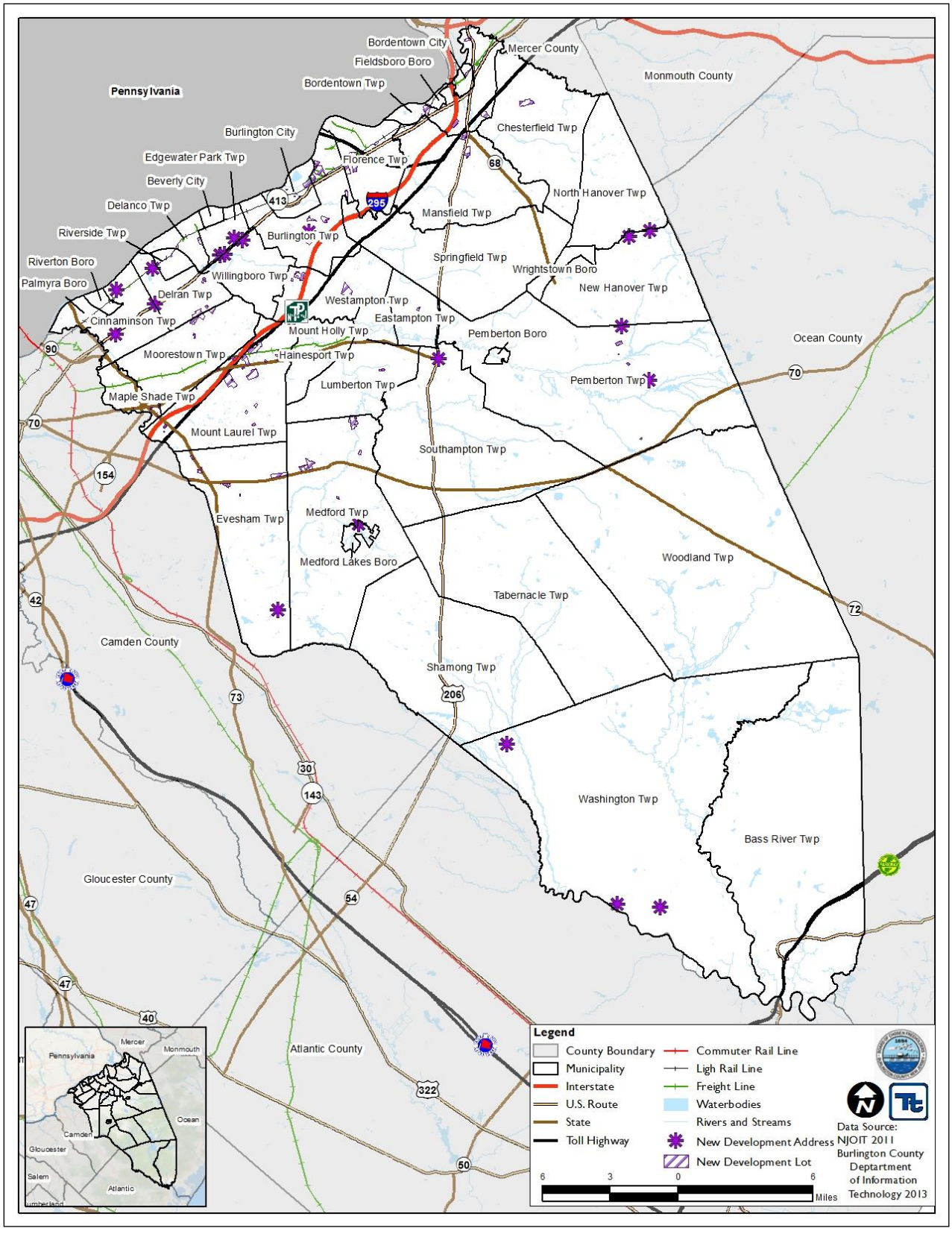


4.5.1 Development Trends and New Development

Local zoning and planning authority is provided for under the New Jersey Municipal Land Use Law, which gives municipalities zoning and planning authority. The DMA 2000 requires that communities consider land use trends, which can impact the need for, and priority of, mitigation options over time. Land use trends significantly impact exposure and vulnerability to various hazards. For example, significant development in a hazard area increases the building stock and population exposed to that hazard.

This plan provides a general overview of population and land use, and types of development occurring within the study area. An understanding of these development trends 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. Figure 4-21 provides locations of potential new development identified in the county over the next five years. For municipal identified new development, refer to the municipal annexes in Section 9.

Figure 4-21. Potential New Development in Burlington County



4.6 CRITICAL FACILITIES

A comprehensive inventory of critical facilities in Burlington County was developed from various sources provided by the county and individual municipalities. The inventory of critical facilities presented in this section represents the current state of this effort at the time of publication of the HMP and was used for the risk assessment in Section 5.

A comprehensive inventory of critical facilities in Burlington County was developed from the Burlington County Department of Information Technology, GIS Division. The inventory of critical facilities presented in this section represents the current state of this effort at the time of publication of the HMP and was used for the risk assessment in Section 5.

Critical facilities are those facilities considered critical to the health and welfare of the population and that are especially important following a hazard. As defined for this HMP, critical facilities include essential facilities, transportation systems, lifeline utility systems, high-potential loss facilities and hazardous material facilities.

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 a subset of critical facilities that, for the purposes of this Plan, include police, fire, emergency medical services (EMS) and emergency operations centers (EOC).

The inventory of critical facilities 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.

4.6.1 Essential Facilities

This section provides information on emergency facilities, hospital and medical facilities, schools, shelters and senior care and living facilities, all of which are considered essential facilities for the purposes of this HMP. Figure 4-22 illustrates the general location of facilities in Burlington County.

Emergency Facilities

For the purposes of this HMP, emergency facilities include police, fire, emergency medical services (EMS), and emergency operations centers (EOC). The county has a highly coordinated and interconnected network of emergency facilities and services at the county and municipal level. The Burlington County OEM serves as the primary coordinating agency between local, state, and federal agencies. In response to an emergency event, the Burlington County OEM will work with county and municipal health agencies and healthcare providers, emergency facilities and the County Sheriff's Office to provide aid to residents of the county.

Each municipality is responsible for maintaining its own fire department; however, not every municipality maintains their own police department or emergency medical services facility. All municipalities except Bass River Township, Hainesport Township, Shamong Township, Southampton Township, Tabernacle Township, Woodland Township, and Wrightstown Borough maintain their own police department and those who do not are covered by the State Police. The Burlington County Sheriff's Office and NJ State Police also provide emergency support to the municipalities. The City of Beverly, Bordentown City, Burlington City, Chesterfield Township, Cinnaminson Township, Delanco Township, Delran Township, Eastampton Township, Evesham Township, Florence Township, Hainesport Township, Lumberton Township, Mansfield Township, Maple Shade Township, Medford Township, Moorestown Township, Mount Holly Township, Mount Laurel Township, New Hanover Township, North Hanover Township, Palmyra Borough, Pemberton Township, Shamong Township, Southampton Township, Springfield Township, Tabernacle Township, Washington Township, Westampton

Township, Willingboro Township, and Woodland Township maintain their own EMS facilities and provide support to surrounding municipalities.

Overall, there are 44 local, county, and state law enforcement facilities, 134 fire and EMS facilities, and 38 EOCs in Burlington County. The EOC total includes all municipal halls, fire departments, department of public work buildings and others that were identified as EOCs by the municipalities.

Hospital and Medical Facilities

Burlington County has a dynamic health care industry that includes hospitals, rehabilitation centers, and behavioral health facilities. There are 12 medical facilities located in Burlington County.

Senior Care and Living Facilities

It is important to identify and account for senior facilities, as their residents are highly vulnerable to the potential impacts of disasters. Understanding the location and numbers of these types of facilities can help manage an effective response post disaster. There are 76 senior facilities located within the county. Figure 4-22 shows the location of senior facilities in Burlington County.

Government Buildings

In addition to the facilities discussed, other county and municipal buildings, and department of public works facilities are essential to the continuity of operations pre-, during and post-disaster. There are 38 government facilities located in the county. In addition to these 40 facilities, the majority of the EOCs discussed above are local municipal buildings. Figure 4-22 shows the location of government buildings in Burlington County.

Schools

There are 245 schools, ranging from elementary to post-secondary education, which service the county. Several municipalities throughout the county have their own school systems, while other municipalities are served by regional school districts. In addition to the number of public schools throughout the county, there are a number of private education facilities. Figure 4-23 show the location of schools in Burlington County.

Shelters

There were 153 shelters identified within Burlington County; many schools, community centers, and municipal buildings could serve as a shelter during an emergency. Figure 4-23 show the location of shelters in Burlington County.

Figure 4-22. Essential Facilities in Burlington County

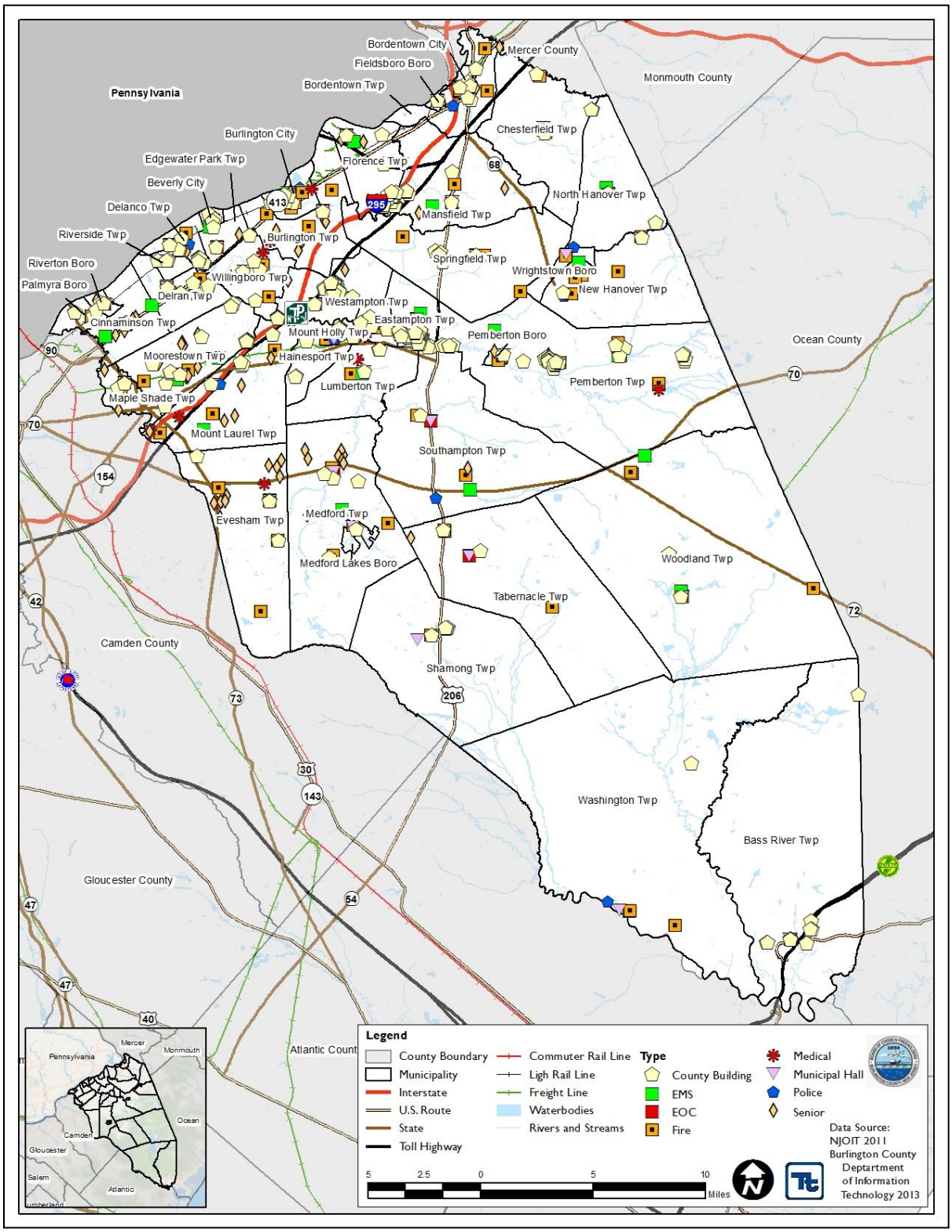
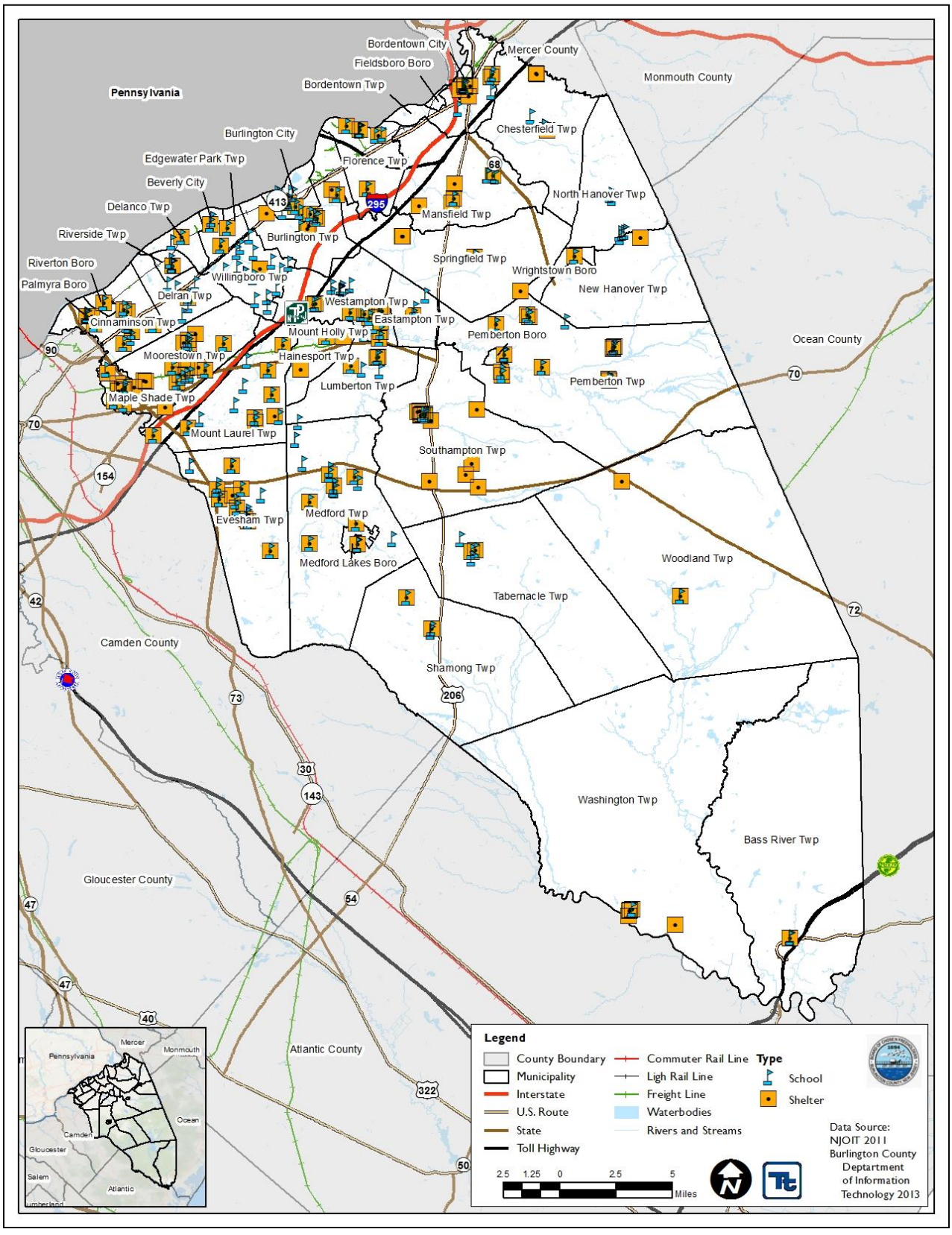


Figure 4-23. Schools and Shelters in Burlington County



4.6.2 Transportation Systems

Transportation plays an important role in Burlington County. This section presents available inventory data for roadways, airports, railways and other transportation systems in Burlington County. Figure 4-24 shows regional transportation lifelines serving the County.

Highway, Roadways and Associated Systems

Interstates 295 and 95 are the major north-south routes that pass through the County. These routes are vital northeast corridors which connect major cities of the east coast. Additionally, a small portion of Interstate 276 connects Interstates 95 and 295 to northern Philadelphia and the Pennsylvania Turnpike's Northeast Extension. Along the eastern edge of the County the Garden State Parkway (US Route 9), another north-south route passes through the County. The Garden State Parkway extends from New York to the tip of Cape May County. This route is one of only two routes in the US with a ferry, as the Cape May-Lewes Ferry connects Cape May to Lewes, Delaware. Other important routes in Burlington County are U.S. Route 206 (north-south), U.S. Route 130 (north-south), NJ Route 70 (east-west), and NJ Route 72 (east-west).

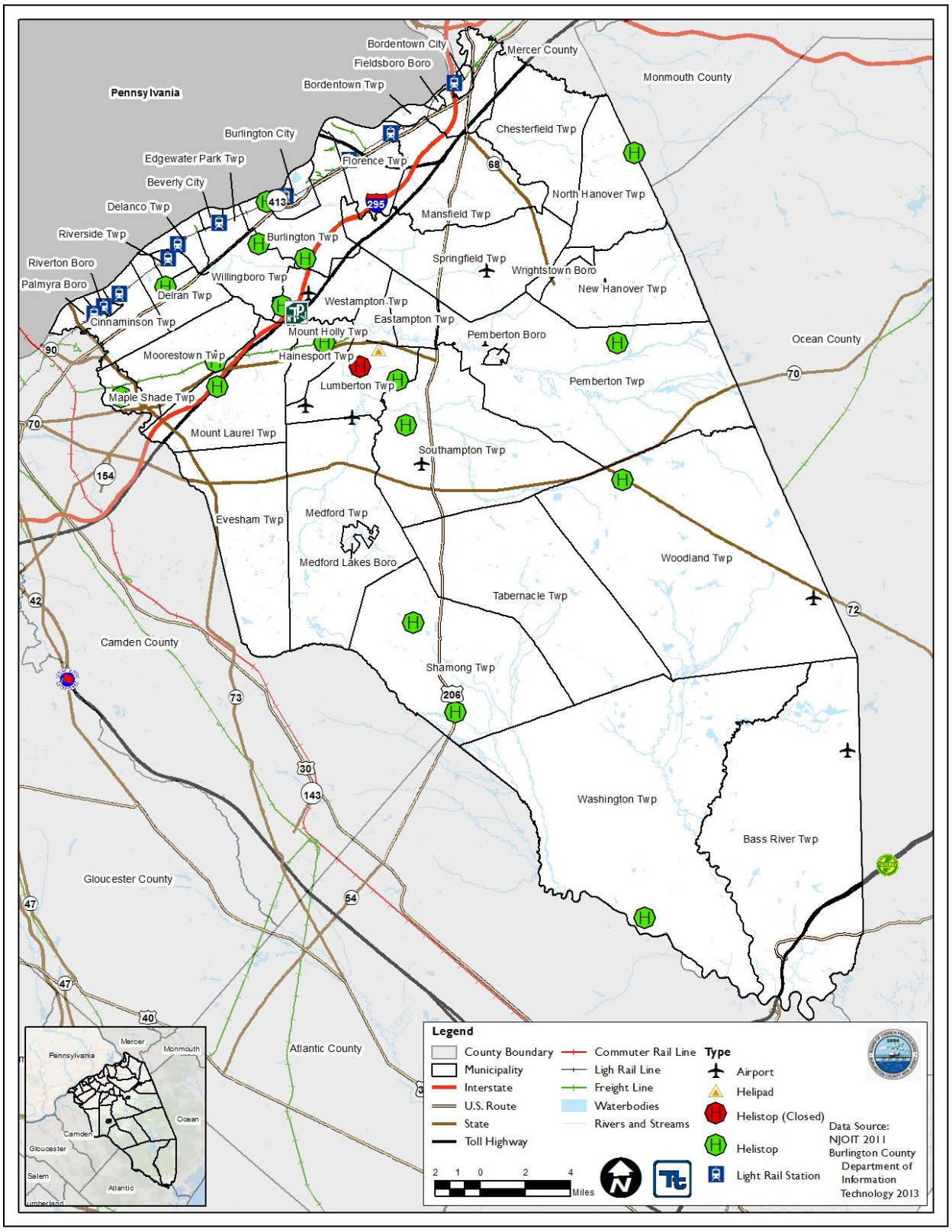
Air

There were 28 air facilities identified within the County. These facilities include both airports and heliports which are utilized for public, private, medical, and military purposes.

Public Transportation

Burlington County is served primarily by New Jersey Transit bus and rail lines. The NJ Transit River Line connects to Amtrak's Northeast Corridor at Trenton and to PATCO which connects Philadelphia to Camden. These lines provide the connection between Burlington County and other major cities such as Washington D.C., Baltimore, MD, Wilmington, DE, Philadelphia, PA, and New York, NY. Rail service extends to points north and south. Table 4-19 lists the river line stations located in the County.

Figure 4-24. Transportation Lifelines in Burlington County



4.6.3 Lifeline Utility Systems

This section presents communication, potable water, wastewater, and energy resource utility system data. Due to heightened security concerns, local utility lifeline data sufficient to complete the analysis have only partially been obtained. Figure 4-25 shows the lifeline utility facilities in Burlington County.

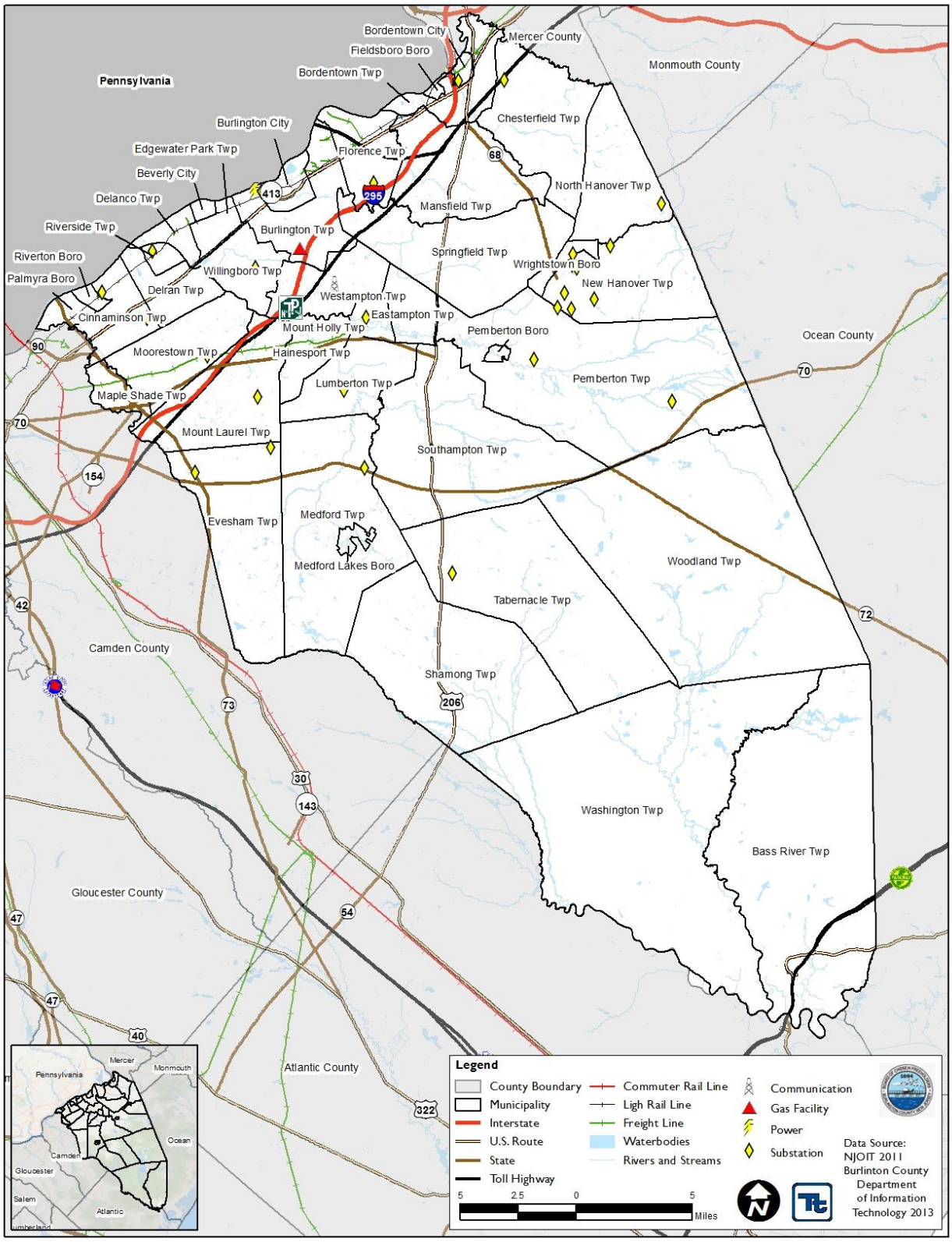
Communication Resources

Burlington County has a Central Communications, which serves as the Public Safety Answering point which dispatches all public safety services throughout the county.

Energy Resources

JCP&L and PSE&G are the primary electric and gas utility companies in Burlington County. In addition, South Jersey Gas provides natural gas service to Burlington County. Verizon is the primary provider of landline service in Burlington County.

Figure 4-25. Lifeline Utility Facilities in Burlington County



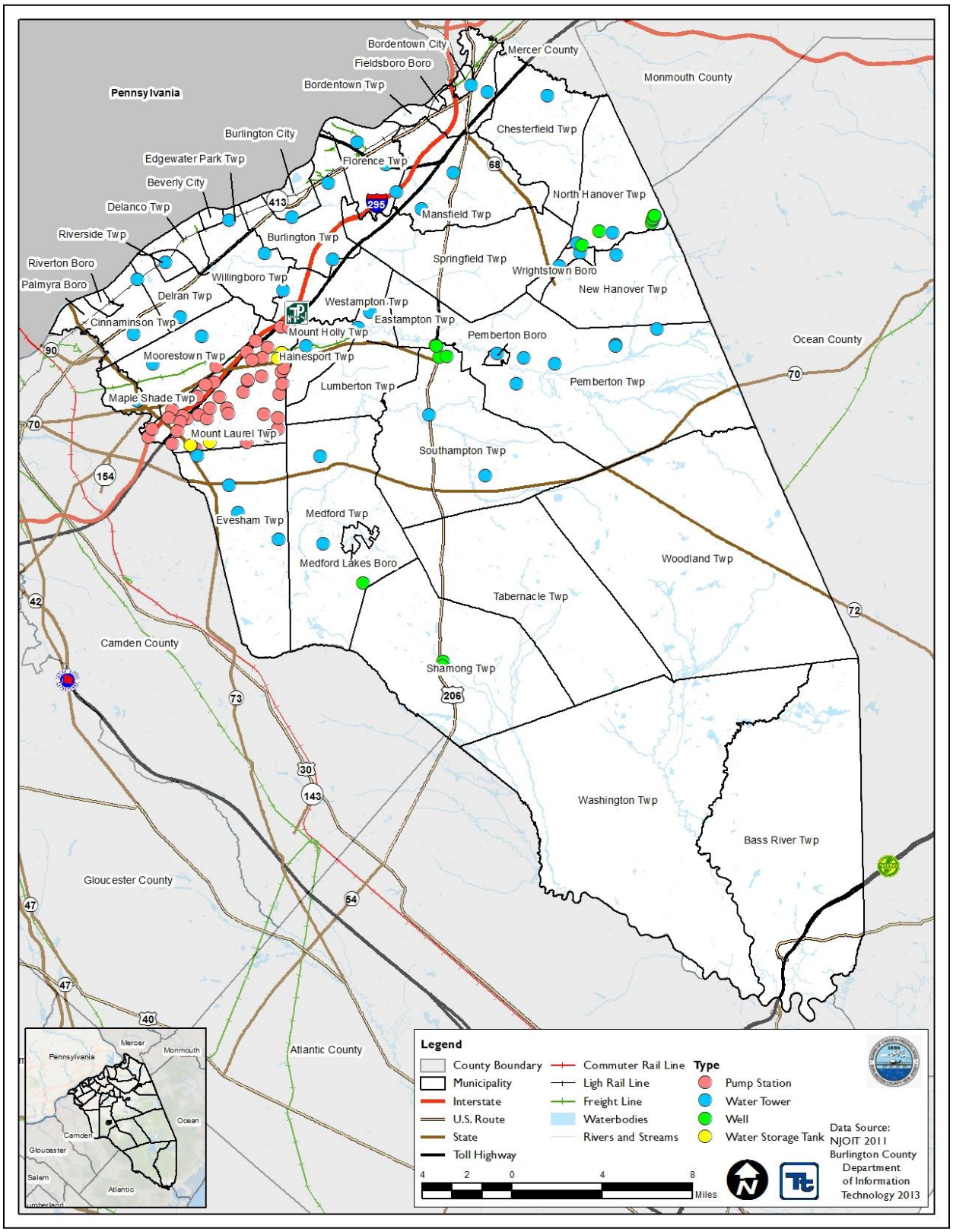
Potable Water

New Jersey American Water (NJAW), serves more than 80,000 people in 20 communities in Burlington County and more than two million people in the Garden State. NJAW's main production facility in the region is the Delaware River Water Treatment Plant (DRWTP), located in Delran. The DRWTP produces an average of 22 million gallons of water per day and serves customers in Burlington, Camden and Gloucester counties. The largest water purveyor in the state, NJAW is a wholly owned subsidiary of American Water, the largest private water services provider in North America. Headquartered in Voorhees, American Water employs approximately 6,900 professionals who provide high quality water, wastewater and other related services to more than 16.2 million people in 32 states and Ontario, Canada (Burlington County Economic Resource Guide, 2008).

Aqua America New Jersey provides drinking water and wastewater services to 150,000 residents in 18 municipalities in nine New Jersey counties (Burlington County Economic Resource Guide, 2008).

Burlington County's water is predominately from surface water sources. Additionally, a small portion of the water supply is well water from well fields distributed throughout the system.

Figure 4-26. Potable Water Facilities in Burlington County



Wastewater Facilities

Table 4-12 lists the wastewater treatment facilities and wastewater pump stations in the County.

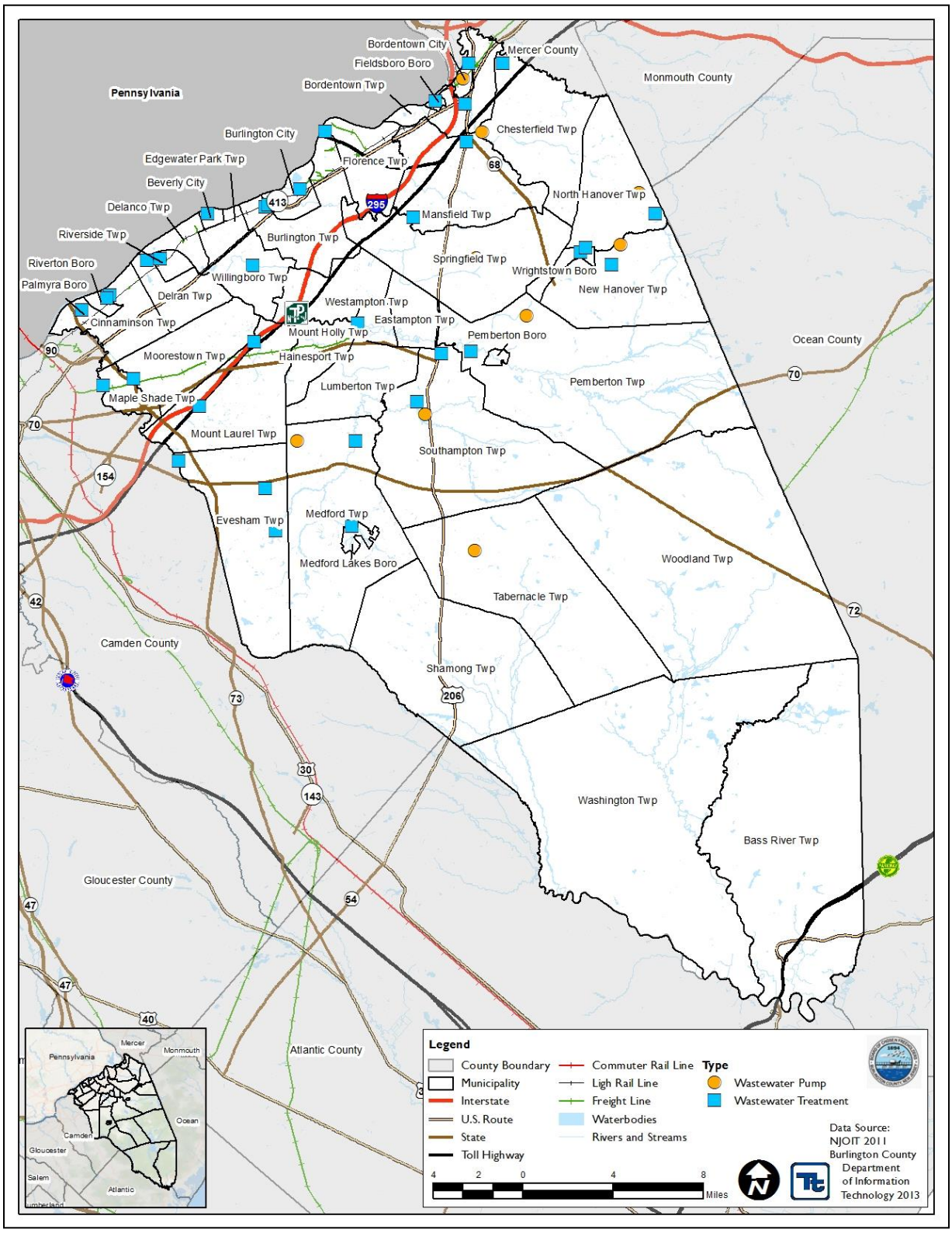
Table 4-12. Burlington County Wastewater Treatment Facilities and Pump Stations

Name	Address	Type	Municipality
Beverly Sewerage Authority	Penn & Magnolia St.	Wastewater Treatment Plant	Beverly (C)
Bordentown Sewerage Authority	Park St.	Wastewater Pump	Bordentown (C)
A.C. Wagner Youth Correctional Institution	Ward Ave	Wastewater Treatment Plant	Bordentown (T)
Bordentown Sewerage Authority	954 Farnsworth Ave	Wastewater Treatment Plant	Bordentown (T)
Bordentown Township Sewage Authority	Off Route 206	Wastewater Treatment Plant	Bordentown (T)
Burlington City Sewerage Authority	601 Pearl St	Wastewater Treatment Plant	Burlington (C)
Common Council Burlington City	900 W Broad St	Wastewater Treatment Plant	Burlington (C)
Central Avenue Sewerage Treatment Plant	31 Central Ave	Wastewater Treatment Plant	Burlington (T)
Olde York Country Club	228 Old York Rd	Wastewater Pump	Chesterfield (T)
Cinnaminson Sewerage Authority	400 North Randolph	Wastewater Treatment Plant	Cinnaminson (T)
Delran Sewerage Authority	Norman Ave	Wastewater Treatment Plant	Delran (T)
Elmwood Sewerage Treatment Plant	260 Elmwood Road North	Wastewater Treatment Plant	Evesham (T)
Kings Grant Sewerage Treatment Plant	791 Barton Run Blvd	Wastewater Treatment Plant	Evesham (T)
Woodstream Sewerage Treatment Plant	355 Brandywine Dr	Wastewater Treatment Plant	Evesham (T)
Fieldsboro Sewerage Treatment Plant	203 Delaware St.	Wastewater Treatment Plant	Fieldsboro (B)
Florence Sewerage Treatment Plant	Front St West	Wastewater Treatment Plant	Florence (T)
Homestead Utility Company	14A Wagon Wheel Lane	Wastewater Treatment Plant	Mansfield (T)
National Auto Dealers Exchange	155 Aaronson Rd	Wastewater Treatment Plant	Mansfield (T)
Maple Shade Sewerage Treatment Plant	438 W Park Ave	Wastewater Treatment Plant	Maple Shade (T)
Medford Water Pollution Control	10 Fostertown Rd	Wastewater Treatment Plant	Medford (T)
Medford Lakes Sewerage Treatment Plant	14 Stokes Rd	Wastewater Treatment Plant	Medford Lakes (B)
Moorestown Township Sewerage Treatment Plant	N Lenola Rd	Wastewater Treatment Plant	Moorestown (T)
Mount Holly Municipal Utility Authority	300 Rancocas Road	Wastewater Treatment Plant	Mount Holly (T)
Mount Laurel Municipal Utilities Authority	Elbo Lane	Wastewater Treatment Plant	Mount Laurel (T)
Sanitary Sewer Treatment	Pike Rd (Along I 295)	Wastewater Treatment Plant	Mount Laurel (T)
Executive Days Inn	121 Walnut St	Wastewater Pump	New Hanover (T)
Hanover Mobile Home Park	202 Jacobstown-New Egypt Rd.	Wastewater Pump	North Hanover (T)
California Village Mobile Home Park	181 Cookstown-New Egypt Rd	Wastewater Treatment Plant	North Hanover (T)
Spartan Village Mobile Home Park	Wrightstown-Sykesville	Wastewater Treatment Plant	North Hanover (T)
Palmyra Sewerage Treatment Plant	Firth Lane	Wastewater Treatment Plant	Palmyra (B)
Helen Fort Middle School	301 Fort Dix Rd	Wastewater Pump	Pemberton (T)

Name	Address	Type	Municipality
Pemberton Township Municipal Utilities Authority	500 Pemberton Browns Mill Rd	Wastewater Treatment Plant	Pemberton (T)
US Army Fort Dix/McGuire Air Force Base	5318 Delaware Ave	Wastewater Treatment Plant	Pemberton (T)
Riverside Sewerage Treatment Plant	301 American Legion Dr.	Wastewater Treatment Plant	Riverside (T)
Riverton Sewerage Treatment Plant	River Bank	Wastewater Treatment Plant	Riverton (B)
Upper Elementary	2101 Route 206	Wastewater Pump	Southampton (T)
Mobile Estates of Southampton	2362 Route 206	Wastewater Treatment Plant	Southampton (T)
Pinelands Sewer Company	117 Newbolds Corner Road	Wastewater Treatment Plant	Southampton (T)
Springfield School Sewerage Treatment Plant	2146 Jacks Jobstown Rd	Wastewater Pump	Springfield (T)
Lenape High School	115 Church Rd	Wastewater Pump	Tabernacle (T)
Tabernacle Middle School	132 New Street	Wastewater Pump	Tabernacle (T)
Willingboro Municipal Sewerage Treatment Plant	58 Meribrook Circle	Wastewater Treatment Plant	Willingsboro (T)
Wrightstown Municipal Utilities Authority	70A Martha Ave	Wastewater Treatment Plant	Wrightstown (B)

Source: Burlington County Department of Information Technology

Figure 4-27. Wastewater Service Areas, Infrastructure and Facilities in Burlington County



Source: Burlington County Department of Information Technology

4.6.4 High-Potential Loss Facilities

High-potential loss facilities include dams, levees, hazardous materials facilities (HAZMAT), nuclear power plants and military installations. No nuclear power plants or military installations were identified in the County. Dams, levees and HAZMAT facilities are discussed below.

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. Dam must also meet the requirements of a Class IV dam above.

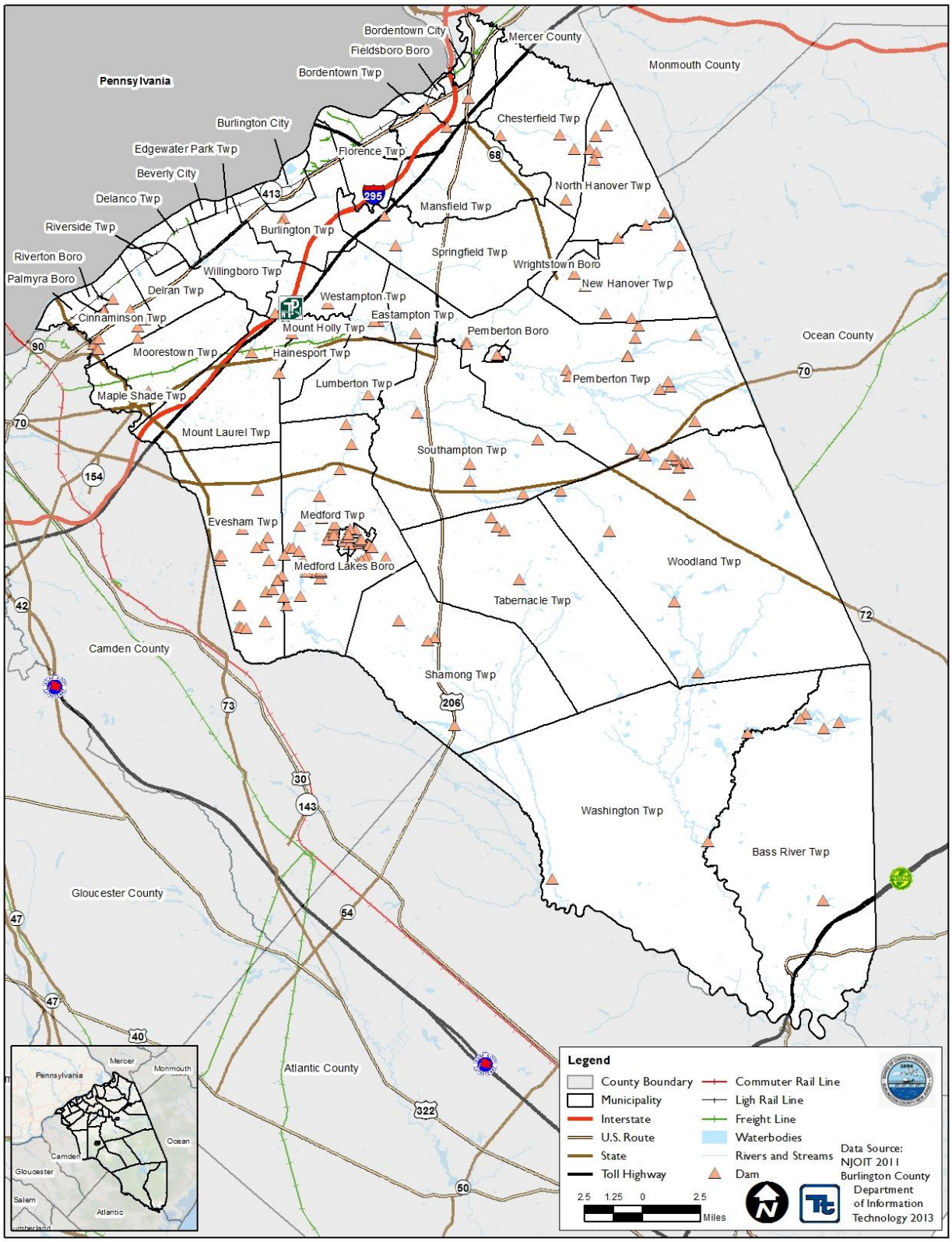
According to the NJDEP Bureau of Dam Safety, the following dams and their classifications are located in Burlington County (Table 4-25). Nine dams have an undefined hazard classification. Figure 4-24 illustrates the locations of these dams.

Table 4-13. Dams in Burlington County

County	Total Count	Class I	Class II	Class III	Class IV
Burlington	139	12	37	53	28

Source: Burlington County Department of Information Technologies

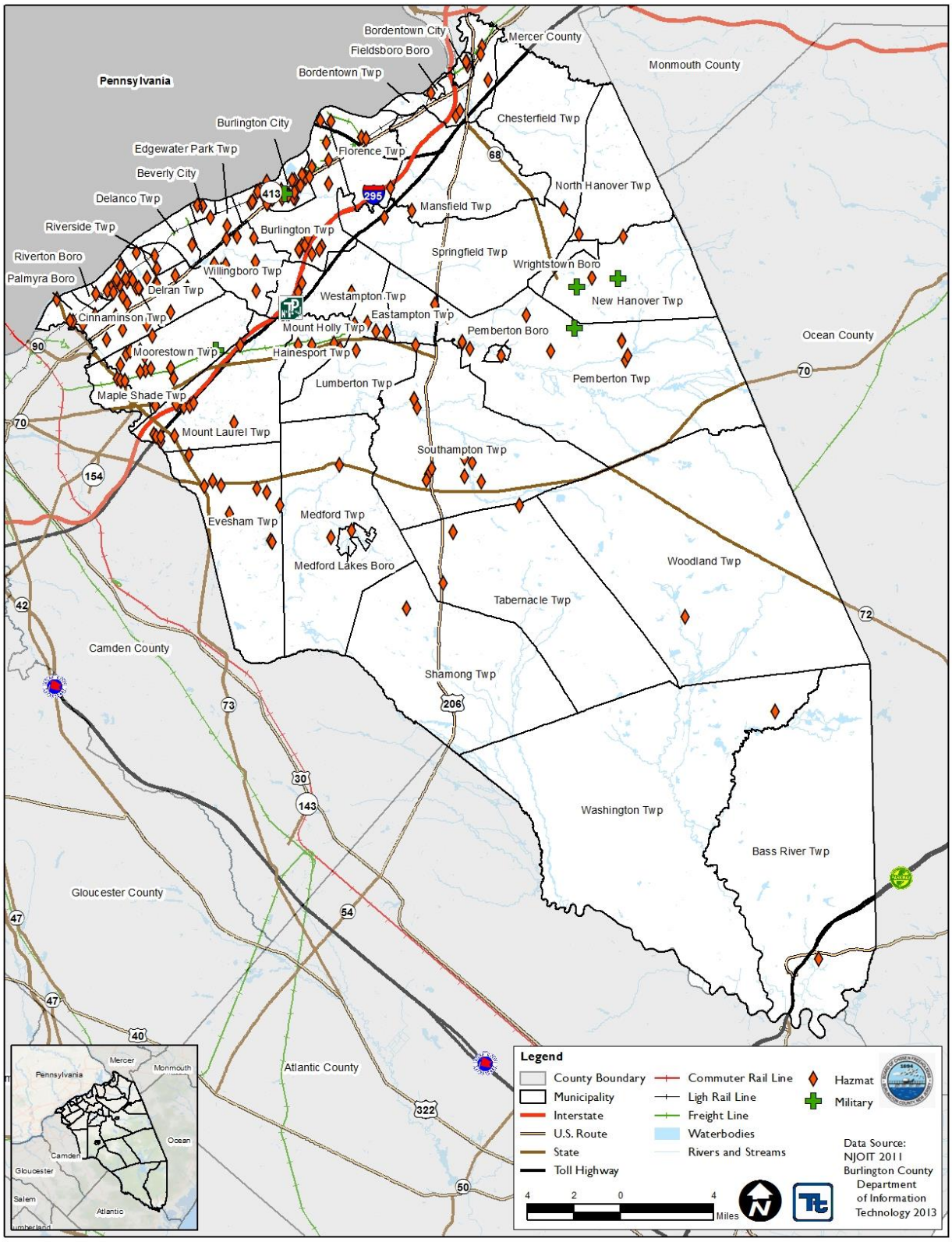
Figure 4-28. Dams in Burlington County



HAZMAT Facilities

The U.S. Environmental Protection Agency's (EPA) 2016 Toxics Release Inventory (TRI) database indicates there are 20 TRI facilities in Burlington County. TRI facilities are those required to report on chemical storage and use based on particular volumes of specified chemicals stored and used (USEPA, 2017). NJDEP Bureau of Release Prevention identifies facilities in the County where an extraordinarily hazardous substance may be present or generated above regulatory levels that are subject to the Toxic Catastrophe Prevention Act, (N.J.S.A. 13:1K-19 et seq.) and the regulations arising from the Act as codified in N.J.A.C. 7:31 (NJDEP, 2018).

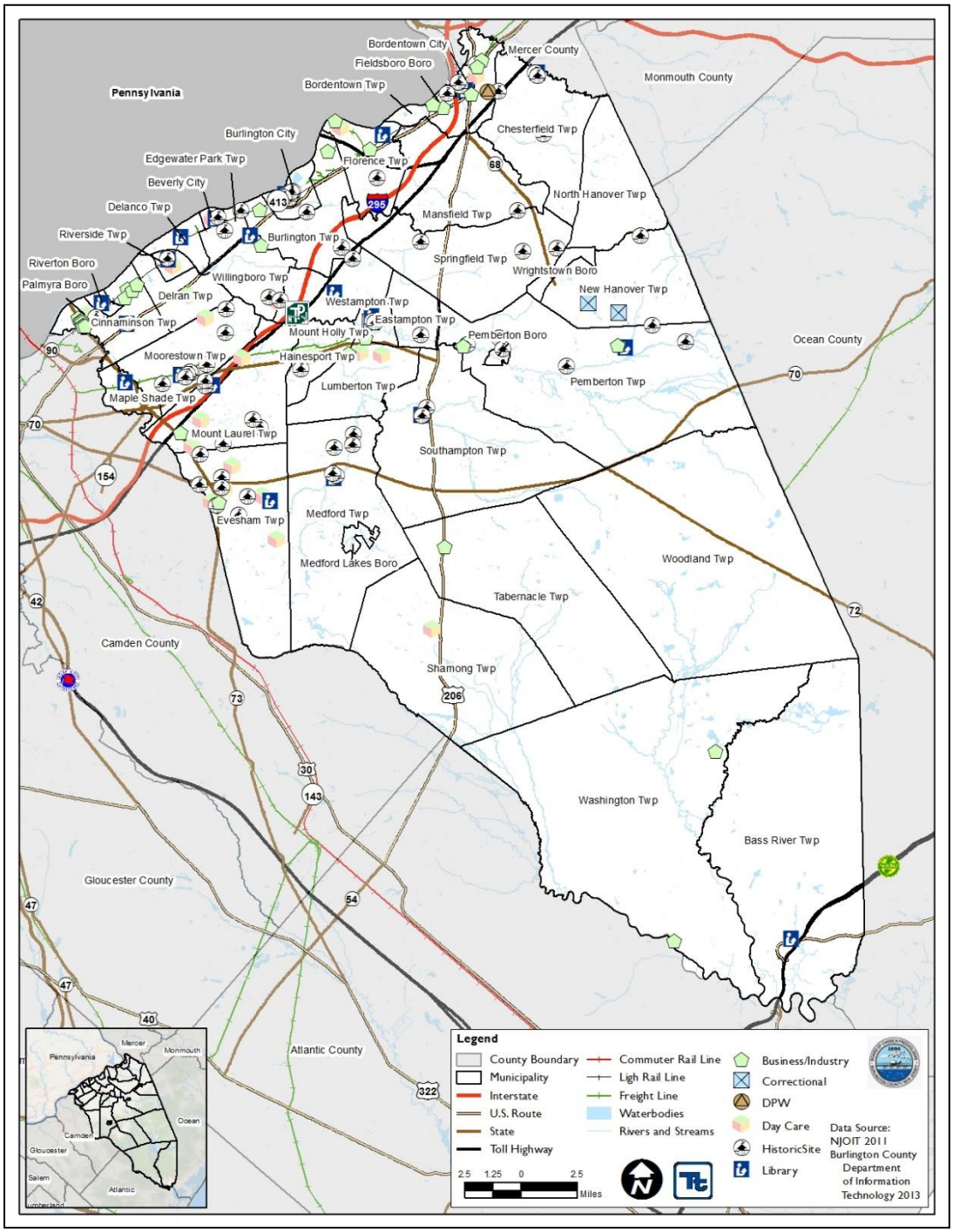
Figure 4-29. High-Potential Loss Facilities in Burlington County



4.6.5 Other Facilities

The Planning Committee identified additional facilities (user-defined facilities) as critical including municipal buildings and dialysis centers. These facilities were included in the risk assessment conducted for the County. Figure 4-30 illustrates the locations of these facilities. These facilities have been incorporated into the Burlington County inventory and the hazard analyses performed for this plan.

Figure 4-30. User Defined Facilities in Burlington County



SECTION 5 RISK ASSESSMENT

Risk, for the purpose of hazard mitigation planning, is the potential for damage, loss or other impacts created by the interaction of hazards with community assets. A risk assessment provides the foundation for the community's decision-makers to evaluate mitigation measures that can help reduce the impacts of a hazard when one occurs (Sections 6 and 9). The process focuses on the following:

Risk Assessment

✓ *The process of measuring the potential for damage or loss caused by the interaction of hazards with community assets such as people, buildings, infrastructure, the economy and/or the environment.*

Step 1: The first step of the risk assessment process is to identify the hazards of concern. FEMA's current regulations only require an evaluation of natural hazards. Natural hazards are natural events that threaten lives, property, and many other assets. Often, natural hazards can be predicted, where they tend to occur repeatedly in the same geographical locations because they are related to weather patterns or physical characteristics of an area. The identified hazards of concern for Burlington County are presented in Section 5.1

Step 2: The next step of the risk assessment is to prepare a profile for each hazard of concern. These profiles assist communities in evaluating and comparing the hazards that can impact their area. Each type of hazard has unique characteristics that vary from event to event. The profile for each hazard is presented in Section 5.4 and is organized as follows:

- Identify and describe hazards
- Location of the hazards and areas vulnerable to damage
- Extent (i.e. strength or magnitude) of hazard
- Previous occurrences of hazard
- Probability of future hazard events, including changes in weather patterns and climate

Step 3: To understand risk, a community must evaluate what assets it possesses and which assets are exposed or vulnerable to the identified hazards of concern. Hazard profile information combined with data regarding population, demographics, general building stock, and critical facilities at risk, located in Section 4, prepares the community to develop risk scenarios and estimate potential damages and losses for each hazard. The vulnerability assessment methodology and assets evaluated are described in Section 5.2 and the results are presented in Section 5.4.

Step 4: To summarize vulnerability, each community can rank the identified hazards based on factors related to the risks faced. These risk factors include the probability of occurrence and impacts. The hazard ranking methodology and results are presented in Section 5.3.

5.1 IDENTIFICATION OF HAZARDS OF CONCERN

2019 HMP UPDATE CHANGES

- The identification of hazards of concern for the 2019 HMP update incorporates the best available data used to develop the hazard profiles.

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.

To provide a strong foundation for mitigation strategies considered in Section 6, Burlington 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. The natural hazard of concern identification process incorporated input from the county and participating jurisdictions; review of the 2014 NJ HMP and previous hazard identification efforts; research of 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 5.2-1 documents the process of identifying the natural hazards of concern for further profiling and evaluation.

For the purposes of this planning effort, the Steering Committee chose to group some natural hazards together, based on the similarity of hazard events, their typical concurrence or their impacts, consideration of how hazards have been grouped in FEMA guidance documents (*FEMA 386-1, Understanding Your Risks, Identifying Hazards and Estimating Losses*; FEMA's *Multi-Hazard Identification and Risk Assessment – The Cornerstone of the National Mitigation Strategy*), and consideration of hazard grouping in the 2014 NJ HMP. A summary of the new groupings and changes is provided below.

The "Flood" hazard includes riverine (inland) flooding, ice jams, and dam failure. Inclusion of the various forms of flooding under a general "Flood" hazard is consistent with that used in FEMA's *Multi-Hazard Identification and Risk Assessment* guidance.

The "Severe Weather" hazard includes tropical cyclones (hurricanes, tropical storms, and tropical depressions), extra-tropical cyclones (Nor'Easters), and windstorms that often entail a variety of other influencing weather conditions including thunderstorms, hail, lightning, extreme temperatures, tornadoes.

The "Severe Winter Weather" hazard includes heavy snowfall, blizzards, freezing rain/sleet, and ice storms. This grouping is consistent with that used in the 2014 NJ HMP.

The "Landslides" hazard includes landslides, land subsidence, and sinkholes. This grouping is consistent with that used in the 2014 NJ HMP "Geological" hazard profile.

Table 5.1-1. Identification of Hazards of Concern for Burlington County

Hazard	Is this a hazard that may occur in Burlington County?	If yes, does this hazard pose a significant threat to Burlington County?	Why was this determination made?	Source(s)
Avalanche	No	No	• The 2014 NJ HMP does not identify avalanche as a hazard of concern for New Jersey. • The topography and climate of Burlington 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 National Avalanche Center-American Avalanche Association (NAC-AAA) between 1950 and 2018.	• 2014 NJ HMP • Review of NAC-AAA database between 1998 and 2018 • Steering and Planning Committee Input
Coastal Erosion	Yes	Yes	• The NJ HMP identifies coastal erosion as a hazard of concern for NJ. Counties bounded by coastal waters are most affected by coastal erosion. • A portion of Burlington County is located within the CAFRA area (Township of Bass River). Coastal erosion may occur because it is tidally influenced. A majority of the County is located along the Delaware River where it is densely populated and in some areas, heavily industrialized. • The Planning Committee identified coastal erosion as a significant concern affecting several municipalities within the County	• NJ HMP • Planning Committee Input
Drought	Yes	Yes	• The NJ HMP identifies drought as a hazard of concern for New Jersey. The NJHMP indicated that Burlington County experienced drought events during the following time periods: o March 1995 o December 1998 o January 1999 o July-September 1999 o November-December 2001 o January-July 2002 o September - October 2002 o September 2005 o May-July 2006 • Burlington County is located in the Southern Climate Divisions. Periods of severe and/or extreme drought in this division includes: o January-February 1931 o May 1965-August 1966 o March-June 1985 o November-December 1998 o July-September 2002 o August-September 2010	• NJ HMP • FEMA • NRCC • Planning Committee Input

Table 5.1-1. Identification of Hazards of Concern for Burlington County

Hazard	Is this a hazard that may occur in Burlington County?	If yes, does this hazard pose a significant threat to Burlington County?	Why was this determination made?	Source(s)
			• Burlington County has been included in one FEMA Disaster Declaration for a drought event: o FEMA-EM-3083 – Water Shortage – October 1980	
Earthquake	Yes	Yes	• The NJ HMP identifies earthquake as a hazard of concern for NJ. 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 2012, there have been 179 earthquakes with epicenters in New Jersey. Of those 179 earthquakes, eight had epicenters in Burlington County. • According to the USGS seismic hazard maps, the PGA with a 10% probability of exceedance over 50 years for Burlington County is between 2%g and 4%g. FEMA's How-To Guide recommends that earthquakes be considered for further evaluation in the planning process in areas where the PGA is over 2%g.	• NJ HMP • FEMA • NJGWS • USGS • NJDEP • Planning Committee Input
Expansive Soils	No	No	• The NJ HMP does not identify expansive soils as a hazard of concern for NJ. • USGS indicated that in Burlington County, 50% or less of the soils consist of clay that has slight to moderate potential of swelling, with some areas underlain by soils with little to no clays with swelling potential.	• NJ HMP • Review of USGS 1989 Swelling Clays Map of the Conterminous United States. • Planning Committee Input
Extreme Temperature	Yes	Yes	Please see Severe Weather	
Flood (Riverine, Flash, Coastal and Dam Flooding)	Yes	Yes	• The NJ HMP stated that flooding is NJ's most common major natural hazard. Between 2010 and 2012, 413 floods were recorded in New Jersey (according to NOAA-NCEI) that resulted in over $21.8 billion in property damage. • Burlington County has been issued five FEMA Disaster Declarations for flooding associated with various storm events (severe storms, snowstorm, severe winter storm). These events include the following: o FEMA-DR-1530 – Severe Storms and Flooding – July 2004 o FEMA-DR-1694 – Severe Storms and Flooding – April 2007 o FEMA-DR-1873 – Snowstorm – February 2010 o FEMA-DR-1889 - Severe Winter Storm and Snowstorm – March 2010 o FEMA-DR-1897 – Severe Storms and Flooding – April 2010 o FEMA-DR-4086, EM-3354 – Hurricane Sandy – October -2012 o FEMA DR-4231 – Severe Storm – June 2015	• NJ HMP • FEMA • NOAA – NCDC • Burlington County GIS • Planning Committee Input

Table 5.1-1. Identification of Hazards of Concern for Burlington County

Hazard	Is this a hazard that may occur in Burlington County?	If yes, does this hazard pose a significant threat to Burlington County?	Why was this determination made?	Source(s)
			○ FEMA DR-4264 – Severe Winter Storm and Snowstorm – January 2016 • Approximately 16.9% of Burlington County's total area is located in an A-Zone (88,574 acres); less than 1% in the V-Zone (1,297 acres); and 18.4% in a 500-year flood area (96,372 acres). • According to NOAA NCEI storm database, between 2013 and 2018, Burlington County experienced 23 flood events.	
Hailstorm	Yes	Yes	Please see Severe Storm	
Hurricane (and other Tropical Cyclones)	Yes	Yes	Please see Severe Storm and Flood	
Ice Jams	Yes	No	Please see Flood	
Ice Storm	Yes	Yes	Please see Severe Winter Storm	
Infestation	Yes	No	• The NJ HMP does not identify infestation as a hazard of concern for the State of New Jersey. • Some infestations of ticks, mosquitoes, gypsy moth and/or other types of pest may be present in the County and with the right combination of gypsy moth infestation and forest fire conditions, a potential risk may exist for residential areas. However, no sources indicate that this is a major hazard of concern across the County.	
Land Subsidence	Yes	Yes	Please see Landslide	
Landslide	Yes	Yes	• The NJ HMP identifies landslide as a hazard of concern for NJ. • NJ HMP indicates NJ is vulnerable to land subsidence; the soil collapse sinkhole is the most concerned type of sinkhole for NJ. • USGS indicates within the National Atlas Map Maker program that the County has a moderate susceptibility/low incidence to landslides along the northwestern most edge, and low incidence (or less than 1.5% of the area is susceptible) throughout the remainder of the County. • NJGWS provides four recorded landslides within Burlington County: ○ May 4, 1893 – Debris flow due to heavy rain in Bordentown Township ○ Unknown Date – Debris flow due to heavy rain in Bordentown Township ○ Unknown Date – Debris flow due to quarrying in Burlington Township ○ Unknown Date – Debris flow due to heavy rain in Southampton Township	• NJ HMP • NJGWS • NationalAtlas.gov (USGS) • Planning Committee Input
Nor'Easters	Yes	Yes	Please see Severe Winter Storm and Flood	
Severe Storm (Windstorms, Thunderstorms,	Yes	Yes	• NJ HMP identifies thunderstorms, lightning, tornadoes, hurricanes and extreme winds as hazards of concern for NJ.	• NJ HMP • FEMA • SPC

Table 5.1-1. Identification of Hazards of Concern for Burlington County

Hazard	Is this a hazard that may occur in Burlington County?	If yes, does this hazard pose a significant threat to Burlington County?	Why was this determination made?	Source(s)
Hail, Lightning, Tornados and Hurricanes)			• Burlington County has been issued eight FEMA Disaster Declarations for severe storm-related events (flooding and hurricane). These events include the following: o FEMA-EM-3148 – Hurricane Floyd – September 1999 o FEMA-DR-1530 – Severe Storms and Flooding – July 2004 o FEMA-DR-1694 – Severe Storms and Inland/Coastal Flooding – April 2007 o FEMA-DR-1897 – Severe Storms and Flooding – March-April 2010 o FEMA-DR-4021 – Hurricane Irene – August-September 2011 o FEMA-DR-4086 – Hurricane Sandy – October 2012 o FEMA-DR-4231 – Severe Storm – June 2015 • The NOAA-NCEI Storm Events Database indicated that between 1950 and 2018, Burlington County experienced 15 tornadoes. • The NJ HMP identifies extreme heat as a hazard of concern for NJ citing 61 extreme heat events between 1950 and 2009. The NJ HMP also identifies extreme cold as a hazard of concern for NJ.	• ONJSC • Planning Committee Input
Severe Winter Storm (Heavy Snow, Blizzards, Freezing Rain/Sleet, Nor'Easters, Ice Storms)	Yes	Yes	• NJ HMP indicates winter storms are significant hazards that impact NJ. • ONJSC indicated that normal seasonal snowfall for Burlington County ranges from 14.4 inches to 21.8 inches. • Burlington County has been issued five FEMA Disaster Declarations for winter storm-related events (severe blizzard, snow, snowstorm, and severe winter storm). These events include the following: o FEMA-EM-3106 – Severe Blizzard – March 1993 o FEMA-EM-3181 – Snow – February 2003 o FEMA-DR-1873 – Snowstorm – December 2009 o FEMA-DR-1889 – Severe Winter Storm and Snowstorm – February 2010 o FEMA-DR-1954 – Severe Winter Storm and Snowstorm – December 2010 o FEMA-DR-4262 – Severe Winter Storm – January 2016 • The NOAA-NCEI Storm Events Database indicated that between 2013 and 2018, Burlington County experienced 58 winter storm events (heavy snow, winter weather, and winter storm).	• NJ HMP • ONJSC • NWS • FEMA • NOAA-NCEI • Planning Committee Input
Tornado	Yes	Yes	Please see Severe Storm	
Tsunami	Yes	No	• The NJ HMP does not identify tsunami as a hazard of concern for NJ; however, tsunamis are discussed and it is indicated that that there is no record of the generation of a catastrophic Atlantic Basin tsunami that has impacted the mid-Atlantic coastline. • Over the past 200 years, the Atlantic and Gulf Coasts have experienced very few tsunamis. The probability of a large tsunami impacting the coastal areas of New Jersey is believed to be small; however, earthquake activity along the Mid-Atlantic Ridge is	• NJ HMP • NOAA / WDS • Planning Committee Input

Table 5.1-1. Identification of Hazards of Concern for Burlington County

Hazard	Is this a hazard that may occur in Burlington County?	If yes, does this hazard pose a significant threat to Burlington County?	Why was this determination made?	Source(s)
			recognized as having the potential to pose some level of tsunami risk to the Atlantic seaboard. • NOAA/WDS Tsunami Event Database did not indicate any tsunami or tsunami-like events that impacted Burlington County. • Burlington County is bounded by coastal waters in the southeastern portion of the County. Although the County is mostly shielded by barrier islands, the impacts from a tsunami could flow in through one of the inlets and up the Mullica River. However, the probability of a large tsunami impacting the coast of New Jersey and Burlington County is very small.	
Volcano	No	No	• The NJ HMP does not identify volcano as a hazard of concern for the State of New Jersey or its counties and jurisdictions.	• NJ HMP • Planning Committee Input
Wildfire	Yes	Yes	• Wildfires are not an uncommon occurrence in NJ, especially in the Pine Barrens. Fires which burn more than 1,000 acres occur, on average, once every 10 years in the Pine Barrens. In May 2007, a wildfire along the border of Ocean and Burlington Counties burned more than 12,000 acres (~19 square miles). • Between 1929 and 2006, there were 2,233 wildfire incidents in Burlington County. They burned over 42,000 acres and destroyed 831 acres. • In Burlington County, over 195 square miles are located within the extreme wildfire fuel hazard area; over 11 square miles in the very high area; over 106 square miles in the high area; over 86 square miles in the moderate area; and over 165 square miles in the low. • According to the NOAA-NCEI, a total of seven wildfires have occurred in Burlington County between 20013 and 2018.	• NJ HMP • NJFFS • NOAA-NCEI
Windstorm	Yes	Yes	Please see Severe Storm	

DR *Presidential Disaster Declaration Number*
FEMA *Federal Emergency Management Agency*
HMP *Hazard Mitigation Plan*
NAC-AAA *National Avalanche Center-American Avalanche Association*
NCEI *National Centers for Environmental Information*
NFIP *National Flood Insurance Program*
NJ *New Jersey*
NJDEP *New Jersey Department of Environmental Protection*
NJDOH *New Jersey Department of Health*
NJFFS *New Jersey Forest Fire Service*
NJGWS *New Jersey Geological and Water Survey*
NJ HMP *State of New Jersey Hazard Mitigation Plan*
NJOEM *New Jersey Office of Emergency Management*
NRCC *Northeast Regional Climate Center*
NOAA *National Oceanic and Atmospheric Administration*
ONJSC *Office of the New Jersey State Climatologist*
SPC *Storm Prediction Center*
USDA *U.S. Department of Agriculture*
USGS *U.S. Geological Survey*

According to input from the County, and review of all available resources, a total of 8 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
- Drought
- Earthquake
- Flooding (including dam failure and ice jams)
- Landslide (including subsidence/sinkholes)
- Severe Weather (Tropical Cyclones, Nor'easters, High Winds, Tornadoes, Thunderstorms, Hail, Extreme Temperatures)
- Severe Winter Weather (Heavy Snow, Blizzards, Ice Storms)
- Wildfire

Other natural and human-caused hazards of concern have occurred within Burlington 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 HMP updates.

5.2 METHODOLOGY AND TOOLS

2019 HMP Update Changes

General Building Stock and Critical Facilities

- Updated general building stock used:
  - Updated building footprints provided by the Burlington County Department of Information Technology were used.
  - RS Means 2018 building valuations were used to estimate replacement cost value for each building in the inventory.
- Updated critical facility inventory used:
  - Burlington County Department of Information Technology provided updated critical facility inventories that were used to generate the final inventory used.

Hazard-Specific Changes

- Earthquake
  - An updated version of FEMA's HAZUS-MH earthquake module (version 4.0) was used to estimate potential losses. The latest version of HAZUS-MH has a longer historical record to pull from when generating probabilistic events; therefore, different probabilistic earthquake scenarios were developed by the model for Burlington County for this plan update and the updated potential loss estimates are reported.
- Flood
  - The 2017 effective Burlington County FEMA Digital Flood Insurance Rate Map (DFIRM) was used for this plan in place of the preliminary and advisory DFIRM used in the 2013 HMP.
  - An updated version of FEMA's HAZUS-MH flood module (version 4.0/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 food event. An exposure analysis was conducted for the 0.2-percent annual chance flood event.
- Landslide
  - Areas of steep slopes greater than 15 percent were generated using 2016 USGS 3-meter resolution elevation data to delineate the landslide hazard area.
  - Subsidence and sinkholes were not assessed as part of the 2014 HMP; Burlington County requested the hazard be included in the assessment.
- Severe Storm
  - An updated version of FEMA's HAZUS-MH hurricane module (version 4.0) was used to estimate potential losses. Several changes to the HAZUS-MH model have been implemented since the 2014 HMP including a longer historical record to pull from when generating probabilistic events. Therefore, different probabilistic hurricane wind scenarios were developed by the model for Burlington County for this plan update and the updated potential loss estimates are reported.

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 in subsequent mitigation planning processes, including determining and prioritizing mitigation actions that reduce each jurisdiction'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 process focuses on the following elements:

- **Hazard identification**—Use all available information to determine what types of hazards may affect a jurisdiction

- **Profile each hazard** – Understand each hazard in terms of:
  - 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
- **Assess Vulnerability –**
  - Exposure identification—Estimate the total number of assets in the jurisdiction that are likely to experience a hazard event if it occurs by overlaying hazard maps with the asset inventories.
  - Vulnerability identification and loss estimation—Assess the impact of hazard events on the people, property, environment, economy and lands of the region, including estimates of the cost of potential damage or cost that can be avoided by mitigation.

The following summarizes the asset inventories, methodology and tools used to support the risk assessment process.

5.2.1 Asset Inventories

Burlington County assets were identified to assess potential exposure and loss associated with the hazards of concern. For the HMP update, Burlington 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.

Population

As discussed in Section 4 (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 Burlington County include children, elderly, low-income, the physically or mentally disabled, non-English speakers and the medically or chemically dependent.

The 2010 U.S. Census block data layers were used to estimate exposure and potential impacts to the general population. The 2010 U.S. Census demographic data available in FEMA's Hazus model was used to estimate potential impacts to the elderly (over 65 years of age) and populations with income below the poverty threshold. The 2012-2016 American Community Survey was utilized to examine the residents living with a disability and that are non-English speaking.

U.S. Census blocks do not follow the boundaries of the hazard areas, possibly leading to gross overestimates or underestimates of exposed populations from use of centroids or intersects of Census blocks with these zones. Limitations of these analyses are recognized, and thus the results are used only to provide a general estimate.

Buildings

The general building stock was updated countywide with a custom-building inventory. To develop the building inventory the building footprint spatial layer and parcel information provided by the county and MODIV tax assessor data obtained from the New Jersey Department of the Treasury 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 2018 values; a regional location factor for Burlington County was applied (1.13) for all occupancy classes. 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

The critical facility inventory, which includes essential facilities, utilities, transportation features and user-defined facilities as outlined in Section 4, was updated beginning with all GIS data provided by the Burlington County Department of Information Technology and then reviewed by the Planning Committee allowing for municipal input. To protect individual privacy and the security of assets, information is presented in aggregate, without details about specific individual properties or facilities.

Environment

NJDEP 2012 Land Use/Land Cover spatial data released in February 2015 was used to delineate the areas of forest and wetlands in the County. The data is available for each HUC8 Watershed in the State; the Land Use/Land Cover spatial data for the Crosswicks-Neshaminy, Lower Delaware, and Mullica-Toms watersheds was merged and clipped to the Burlington County boundary in ArcGIS to generate the County's composite Land Use/Land Cover spatial layer. 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 provides data that documents threatened and endangered species habitat for landscape regions in the State. The Piedmont Plains and Pinelands Landscape spatial data were merged and clipped to the Burlington County boundary in ArcGIS to generate the spatial layer of the County's critical habitat areas for endangered species.

New Development

In addition to summarizing the current vulnerability, Burlington County examined recent and anticipated new development that can affect the County's vulnerability to hazards. Identifying these changes and integrating into the risk assessment ensures they are considered when developing the mitigation strategy to reduce these vulnerabilities in the future. An exposure analysis was conducted using anticipated and recent new development provided by each jurisdiction. The development is presented in Section 9, as a table in each annex.

5.2.2 Methodology

To address the requirements of the DMA 2000 and better understand potential vulnerability and losses associated with hazards of concern, Burlington 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.

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 5.2-1. Summary of Risk Assessment Analyses

Hazard	Data Analyzed				
	Population	General Building Stock	Critical Facilities	Environment	New Development
Coastal Erosion	E	E	E	-	E
Drought	Q	Q	Q	Q	Q
Earthquake	H	H	H	-	Q
Flood	E, H	E, H	E, H	E	E
Landslide	E	E	E	-	E
Severe Storm	E, H	E, H	E, H	-	E
Severe Winter Storm	Q	Q	Q	-	Q
Wildfire	E	E	E	-	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 5.2-2 displays the various levels of analyses that can be conducted using the HAZUS-MH software.

Table 5.2-2. 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.

Coastal Erosion

While Burlington County has no open water on the Atlantic Ocean or Delaware Bay, it has two distinct areas that are at risk of shoreline erosion: the western border along the Delaware River and the southeastern portion along Mullica River Great Bay and its tributaries. The coastal boundary of the State of New Jersey encompasses the latter area (NJDEP, 2007; NJDEP, 2002).

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. The average net long-term rate of shoreline change for the New Jersey 'North' region (located from Sandy Hook to south to Little Egg Inlet) was -0.6 meters per year. Meanwhile, the long-term net shoreline change rate in the New Jersey 'South' region (located from Little Egg Inlet south to Cape May Point) is strongly accretional (0.8 meters per year) (USGS 2011).

To estimate risk to long-term coastal erosion for purposes of this assessment, the following shoreline types as defined by NJDEP were used: (1) "beach," which includes waterfront areas composed of 100 percent sand; and (2) "erodible," which includes any soft shoreline other than beach, such as rock, marsh, sea wall or earthen dike. To generate the extent of the estimated coastal erosion hazard area, an erosion rate of 0.6 meters per year was multiplied by 60 to include all structure types and developed/undeveloped areas (annual erosion rate of 0.6 meters x 60 years = 36 meters or approximately 120 feet). Although the 'South' region indicated an average accretion rate, the average rate of erosion of the 'North' region was used as a conservative estimate. Therefore, population, buildings, and infrastructure within 120 feet of the identified beach or erodible shoreline types are identified as potentially vulnerable to 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 2014 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. Miller et al. projects an approximate 2-foot in sea-level rise by 2050 for the State of New Jersey in *A geological perspective on sea-level rise and impacts along the U.S. mid-Atlantic coast* (July 2013, Submitted to Earth's Future). For the purposes of this planning effort, the year 2050 and associated projected 2-foot rise was used as a reasonable and responsible planning horizon.

According to sea-level rise mapping, a 2-foot rise in sea level would impact more than just the CAFRA identified portion of Burlington County. Washington Township along the Mullica River and the City of Burlington would both have significant area that would likely experience flooding. Elsewhere, a 2-foot rise would cause modest shoreline retreat in many tidally impacted rivers.

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.

Drought

To assess the vulnerability of the State to drought and its associated impacts, a qualitative assessment was conducted. The United States Department of Agriculture Census of Agriculture 2012 was used to estimate economic impacts to the County. Information regarding the number of farms, land area in farms, total market value of products sold, etc. was extracted from the report and summarized in the vulnerability assessment. Additional resources from the Center for Disease Control and North Carolina State University were used to assess the potential impacts to the population from a drought event.

Earthquake

A probabilistic assessment was conducted for Burlington County for the 100-, 500- and 2,500-year MRPs through a Level 2 analysis in HAZUS-MH v4.0 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.

NEHRP soil classifications were not available for Burlington County at the time of this analysis. Soils were estimated as NEHRP soil Type D across Burlington County, as a conservative approach to this risk assessment. Groundwater was set at a depth of 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. The model estimated potential losses to buildings at the Census tract level; results are presented by municipalities contained within each Census tract.

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.

Flood

The 1- and 0.2-percent chance flood events were examined to evaluate Burlington County 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 effective Burlington County FEMA Digital Flood Insurance Rate Map (DFIRM) dated December 2017 was used to evaluate exposure and determine potential future losses. A FEMA Risk MAP depth grid for Burlington County generated in 2017 was integrated into the HAZUS-MH v4.0 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 building and critical facility inventories and 2010 U.S. 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 v4.0 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 v4.0 riverine flood model was run to estimate potential losses in Burlington 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 v4.0 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 v4.0 damage functions in the flood model.

To estimate debris generated by the 1-percent annual chance flood event, HAZUS-MH v4.2, which was released on January 29, 2018, was used instead of HAZUS-MH v4.0. This is because a FEMA-known error in v4.0 was detected, and the issue appears to have been resolved with the latest software release.

Locations of the properties with policies, claims, and repetitive and severe repetitive flooding were geocoded by FEMA with the understanding that differences (and variations in those differences) were possible between listed longitude and latitude coordinates of properties and actual locations of property addresses—namely, that indications of some locations were more accurate than others. For properties without longitude or latitude coordinates provided, addresses provided in datasets were used to geocode each location.

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.

Landslide

To provide a more detailed vulnerability assessment, the 2016 USGS 3-meter resolution Digital Elevation Model (DEM) was used to generate areas of steep slopes for the County. In ArcGIS 10.5.2, the percent slope spatial layer was derived using Spatial Analysis tools. Areas with slopes greater than 15% were extracted and used as the hazard area.

The NJGS' Carbonate Formations GIS layer differentiates areas of carbonate and non-carbonate geological formations for New Jersey; this layer was used to estimate the County's vulnerability to ground failure due to subsidence and sinkholes. The Carbonate Formations GIS layer was derived from selecting out bedrock types from the Bedrock Geology of New Jersey (2000) that were categorized as having carbonate lithologies.

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 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 totals and values exposed to a hazard event.

Severe Storm

A HAZUS-MH v4.0 probabilistic analysis was performed to analyze the wind hazard losses for Burlington 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 Burlington 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 MRPs were examined for the wind/severe storm hazard. Default demographic and updated building and critical facility inventories in HAZUS-MH v4.0 were used for the analysis.

There is currently a FEMA-acknowledged issue with importing user-defined facilities in HAZUS-MH v4.0. To estimate potential losses to user-defined facilities identified by Burlington 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 incorporated into FEMA's 2012 Coastal Flood Loss Atlas, 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 National Weather Service 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.

Severe Winter Storm

The entire general building stock inventory in Burlington 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 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 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 2010 U.S. Census demographic data is the only data available at the U.S. Census Block level during the next plan update, estimate the current population for each census block using the American Community Survey 5-Year Estimate populations counts at the census block group or census tract level available at the time of the update. Additionally, residential building footprints or parcels can be utilized along with the County's average household size to estimate population exposure.
  - Update the custom general building stock inventory using updated County tax assessor data and building location data; See individual hazards below for additional attributes that can enhance loss estimates
- Coastal Erosion
  - If available during the next plan update, update the risk assessment using a comprehensive coastal erosion hazard area map.
  - Collect data on historic costs incurred to reconstruct buildings, cultural resources and/or infrastructure due to coastal erosion impacts.
- 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.
  - Should data become available regarding NEHRP soil classifications and/or liquefaction for the County, incorporated in the HAZUS-MH Earthquake model during the next plan update to provide a more accurate and detailed estimation of potential losses.
- Landslide
  - 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%. Slopes greater than 25% should be used to delineate the hazard area for the vulnerability assessment. Should the County determine the need for a more

detailed assessment of risk, the 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 Weather
  - General building stock inventory can be updated to include attributes regarding protections against strong winds, such as hurricane straps, to enhance loss estimates.
  - Track extreme temperature data for injuries, deaths, shelter needs, pipe freezing, agricultural losses, and other impacts to determine distributions of 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.

5.2.3 Data Source Summary

Table 5.2-3 summarizes the data sources used for the risk assessment for this plan.

Table 5.2-3. Risk Assessment Data Documentation

Data	Source	Date	Format
Population data	U.S. Census Bureau	2010	Digital (GIS) format
Building footprints	Burlington County Department of Information Technology	2017	Digital (GIS) format
MODIV Tax Assessor data	NJ Department of the Treasury	2017	Digital (Tabular) format
Critical facilities	Burlington County Department of Information Technology	2017	Digital (GIS) format
Digitized effective FIRM maps	FEMA	2017	Digital (GIS) format
RiskMAP 1-percent annual chance event depth grid	FEMA	2017	Digital (GIS) format
Landslide Incidence/Susceptibility	USGS	2011	Digital (GIS) format
Carbonate Formations	NJGS	2008	Digital (GIS) format
Wildfire Fuel Hazard	NJFFS	2012	Digital (GIS) format
Census of Agriculture	USDA	2012	Digital (PDF Report) format
2-foot Sea-Level Rise	NOAA	2016	Digital (GIS) Format
Sea-Lake Overland Surge from Hurricanes (SLOSH) Model	FEMA	2012	Digital (GIS) Format
3-meter Resolution Digital Elevation Model	USGS	2016	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:

1) Approximations and simplifications necessary to conduct such a study
2) Incomplete or dated inventory, demographic, or economic parameter data

3) The unique nature, geographic extent, and severity of each hazard
4) Mitigation measures already employed by the participating municipalities
5) 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, Burlington County will collect additional data to collect additional data, 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.

5.3 HAZARD RANKING

After the hazards of concern were identified for Burlington County and the risk assessment completed, the hazards were ranked to describe their probability of occurrence and their impact on population, property (general building stock including critical facilities) and the economy. Each participating city, town, township, or borough may have differing degrees of risk exposure and vulnerability compared to the county as a whole; therefore, each jurisdiction ranked the degree of risk to each hazard as it pertains to their community using the same methodology as applied to the county-wide ranking. This assured consistency in the overall ranking of risk process. The hazard ranking for the county and each participating jurisdiction can be found in their annex in Volume II of this HMP.

2019 HMP Update Changes

- The hazard ranking for the 2019 HMP update incorporates the best available data used to conduct the vulnerability assessments for each profiled hazard.

5.3.1 Hazard Ranking Methodology

The methodology used to rank the hazards of concern for Burlington County is described below. Estimates of risk for the county were developed using methodologies promoted by FEMA's hazard mitigation planning guidance and generated by FEMA's HAZUS-MH risk assessment tool.

Probability of Occurrence

The probability of occurrence is an estimate of how often a hazard event occurs. A review of historic events assists with this determination. Each hazard of concern is rated in accordance with the numerical ratings and definitions in Table 5.3-1.

Table 5.3-1. Probability of Occurrence Ranking Factors

Rating	Probability Category	Definition
1	Rare	Hazard event is not likely to occur within 100 years (>1% chance of occurrence in any given year)
2	Occasional	Hazard event is likely to occur within 100 years (1% chance of occurrence in any given year)
3	Frequent	Hazard event is likely to occur within 25 years (4% chance of occurrence in any given year)

Impact

The impact of each hazard is considered in three categories: impact on population, impact on property (general building stock including critical facilities), and impact on the economy. Based on documented historic losses and a subjective assessment by the Planning Committee, an impact rating of high, medium, or low is assigned with a corresponding numeric value for each hazard of concern. In addition, a weighting factor is assigned to each impact category: three (3) for population, two (2) for property, and one (1) for economy. This gives the impact on population the greatest weight in evaluating the impact of a hazard. Table 5.3-2 presents the numerical rating, weighted factor and description for each impact category

Table 5.3-2. Numerical Values and Definitions for Impacts on Population, Property and Economy

Category	Weighting Factor	Low Impact* (1)	Medium Impact (2)	High Impact (3)
Population	3	14% or less of your population is exposed to a hazard with potential for measurable life safety impact, due to its extent and location	15% to 29% of your population is exposed to a hazard with potential for measurable life safety impact, due to its extent and location	30% or more of your population is exposed to a hazard with potential for measurable life safety impact, due to its extent and location
Property	2	Property exposure is 14% or less of the total replacement cost for your community	Property exposure is 15% to 29% of the total replacement for your community	Property exposure is 30% or more of the total replacement cost for your community
Economy	1	Loss estimate is 9% or less of the total replacement cost for your community	Loss estimate is 10% to 19% of the total replacement cost for your community	Loss estimate is 20% or more of the total replacement cost for your community

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 loss for economy.*

Risk Ranking Value

The risk ranking for each hazard is then calculated by multiplying the numerical value for probability of occurrence by the sum of the numerical values for impact. The equation is as follows: Weighting Factor (1, 2, or 3) × Impact Value (6 to 18) = Hazard Ranking Value. Based on the total for each hazard, a priority ranking is assigned to each hazard of concern (high, medium, or low).

5.3.2 Hazard Ranking Results

Using the process described above, the risk ranking for the identified hazards of concern was determined for Burlington County. Based on the combined risk values for probability of occurrence and impact to Burlington County, a priority ranking of "high", "medium" or "low" risk was assigned. The hazard ranking for the Burlington County planning area is detailed in the subsequent tables that present the step-wise process for the ranking. The county–wide 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 county-wide risk and local rankings to ensure consistency in the overall ranking of risk.

This risk ranking exercise serves two purposes: 1) to describe the probability of occurrence for each hazard, and 2) to describe the impact each would have on the people, property and economy of Burlington County. Estimates of risk for the county were developed using methodologies promoted by FEMA's hazard mitigation planning guidance and generated by FEMA's HAZUS-MH risk assessment tool.

Table 5.3-3 shows the probability ranking assigned for likelihood of occurrence for each hazard.

Table 5.3-3. Probability of Occurrence Ranking for Hazards of Concern for Burlington County

Hazard of Concern	Probability	Numeric Value
Coastal Erosion	Occasional	2
Drought	Frequent	3
Earthquake	Occasional	2
Flood	Frequent	3
Landslide	Frequent	3
Severe Weather	Frequent	3
Severe Winter Weather	Frequent	3
Wildfire	Frequent	3

Table 5.3-4 shows the impact evaluation results for each hazard of concern, including impact on property, structures, and the economy on the county level. It is noted that several hazards that have a high impact on the local jurisdictional level, may have a lower impact when analyzed county-wide. Jurisdictional ranking results are presented in each local annex in Section 9 of this HMP. The weighting factor results and a total impact for each hazard also are summarized.

Table 5.3-4. Impact Ranking for Hazards of Concern for Burlington County

Hazard of Concern	Population			Property			Economy			Total Impact Rating (Population + Property + Economy)
	Impact	Numeric Value	Multiplied by Weighing Factor (3)	Impact	Numeric Value	Multiplied by Weighing Factor (2)	Impact	Numeric Value	Multiplied by Weighing Factor (1)	
Coastal Erosion	Low	1	3 x 1 = 3	Low	1	2 x 1 = 2	Low	1	1 x 1 = 2	12
Drought	Medium	2	3 x 2 = 6	Low	1	2 x 1 = 2	Medium	2	1 x 2 = 2	10
Earthquake	High	3	3 x 3 = 9	Medium	2	2 x 2 = 4	Low	1	1 x 1 = 1	14
Flood	Medium	2	3 x 2 = 6	Low	1	2 x 1 = 2	Low	1	1 x 1 = 1	9
Landslide	Medium	2	3 x 2 = 6	Medium	2	2 x 2 = 4	Low	1	1 x 1 = 1	11
Severe Weather	High	3	3 x 3 = 9	High	3	2 x 3 = 6	Low	1	1 x 1 = 1	16
Severe Winter Weather	High	3	3 x 3 = 9	High	3	2 x 3 = 6	Medium	2	1 x 2 = 2	17
Wildfire	Low	1	3 x 1 = 3	Medium	2	2 x 2 = 4	Low	1	1 x 1 = 1	8

Table 5.3-5 presents the total ranking value for each hazard.

Table 5.3-5. Total Risk Ranking Value for Hazards of Concern for Burlington County

Hazard of Concern	Probability	Impact	Total = (Probability x Impact)
Coastal Erosion	2	12	12
Drought	3	10	30
Earthquake	2	14	28
Flood	3	9	27
Landslide	3	11	33
Severe Weather	3	16	48
Severe Winter Weather	3	17	51
Wildfire	3	8	24

Refer to Section 9 for the hazard ranking category by jurisdiction assigned for each hazard of concern. The ranking categories are determined by an evaluation of the total risk ranking score into three categories (low, medium and high) whereby a score of below 20 is categorized as low, 20 to 30 is medium, and 31 and over is considered a high-risk category.

These rankings have been used as one of the bases for identifying the jurisdictional hazard mitigation strategies included in Section 9 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 dam failure hazard may be ranked high in one jurisdiction, but due to the exposure and impact county-wide, it is ranked as a medium hazard and is addressed in the county mitigation strategy accordingly

The hazard rankings indicated in this plan update have been adjusted from the 2013 HMP due to the improved vulnerability assessment based on structure-specific data available from the county rather than HAZUS default aggregate data as discussed in Section 5.1, Methodology. Any changes to the ranking results therefore do not necessarily reflect significant changes in exposure, but a more refined vulnerability analysis methodology. The summary county-level values reflect the vulnerability data on the county level and do not represent an average of jurisdiction ranks or the highest rank indicated in Burlington County. These designations are an element of the prioritization criteria as detailed in Section 6 of this plan.

5.4 HAZARDS PROFILES AND VULNERABILITY ASSESSMENTS

The following sections profile and assess vulnerability for each hazard of concern. For each hazard, the profile includes: the hazard description; its location and extent; previous occurrences and losses; and the probability of future events. The vulnerability assessment for each hazard includes: an overview of vulnerability; the data and methodology used; the impacts to life, health and safety; impacts to general building stock; impacts to critical facilities; impacts to the economy; effect of climate change on vulnerability; change of vulnerability as compared to that presented in the 2014 HMP; and additional data needs and next steps.

5.4.1 COASTAL EROSION

The following section provides the hazard profile (hazard description, location, extent, previous occurrences and losses, probability of future occurrences, and impact of climate change) and vulnerability assessment for the coastal erosion hazard in Burlington County.

2019 Plan Update Changes

- The hazard profile has been significantly enhanced to include a detailed hazard description, location, extent, previous occurrences (updated with events that occurred between January 1, 2013 and December 31, 2017), probability of future occurrence, and potential climate change impacts using best available data.
- A vulnerability assessment section was completed for the coastal erosion hazard that provides a more accurate estimated exposure and potential losses to Burlington County.

5.4.1.1 Profile

Hazard Description

Erosion is the process of the wearing away of beaches and bluffs along the coastline by large storms, flooding, strong wave action, sea level rise, fluvial currents, and human activities. Erosion occurs when the waves and currents remove sediment from the shoreline. The loss of sediment causes the land along the shore to become narrower and lower in elevation. During storms, waves and currents carry the sand away from the shoreline, depositing and storing the sediment in the nearshore sandbars or down-drift to adjacent shorelines. In weeks and months following the storm, the nearshore sediment can be returned to the shoreline by calmer waves (CRS User Manual 2017).

Sandy barrier/bluff coastlines are constantly changing as the result of wind, currents, storms, and sea-level rise. Because of this, developed sandy shorelines are often stabilized with hardened structures (seawalls, bulkheads, revetments, rip-rap, gabions, and groins) to protect coastal properties from erosion. While hardened structures typically prove to be beneficial in reducing property damage, the rate of coastal erosion typically increases near stabilization structures. This increased erosion impacts natural habitats, spawning grounds, recreational activity areas, and public access (Frizzera 2011).

Location

As defined through the New Jersey Coastal Management Program (NJCMP), the coastal zones of New Jersey include all areas where the State has authority, through the NJDEP and the Meadowlands Commission, to regulate land and water uses that may have significant impact on coastal resources. The primary implementing authorities for NJCMP are the Coastal Area Facility Review Act (CAFRA), the Waterfront Development Law, the Wetlands Act of 1970, Tidelands Statutes and the Hackensack Meadowlands Reclamation Development Act (NJDEP, 2002).

While Burlington County has no open water on the Atlantic Ocean or Delaware Bay, it has two distinct areas that are at risk of shoreline erosion: the western border along the Delaware River and the southeastern portion along Mullica River Great Bay and its tributaries. Figure 5.4.1-1 illustrates the coastal boundary of the State of New Jersey and shows that a small portion of Burlington County lies within the CAFRA area. In the Township of Bass River, there is a small, 19-acre center located in the CAFRA area, where U.S. Route 9, a county road, and the Garden State Parkway intersect. The rest of the southeast portion of the County is in Pinelands protected area zoning (Craghan et al., 2010).

Figure 5.4.1-1 illustrates the coastal areas of Burlington County. The figure shows that the county borders or contains numerous tidally influenced waterways including the Mullica River, the Delaware River, and their tributaries.

Figure 5.4.1-1. New Jersey Coastal Boundary Map

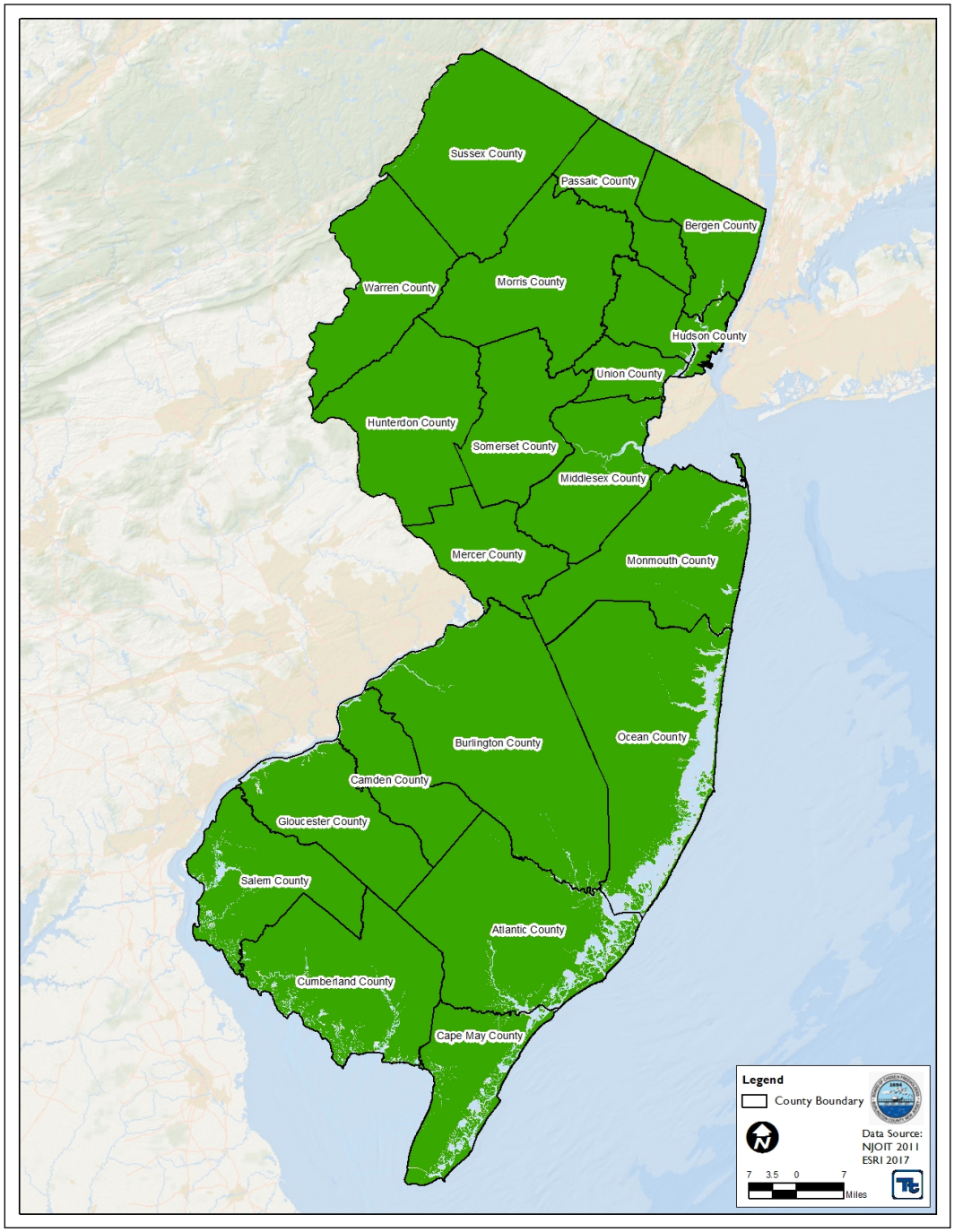
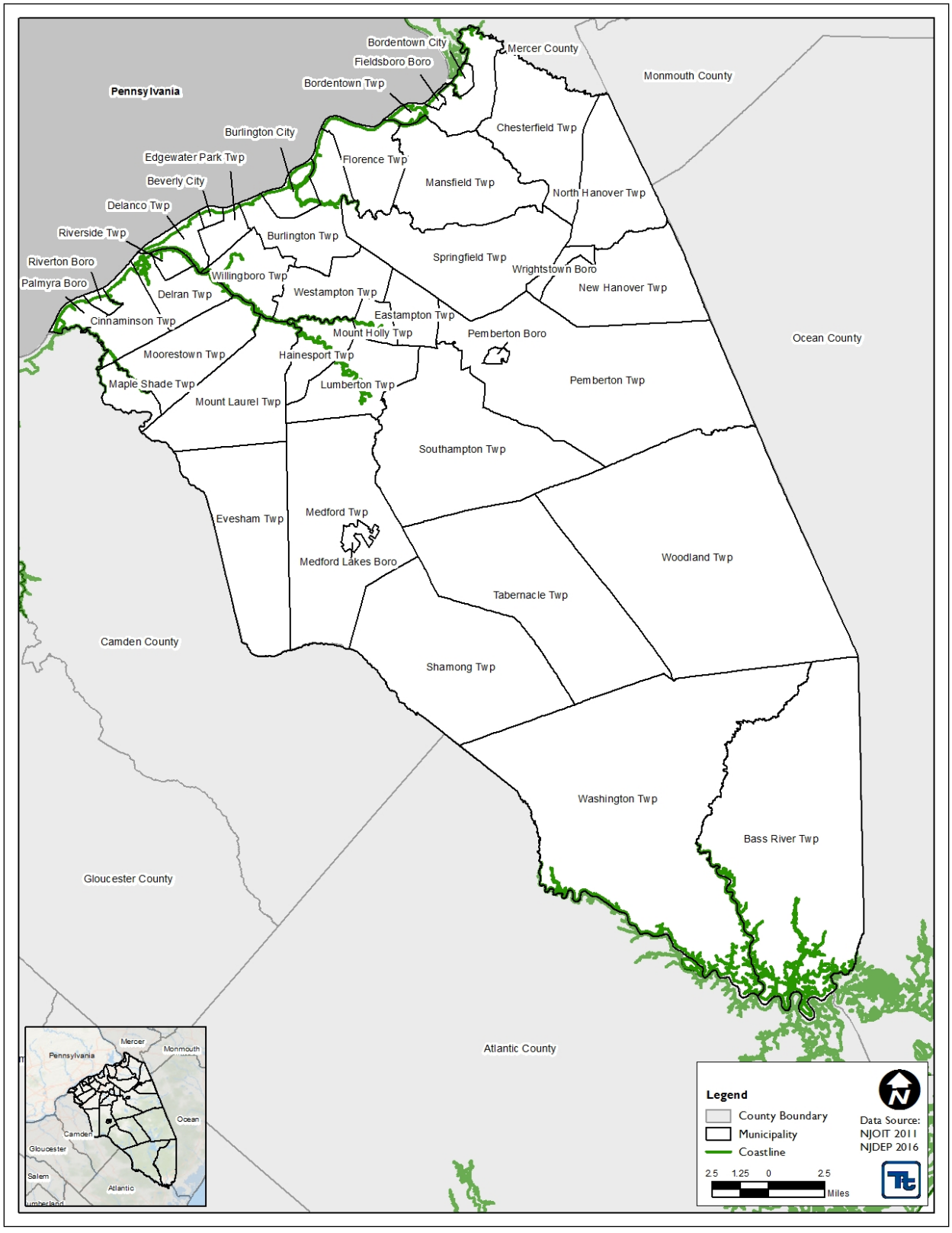


Figure 5.4.1-2. Coastline of Burlington County



Extent

Shorelines are affected by storms and other natural events that cause erosion; however, the extent and severity of erosion differs across the United States. It may be intensified by activities such as boat wakes, shoreline hardening, or dredging. Coastal erosion is classified as short-term and long-term. The long-term changes of shoreline may not be evident on a day-to-day or even year-to-year basis. They occur over a period of decades, over which short-term changes tend to average out to the underlying erosion or accretion trend. However, short-term changes due to storm events are immediately noticed. Short-term changes occur over periods ranging from a few days to a few years. They can be highly variable in direction and magnitude. Natural recovery after erosive episodes can take months or years. If a shoreline does not recover quickly enough via natural processes, coastal and upland property may be exposed to further damage in subsequent events. Coastal erosion can cause the destruction of buildings and infrastructure (FEMA 1997).

Coastal erosion hazards and the vulnerability of development and infrastructure vary significantly by geographic region. By virtue of their location at the interface between oceans and land, coastal areas are among the most dynamic environments on earth susceptible to a broad range of natural hazards. Many parts of New Jersey's densely populated coast are highly vulnerable to the effects of flooding, storm surge, episodic erosion, chronic erosion, sea level rise, and extra-tropical storms. Much of the developed shoreline of New Jersey has been stabilized with seawalls and other armaments, which in some areas have caused extensive beach loss (NJOEM, 2012).

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 two 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. This includes: 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 (FEMA 2015).

Previous Occurrences and Losses

As mentioned previously, 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. Many sources provided historical information regarding previous occurrences and losses associated with coastal erosion events throughout the State of New Jersey and Burlington County. With so many sources reviewed for the purpose of this HMP, 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.

Between 1954 and 2018, the State of New Jersey was included in eight FEMA coastal erosion-related disasters (DR) or emergencies (EM), classified as one or a combination of the following event types: severe storm, flood, coastal storm, high tides, heavy rain, Nor'Easter, tropical storm, and hurricane. Generally, these disasters cover a wide region of the State; therefore, they may have impacted many counties.

For this 2019 Plan Update, known coastal erosion events were not identified due to limitations in datasets that were researched. However, municipal specific erosion descriptions are described in Section 9.

Probability of Future Occurrences

Long-term coastal erosion is a continuous and dynamic process, impacting the coastal counties along the Atlantic Ocean, Delaware Bay, and Delaware River. It is anticipated that coastal erosion will continue due to the predicted increase in sea level rise and storm frequency and intensity. For Burlington County, impacts will vary from place to place along the surge-impacted areas of the County. As temperatures increase (see climate change impacts), the probability for future events will likely increase as well. It is estimated that Burlington County will continue to experience direct and indirect impacts of coastal erosion on occasion.

In Section 5.3, the identified hazards of concern for the 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 coastal erosion in the County is considered 'occasional' (likely to occur within 100 years, as presented in Table 5.3-3).

Impacts of Climate Change

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 may lead to an increase in frequency of storms, thus leading to more weather events that cause coastal erosion.

Temperatures in the Northeast United States have increased 1.5 degrees Fahrenheit (°F) on average since 1900. 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 (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).

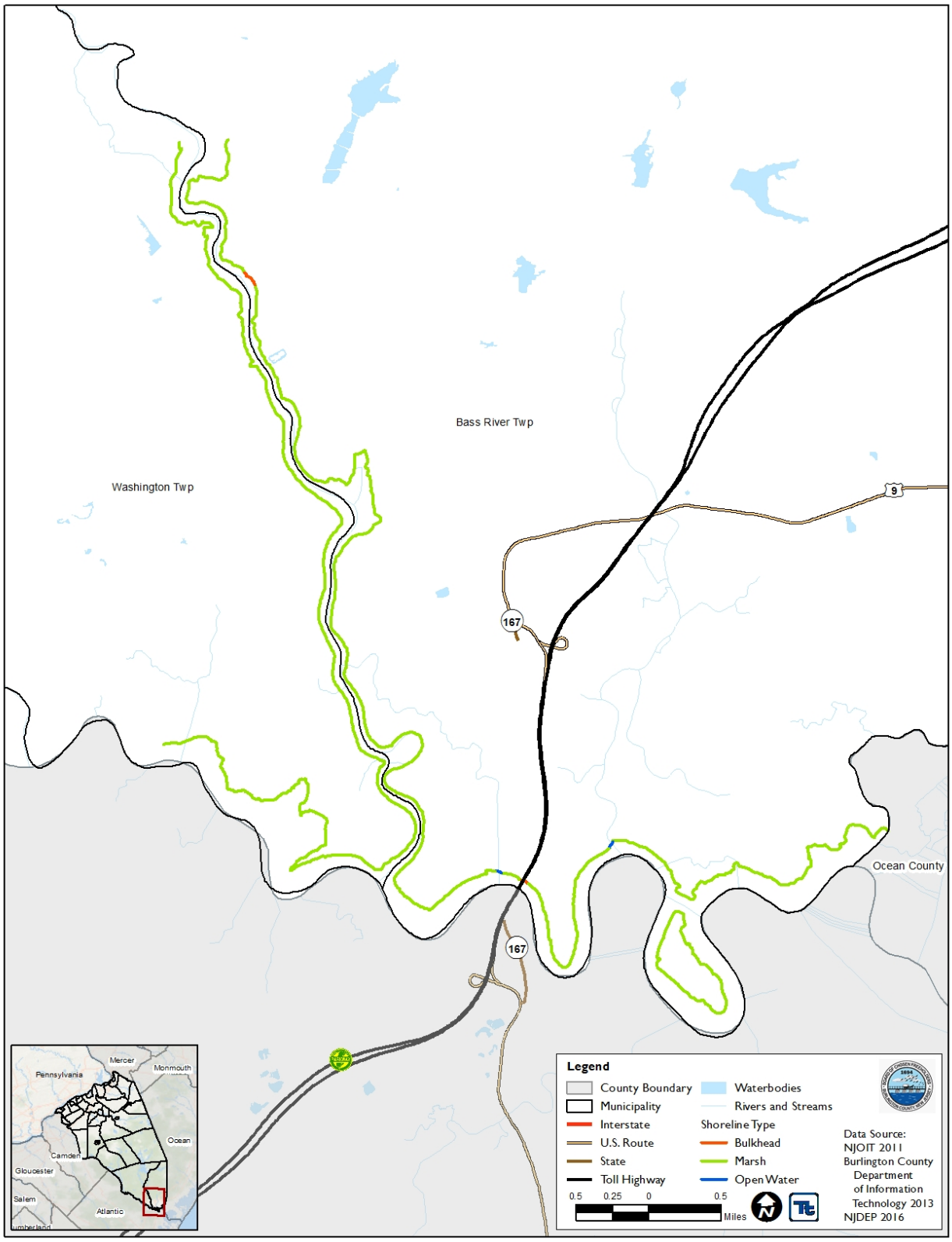
Changes in global temperatures, hydrologic cycles, coverage of glaciers and ice sheets, and storm frequency and intensity are captured in long-term sea level records. Sea levels provide a key to understanding the impact of climate change (NOAA 2013). Sea level rise increases the risks coastal communities face from coastal hazards (floods, storm surges, and chronic erosion). It may also lead to the loss of important coastal habitats. 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).

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).

5.4.1.2 Vulnerability Assessment

To understand risk, a community must evaluate what assets are exposed or vulnerable to the identified hazard. Coastal erosion may impact public safety, property, infrastructure, environmental resources and local economies. The following text evaluates and estimates the potential impact of coastal erosion on Burlington County. Figure 5.4.1-3 below displays the shoreline classifications for Burlington County; none of which are considered to be highly susceptible to coastal erosion. Refer to Section 5.2 for additional details on the methodology used to assess coastal erosion risk.

Figure 5.4.1-3. NJDEP Shoreline Classification for Burlington County



Impact on Life, Health and Safety

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 homes and public safety. The population exposed, or located in the estimated hazard area, is also considered vulnerable to this hazard. None of the County is exposed to the 120' beach or erodible shoreline buffer hazard area, as defined in Section 5.2 – Methodology and Tools.

Table 5.4.1-1 summarizes these results by municipality. The analysis indicates that 2,668 people are located in the estimated 2-foot sea-level rise hazard area. Burlington Township has the greatest number of people exposed to the hazard area with 393 people (approximately 1.7% of the total population). However, while not having the greatest total exposure, Washington Township has the greatest percentage of its population exposed to the hazard area 32.6%. Socially vulnerable populations (e.g. the elderly and low-income populations) are particularly vulnerable to a hazard event. Of these 2,668 people, 340 people are over the age of 65 and 204 people considered low income populations.

Table 5.4.1-1. Estimated Population Exposed to the 2-foot Sea-Level Rise Scenario

Municipality	U.S. Census 2010 Population	Estimated Population Exposed	
		Number in the Sea-Level Rise Hazard Area	% of Total Exposed
Bass River Township	1,443	197	13.7%
Beverly City	2,577	0	0.0%
Bordentown City	3,924	69	1.8%
Bordentown Township	11,367	449	4.0%
Burlington City	9,920	59	0.6%
Burlington Township	22,594	393	1.7%
Cinnaminson Township	15,569	113	0.7%
Delanco Township	4,283	3	0.1%
Delran Township	16,896	289	1.7%
Edgewater Park Township	8,881	0	0.0%
Florence Township	12,109	0	0.0%
Hainesport Township	6,110	90	1.5%
Lumberton Township	12,559	216	1.7%
Mansfield Township	8,544	36	0.4%
Maple Shade Township	19,131	233	1.2%
Moorestown Township	20,726	0	0.0%
Mount Holly Township	9,536	0	0.0%
Mount Laurel Township	41,864	0	0.0%
Palmyra Borough	7,398	0	0.0%
Riverside Township	8,079	109	1.3%
Riverton Borough	2,779	10	0.4%
Springfield Township	3,414	38	1.1%

Municipality	U.S. Census 2010 Population	Estimated Population Exposed	
		Number in the Sea-Level Rise Hazard Area	% of Total Exposed
Washington Township	687	224	32.6%
Westampton Township	8,813	0	0.0%
Willingboro Township	31,629	140	0.4%
Burlington County	**448,734**	**2,668**	**0.6%**

Source: U.S. Census 2010, NOAA, 2016
Note: The NOAA 2-foot SLR boundary was overlaid on the U.S. Census block; the blocks with their centroids within the hazard are were totaled for each municipality.

Impact on General Building Stock

As detailed above, none of the County is exposed to the 120' beach or erodible shoreline buffer hazard area. Table 5.4.1-2 summarizes the total replacement cost value of buildings in the area mapped with 2-feet of sea level rise. Bass River Township has the greatest total number of buildings and percentage of its building stock located in the 2-foot sea level rise hazard area (59 buildings, of 3.2% of the total building stock, worth $62.4 million, or 6.1% of the Township's total replacement cost value).

Table 5.4.1-2. Estimated Buildings Exposed to the Coastal Erosion Hazard

Municipality	Total # Buildings	Total RCV (Structure and Contents)	Estimated Building Stock Exposed			
			Number in the Sea-Level Rise Hazard Area	% of Total Exposed	RCV in the Sea-Level Rise Hazard Area	% of Total Exposed
Bass River Township	1,863	$1,027,917,130	59	3.2%	$62,431,039	6.1%
Beverly City	964	$471,487,138	1	<1%	$73,441	<1%
Bordentown City	1,219	$1,244,995,904	1	<1%	$235,495	<1%
Bordentown Township	3,113	$2,820,041,247	7	<1%	$4,916,624	<1%
Burlington City	3,644	$3,215,233,092	16	<1%	$12,466,747	<1%
Burlington Township	7,757	$8,013,259,672	6	<1%	$4,767,843	<1%
Cinnaminson Township	6,358	$5,703,895,752	38	<1%	$26,507,336	<1%
Delanco Township	1,562	$1,422,201,479	22	1.4%	$22,228,590	1.6%
Delran Township	5,191	$5,145,622,596	33	<1%	$15,333,892	<1%
Edgewater Park Township	2,567	$2,307,285,215	1	<1%	$265,724	<1%
Florence Township	2,522	$2,787,263,607	0	0.0%	$0	0.0%
Hainesport Township	2,747	$3,447,208,735	27	1.0%	$76,170,793	2.2%
Lumberton Township	4,009	$5,459,557,257	8	<1%	$9,585,084	<1%
Mansfield Township	2,798	$4,056,501,589	0	0.0%	$0	0.0%
Maple Shade Township	6,006	$4,385,500,913	0	0.0%	$0	0.0%
Moorestown Township	8,736	$10,108,801,626	10	<1%	$32,373,121	<1%

Municipality	Total # Buildings	Total RCV (Structure and Contents)	Estimated Building Stock Exposed			
			Number in the Sea-Level Rise Hazard Area	% of Total Exposed	RCV in the Sea-Level Rise Hazard Area	% of Total Exposed
Mount Holly Township	4,573	$3,498,352,996	3	<1%	$5,654,446	<1%
Mount Laurel Township	12,900	$14,653,800,804	3	<1%	$10,098,807	<1%
Palmyra Borough	2,713	$1,788,398,557	2	<1%	$486,633	<1%
Riverside Township	2,868	$2,039,139,951	13	<1%	$4,865,588	<1%
Riverton Borough	1,274	$916,434,789	0	0.0%	$0	0.0%
Springfield Township	2,876	$3,853,514,909	1	0.0%	$1,486,222	<1%
Washington Township	939	$597,426,933	18	1.9%	$12,625,914	2.1%
Westampton Township	3,006	$4,269,433,407	10	<1%	$18,856,759	<1%
Willingboro Township	12,395	$8,259,747,413	7	<1%	$2,436,725	<1%
Burlington County	**173,044**	**$165,526,729,867**	**286**	**<1%**	**$323,866,823**	**<1%**

Source: Burlington County, NOAA 2016
Note: The NOAA 2-foot SLR boundary was overlaid on the custom general building stock inventory; the structures with their centroids within the hazard are were totaled for each municipality.

Impact on Critical Facilities

Coastal erosion can also impact critical facilities. It can degrade the surrounding infrastructure and utility lines, depending on their location on the property. This could inhibit the facilities 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. As detailed above, none of the County is exposed to the 120' beach or erodible shoreline buffer hazard area. There are 10 critical facilities located in the 2-foot sea-level rise hazard area. Of these 10, the majority are dams located within the hazard area; the frequent to permanent inundation of these dams will hinder each dam's ability to function as intended. Refer to Table 5.4.1-3 for these results by municipality and critical facility type.

Table 5.4.1-3. Critical Facilities Located in the Estimated Coastal Erosion Hazard Area

Municipality	Facility Type			
	Airport	Chemical	Dam	Tier Facility
Burlington City	0	0	0	1
Cinnaminson Township	0	1	3	0
Hainesport Township	0	0	1	0
Lumberton Township	0	0	1	0
Mount Holly Township	0	0	1	0
Palmyra Borough	0	0	0	1

Municipality	Facility Type			
	Airport	Chemical	Dam	Tier Facility
Washington Township	1	0	0	0
Burlington County	**1**	**1**	**6**	**2**

Source: Burlington County, NOAA 2016

Impact on Economy

Coastal erosion can also severely impact roads and infrastructure. None of the County's roadways are located within the 120' beach or erodible shoreline buffer. However, there are 6.1 miles of roadway (Interstate, US Route, State Route, County Route, and local roads) that lie within the 2-foot sea-level rise boundary. These include portions of I-295, NJ-38, NJ-413, NJ-73, NJ-90, US-130, US-206, US-9, Marne Highway, the Garden State Parkway, and the NJ Turnpike.

Future Growth and Development

As discussed in Section 4, areas targeted for future growth and development have been identified across the County. Any areas of growth located in the defined coastal erosion hazard areas could be potentially impacted by coastal erosion similar to those that currently exist within the County. Please refer to Figure 5.4.1-4 for the potential new development in the County and the coastal erosion hazard area.

There are 8 recent and proposed developments around the County located in the 2-foot sea level rise hazard area. Burlington Township has the most developments located in the hazard area (3 developments). Refer to each jurisdictional annex for the results of each exposure analysis on new development.

Effect of Climate Change on Vulnerability

Climate is defined not simply as average temperature and precipitation but also by the type, frequency and intensity of weather events. Both globally and at the local scale, climate change has the potential to alter the prevalence and severity of events that exacerbate coastal erosion. While predicting changes of coastal erosion 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).

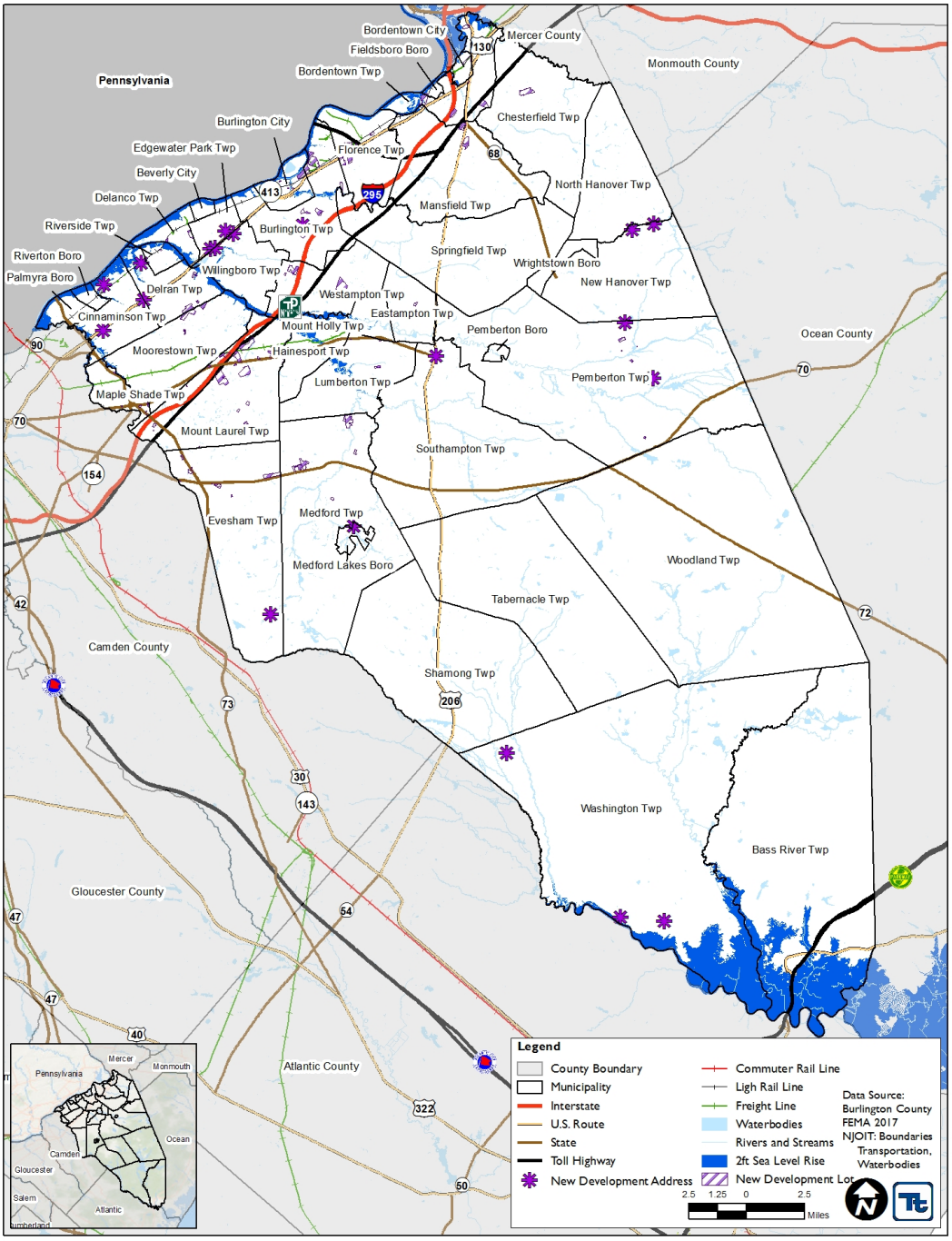
Impacts of climate change can lead to shoreline erosion, coastal flooding, and water pollution, affecting man-made coastal infrastructure and coastal ecosystems. Coastal areas may be impacted by climate change in different ways. Coastal areas are sensitive to sea-level rise, changes in the frequency 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 (EPA 2013). As previously stated, warmer temperatures may lead to an increase in frequency of storms, thus leading to more weather events with potentially increased severity, that cause coastal erosion.

Change of Vulnerability Since 2014 HMP

Burlington County and all plan participants continue to be vulnerable to the coastal erosion hazard. Several differences exist between the 2014 Plan and this update. For this plan update, an updated general building stock

based upon replacement cost value from MODIV tax assessment data and 2018 RS Means, and an updated critical facility inventory were used to assess the county's risk to the hazard areas. An updated hazard area was used as well; the 2016 sea-level rise spatial layer from FEMA was used. Overall, the 2016 FEMA spatial layer increased the 2-foot sea-level rise extent to encompass a larger area of the County; in Bass River Township, 24 people were exposed to the sea-level rise hazard, while in this plan update, there are 197 people exposed to the hazard area. The updated vulnerability assessment provides a more current exposure analysis for the county.

Figure 5.4.1-4. Potential New Development in Burlington and the Coastal Erosion Hazard Area



Source: FEMA 2017, Burlington County

5.4.2 DROUGHT

The following section provides the hazard profile (hazard description, location, extent, previous occurrences and losses, probability of future occurrences, and impact of climate change) and vulnerability assessment for the drought hazard in Burlington County.

2019 HMP UPDATE CHANGES

- The hazard profile has been significantly enhanced to include a detailed hazard description, location, extent, previous occurrences, probability of future occurrence, and potential change in climate and its impacts on the drought hazard is discussed.
- New and updated figures from federal and state agencies are incorporated. U.S. 2010 Census data was incorporated, where appropriate.
- Previous occurrences were updated with events that occurred between 2013 and 2018.
- A vulnerability assessment was conducted for the drought hazard that provides a qualitative analysis of exposure and potential losses to Burlington County.

5.4.2.1 PROFILE

Hazard Description

As defined by the National Weather Service (NWS), drought is a deficiency in precipitation over an extended period, usually a season or more, resulting in a water shortage causing adverse impacts on vegetation, animals, and/or people. It is a normal, recurrent feature of climate that occurs in virtually all climate zones, from very wet to very dry. Drought is a temporary aberration from normal climatic conditions and can vary significantly from one region to another. Human factors, such as water demand and water management, can exacerbate the impact that a drought has on a region. There are four different ways that drought can be defined or grouped:

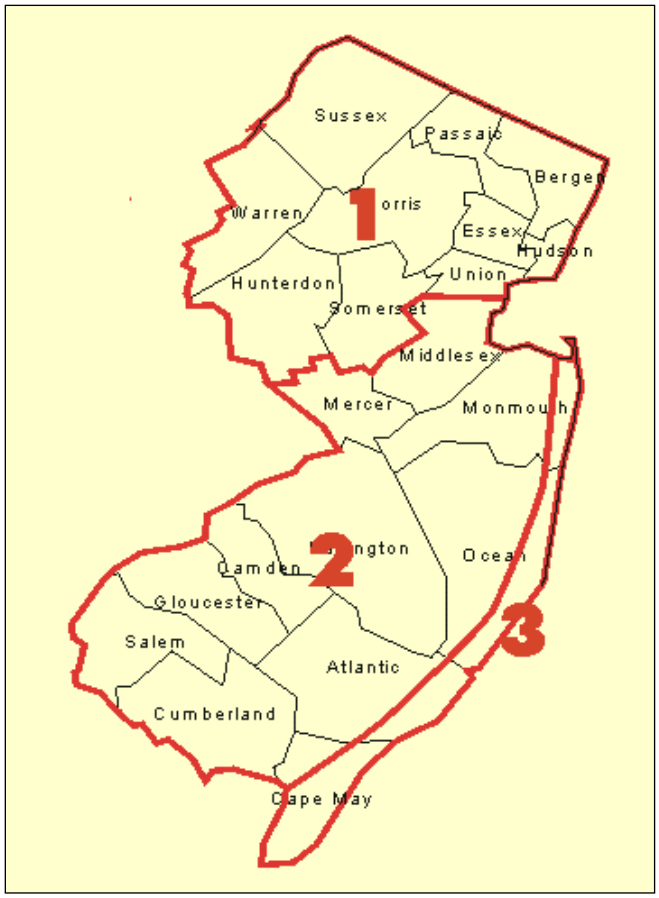
- Meteorological drought is a measure of departure of precipitation from normal. It is defined solely on the relative degree of dryness. Due to climatic differences, what might be considered a drought in one location of the country may not be a drought in another location.
- Agricultural drought links various characteristics of meteorological (or hydrological) drought to agricultural impacts, focusing on precipitation shortages, differences between actual and potential evapotranspiration, soil water deficits, reduced ground water or reservoir levels, and other parameters. It occurs when there is not enough water available for a particular crop to grow at a particular time. Agricultural drought is defined in terms of soil moisture deficiencies relative to water demands of plant life, primarily crops.
- Hydrological drought is associated with the effects of periods of precipitation shortfalls (including snowfall) on surface or subsurface water supply. It occurs when these water supplies are below normal. It is related to the effects of precipitation shortfalls on stream flows and reservoir, lake, and groundwater levels.
- Socioeconomic drought is associated with the supply and demand of an economic good with elements of meteorological, hydrological, and agricultural drought. This differs from the aforementioned types of drought because its occurrence depends on the time and space processes of supply and demand to identify or classify droughts. The supply of many economic goods depends on weather (for example water, forage, food grains, fish, and hydroelectric power). Socioeconomic drought occurs when the demand for an economic good exceeds supply as a result of a weather-related shortfall in water supply (National Drought Mitigation Center 2012).

The National Weather Service Climate Prediction Center can provide seasonal outlooks for droughts that last for 3 month increments. To view the current seasonal outlook visit, http://www.cpc.ncep.noaa.gov/products/expert_assessment/sdo_summary.php. Predicting drought depends on the ability to forecast precipitation and temperature. Anomalies of precipitation and temperature may last from several months to several decades. How long they last depends on interactions between the atmosphere and the oceans, soil moisture and land surface processes, topography, internal dynamics, and the accumulated influence of weather systems on the global scale (NDMC Date Unknown).

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 344 climate divisions with New Jersey being made up of three climate divisions: Northern, Southern, and Coastal; Burlington County is located in the Southern Climate Division (NOAA NCEI, 2018) (Figure 5.4.2-1).

Figure 5.4.2-1. Climate Divisions of NJ



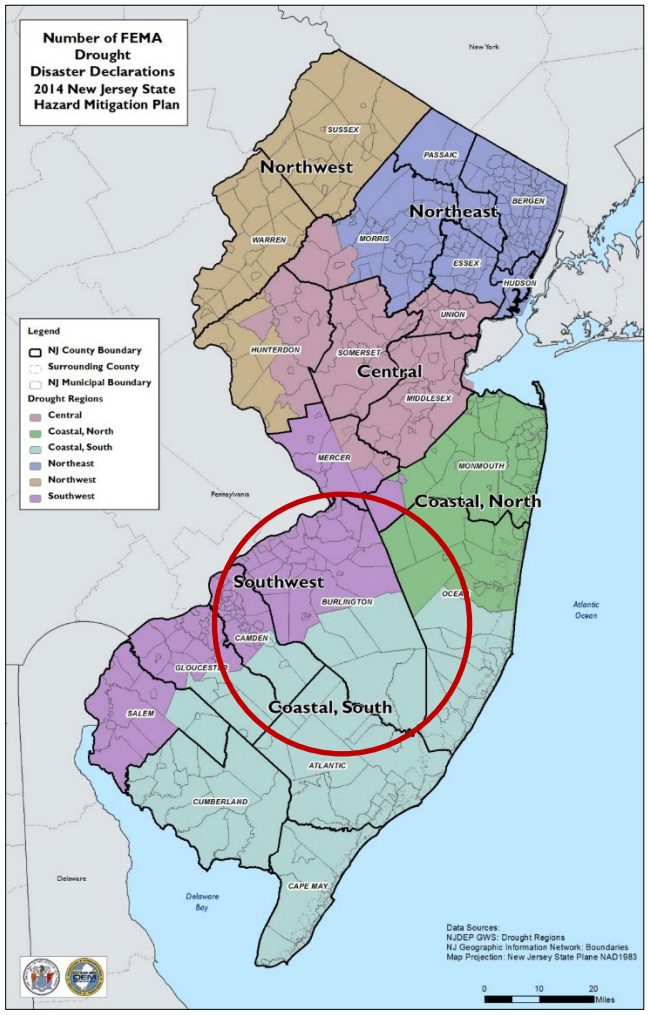
Source: Climate Prediction Center (CPC), 2005
Note: 1 = Northern Climate Division; 2 = Southern Climate Division; 3 = Coastal Climate Division

The New Jersey Department of Environmental Protection (NJDEP) divides the State of New Jersey into six drought regions - Northeast, Central, Northwest, Southwest, Coastal North and Coastal South. The drought regions generally follow natural watershed boundaries and account for regional similarities in climate and water supply sources, among other things. The drought regions allow the NJDEP to respond to changing conditions in one region without imposing constraints in areas not experiencing a water shortage. The drought regions also

align with municipal borders because the primary enforcement mechanism for water restrictions during a drought emergency is the local police department (NJDEP Division of Water Supply and Geoscience 2018).

Burlington County is located in two drought regions – the Southwest Drought Region and the Coastal South Drought Region. Other counties in the Southwest Drought region include Camden, Gloucester, Mercer, Monmouth, and Salem Counties. The Coastal South Drought Region also includes Atlantic, Camden, Cape May, Cumberland, Gloucester, Ocean, and Salem Counties (Hoffman and Domber 2003) (see Figure 5.4.2-2).

Figure 5.4.2-2. Drought Regions of New Jersey



Source: *NJHMP 2014*

Note: The red circle indicates the location of Burlington County. The County is located within the Southwest Drought Region and Coastal, South Drought Region of New Jersey.

Extent

According to the New Jersey HMP, counties most often affected by a drought are densely populated areas that rely on above-ground reservoirs for their water supply; however, this does not include Burlington County. As noted in the New Jersey HMP, all but five of the county's water suppliers use groundwater for drinking water supplies. This ultimately makes the county and its municipalities more resistant to drought conditions (NJ HMP, 2014). According to the NJDEP, available water supply sources for the Southwest Drought Region are the Delaware River Basin Reservoirs, unconfined ground water, and rivers. The Coastal South Drought Region is

unconfined groundwater, as well as a minor supply source of New Jersey reservoirs (NJDEP 2018).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 (NOAA Date Unknown). In New Jersey, the NJDEP utilizes several drought indices to assess the severity of drought throughout the state.

The Division of Water Supply and Geoscience within the NJDEP, regularly monitors various water supply conditions within the state based on the different Water Supply Regions. The water supply conditions aid the Department 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).

Previous Occurrences and Losses

Many sources provided historical information regarding previous occurrences and losses associated with drought events throughout the State of New Jersey and Burlington County. With numerous sources reviewed for the purpose of this HMP, loss and impact information for events could vary depending on the source. Therefore, the accuracy of monetary figures discussed is based only on the available information identified during the HMP research.

Between 1954 and 2018, FEMA declared that the State of New Jersey experienced two drought-related disaster declarations: one major disaster (DR) and one emergency (EM); both were classified as water shortages. Generally, these disasters cover a wide region of the State; therefore, they may have impacted many counties. However, not all counties were included in the disaster declarations. Of those events, the New Jersey HMP, FEMA, and other sources indicate that Burlington County has been declared as a disaster area as a result of two drought-related events (FEMA, 2018). Table 5.4.2-1 provides information regarding FEMA declarations for Burlington County.

Table 5.4.2-1. FEMA Declarations for Drought Events in Burlington County

FEMA Disaster Number	Date(s) of Incident	Incident Type / Title	Declared Counties
DR-205	August 1965	Drought / Water Shortage	All 21 counties including Burlington County
EM-3083	October 1980	Drought / Water Shortage	All 21 counties including Burlington County

Source: FEMA 2018

Agriculture-related drought disasters are quite common. One-half to two-thirds of the counties in the U.S. have been designated as disaster areas in each of the past several years. The USDA Secretary of Agriculture 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 2013 and 2018, Burlington County has been included in 4 USDA declarations that were a result of drought conditions (S3930 and S3932 in 2015 and S4071 and S4165 in 2016).

For this 2019 Plan update, known drought events, including FEMA and USDA disasters, that have impacted Burlington County between 2013 and 2018 are identified in Table 5.4.2-2. For events prior to 2013, refer to Appendix G (Supplementary Data). Please note that not all events that have occurred in the County are included due to the extent of documentation and the fact that not all sources may have been identified or researched. Loss and impact information 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.

Table 5.4.2-2. Drought Events Impacting Burlington County, 2013 to 2018

Dates of Event	Event Type	FEMA Declaration Number	County Designated?	Losses / Impacts
April – September 2015	Excessive Heat & Drought	N/A	N/A	Excessive Heat and Drought resulted in Crop Disaster (USDA Designation number S3930)
July – September 2015	Excessive Heat & Drought	N/A	N/A	Excessive Heat and Drought resulted in Crop Disaster (USDA Designation number S3932)
April – September 2016	Freeze, Excessive Heat, & Drought	N/A	N/A	Combined effects of freeze, excessive heat, and drought resulted in a Crop Disaster (USDA Designation number S4071)
May – December 2016	Drought	N/A	N/A	Drought resulted in Crop Disaster (USDA Designation number S4165)

Source(s): NOAA-NCEI, FEMA, Burlington County HMP

FEMA Federal Emergency Management Agency
HMP Hazard Mitigation Plan
N/A Not Applicable
NCEI National Centers for Environmental Information
NDMC National Drought Mitigation Center
NOAA National Oceanic and Atmospheric Administration
USDA U.S. Department of Agriculture

Probability of Future Occurrences

Based upon risk factors for and past occurrences, it is likely that droughts will occur across New Jersey and Burlington County in the future. According to the USGS Division of Water Resources, Burlington County and its jurisdictions fall within what is described as a "humid region" and is more likely to experience a short-term drought (Burlington County HMP, 2008, 2014). In addition, as temperatures increase (see climate change impacts), the probability for future droughts will likely increase as well. Therefore, it is likely that droughts will occur in New Jersey of varied severity in the future.

According to NOAA NCEI, FEMA, Northeast Regional Climate Center, and the Drought Impact Reporter, Burlington County experienced 45 drought events between 1950 and 2018. The table below shows these

statistics, as well as the annual average number of events and the percent chance of droughts occurring in Burlington County in future years.

Table 5.4.2-3. Probability of Future Occurrence of Drought Events

Hazard Type	Number of Occurrences Between 1950 and 2018	Rate of Occurrence or Annual Number of Events (average)	Recurrence Interval (in years) (# Years/Number of Events)	Probability of Event in any given year	% chance of occurrence in any given year
Drought	45	0.67	1.51	0.66	66.18

Source: FEMA 2018; NOAA-NCEI 2018; NRCC 2018

It is estimated that Burlington 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. The table below shows the probability of future drought events in the county.

In Section 5.3, the identified hazards of concern for Burlington 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 drought in the county is considered 'frequent' (likely to occur within 25 years, as presented in Table 5.3-3).

Climate Change Impacts

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 2015). With an overall increase in temperature, drought conditions may become more frequent.

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 Burlington County.

5.4.2.2 VULNERABILITY ASSESSMENT

To understand risk, a community must evaluate its assets that are exposed or vulnerable to the identified hazard. Regarding the drought hazard, all of Burlington County is exposed. Therefore, all assets within the County (population, structures, critical facilities, and lifelines), as described in the County Profile (Section 4), are potentially vulnerable to a drought. Areas at particular risk are areas used for agricultural purposes (farms and cropland), open/forested land vulnerable to the wildfire hazard, densely-populated areas where communities rely on surface water supplies (above ground reservoirs) for industrial, commercial, and domestic purposes, and certain areas where elderly, impoverished or otherwise vulnerable populations are located. The following text evaluates and estimates the potential impact of the drought hazard on the County. Refer to Section 5.2 for additional details on the methodology used to assess drought risk.

Impact on Life, Health and Safety

The entire population of Burlington County is vulnerable to drought events (population of 450,236 people, according to U.S. Census 2016 population estimates) (U.S. Census Bureau 2016). Drought conditions can cause a shortage of water for human consumption and reduce local fire-fighting capabilities.

The impacts on public health from drought can be severe which includes increase in heat-related illnesses, waterborne illnesses, recreational risks, limited food availability, and reduced living conditions. Those individuals who rely on water, such as farmers, may experience financial-related stress. Decreased amounts and quality of water during drought events have the potential to reduce the availability of electricity (hydropower, coal-burning and nuclear) (North Carolina State University 2013). 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.

Drought conditions can affect people's health and safety including health problems related to low water flows and poor water quality; and health problems related to dust. Droughts also have the potential to lead to loss of human life (NDMC 202). 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 2012).

According the USGS Water Science School, groundwater levels are dependent on recharge from infiltration of precipitation, so when a drought hits the land surface, it can impact the water levels below ground. When rainfall is less than normal for several weeks, months, or years, the flow of streams and rivers declines, water levels in lakes and reservoirs fall, and the depth to water in wells increases. If dry weather persists and water-supply problems develop, the dry period can become a drought.

The water level in the aquifer that supplies a well does not always stay the same. Droughts, seasonal variations in rainfall, and pumping affect the height of the groundwater levels. If a well is pumped at a faster rate than the aquifer feeding it is recharged by precipitation or other underground flow, then water levels in the well can be lowered. This can happen during drought, due to the extreme deficit of rain. The water level in a well can also be lowered if other wells near it are withdrawing too much water (USGS 2019).

Drought affects groundwater sources, but generally not as quickly as surface water supplies. Groundwater supplies generally take longer to recover. Reduced precipitation during a drought means that groundwater supplies are not replenished at a normal rate. This can lead to a reduction in groundwater levels and problems such as reduced pumping capacity or wells going dry. Shallow wells are more susceptible than deep wells. Reduced replenishment of groundwater affects streams also. Much of the flow in streams comes from groundwater, especially during the summer when there is less precipitation and after snowmelt ends. Reduced

groundwater levels mean that even less water will enter streams when steam flows are lowest. Burlington County water supplies are primarily sourced from groundwater, while the remaining supply is soured from surface water. The following table provides the drinking water suppliers for Burlington County.

Table 5.4.2-**4.** Drinking Water Suppliers in Burlington County

Name	Population Served	Source Type
Albert C Wagner Youth Co	2,500	Ground water
Allenwood Estates, Llc	135	Ground water
Aqua Nj - California Village	300	Ground water
Aqua Nj - Hanover Mobile Village	285	Ground water
Aqua Nj - Spartan Village	471	Ground water
Blueberry Estates	75	Ground water
Bordentown Water Departm	15,821	Ground water
Burlington City Water De	9,835	Surface water
Burlington County Instit	500	Ground water
Burlington Twp W Dept	22,594	Surface water purchased
Buttonwood Mobile Home Park	55	Ground water
Cedar Grove Apartments	96	Ground water
Estaugh Corp T/A Medford Leas	450	Ground water
Evesham Mua	45,538	Surface water purchased
Fawn Lake Village	300	Ground water
Fenimore Trailer Park	88	Ground water
Fenimore Woods Mhp	40	Ground water
Fieldsboro Water Department	650	Ground water purchased
Florence Twp W Dept	11,214	Ground water
Hanover East Apartments	96	Ground water
Hilltop Mobile Village	200	Ground water
Jbmdl-Dix Main System	12,765	Surface water
Maple Shade Water Department	19,400	Surface water purchased
Maplewood Apartments	55	Ground water
Mcguire Afb	12,227	Ground water
Medford Twp Dept Of Muni	17,272	Ground water
Millstream South Apts	128	Ground water
Mobile Estates Of Southa	700	Ground water
Moorestown Water Dept	20,700	Surface water purchased
Mt Laurel Twp Mua	41,743	Surface water purchased
New Lisbon Development Ctr	2,014	Ground water
Nj American Water - Homestead	2,420	Ground water
Nj American Water - Mount Holly	47,427	Surface water purchased
Nj American Water - Sunbury	888	Ground water
Nj American Water - Vincentown	598	Ground water
Nj American Water - Western	264,586	Surface water
Oakview Leisure Village	250	Ground water

Table 5.4.2-**4.** Drinking Water Suppliers in Burlington County

Name	Population Served	Source Type
Pemberton Borough Water	1,610	Ground water
Pemberton Township Water - Lake Valley	3,500	Ground water
Pemberton Twp Dept Main	12,378	Ground water
Pemberton Twp Water Dept - Pemberton Hei	650	Ground water purchased
Pinefield Apartments	120	Ground water
Pinelands Water Co	4,926	Ground water
Pineview Terrace Incorporated	300	Ground water
Richards Mobile Home Cou	100	Ground water
Souths Mobile Home Park	110	Ground water
Wagon Wheel Estates	84	Ground water
Willingboro Mua	35,000	Ground water
Wrightstown Mua	748	Ground water

Source: EPA 2018

As previously stated, drought conditions can cause shortages in water for human consumption. Droughts can also lead to reduced local firefighting capabilities. The drought hazard is a concern for Burlington County because the county's water is supplied by both surface water and groundwater. Surface water supplies are affected more quickly during droughts than groundwater sources.

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. Approximately 35% of the County's land is forested. Due to Burlington County's largely undeveloped nature, fuel is plentiful for wildfires, particularly in the Pine Barrens. In Burlington County, fuel tends to be most plentiful in areas where development densities are lowest; this works to reduce possible property damages and loss of life (Burlington County HMP 2014). Risk to life and property is greatest in high to extreme wildfire risk areas and 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 WUI zones, including population, structures, critical facilities, lifelines, and businesses, are considered vulnerable to wildfire. Refer Section 5.4.8 for the Wildfire risk assessment for County assets located within the high to extreme wildfire risk areas.

Impact on Critical Facilities

Water supply facilities may be affected by short supplies of water. 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. This is particularly important to Burlington County due to its high amount of acreage devoted to farmland. Also, those critical facilities in and adjacent to the WUI zone are considered vulnerable to wildfire.

Impact on the Economy

Drought can produce a range of impacts that span many sectors of an economy and can reach beyond an area experiencing physical drought. This exists because water is integral to our ability to produce goods and provide services. Direct impacts of drought include reduced crop yield, increased fire hazard, reduced water levels, and

damage to wildlife and fish habitat. The consequences of these impacts illustrate indirect impacts that include: reduction in crop, rangeland, and forest productivity that may result in reduced income for farmers and agribusiness, increased prices for food and timber, unemployment, reduced tax revenues due to reduced expenditures, increased crime, foreclosures, migration, and disaster relief programs. The many impacts of drought can be listed as economic, environmental, or social.

Economic impacts occur in agriculture and related sectors because of the reliance of these sectors on surface and subsurface water supplies. Environmental impacts are the result of damage to plant and animal species, wildlife habitat, and air and water quality, forest and grass fires, degradation of landscape quality, loss of biodiversity, and soil erosion. Social impacts involve public safety, health, conflicts between water users, reduced quality of life, and inequities in the distribution of impacts and disaster relief. A summary of potential impacts associated with drought are identified in Table 5.4.2-5. This table includes only some of the potential impacts of drought.

Table 5.4.2-5. Economic, Environmental, and Social Impacts of Drought

Economic	Environmental	Social
Loss of national economic growth, slowing down of economic development	Increased desertification - damage to animal species	Food shortages
Loss of national economic growth, slowing down of economic development	Reduction and degradation of fish and wildlife habitat	Loss of human life from food shortages, heat, suicides, violence
Damage to crop quality, less food production	Lack of feed and drinking water	Mental and physical stress
Increase in food prices	Disease	Water user conflicts
Increased importation of food (higher costs)	Increased vulnerability to predation	Political conflicts
Insect infestation	Loss of wildlife in some areas and too many in others	Social unrest
Plant disease	Increased stress to endangered species	Public dissatisfaction with government regarding drought response
Loss from dairy and livestock production	Damage to plant species, loss of biodiversity	Inequity in the distribution of drought relief
Unavailability of water and feed for livestock which leads to high livestock mortality rates	Increased number and severity of fires	Loss of cultural sites
Disruption of reproduction cycles (breeding delays or unfilled pregnancies)	Wind and water erosion of soils	Reduced quality of life which leads to changes in lifestyle
Increased predation	Loss of wetlands	Increased poverty
Increased fire hazard - range fires and wildland fires	Increased groundwater depletion	Population migrations
Damage to fish habitat, loss from fishery production	Water quality effects	
Income loss for farmers and others affected	Increased number and severity of fires	
Unemployment from production declines	Air quality effects	
Loss to recreational and tourism industry		
Loss of hydroelectric power		
Loss of navigability of rivers and canals		

A prolonged drought can have a serious economic impact on a community. Increased demand for water and electricity may result in shortages and a higher cost for these resources (FEMA 2005). Industries that rely on water for business may be impacted the hardest (e.g., landscaping businesses). Even though most businesses will still be operational, they may be impacted aesthetically. These aesthetic impacts are most significant to the

recreation and tourism industry. In addition, droughts in another area could impact the food supply/price of food for residents in the county.

When drought conditions persist with little to no relief, water restrictions may be put into place by local or state governments. The agricultural industry is most at risk in terms of economic impact and damage. In exceptional drought conditions, watering of lawns and crops may not be an option. If crops are not able to receive water, farmland will dry out and crops will die. This can lead to crop shortages, which, in turn, increases the price of food (FEMA 1997).

A drought directly or indirectly impacts all people in affected areas. A drought can result in farmers not being able to plant crops or the failure of already planted crops. This results in loss of work for farm workers and those in related food processing jobs. Based on the 2012 Census of Agriculture, there were 838 farms in Burlington County, with 95,899 acres of total land in farms. The average farm size was 114 acres. Burlington County farms had a total market value of products sold of $100.8 million; approximately $96.2 million in crop sales and $4.7 million in livestock sales, averaging $120,390 per farm. The Census indicated that 473 of farm operators reported farming as their primary occupation (USDA 2012). Table 5.4.2-6 shows the acreage of agricultural land exposed to the drought hazard.

Table 5.4.2-6. Agricultural Land in Burlington County in 2012

Number of Farms	Land in Farms (acres)	Total Cropland (acres)	Harvested Cropland (acres)	Irrigated Land (acres)
838	95,899	52,286	48,795	13,123

Source: USDA 2012

The 2012 Census of Agriculture for Burlington County indicated that the top crop items, by acres, in the county are soybeans for beans (19,288 acres); corn for grain (7,557 acres); vegetables for sale (5,071 acres); forage-land used for all hay and haylage, grass silage, and greenchop (4,663 acres); and wheat for grain (2,664 acres) (USDA 2012).

Impact on the Environment

A common effect of drought is fish and wildlife mortality. Burlington County is largely rural has diverse populations of fish and wildlife. Its wetlands, scrub pine and oak woodlands, and Atlantic white cedar forests shelter a wide variety of wildlife, while abundant creeks, estuaries and aquifers provide essential water resources. Nine different threatened and endangered species reside in Burlington County. The New Jersey Pinelands, which cover approximately 64 percent of the county's land area, is the largest pine barrens complex in the world. It supports globally rare communities and species and is an area of national significance, supporting: five federally listed threatened and endangered species, 17 federal candidate species and species of concern, and 54 state listed threatened and endangered species. Because so much of the land area in Burlington County is undeveloped, fish and wildlife habitats are high and therefore losses to fish and wildlife could likely be high (Burlington County HMP 2014).

Future Growth and Development

As discussed in Section 4, areas targeted for future growth and development have been identified across Burlington County. Future growth could impact the amount of potable water available due to a drain on the available water resources. Other areas that could be impacted include agriculture and recreational facilities such as golf courses, farms, and nurseries. Areas targeted for potential future growth and development in the next five years have been identified across the county at the municipal level. Refer to the jurisdictional annexes in Volume II of this HMP for a list of new developments in each municipality.

Effect of Climate Change on Vulnerability

Nearly every region in the country is facing some increased risk of seasonal drought. Climate change can significantly affect the sustainability of water supplies in the future. As parts of the United States get drier, the amount and quality of water available will likely decrease, impacting people's health and food supplies. Western United States have already been experiencing water shortages due to severe dry-spells. With climate change, the entire country will likely face some level of drought. A report by the Natural Resources Defense Council (NRDC) found that 1,100 counties (one-third of all counties in the contiguous 48 states) face higher risks of water shortages by mid-century as a result of climate change. More than 400 of these counties will face extremely high risks of water shortages.

An increased incidence of drought may impact availability of water supplies, primarily placing an increased stress on the population. It is unlikely that structure exposure and vulnerability would increase as a direct result of drought, although secondary impacts of drought, such as wildfire, may increase and threaten structures. If a wildfire were to occur during a drought, emergency services may face complications from a water shortage depending on their water source. Critical water-related service sectors may need to adjust management practices and actively manage resources. Increased incidence of drought may also increase the potential for impacts on the local economy including the production of agricultural products.

Change of Vulnerability Since 2014 HMP

When examining the change in the county's vulnerability to drought events from the 2014 HMP to this update, it is important to look at each entity that is exposed and vulnerable. The total population across the county has continued to increase over the past few years, which will place a greater stress on the water supply during a drought event. In terms of the agricultural industry for Burlington County, since the 2007 Census of Agriculture there has been an 9.1-percent decrease in the total number of farms, while an 11.1-percent increase in total farmland area; the average size of a farm has also increased by 11.8-percent (USDA 2012).

5.4.3 EARTHQUAKE

The following section provides the hazard profile (hazard description, location, extent, previous occurrences and losses, probability of future occurrences, and impact of climate change) and vulnerability assessment for the earthquake hazard in Burlington County.

2019 HMP UPDATE CHANGES

- The hazard profile has been significantly enhanced to include a detailed hazard description, location, extent, previous occurrences, probability of future occurrence, and potential change in climate and its impacts on the earthquake hazard is discussed.
- New and updated figures from federal and state agencies are incorporated. U.S. 2010 Census data was incorporated, where appropriate.
- Previous occurrences were updated with events that occurred between 2013 and 2018.
- A vulnerability assessment was conducted for the earthquake hazard that provides a quantitative analysis of exposure and potential losses to Burlington County.

5.4.3.1 PROFILE

Hazard Description

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 the rarer plate interior-related earthquakes 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).

According to the U.S. Geological Society (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:

- *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. Liquefaction susceptibility is determined by the geological history, depositional setting, and topographic position of the soil. 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.
- *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 2012).

Location

Earthquakes are most likely to occur in the northern parts of New Jersey; however, low-magnitude events occur throughout the state, including Burlington County. 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 5.4.3-1, 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. Studies have not yet been conducted by NJGWS to determine the NEHRP classifications for Burlington County; however, other New Jersey agencies have compiled similar data on soil classification for the county.

Table 5.4.3-1. 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 2016

New Jersey Department of Transportation (NJDOT) compiled a report on seismic design consideration for bridges in New Jersey, dated March 2012. In the report, NJDOT classifies the seismic nature of soils according to the American Association of State Highway and Transportation Officials (AASHTO) Guide Specifications for Bridge Seismic Design (SGS). For the purpose of seismic analysis and design, sites can be classified into Soil Classes A, B, C, D, E and F, ranging from hard rock to soft soil and special soils (similar to the NEHRP soil classifications with an additional class F); refer to Table 5.4.3-2.

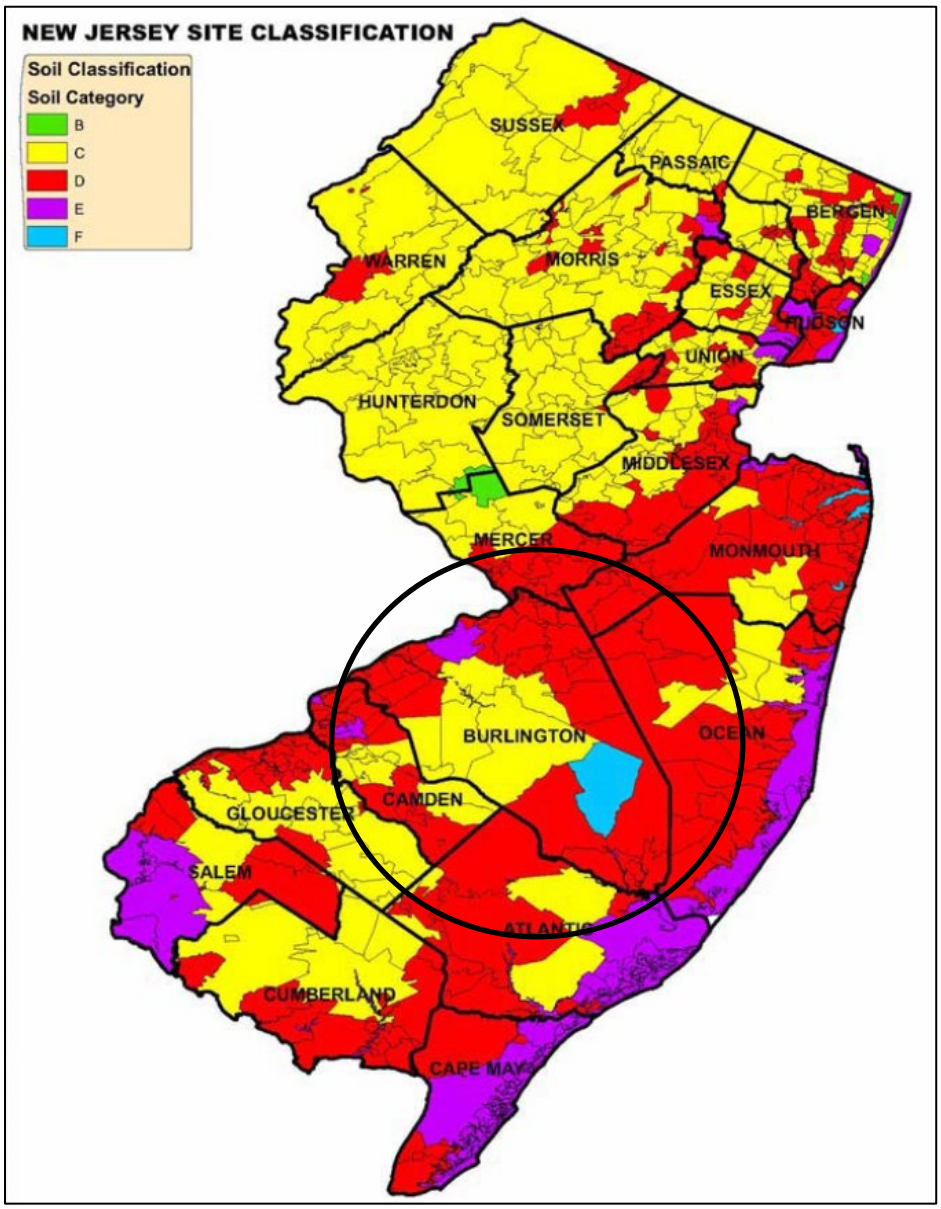
Table 5.4.3-2. NJDOT Soil Classifications

Soil Classification	Description
A-B	Rock sites
C	Very dense soil
D	Dense soil
E	Soft soil
F	Special soil requiring site-specific analysis

Source: NJDOT 2012

NJDOT also developed a Geotechnical Database Management System, which contains soil boring data across New Jersey. The soil boring logs were then used to classify soil sites. Through this analysis, NJDOT developed a map of soil site classes according to ZIP codes in New Jersey where each ZIP code was assigned a class based on its predominant soil condition. In Burlington County, most ZIP codes were rated as a Categories C and D, and a few were rated as Categories E and F. Figure 5.4.3-1 provides a visual confirmation of this information.

Figure 5.4.3-1. ZIP Code-Based Soil Site Class Map



Source: *NJDOT 2012*

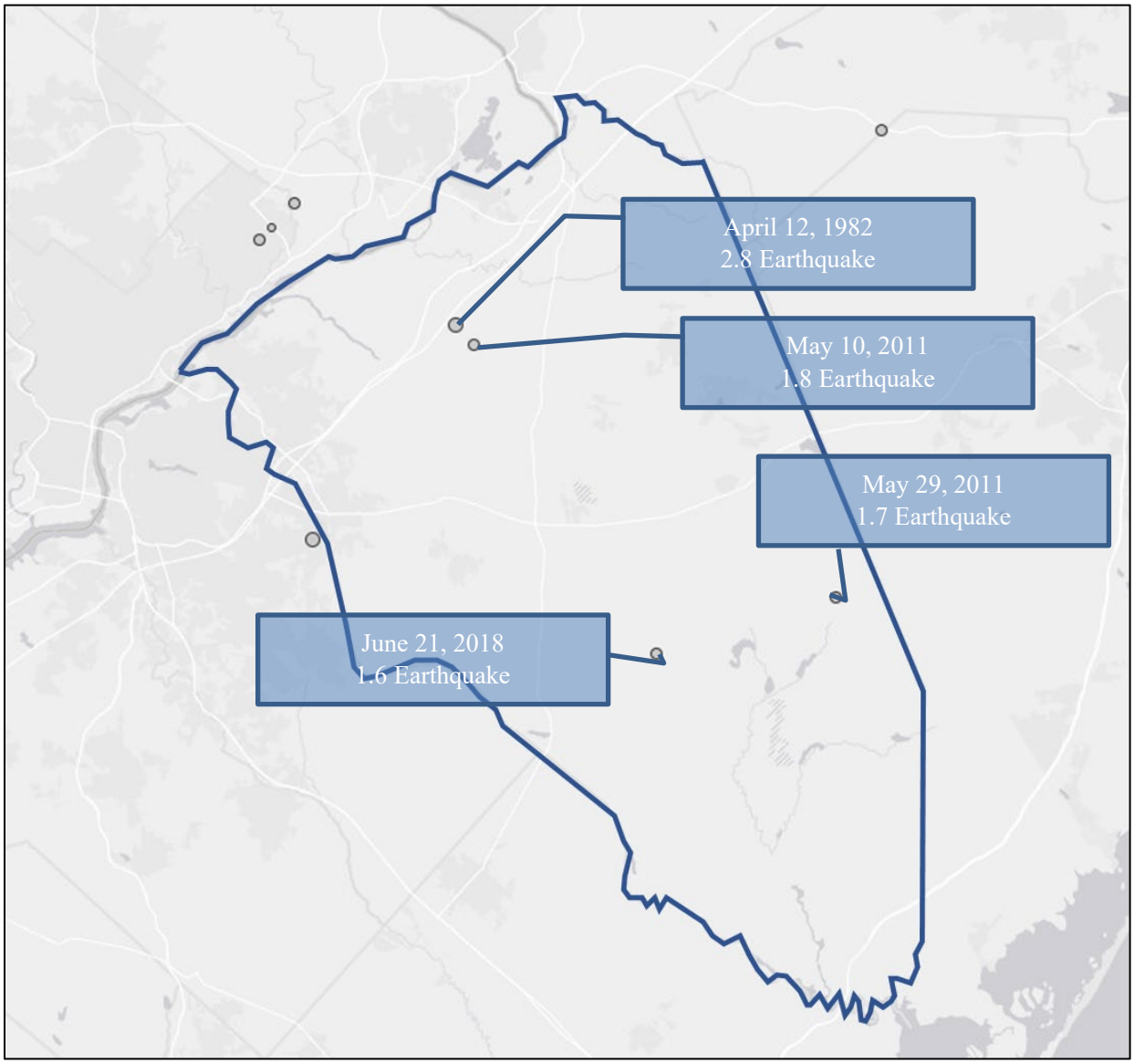
Note: *Burlington County is indicated by the black circle.*
Soil Classes A and B are rock sites
Soil Class C is very dense soil
Soil Class D is dense soil
Soil Class E is soft soil
Soil Class F is special soil requiring site-specific analysis

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. Although liquefaction susceptibility will vary throughout the County, the majority of the County most likely has a low to very low susceptibility (NJDOT 2012).

Liquefaction occurs in saturated soils and when it occurs, the strength of the soil decreases and the ability of a soil deposit to support foundations for buildings and bridges is reduced. Shaking from earthquakes often triggers an increase in water pressure which can trigger landslides and the collapse of dams. For information regarding dam failures, refer to Section 5.4.4 (Flood) and for landslides refer to Section 5.4.5 (Landslides). On the other side, earthquakes contribute to landslide hazards. Earthquakes create stresses that make weak slopes fail. Earthquakes of magnitude 4.0 or greater have been known to trigger landslides.

Figure 5.4.3-2 illustrates historic earthquake epicenters in and surrounding Burlington County between 1950 and 2018. According to this figure, there have been four earthquakes with epicenters in Burlington County (April 1982, May 2011 [2], and June 2018). In addition to those in Burlington County, there have been numerous earthquakes originating outside of the county that may have been felt within the county. For details regarding these events, please refer to

Figure 5.4.3-2. Earthquake Epicenters in Burlington County and the Surrounding Area, 1950 – 2018



Source: *USGS 2018*
Note: *Burlington County is outlined in blue*

Extent

An earthquake's magnitude and intensity are used to describe the size and severity of the event. Magnitude is commonly expressed by ratings on the moment magnitude scale (M_W), the most common scale used today. It has replaced the Richter Scale. For very large earthquakes, moment magnitude gives the most reliable estimates of earthquake size. It measures earthquake strength based on the amount of energy released by calculating size of the fault, amount of movement, and type of rock (stiffness) (USGS 2018). 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

The most commonly used intensity scale is the modified Mercalli intensity scale (MMI). It expresses intensity of an earthquake and describes how strong a shock was felt at a particular location in values. Table 5.4.3-3 shows the ratings of the MMI as well as the perceived shaking and damage potential for structures.

Table 5.4.3-3. Mercalli Scale and Peak Ground Acceleration Comparison

Modified Mercalli Scale	Perceived Shaking	Potential Structure Damage		Estimated PGA (%g)
		Resistant Buildings	Vulnerable Buildings	
I	Not Felt	None	None	< .17
II	Weak	None	None	.17 – 1.4
III	Weak	None	None	.17 – 1.4
IV	Light	None	None	1.4 – 3.9
V	Moderate	Very Light	Light	3.9 – 9.2
VI	Strong	Light	Moderate	9.2 – 18
VII	Very Strong	Moderate	Moderate/Heavy	18 – 34
VIII	Severe	Moderate/Heavy	Heavy	34 – 65
IX	Violent	Heavy	Very Heavy	65-124
X	Extreme	Very Heavy	Very Heavy	>124

Source: USGS 2014; Freeman et al. (Purdue University) 2004
Note: PGA Peak Ground Acceleration

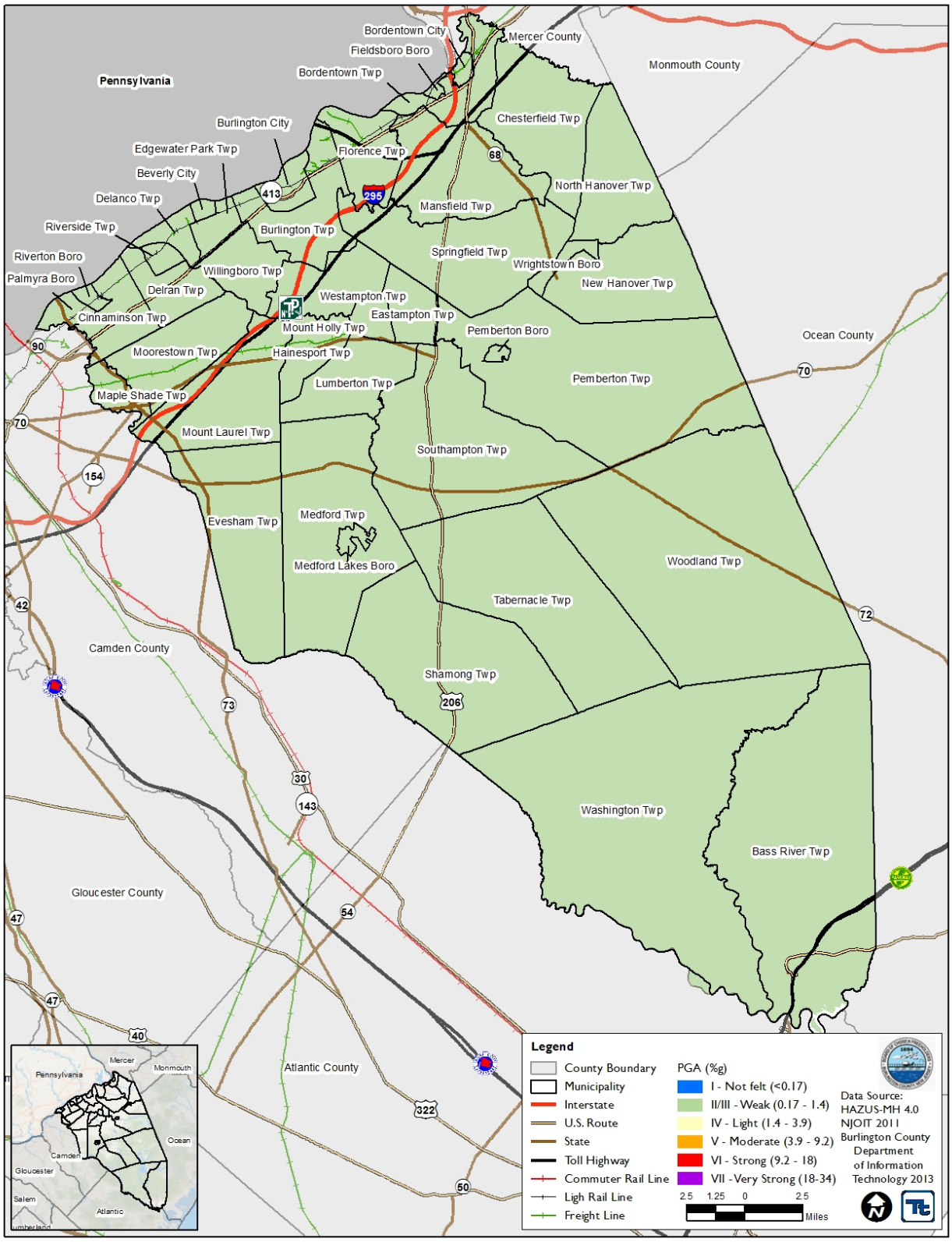
National maps of earthquake shaking hazards have been produced since 1948. They provide information essential to creating and updating the seismic design requirements for building codes, insurance rate structures, earthquake loss studies, retrofit priorities and land use planning used in the United States. Scientists frequently revise these maps to reflect new information and knowledge. Buildings, bridges, highways and utilities built to meet modern seismic design requirements are typically able to withstand earthquakes better, with less damages and disruption. 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, which superseded the 2008 maps. 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. According to

the data, Burlington County has a PGA between 2%g and 3%g (USGS 2014). The 2014 PGA map can be found at https://earthquake.usgs.gov/hazards/hazmaps/conterminous/index.php#2014

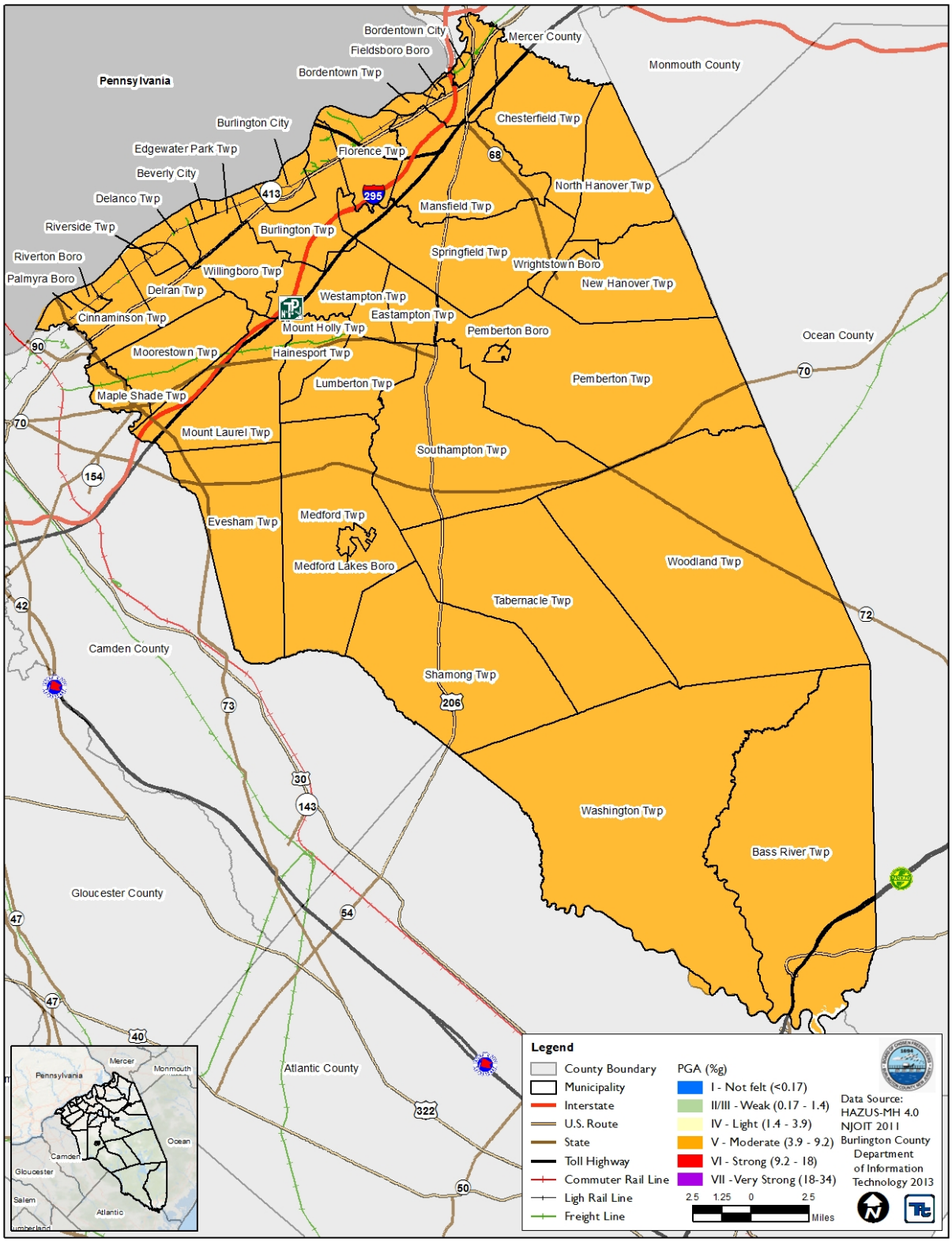
A probabilistic assessment was conducted for the 100-, 500- and 2,500-year mean return periods (MRP) in HAZUS-MH 2.2 to analyze the earthquake hazard for Burlington County. The HAZUS analysis evaluates the statistical likelihood that a specific event will occur and what consequences will occur. Figure 5.4.3-3 through Figure 5.4.3-5 illustrates the geographic distribution of PGA (*g*) across the County or 100-, 500- and 2,500-year MRP events by Census-tract.

Figure 5.4.3-3. Peak Ground Acceleration 100-Year Mean Return Period for Burlington County



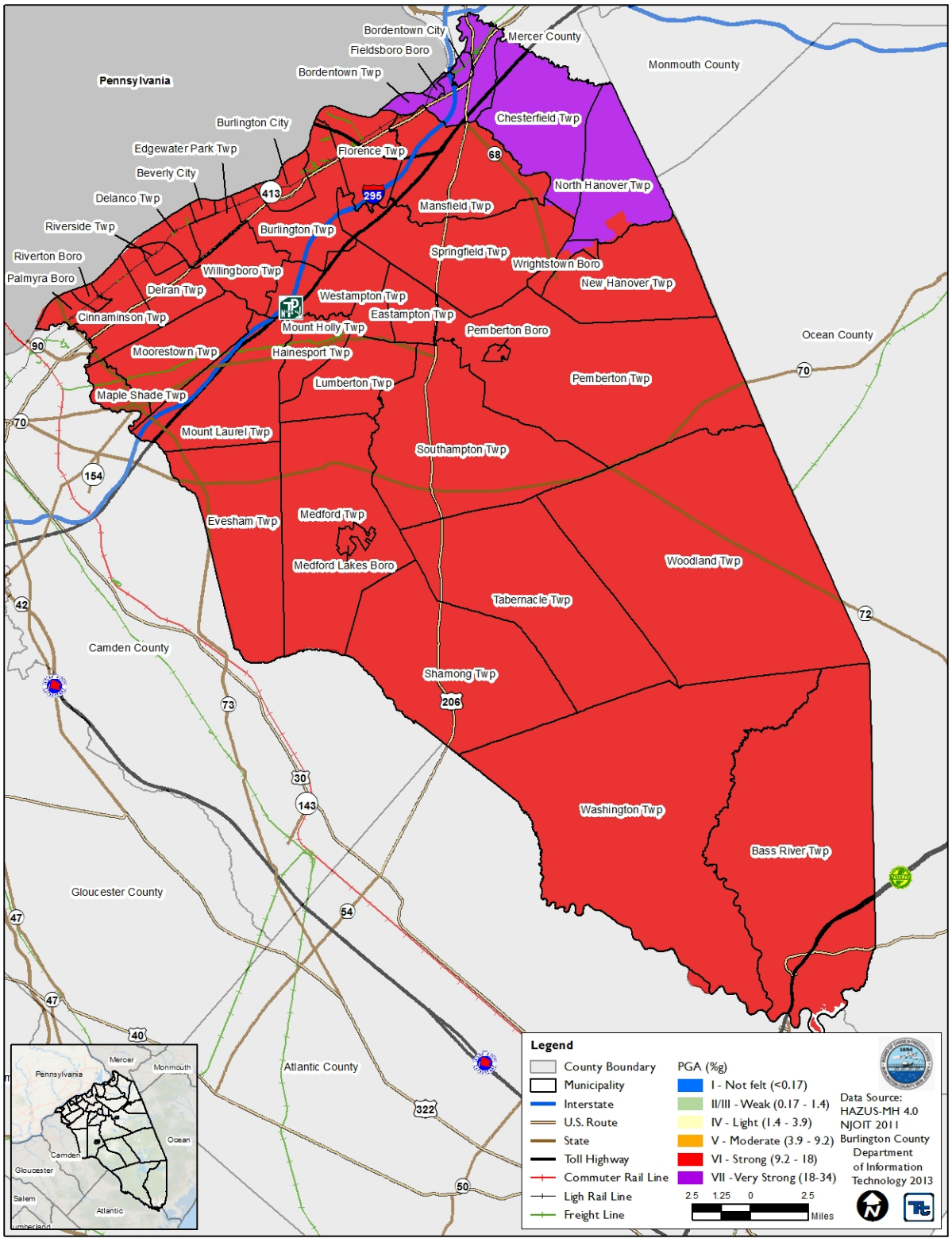
Note: The peak ground acceleration for the 100-year MRP is 1.24 to 1.40 %g.

Figure 5.4.3-4. Peak Ground Acceleration 500-Year Mean Return Period for Burlington County



Note: The peak ground acceleration for the 500-year MRP is 4.43 to 5.58 %g.

Figure 5.4.3-5. Peak Ground Acceleration 2,500-Year Mean Return Period for Burlington County



Note: The peak ground acceleration for the 2,500-year MRP is 13.43 to 18.66 %g.

Previous Occurrences and Losses

Historically, New Jersey and Burlington County have not experienced a major earthquake. Between 1954 and 2017, the State of New Jersey was not included in any FEMA earthquake-related major disaster (DR) or emergency (EM) declarations (FEMA 2018). However, there have been a number of earthquakes of relatively low intensity. The majority of earthquakes that have occurred in New Jersey have occurred along faults in the central and eastern Highlands, with the Ramapo fault being the most seismically active fault in the region (Volkert and Witte 2015). Small earthquakes may occur several times a year and generally do not cause significant damage. The strongest earthquake with an epicenter in Burlington County was a 3.0 quake in Medford Lakes in 1980.

According to the New Jersey Geological and Water Survey (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 5.4.3-6 illustrates earthquake events where the epicenters were located in Burlington County. The figure shows that 10 earthquakes had epicenters in the county (NJGWS 2018).

In Burlington County, between 2013 and 2018, there was one earthquake that had an epicenter in the County. In addition, a 4.4 quake in Dover, Delaware in 2017 was felt in Burlington County. For events prior to 2013, refer to Appendix G (Supplementary Data). Please note that many sources were researched for historical information regarding earthquake events in Burlington County; therefore, not all earthquake events that have impacted the County may be included. Additionally, not all sources may have been identified or researched. Loss and impact information could vary depending on the source.

Figure 5.4.3-6. Earthquakes with Epicenters in Burlington County, 1877 to 2018

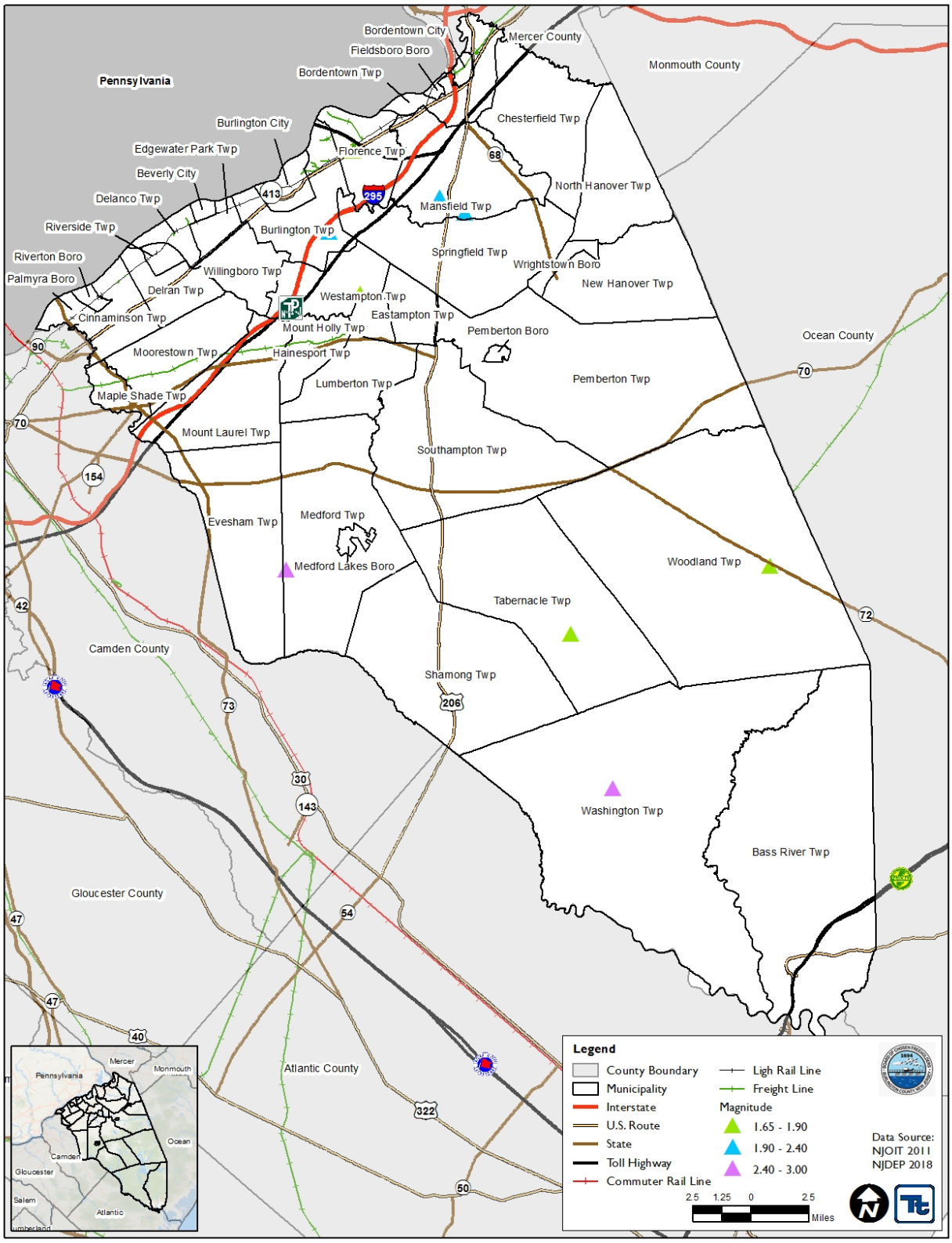


Table 5.4.3-4. Earthquake Events Impacting Burlington County, 2013 to 2018

Dates of Event	Event Type	Location	FEMA Declaration Number (if applicable)	County Designated?	Losses / Impacts
November 30, 2017	4.1 Earthquake	Dover, Delaware	N/A	N/A	Burlington County residents felt ground shake from nearby 4.1 magnitude earthquake in Dover, Delaware. The quake was felt from central Virginia to Massachusetts.
June 21, 2018	1.6 Earthquake	Tabernacle Township	N/A	N/A	A "microquake" was centered near Southampton. No damage was reported.
September 17, 2018	1.2 Earthquake	Washington Township	N/A	N/A	No losses and/or damages reported for this event

Sources: FEMA 2018; USGS 2018; NJGWS 2018, Press of AC 2018
FEMA Federal Emergency Management Agency
USGS United States Geological Survey
NJGWS New Jersey Geological and Water Survey

Probability of Future Occurrences

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

Earthquake hazard maps illustrate the distribution of earthquake shaking levels that have a certain probability of occurring over a given time period. According to the USGS, in 2014 (the date of the most recent analysis), Burlington County had a PGA of 2-3%g for earthquakes with a 10-percent probability of occurring within 50 years.

According to USGS and NJGWS, Burlington County has experienced 10 earthquakes with epicenters in the county. The table below shows these statistics, as well as the annual average number of events and the percent chance of earthquakes occurring in Burlington County in future years (USGS 2018; NJGWS 2018). In addition to earthquakes centered within the county, numerous earthquakes located outside of the county have also directly and indirectly impacted Burlington County. However, since impacts of these earthquakes are difficult to quantify, they are not considered in Table 5.4.3-5.

Table 5.4.3-5. Probability of Future Occurrence of Earthquake Events

Hazard Type	Number of Occurrences Between 1877 and 2018	Rate of Occurrence or Annual Number of Events (average)	Recurrence Interval (in years) (# Years/Number of Events)	Probability of Event in any given year	Percent chance of occurrence in any given year
Earthquake with Epicenter inside County	10	0.15	6.90	0.14	14.49%

Source: NJGWS 2015

Earlier in this section, the identified hazards of concern for Burlington 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 earthquakes in the County is considered "occasional" (is likely to occur within 100 years as presented in Table 5.3-3). It is anticipated that the County will experience indirect impacts from earthquakes that may affect the general building stock, local economy and may induce secondary hazards such as sporadic ignition of fires and utility failure.

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. 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).

5.4.3.2 VULNERABILITY ASSESSMENT

Earthquake vulnerability data was generated using a HAZUS analysis. A probabilistic assessment was conducted for the 100-, 500- and 2,500-year MRPs through a Level 2 analysis in HAZUS-MH 4.0 to analyze the earthquake hazard and provide a range of loss estimates. Refer to Section 5.1 for additional details on the methodology used to assess earthquake risk.

Impact on Life, Health and Safety

Overall, the entire population of Burlington County is exposed to an earthquake event. The impact of earthquakes on life, health and safety is dependent upon the severity of the event. Risk to public safety and loss of life from an earthquake in Burlington County is minimal with higher risk occurring in buildings as a result of damage to the structure, or people walking below building ornamentation and chimneys that may be shaken loose and fall as a result of the quake.

According to the 2010 U.S. Census, Burlington County had a population of 448,734 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 loose and fall as a result of an earthquake.

Populations considered most vulnerable are those located in/near the built environment, particularly near unreinforced masonry construction. In addition, the vulnerable population includes the elderly (persons over the age of 65) and individuals living below the U.S. Census poverty threshold. These socially vulnerable populations are most susceptible, based on a number of factors including their physical and financial ability to react or respond during a hazard and the location and construction quality of their housing. Refer to Section 4 (County Profile) for the vulnerable population statistics in Burlington County.

Residents may be displaced or require temporary to long-term sheltering due to the 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. HAZUS-MH 4.0 estimated sheltering needs for the earthquake hazard. HAZUS-MH 4.0 estimates there will be no displaced households or people seeking short-term shelter as a result of the 100-year event. Table 5.4.3-6 summarizes the population HAZUS-MH estimates will be displaced or will require short-term sheltering for 500- and 2,500-year MRP by municipality.

Table 5.4.3-**6**. Summary of Estimated Sheltering Needs for Burlington County

Scenario	Displaced Households	Persons Seeking Short-Term Shelter
100-Year Earthquake	0	0
500-Year Earthquake	33	18
2,500-Year Earthquake	382	211

Source: HAZUS-MH 4.0
Note: The number of displaced households and persons seeking shelter was calculated using the 2010 U.S. Census data (HAZUS-MH 4.0 default demographic data).

According to the 1999-2003 NYCEM Summary Report (*Earthquake Risks and Mitigation in the New York / New Jersey / Connecticut Region*), there is a strong correlation between structural building damage and the number of injuries and casualties from an earthquake event. Further, the time of day also exposes different sectors of the community to the hazard. For example, HAZUS-MH considers the residential occupancy at its maximum at 2:00 a.m., where the educational, commercial and industrial sectors are at their maximum at 2:00 p.m., and peak commute time is at 5:00 p.m. Whether directly impacted or indirectly impact, the entire population will have to deal with the consequences of earthquakes to some degree. Business interruption could keep people from working, road closures could isolate populations, and loss of functions of utilities could impact populations that suffered no direct damage from an event itself.

There are no injuries or casualties estimated for the 100-year event. Table 5.4.3-7 summarizes the County-wide injuries and casualties estimated for the 500- and 2,500-year MRP earthquake events.

Table 5.4.3-7. Estimated Number of Injuries and Casualties from the 500 and 2,500-Year MRP Earthquake Events

Level of Severity	Time of Day		
	2:00 AM	2:00 PM	5:00 PM
500-year			
Injuries	12	18	13
Hospitalization	1	2	2
Casualties	0	0	0
2,500-Year			
Injuries	108	169	123
Hospitalization	18	30	21
Casualties	3	5	4

Source: HAZUS-MH 4.0

Impact on General Building Stock

The entire county's general building stock is considered at risk and exposed to this hazard. The HAZUS-MH 4.0 model estimates the value of the exposed building stock and the loss (in terms of damage to the exposed stock). Refer to the County Profile (Section 4) for general building stock statistics (structure and contents).

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 model was applied to analyze effects from the earthquake hazard on general building stock in Burlington County. See Figure 5.4.3-3 through Figure 5.4.3-5 earlier in this profile that 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 un-reinforced 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 contribute to a building's capability to withstand an earthquake's force include its age, number of stories and quality of construction. HAZUS-MH considers building construction and the age of buildings as part of the analysis.

Potential building damage was evaluated by HAZUS-MH 4.0 across the following damage categories (none, slight, moderate, extensive and complete). Table 5.4.3-8 provides definitions of these five categories of damage for a light wood-framed building; definitions for other building types are included in HAZUS-MH technical manual documentation. General building stock damage for these damage categories by occupancy class and building type on a county-wide basis is summarized below for the 100-, 500- and 2,500-year events.

Table 5.4.3-8. 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 may have large permanent lateral displacement, may collapse, or be in imminent danger of collapse due to cripple wall failure or the failure of the lateral load resisting system; some structures may slip and fall off the foundations; large foundation cracks.

Source: HAZUS-MH Technical Manual

The value of general building stock exposed to and damaged by 100-, 500-, and 2,500-year MRP earthquake events were evaluated and annualized losses were calculated via HAZUS-MH. Table 5.4.3-9 below lists estimated numbers of buildings damaged (within general occupancy categories) during 500- and 2,500-year MRP earthquake events; no building damages are expected as a result of the 100-year MRP event. Damage loss estimates include structural and non-structural damage to the building and loss of contents. Table 5.4.3-10 summarizes the damage estimated for the 500- and 2,500-year MRP earthquake events. No damages are estimated as a result of the 100-year MRP earthquake event. Damage loss estimates include structural and non-structural damage to the building and loss of contents. The total cost of all damage estimates for both mean return periods is less than 1% of total replacement cost value for each municipality.

Table 5.4.3-9. Estimated Number Buildings Damaged by the 500-year and 2,500-year MRP Earthquake Events

	Average Damage State									
	500-Year MRP					2,500-Year MRP				
Category	None	Slight	Moderate	Extensive	Complete	None	Slight	Moderate	Extensive	Complete
Residential	145,155 (83.9%)	1,959 (1.1%)	440 (<1%)	50 (<1%)	5 (<1%)	129,799 (75.0%)	13,676 (7.9%	3,480 (2.0%)	532 (<1%)	71 (<1%)
Commercial	7,231 (4.2%)	201 (<1%)	60 (<1%)	7 (<1%)	0 (0%)	5,887 (3.4%	977 (<1%)	535 (<1%)	92 (<1%)	9 (<1%)
Industrial	1,460 (<1%)	44 (<1%)	15 (<1%)	2 (<1%)	0 (0%)	1,164 (<1%)	202 (<1%)	127 (<1%)	26 (<1%)	2 (<1%)
Education, Government, Religious and Agricultural	15,887 (9.2%)	437 (<1%)	128 (<1%)	15 (<1%)	0 (0%)	12,933 (7.5%)	2,175 (1.3%	1,136 (<1%)	205 (<1%)	19 (<1%)

Source: HAZUS-MH 4.0

Table 5.4.3-**10**. Estimated Buildings Damaged (Replacement Cost) for the 500- and 2,500-Year MRP Earthquake Events

Municipality	Total Replacement Cost Value (Structure and Contents)	Estimated Total Damages*		
		Annualized Loss	500-Year	2,500-Year
Bass River Township-Washington Township-Woodland Township	$3,282,092,309	$23,023	$1,492,383	$21,157,418
Beverly City	$471,487,138	$3,736	$256,547	$3,789,551
Bordentown City	$1,244,995,904	$14,478	$928,772	$13,957,621
Bordentown Township	$916,111,126	$10,648	$686,415	$10,318,820
Bordentown Township-Fieldsboro Borough	$2,043,301,247	$23,292	$1,489,167	$22,126,226
Burlington City	$3,215,233,092	$30,491	$2,015,192	$29,455,384
Burlington Township	$8,013,259,672	$73,275	$4,851,686	$72,052,936
Chesterfield Township	$2,443,294,418	$28,424	$1,772,693	$26,984,602
Cinnaminson Township	$5,703,895,752	$50,443	$3,303,408	$48,658,473
Delanco Township	$1,422,201,479	$11,462	$776,057	$11,537,751
Delran Township	$5,145,622,596	$44,132	$2,951,059	$43,245,088
Eastampton Township	$1,687,017,512	$14,701	$979,820	$14,449,572
Edgewater Park Township	$2,307,285,215	$21,072	$1,406,874	$20,723,715
Evesham Township	$14,666,082,424	$109,673	$7,396,226	$108,062,851
Florence Township	$2,787,263,607	$28,077	$1,835,044	$27,278,153
Hainesport Township	$3,447,208,735	$30,464	$1,980,376	$29,503,406
Lumberton Township	$5,459,557,257	$45,002	$3,006,570	$44,294,305
Mansfield Township	$4,056,501,589	$45,429	$2,832,634	$42,434,668
Maple Shade Township	$4,385,500,913	$38,743	$2,575,554	$37,409,263
Medford Borough	$1,280,050,871	$8,204	$560,296	$8,327,863
Medford Township	$12,845,907,494	$94,376	$6,370,740	$92,821,965
Moorestown Township	$10,108,801,626	$87,213	$5,750,456	$84,645,373
Mount Holly Township	$3,498,352,996	$31,498	$2,101,142	$30,582,802
Mount Laurel Township	$14,653,800,804	$112,248	$7,618,995	$111,811,091
New Hanover Township	$1,160,482,516	$14,664	$866,938	$12,963,775
New Hanover Township-Springfield Township-Wrightstown Borough	$1,711,229,964	$21,007	$1,242,763	$18,614,028
North Hanover Township	$602,320,488	$7,193	$434,673	$6,518,868
North Hanover Township-Wrightstown Borough	$2,675,960,726	$30,971	$1,973,744	$29,511,268
Palmyra Borough	$1,788,398,557	$14,997	$1,006,191	$14,723,044
Pemberton Borough	$345,869,906	$3,065	$204,133	$2,950,703
Pemberton Township	$9,786,191,797	$84,177	$5,550,565	$81,983,763
Riverside Township	$2,039,139,951	$17,705	$1,189,807	$17,536,060
Riverton Borough	$916,434,789	$7,242	$495,500	$7,278,074
Shamong Township	$2,742,281,082	$18,070	$1,220,960	$17,435,907
Southampton Township	$6,722,347,774	$57,190	$3,736,462	$54,523,655
Springfield Township	$3,806,921,605	$38,999	$2,488,701	$37,235,016
Tabernacle Township	$3,615,144,116	$25,954	$1,717,417	$24,887,104

Table 5.4.3-**10**. Estimated Buildings Damaged (Replacement Cost) for the 500- and 2,500-Year MRP Earthquake Events

Municipality	Total Replacement Cost Value (Structure and Contents)	Estimated Total Damages*		
		Annualized Loss	500-Year	2,500-Year
Westampton Township	$4,269,433,407	$41,964	$2,702,109	$39,798,267
Willingboro Township	$8,259,747,413	$67,514	$4,595,271	$67,289,902
Burlington County	**$165,526,729,867**	**$1,430,814**	**$94,363,339**	**$1,388,878,330**

Source: HAZUS-MH 4.0
**Total Damages is the sum of damages for all occupancy classes (residential, commercial, industrial, agricultural, educational, religious, and government).*

HAZUS-MH 4.0 estimated that there may be $94.3 million in damages to buildings in the county as a result of a 500-year earthquake event. These includes structural damage, non-structural damage and loss of contents, representing less than 1% of the total improved value for general building stock in Burlington County. For a 2,500-year MRP earthquake event, HAZUS-MH estimates greater than $1.4 billion (<1%) of the total general building stock replacement cost value. Residential and commercial buildings account for most of the damage for earthquake events.

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 relies 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.

Earthquakes can cause secondary hazard events such as fires. Zero fires are anticipated as a result of the 100-, 500- and 2,500-year MRP events.

Impact on Critical Facilities

All critical facilities (essential facilities, transportation systems, lifeline utility systems, high-potential loss facilities and user-defined facilities) in Burlington County are considered exposed and potentially vulnerable to the earthquake hazard. Refer to subsection "Critical Facilities" in Section 4 (County Profile) of this HMP update for a description of the critical facilities in the county.

HAZUS-MH 4.0 estimates the probability that critical facilities may sustain damage as a result of 100-, 500- and 2,500-year MRP earthquake events. The model was used to assign a probability of each damage state to every critical facility in the planning area, which was then averaged across the facility category. Additionally, HAZUS-MH estimates percent functionality for each facility days after the event. Results are presented as probability of being functional at specified time increments. For example, Hazus may 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. As a result of a 100-Year MRP event, HAZUS-MH 4.0 estimates that emergency facilities (police, fire, EMS and medical facilities), schools, utilities and specific facilities identified by Burlington County as critical will be nearly 100% functional with negligible damages. Therefore, the impact to critical facilities is not significant for the 100-year event. Results for the 500- and 2,500-year events are summarized in Table 5.4.3-11 and Table 5.4.3-12.

Table 5.4.3-11. Estimated Damage and Loss of Functionality for Critical Facilities in Burlington County 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
Fire	91-98	2-6	0.5-3	<1	0	91-97	97-99	100	100
Police	91-97	2-6	0.6-3	<1	0	91-97	97-99	100	100
EOC	96-98	2-3	<1	<1	0	96-97	99	100	100
Medical	91	3-6	1-3	<1	0	91-97	97-99	100	100
School	91-98	2-6	0.5-3	<1	0	91-97	97-99	100	100
Senior	96-97	2-3	<1	<1	0	96-97	99	100	100
Shelter	96-98	2-3	0.5-1	<1	0	96-97	99	100	100
Municipal Hall	96-98	2-3	<1	<1	0	96-97	99	100	100

Source: HAZUS-MH 4.0

Table 5.4.3-12. Estimated Damage and Loss of Functionality for Critical Facilities in Burlington County 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
Fire	68-85	10-17	4-11	0.7-3	<1	68-85	85-95	96-99	98-100
Police	68-84	10-17	5-11	1-3	<1	68-84	85-94	93-99	98-100
EOC	76-85	10-15	4-8	0.7-2	<1	76-85	90-95	98-99	99-100
Medical	66-68	13-17	6-11	1-3	<1	66-80	84-92	96-99	98-99
School	68-85	10-17	4-11	0.7-3	<1	68-85	85-95	96-99	98-100
Senior	76-81	12-15	6-8	1-2	<1	76-81	91-93	98-99	100
Shelter	76-85	10-15	4-8	0.7-2	<1	76-85	90-95	98-99	100
Municipal Hall	76-85	10-15	4-8	0.7-2	<1	76-85	91-95	98-99	100

Source: HAZUS-MH 4.0

Impact on Economy

The risk of a damaging earthquake, in combination with the density of value of buildings in New Jersey, place the State 10th among all states for potential economic loss from earthquakes (Stanford 2003).

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. Direct building losses are the estimated costs to repair or replace the damage caused to the building ("Impact on General Building Stock"). Lifeline-related losses include the direct repair cost to transportation and utility systems and are reported in terms of the probability of reaching or exceeding a specified level of damage when subjected to a given level of ground motion. HAZUS-MH 4.0 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 4.0 are summarized in Table 5.4.3-13; no economic losses were estimated for the 100-year MRP event.

Table 5.4.3-13. Building-Related Economic Losses from the 500 and 2,500-Year MRP Earthquake Event

Level of Severity	Mean Return Period	
	500-year	2,500-year
Income Losses		
Wage	$1,970,000	$17,430,000
Capital Related	$700,000	$6,610,000
Rental	$2,790,000	$25,250,000
Relocation	$7,890,000	$74,610,000
Subtotal	**$13,350,000**	**$123,900,000**
Capital Stock Losses		
Structural	$26,380,000	$233,730,000
Non-Structural	$51,830,000	$783,130,000
Content	$16,150,000	$372,030,000
Inventory	$250,000	$5,240,000
Subtotal	**$94,610,000**	**$1,394,120,000**

Source: HAZUS-MH 4.0.

Utility damage results are not considered to be significant as a result of the 100-year and 500-year events. For the 500-year event, there is a 96-percent or greater probability that utilities will not experience any damage; and up to a four-percent probability 'slight' damage could be experienced. Therefore, utility loss estimates as a result of the 100- and 500-year events are not discussed further in this assessment for this HMP. Table 5.4.3-14 summarizes the estimated losses to utilities as a result of the 2,500-year event.

Table 5.4.3-14. Estimated Utility Impacts in Burlington County from 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
Communication	39-83	11-42	6-17	0.3-2	<1	90-96	98-100	99-100	100
Electric	81-85	9-11	5-7	<1	<1	87-95	96-97	99-100	100
Potable Water	43-87	8-41	4-15	0.2-2	<1	72-96	96-99	99-100	99-100
Wastewater	42-85	9-41	5-15	0.2-2	<1	57-89	86-97	97-100	98-100

Source: HAZUS-MH 4.0

Earthquake events can significantly impact road bridges. These are important because they often provide the only access to certain neighborhoods. Since softer soils can generally follow floodplain boundaries, bridges that cross watercourses should be considered vulnerable. A key factor in the degree of vulnerability will be the age of the facility or infrastructure, which will help indicate to which standards the facility was built. HAZUS-MH estimates the long-term economic impacts to the county for 15-years after the 2,500-year earthquake event. In terms of the transportation infrastructure, HAZUS-MH 4.0 estimates $14.7 million in direct repair costs to bridges, highway, railways, bus, and airport facilities. There are no losses computed by HAZUS-MH for business interruption due to transportation or utility lifeline losses.

It is estimated that the airports in Burlington County will be 96-percent functional on day one of the 2,500-year event and an estimated 10-percent probability they will experience slight damage.

HAZUS-MH 4.0 also estimated 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 of these 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 4.0 estimated that no debris would result from the 100-year event. HAZUS-MH 4.0 estimated generation of more than 2,500 tons of debris during the 500-year MRP event, and nearly 14,000 tons of debris during the 2,500-year MRP event. Table 5.4.3-15 below lists estimated County-wide debris amounts by Mean Return Period during 500- and 2,500-year events.

Table 5.4.3-15. Estimated Debris Generated by the 500- and 2,500-year MRP Earthquake Events

Mean Return Period	Brick/Wood (tons)	Concrete/Steel (tons)
500-Year	20,750	6,710
2,500-Year	125,781	78,385

Source: HAZUS-MH 4.0

Future Growth and Development

As discussed in Section 4, areas targeted for future growth and development have been identified across the county. It is anticipated that the human exposure and vulnerability to earthquake impacts in newly developed areas will be similar to those that currently exist within the county. 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. Overall, any new developments in the County will be impacted by earthquakes. Refer to the jurisdictional annexes in Volume II of this HMP for a list of new developments in each municipality.

Effect of Climate Change on Vulnerability

Providing projections of future climate change for a specific region is challenging. 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.

Secondary impacts of earthquakes could be magnified by future climate change. Increased rainfall will lead to changes in soil saturation and increase the risk to liquefaction from seismic activity on more saturated soils. In areas of saturated soils and steep slopes, the County's assets on or at the base of these slopes are at a higher to landslides/mudslides as a result of seismic activity. Seismic activity can also impact the structural integrity of a dam storing increased volumes of water because of changes in flow rates. Failure of the dam would result in flooding of the County's assets located in the inundation area.

Change of Vulnerability Since the 2014 HMP

Burlington County continues to be vulnerable to the earthquake hazard. However, there are differences between the potential loss estimates between this plan update to the results in the 2014 HMP. For the 2019 HMP update, probabilistic scenarios were evaluated using an updated version of HAZUS-MH. In addition, a more current and accurate building stock inventory and critical facility inventory was used for this HMP update.

5.4.4 FLOOD

The following section provides the hazard profile (hazard description, location, extent, previous occurrences and losses, probability of future occurrences, and impact of climate change) and vulnerability assessment for the flood hazard in Burlington County.

2019 HMP UPDATE CHANGES

- The hazard profile has been significantly enhanced to include a detailed hazard description, location, extent, previous occurrences, probability of future occurrence, and potential change in climate and its impacts on the flood hazard is discussed. The flood hazard is now located in Section 5 of the plan update.
- New and updated figures from federal and state agencies are incorporated.
- Previous occurrences were updated with events that occurred between 2012 and 2018.
- A vulnerability assessment was conducted for the flood hazard and it now directly follows the hazard profile.

5.4.4.1 PROFILE

Hazard Description

Floods are one of the most common natural hazards in the United States. 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 and multiple counties or states). Most communities in the U.S. have experienced some kind of flooding after spring rains, heavy thunderstorms, coastal storms, or winter snow thaws (George Washington University 2001). 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.

Many floods fall into three categories: riverine, coastal, and shallow (FEMA 2007). Other types of floods may include ice-jam floods, alluvial fan floods, dam failure floods, and floods associated with local drainage or high groundwater (as indicated in the previous flood definition). Flooding in Burlington County can be the result of heavy rainfall produced by hurricanes or thunderstorms; flash flooding; ice jams and severe winter storms. For the purpose of this HMP, and as deemed appropriate by the Burlington County Planning Committee, riverine/flash flooding, coastal flooding, and dam failure floods are the main flood types of concern for the county. These types of flood are further discussed below.

Riverine/Flash Floods

Riverine floods occur along a channel and include overbank and flash flooding. Channels are defined, ground features that carry water through and out of a watershed. They may be called rivers, creeks, streams, or ditches. When a channel receives too much water, the excess water flows over its banks and inundates low-lying areas (The Illinois Association for Floodplain and Stormwater Management 2006).

A flash flood is:

> "a rapid and extreme flow of high water into a normally dry area, or a rapid water level rise in a stream or creek above a predetermined flood level, beginning within six hours of the causative event (e.g., intense rainfall, dam failure, ice jam). However, the actual time threshold may vary in different parts of the country. Ongoing flooding can intensify to flash flooding in cases where intense rainfall results in a rapid surge of rising flood waters" (National Weather Service [NWS] 2009).

Additionally, riverine flooding can lead to stormwater and urban drainage flooding in Burlington County. Stormwater flooding described below is due to local drainage issues and high groundwater levels. Locally, heavy precipitation may produce flooding in areas other than delineated floodplains or along recognizable channels. If local conditions cannot accommodate intense precipitation through a combination of infiltration and surface runoff, water may accumulate and cause flooding problems. During winter and spring, frozen ground and snow accumulations may contribute to inadequate drainage and localized ponding. Flooding issues of this nature generally occur in areas with flat gradients and generally increase with urbanization which speeds the accumulation of floodwaters because of impervious areas. Shallow street flooding can occur unless channels have been improved to account for increased flows (FEMA 1997).

High groundwater levels can be a concern and cause problems even where there is no surface flooding. Basements are susceptible to high groundwater levels. Seasonally high groundwater is common in many areas, while elsewhere high groundwater occurs only after long periods of above-average precipitation (FEMA 1997).

Urban drainage flooding is caused by increased water runoff due to urban development and drainage systems. 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. They 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. Since 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 (FEMA 2007).

Coastal Flooding

Coastal flooding occurs along the coasts of oceans, bays, estuaries, coastal rivers, and large lakes. 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. They are a result of the storm surge where local sea levels rise often resulting in weakened or destroyed coastal structures. Hurricanes and tropical storms, severe storms, and Nor'Easters cause most of the coastal flooding in Burlington County. Coastal flooding has many of the same problems identified for riverine flooding but also has additional problems such as 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. Coastal structures can include sea walls, piers, bulkheads, bridges, or buildings (FEMA 2011).

There are several forces that occur with coastal flooding:

- *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).

Dam Failure Flooding

A dam is an artificial barrier that can impound water, wastewater, or any liquid-borne material for the purpose of storage or control of water (FEMA 2007). Dams are man-made structures built across a stream or river that impound water and reduce downstream flow (FEMA 2003). They are built for purposes of power production, agriculture, water supply, recreation, and flood protection. Dam failure is any malfunction or abnormality outside of the design that adversely affects a dam's primary function of impounding water (FEMA 2007). Dams can fail for one or a combination of the following reasons:

- Overtopping caused by floods that exceed the capacity of the dam (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
- Earthquake (liquefaction/landslides) (FEMA 2013)

A break in a dam can produce extremely dangerous flood situations because of the high velocities and large volumes of water released by such a break. Sometimes dam breaks can occur with little to no warning. Breaching of dams often occurs within hours after the first visible sign of dam failure, leaving little or no time for evacuation (FEMA 2013).

Location

Burlington County and its jurisdictions experience many types of flooding. While none of the County's municipalities directly border the Atlantic Ocean or Great Bay, many waterways are influenced by the tides for at least some of their reaches. Flooding in Burlington County ranges from tidal and riverine flooding to shallow flooding which result from urban drainage issues (Burlington County HMP 2013). Please refer to Section 4 (County Profile) for detailed information regarding the river basins and the hydrography/hydrology of Burlington County.

The December 2017 Preliminary Flood Insurance Study (FIS) for Burlington County describes the principal flood problems for the county and municipalities. The information from the FIS is presented in Table 5.4.4-1.

Table 5.4.4-1. Principal Flood Problems in Burlington County

Flooding Source	Description of Flood Problems
All Sources	• Most flooding in Burlington County occurs during the summer and early fall months; however, floods have occurred at different times throughout the year. Portions of Burlington County experience tidal flooding from the Delaware River caused by extremely high tides, hurricane activity and tropical storms. • Township of Lumberton – flooding is primarily due to torrential rains during summer and autumn months. • Township of Mount Holly – flooding is primarily due to continental and ocean-bred storms resulting in both riverine and tidal flooding. Mount Holly is affected by tidal surge of the Delaware River. Tidal backwater from the Delaware River affects inland locations in Mount Holly • Township of Mount Laurel – all streams are flooding sources.
Assiscunk Creek	• City of Burlington - Riverine and tidal flooding impact the City of Burlington and has caused heavy flooding damage in the area of U.S. Route 130, combined with the effects from the Delaware River.
Bass River	• Township of Bass River – flooding occurs at Bass River near Allens Dock at U.S. Route 9; at East Branch Bass River near Stage Road; and the Merrygold Branch of Wading River at Hammonton Road. All these flooding problems are affected by tidal flooding from the Great Bay
Beaverdam Creek	• Township of Southampton – primary flooding source due to torrential rains during summer and autumn months.
Delaware River	• Subject to flooding from intense rainfall runoff and is also subject to tidal • flooding caused by extremely high tides, hurricane activity, or tropical storms. The Delaware River causes flooding in the Borough of Palmyra, and the Cities of Bordentown and Burlington; the Township of Bordentown, Burlington, Cinnaminson, Delcano, Delran, Florence, Hainesport, Mansfield • Township of Cinnaminson – high tides on the Delaware River produce major flooding in Pompeston Creek's lower reaches • Borough of Palmyra – flows through the tidal flatlands creating flooding.
East Branch	• Township of Cinnaminson – East Branch is easily overflows its banks during storms of high intensity and short duration
Jacks Run	• Borough of Riverton and Township of Cinnaminson – Jacks Run is easily overflows its banks during storms of high intensity and short duration. Urbanization in the vicinity of Jacks Run has decreased the ability of the watershed to absorb water, creating more surface water for a given frequency rainfall than existed in the past.
Laurel Run	• Township of Delran – primary flooding source
Lake Flooding	• Borough of Medford Lakes – lake flooding is the primary source of flooding in the Borough of Medford Lakes when lake levels are at their highest for summer recreational purposes and a downpour causes the lakes to overtop their banks.
Masons Creek	• Township of Hainesport – flooding source impacted by high tides caused on the Delaware River due to passing hurricanes and other large storms
Mullica River	• Township of Washington – the Mullica River is the primary cause of flooding in the Township, typically associated with hurricanes and tropical storms. Downstream of the Pleasant Mills Bridge, flooding on the River is tidally influenced. Tributaries to the River have also experienced flooding, like the Batsto River
Pennsauken Creek	• Borough of Palmyra – flows through the tidal flatlands and confluences with the Delaware River, making it subject to tidal flooding.
Pennsauken Creek North Branch	• Township of Maple Shade – primary flooding source due to heavy rains and local thunderstorms.
Pennsauken Creek South Branch	• Township of Maple Shade – primary flooding source due to heavy rains and local thunderstorms.

Flooding Source	Description of Flood Problems
Pompeston Creek	• Borough of Riverton – high tides on the Delaware River produce major flooding in Pompeston Creek's lower reaches
Rancocas Creek	• Township of Delanco – Rancocas Creek, along with the Delaware River, is a primary flooding source. Tidal surge occurs along the Delaware River especially when hurricane tracks are close to the Delaware River. • Township of Delran – primary flooding source • Townships of Riverside, Westampton, and Willingboro - primary flooding source
Rancocas Creek North Branch	• Township of Eastampton – flooding occurs in the low-lying areas adjacent to Rancocas Creek North Branch during hurricanes and other large storms. • Township of Hainesport – flooding source impacted by high tides caused on the Delaware River due to passing hurricanes and other large storms. • Township of Medford – flooding is primarily due to torrential rains during summer and autumn month. • Township of Mount Holly – flooding is made more severe due to undersized culverts connecting the dredged stream to the former stream under the railroad embankment and from Buttonwood Run due to increasing development upstream in the Township of Eastampton. • Borough of Pemberton; Townships of Pemberton, Southampton – primary flooding source due to torrential rains during summer and autumn months.
Rancocas Creek South Branch	• Township of Hainesport – flooding source impacted by high tides caused on the Delaware River due to passing hurricanes and other large storms. • Township of Medford – flooding is primarily due to torrential rains during summer and autumn months.
Rancocas Creek Southwest Branch	• Township of Medford – flooding is primarily due to torrential rains during summer and autumn months
Swede Run	• Township of Delran – primary flooding source
Wading River West Branch	• Township of Woodland – primary flooding source.
Within the extent of the Lower Delaware River Basin	Heavy rains, balmy temperatures, and rapid snowmelt can cause serious flooding in the Lower Delaware River Basin during the winter months. Flooding upstream and on the main stem of the Delaware River can severely affect flooding in the lower basin. Slow moving storms can cause flash flooding on the Lower Delaware River Basin.

Source: FEMA FIS 2017

The DVRPC conducted a series of Coastal Vulnerability Assessment reports for six municipalities in Burlington County along the Delaware River. While the reports focused on coastal flooding impacts combined with sea level rise, they also identified the following locations as prone to riverine flooding and flash flooding:

- Delran Township:
  - Flooding in upstream municipalities during storms exacerbates flooding in some of Delran's neighborhoods, with roadway flooding
    in the Westover Drive neighborhood as one affected location. A culverted tributary of the Pompeston Creek has also historically created flooding on this road.
  - Flooding causes scour and erosion which threatens the integrity of Conrow Road, and an outdated culvert causes flooding at Bridgeboro Road and adjacent properties.
- City of Beverly
  - Riverine flooding poses a threat for the area along Railroad Avenue and Manor Road, which includes such critical municipal facilities as the Beverly Edgewater Park Emergency Squad building, the Beverly City Elementary School, and the American Legion building.
  - The area around Bridgeboro Road in Edgewater Park Township also floods; although it is outside Beverly's borders, flooding at this location has the potential to block egress from the city along its Broad Street evacuation route.
- Bordentown Township:

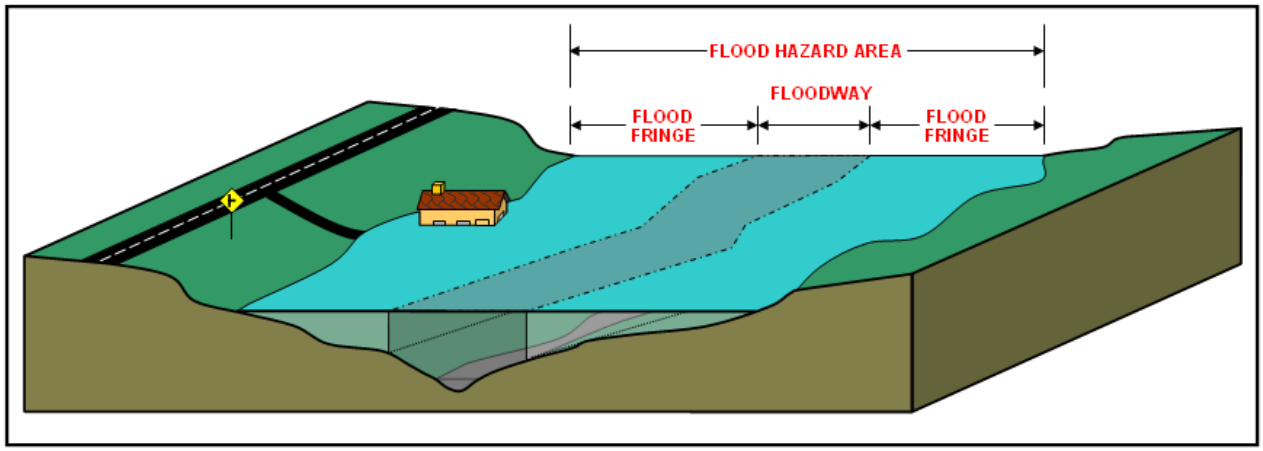
- The area around Jumble Gut Run and near the Old Amboy Railroad. The Sylvan Glen neighborhood and the Old Amboy Railroad are vulnerable to high volumes and velocities of stormwater runoff pose a problem for these areas. In the Sylvan Glen neighborhood, stormwater volume in Jumble Gut Run causes bank erosion and slope destabilization, undermines utilities and stormwater infrastructure, and can cut off ingress and egress from the overtopping of NJ-206 and Orchard Road. In the Old Amboy neighborhood, poor drainage at a culvert leads to flooding of properties along the adjacent rail corridor during heavy rainfall events.

- Burlington Township
  - Riverine flooding impacts areas around Route 130, Jennifer Lane, Fountain Avenue, and Spring Hill Lane.
  - "Upstream-downstream" concerns were cited regarding the position of the Township in the watershed relative to other neighboring municipalities, which causes them to receive stormwater runoff from upstream municipalities.

Floodplains

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. Most often floodplains are referred to as 100-year floodplains. A 100-year floodplain is not a flood that will occur once every 100 years, rather it is 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 properly defined it as the 1-percent annual chance flood. This 1-percent annual chance flood is now the standard used by most federal and state agencies and by the NFIP (FEMA 1997).

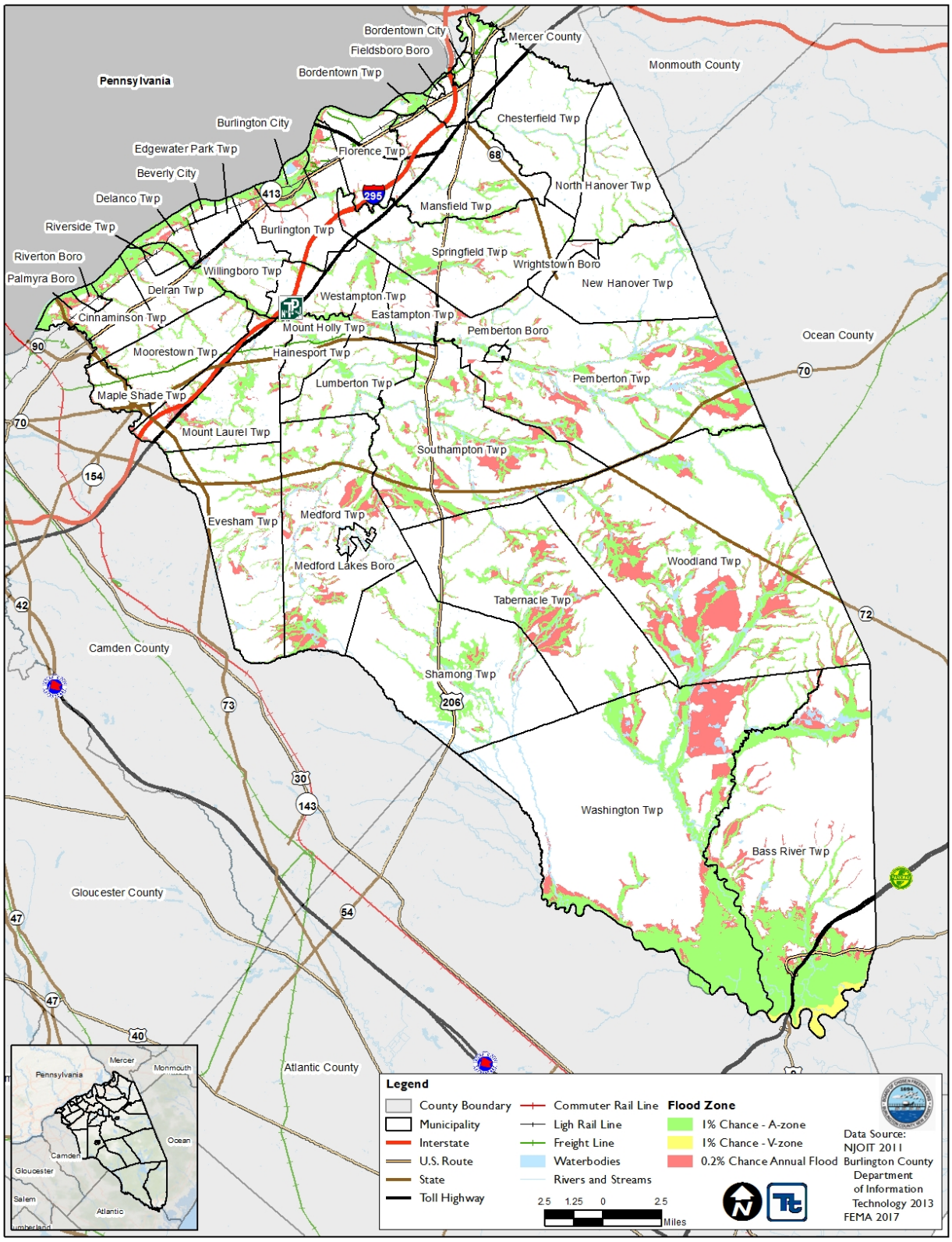
Figure 5.4.4-1. The Floodplain



Source: NJDEP, Date Unknown

The 1-percent annual chance of flood hazard zones are widely dispersed in Burlington County, generally following riverine corridors as shown in Figure 5.4.4-2. A significant concentration of 1-percent annual chance flood hazard zones borders the Delaware and Mullica Rivers. There is a very small portion of the County located in the 1-percent annual chance V-zone (Bass River Township). V-zones include areas along coasts that are subject to flooding with additional hazards associated with storm-induced waves. Bass River Township experiences tidal flooding from the Great Bay. Other 1-percent annual chance flood hazard zones exist along various creeks throughout the interior of Burlington County. Refer to Table 5.4.4-2 to see the total land area each municipality has in the 1-percent and 0.2-percent annual chance flood hazard zones.

Figure 5.4.4-2. FEMA Flood Hazard Areas in Burlington County



Source: FEMA 2017
FEMA Federal Emergency Management Agency

Table 5.4.4-2. Total land area located in the 1- and 0.2-percent annual chance flood zones (acres)

Municipality	Total Area (acres)	1% Flood Event Hazard Area				0.2% Flood Event Hazard Area	
		A-Zone Area Exposed (acres)	% of Total	V-Zone Area Exposed (acres)	Area Exposed (acres)	Area Exposed (acres)	% of total
Bass River Township	50,168.0	13,629.0	27.2%	1,292.9	2.6%	16,004.2	31.9%
Beverly City	493.2	189.2	38.4%	0.0	0.0%	211.3	42.9%
Bordentown City	617.4	105.0	17.0%	0.0	0.0%	111.0	18.0%
Bordentown Township	5,764.9	1,327.7	23.0%	0.0	0.0%	1,383.6	24.0%
Burlington City	2,390.7	1,697.0	71.0%	0.0	0.0%	2,008.2	84.0%
Burlington Township	8,935.9	844.6	9.5%	0.0	0.0%	1,232.7	13.8%
Chesterfield Township	13,946.8	921.5	6.6%	0.0	0.0%	938.4	6.7%
Cinnaminson Township	5,132.8	1,005.2	19.6%	0.0	0.0%	1,213.0	23.6%
Delanco Township	2,156.7	906.8	42.0%	0.0	0.0%	1,135.5	52.7%
Delran Township	4,662.5	921.5	19.8%	0.0	0.0%	1,036.5	22.2%
Eastampton Township	3,745.5	552.4	14.7%	0.0	0.0%	595.6	15.9%
Edgewater Park Township	1,959.6	97.3	5.0%	0.0	0.0%	104.3	5.3%
Evesham Township	19,000.8	1,973.4	10.4%	0.0	0.0%	2,103.6	11.1%
Fieldsboro Borough	303.9	129.3	42.6%	0.0	0.0%	133.1	43.8%
Florence Township	6,507.0	576.1	8.9%	0.0	0.0%	616.4	9.5%
Hainesport Township	4,362.6	1,107.8	25.4%	0.0	0.0%	1,203.3	27.6%
Lumberton Township	8,335.7	1,419.3	17.0%	0.0	0.0%	1,457.4	17.5%
Mansfield Township	14,040.8	1,383.0	9.8%	0.0	0.0%	1,389.6	9.9%
Maple Shade Township	2,453.7	193.1	7.9%	0.0	0.0%	268.8	11.0%
Medford Lakes Borough	799.2	142.7	17.9%	0.0	0.0%	146.7	18.4%
Medford Township	25,531.6	3,774.2	14.8%	0.0	0.0%	4,137.9	16.2%
Moorestown Township	9,552.0	960.2	10.1%	0.0	0.0%	1,097.7	11.5%
Mount Holly Township	1,850.9	316.0	17.1%	0.0	0.0%	431.6	23.3%
Mount Laurel Township	14,048.0	1,659.5	11.8%	0.0	0.0%	2,147.6	15.3%
New Hanover Township	14,360.2	520.6	3.6%	0.0	0.0%	520.6	3.6%
North Hanover Township	10,945.7	855.4	7.8%	0.0	0.0%	855.8	7.8%
Palmyra Borough	1,532.7	638.1	41.6%	0.0	0.0%	881.2	57.5%
Pemberton Borough	395.4	82.8	20.9%	0.0	0.0%	92.3	23.4%
Pemberton Township	40,295.9	7,471.8	18.5%	0.0	0.0%	7,601.8	18.9%
Riverside Township	1,044.0	356.3	34.1%	0.0	0.0%	410.8	39.3%
Riverton Borough	609.5	236.1	38.7%	0.0	0.0%	303.4	49.8%
Shamong Township	28,910.4	4,157.6	14.4%	0.0	0.0%	4,239.1	14.7%
Southampton Township	28,027.8	5,259.6	18.8%	0.0	0.0%	5,346.7	19.1%
Springfield Township	18,725.8	2,269.0	12.1%	0.0	0.0%	2,385.8	12.7%
Tabernacle Township	31,717.9	3,769.4	11.9%	0.0	0.0%	3,781.0	11.9%
Washington Township	66,071.1	15,241.5	23.1%	4.9	<1%	16,695.9	25.3%
Westampton Township	7,106.0	1,050.3	14.8%	0.0	0.0%	1,108.4	15.6%
Willingboro Township	5,200.1	712.8	13.7%	0.0	0.0%	868.6	16.7%

Municipality	Total Area (acres)	1% Flood Event Hazard Area				0.2% Flood Event Hazard Area	
		A-Zone Area Exposed (acres)	% of Total	V-Zone Area Exposed (acres)	Area Exposed (acres)	Area Exposed (acres)	% of total
Woodland Township	61,174.2	10,115.6	16.5%	0.0	0.0%	10,167.9	16.6%
Wrightstown Borough	1,328.0	5.2	0.4%	0.0	0.0%	5.2	<1%
Burlington County Total:	**524,204.7**	**88,574.1**	**16.9%**	**1,297.8**	**<1%**	**96,372.6**	**18.4%**

Source: FEMA 2017
Note: % = Percent;
The area presented includes the area of inland waterways

Natural and Beneficial Floodplain Areas

Although typically associated as a hazard area, floodplains also serve beneficial and natural functions (on ecological/environmental, social, and economic levels). Disruption of these natural systems can have long-term consequences on entire regions; however, this potential impact has only recently been noted. Some of the more well-known water-related functions for floodplains include:

- Natural flood and erosion control
  - Provide flood storage and conveyance
  - Reduce flood velocities
  - Reduce flood peaks
  - Reduce sedimentation
- Surface water quality maintenance
  - Filter nutrients and impurities from runoff
  - Process organic wastes
  - Moderate temperatures of water
- Groundwater recharge
  - Promote infiltration and aquifer recharge
  - Reduce frequency and duration of low surface flows (FEMA 2007)

Areas in the floodplain that typically provide these natural functions are wetlands, riparian areas, sensitive areas, and habitats for rare and endangered species. According to NJ DEP 2015 Land-Use Land-Cover data and 2017 NJDEP Landscape Project Data, the County has several floodplain areas that could serve natural and beneficial functions (Landscape Project contains the endangered species data). This information is summarized in the table below.

Table 5.4.4-3. Acreage of Wetlands by Municipality

Municipality	Total Area (acres)	Wetland Area (acres)	Percent of Total
Bass River Township	50,168.0	12,552.4	25.0%
Beverly City	493.2	10.0	2.0%
Bordentown City	617.4	57.5	9.3%
Bordentown Township	5,764.9	1,078.7	18.7%
Burlington City	2,390.7	97.6	4.1%
Burlington Township	8,935.9	1,016.8	11.4%
Chesterfield Township	13,946.8	3,387.9	24.3%

Municipality	Total Area (acres)	Wetland Area (acres)	Percent of Total
Cinnaminson Township	5,132.8	251.5	4.9%
Delanco Township	2,156.7	76.9	3.6%
Delran Township	4,662.5	313.9	6.7%
Eastampton Township	3,745.5	1,202.7	32.1%
Edgewater Park Township	1,959.6	4.6	0.2%
Evesham Township	19,000.8	5,465.3	28.8%
Fieldsboro Borough	303.9	51.5	17.0%
Florence Township	6,507.0	945.9	14.5%
Hainesport Township	4,362.6	550.1	12.6%
Lumberton Township	8,335.7	1,909.9	22.9%
Mansfield Township	14,040.8	3,535.1	25.2%
Maple Shade Township	2,453.7	112.1	4.6%
Medford Lakes Borough	799.2	4.6	0.6%
Medford Township	25,531.6	9,299.3	36.4%
Moorestown Township	9,552.0	903.9	9.5%
Mount Holly Township	1,850.9	134.2	7.2%
Mount Laurel Township	14,048.0	2,536.8	18.1%
New Hanover Township	14,360.2	3,894.4	27.1%
North Hanover Township	10,945.7	1,776.9	16.2%
Palmyra Borough	1,532.7	60.1	3.9%
Pemberton Borough	395.4	68.0	17.2%
Pemberton Township	40,295.9	14,274.8	35.4%
Riverside Township	1,044.0	41.9	4.0%
Riverton Borough	609.5	0.5	0.1%
Shamong Township	28,910.4	10,761.7	37.2%
Southampton Township	28,027.8	12,543.3	44.8%
Springfield Township	18,725.8	6,599.5	35.2%
Tabernacle Township	31,717.9	8,529.6	26.9%
Washington Township	66,071.1	24,946.4	37.8%
Westampton Township	7,106.0	1,464.5	20.6%
Willingboro Township	5,200.1	264.0	5.1%
Woodland Township	61,174.2	17,549.2	28.7%
Wrightstown Borough	1,328.0	244.4	18.4%
Burlington County Total:	**524,204.7**	**148,518.6**	**28.3%**

Source: NJDEP 2015

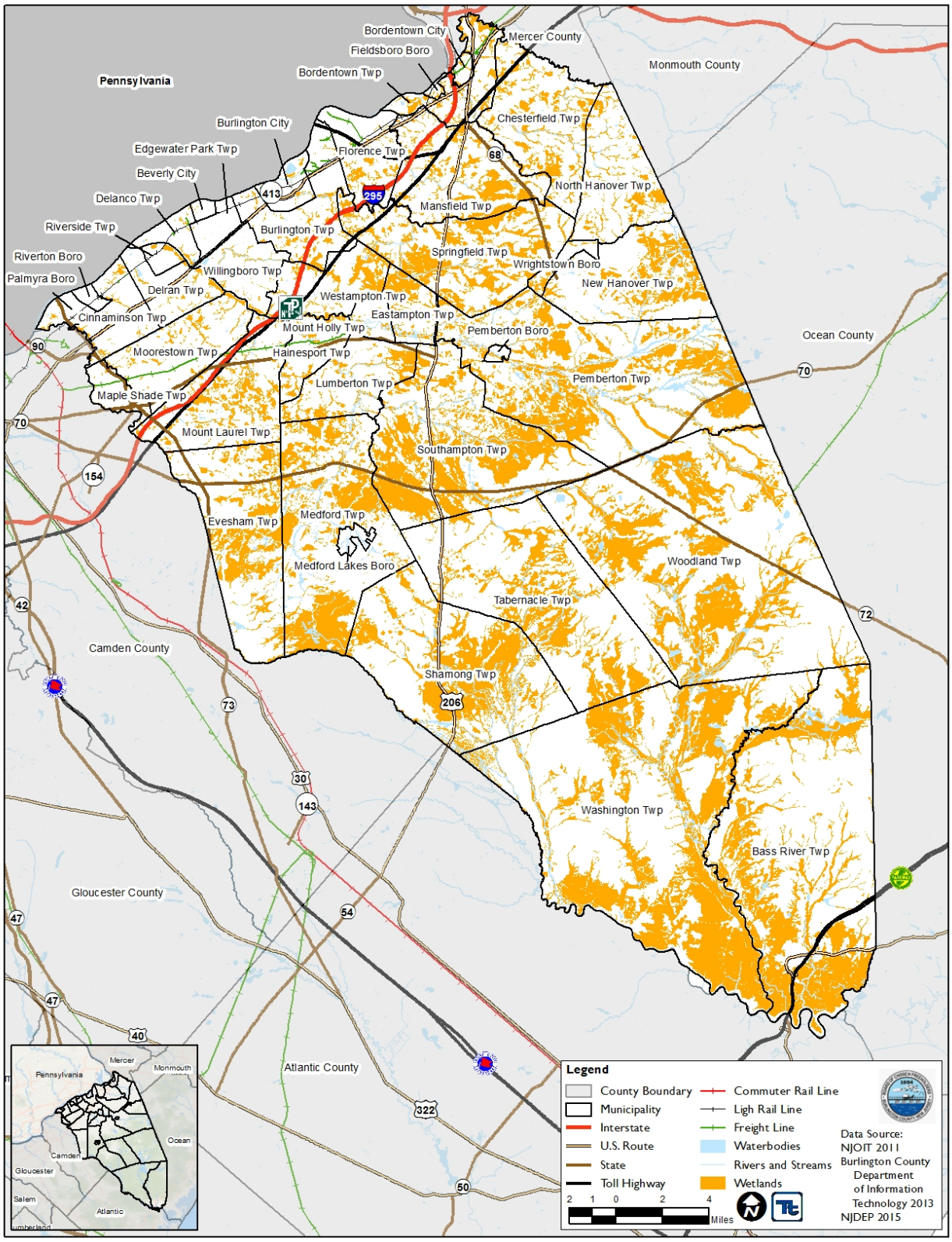
Table 5.4.4-4. Natural and Beneficial Land in Burlington County

Wetlands	Area (acres)	Forest	Area (acres)	Endangered Species	Area (acres)
Agricultural Wetlands (Modified)	5,370.3	Coniferous Brush/Shrubland	155.6	Special Concern	11,801.6
Atlantic White Cedar Wetlands	9,932.3	Coniferous Forest (>50% Crown Closure)	3,331.2	State Endangered	59,683.5
Coniferous Scrub/Shrub Wetlands	209.7	Coniferous Forest (10-50% Crown Closure)	1,244.7	State Threatened	3,966.0
Coniferous Wooded Wetlands	5,654.9	Deciduous Brush/Shrubland	251.8		
Deciduous Scrub/Shrub Wetlands	2,856.6	Deciduous Forest (>50% Crown Closure)	2,172.8		
Deciduous Wooded Wetlands	18,209.1	Deciduous Forest (10-50% Crown Closure)	833.8		
Disturbed Wetlands (Modified)	131.5	Mixed Deciduous/Coniferous Brush/Shrubland	184.7		
Former Agricultural Wetland (Becoming Shrubby, Not Built-Up)	123.2	Mixed Forest (>50% Coniferous With >50% Crown Closure)	861.4		
Freshwater Tidal Marshes	1,581.2	Mixed Forest (>50% Coniferous With 10-50% Crown Closure)	110.1		
Herbaceous Wetlands	2,160.0	Mixed Forest (>50% Deciduous With >50% Crown Closure)	556.1		
Managed Wetland in Built-Up Maintained Rec Area	87.6	Mixed Forest (>50% Deciduous With 10-50% Crown Closure)	104.6		
Managed Wetland in Maintained Lawn Greenspace	100.9	Old Field (< 25% Brush Covered)	293.6		
Mixed Scrub/Shrub Wetlands (Coniferous Dom.)	598.1	Phragmites Dominate Old Field	16.3		
Mixed Scrub/Shrub Wetlands (Deciduous Dom.)	917.1	Plantation	2.9		
Mixed Wooded Wetlands (Coniferous Dom.)	5,048.2				
Mixed Wooded Wetlands (Deciduous Dom.)	3,553.4				
Phragmites Dominate Coastal Wetlands	1,529.4				
Phragmites Dominate Interior Wetlands	160.5				
Phragmites Dominate Urban Area	0.3				
Saline Marsh (High Marsh)	263.1				
Saline Marsh (Low Marsh)	5,953.4				

Wetlands	Area (acres)	Forest	Area (acres)	Endangered Species	Area (acres)
Wetland Rights-Of-Way	162.3				

Note: An additional 8,154.2 acres of land didn't have a joinable ID number for the Landscape Project data. This could be a miscellaneous potential habitat for endangered species.

Figure 5.4.4-3. Wetlands in Burlington County



Source: NJDEP 2015

According to the Landscape Project data, Burlington County contains potential habitats for over 50 endangered species from multiple taxonomic classes, including Amphibia, Aves, Bivalvia, Insecta, Mammalia, Osteichthyes, and Reptilia. Habitats for about 48 of these species are located within the 1-percent annual chance floodplain. These species include, the Indiana bat, the bald eagle, the shortnose sturgeon and the bog turtle.

Extent

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 evacuations of people and/or transfer of property to higher elevations are necessary.
- Major Flooding - extensive inundation of structures and roads. Significant evacuations of people and/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 of time, 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 2001).

Previous Occurrences and Losses

Many sources provided historical information regarding previous occurrences and losses associated with flooding events throughout the State of New Jersey and Burlington County. With numerous sources reviewed for the purpose of this HMP, 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.

Between 1954 and 2018, FEMA declared that the State of New Jersey experienced 34 flood-related disasters (DR) or emergencies (EM) classified as flooding, or as flooding with one or a combination of the following disaster types: Severe Storms; Inland and Coastal Flooding; Mudslides; Coastal Storm; High Tides; Heavy Rain; High Winds; and Hurricane. Generally, these disasters cover a wide region of the State; therefore, they may have impacted many counties. Burlington County was included in 12 of these flood-related declarations between 1954 and 2018, and two declarations since the 2014 Burlington County HMP. Table 5.4.4-5 lists FEMA DR declarations from January 1, 2012 to January 1, 2018 for this HMP update.

Table 5.4.4-5. FEMA Declarations since 2012 for Flood Events in Burlington County

FEMA Disaster Number	Date(s) of Incident	Incident Type / Title	Declared Counties
DR-4086, EM 3354	October 26 – November 8, 2012	Hurricane Sandy	Atlantic, Bergen, Burlington, Camden, Cape May, Cumberland, Essex, Gloucester, Hudson, Hunterdon, Mercer, Middlesex, Monmouth, Morris, Ocean, Passaic, Salem, Somerset, Sussex, Union, and Warren
DR-4231	June 23, 2015	Severe Storm	Atlantic, Burlington, Camden, and Gloucester
DR-4264	January 22-24, 2016	Severe Winter Storm and Snowstorm	Atlantic, Bergen, Burlington, Camden, Cape May, Cumberland, Essex, Hudson, Hunterdon, Mercer, Middlesex, Monmouth, Morris, Ocean, Somerset, Union, and Warren

Source: FEMA 2018

United States Department of Agriculture (USDA) crop losses 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. Burlington County has experienced annual crop losses due to natural hazard events. The USDA records from 2012 to 2018 note that Burlington County had two USDA agricultural disasters (2013 and 2015) that were related to flood damages. (USDA 2018).

For this 2019 HMP update, flood events were summarized from January 1, 2012 to January 1, 2018. Known flood events, including FEMA disaster declarations, which have impacted Burlington County between 2012 and 2018 are identified in Table 5.4.4-6. For events prior to 2012, please refer to Appendix G (Supplementary Data). Please note that not all events that have occurred in Burlington County are included due to the extent of documentation and the fact that not all sources may have been identified or researched. Loss and impact information 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. Please see Section 9 for detailed information regarding impacts and losses to each municipality.

Table 5.4.4-6. Flood Events in Burlington County, 2012 to 2018

Dates of Event	Event Type	FEMA Declaration Number (if applicable)	County Designated?	Losses / Impacts
June 4, 2012	Coastal Flood	N/A	N/A	Spring tides associated with the full moon caused minor to moderate tidal flooding during the first few days of June. Moderate tidal flooding occurred along Raritan Bay, coastal New Jersey, and Delaware Bay during the overnight high tide cycle on June 4th. Flooding occurred up and down the coast of New Jersey. In Burlington County, in the City of Burlington, the Delaware River was 10.1 feet above MLLW on the 4th.
September 3-6, 2012	Flash Flood, Flood	N/A	N/A	Waves of thunderstorms brought heavy rain on the 3rd and 4th that produced flash flooding in southwestern Ocean County and southeastern Burlington County. Storm total estimates reached around 10 inches in southeastern Burlington County, more than half of which fell with the first wave of storms. The storms caused small stream and poor drainage flooding in sections of Bass River Township and Woodland Township. Rainfall totals included 5.19 inches in Woodland. Additional storms that fell after the 4th led to flooding along County Routes 563 and 679. Route 563 was closed and barricaded at the Evans Bridge. The roadway was also closed between Greenbank-Chatsworth Road in Washington Township and Leektown Road in Bass River Township.
October 29-30, 2012	Hurricane Sandy	DR-4086, EM 3354	Yes	Post Tropical Storm Sandy was the costliest natural disaster by far in the state of New Jersey. Record breaking high tides and wave action combined with sustained winds as high as 60 to 70 mph with wind gusts as high as around 90 mph to batter the state. Statewide, Sandy caused an estimated $29.4 billion in damage, destroyed or significantly damaged 30,000 homes and businesses, affected 42,000 additional structures and was responsible directly or indirectly for 38 deaths. A new temporary inlet formed in Mantaloking (Ocean County) where some homes were swept away. About 2.4 million households in the state lost power. It would take two weeks for power to be fully restored to homes and businesses that were inhabitable. In the Mount Holly warning and forecast area of New Jersey, Sandy was responsible for 24 deaths, 8 that are considered directly caused by the system: two drownings, five people killed by fallen trees and one person was blown over by the wind. Hardest hit were the coastal areas of Ocean and Monmouth Counties. Approximately 230,000 residents of the state have applied for assistance from FEMA. In Burlington County, heavy rain caused urban and poor drainage flooding and exacerbated the tidal flooding along the Delaware River and near the Atlantic Coast. Along the Delaware River, tidal flooding occurred in the Columbus Park development along Assiscunk Creek in the City of Burlington. In Mount Laurel Township, Union Mill Road was closed because Parkers Creek flooded. The North Branch of the Rancocas Creek at Pemberton was above its 2.5-foot flood stage from 4:30 p.m. on the 30th through 6 p.m. on the 31st. It crested at 2.58 feet at 1:30 a.m. on the 31st. The highest crest in the County was 8.67 feet MLLW at the City of Burlington. Rainfall totals in Burlington County included 4.10 inches in Medford Township, 3.51 inches in Chatsworth, 3.15 inches in Medford Lakes, 2.92 inches in Mount Laurel Township, 2.82 inches in Morrestown Township and 2.42 inches in Westampton Township. Peak wind gusts in the County ranged from 56 mph in Woodland Township to 70 mph in Florence Township.

Dates of Event	Event Type	FEMA Declaration Number (if applicable)	County Designated?	Losses / Impacts
				The most widespread damage in Burlington County was reported in Bass River Township, mainly due to tidal and flood-related damages. In Mount Holly Township, a resident was trapped inside their home after a tree landed on the house. Seven roadways in Medford Township were closed due to downed trees. Overall, the County reported approximately $5 million in property damage from Hurricane Sandy.
December 21, 2012	Coastal Flood	N/A	N/A	Strong wind gusts ranging from 46 mph to 64 mph across New Jersey downed trees and power lines. The winds also allowed water to pile up along the New Jersey shore and into the Delaware Bay, producing minor to moderate coastal flooding. Moderate to heavy rain also fell across the state, with storm totals ranging between one and three inches. This rain also resulted in some minor flooding of smaller streams and creeks in southern New Jersey. In Burlington County, homes were evacuated in the City of Burlington due to tidal flooding. The high tide in the City reached 11.13 feet above MLLW. Wind gusts in the County ranged from 52 mph at McGuire Air Force Base to 62 mph at the City of Burlington.
December 27, 2012	Flood	N/A	N/A	Heavy rain caused poor drainage flooding as well as stream and river flooding in the central portion of New Jersey, including Burlington County. Rainfall totals ranged from one to three inches, flooding many roadways. The North Branch of the Rancocas Creek at Pemberton Township was above its 2.5-foot flood stage from 8:45 p.m. on the 27th through 9:45 a.m. on the 29th. It crested at 2.56 feet at 945 a.m. on the 28th. The McDonald's Branch in Woodland Township was above its 1.7-foot flood stage from 3:45 p.m. through 9:44 p.m. on the 27th. It crested at 1.71 feet at 4 p.m.. Event precipitation totals included 2.98 inches in Oswego Lake, 2.21 inches in Tabernacle Township, 2.20 inches in Pemberton Township, 2.00 inches in Southampton Township, 1.97 inches in Lumberton Township, 1.85 inches at the McGuire Air Force Base, 1.73 inches in Mount Laurel Township, and 1.59 inches in Westampton Township.
March 7, 2013	Coastal Flood	N/A	N/A	An intense Nor'Easter brought strong to high winds across central and southern New Jersey, as well as minor to moderate tidal flooding along the Raritan Bay, lower Delaware Bay and along the Atlantic Ocean. In Burlington County, tidal flooding was reported in Washington Township. Wind gusts in the county ranged from 49 mph in Coyle Field to 51 mph at McGuire Air Force Base. Approximately $10,000 in property damage.
June 18, 2013	Flash Flood	N/A	N/A	Thunderstorms with heavy rain caused flash flooding along the Southampton and Pemberton Township borders. The flooding also affected New Jersey State Routes 70 and 72. Event precipitation totals included 3.07 inches in Tabernacle Township, 2.15 inches in Pemberton Township and 1.98 inches in Oswego Lake.
June 30, 2013	Flash Flood	N/A	N/A	Thunderstorms with very heavy rain caused flash flooding along roadways and smaller creeks in the southern part of Evesham Township. Event precipitation totals included 2.10 inches in nearby Medford Lakes Borough and 1.80 inches in Medford Township.
July 13, 2013	Flood	N/A	N/A	Slow moving showers and thunderstorms caused heavy rain to fall across extreme northwest Burlington County during the evening. Roadway flooding was reported in Florence Township and Roebling. Event totals included 1.65 inches in Florence Township. Doppler Radar storm total estimates reached 1 to 2 inches in the northwestern part of the county
July 22-23, 2013	Flash Flood, Flood	N/A	N/A	Heavy rain fell through the night of the 22nd and caused poor drainage and small stream flash flooding to occur during the early morning of the 23rd in Burlington County. Several roads

Dates of Event	Event Type	FEMA Declaration Number (if applicable)	County Designated?	Losses / Impacts
				reported flooding through the Mount Holly Township/Westampton Township/Mount Laurel Township area. In Mount Holly Township, two homes were damaged by flooding on Cherry Street as the Buttonwood Run flooded. Part of the foundation of one home was washed away and was uninhabitable. The other home was severely damaged but was unoccupied. The intersection of Rancocas Road and the Mount Holly By-Pass (County Route 541) was flooded and closed. The basement of the First Presbyterian Church also flooded. In Mount Laurel, flash flooding along Parkers Creek shut down Hartford and Union Mill Rods. The runoff from all of the rain caused the Rancocas Creek to exceed its flood stage. Flooding closed Mill and King Streets as well as Rancocas-Mount Holly Road along the creek. The North Branch of the Rancocas Creek at Iron Works Park was above its 11.7-foot flood stage from 9:22 a.m. through 145 p.m. on the 23rd. It crested at 11.74 feet at 11:15 a.m. Event precipitation totals included 6.71 inches in Eastampton Township, 6.25 inches at the Mount Holly WFO, 4.00 inches in Florence Township, 3.43 inches in Hainesport Township, and 3.36 inches in Mount Laurel Township. Springside reported $100,000 in property damages.
July 28, 2013	Flash Flood, Flood	N/A	N/A	Thunderstorms with torrential downpours caused small stream and poor drainage flash flooding in western Burlington County. The Southwest Branch of the Rancocas Creek flooded sections of the Golden Pheasant Golf Course in Lumberton. In Southampton, several apartment buildings flooded at the Sherwood Village Complex. Event precipitation totals included 2.91 inches in Mount Laurel Township, 2.76 inches in Mount Holly Township, 2.37 inches in Cinnaminson Township, 2.32 inches in Westampton Township, 2.08 inches in Palmyra Borough, and 2.05 inches in Moorestown Township. Riverton Borough reported $10,000 in property damages. The South Branch of the Pennsauken Creek near Mill Road on New Jersey State Route 38 in Cherry Hill was above its 9-foot flood stage from 10:22 p.m. on the 28th through 6:39 a.m. on the 29th. It crested at 10.03 feet at 3 a.m. on the 29th.
August 13, 2013	Flash Flood	N/A	N/A	Thunderstorms with torrential downpours caused flash flooding of roadways and creeks, especially across the central third of Burlington County. In Evesham Township, a school bus became stuck in flood waters on Erindale Drive. Thirty-one children were rescued. Also, within the township, a motorist was rescued from flood waters on New Jersey State Route 70 near Cropwell Road. Flooded and closed roadways also included Marlton Parkway in Evesham Township and Hartford Road in Medford Township. The flooding also affected the primary election as voting booths had to be moved after flooding occurred at some polling places. Event precipitation totals included 2.64 inches in Medford Township, 2.53 inches in Southampton Township, 2.35 inches in Pemberton Township and 2.30 inches in Tabernacle Township.
March 30- April 1, 2014	Flood	N/A	N/A	The runoff from waves of heavy precipitation caused minor flooding along the North Branch Rancocas from the late evening of the 30th through the late evening of April 1st. The North Branch Rancocas at Pemberton Township was above its 2.5 foot flood stage from 10:45 p.m. on the 30th through 10:30 p.m. on April 1st, and it crested at 2.65 feet at 530 p.m. on the 31st. Event precipitation totals included 3.08 inches in Moorestown Township, 3.06 inches in Riverton, 2.96 inches in Mount Laurel Township, 2.85 inches in Tabernacle Township, 2.81 inches in Medford Lakes, 2.73 inches in Burlington Township, and 2.70 inches at WFO Mount Holly.
April 30-May 1, 2014	Coastal Flood, Flood	N/A	N/A	Very heavy rain caused considerable poor drainage and creek flooding in the northern two-thirds of Burlington County. Event precipitation totals included 6.32 inches in Riverton Borough, 5.44

Dates of Event	Event Type	FEMA Declaration Number (if applicable)	County Designated?	Losses / Impacts
				inches in Medford Township, 5.28 inches in Crosswicks, 5.23 inches in Moorestown Township, 5.14 inches in Mount Laurel Township, and 4.96 inches at the Mount Holly WFO. This event led to many creeks and rivers in the county reaching and exceeding flood stages. Overall, the County had approximately $500,000 in property damage from this event. Municipalities along the branches of the Rancocas Creek were hardest hit by the flooding, in particular Lumberton Township and Mount Holly Township. County Route 541 through Lumberton was closed through the morning of May 2nd because of flooding along the South Branch of the Rancocas Creek. Residents from 30 homes in Lumberton Township were evacuated. Four to five homes in Lumberton Township suffered damage onto the first floor. Most of the other home damage in the township involved flooded basements or damaged vehicles. Along the North Branch of the Rancocas Creek, the Mount Holly Municipal Building was flooded, and the Township's Buttonwood Dam was badly damaged. Floodwaters along the creek were lapping at homes in Eastampton Township. Residents from several homes in Medford Township near the Southwest Branch of the Rancocas Creek were also evacuated. All families in the county displaced by flooding were able to return to their homes. Major roadways that were flooded and closed included New Jersey State Route 73 in Maple Shade Township and New Jersey State Route 70 in Medford Township. Major roadway partial closures included New Jersey State Route 38 in Moorestown and Mount Laurel Townships, New Jersey State Route 73 in Palmyra Township, U.S. Route 130 in Burlington Township and U.S. Route 206 in Bordentown Township.
July 14, 2014	Flash Flood	N/A	N/A	Thunderstorms with torrential downpours caused the closure of Interstate 295 in Bordentown Township near Blacks Creek and the evacuation of residents along Ellisdale Road near the Crosswicks Creek in Chesterfield Township. Doppler Radar storm total estimates reached between 2.5 and 3.0 inches in the area. Event precipitation totals included 2.62 inches in Burlington Township.
January 18, 2015	Flood	N/A	N/A	Heavy rain caused flooding along Parkers Creek and closed both Union Mill and Hartford Roads in the vicinity of the creek in Mount Laurel Township. Event precipitation totals included 1.99 inches in Mount Laurel Township, 1.96 inches in Medford Township, and 1.95 inches in Moorestown Township.
June 27, 2015	Flash Flood	N/A	N/A	Thunderstorms with very heavy rain caused flash flooding of smaller streams as well as poor drainage flooding in southeastern Burlington County. Event precipitation totals included 4.46 inches in Chatsworth, 3.39 inches in Oswego Lake, 2.53 inches in Shamong Township and 2.23 inches in Westampton Township.
August 1-3, 2017	Flash Flood, Flood	N/A	N/A	A hot and humid airmass with weak boundaries led to slow moving strong to severe thunderstorms with damaging winds, hail and flooding. Over 2,000 people lost power. In Palmyra, several roads were flooded and impassable. In Willing Borough several apartments flooded on Brittany Court. In Burlington Township, water entering a house on Cornell Road due to a nearby creek overflowing its banks. In Ramblewood, Locust Street closed between Kenilworth and the railroad due to flooding. In Roebling, Route 130 north near Kinkira Road was impassable. In Columbus, the Exit 52 ramp on Interstate 295 was closed. In Florence, all lanes on US-130 north of CR656 were closed due to flooding. In Stevens, US-130 was closed at Neck Road due to flooding. In Burlington, the save-a-lot and Roger Wilco stores on Rt 130 were flooded.

Dates of Event	Event Type	FEMA Declaration Number (if applicable)	County Designated?	Losses / Impacts
September 19, 2017	Coastal Flood	N/A	N/A	Moderate coastal flooding affected southeastern Burlington County with the evening high tide on Tuesday, September 19. Widespread roadway flooding was reported in the communities along tidal waters and many roads were closed.
March 3-4, 2018	Coastal Flooding	N/A	N/A	Minor coastal flooding over multiple tide cycles occurred along the New Jersey coast March 2nd through 4th. In Burlington County, moderate coastal flooding with some road closures along tidal waterways were reported in southeastern portions of the county.
July 11, 2018	Heavy Rain and Flash Flood	N/A	N/A	Torrential rain fell across parts of southeastern Pennsylvania and central and southern new Jersey. Rainfall totals of up to six inches was reported. In Burlington County, water rescues were conducted along and around Willow Bend Drive in Delran Township. At least five persons were rescued from vehicles that were stranded in flood waters. Rancocas Road was closed near the Mount Holly Bypass in Mount Holly and Westampton Township. Significant flooding occurred along the Leavitt Parkway in Willingboro. Several vehicles were trapped in flood waters around John F Kennedy Way. The Leavitt Parkway was closed in both directions at Echo Lane due to the development of a sink hole.
August 31, 2018	Flash Flood	N/A	N/A	Heavy rain produced flash flooding in parts of Burlington County on the morning of August 31. Rainfall totals of 2.5 to 5.5 inches fell in a short amount of time. Heavy rain produced flash flooding on Route 530 just east of Route 206 in Southampton Township.

Source: NOAA-NCEI 2018; CRREL 2018
CRREL Cold Regions Research and Engineering Laboratory
DR Major Disaster Declaration (FEMA)
EM Emergency Declaration (FEMA)
FEMA Federal Emergency Management Agency
MLLW Mean Lower Low Water
Mph Miles per hour
NOAA National Oceanic and Atmospheric Administration
NCEI National Centers for Environmental Information
N/A Not Applicable
WFO Weather Forecast Office

Table 5.4.4-7. Flood Events 1950-2018

Hazard Type	Number of Occurrences Between 1950 and 2018	Total Fatalities	Total Injuries	Total Property Damage ($)	Total Crop Damage ($)
Coastal Flood	40	0	0	$5.36 million	$0
Flood	43	0	0	$59.005 million	$1,000
Flash Flood	45	0	0	$57.110 million	$0
Ice Jam	0	0	0	$0	$0
TOTAL	**128**	**0**	**0**	**$121.475 million**	**$1,000**

Source: NOAA-NCEI 2018; CRREL 2018

Probability of Future Occurrences

Based on the historic and more recent flood events in Burlington County, it is clear that the county has a high probability of flooding for the future. The fact that the elements required for flooding exist and that major flooding has occurred throughout the county in the past suggests that many people and properties are at risk from the flood hazard in the future. It is estimated that Burlington County will continue to experience direct and indirect impacts of flooding events annually that may induce secondary hazards such as 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.

As defined by FEMA, geographic areas within the 1-percent annual chance flood area in Burlington County are estimated to have a one-percent chance of flooding in any given year. A structure located within a 1-percent annual chance flood area has a 26-percent chance of suffering flood damage during the term of a 30-year mortgage. Geographic areas in Burlington County located within the 0.2-percent annual chance flood area boundary are estimated to have a 0.2-percent chance of being flooded in any given year (FEMA 2007).

According to the NOAA National Climate Data Center (NCDC) and the CRREL database, Burlington County experienced 128 flood events between 1950 and 2018, including 40 coastal floods, 43 floods, 45 flash floods, and no ice jams. The table below shows these statistics, as well as the annual average number of events and the percent chance of these individual flood hazards occurring in Burlington County in future years (NOAA NCDC 2018).

Table 5.4.4-8. Probability of Future Occurrences of Flood Events

Hazard Type	Number of Occurrences Between 1950 and 2015	Rate of Occurrence or Annual Number of Events (average)	Recurrence Interval (in years) (# Years/Number of Events)	Probability of Event in any given year	Percent chance of occurrence in any given year
Coastal Flood	40	0.59	1.73	0.58	57.97
Flood	43	0.63	1.60	0.62	62.32
Flash Flood	45	15.00	0.09	11.25	1125.00
Ice Jams	0	0.00	0	0	0

Source: NOAA-NCDC 2018; CRREL 2018

In Section 5.3, the identified hazards of concern for Burlington 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 flood in the county is considered 'frequent' (likely to occur within 25 years, as presented in Table 5.3-3).

Climate Change Impacts

The climate of New Jersey is already changing and will continue to change over the course of this century. Since 1900, temperatures in the northeastern U.S. have increased an average of 1.5°F. The majority of this warming has occurred since 1970. From 1970 to 2010, average temperatures in New Jersey have increased 1.2°F (ONJSC 2013). In terms of winter temperatures, the northeastern U.S. has seen an increase in the average temperature by 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 2015).

In addition to the effect of increased temperatures, precipitation is expected to increase over the next several decades. Average annual precipitation is projected to increase in the region by 0-10 percent by the 2020s and 5-10 percent 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). Although precipitation is expected to increase, extreme precipitation is the most likely concern for New Jersey. Extreme precipitation has the potential to cause significant flooding and, in the winter, produce heavy snowfall. While exact projections are not available, it is estimated that the New York City region will see an increase of 10% to 25% of the frequency of intense precipitation events (Sustainable Jersey Climate Change Adaptation Task Force 2013). Both northern and southern New Jersey have become wetter over the past century. New Jersey's Statewide precipitation average for the last 30 years (1987-2017) was 1.05" greater than the average for the period of record (1895-2017) (Office of New Jersey State Climatologist).

With this increase in frequency of precipitation, New Jersey and Burlington County may experience more flooding events. More intense, frequent flooding could lead to significant habitat loss for wildlife. Salt marshes and estuaries that serve as critical feeding grounds for birds and waterfowl, and as nursery habitats for commercial fish, could be lost. Climate change may also increase the rate of sea level rise which will lead to more frequent and extensive coastal flooding.

5.4.4.2 VULNERABILITY ASSESSMENT

To assess Burlington 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-MHv4.0 model. These results are summarized below. Refer to Section 5.1 for additional details on the methodology used to assess flood risk.

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 or not 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. Additionally, exposure should not be limited to only those who reside in a defined hazard zone, but everyone 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. Using the 2010 U.S. Census blocks, there are an estimated 28,446 people are exposed to the one-percent annual chance event and 39,268 people are exposed to the

0.2-percent annual chance flood event. These residents may be displaced by the flooding of their homes, requiring them to seek temporary shelter with friends and family or in emergency shelters. Burlington City has the greatest total number and proportion of its population located in the floodplain; 7,585 (approximately 76.5-percent) and 8,534 (approximately 86.0-percent) for the 1-percent chance event and 0.2-percent chance event, respectively. For this project, the potential population exposed is used as a guide for planning purposes.

Table 5.4.4-9. Estimated Population Exposed to the Flood Hazard

Municipality	Total Population	1-Percent Chance Event		0.2-Percent Chance Event	
		Population in Hazard Area	Percent of Total Population	Population in Hazard Area	Percent of Total Population
Bass River Township	1,443	647	44.8%	822	57.0%
Beverly City	2,577	233	9.0%	373	14.5%
Bordentown City	3,924	76	1.9%	76	1.9%
Bordentown Township	11,367	701	6.2%	792	7.0%
Burlington City	9,920	7,585	76.5%	8,534	86.0%
Burlington Township	22,594	653	2.9%	1,143	5.1%
Chesterfield Township	7,699	22	<1%	22	<1%
Cinnaminson Township	15,569	1,047	6.7%	1,554	10.0%
Delanco Township	4,283	136	3.2%	1,018	23.8%
Delran Township	16,896	656	3.9%	928	5.5%
Eastampton Township	6,069	36	<1%	64	1.1%
Edgewater Park Township	8,881	0	0.0%	0	0.0%
Evesham Township	45,538	2,052	4.5%	2,142	4.7%
Fieldsboro Borough	540	22	4.1%	22	4.1%
Florence Township	12,109	88	<1%	88	<1%
Hainesport Township	6,110	170	2.8%	170	2.8%
Lumberton Township	12,559	754	6.0%	800	6.4%
Mansfield Township	8,544	184	2.2%	184	2.2%
Maple Shade Township	19,131	547	2.9%	1,194	6.2%
Medford Lakes Borough	4,146	425	10.3%	425	10.3%
Medford Township	23,033	1,448	6.3%	1,856	8.1%
Moorestown Township	20,726	246	1.2%	326	1.6%
Mount Holly Township	9,536	1,243	13.0%	2,206	23.1%
Mount Laurel Township	41,864	920	2.2%	2,466	5.9%
New Hanover Township	7,385	7	<1%	7	<1%
North Hanover Township	7,678	327	4.3%	327	4.3%
Palmyra Borough	7,398	748	10.1%	3,048	41.2%
Pemberton Borough	1,409	0	0.0%	40	2.8%
Pemberton Township	27,912	1,338	4.8%	1,413	5.1%
Riverside Township	8,079	530	6.6%	937	11.6%
Riverton Borough	2,779	175	6.3%	571	20.5%
Shamong Township	6,490	946	14.6%	946	14.6%
Southampton Township	10,464	1,364	13.0%	1,523	14.6%
Springfield Township	3,414	230	6.7%	260	7.6%
Tabernacle Township	6,949	157	2.3%	157	2.3%
Washington Township	687	429	62.4%	429	62.4%

Table 5.4.4-9. Estimated Population Exposed to the Flood Hazard

Municipality	Total Population	1-Percent Chance Event		0.2-Percent Chance Event	
		Population in Hazard Area	Percent of Total Population	Population in Hazard Area	Percent of Total Population
Westampton Township	8,813	1,262	14.3%	1,276	14.5%
Willingboro Township	31,629	1,039	3.3%	1,126	3.6%
Woodland Township	1,788	3	<1%	3	<1%
Wrightstown Borough	802	0	0.0%	0	0.0%
Burlington County	**448,734**	**28,446**	**6.3%**	**39,268**	**8.8%**

Sources: U.S. Census 2010; FEMA, 2017
The FEMA DFIRM boundaries were overlaid on the U.S. Census block; the blocks with their centroids within the hazard areas were totaled for each municipality.

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 flood event, and they may have more difficulty evacuating. Within the 1-percent annual chance event, there are approximately 3,871 people over the age of 65 and 3,364 people considered low income populations. These populations are all located within the 1-percent annual chance flood A-zones; no elderly or low-income populations are located within the 1-percent annual chance flood V-zones. As for the 0.2-percent chance event, there are approximately 6,836 people over the age 65 and 5,248 people considered low income populations.

Using 2010 U.S. Census data, HAZUS-MH 4.0 estimates the potential sheltering needs as a result of a 1-percent annual chance flood event. For the 1-percent flood event, HAZUS-MH 4.0 estimates 23,057 households will be displaced, and 15,599 people will seek short-term sheltering. These statistics, by municipality, are presented in Table 5.4.4-10. 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.

Table 5.4.4-10. 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
Bass River Township	1,443	432	293
Beverly City	2,577	76	33
Bordentown City	3,924	65	16
Bordentown Township	11,367	180	77
Burlington City	9,920	7,485	6,908
Burlington Township	22,594	280	126
Chesterfield Township	7,699	122	3
Cinnaminson Township	15,569	1,109	707
Delanco Township	4,283	321	194

Table 5.4.4-10. 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
Delran Township	16,896	676	490
Eastampton Township	6,069	145	111
Edgewater Park Township	8,881	2	0
Evesham Township	45,538	1,327	732
Fieldsboro Borough	540	9	0
Florence Township	12,109	59	6
Hainesport Township	6,110	305	191
Lumberton Township	12,559	385	198
Mansfield Township	8,544	112	37
Maple Shade Township	19,131	407	291
Medford Lakes Borough	4,146	209	46
Medford Township	23,033	1,074	578
Moorestown Township	20,726	684	327
Mount Holly Township	9,536	670	458
Mount Laurel Township	41,864	1,425	896
New Hanover Township	7,385	16	0
North Hanover Township	7,678	77	10
Palmyra Borough	7,398	1,092	847
Pemberton Borough	1,409	6	0
Pemberton Township	27,912	1,070	340
Riverside Township	8,079	478	324
Riverton Borough	2,779	129	61
Shamong Township	6,490	193	59
Southampton Township	10,464	527	173
Springfield Township	3,414	136	34
Tabernacle Township	6,949	107	14
Washington Township	687	218	156
Westampton Township	8,813	432	274
Willingboro Township	31,629	954	576
Woodland Township	1,788	63	13
Wrightstown Borough	802	0	0
Burlington County	**448,734**	**23,057**	**15,599**

Source: HAZUS-MH 4.0

Total numbers of injuries and casualties resulting from typical riverine 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. Molds 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, 2015).

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 and potential damage is the modeled loss that could occur to the exposed inventory, including structural and content value. In summary, there are 8,424 buildings located in 1-percent annual chance flood boundary with approximately $7.8 billion of building/contents exposed (based on replacement cost value). This represents approximately 4.7-percent of the county's total general building stock inventory (approximately $165.5 billion). There are 12,766 buildings located in the 0.2-percent annual chance flood boundary with approximately $12 billion of building/contents exposed. This represents approximately 7.3-percent of the County's total general building stock inventory. The City of Burlington has the greatest exposure to its building stock for both the 1- and 0.2-percent annual chance flood events. Refer to Table 5.4.4-11 and Table 5.4.4-12 for the results of the 1- and 0.2-percent annual chance flood exposure on the general building stock.

The potential damage estimated by HAZUS-MH to the general building stock inventory associated with the 1-percent annual chance flood is approximately $1.2 billion or less than 1-percent of the total building stock replacement cost value (structure and estimated contents). The potential damage estimated by HAZUS-MH 4.0 to the residential general building stock inventory associated with the 1-percent annual chance flood is $605 million or less than 1-percent of the total building stock replacement cost value (structure and estimated contents). Refer to Table 5.4.4-13 for the potential losses estimated by HAZUS-MH 4.0 by municipality.

Table 5.4.4-11. Estimated General Building Stock Exposure to the 1-Percent Annual Chance Flood Event – All Occupancies

Municipality	Total # Buildings	Total Replacement Cost Value	Total (All Occupancies) in the 1-Percent Annual Chance Flood Zone			
			# Buildings	Percent of Total	Replacement Cost Value	Percent of Total
Bass River Township	1,863	$1,027,917,130	530	28.4%	$328,406,175	31.9%
Beverly City	964	$471,487,138	10	1.0%	$6,632,164	1.4%
Bordentown City	1,219	$1,244,995,904	17	1.4%	$9,767,552	0.8%
Bordentown Township	3,113	$2,820,041,247	60	1.9%	$64,670,462	2.3%
Burlington City	3,644	$3,215,233,092	2,374	65.1%	$2,194,748,648	68.3%
Burlington Township	7,757	$8,013,259,672	124	1.6%	$217,856,658	2.7%
Chesterfield Township	2,093	$2,443,294,418	32	1.5%	$59,466,822	2.4%
Cinnaminson Township	6,358	$5,703,895,752	365	5.7%	$195,202,321	3.4%
Delanco Township	1,562	$1,422,201,479	129	8.3%	$142,092,069	10.0%
Delran Township	5,191	$5,145,622,596	297	5.7%	$181,464,342	3.5%
Eastampton Township	2,499	$1,687,017,512	212	8.5%	$58,884,301	3.5%
Edgewater Park Township	2,567	$2,307,285,215	6	0.2%	$1,159,758	0.1%
Evesham Township	14,319	$14,666,082,424	241	1.7%	$209,842,379	1.4%
Fieldsboro Borough	242	$139,371,126	8	3.3%	$3,405,520	2.4%
Florence Township	2,522	$2,787,263,607	48	1.9%	$73,215,203	2.6%
Hainesport Township	2,747	$3,447,208,735	85	3.1%	$117,068,572	3.4%
Lumberton Township	4,009	$5,459,557,257	218	5.4%	$194,758,556	3.6%
Mansfield Township	2,798	$4,056,501,589	70	2.5%	$92,363,074	2.3%
Maple Shade Township	6,006	$4,385,500,913	53	0.9%	$86,328,706	2.0%
Medford Lakes Borough	1,909	$1,280,050,871	88	4.6%	$42,554,968	3.3%
Medford Township	10,627	$12,845,907,494	480	4.5%	$367,010,672	2.9%
Moorestown Township	8,736	$10,108,801,626	178	2.0%	$250,295,272	2.5%
Mount Holly Township	4,573	$3,498,352,996	166	3.6%	$124,879,749	3.6%
Mount Laurel Township	12,900	$14,653,800,804	229	1.8%	$260,222,222	1.8%
New Hanover Township	1,964	$3,022,835,486	28	1.4%	$17,056,530	0.6%
North Hanover Township	2,901	$3,079,878,987	35	1.2%	$117,216,744	3.8%
Palmyra Borough	2,713	$1,788,398,557	209	7.7%	$93,313,877	5.2%
Pemberton Borough	514	$345,869,906	0	0.0%	$0	0.0%
Pemberton Township	13,511	$9,374,914,679	615	4.6%	$792,660,953	8.5%
Riverside Township	2,868	$2,039,139,951	201	7.0%	$143,737,008	7.0%

Table 5.4.4-11. Estimated General Building Stock Exposure to the 1-Percent Annual Chance Flood Event – All Occupancies

Municipality	Total # Buildings	Total Replacement Cost Value	Total (All Occupancies) in the 1-Percent Annual Chance Flood Zone			
			# Buildings	Percent of Total	Replacement Cost Value	Percent of Total
Riverton Borough	1,274	$916,434,789	37	2.9%	$33,097,785	3.6%
Shamong Township	3,623	$2,738,384,433	51	1.4%	$16,751,317	0.6%
Southampton Township	7,982	$6,722,347,774	340	4.3%	$247,542,681	3.7%
Springfield Township	2,876	$3,853,514,909	122	4.2%	$177,045,818	4.6%
Tabernacle Township	4,452	$3,619,040,765	23	0.5%	$123,817,987	3.4%
Washington Township	939	$597,426,933	339	36.1%	$248,684,908	41.6%
Westampton Township	3,006	$4,269,433,407	86	2.9%	$110,182,624	2.6%
Willingboro Township	12,395	$8,259,747,413	261	2.1%	$140,529,678	1.7%
Woodland Township	1,323	$1,656,748,246	57	4.3%	$257,980,778	15.6%
Wrightstown Borough	485	$411,963,035	0	0.0%	$0	0.0%
Burlington County	**173,044**	**$165,526,729,867**	**8,424**	**4.9%**	**$7,801,914,854**	**4.7%**

Source: FEMA 2017, Burlington County, NJ Department of the Treasury, 2017
Note: The FEMA DFIRM boundaries were overlaid on the custom general building stock inventory; the structures with their centroids within the hazard are were totaled for each municipality.

Table 5.4.4-12. Estimated General Building Stock Exposure to the 0.2-Percent Annual Chance Flood Event – All Occupancies

Municipality	Total # Buildings	Total Replacement Cost Value	Total (All Occupancies) in the 0.2-Percent Annual Chance Flood Zone			
			# Buildings	Percent of Total	Replacement Cost Value	Percent of Total
Bass River Township	1,863	$1,027,917,130	852	45.7%	$557,034,227	54.2%
Beverly City	964	$471,487,138	50	5.2%	$24,194,626	5.1%
Bordentown City	1,219	$1,244,995,904	19	1.6%	$10,998,968	0.9%
Bordentown Township	3,113	$2,820,041,247	78	2.5%	$92,475,544	3.3%
Burlington City	3,644	$3,215,233,092	2,905	79.7%	$2,746,821,720	85.4%
Burlington Township	7,757	$8,013,259,672	465	6.0%	$546,728,337	6.8%
Chesterfield Township	2,093	$2,443,294,418	32	1.5%	$59,466,822	2.4%
Cinnaminson Township	6,358	$5,703,895,752	573	9.0%	$425,876,406	7.5%
Delanco Township	1,562	$1,422,201,479	485	31.0%	$360,805,718	25.4%
Delran Township	5,191	$5,145,622,596	420	8.1%	$298,976,437	5.8%
Eastampton Township	2,499	$1,687,017,512	236	9.4%	$65,086,684	3.9%
Edgewater Park Township	2,567	$2,307,285,215	11	0.4%	$4,595,037	0.2%

Table 5.4.4-12. Estimated General Building Stock Exposure to the 0.2-Percent Annual Chance Flood Event – All Occupancies

Municipality	Total # Buildings	Total Replacement Cost Value	Total (All Occupancies) in the 0.2-Percent Annual Chance Flood Zone			
			# Buildings	Percent of Total	Replacement Cost Value	Percent of Total
Evesham Township	14,319	$14,666,082,424	296	2.1%	$242,326,131	1.7%
Fieldsboro Borough	242	$139,371,126	9	3.7%	$3,593,195	2.6%
Florence Township	2,522	$2,787,263,607	51	2.0%	$75,315,270	2.7%
Hainesport Township	2,747	$3,447,208,735	101	3.7%	$143,335,791	4.2%
Lumberton Township	4,009	$5,459,557,257	229	5.7%	$201,938,177	3.7%
Mansfield Township	2,798	$4,056,501,589	70	2.5%	$92,363,074	2.3%
Maple Shade Township	6,006	$4,385,500,913	123	2.0%	$243,048,073	5.5%
Medford Lakes Borough	1,909	$1,280,050,871	93	4.9%	$43,641,024	3.4%
Medford Township	10,627	$12,845,907,494	637	6.0%	$569,556,858	4.4%
Moorestown Township	8,736	$10,108,801,626	257	2.9%	$346,356,682	3.4%
Mount Holly Township	4,573	$3,498,352,996	479	10.5%	$460,823,782	13.2%
Mount Laurel Township	12,900	$14,653,800,804	694	5.4%	$895,193,432	6.1%
New Hanover Township	1,964	$3,022,835,486	28	1.4%	$17,056,530	0.6%
North Hanover Township	2,901	$3,079,878,987	35	1.2%	$117,216,744	3.8%
Palmyra Borough	2,713	$1,788,398,557	712	26.2%	$552,888,735	30.9%
Pemberton Borough	514	$345,869,906	2	0.4%	$585,435	0.2%
Pemberton Township	13,511	$9,374,914,679	675	5.0%	$917,774,126	9.8%
Riverside Township	2,868	$2,039,139,951	362	12.6%	$250,453,649	12.3%
Riverton Borough	1,274	$916,434,789	253	19.9%	$190,429,316	20.8%
Shamong Township	3,623	$2,738,384,433	71	2.0%	$20,509,550	0.7%
Southampton Township	7,982	$6,722,347,774	376	4.7%	$258,973,214	3.9%
Springfield Township	2,876	$3,853,514,909	131	4.6%	$181,707,319	4.7%
Tabernacle Township	4,452	$3,619,040,765	23	0.5%	$123,817,987	3.4%
Washington Township	939	$597,426,933	442	47.1%	$329,355,215	55.1%
Westampton Township	3,006	$4,269,433,407	101	3.4%	$115,582,178	2.7%
Willingboro Township	12,395	$8,259,747,413	332	2.7%	$184,986,004	2.2%
Woodland Township	1,323	$1,656,748,246	58	4.4%	$258,508,844	15.6%
Wrightstown Borough	485	$411,963,035	0	0.0%	$0	0.0%
Burlington County	**173,044**	**$165,526,729,867**	**12,766**	**7.4%**	**$12,030,396,860**	**7.3%**

Source: FEMA 2017, Burlington County, NJ Department of the Treasury, 2017
Note: The FEMA DFIRM boundaries were overlaid on the custom general building stock inventory; the structures with their centroids within the hazard are were totaled for each municipality.

Table 5.4.4-13. 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		Industrial, Religious, Education and Government	
		Estimated Loss	% of Total	Estimated Loss	% of Total	Estimated Loss	% of Total	Estimated Loss	% of Total
Bass River Township	$1,027,917,130	$98,108,935	9.5%	$32,063,779	3.1%	$11,263,192	1.1%	$54,781,964	5.3%
Beverly City	$471,487,138	$2,106,654	<1%	$378,662	<1%	$0	0.0%	$1,727,992	<1%
Bordentown City	$1,244,995,904	$3,682,945	<1%	$189,609	<1%	$3,004,925	<1%	$488,412	<1%
Bordentown Township	$2,820,041,247	$16,965,329	<1%	$5,955,081	<1%	$1,212,021	<1%	$9,798,228	<1%
Burlington City	$3,215,233,092	$452,114,703	14.1%	$254,514,061	7.9%	$78,521,419	2.4%	$119,079,223	<1%
Burlington Township	$8,013,259,672	$41,694,948	<1%	$34,959,728	<1%	$2,224,981	<1%	$4,510,239	<1%
Chesterfield Township	$2,443,294,418	$17,053,346	<1%	$8,804,419	<1%	$0	0.0%	$8,248,927	<1%
Cinnaminson Township	$5,703,895,752	$33,082,348	<1%	$17,564,325	<1%	$1,217,854	<1%	$14,300,169	<1%
Delanco Township	$1,422,201,479	$15,320,918	1.1%	$11,571,875	<1%	$1,246,804	<1%	$2,502,240	<1%
Delran Township	$5,145,622,596	$32,649,850	<1%	$17,472,074	<1%	$13,080,642	<1%	$2,097,133	<1%
Eastampton Township	$1,687,017,512	$13,058,605	<1%	$2,537,456	<1%	$2,115,395	<1%	$8,405,754	<1%
Edgewater Park Township	$2,307,285,215	$10,434	<1%	$8,558	<1%	$0	0.0%	$1,876	<1%
Evesham Township	$14,666,082,424	$13,611,662	<1%	$6,074,244	<1%	$63,984	<1%	$7,473,433	<1%
Fieldsboro Borough	$139,371,126	$513,300	<1%	$513,300	<1%	$0	0.0%	$0	0.0%
Florence Township	$2,787,263,607	$16,913,921	<1%	$719,091	<1%	$4,007,344	<1%	$12,187,487	<1%
Hainesport Township	$3,447,208,735	$44,043,475	1.3%	$5,119,472	<1%	$162,065	<1%	$38,761,938	<1%
Lumberton Township	$5,459,557,257	$38,165,788	<1%	$28,412,272	<1%	$3,739,275	<1%	$6,014,241	<1%
Mansfield Township	$4,056,501,589	$25,305,486	<1%	$712,522	<1%	$940,093	<1%	$23,652,871	<1%
Maple Shade Township	$4,385,500,913	$2,744,663	<1%	$2,012,216	<1%	$309,696	<1%	$422,750	<1%
Medford Lakes Borough	$1,280,050,871	$1,556,958	<1%	$1,551,036	<1%	$2,213	<1%	$3,709	<1%
Medford Township	$12,845,907,494	$36,085,020	<1%	$21,531,717	<1%	$3,510,713	<1%	$11,042,591	<1%
Moorestown Township	$10,108,801,626	$22,962,994	<1%	$10,461,934	<1%	$1,880,540	<1%	$10,620,520	<1%
Mount Holly Township	$3,498,352,996	$18,525,170	<1%	$13,257,276	<1%	$1,242,965	<1%	$4,024,929	<1%
Mount Laurel Township	$14,653,800,804	$31,823,704	<1%	$22,402,621	<1%	$411,498	<1%	$9,009,584	<1%
New Hanover Township	$3,022,835,486	$4,896,176	<1%	$193,669	<1%	$0	0.0%	$4,702,508	<1%
North Hanover Township	$3,079,878,987	$22,724,485	<1%	$2,237,183	<1%	$962,741	<1%	$19,524,560	<1%
Palmyra Borough	$1,788,398,557	$7,954,249	<1%	$3,704,028	<1%	$1,157,364	<1%	$3,092,858	<1%
Pemberton Borough	$345,869,906	$0	0.0%	$0	0.0%	$0	0.0%	$0	0.0%
Pemberton Township	$9,374,914,679	$47,063,059	<1%	$39,770,781	<1%	$387,129	<1%	$6,905,149	<1%
Riverside Township	$2,039,139,951	$17,301,486	<1%	$7,396,326	<1%	$1,347,288	<1%	$8,557,872	<1%
Riverton Borough	$916,434,789	$2,777,240	<1%	$1,557,507	<1%	$0	0.0%	$1,219,733	<1%
Shamong Township	$2,738,384,433	$1,564,073	<1%	$961,360	<1%	$0	0.0%	$602,713	0.0%

Table 5.4.4-13. 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		Industrial, Religious, Education and Government	
		Estimated Loss	% of Total	Estimated Loss	% of Total	Estimated Loss	% of Total	Estimated Loss	% of Total
Southampton Township	$6,722,347,774	$14,822,393	<1%	$9,034,171	<1%	$96,001	<1%	$5,692,221	<1%
Springfield Township	$3,853,514,909	$25,342,380	<1%	$8,011,267	<1%	$2,410,260	<1%	$14,920,853	<1%
Tabernacle Township	$3,619,040,765	$3,451,046	<1%	$170,230	<1%	$199,932	<1%	$3,080,883	<1%
Washington Township	$597,426,933	$21,199,734	3.5%	$11,563,229	1.9%	$122,470	<1%	$9,514,035	1.6%
Westampton Township	$4,269,433,407	$15,933,089	<1%	$5,292,326	<1%	$163,843	<1%	$10,476,920	<1%
Willingboro Township	$8,259,747,413	$16,985,969	<1%	$16,519,730	<1%	$0	0.0%	$466,239	<1%
Woodland Township	$1,656,748,246	$8,943,606	<1%	$59,571	<1%	$0	0.0%	$8,884,035	<1%
Wrightstown Borough	$411,963,035	$0	0.0%	$0	0.0%	$0	0.0%	$0	0.0%
Burlington County	**$165,526,729,867**	**$1,189,060,143**	**<1%**	**$605,258,706**	**<1%**	**$137,004,647**	**<1%**	**$446,796,790**	**<1%**

Source: HAZUS-MH 4.0, Burlington County

NFIP Statistics

In addition to total building stock modeling, individual data available on flood policies, claims, Repetitive Loss (RL) properties and severe repetitive loss (SRL) properties were analyzed. FEMA Region 2 provided a list of residential properties with NFIP policies, past claims and multiple claims (RL and SRL properties). According to the metadata provided: "The (*sic* National Flood Insurance Program) NFIP Repetitive Loss File contains losses reported from individuals who have flood insurance through the Federal Government. A property is considered a repetitive loss property when there are two or more losses reported which were paid more than $1,000 for each loss. The two losses must be within 10 years of each other & be as least 10 days apart. Only losses from (*sic* since) 1/1/1978 that are closed are considered."

SRLs were then examined for the county. According to section 1361A of the National Flood Insurance Act, as amended (NFIA), 42 U.S.C. 4102a, an SRL property is defined as a residential property that is covered under an NFIP flood insurance policy and:

- Has at least four NFIP claim payments (including building and contents) over $5,000 each, and the cumulative amount of such claims payments exceeds $20,000; or
- For which at least two separate claims payments (building payments only) have been made with the cumulative amount of the building portion of such claims exceeding the market value of the building.
- For both of the above, at least two of the referenced claims must have occurred within any 10- year period and must be greater than 10 days apart.

The location of the properties with policies, claims and repetitive and severe repetitive flooding were geocoded by FEMA with the understanding that there are varying tolerances between how closely the longitude and latitude coordinates correspond to the location of the property address, or that the indication of some locations is more accurate than others.

Table 5.4.4-16 summarizes the NFIP policies, claims and repetitive loss statistics for Burlington County. According to FEMA, Table 5.4.4-15 summarizes the occupancy classes of the repetitive loss and severe repetitive loss properties in Burlington County. The majority of the RL property occupancy class is single family residences (90.2-percent). All the SRL property occupancy class is also single-family residences (FEMA Region 2, 2017). This information is current as of October 31, 2017. Note, the severe repetitive loss counts below represent validated severe repetitive loss properties only. There are an additional 11 severe repetitive loss properties that have not been validated: nine single-family residences, one assumed condo, and one 2-4 family residence.

The location of the properties with policies, claims and characterized as RL and SRL properties were geocoded by FEMA with the understanding that there are varying tolerances between how closely the longitude and latitude coordinates correspond to the location of the property address, or that the indication of some locations is more accurate than others.

Table 5.4.4-14. Occupancy Class of Repetitive Loss Structures in Burlington County

Occupancy Class	Total RL Loss Properties	Total Number of SRL Properties	Total (RL and SRL)
Single Family	167	15	182
Condo	3	0	3
2-4 Family	5	0	5
Other Residential	2	0	2
Non-Residential	8	0	8

Occupancy Class	Total RL Loss Properties	Total Number of SRL Properties	Total (RL and SRL)
Burlington County	**185**	**15**	**200**

Source: FEMA Region 2, 2017 RL = Repetitive Loss SRL = Severe Repetitive Loss

Note (1): Policies, claims, repetitive loss and severe repetitive loss statistics provided by FEMA Region 2 and are current as of 12/31/2014.

Note (2): The total number of repetitive loss properties does not include severe repetitive loss properties.

Table **5.4.4-15. Occupancy Class of Repetitive Loss Structures in Burlington County, by Municipality**

Municipality	Repetitive Loss Properties					Severe Repetitive Loss Properties				
	2-4 Family	Assumed Condo	Non-Residential	Other Residential	Single Family	2-4 Family	Assumed Condo	Non-Residential	Other Residential	Single Family
Bass River Township	0	0	0	0	4	0	0	0	0	0
Beverly City	0	0	0	0	0	0	0	0	0	0
Bordentown City	0	0	0	0	2	0	0	0	0	0
Bordentown Township	0	0	0	0	1	0	0	0	0	0
Burlington City	0	0	0	0	10	0	0	0	0	0
Burlington Township	0	0	0	0	3	0	0	0	0	0
Chesterfield Township	0	0	0	0	0	0	0	0	0	0
Cinnaminson Township	1	0	0	0	15	0	0	0	0	2
Delanco Township	0	0	0	0	1	0	0	0	0	0
Delran Township	0	0	1	0	9	0	0	0	0	0
Eastampton Township	1	1	0	0	17	0	0	0	0	1
Edgewater Park Township	0	0	0	0	0	0	0	0	0	0
Evesham Township	0	0	0	0	4	0	0	0	0	0
Fieldsboro Borough	0	0	0	0	0	0	0	0	0	0
Florence Township	0	0	0	0	0	0	0	0	0	0
Hainesport Township	0	0	0	0	2	0	0	0	0	0
Lumberton Township	1	0	1	1	41	0	0	0	0	7
Mansfield Township	0	0	0	0	0	0	0	0	0	0
Maple Shade Township	2	1	0	1	0	0	0	0	0	0
Medford Lakes Borough	0	0	0	0	1	0	0	0	0	0
Medford Township	0	1	1	0	10	0	0	0	0	1
Moorestown Township	0	0	0	0	0	0	0	0	0	0
Mount Holly Township	0	0	2	0	3	0	0	0	0	0
Mount Laurel Township	0	0	0	0	2	0	0	0	0	0
New Hanover Township	0	0	0	0	0	0	0	0	0	0
North Hanover Township	0	0	0	0	0	0	0	0	0	0
Palmyra Borough	0	0	1	0	3	0	0	0	0	1

Table **5.4.4-15. Occupancy Class of Repetitive Loss Structures in Burlington County, by Municipality**

Municipality	Repetitive Loss Properties					Severe Repetitive Loss Properties				
	2-4 Family	Assumed Condo	Non-Residential	Other Residential	Single Family	2-4 Family	Assumed Condo	Non-Residential	Other Residential	Single Family
Pemberton Borough	0	0	0	0	0	0	0	0	0	0
Pemberton Township	0	0	0	0	4	0	0	0	0	0
Riverside Township	0	0	1	0	4	0	0	0	0	1
Riverton Borough	0	0	0	0	0	0	0	0	0	0
Shamong Township	0	0	0	0	1	0	0	0	0	0
Southampton Township	0	0	1	0	22	0	0	0	0	1
Springfield Township	0	0	0	0	0	0	0	0	0	0
Tabernacle Township	0	0	0	0	0	0	0	0	0	0
Washington Township	0	0	0	0	1	0	0	0	0	0
Westampton Township	0	0	0	0	4	0	0	0	0	1
Willingboro Township	0	0	0	0	2	0	0	0	0	0
Woodland Township	0	0	0	0	0	0	0	0	0	0
Wrightstown Borough	0	0	0	0	0	0	0	0	0	0
Burlington County	**5**	**3**	**8**	**2**	**166**	**0**	**0**	**0**	**0**	**15**

Source: FEMA, 2017
Note (1): Policies, claims, repetitive loss and severe repetitive loss statistics provided by FEMA Region 2, and are current as of 10/31/2017
Note (2): The statistics were summarized using the Community Name provided by FEMA Region 2.
Note (3): The total number of repetitive loss properties does not include severe repetitive loss properties.

Table **5.4.4-16. NFIP Policies, Claims and Repetitive Loss Statistics**

Municipality	# Policies (1)	# Claims (Losses) (1)	Total Loss Payments (2)	# Rep. Loss Prop. (1)	# Severe Rep. Loss Prop. (1)	# Policies in the 1% Flood Boundary (3)
Bass River Township	68	59	$2,085,531.76	4	0	4
Beverly	5	1	$3,513.71	0	0	0
City of Bordentown	6	7	$31,802.20	2	0	0
Bordentown	42	12	$119,313.25	1	0	0
City of Burlington	976	240	$621,951.30	10	0	895

Table **5.4.4-16. NFIP Policies, Claims and Repetitive Loss Statistics**

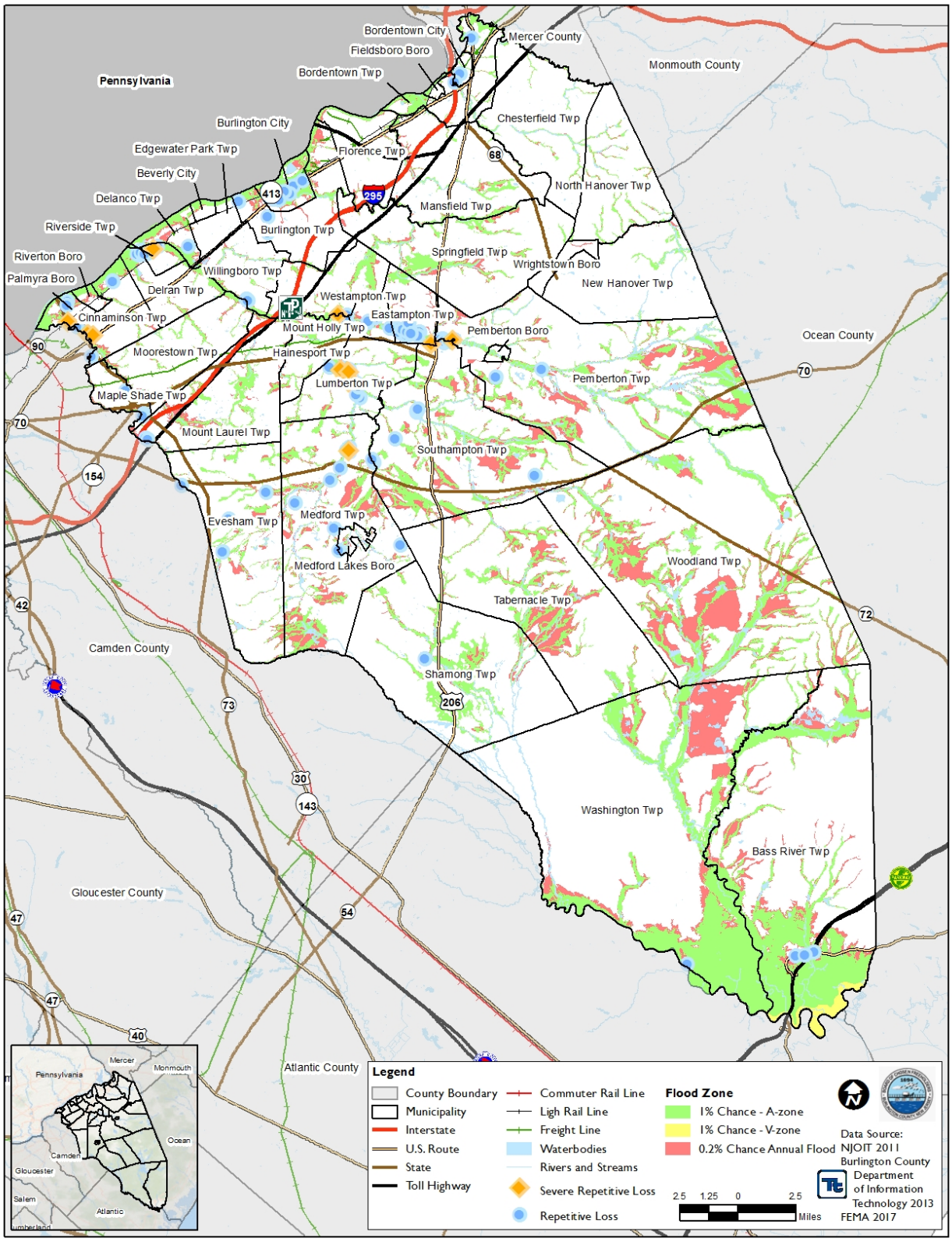
Municipality	# Policies (1)	# Claims (Losses) (1)	Total Loss Payments (2)	# Rep. Loss Prop. (1)	# Severe Rep. Loss Prop. (1)	# Policies in the 1% Flood Boundary (3)
Burlington Township	95	38	$254,785.12	3	0	0
Chesterfield	11	2	$2,128.40	0	0	11
Cinnaminson	220	153	$1,172,340.97	16	2	13
Delanco Township	102	21	$67,299.23	1	0	2
Delran Township	114	99	$690,575.82	10	0	11
Eastampton Township	25	110	$790,919.42	19	0	0
Edgewater Park Township	9	5	$35,201.23	0	0	0
Evesham Township	169	37	$250,315.31	4	0	0
Fieldsboro Borough (NP)	0	2	$707.00	0	0	0
Florence Township	20	4	$16,325.05	0	0	1
Hainesport Township	31	6	$32,269.89	2	0	0
Lumberton Township	79	187	$6,782,899.98	44	7	10
Mansfield	18	5	$9,489.05	0	0	0
Maple Shade Township	27	7	$240,619.32	4	0	0
Medford Lakes	82	28	$251,645.28	1	0	2
Medford	249	179	$3,355,285.87	13	1	2
Moorestown Township	140	58	$312,472.02	0	0	0
Mount Holly	75	108	$1,470,161.61	6	0	2
Mount Laurel	238	74	$413,085.52	2	0	2
New Hanover	2	5	$889.34	0	0	0
North Hanover	5	1	$13,060.31	0	0	0
Palmyra	189	35	$198,231.08	4	1	143
Pemberton	2	3	$458.74	**0**	0	0
Pemberton Township	202	98	$900,851.07	4	0	6
Riverside Township	64	49	$515,071.80	5	1	2
Riverton	36	5	$9,225.31	0	0	3

Table **5.4.4-16. NFIP Policies, Claims and Repetitive Loss Statistics**

Municipality	# Policies (1)	# Claims (Losses) (1)	Total Loss Payments (2)	# Rep. Loss Prop. (1)	# Severe Rep. Loss Prop. (1)	# Policies in the 1% Flood Boundary (3)
Shamong Township	23	7	$8,926.85	1	0	0
Southampton Township	100	138	$2,301,683.67	23	2	10
Springfield Township	13	8	$137,767.37	0	0	0
Tabernacle Township	12	1	$6,406.91	0	0	1
Washington Township	38	24	$1,136,241.46	1	0	2
Westampton Township	49	20	$199,139.41	4	1	0
Willingboro Township	177	30	$688,095.88	2	0	1
Woodland Township	0	1	$861.92	0	0	0
Wrightstown Borough	0	2	$15,631.58	0	0	0
Burlington County	**3,713**	**1,869**	**$25,143,181.01**	**185**	**15**	**1,157**

Source: FEMA Region 2 2017, 2018
(1) Repetitive loss and severe repetitive loss statistics provided by FEMA Region 2 and are current as of 10/31/2017. Policy and claims statistics current as of 9/30/2018
Please note the total number of repetitive loss properties does not include the severe repetitive loss properties. The number of claims represents claims closed by 9/30/2018.
(2) Total building and content losses from the claims file provided by FEMA Region 2.
(3) The policies inside and outside of the flood zones are based on the addresses geocoded from the FEMA Region 2 policy file – 10/31/2017.
Notes: FEMA noted that where there is more than one entry for a property, there may be more than one policy in force or more than one GIS possibility.
A zero percentage denotes less than 1/100th percentage and not zero damages or vulnerability as may be the case.

Figure 5.4.4-4. NFIP Repetitive and Severe Repetitive Loss Areas in Burlington County

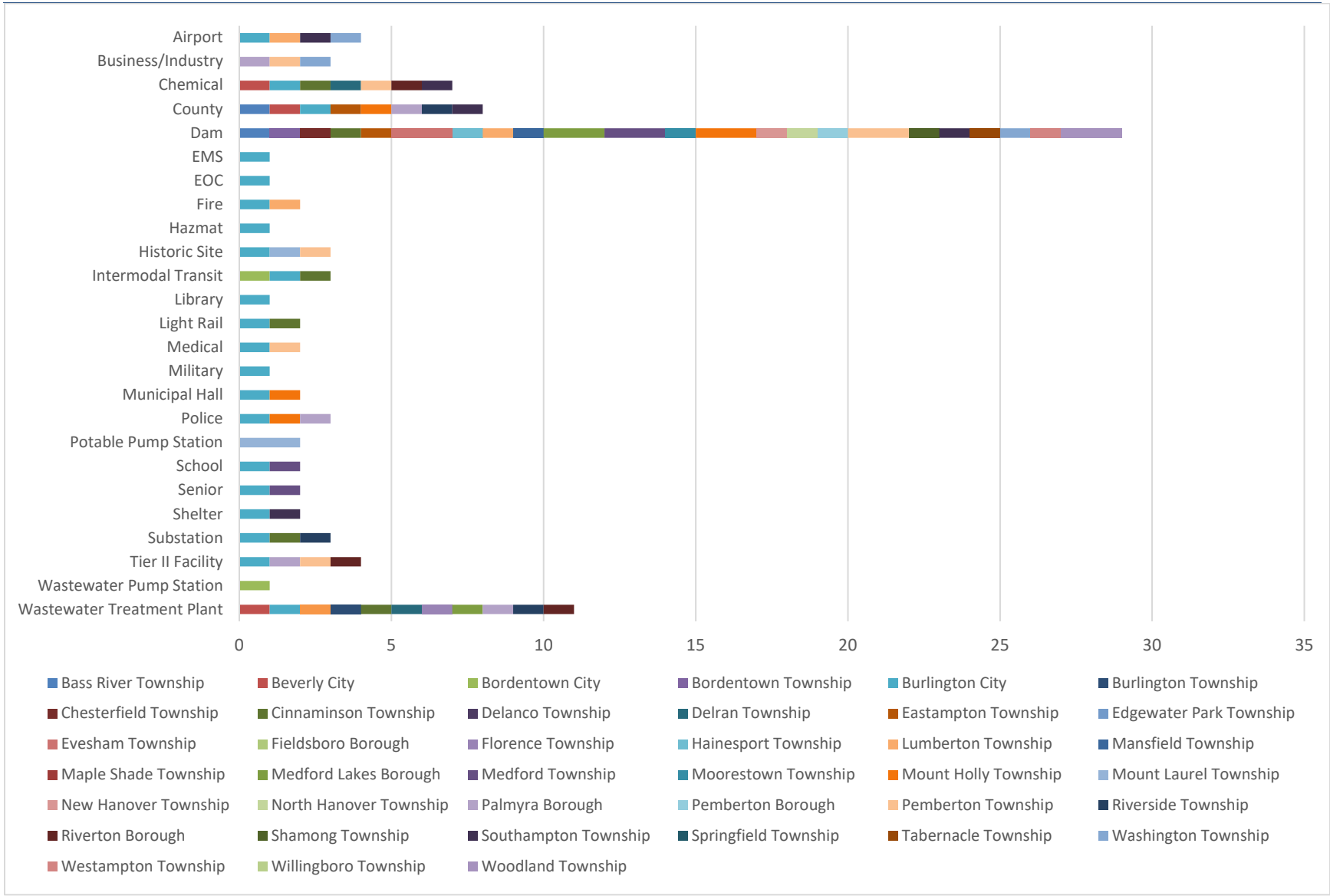


Impact on Critical Facilities

It is important to determine what critical facilities and infrastructure 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 facility structures 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, including for emergency service providers needing to get to vulnerable populations or to make repairs. Major roadways that may be impacted by the 1-percent annual chance flood event include I-295, NJ-38, NJ-413, NJ-70, NJ-72, NJ-73, NJ-90, US-130, US-302, US-9, the Garden State Parkway, and The NJ Turnpike. Bridges washed out or blocked by floods or debris also can cause isolation. Water and sewer systems can be flooded or backed up, causing health problems. Floodwaters can get into drinking water supplies, causing contamination. Culverts can be blocked by debris from flood events, also causing localized urban flooding. Sewer systems can be backed up, causing wastewater to spill into homes, neighborhoods, rivers and streams.

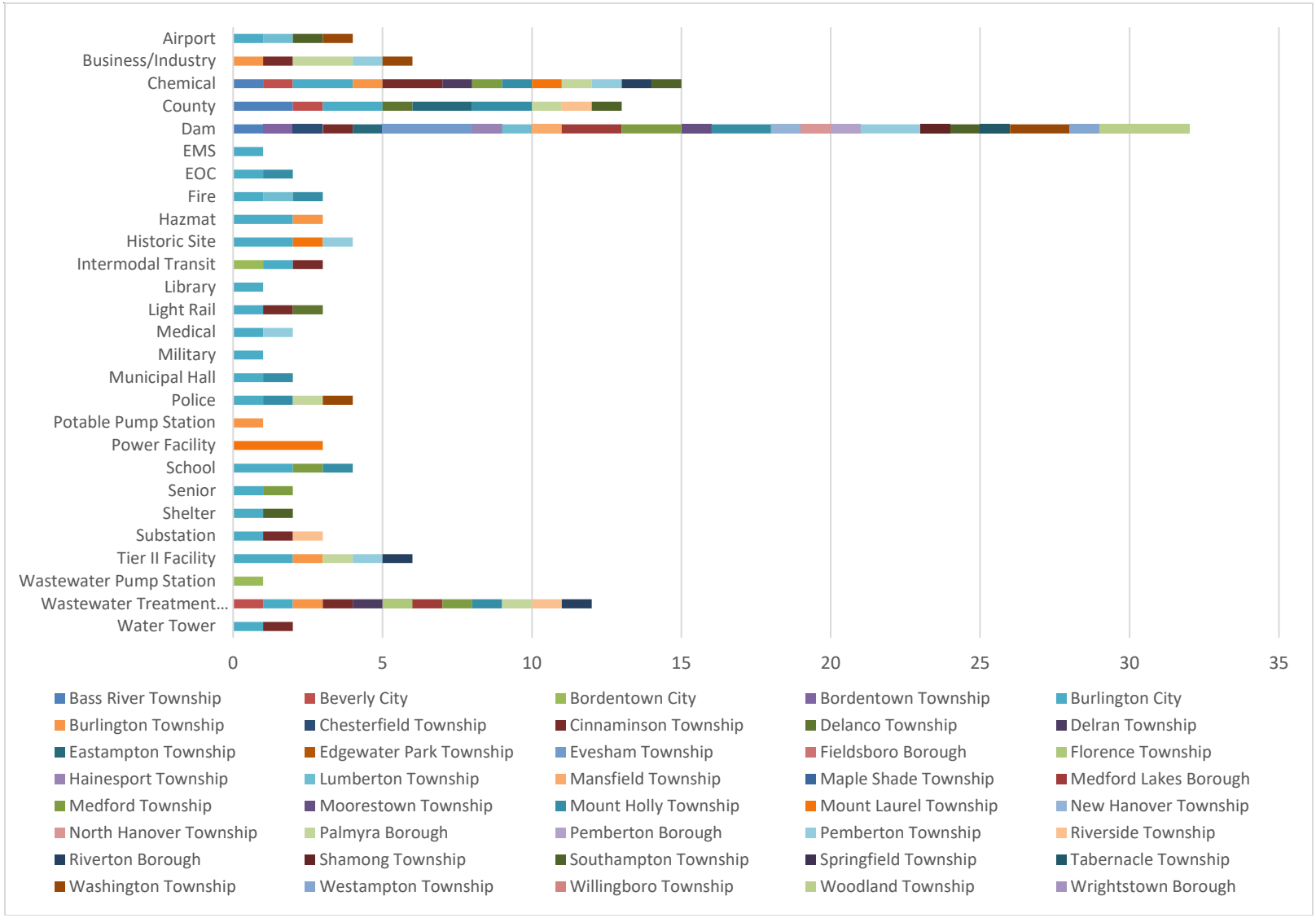
Critical facility exposure to the flood hazard was examined. In addition, HAZUS-MH 4.0 was used to estimate the flood loss potential to critical facilities exposed to the flood risk. Tables G-11 through G-14 in Appendix G summarizes these results. Figure 5.4.4-5 and Figure 5.4.4-6 display the number of critical facilities located in the FEMA flood zones by type and by jurisdiction. Dams have the greatest exposure to both the 1- and 0.2-percent annual chance flood events of all these critical facility types; there are 29 dams located in the 1-percent annual chance flood event boundary and 32 dams located in the 0.2-percent annual chance flood event boundary.

Figure 5.4.4-5. Number of Critical Facilities Located in the 1-percent Annual Chance Flood Zone



Source: FEMA 2017, Burlington County

Figure 5.4.4-6. Number of Critical Facilities Located in the 0.2-Percent Annual Chance Flood Zone



Source: FEMA 2017, Burlington County

Impact on the Economy

For impact on economy, estimated losses from a flood event are considered. Losses include but are not limited to general building stock damages, agricultural losses, business interruption, impacts to tourism and tax base to Burlington County. Damages to general building stock can be quantified using HAZUS-MH as discussed above. Other economic components such as loss of facility use, functional downtime and social economic factors are less measurable with a high degree of certainty.

Flooding can cause extensive damage to public utilities and disruptions to the delivery of services. Loss of power and communications may occur; and drinking water and wastewater treatment facilities may be temporarily out of operation. Flooded streets and road blocks make it difficult for emergency vehicles to respond to calls for service.

Direct building losses are the estimated costs to repair or replace the damage caused to the building. Refer to the 'Impact on General Building Stock' subsection which discusses these potential losses. These dollar value losses to the County's total building inventory replacement value (based on estimated replacement cost value), in addition to damages to roadways and infrastructure, would greatly impact the local economy.

HAZUS-MH estimated the amount of debris generated from the 1-percent annual chance 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.). The distinction is made because of the different types of equipment needed to handle the debris. Table 5.4.4-17 summarizes the debris estimated for the 1-percent flood annual chance event.

Please note this table only represents estimated debris generated by riverine flooding and does not include additional potential damage and debris which may be generated with the presence of wind.

Table 5.4.4-17. Estimated Debris Generated from the 1-Percent Annual Chance Flood Event

Total (tons)	Finish (tons)	Structure (tons)	Foundation (tons)
18,358	16,175	1,232	951

Source: HAZUS-MH 4.2.

Impact on the Environment

Floodplains serve beneficial and natural functions on ecological/environmental, social and economic levels. Areas in the floodplain that typically provide these natural functions and benefits are wetlands, riparian areas, sensitive areas, and habitats for rare and endangered species. However, floods can also lead to negative impacts on the environment. According to FEMA, well-known, water-related functions of floodplains include the following. Disruption of natural systems and the benefits they provide can have long-term consequences for entire regions.

- Natural flood and erosion control
- Provide flood storage and conveyance
- Reduce flood velocities
- Reduce flood peaks
- Reduce sedimentation
- Surface water quality maintenance
- Process organic wastes
- Moderate temperatures of water
- Groundwater recharge
- Filter nutrients and impurities from runoff
- Promote infiltration and aquifer recharge
- Reduce frequency and duration of low surface
- flows.

To determine the exposure of the natural and beneficial land in Burlington County to the flood hazard, the acreage of wetlands, forested land, and endangered species was calculated. Refer to Table 5.4.4-18.

Table 5.4.4-18. Acreage of Natural and Beneficial Land Located in the Floodplain

Wetlands	Area in the 1-Percent Annual Chance Floodplain (acres)	Area in the 0.2-Percent Annual Chance Floodplain (acres)
Wetlands	62,633	64,603
Forest	8,479	10,120
Endangered Species	72,321	75,451

Source: NJDEP 2017, NJDEP 2015, FEMA 2017

In addition, floods may generate large amounts of tree and construction debris (refer to Table 5.4.4-17), disperse household hazardous waste into the fluvial system, and contaminate water supplies and wildlife habitats with extremely toxic substances. Long duration floods could exacerbate environmental problems because clean-up will likely be delayed, and contaminants have the potential of remaining in the environment for a longer period of time.

Future Growth and Development

As discussed in Section 4, 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 identified hazard areas. Figure 5.4.4-7 illustrates the identified areas of potential new development in relation to the flood boundaries. It is the intention of the county and all participating municipalities to discourage development in vulnerable areas or to encourage higher regulatory standards on the local level.

There are 35 recent and proposed developments around the County exposed to the 1- and 0.2-percent annual chance flood event boundaries; 32 of these developments are located within the 1-percent annual chance flood event boundary. Mount Laurel Township has the most developments located in the hazard area (7 developments in the 1-percent annual chance flood event boundary). The Townships of Bordentown, Delran, and Riverside each have 1 development located within the 0.2-percent annual chance flood event boundary. Refer to each jurisdictional annex for the results of each exposure analysis on new development.

Effect of Climate Change on Vulnerability

As discussed earlier, annual precipitation amounts in the region are projected to increase by 0-10% by the 2020s and 5-10% by the 2050s (NPCC 2013). Additionally, according to the Sustainable Jersey Climate Change Adaptation Task Force, the region will experience an increase of 10-25% in the frequency of intense precipitation events. Increased rainfalls have the potential to affect drinking water, 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 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.

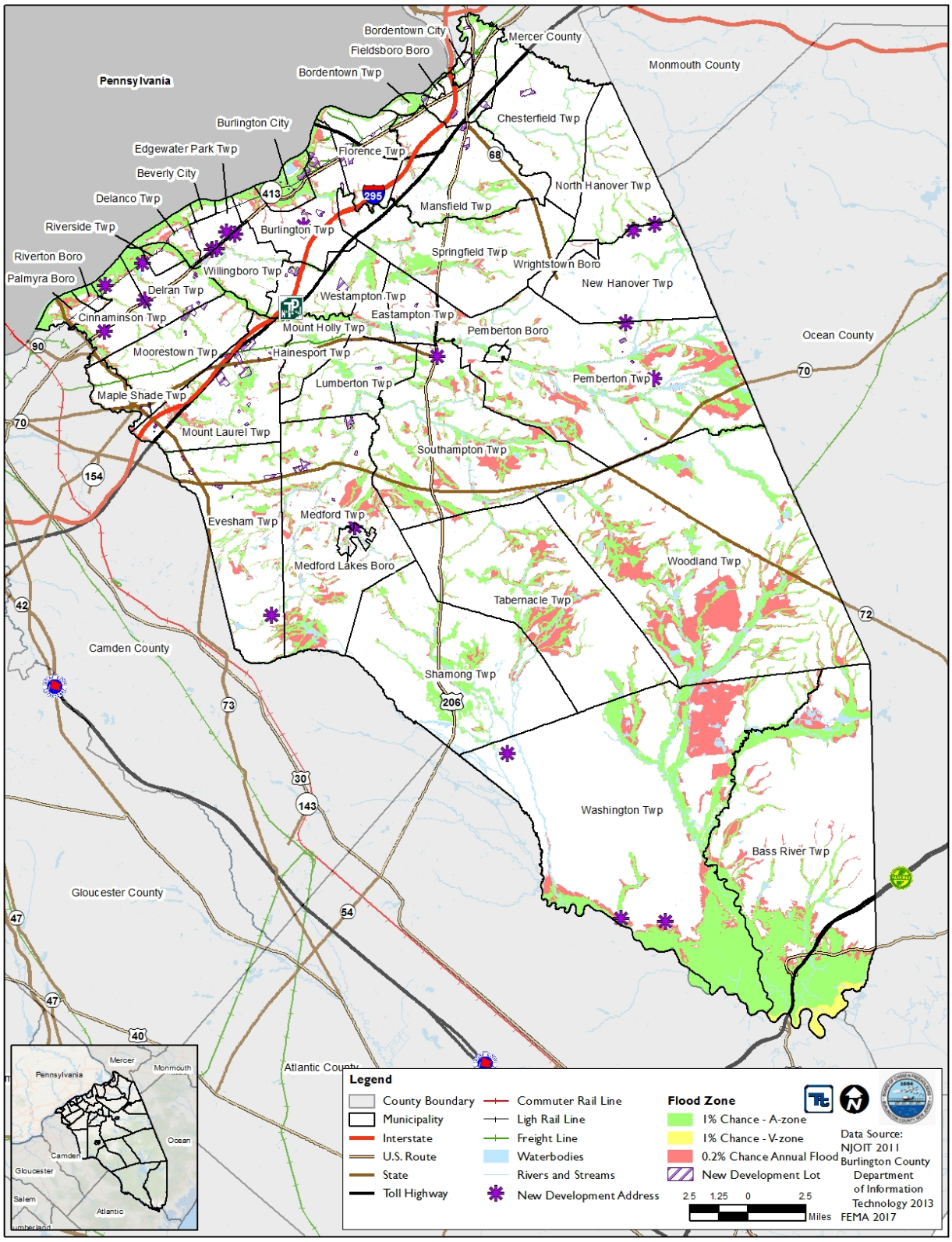
Change of Vulnerability

Burlington County and its municipalities continue to be vulnerable to the flood hazard. However, there are several differences between the exposure and potential loss estimates between this plan update to the results in the 2014 HMP. The building inventory and critical facilities were updated and a more accurate flood depth grids used to estimate potential losses in HAZUS-MH due to the availability of their DFIRM.

The 2014 HMP utilized the improvement value at the parcel level. For this plan update, the potential loss analysis was conducted using a custom county-wide building inventory using the MODIV tax assessment data and replacement cost value based on 2018 RS Means valuations. The 2014 HMP potential loss estimates were calculated at the Census Block level in HAZUS-MH 2.1; however, the 2017 update estimates potential losses at the structure level using the updated building inventory in HAZUS-MH 4.0.

For this plan update, an updated depth grid was used. The depth grid was integrated into HAZUS-MH 4.0, and the model was run to estimate potential losses at the structure level utilizing the custom-building inventory developed for this plan update. Overall, this vulnerability assessment uses a more accurate and updated building inventory and updated flood mapping which provides more accurate estimated exposure and potential losses for Burlington County.

Figure 5.4.4-7. Potential New Development and Flood Boundaries



Source: FEMA 2017 and Burlington County

5.4.5 LANDSLIDE

The following section provides the hazard profile (hazard description, location, extent, previous occurrences and losses, probability of future occurrences, and impact of climate change) and vulnerability assessment for the landslide hazard in Burlington County.

2019 HMP UPDATE CHANGES

- The hazard profile has been significantly enhanced to include a detailed hazard description, location, extent, previous occurrences, probability of future occurrence, and potential change in climate and its impacts on the landslide hazard is discussed. Additionally, it includes information regarding sinkholes.
- New and updated figures from federal and state agencies are incorporated. U.S. 2010 Census data was incorporated, where appropriate.
- Previous occurrences were updated with events that occurred between 2013 and 2018.
- A vulnerability assessment was conducted for the geological hazards; it now directly follows the hazard profile.

5.4.5.1 PROFILE

Hazard Description

Geologic hazards are any geological or hydrological processes that pose a threat to humans and natural properties. Every year, severe natural events destroy infrastructure and cause injuries and deaths. Geologic hazards may include volcanic eruptions and other geothermal related features, earthquakes, landslides and other slope failures, mudflows, sinkhole collapses, snow avalanches, flooding, glacial surges and outburst floods, tsunamis, and shoreline movements. For the purpose of this HMP update, only landslides and land subsidence/sinkholes will be discussed.

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 (NJGWS 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).

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 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 rain water 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 at which time it 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 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 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).

Location

Table 5.4.5-1 summarizes the land area within the 'Low Incidence and 'Moderate Susceptibility/Low Incidence' landslide hazard areas and the areas underlain by carbonate bedrock by municipality.

Table 5.4.5-1. Estimated Area Exposed to the Hazard Areas in Burlington County

Municipality	Total Area in Acres	Landslide Incidence		Landslide Susceptibility/Incidence		Carbonate Formations	
		Low		Moderate/Low			
		Acres	% of Total	Acres	% of Total	Acres	% of Total
Bass River Township	50,140	50,140	100%	0	0%	0	0%
Beverly City	486	0	0%	486	100%	0	0%
Bordentown City	618	36	6%	581	94%	0	0%
Bordentown Township	5,926	3,295	56%	2,632	44%	0	0%
Burlington City	2,426	147	6%	2,272	94%	0	0%
Burlington Township	8,992	5,532	62%	3,477	39%	0	0%
Chesterfield Township	13,736	13,736	100%	0	0%	4	0%
Cinnaminson Township	5,099	51	1%	5,040	99%	0	0%

Municipality	Total Area in Acres	Landslide Incidence		Landslide Susceptibility/Incidence		Carbonate Formations	
		Low		Moderate/Low			
		Acres	% of Total	Acres	% of Total	Acres	% of Total
Delanco Township	2,190	0	0%	2,190	100%	0	0%
Delran Township	4,654	872	19%	3,772	81%	0	0%
Eastampton Township	3,723	3,723	100%	0	0%	0	0%
Edgewater Park Township	1,976	0	0%	1,976	100%	0	0%
Evesham Township	18,943	18,932	100%	0	0%	1,349	7%
Fieldsboro Borough	224	0	0%	224	100%	0	0%
Florence Township	6,559	3,411	52%	3,137	48%	0	0%
Hainesport Township	4,344	4,343	100%	0	0%	0	0%
Lumberton Township	8,327	8,327	100%	0	0%	71	1%
Mansfield Township	14,010	13,576	97%	446	3%	0	0%
Maple Shade Township	2,451	2,244	92%	207	8%	0	0%
Medford Lakes Borough	812	812	100%	0	0%	0	0%
Medford Township	25,474	25,475	100%	0	0%	3,754	15%
Moorestown Township	9,585	9,415	98%	164	2%	0	0%
Mount Holly Township	1,837	1,837	100%	0	0%	0	0%
Mount Laurel Township	14,066	14,073	100%	0	0%	0	0%
New Hanover Township	14,483	14,483	100%	0	0%	382	3%
North Hanover Township	11,203	11,203	100%	0	0%	2,025	18%
Palmyra Borough	1,673	0	0%	1,673	100%	0	0%
Pemberton Borough	403	403	100%	0	0%	38	9%
Pemberton Township	40,171	40,164	100%	0	0%	3,146	8%
Riverside Township	1,048	0	0%	1,047	100%	0	0%
Riverton Borough	614	0	0%	614	100%	0	0%
Shamong Township	28,791	28,824	100%	0	0%	0	0%
Southampton Township	28,446	28,422	100%	0	0%	2,910	10%
Springfield Township	18,924	18,920	100%	0	0%	761	4%
Tabernacle Township	31,688	31,725	100%	0	0%	0	0%
Washington Township	66,539	67,067	101%	0	0%	0	0%
Westampton Township	7,104	7,101	100%	0	0%	0	0%
Willingboro Township	5,175	3,540	68%	1,654	32%	0	0%
Woodland Township	61,001	60,439	99%	0	0%	0	0%
Wrightstown Borough	1,146	1,146	100%	0	0%	223	19%
Burlington County	**525,009**	**493,412**	**94%**	**31,592**	**6%**	**14,664**	**3%**

Source: USGS, 2011; NJGS 2008

Landslides

Landslides are common in New Jersey, primarily in the northern region of the state. According to the USGS and the landslide susceptibility map in the 2014 New Jersey State HMP, Burlington County has moderate susceptibility/low incidence landslide potential in the northwestern region of the County. 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 (USGS 2005).

According to the NJGWS, the entire county has a low susceptibility to landslides. Figure 5.4.5-1 illustrates the historic landslide locations overlaid by areas of steep slopes (greater than 15%) in Burlington County. A majority of occurrences have been concentrated in the northern portion of the County, in the municipalities of Bordentown Township, Burlington Township, and Florence Township; most of these events occurred on or at the base of steep slopes (greater than 15%). This correlates with the location of moderate landslide susceptibility areas found along the northern border of Burlington County.

Subsidence/Sinkholes

New Jersey is susceptible to the effects of subsidence and sinkholes, primarily in the northwestern section 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. The only spatial coverage for historic sinkholes in the State of New Jersey is in Warren County; however, limiting analysis of past occurrences for other counties in the state.

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. Burlington County has a lower occurrence rate of carbonate bedrock than other counties in the northwestern part of the state. The County has a thin strip of carbonate bedrock that runs from New Hanover to Evesham. Overall, approximately 3-percent (22.9 square miles) of the county has carbonate rock formation (NJGS 2008).

Figure 5.4.5-1. Historic Landslide Locations in Burlington County, 1869 –2018

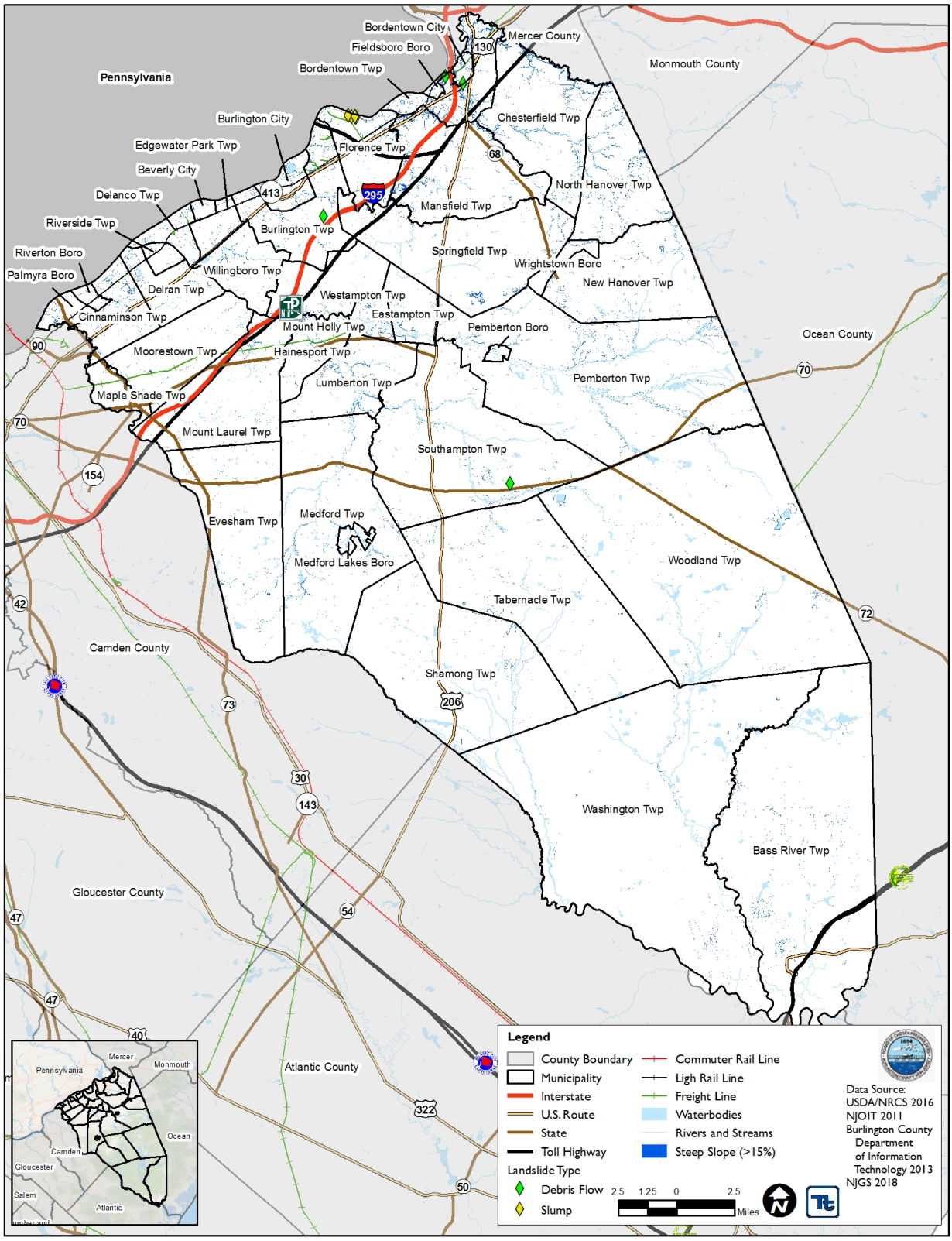
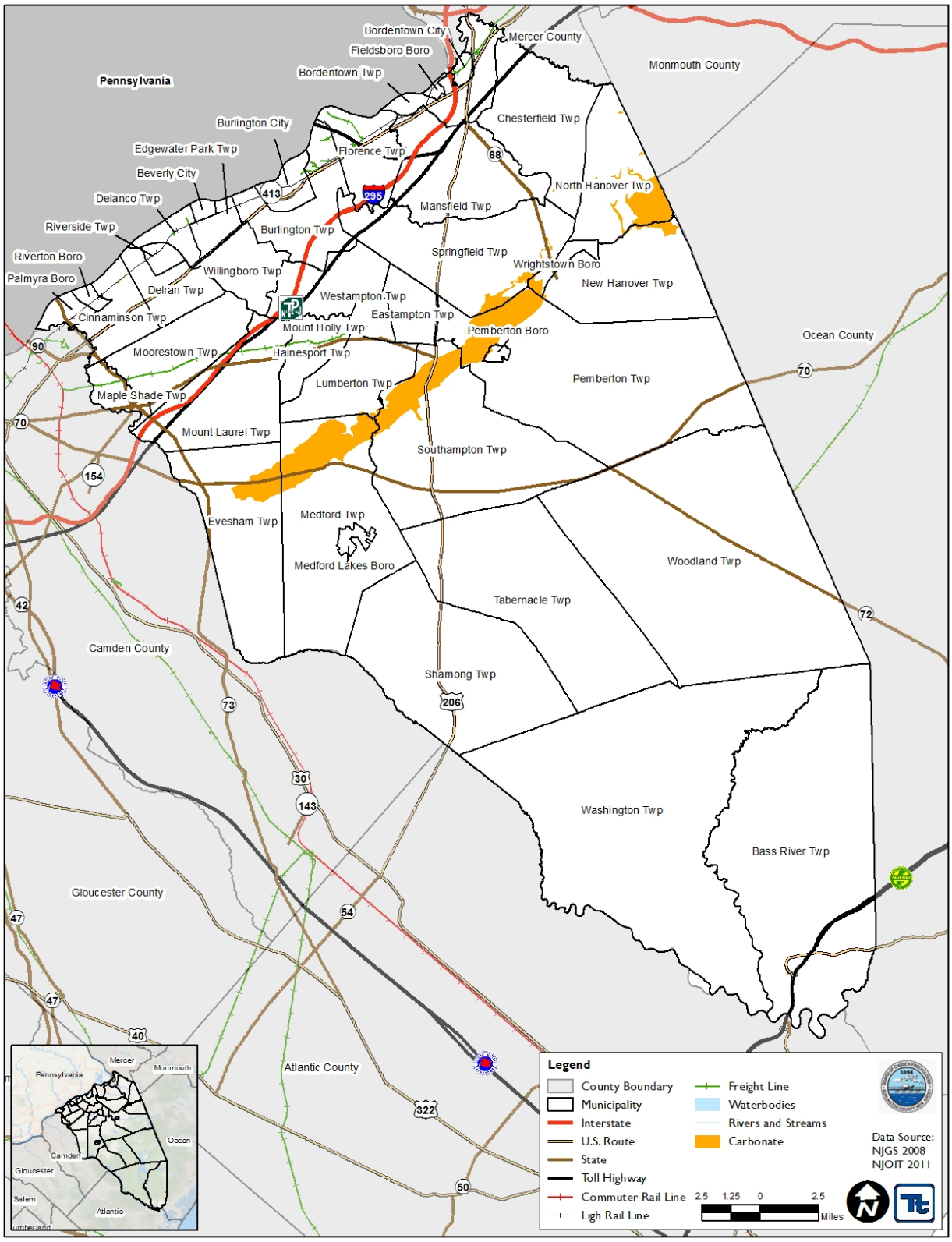


Figure 5.4.5-2. Carbonate Formations in Burlington County



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-percent of a given area has been involved in landsliding; medium incidence means that 1.5- to 15-percent of an area has been involved; and low incidence means that less than 1.5-percent of an area has been involved (State of Alabama 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 (USGS 1997).

Subsidence/Sinkhole

Landslide subsidence occurs 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. 1999). 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 2009).

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 2015).

Previous Occurrences and Losses

Numerous sources provided historical information regarding previous occurrences and losses associated with geological hazard events throughout Burlington County. Burlington County has experienced 6 landslide events between 1782 and 2017; however, sinkhole/subsidence history could not be determined due to limited historical records. Many sources were reviewed for the purpose of this HMP and loss and impact information could vary depending on the source. Therefore, the accuracy of monetary figures, if any, is based only on the available information identified during research for this HMP.

Between 1954 and 2015, FEMA issued a disaster (DR) or emergency (EM) declaration for the State of New Jersey for one geological hazard-related event, classified as severe storms, flooding and mudslide. This declaration did not include Burlington County (FEMA 2018).

For this HMP, known landslide and sinkhole events that have occurred in Burlington County between 2013 and 2018 are identified in Table 5.4.5-2. For events prior to 2013, refer to Appendix G (Supplementary Data). Please note that many sources were researched for historical information regarding landslide and sinkhole events in Burlington County; therefore, Table 5.4.5-2 may not include all landslide and sinkhole events that have impacted the County. Additionally, not all sources may have been identified or researched. Loss and impact information 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.

Table 5.4.5-2. Landslide and Sinkhole Events Impacting Burlington County, 2013 to 2018

Dates of Event	Event Type	Location	FEMA Declaration Number (if applicable)	County Designated?	Losses / Impacts
April 20, 2015	Slump	Florence Township	N/A	No	Portions of two properties developed a sinkhole in the backyard and forced evacuations of two homes. The homes were purchased by the county and a stabilization project has been planned.
2017	Slump	Florence Township	N/A	No	Heavy rain caused a washout and a 15-foot tall caved bank on the bluff, above a steel culvert, broke and caused a piping failure that led to the original slump and caving of the bank. Smaller slumps occurred in Florence Township as well. A smaller slump to the east of the main area of slumping occurred and a smaller reactivation of the previous larger slump also occurred.

Source: *NJGWS 2018; NJ.Com 2015; Burlington County Times 2015*
FEMA *Federal Emergency Management Agency*
N/A *Not Applicable*
NJGWS *New Jersey Geological and Water Survey*

Probability of Future Occurrences

Based upon risk factors for the county and past occurrences, it is likely that geological hazards will occur in Burlington County in the future. Landslide probabilities are largely a function of surface geology, but are also influenced by both weather and human activities. The vast majority of the County (96 percent) lies outside of mapped hazard areas. Therefore, the probability would be low; however, that probability would increase slightly within the narrow band of land roughly bounding the Delaware River in the northwestern portion of Burlington County in the municipalities of: Cities of Beverly and Burlington, Townships of Burlington, Cinnaminson, Delanco, Delran, Edgewater Park, Riverside and Florence, and the Boroughs of Palmyra and Riverton, and a small portion (approximately 2 percent) of the Township of Moorestown. Areas of past landslides are also more susceptible. There are presumably other smaller landslides and sinkholes that have occurred in the county that have not been reported to the NJGWS and are not included in these calculations.

The probability of future landslides and sinkholes having a significant impact on life and property in Burlington County is relatively low. The county will continue to experience the direct and indirect impacts of geological hazards and its impacts on occasion, with the secondary effects causing potential disruption or damage to communities. The table below shows the probability of future geologic events impacting the county.

According to NJGWS, 2013 Burlington County HMP, and NOAA-NCEI Storm Events Database, Burlington County experienced eight landslide events between 1950 and 2018. The table below shows these statistics, as well as the annual average number of events and the percent chance of these individual landslide hazards occurring in Burlington County in future years.

Table 5.4.5-3. Probability of Future Occurrence of Landslide and Sinkhole Events

Hazard Type	Number of Occurrences Between 1950 and 2018	Rate of Occurrence or Annual Number of Events (average)	Recurrence Interval (in years) (# Years/Number of Events)	Probability of Event in any given year	Percent chance of occurrence in any given year
Landslide – Debris Flow	4	0.06	17.25	6	5.8
Landslide – Rockfall	0	0	0	0	0
Landslide – Rockslide	0	0	0	0	0
Landslide – Slump	4	0.12	8.63	0.12	11.59

Sources: NJGWS 2018; NOAA-NCEI 2018; NJ.com 2015; NJ State HMP 2014

In Section 5.3, the identified hazards of concern for Burlington 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 'frequent' (likely to occur within 25 years, as presented in Table 5.3-3).

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.

Temperatures in the Northeast United States have increased 1.5 degrees Fahrenheit (°F) on average since 1900. 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 (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). Both northern and southern New Jersey have become wetter over the past century. Northern New Jersey's 1971-2000 precipitation average was over 5" (12-percent) greater than the average from 1895-1970. Southern New Jersey became 2" (5-percent) wetter late in the 20th century (Office of New Jersey State Climatologist).

Landslides

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.

More recently, sinkholes have been correlated to land use practices, especially from groundwater pumping and from construction and development practices. Sinkholes may also form when the land surface is changed, such as when industrial and runoff-storage ponds are created. The substantial weight of the new material can trigger an underground collapse of supporting material, thus causing a sinkhole. Additionally, the overburden sediments that cover buried cavities in the aquifer systems are delicately balanced by groundwater fluid pressure. Groundwater is helping keep the surface soil in place. Pumping groundwater for urban water supply and for irrigation can produce new sinkholes in sinkhole-prone areas. If pumping results in a lowering of groundwater levels, then underground structural failure, sinkholes may occur as well (USGS 2014).

5.4.5.2 VULNERABILITY ASSESSMENT

To understand risk, a community must evaluate what assets are exposed and/or vulnerable to the identified hazard. For landslide and other geologic hazards, areas of slopes greater than 15 percent and carbonate formations have been identified as the hazard area. The following text summarizes the potential impact of geologic hazards on the county. Refer to Section 5.1 for additional details on the methodology used to assess geologic hazard risk.

Impact on Life, Health and Safety

Overall, a landslide or subsidence event would be 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 to this hazard. 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. Due to the nature of Census block data, it is difficult to determine demographics of populations vulnerable to mass movements of geological material.

Table 5.4.5-4 summarizes the population located on steep slopes and the areas underlain by carbonate bedrock by municipality (U.S. Census 2010). Bordentown Township has the greatest total number of people located on areas of steep slopes (703), while the Pemberton Borough has the greatest percentage of its population located on areas of steep slopes (37.7 percent). Evesham Township has the greatest total number of people located above carbonate formations and susceptible to subsidence events with 4,067 people. North Hanover Township has 19.7% of its population located above carbonate formations and has the greatest percentage exposed to the hazard area.

Table 5.4.5-4. Estimated Population Located in the Hazard Areas

Municipality	Total Population (2010 U.S. Census)	Steep Slopes (Greater than 15%)		Carbonate Formations	
		Population Exposed	Population Exposed	Percent Total	Percent Total
Bass River Township	1,443	65	4.5%	0	0.0%
Beverly City	2,577	0	0.0%	0	0.0%
Bordentown City	3,924	77	2.0%	0	0.0%
Bordentown Township	11,367	703	6.2%	0	0.0%
Burlington City	9,920	94	0.9%	0	0.0%
Burlington Township	22,594	50	0.2%	0	0.0%
Chesterfield Township	7,699	3	0.0%	0	0.0%
Cinnaminson Township	15,569	312	2.0%	0	0.0%
Delanco Township	4,283	55	1.3%	0	0.0%
Delran Township	16,896	112	0.7%	0	0.0%
Eastampton Township	6,069	50	0.8%	0	0.0%
Edgewater Park Township	8,881	0	0.0%	0	0.0%
Evesham Township	45,538	525	1.2%	4,067	8.9%
Fieldsboro Borough	540	22	4.1%	0	0.0%
Florence Township	12,109	150	1.2%	0	0.0%
Hainesport Township	6,110	223	3.6%	0	0.0%
Lumberton Township	12,559	289	2.3%	0	0.0%
Mansfield Township	8,544	202	2.4%	0	0.0%
Maple Shade Township	19,131	0	0.0%	0	0.0%
Medford Lakes Borough	4,146	145	3.5%	0	0.0%
Medford Township	23,033	202	0.9%	2,990	13.0%
Moorestown Township	20,726	257	1.2%	0	0.0%
Mount Holly Township	9,536	96	1.0%	0	0.0%
Mount Laurel Township	41,864	339	0.8%	0	0.0%
New Hanover Township	7,385	0	0.0%	256	3.5%
North Hanover Township	7,678	0	0.0%	1,512	19.7%
Palmyra Borough	7,398	0	0.0%	0	0.0%
Pemberton Borough	1,409	531	37.7%	0	0.0%
Pemberton Township	27,912	0	0.0%	391	1.4%

Municipality	Total Population (2010 U.S. Census)	Steep Slopes (Greater than 15%)		Carbonate Formations	
		Population Exposed	Population Exposed	Percent Total	Percent Total
Riverside Township	8,079	109	1.3%	0	0.0%
Riverton Borough	2,779	103	3.7%	0	0.0%
Shamong Township	6,490	0	0.0%	0	0.0%
Southampton Township	10,464	260	2.5%	886	8.5%
Springfield Township	3,414	90	2.6%	235	6.9%
Tabernacle Township	6,949	0	0.0%	0	0.0%
Washington Township	687	2	0.3%	0	0.0%
Westampton Township	8,813	40	0.5%	0	0.0%
Willingboro Township	31,629	535	1.7%	0	0.0%
Woodland Township	1,788	0	0.0%	0	0.0%
Wrightstown Borough	802	0	0.0%	0	0.0%
Burlington County	**448,734**	**5,641**	**1.3%**	**10,337**	**2.3%**

Source: United States Census 2010; USGS 2016; NJGS 2008
Note: The hazard area boundaries were overlaid on the U.S. Census block; the blocks with their centroids within hazard areas were totaled for each municipality.

Socially vulnerable populations (e.g. the elderly and low-income populations) are particularly vulnerable to a hazard event. Within the steep slope hazard area, there are approximately 1,120 people over the age of 65 and 469 people considered low income populations. As for populations within areas underlain by carbonate formations, there are approximately 1,730 people over the age 65 and 1,095 people considered low income populations.

Impact on General Building Stock

Landslides have the potential of destabilizing the foundation of structures, which may result in monetary losses to businesses and residents. Table 5.4.5-5 summarize the exposed building stock located on steep slopes by municipality and Table 5.4.5-6 summarizes the exposed building stock underlain by carbonate bedrock by municipality. There are 952 buildings located on areas of steep slopes countywide. Medford Township has the greatest number of buildings and greatest percentage of buildings located on areas of steep slopes (105 – 21.6 percent). Medford Township also has the greatest total number of buildings located above carbonate formations and susceptible to subsidence events with 1,294 structures worth $1.7 billion. North Hanover Township has 24.9% of its building stock located above carbonate formations and has the greatest percentage exposed to the hazard area.

Table 5.4.5-5. Estimated General Building Stock Located on Areas of Steep Slopes (Greater than 15%)

Municipality	Total Number of Buildings	Total Replacement Cost (Estimated Structure and Contents)	Steep Slopes (Greater than 15%)			
			# Buildings	Percent Total	Estimated Replacement Cost Value	Percent Total
Bass River Township	1,863	$1,027,917,130	3	0.2%	$2,057,647	0.2%
Beverly City	964	$471,487,138	1	0.1%	$120,186	0.0%
Bordentown City	1,219	$1,244,995,904	14	1.1%	$19,220,137	1.5%
Bordentown Township	3,113	$2,820,041,247	50	1.6%	$39,476,063	1.4%

Municipality	Total Number of Buildings	Total Replacement Cost (Estimated Structure and Contents)	Steep Slopes (Greater than 15%)			
			# Buildings	Percent Total	Estimated Replacement Cost Value	Percent Total
Burlington City	3,644	$3,215,233,092	14	0.4%	$6,495,782	0.2%
Burlington Township	7,757	$8,013,259,672	50	0.6%	$50,120,811	0.6%
Chesterfield Township	2,093	$2,443,294,418	40	1.9%	$27,111,803	1.1%
Cinnaminson Township	6,358	$5,703,895,752	42	0.7%	$13,193,532	0.2%
Delanco Township	1,562	$1,422,201,479	19	1.2%	$4,304,164	0.3%
Delran Township	5,191	$5,145,622,596	42	0.8%	$11,727,208	0.2%
Eastampton Township	2,499	$1,687,017,512	26	1.0%	$7,519,101	0.4%
Edgewater Park Township	2,567	$2,307,285,215	21	0.8%	$4,189,004	0.2%
Evesham Township	14,319	$14,666,082,424	24	0.2%	$10,508,242	0.1%
Fieldsboro Borough	242	$139,371,126	6	2.5%	$2,224,837	1.6%
Florence Township	2,522	$2,787,263,607	33	1.3%	$55,721,336	2.0%
Hainesport Township	2,747	$3,447,208,735	30	1.1%	$125,342,076	3.6%
Lumberton Township	4,009	$5,459,557,257	34	0.8%	$24,958,176	0.5%
Mansfield Township	2,798	$4,056,501,589	48	1.7%	$88,678,811	2.2%
Maple Shade Township	6,006	$4,385,500,913	15	0.2%	$3,425,847	0.1%
Medford Lakes Borough	1,909	$1,280,050,871	27	1.4%	$12,246,894	1.0%
Medford Township	10,627	$12,845,907,494	105	1.0%	$63,000,770	0.5%
Moorestown Township	8,736	$10,108,801,626	22	0.3%	$48,638,926	0.5%
Mount Holly Township	4,573	$3,498,352,996	50	1.1%	$20,245,355	0.6%
Mount Laurel Township	12,900	$14,653,800,804	33	0.3%	$25,363,584	0.2%
New Hanover Township	1,964	$3,022,835,486	10	0.5%	$11,311,016	0.4%
North Hanover Township	2,901	$3,079,878,987	21	0.7%	$18,034,941	0.6%
Palmyra Borough	2,713	$1,788,398,557	1	0.0%	$641,764	0.0%
Pemberton Borough	514	$345,869,906	1	0.2%	$452,244	0.1%
Pemberton Township	13,511	$9,374,914,679	40	0.3%	$12,516,733	0.1%
Riverside Township	2,868	$2,039,139,951	7	0.2%	$3,280,023	0.2%
Riverton Borough	1,274	$916,434,789	8	0.6%	$7,079,243	0.8%
Shamong Township	3,623	$2,738,384,433	22	0.6%	$20,956,497	0.8%
Southampton Township	7,982	$6,722,347,774	22	0.3%	$4,954,969	0.1%
Springfield Township	2,876	$3,853,514,909	16	0.6%	$20,022,395	0.5%
Tabernacle Township	4,452	$3,619,040,765	18	0.4%	$12,145,684	0.3%
Washington Township	939	$597,426,933	4	0.4%	$1,736,567	0.3%
Westampton Township	3,006	$4,269,433,407	11	0.4%	$6,027,729	0.1%
Willingboro Township	12,395	$8,259,747,413	17	0.1%	$2,447,308	0.0%
Woodland Township	1,323	$1,656,748,246	2	0.2%	$2,411,475	0.1%
Wrightstown Borough	485	$411,963,035	3	0.6%	$6,251,788	1.5%
Burlington County	**173,044**	**$165,526,729,867**	**952**	**0.6%**	**$796,160,667**	**0.5%**

Source: Burlington County; NJ Department of Treasury, 2017; USGS 2016

Note: Areas of steep slopes were overlaid on the custom general building stock inventory; the structures with their centroids within hazard areas were totaled for each municipality.

Table 5.4.5-6. Estimated Building Located in the Carbonate Formation Hazard Area

Municipality	Total Number of Buildings	Total Replacement Cost (Estimated Structure and Contents)	Carbonate Formation			
			# Buildings	Percent Total	Estimated Replacement Cost Value	Percent Total
Bass River Township	1,863	$1,027,917,130	0	0.0%	$0	0.0%
Beverly City	964	$471,487,138	0	0.0%	$0	0.0%
Bordentown City	1,219	$1,244,995,904	0	0.0%	$0	0.0%
Bordentown Township	3,113	$2,820,041,247	0	0.0%	$0	0.0%
Burlington City	3,644	$3,215,233,092	0	0.0%	$0	0.0%
Burlington Township	7,757	$8,013,259,672	0	0.0%	$0	0.0%
Chesterfield Township	2,093	$2,443,294,418	0	0.0%	$0	0.0%
Cinnaminson Township	6,358	$5,703,895,752	0	0.0%	$0	0.0%
Delanco Township	1,562	$1,422,201,479	0	0.0%	$0	0.0%
Delran Township	5,191	$5,145,622,596	0	0.0%	$0	0.0%
Eastampton Township	2,499	$1,687,017,512	0	0.0%	$0	0.0%
Edgewater Park Township	2,567	$2,307,285,215	0	0.0%	$0	0.0%
Evesham Township	14,319	$14,666,082,424	839	5.9%	$823,363,133	5.6%
Fieldsboro Borough	242	$139,371,126	0	0.0%	$0	0.0%
Florence Township	2,522	$2,787,263,607	0	0.0%	$0	0.0%
Hainesport Township	2,747	$3,447,208,735	0	0.0%	$0	0.0%
Lumberton Township	4,009	$5,459,557,257	10	<1%	$6,301,132	<1%
Mansfield Township	2,798	$4,056,501,589	0	0.0%	$0	0.0%
Maple Shade Township	6,006	$4,385,500,913	0	0.0%	$0	0.0%
Medford Lakes Borough	1,909	$1,280,050,871	0	0.0%	$0	0.0%
Medford Township	10,627	$12,845,907,494	1,294	12.2%	$1,740,439,973	13.5%
Moorestown Township	8,736	$10,108,801,626	0	0.0%	$0	0.0%
Mount Holly Township	4,573	$3,498,352,996	0	0.0%	$0	0.0%
Mount Laurel Township	12,900	$14,653,800,804	0	0.0%	$0	0.0%
New Hanover Township	1,964	$3,022,835,486	121	6.2%	$72,805,949	2.4%
North Hanover Township	2,901	$3,079,878,987	723	24.9%	$322,034,143	10.5%
Palmyra Borough	2,713	$1,788,398,557	0	0.0%	0	0.0%
Pemberton Borough	514	$345,869,906	1	0.2%	$1,180,580	0.3%
Pemberton Township	13,511	$9,374,914,679	494	3.7%	$818,250,019	8.7%
Riverside Township	2,868	$2,039,139,951	0	0.0%	$0	0.0%
Riverton Borough	1,274	$916,434,789	0	0.0%	$0	0.0%
Shamong Township	3,623	$2,738,384,433	0	0.0%	$0	0.0%
Southampton Township	7,982	$6,722,347,774	921	11.5%	$627,336,936	9.3%
Springfield Township	2,876	$3,853,514,909	180	6.3%	$331,822,080	8.6%
Tabernacle Township	4,452	$3,619,040,765	0	0.0%	$0	0.0%
Washington Township	939	$597,426,933	0	0.0%	$0	0.0%
Westampton Township	3,006	$4,269,433,407	0	0.0%	$0	0.0%
Willingboro Township	12,395	$8,259,747,413	0	0.0%	$0	0.0%
Woodland Township	1,323	$1,656,748,246	0	0.0%	$0	0.0%
Wrightstown Borough	485	$411,963,035	1	<1%	$210,870	<1%
Burlington County	**173,044**	**$165,526,729,867**	**4,584**	**2.6%**	**$4,743,744,814**	**2.9%**

Source: Burlington County; NJ Department of Treasury, 2017; NJGS, 2008

Note: The NJGS Carbonate Formation boundaries were overlaid on the custom general building stock inventory; the structures with their centroids within hazard areas were totaled for each municipality.

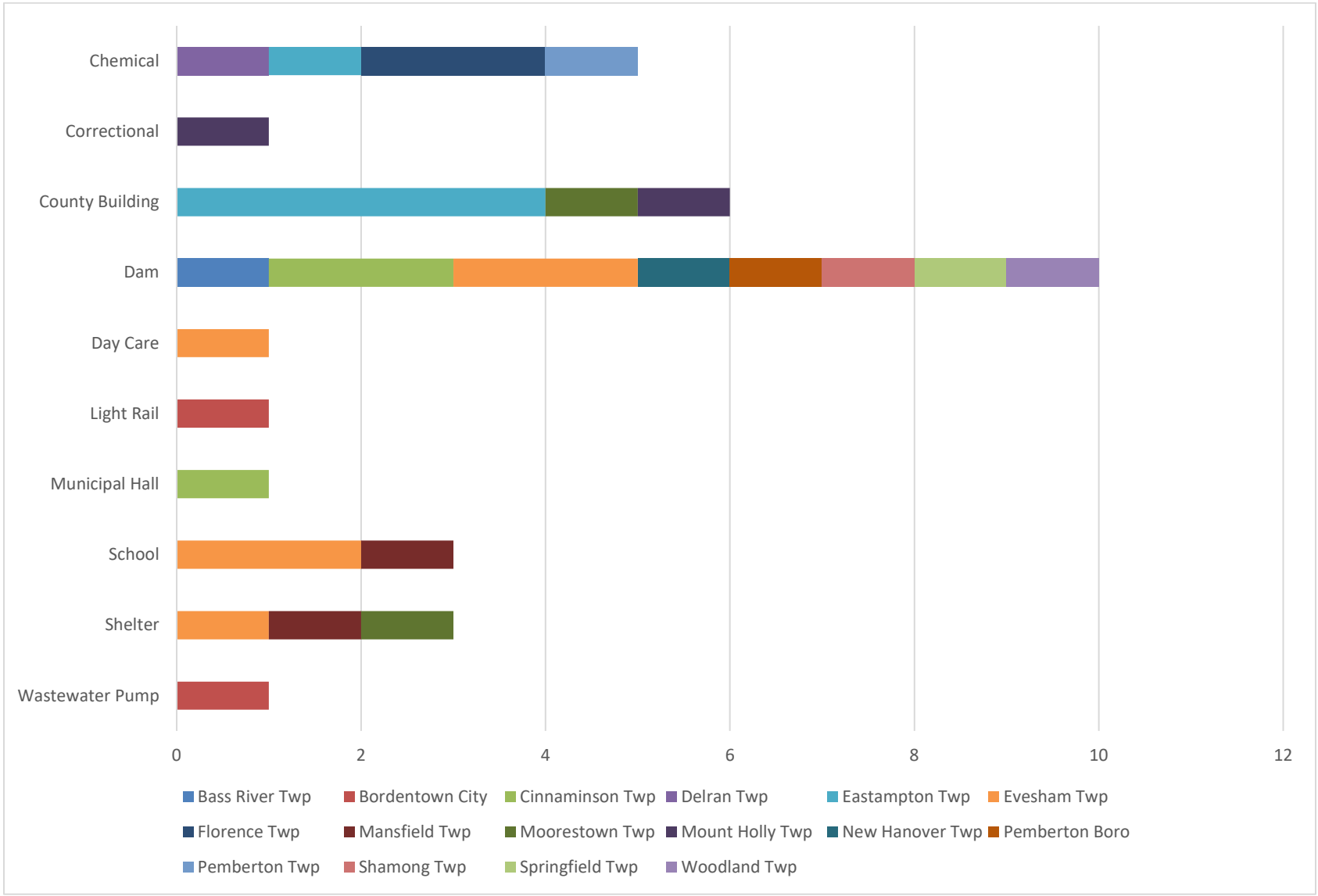
Impact on Critical Facilities

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.

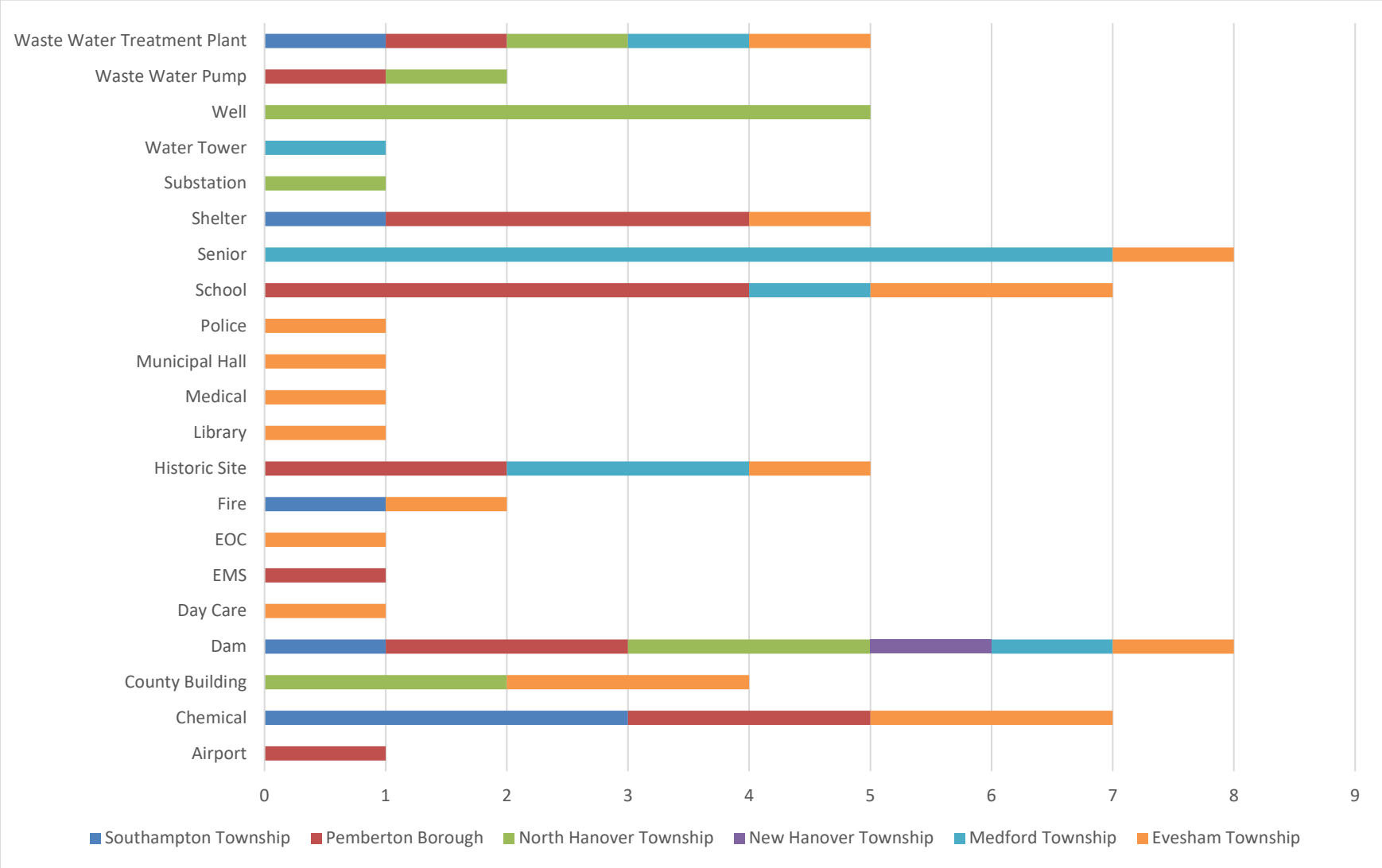
Several other types of infrastructure may also be exposed to landslides, including water and sewer infrastructure. At this time all critical facilities, infrastructure, and transportation corridors located within the hazard areas are considered vulnerable until more information becomes available. Figure 5.4.5-3 and Figure 5.4.5-4 display the critical facilities located on areas of steep slopes and above carbonate formations, respectively. Overall there are 32 critical facilities located on steep slopes, with dams being the most exposed with 10. There are 68 critical facilities located above carbonate formations. Senior facilities and dams have the greatest exposure to carbonate formations with 8 facilities each.

Figure 5.4.5-3. Critical Facilities Located on Areas of Steep Slopes (Greater than 15%)



Source: Burlington County; USGS 2016

Figure 5.4.5-4. Critical Facilities Located in the Carbonate Formation Hazard Area



Source: Burlington County; NJGS, 2008
Note: EMS – Emergency Medical Services
EOC – Emergency Operation Center

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.

A landslide or sinkhole/subsidence event will alter the landscape. In addition to changes in topography, vegetation and wildlife habitats may be damaged or destroyed, and soil and sediment runoff will accumulate downslope potentially blocking waterways and roadways and impacting quality of streams and other water bodies. Additional environmental impacts include loss of forest productivity. There are 952 buildings located on steep slopes and account for $796 million, or less than 1-percent of the County's total building cost; for areas above carbonate formations, there are 4,584 buildings worth $4.7 billion (2.9% of the County's total) exposed. These dollar value losses to Burlington County's total building inventory replacement cost value would impact Burlington County's tax base and the local economy.

The New Jersey Turnpike, I-295, and Route 130 are the major roadways that traverse the western portion of the county from northeast to southwest. These roads serve as the major thoroughfares of the county and run through the most densely populated areas of the county; all three of these roadways traverse areas of steep slopes. Other major roadways that traverse areas of steep slopes include the Garden State Parkway, NJ-38, NJ-413, NJ-70, NJ-73, NJ-90, US-206, and US-9. Lengths of US-206 and State Route 70 intersect areas underlain by carbonate formations.

Since the county is substantially developed in the areas adjacent to the Delaware River many of the major utilities including power generation plants and regional sewerage treatment plants are located with the landslide moderate susceptibility/low incidence area.

Future Growth and Development

As discussed in Section 4 and Volume II, Section 9, areas targeted for future growth and development have been identified across Burlington County. It is anticipated that new development within the identified landslide and subsidence hazard areas will be exposed to such risks. Any developments at or near the base of steep slopes may be at risk to losses from a landslide. Although areas of steep slopes are most at risk for landslides, landslides are still possible on lesser slopes, and future developments are not completely free of risk.

There are no recent or proposed developments around the County located on areas of steep slopes. There are 5 new developments located above carbonate formations; three of these developments are located in Medford Township. Refer to Figure 5.4.5-5 for a map of proposed new development and the landslide susceptibility areas of Burlington County.

Effect of Climate Change on Vulnerability

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

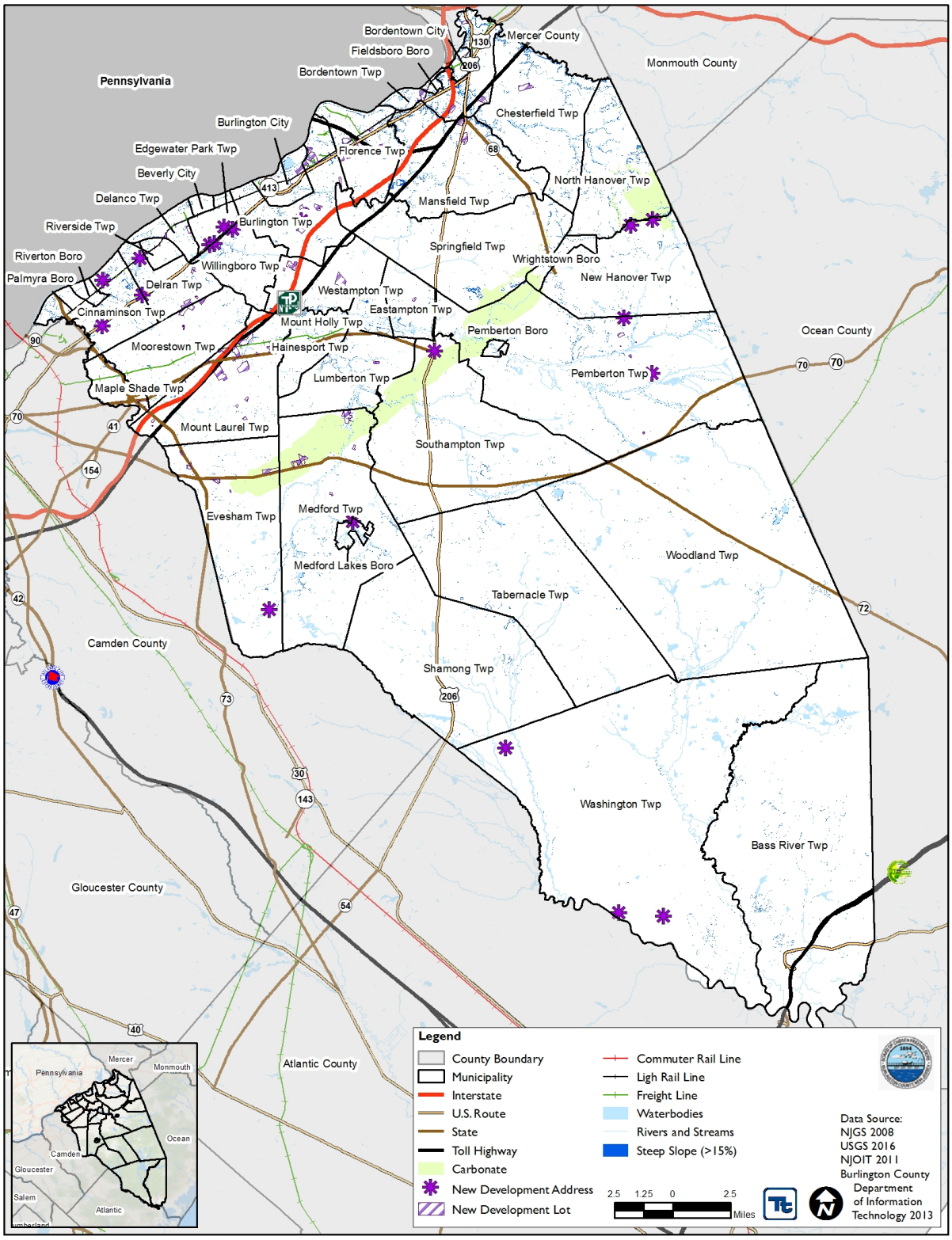
risk of closure, which would impact the County's risk as described above under Impact on Life, Health, and Safety, General Building Stock, and Critical Facilities and Impact on Economy.

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 the 2014 HMP

Burlington County and all plan participants continue to be vulnerable to the landslide hazards. Several differences exist between the 2013 Plan and this update. For this plan update, an updated general building stock based upon replacement cost value from MODIV tax assessment data and 2018 RS Means, and an updated critical facility inventory were used to assess the county's risk to the hazard areas. Additionally, steep slopes were used to delineate the landslide hazard area for this plan to provide a more detailed assessment of the County's risk. The County also requested that the risk to subsidence and sinkholes be assessed for the this HMP update. Due to differences in data used for the vulnerability assessment, a direct comparison could not be conducted to determine whether there has been a change in vulnerability since the last HMP.

Figure 5.4.5-5. Potential New Development and Landslide Hazard Boundaries



5.4.6 SEVERE WEATHER

The following section provides the hazard profile (hazard description, location, extent, previous occurrences and losses, probability of future occurrences, and impact of climate change) and vulnerability assessment for the severe weather hazard in Burlington County.

2019 HMP UPDATE CHANGES

- For the 2019 HMP update, the severe weather hazard groups together high winds, tornadoes, thunderstorms and lightning, hailstorms, hurricanes/tropical storms, and extreme temperature. The hazard profile has been significantly enhanced to include a detailed hazard description, location, extent, previous occurrences, probability of future occurrence, and potential change in climate and its impacts on the severe weather hazard is discussed.
- New and updated figures from federal and state agencies are incorporated.
- Previous occurrences were updated with events that occurred between 2012 and 2018.
- A vulnerability assessment was conducted for the severe weather hazard; it directly follows the hazard profile.

5.4.6.1 PROFILE

Hazard Description

For the purpose of this HMP update and as deemed appropriated by the Burlington County Planning Committee, the severe weather hazard includes high wind, tornadoes, thunderstorms and lightning, hailstorms, hurricane/tropical storms, and extreme temperature, which are defined below.

High Winds

High winds, other than tornadoes, are experienced in all parts of the United States. Areas that experience the highest wind speeds are coastal regions from Texas to Maine, and the Alaskan coast; however, exposed mountain areas experience winds at least as high as those along the coast (FEMA 1997). Wind begins with differences in air pressures. It is 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 (Rosenstiel School of Marine & Atmospheric Science 2005). High winds have the potential to down trees, tree limbs and power lines which lead to widespread power outages and damaging residential and commercial structures throughout Burlington County. High winds are often associated by other severe weather events such as thunderstorms, tornadoes, hurricanes and tropical storms (all discussed further in this section).

A type of windstorm that is experienced often during rapidly moving thunderstorms is a derecho. A derecho is a long-lived windstorm that is associated with a rapidly moving squall line of thunderstorms. It produces straight-line winds gusts of at least 58 miles per hour (mph) and often has isolated gusts exceeding 75 mph. This means that trees generally fall and debris is blown in one direction. To be considered a derecho, these conditions must continue along a path of at least 240 miles. Derechos are more common in the Great Lakes and Midwest regions of the U.S., though, on occasion, can persist into the mid-Atlantic and northeast U.S. (ONJSC Rutgers University 2013).

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).

Thunderstorms and Lightning

A thunderstorm is a local storm produced by a cumulonimbus cloud and accompanied by lightning and thunder (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 and 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 in generating tornadoes, hailstorms, strong winds, flash flooding, and lightning. The NWS considers a thunderstorm severe only if it produces damaging wind gusts of 58 mph or higher or large hail one-inch (quarter size) in diameter or larger or tornadoes (NWS 2010).

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. It ranks as one of the top weather killers in the United States and kills approximately 50 people and injures hundreds each year. Lightning can occur anywhere there is a thunderstorm.

Thunderstorms can lead to 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 utility losses, such as water, phone and electricity. Lightning can damage homes and injure people. In the U.S., an average of 300 people are injured and 80 people are killed by lightning each year. Typical thunderstorms are 15 miles in diameter and last an average of 30 minutes. An estimated 100,000 thunderstorms occur each year in the U.S., with approximately 10-percent of them classified as severe. During the warm season, thunderstorms are responsible for most of the rainfall.

Hailstorms

Hail forms inside a thunderstorm where there are 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°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 two inches in diameter (NWS 2010).

Hurricanes/Tropical Storms

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 storms from other cyclonic systems is that at any height in the atmosphere, the center of a tropical storm will be warmer than its surroundings, a phenomenon called "warm core" storm systems (National Oceanic and Atmospheric Administration [NOAA] 2013). 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. Tropical cyclones begin as disturbed areas of weather often referred to as tropical waves. As the storm organizes, it is designated as a tropical depression.

A tropical storm system is characterized by a low-pressure center and numerous thunderstorms that produce strong winds of 39 to 73 mph and heavy rain. A hurricane is a tropical storm that attains hurricane status when

its wind speed reaches 74 mph or higher. Tropical systems may develop in the Atlantic between the Lesser Antilles and the African coast, or may develop in the warm tropical waters of the Caribbean and Gulf of Mexico. These storms may move up the Atlantic coast of the United States and impact the eastern seaboard, or move into the United States through the states along the Gulf Coast, bringing wind and rain as far north as New England before moving offshore and heading east.

Extreme Temperatures

Extreme temperature includes both heat and cold events, which can have significant impact to human health, commercial/agricultural businesses, and primary and secondary effects on infrastructure (e.g., burst pipes and power failures). What constitutes as extreme cold or extreme heat can vary across different areas of the U.S., based on what the population is accustomed to.

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).

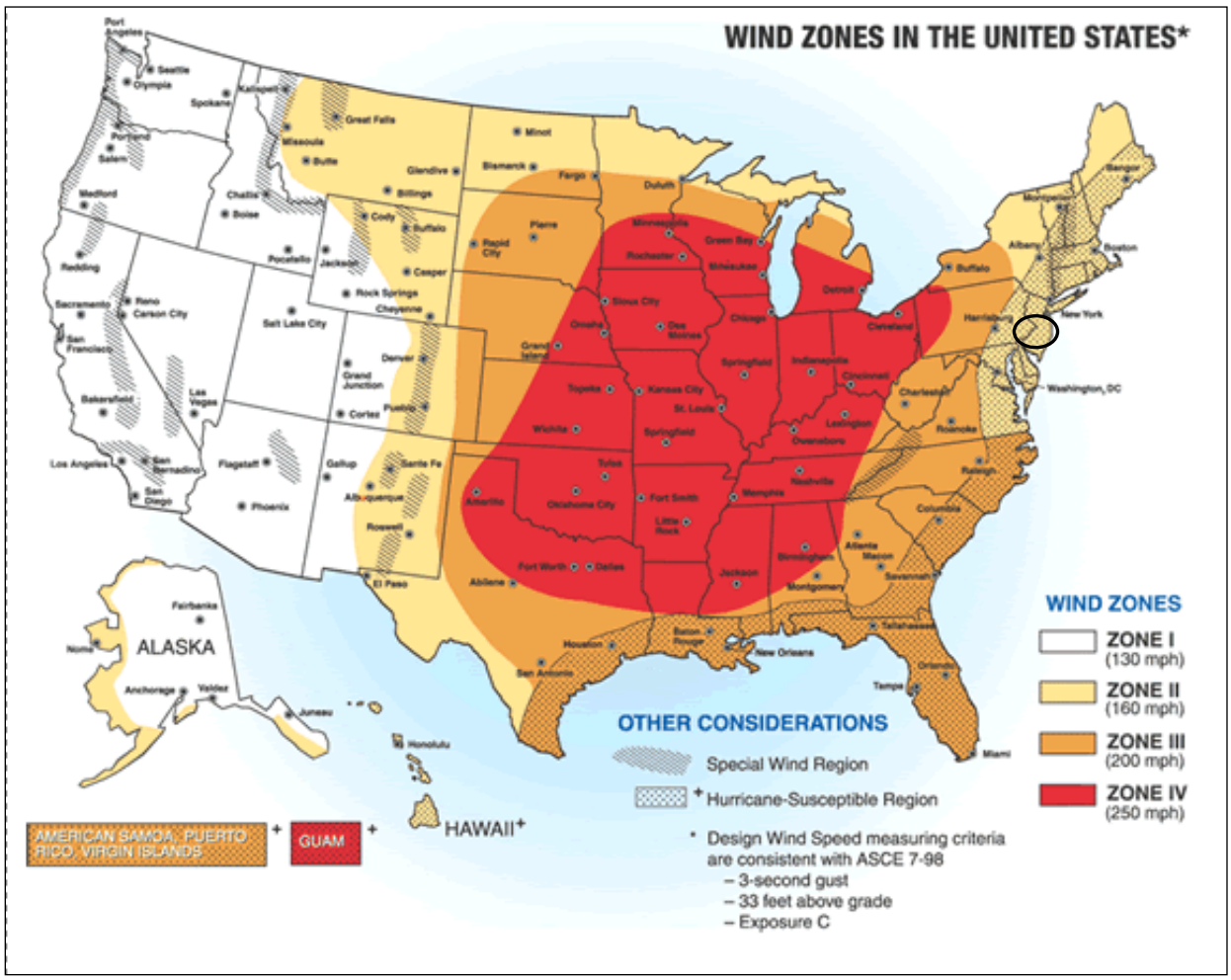
Conditions of extreme heat are defined as summertime temperatures that are substantially hotter and/or more humid than average for a location at that time of year (CDC 2009). An extended period of extreme heat of three or more consecutive days is typically called a heat wave and is often accompanied by high humidity (NWS 2011). 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). A basic definition of a heat wave implies that it is an extended period of unusually high atmosphere-related heat stress, which causes temporary modifications in lifestyle and which may have adverse health consequences for the affected population. A heat wave is defined has three consecutive days of temperatures ≥90°F.

Extreme heat is the number one weather-related cause of death in the U.S. In a ten-year average of weather fatalities across the nation from 2005-2014, excessive heat claimed more lives each year than floods, lightning, tornadoes, and hurricanes. In 2017, heat claimed 107 lives, though none of them were in the State of New Jersey (NWS 2018).

Location

All of Burlington County is exposed to severe weather events (high winds, tornadoes, thunderstorms, lightning, hail, hurricanes/tropical storms, and extreme temperatures) and the entire County is subject to high winds from severe weather events. According to the FEMA Winds Zones of the United States map, Burlington County is located in Wind Zones II, where wind speeds can reach up to 160 mph. Figure 5.4.6-1 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 5.4.6-1. Wind Zones in the United States



Source: *FEMA 2018*
Note: *The black oval indicates the approximate location of Burlington County.*

Hurricanes/Tropical Storms

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 2013 (latest date available from data source). Between 1842 and 2018, 16 tropical cyclones tracked within 65 nautical miles of Burlington County. Between 2012 and 2018, no tropical cyclones tracked within 65 miles of Burlington County although post-Tropical Storm Sandy did cross directly over Burlington County in 2012. Table 5.4.6-1 displays the percent area for the Category 1 through Category 4 storm surge scenarios in each municipality. Bass River Township has the greatest percentage of area located in the Category 1 through Category 3 storm surge scenarios, while Palmyra Borough has the greatest percentage of area located in the Category 4 storm surge scenario.

Table 5.4.6-1. Summary of Potential Surge Inundation Areas by Community

Municipality	Total Acres	% in CAT1 Surge Zone	% in CAT2 Surge Zone	% in CAT3 Surge Zone	% in CAT4 Surge Zone
Bass River Township	50,140	12.6%	22.7%	25.6%	31.6%
Beverly City	486	0.4%	0.5%	0.5%	0.7%

Municipality	Total Acres	% in CAT1 Surge Zone	% in CAT2 Surge Zone	% in CAT3 Surge Zone	% in CAT4 Surge Zone
Bordentown City	618	5.0%	5.0%	5.0%	5.0%
Bordentown Township	5,926	2.9%	2.9%	2.9%	2.9%
Burlington City	2,426	5.3%	5.4%	5.4%	7.7%
Burlington Township	8,992	0.3%	0.4%	0.6%	3.0%
Chesterfield Township	13,736	0.0%	0.0%	0.0%	0.0%
Cinnaminson Township	5,099	0.6%	0.7%	0.7%	8.6%
Delanco Township	2,190	0.8%	0.9%	0.9%	1.4%
Delran Township	4,654	2.1%	2.2%	2.2%	3.2%
Eastampton Township	3,723	0.0%	0.0%	0.0%	0.0%
Edgewater Park Township	1,976	0.1%	0.1%	0.2%	0.2%
Evesham Township	18,943	0.0%	0.0%	0.0%	0.0%
Fieldsboro Borough	224	1.0%	1.0%	1.0%	1.0%
Florence Township	6,559	0.3%	0.4%	0.4%	0.4%
Hainesport Township	4,344	0.1%	11.9%	13.8%	20.7%
Lumberton Township	8,327	0.0%	3.2%	4.1%	8.1%
Mansfield Township	14,010	0.4%	0.4%	0.4%	0.4%
Maple Shade Township	2,451	0.0%	0.0%	0.0%	3.7%
Medford Lakes Borough	812	0.0%	3.1%	4.0%	9.4%
Medford Township	25,474	0.0%	0.0%	0.0%	0.0%
Moorestown Township	9,585	0.2%	0.4%	0.4%	2.4%
Mount Holly Township	1,837	0.0%	0.4%	0.8%	3.2%
Mount Laurel Township	14,066	0.1%	0.7%	0.8%	1.5%
New Hanover Township	14,483	0.0%	0.0%	0.0%	0.0%
North Hanover Township	11,203	0.0%	0.0%	0.0%	0.0%
Palmyra Borough	1,673	1.7%	1.8%	4.4%	39.2%
Pemberton Borough	403	0.0%	0.0%	0.0%	0.0%
Pemberton Township	40,171	0.0%	0.0%	0.0%	0.0%
Riverside Township	1,048	0.5%	0.5%	0.6%	0.9%
Riverton Borough	614	1.3%	0.0%	1.6%	36.1%
Shamong Township	28,791	0.0%	0.0%	0.0%	0.0%
Southampton Township	28,446	0.0%	0.0%	0.0%	0.1%
Springfield Township	18,924	0.0%	0.0%	0.0%	0.0%
Tabernacle Township	31,688	0.0%	0.0%	0.0%	0.0%
Washington Township	66,539	8.3%	14.3%	18.2%	27.0%
Westampton Township	7,104	0.0%	1.6%	1.9%	3.2%
Willingboro Township	5,175	0.9%	1.0%	1.1%	1.7%
Woodland Township	61,001	0.0%	0.0%	0.0%	0.0%
Wrightstown Borough	1,146	0.0%	0.0%	0.0%	0.0%
Burlington County	**525,009**	**2.4%**	**4.3%**	**5.1%**	**7.4%**

Source: FEMA, 2012; Burlington County GIS

Extent

High Winds

The following table provides the descriptions of winds used by the NWS during wind-producing events.

Table 5.4.6-2. 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 2011
mph miles per hour

The NWS issues advisories and warnings for winds. Issuance is normally site-specific. High wind advisories, watches and warnings are products issued by the NWS when wind speeds may pose a hazard or is life threatening. The criterion for each of these varies from state to state. Wind warnings and advisories for New Jersey are as follows:

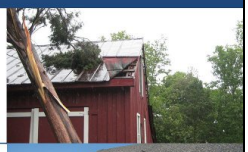
- High Wind Warnings are issued when sustained wind speeds of 40 mph or greater lasting for one hour or longer or for winds of 58 mph or greater for any duration or widespread damage are possible.
- Wind Advisories are issues when sustained winds of 30 to 39 mph are forecast for one hour or longer, or wind gusts of 46 to 57 mph for any duration (NWS 2018).

Tornadoes

The magnitude or severity of a tornado is categorized using the Enhanced Fujita Tornado Intensity Scale (EF Scale). This is the scale now used exclusively for determining tornado ratings by comparing wind speed and actual damage. Figure 5.4.6-2 illustrates the relationship between EF ratings, wind speed, and expected tornado damage.

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; however, warning times for New Jersey may be shorter due to the fact that the State experiences smaller tornadoes that are difficult to warn. Occasionally, tornadoes develop so rapidly, that little, if any, advance warning is possible (NOAA 2013).

Figure 5.4.6-2. Explanation of EF-Scale Ratings

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.		

Thunderstorms and Lightning

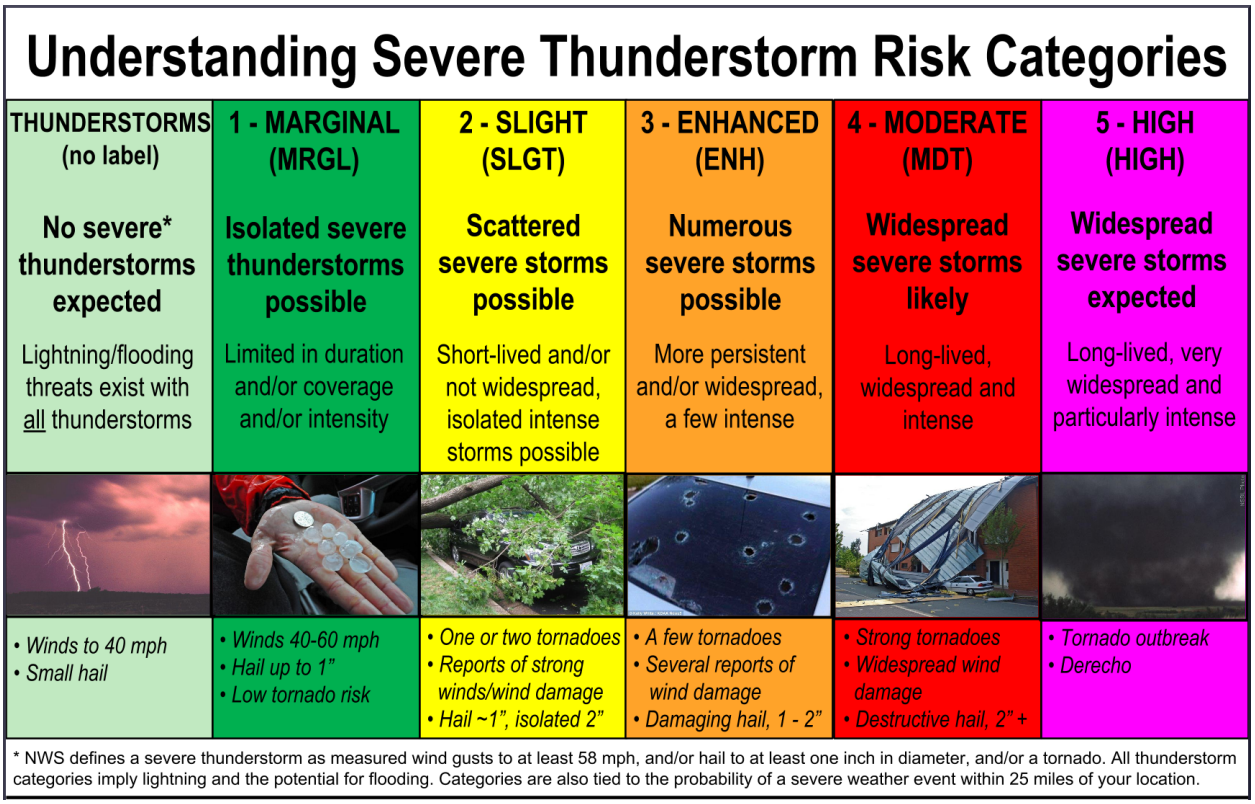
Severe thunderstorm watches and warnings are issued by the local NWS office and SPC. The NWS and SPC will update the watches and warnings and will notify the public when they are no longer in effect. Watches and warnings for tornadoes in New Jersey are as follows:

- Severe Thunderstorm Warnings are issued when there is evidence based on radar or a reliable spotter report that a thunderstorm is producing, or forecast to produce, wind gusts of 58 mph or greater, structural wind damage, and/or hail one-inch in diameter or greater. A warning will include where the storm was located, what municipalities will 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.
- 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 three 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, the NWS will keep the public informed on what is happening in the watch area and also let the public know when the watch has expired or been cancelled (NWS 2009; NWS 2010).

- Special Weather State for Near Severe Thunderstorms 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-inch in diameter (NWS 2010).

Figure 5.4.6-2 below provides the various risk categories for thunderstorms, as presented by the Storm Prediction Center (SPC).

Figure 5.4.6-3. Severe Thunderstorm Risk Categories



Source: NOAA SPC 2017

Hailstorms

The severity of hail is measured by duration, hail size, and geographic extent. All of these factors are directly related to thunderstorms, which creates hail. There is wide potential variation in these severity components. The most significant impact of hail is damage to crops. Hail also has the potential to damage structures and vehicles during hailstorms.

Hail can be produced from many different types of storms. Typically, hail occurs with thunderstorm events. The size of hail is estimated by comparing it to a known object. Most hailstorms are made up of a variety of sizes, and only the very largest hail stones pose serious risk to people, when exposed. Table 5.4.6-4 shows the different sizes of hail and the comparison to real-world objects.

Table 5.4.6-3. Hail Size

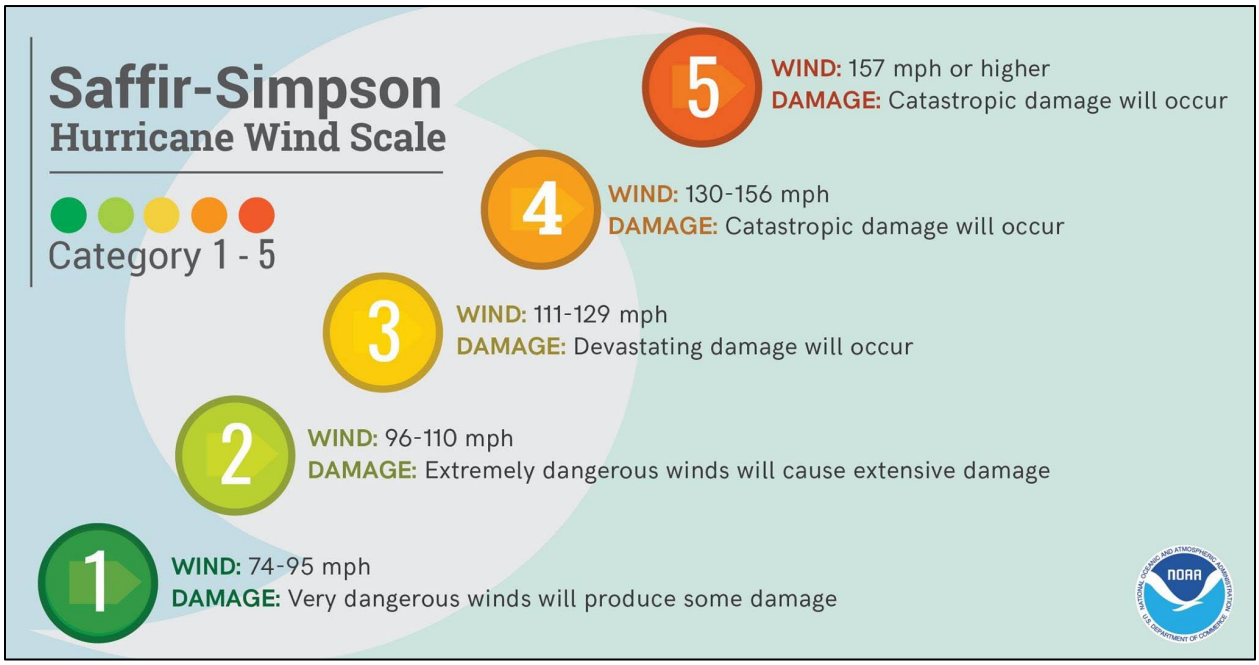
Size	Inches in Diameter
Pea	0.25 inch
Marble/mothball	0.50 inch
Dime/Penny	0.75 inch
Nickel	0.875 inch
Quarter	1.0 inch
Ping-Pong Ball	1.5 inches
Golf Ball	1.75 inches
Tennis Ball	2.5 inches
Baseball	2.75 inches
Tea Cup	3.0 inches
Grapefruit	4.0 inches
Softball	4.5 inches

Source: NWS 2010

Hurricanes/Tropical Storms

The extent of a hurricane is 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 2013). Figure 5.4.6-4 presents this scale, which is used to estimate the potential property damage and flooding expected when a hurricane makes landfall.

Figure 5.4.6-4. The Saffir-Simpson Scale



Source: Disaster Readiness Portal 2017

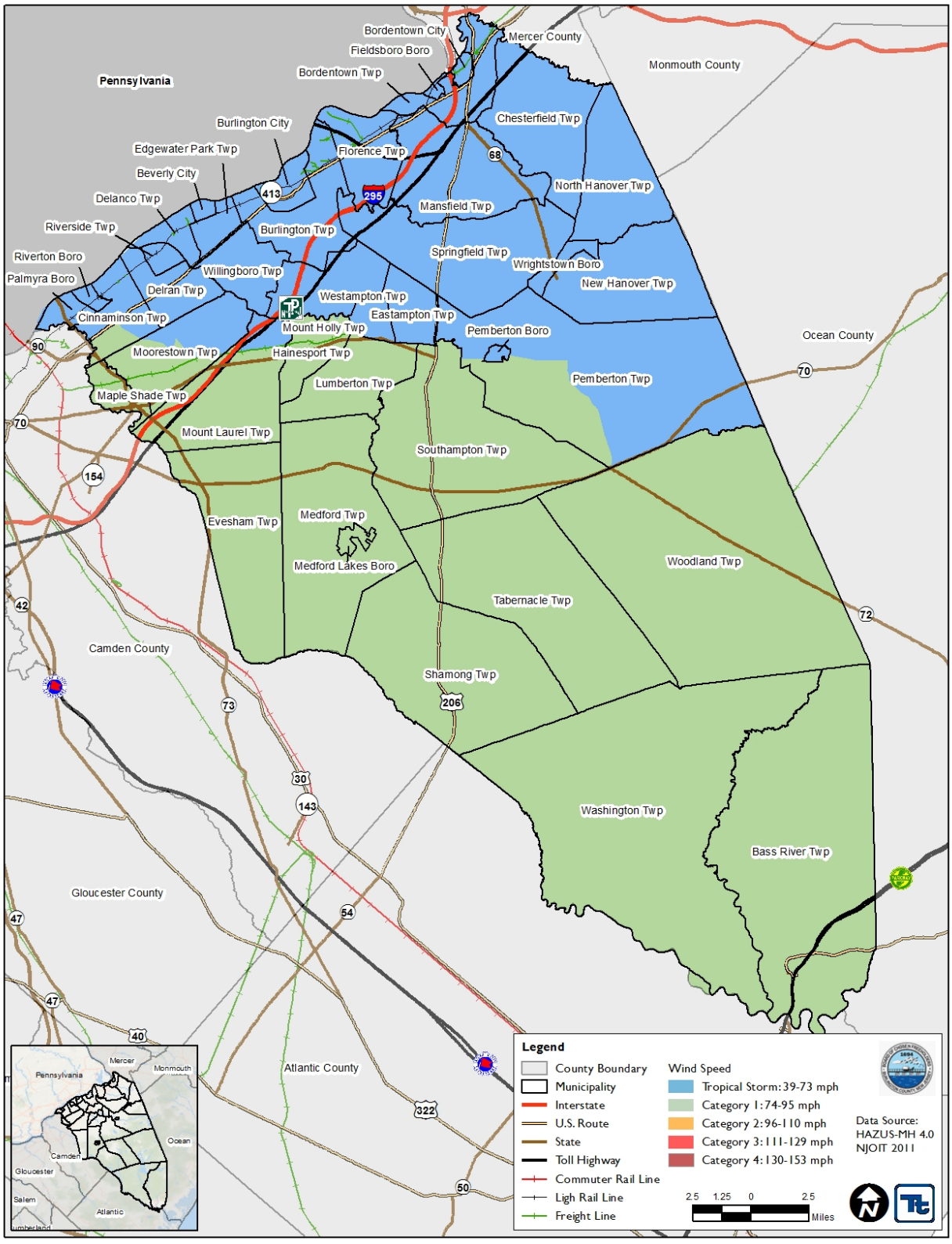
Mean Return Period

In evaluating the potential for hazard events of a given magnitude, a 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 of time, in years, between occurrences of a particular hazard event, equal to the inverse of the annual frequency of exceedance (Dinicola 2009).

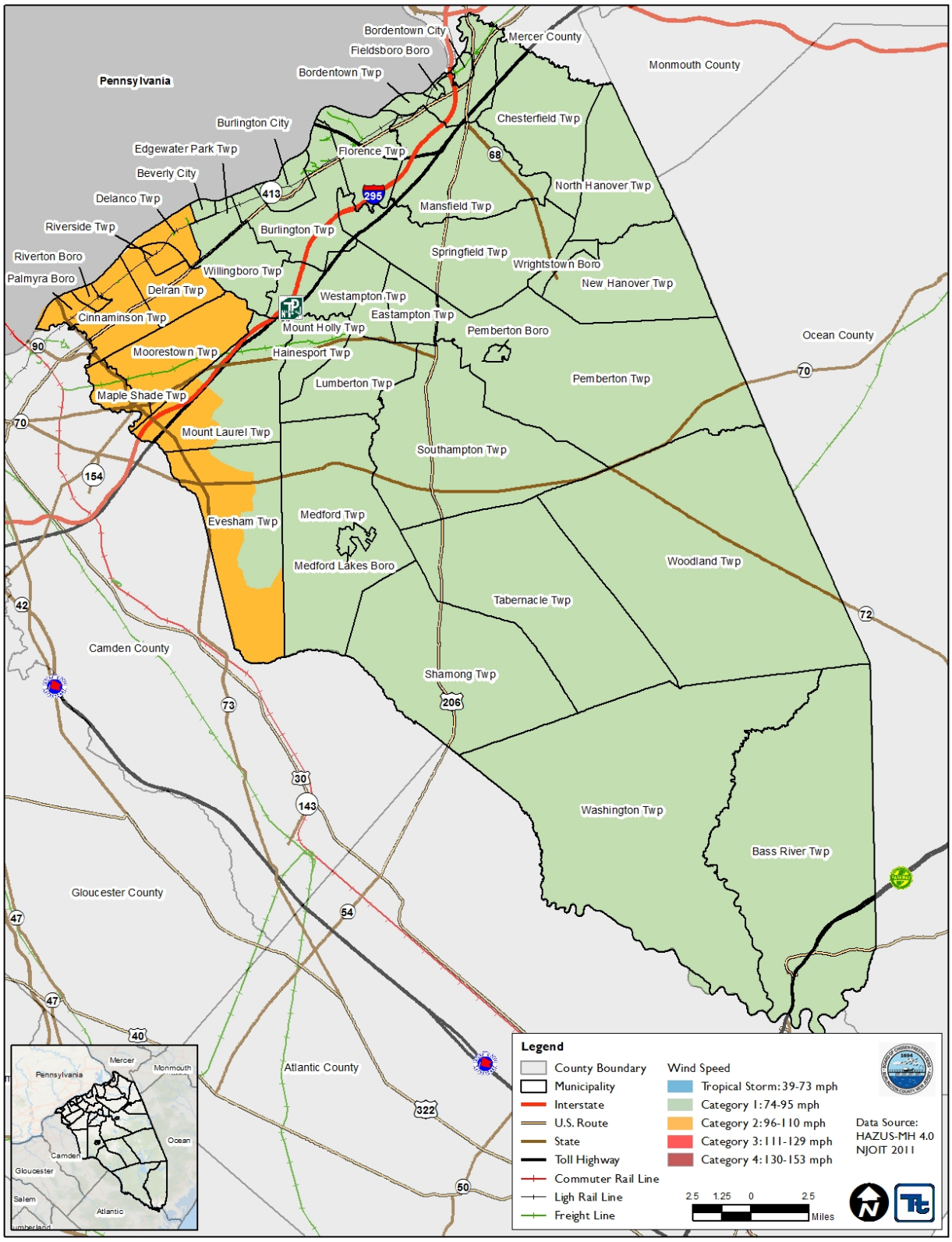
Figure 5.4.6-2 and Figure 5.4.6-3 display the estimated maximum 3-second gust wind speeds that can be anticipated in the study area associated with the 100- and 500-year MRP events. These peak wind speed projections were generated using HAZUS-MH model runs. The maximum 3-second gust wind speeds for Burlington County are 64 to 84 mph (Tropical Storm to Category 1 hurricane), for the 100-year MRP event. The maximum 3-second gust wind speeds for Burlington County are 82 to 98 mph (Category 1 hurricane), for the 500-year MRP event. The storm tracks for the 100- and 500-year event were not available in HAZUS-MH 4.0; a HAZUS-acknowledged error in this version that will be addressed in the future. The associated impacts and losses from these 100-year and 500-year MRP hurricane events are discussed later in the Vulnerability Assessment subsection.

Figure 5.4.6-5. Wind Speeds for the 100-Year Mean Return Period Event



Source: HAZUS-MH 4.0

Figure 5.4.6-6. Wind Speeds for the 500-Year Mean Return Period Event



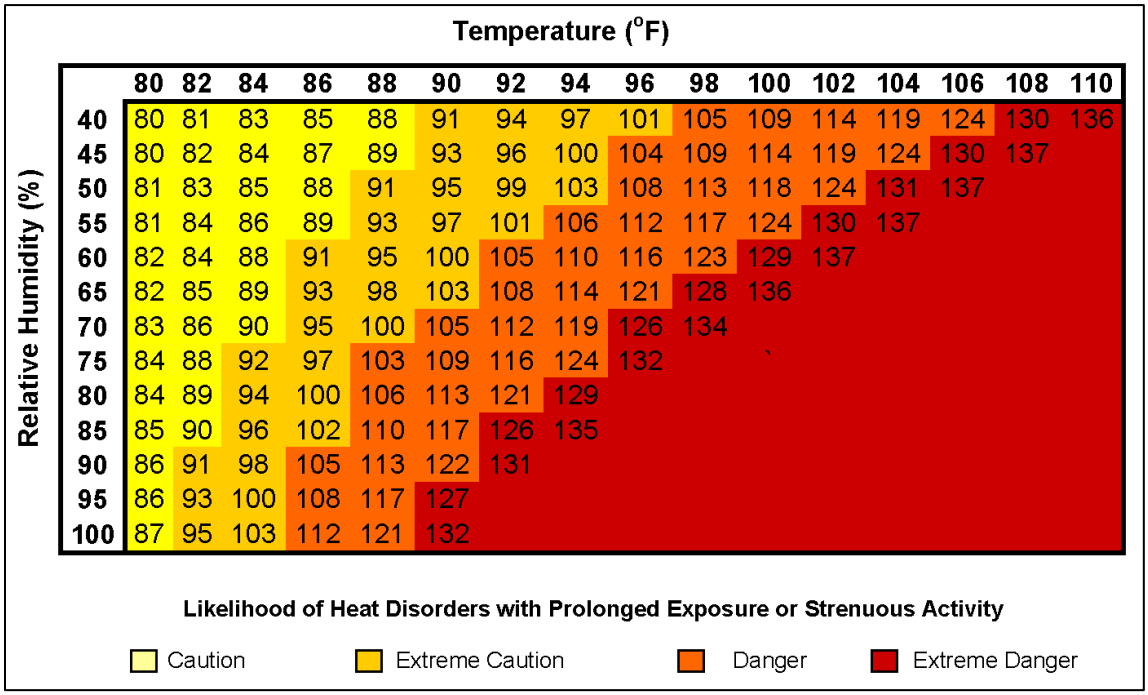
Source: HAZUS-MH 4.0

Extreme Temperature

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 5.4.6-4). 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 5.4.6-7. NWS Heat Index Chart



Source: NWS 2016
°F degrees Fahrenheit
% percent

Figure 5.4.6-8. Adverse Effects of Prolonged Exposures to Heat on Individuals

Category	Heat Index	Health Hazards
Extreme Danger	130 °F – Higher	Heat Stroke / Sunstroke is likely with continued exposure.
Danger	105 °F – 129 °F	Sunstroke, muscle cramps, and/or heat exhaustion possible with prolonged exposure and/or physical activity.
Extreme Caution	90 °F – 105 °F	Sunstroke, muscle cramps, and/or heat exhaustions possible with prolonged exposure and/or physical activity.
Caution	80 °F – 90 °F	Fatigue possible with prolonged exposure and/or physical activity.

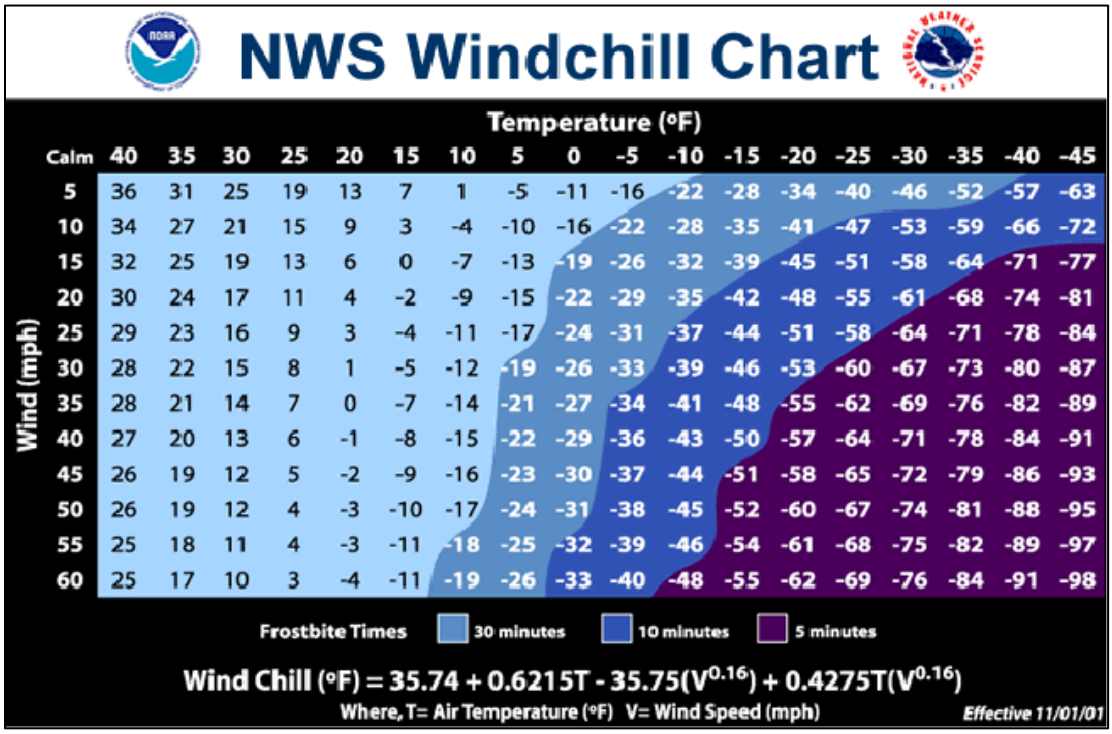
Source: NWS 2009
°F degrees Fahrenheit

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 5.4.6-6 shows three shaded areas of frostbite danger. Each shaded area shows how long a person can be exposed before frostbite develops (NWS 2001).

Figure 5.4.6-9. NWS Wind Chill Index



Source: NWS 2001
°F degrees Fahrenheit
mph miles per hour

Warning Time

Meteorologists can accurately forecast extreme temperature event development and the severity of the associated conditions with several days lead time. These forecasts provide an opportunity for public health and other officials to notify vulnerable populations. For heat events, the NWS issues excessive heat outlooks when the potential exists for an excessive heat event in the next three to seven days. Watches are issued when conditions are favorable for an excessive heat event in the next 24 to 72 hours. Excessive heat warning/advisories are issued when an excessive heat event is expected in the next 36 hours (NWS 2013). Winter temperatures may fall to extreme cold readings with no wind occurring. Currently, the only way to headline very cold temperatures is with the use of the NWS-designated Wind Chill Advisory or Warning products. When actual temperatures reach Wind Chill Warning criteria with little to no wind, extreme cold warnings may be issued (NWS Date Unknown a).

Previous Occurrences and Losses

Many sources provided historical information regarding previous occurrences and losses associated with severe weather events throughout Burlington County. With so many sources reviewed for the purpose of this HMP, 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.

Based on the Midwestern Regional Climate Center (MRCC) data for Burlington County, Table 5.4.6-6 presents the extreme cold (minimum) and hot (maximum) temperature records for the weather stations located in Burlington County between 1836 and 2018.

Table 5.4.6-4. MRCC Temperature Extremes

Station Name	Highest Max (°F)	Date	Lowest Minimum (°F)	Date
Burlington	106	July 10, 1936	-14	February 9, 1934
Chatsworth	104	July 19, 1977	-15	January 18, 1965
Indian Mills 2 W	107	July 2, 1901	-25	February 9, 1934
McGuire AFB	101	July 3, 1966	-4	February 2, 1961
Moorestown	106	July 10, 1936	-13	February 9, 1934
Mount Holly South Jersey Regional AP	104	July 6, 2010	-3	January 4, 2014
Pemberton	107	July 10, 1936	-17	February 9, 1934
Philadelphia/Mt. Holly WFO	103	July 7, 2010	-6	January 19, 1994

Source: *MRCC 2018*

Note: *There may be some potential problems with the data collected at the stations. The values of the all-time records for stations with brief histories are limited in accuracy and could vary from nearby stations with longer records. Although the data sets have been through quality control, there is still a need for more resources to quality control extremes. The record sets are for single stations in the cooperative observer network and are limited to the time of operation of each station under one coop number. The records for a place may need to be constructed from several individual station histories. Some of the data may vary from NWS records due to NWS using multiple stations and additional sources like record books (MRCC, Date Unknown).*

Between 1954 and 2018, the State of New Jersey was included in 32 FEMA declared severe weather-related disasters (DR) or emergencies (EM) classified as one or a combination of the following hazards: coastal storm, high tides, heavy rain, flooding, hurricane, tropical storm, Nor'Easter, straight-line winds, and mudslide. Generally, these disasters cover a wide region of the State; therefore, they may have impacted many counties. Of those declarations, Burlington County has been included in 11 declarations (FEMA 2018). Since the original 2014 HMP, Burlington County has been included in the FEMA disaster declarations for two additional declarations. Table 5.4.6-7 lists FEMA DR and EM declarations from January 1, 2012 to May 2019 for this HMP update.

Table 5.4.6-5. FEMA DR and EM Declarations Since 2012 for Severe Storm Events in Burlington County

FEMA Declaration Number	Date(s) of Event	Event Type	Location
DR-4086, EM 3354	October 26 – November 8, 2012	Hurricane Sandy	Atlantic, Bergen, Burlington, Camden, Cape May, Cumberland, Essex, Gloucester, Hudson, Hunterdon, Mercer, Middlesex, Monmouth, Morris, Ocean, Passaic, Salem, Somerset, Sussex, Union, and Warren
DR-4231	June 23, 2015	Severe Storm	Atlantic, Burlington, Camden, and Gloucester

Source: *FEMA 2018*

Agriculture-related severe weather disasters are quite common. One-half to two-thirds of the counties in the U.S. have been designated as disaster areas in each of the past several years. The USDA Secretary of Agriculture 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 2012 and 2018, New Jersey has been included in 10 USDA severe weather-related declarations. Burlington County was included in six of these declarations, to date.

- S3487 – June-November 2012 – disaster declared as a result of the combined effects of drought, high winds (derecho), hail, excessive heat, excessive rain, flash flooding, Hurricane Sandy, a snowstorm, and a Nor'Easter; over $62,000 in claims filed in Burlington County
- S3603 – May-September 2013 – disaster declared as a result of the combined effects of excessive rain, related flooding, high winds, and hail
- S3930 – April-September 2015 – disaster declared as a result of excessive heat and drought; over $328,000 in claims filed in Burlington County
- S3931 – May-July 2015 – disaster declared as a result of excessive rain, flash flooding, high winds, and lightning; over $328,000 in claims filed in Burlington County
- S3932 – July-September 2015 – disaster declared as a result of excessive heat and drought; over $328,000 in claims filed in Burlington County
- S4071 – April-September 2016 – disaster declared as a result of the combined effects of freeze, excessive heat, and drought; over $203,000 in claims filed in Burlington County

For this 2019 HMP update, severe weather events were summarized from January 1, 2012 to May 2019. Known severe weather events, including FEMA disaster declarations, which have impacted Burlington County between 2012 and 2018 are identified in Table 5.4.6-8. For events prior to 2012, please refer to Appendix G (Supplementary Data). Please note that not all events that have occurred in Burlington County are included due to the extent of documentation and the fact that not all sources may have been identified or researched. Loss and impact information 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. Please see Section 9 for detailed information regarding impacts and losses to each municipality.

Table 5.4.6-6. Severe Weather Events in Burlington County, 2012 to 2018

Dates of Event	Event Type	FEMA Declaration Number (if applicable)	County Designated?	Losses / Impacts
June 1, 2012	Thunderstorm Wind	N/A	N/A	A strong thunderstorm knocked down one tree onto a house on Montrose Lane in the Millbrook Park section of Willingboro Township. Doppler Radar suggested the wind gusts were around 45 mph. No injuries were reported. Willingboro reported $10,000 in property damages.
October 29-30, 2012	Hurricane Sandy	DR-4086, EM 3354	Yes	Post Tropical Storm Sandy was the costliest natural disaster by far in the state of New Jersey. Record breaking high tides and wave action combined with sustained winds as high as 60 to 70 mph with wind gusts as high as around 90 mph to batter the state. Statewide, Sandy caused an estimated $29.4 billion in damage, destroyed or significantly damaged 30,000 homes and businesses, affected 42,000 additional structures and was responsible directly or indirectly for 38 deaths. A new temporary inlet formed in Mantaloking (Ocean County) where some homes were swept away. About 2.4 million households in the state lost power. It would take two weeks for power to be fully restored to homes and businesses that were inhabitable. In the Mount Holly warning and forecast area of New Jersey, Sandy was responsible for 24 deaths, 8 that are considered directly caused by the system: two drownings, five people killed by fallen trees and one person was blown over by the wind. Hardest hit were the coastal areas of Ocean and Monmouth Counties. Approximately 230,000 residents of the state have applied for assistance from FEMA. In Burlington County, heavy rain caused urban and poor drainage flooding and exacerbated the tidal flooding along the Delaware River and near the Atlantic Coast. Along the Delaware River, tidal flooding occurred in the Columbus Park development along Assiscunk Creek in the City of Burlington. In Mount Laurel Township, Union Mill Road was closed because Parkers Creek flooded. Rainfall totals in Burlington County included 4.10 inches in Medford Township, 3.51 inches in Chatsworth, 3.15 inches in Medford Lakes, 2.92 inches in Mount Laurel Township, 2.82 inches in Morrestown Township and 2.42 inches in Westampton Township. Peak wind gusts in the County ranged from 56 mph in Woodland Township to 70 mph in Florence Township. The most widespread damage in Burlington County was reported in Bass River Township, mainly due to tidal and flood-related damages. In Mount Holly Township, a resident was trapped inside their home after a tree landed on the house. Seven roadways in Medford Township were closed due to downed trees. Overall, the County reported approximately $5 million in property damage from Hurricane Sandy.
December 26, 2012	Strong Wind	N/A	N/A	A 54 mph gust was reported in Florence Township; $10,000 in property damages were reported.
March 6, 2013	Strong Wind	N/A	N/A	A 49 mph gust was recorded at Coyle Field (Woodland Township); $5,000 in property damages were reported.

Dates of Event	Event Type	FEMA Declaration Number (if applicable)	County Designated?	Losses / Impacts
June 24, 2013	Lightning	N/A	N/A	Strong to severe thunderstorms moved across central and southern New Jersey, bringing damaging winds, hail and lightning strikes. In Burlington County, a lightning strike caused minor damage to a home in Shamong Township. The Township reported $5,000 in property damage from this event.
July 21, 2013	Lightning	N/A	N/A	Strong thunderstorms in Burlington County brought strong winds and lightning. A lightning strike took down a couple of wires in Bordentown Township. Bordentown Township reported $1,000 in property damages.
August 13, 2013	Thunderstorm Wind	N/A	N/A	A severe thunderstorm knocked down numerous trees and wires in Shamong Township with the wind damage centered around Indian Mills Road. A few homes were damaged by downed trees and a roof was blown off a barn. One downed tree crashed through the bedroom roof of one home. Indian Mills Road remained closed for most of the day. No serious injuries were reported. Indian Mills reported $50,000 in property damages.
March 12, 2014	Strong Wind	N/A	N/A	Strong northwest winds moved across New Jersey, bringing peak wind gusts of around 50 mph to 60 mph in central and southern New Jersey. In Burlington County, gusts of 49 mph were recorded at McGuire Air Force Base and 45 mph was recorded in Lumberton Township. The winds caused $10,000 in property damage.
May 10, 2014	Hail	N/A	N/A	A thunderstorm dropped penny size hail in Burlington Township and Florence Township. A 56 mph wind gust was also measured with this thunderstorm in Burlington Township. Burlington Township reported $500 in property damages; Florence Township reported $500 in property damages.
May 23, 2014	Lightning	N/A	N/A	A lightning strike and ensuing fire left several people displaced from their homes in a condominium complex on Friday night on Tarnbrook Drive in Mount Laurel Township. Eight units were declared uninhabitable after the blaze, which was controlled in less than an hour. Four nearby townships assisted in battling the blaze. Lightning struck the upper part of the building and started a roof fire. Other condominium units suffered fire, smoke and water damage. Springville reported $250,000 in property damages.
July 2, 2014	Thunderstorm Wind	N/A	N/A	A severe thunderstorm damaged sail boats in the Delaware River off of Cinnaminson Township. No injuries were reported. Palmyra Borough reported $10,000 in property damages.
July 3, 2014	Lightning	N/A	N/A	A lightning strike and ensuing fire damaged a home in Beverly City. No injuries were reported. Beverly City reported $25,000 in property damages.
July 14, 2014	Thunderstorm Wind	N/A	N/A	A severe thunderstorm caused wind damage in Southampton Township. Trees and power lines were knocked down and an irrigation pipe was blown across Buddtown Road. Nearly 4,300 homes and businesses lost power in Burlington County. Vincentown reported $10,000 in property damages.
July 15, 2014	Lightning, Thunderstorm Wind	N/A	N/A	A severe thunderstorm knocked down large tree limbs and wires around New Jersey State Route 70 in from Friendship Road east to Big Hill Road in Southampton Township. North Friendship reported $5,000 in property damages. The storm

Dates of Event	Event Type	FEMA Declaration Number (if applicable)	County Designated?	Losses / Impacts
				knocked down large tree limbs and wires in Tabernacle Township resulting in $5,000 in property damages. Lightning struck the Shawnee Baptist Church on Oakshade Road in Shamong Township. Tabernacle Township reported $5,000 in property damages.
July 28, 2014	Lightning, Thunderstorm Wind	N/A	N/A	A severe thunderstorm tore down several trees and caused wind damage in the Hoot Owl subdivision of Medford Township. Two homes suffered major damage and were uninhabitable. A tree fell onto a home on Christopher Mills Road. About four or five other homes suffered shingle or siding damage. Three vehicles were also damaged by fallen trees. Lake Pine reported $1,000,000 in property damages. A lightning strike and ensuing fire destroyed a shed and its contents on Ridge Road in Southampton Township. Buddtown (Southampton Township) reported $3,000 in property damages.
April 22, 2015	Thunderstorm Wind	N/A	N/A	A severe thunderstorm knocked down a tree that damaged the roof of a home in Wrightstown Borough resulting in $20,000 in property damages. Trees were knocked down trees along New Jersey State Route 70 in Pemberton Township resulting in $20,000 in property damages at Country Lake Estates.
May 28, 2015	Thunderstorm Wind	N/A	N/A	A severe thunderstorm knocked down a couple of trees in Washington Township, one of which fell onto and damaged a home. Jenkins reported $10,000 in property damages.
June 23, 2015	Thunderstorm Wind	DR-4231	Yes	A severe thunderstorm knocked down several trees in Palmyra Borough. Riverton Borough reported $50,000 in property damages. A severe thunderstorm knocked down several trees in Maple Shade Township. One downed tree damaged a home resulting in $50,000 in property damages. Dozens of trees were knocked down in Evesboro resulting in $50,000 in property damages. $1,000,000 in property damages were reported in Mount Laurel Township as trees were snapped, siding was ripped from some homes, and sheds and fences destroyed. In Medford Township, hundreds upon hundreds of trees were either uprooted or snapped. Three people were injured after a tree fell onto their vehicle. Another person was injured after a tree fell on their home on Mississippi Trail. Several other people were trapped in their homes. Some gas lines were ruptured. A firefighter suffered cardiac arrest the next day after assisting people through the night. There were approximately 350 calls for assistance because of wind damage from the thunderstorms within the township. Medford Township reported $8,000,000 in property damages. Medford Lakes Borough had multiple downed trees resulting in $1,000,000 in property damages. In Tabernacle Township the storm knocked down several trees. One downed tree fell onto and damaged a truck. The thunderstorm winds also damaged the roof of Seneca High School. Tabernacle Township reported $100,000 in property damages.

Dates of Event	Event Type	FEMA Declaration Number (if applicable)	County Designated?	Losses / Impacts
				Vincentown and Jenkins each reported $50,000 in property damages from downed trees.
March 28, 2016	Strong Wind	N/A	N/A	A utility pole and downed wires due to wind on route 73 in Maple Shade Township due to wind. $10,000 in property damages were reported.
July 3, 2018	Hail	N/A	N/A	Severe thunderstorms caused wind damage across portions of southwestern New jersey. Rainfall amounts of one to three inches fell along the I-95/New Jersey Turnpike corridor. In Burlington County, nickel to quarter size hail was reported in Riverside Township.

Source: NOAA-NCEI 2018, FEMA 2018
DR Major Disaster Declaration (FEMA)
EM Emergency Disaster Declaration (FEMA)
FEMA Federal Emergency Management Agency
Mph miles per hour
NOAA National Oceanic and Atmospheric Administration
NCEI National Center for Environmental Information

Table 5.4.6-9 documents the number of severe weather events that have occurred in Burlington County from 1950 to 2018, including the number of fatalities, injuries, property damages, and crop damages that have been associated with severe weather according to the NOAA National Climatic Data Center (NCEI) Storm Events Database. Between 1950 and 2018, Burlington County has experienced 1,210 severe weather events resulting in three fatalities, 59 injuries, over $135 million in property damage, and over $1 million in crop damages. Please note that the information provided in the NOAA-NCEI database includes information as reported by the NWS. The NWS receives their information from a variety of sources, including but not limited to: county, state and federal emergency management officials, local law enforcement officials, skywarn spotters, NWS damage surveys, newspaper clipping services, the insurance industry and the general public, among others. It may not include all losses associated with the events.

Table 5.4.6-7. Severe Weather Events 1950-2018

Hazard Type	Number of Occurrences Between 1950 and 2018	Total Fatalities	Total Injuries	Total Property Damage ($)	Total Crop Damage ($)
Excessive Heat	39	1	1	0	0
Extreme Cold/Wind Chill	4	0	0	0	0
Funnel Cloud	14	0	0	0	0
Hail	100	0	0	$1,000	0
Heat	84	3	3	0	0
Heavy Rain	287	0	0	$1,000,000	0
High Wind	47	0	3	$101,426,000	0
Hurricane	0	0	0	0	0
Lightning	45	1	21	$3,071,000	0
Strong Wind	207	0	0	$657,890	$20
Thunderstorm Wind	364	1	16	$25,715,000	$1,000,000
Tornado	15	1	8	$2,430,000	0
Tropical Storm	4	0	1	$1,000,000	0
TOTAL	**1,210**	**7**	**53**	**$135,300,890**	**$1,000,020**

Source: NOAA-NCEI 2018

Probability of Future Occurrences

Predicting future severe weather events in a constantly changing climate has proven to be a difficult task. Predicting extremes in New Jersey and Burlington County is particularly difficult because of their geographic location. Both are positioned roughly halfway between the equator and the North Pole and are exposed to both cold and dry airstreams from the south. The interaction between these opposing air masses often leads to turbulent weather across the region (Keim 1997).

It is estimated that Burlington County will continue to experience direct and indirect impacts of severe weather events annually that may induce secondary hazards such as flooding, infrastructure deterioration or failure, utility failures, power outages, water quality and supply concerns, and transportation delays, accidents and inconveniences.

Extreme temperatures are expected to occur more frequently as part of regular seasons. Specifically, extreme heat will continue to impact New Jersey and its counties and, based upon data presented, will increase in the

next several decades. As previously stated, several extreme temperature events occur each year in Burlington County. It is estimated that the county will continue to experience these events annually.

In order to determine the recurrence interval and the average annual number of events, data from 1950 to 2018 was examined using the NOAA National Climatic Data Center (NCEI) Storm Events Database to calculate these statistics for Burlington County. According to the database, Burlington County experienced 1,210 severe weather events. The table below shows these statistics, as well as the annual average number of events and the percent chance of these individual severe weather events occurring in Burlington County in future years.

Table 5.4.6-8. Probability of Future Occurrences of Severe Weather Events

Hazard Type	Number of Occurrences Between 1950 and 2018	Rate of Occurrence or Annual Number of Events (average)	Recurrence Interval (in years) (# Years/Number of Events)	Probability of Event in any given year	Percent chance of occurrence in any given year
Excessive Heat	39	0.57	1.77	0.57	56.52%
Extreme Cold/Wind Chill	4	0.06	17.25	0.06	5.80%
Funnel Cloud	14	0.21	4.93	0.20	20.29%
Hail	100	1.47	0.69	1.45	100%
Heat	84	1.24	0.82	1.22	100%
Heavy Rain	287	4.22	0.24	4.16	100%
High Wind	47	0.69	1.47	0.68	68.12%
Hurricane	0	0	0	0	0%
Lightning	45	0.66	1.53	0.65	65.22%
Strong Wind	207	3.04	0.33	3.00	100%
Thunderstorm Wind	364	5.35	0.19	5.28	100%
Tornado	15	0.22	4.60	0.22	21.74%
Tropical Storm	4	0.06	17.25	0.06	5.80%

``Source: NOAA-NCEI 2018; SPC 2018

In Section 5.3, the identified hazards of concern for Burlington 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 severe weather events in the county is considered 'frequent' (likely to occur within 25 years, as presented in Table 5.3-3).

Climate Change Impacts

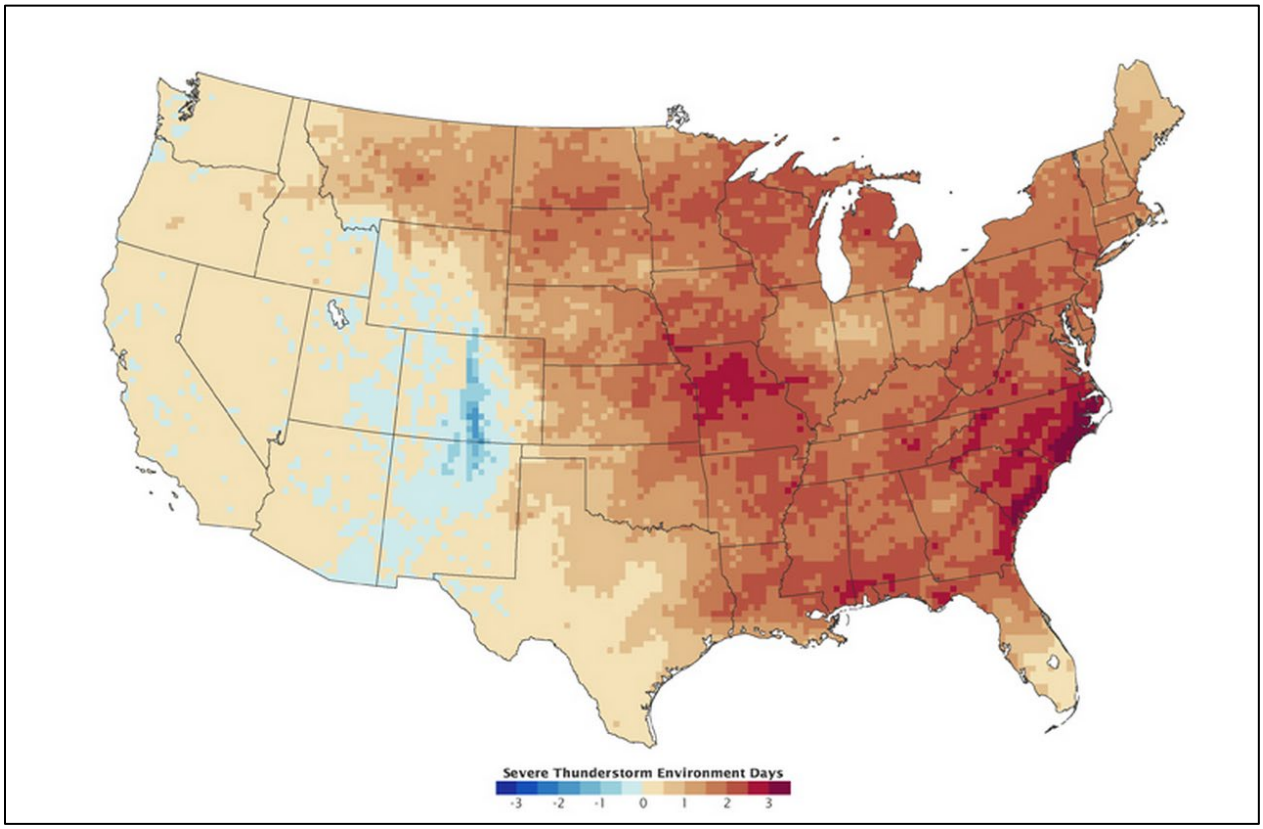
Providing projections of future climate change for a specific region is challenging. Shorter term projections are more closely tied to existing trends making longer term projections even more challenging. The further out a prediction reaches the more subject to changing dynamics it becomes.

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-percent) greater than the average from 1895-1970 (Sustainable Jersey Climate Change Adaptation Task Force [CATF] 2011). 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).

As prepared by the NASA, Figure 5.4.6-7 identifies those areas, particularly within the eastern United States, that are predicted to be more prone to thunderstorms, including New Jersey and Burlington County. NASA scientists suggest that the United States will face more severe thunderstorms in the future, with deadly lightning, damaging hail, and the potential for tornadoes in the event of climate change. A recent study conducted by NASA predicts that smaller storm events like thunderstorms will also be more dangerous due to climate change.

Figure 5.4.6-10. Predicted Change in Severe Thunderstorm Environment Days from the 1962-1989 Period to the 2072-2099 Period



Source: NASA 2013

Temperatures in the Northeast United States have increased 1.5 degrees Fahrenheit (°F) on average since 1900, with the regional warming trend greater in the Northeast than in the United States as a whole. 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).

5.4.6.2 VULNERABILITY ASSESSMENT

Wind-related vulnerability data was generated using a HAZUS analysis for the severe storm hazard. A probabilistic assessment was conducted for the 100- and 500-year MRPs through a Level 2 analysis in HAZUS-MH 4.0 to analyze the severe storm hazard and provide a range of loss estimates. Storm surge impacts were assessed using SLOSH data from FEMA's Coastal Flood Loss Atlas. The other severe weather hazards profiled above were assess qualitatively. Refer to Section 5.1 for additional details on the methodology used to assess severe weather risk.

Impact on Life, Health and Safety

For the purposes of this HMP, the entire population of Burlington County (448,734 people) is exposed to severe weather events (U.S. Census, 2010). Residents may be displaced or require temporary to long-term sheltering due to severe weather events. In addition, downed trees, damaged buildings, and debris carried by high winds can lead to injury or loss of life. Socially vulnerable populations are most susceptible, based on a number of factors including their physical and financial ability to react or respond during a hazard and the location and construction quality of their housing.

People located outdoors (i.e., recreational activities and farming) are considered most vulnerable to hailstorms, thunderstorms and tornadoes. This is because there is little to no warning and shelter may not be available. Moving to a lower risk location will decrease a person's vulnerability.

Extreme temperatures generally occur for a short period of time but can cause a range of impacts, particularly to vulnerable populations that may not have access to adequate cooling or heating. Extreme temperature events have potential health impacts including injury and death. According to the Centers for Disease Control and Prevention, 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 who are physically ill (e.g., heart disease or 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, 2007; CDC 2009).

Meteorologists can accurately forecast extreme heat 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.

Due to the large geographic area the County covers with both coastal and inland locations, the loss associated with hurricanes can vary across the County; secondary flooding associated with the torrential downpours during hurricanes/tropical storms is also a primary concern in the County (see flooding discussion in Section 5.4.4 Flood). The estimated population in the Category 1 through 4 inundation zones is summarized in Table 5.4.6-11 by municipality. For the Category 1 inundation zone, Burlington City has the greatest total exposure with 272 people located in the inundation zone. For the Category 2 and Category 3 inundation zones, Bass River Township has the greatest total exposure with 962 and 977 people located in the Category 2 and Category 3 inundation zones, respectively. For the Category 4 inundation zone, Palmyra Borough has the greatest total exposure with 4,067 people located in the hazard area.

Table 5.4.6-9. Estimated Population Exposed to Storm Surge in Burlington County

Municipality	Total Population (U.S. Census 2010)	Population in Hazard Area							
		Cat 1 Exposure	% of Total	Cat 2 Exposure	% of Total	Cat 3 Exposure	% of Total	Cat 4 Exposure	% of Total
Bass River Township	1,443	55	3.8%	962	66.7%	977	67.7%	1,337	92.7%
Beverly City	2,577	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Bordentown City	3,924	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Bordentown Township	11,367	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Burlington City	9,920	272	2.7%	272	2.7%	272	2.7%	272	2.7%
Burlington Township	22,594	0	0.0%	0	0.0%	8	0.0%	446	2.0%
Chesterfield Township	7,699	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Cinnaminson Township	15,569	0	0.0%	0	0.0%	0	0.0%	814	5.2%
Delanco Township	4,283	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Delran Township	16,896	36	0.2%	36	0.2%	36	0.2%	218	1.3%
Eastampton Township	6,069	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Edgewater Park Township	8,881	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Evesham Township	45,538	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Fieldsboro Borough	540	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Florence Township	12,109	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Hainesport Township	6,110	0	0.0%	11	0.2%	70	1.1%	90	1.5%
Lumberton Township	12,559	0	0.0%	161	1.3%	313	2.5%	410	3.3%
Mansfield Township	8,544	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Maple Shade Township	19,131	0	0.0%	0	0.0%	0	0.0%	112	0.6%
Medford Lakes Borough	4,146	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Medford Township	23,033	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Moorestown Township	20,726	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Mount Holly Township	9,536	0	0.0%	0	0.0%	0	0.0%	114	1.2%
Mount Laurel Township	41,864	0	0.0%	0	0.0%	3	0.0%	264	0.6%
New Hanover Township	7,385	0	0.0%	0	0.0%	0	0.0%	0	0.0%
North Hanover Township	7,678	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Palmyra Borough	7,398	0	0.0%	0	0.0%	453	6.1%	4,067	55.0%
Pemberton Borough	1,409	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Pemberton Township	27,912	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Riverside Township	8,079	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Riverton Borough	2,779	0	0.0%	0	0.0%	0	0.0%	1,261	45.4%
Shamong Township	6,490	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Southampton Township	10,464	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Springfield Township	3,414	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Tabernacle Township	6,949	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Washington Township	687	127	18.5%	396	57.6%	477	69.4%	505	73.5%
Westampton Township	8,813	0	0.0%	0	0.0%	0	0.0%	19	0.2%

Municipality	Total Population (U.S. Census 2010)	Population in Hazard Area							
		Cat 1 Exposure	% of Total	Cat 2 Exposure	% of Total	Cat 3 Exposure	% of Total	Cat 4 Exposure	% of Total
Willingboro Township	31,629	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Woodland Township	1,788	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Wrightstown Borough	802	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Burlington County	**448,734**	**490**	**0.1%**	**1,838**	**0.4%**	**2,609**	**0.6%**	**9,929**	**2.2%**

Source: Burlington County GIS; U.S. Census 2010
The SLOSH boundaries were overlaid on the U.S. Census block; the blocks with their centroids within the hazard areas were totaled for each municipality.

Socially vulnerable and economically disadvantaged populations are most susceptible, based on a number of factors including their physical and financial ability to react or respond during a hazard and the location and construction quality of their housing. The population over the age of 65 is also more vulnerable and, physically, they may have more difficulty evacuating. The elderly are considered most vulnerable because they 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. Within the Category 1 inundation area, there are approximately 106 people over the age of 65 and 60 people considered low income populations (as present in Table 4-3 of the County Profile). Within the Category 2 inundation area, there are approximately 917 people over the age of 65 and 841 people considered low income populations. Within the Category 3 inundation area, there are approximately 1,340 people over the age of 65 and 2,775 people considered low income populations. Within the Category 4 inundation area, there are approximately 5,050 people over the age of 65 and 4,268 people considered low income populations.

Residents may be displaced 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. HAZUS-MH 4.0 estimates there will be no households displaced and no one that may require temporary shelter due to a 100-year MRP event. For a 500-year MRP event, HAZUS-MH 4.0 Hurricane wind model estimates 27 households will be displaced, and 4 people require short-term sheltering. Refer to Table 5.4.6-12 which summarizes the sheltering estimates for the 500-year MRP event by municipality.

Table 5.4.6-10. Sheltering Needs for the 500-year MRP Hurricane Events for Burlington County

Mean Return Period	Displaced Households	Households Requiring Short-Term Shelter
100-year MRP	0	0
500-year MRP	27	4

Source: HAZUS-MH 4.0 (U.S. Census 2010)

Impact on General Building Stock

Damage to buildings is dependent upon several factors, including wind speed, storm duration, path of the storm track or tornado, and distance from the tornado funnel. Depending on the size of the hail and severity of the storm, the County could see damage from hail impacting structures. Lightning can spark wildfires or building fires, especially if structures are not protected by surge protectors on critical electronic, lighting, or information technology systems. While damage to the building stock are possible as a result of lightning and hail, they are difficult to estimate and would not have as wide of an impact as a high wind or tornado event.

Building construction plays a major role in the extent of damage resulting from a severe storm event. 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. High-rise buildings are also very vulnerable structures. Mobile homes are the most vulnerable to damage, even if tied down, and offer little protection to people inside.

Extreme heat generally does not impact buildings. Losses may be associated with the overheating of heating, ventilation, and air conditioning (HVAC) systems. Extreme cold temperature events can damage buildings through freezing/bursting pipes and freeze/thaw cycles. Additionally, manufactured homes (mobile homes) and antiquated or poorly constructed facilities may have inadequate capabilities to withstand extreme temperatures.

The U.S. Census Bureau defines manufactured homes as "movable dwellings, 8 feet or wider and 40 feet or more long, designed to be towed on its own chassis, with transportation gear integral to the unit when it leaves the factory, and without need of a permanent foundation (U.S. Census, 2010)." They can include multi-wides and expandable manufactured homes but exclude travel trailers, motor homes, and modular housing. Due to their light-weight and often unanchored design, manufactured housing is extremely vulnerable to high winds and will generally sustain the most damage.

Table 5.4.6-13 displays the number of manufactured housing units per municipality in Burlington County. Total counts were obtained from the custom general building stock; manufactured housing occupancy class determined using the property class descriptions from the NJ Department of the Treasury tax assessor data. As noted below, North Hanover Township contains the greatest number of manufactured homes.

Table 5.4.6-11. Manufactured Housing Units per Municipality in Burlington County

Municipality	Number of Manufactured Homes		Municipality	Number of Manufactured Homes
Bass River Township	2		North Hanover Township	594
Hainesport Township	19		Pemberton Township	56
Maple Shade Township	1		Shamong Township	335
			Burlington County:	**1,007**

Source: Burlington County, NJ Department of the Treasury, 2017

The entire County's general building stock is assumed to be exposed to the severe storm wind hazard (greater than $101 billion in structure cost only). Expected building damage was estimated by HAZUS-MH 4.0 and includes buildings damaged at the following wind damage categories: no damage/very minor damage, minor damage, moderate damage, severe damage, and total destruction. Table 5.4.6-14 summarizes the definition of the damage categories.

Table 5.4.6-12. 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

Qualitative Damage Description	Roof Cover Failure	Window Door Failures	Roof Deck	Missile Impacts on Walls	Roof Structure Failure	Wall Structure Failure
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
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

As noted earlier in the profile, HAZUS estimates the 100-year MRP peak gust wind speeds for Burlington County to be 64 to 84 miles per hour (mph). This equates to a tropical storm. For the 100-year MRP event, HAZUS-MH 4.0 estimates $124.4 Million in structure damages across the County. Residential buildings comprise the majority of the building inventory and are estimated to experience all of the damage.

HAZUS estimates the 500-year MRP peak gust wind speeds for Burlington County to range from 82 to 98 mph. This equates to a Category 1 hurricane and $588.9 Million in damages to the general building stock (structure only). This is between one- and two-percent of the County's building inventory. The residential buildings are estimated to experience the majority of the damage. Table 5.4.6-15 summarizes the building value (structure only) damage estimated for the annualized and 100- and 500-year MRP wind-only events by occupancy class. The total cost of all damage estimates for both mean return periods and annualized loss is less than 1% of total replacement cost value for each municipality.

Table 5.4.6-13. 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	500-Year
Bass River Township	$592,479,667	$63,734	$1,086,271	$1,198,399
Beverly City	$307,500,140	$17,881	$303,079	$2,673,508
Bordentown City	$744,949,381	$35,102	$218,329	$2,897,951
Bordentown Township	$1,674,099,210	$74,182	$506,809	$5,817,204
Burlington City	$1,962,644,603	$88,160	$1,233,308	$10,871,676
Burlington Township	$5,000,155,300	$246,204	$3,366,026	$29,584,190
Chesterfield Township	$1,400,485,206	$83,460	$433,408	$4,529,647
Cinnaminson Township	$3,443,136,617	$135,322	$3,490,709	$25,509,624
Delanco Township	$918,559,858	$53,304	$980,085	$8,442,694
Delran Township	$3,217,120,782	$156,070	$3,375,285	$26,921,484
Eastampton Township	$1,060,270,313	$66,988	$988,097	$5,331,464
Edgewater Park Township	$1,457,974,255	$74,005	$1,072,498	$11,983,371
Evesham Township	$9,168,653,192	$538,952	$19,599,968	$66,107,914
Fieldsboro Borough	$84,982,564	$4,029	$29,766	$321,067
Florence Township	$1,673,982,403	$79,656	$824,115	$7,802,946

Municipality	Total Replacement Cost Value (Structure Only)	Estimated Total Damages*		
		Annualized Loss	100-Year	500-Year
Hainesport Township	$2,080,207,178	$102,159	$2,095,234	$10,689,794
Lumberton Township	$3,424,896,916	$237,536	$4,488,461	$20,719,417
Mansfield Township	$2,285,414,884	$111,611	$923,477	$7,898,645
Maple Shade Township	$2,679,790,126	$122,981	$3,376,477	$25,403,710
Medford Lakes Borough	$837,422,542	$62,146	$2,155,908	$5,295,461
Medford Township	$7,999,936,346	$516,992	$17,479,571	$46,668,322
Moorestown Township	$6,109,599,449	$278,625	$7,018,194	$43,702,347
Mount Holly Township	$2,150,068,863	$120,881	$2,113,887	$10,559,089
Mount Laurel Township	$9,343,991,534	$513,276	$14,358,752	$67,873,218
New Hanover Township	$1,546,232,618	$41,619	$274,549	$1,101,525
North Hanover Township	$1,729,559,019	$102,338	$476,842	$3,790,566
Palmyra Borough	$1,106,819,144	$49,933	$1,324,046	$10,846,848
Pemberton Borough	$207,432,867	$12,225	$178,587	$715,940
Pemberton Township	$5,772,021,833	$452,382	$5,347,002	$18,058,353
Riverside Township	$1,276,520,301	$54,671	$1,115,625	$9,549,798
Riverton Borough	$585,858,006	$32,130	$781,439	$6,782,962
Shamong Township	$1,696,218,832	$142,126	$4,465,749	$7,373,057
Southampton Township	$3,975,061,802	$295,912	$5,161,880	$17,209,412
Springfield Township	$2,223,461,090	$143,137	$1,337,822	$8,912,525
Tabernacle Township	$2,175,794,267	$162,814	$3,544,784	$6,655,568
Washington Township	$357,333,022	$40,123	$743,863	$823,158
Westampton Township	$2,487,347,035	$107,267	$1,655,690	$10,595,342
Willingboro Township	$5,281,247,833	$285,919	$5,544,354	$36,200,597
Woodland Township	$888,068,601	$63,541	$905,985	$1,030,013
Wrightstown Borough	$223,368,035	$10,150	$54,172	$413,181
Burlington County	**$101,150,665,635**	**$5,779,543**	**$124,430,102**	**$588,861,987**

Source: HAZUS-MH 4.0

**The Total Damages column represents the sum of damages for all occupancy classes (residential, commercial, industrial, agricultural, educational, religious and government) based on replacement cost value.*

The total damage to buildings (structure only) for all occupancy types across Burlington County is estimated to be $124.4 million for the 100-year MRP wind-only event, and approximately $588.9 million for the 500-year MRP wind-only event. The majority of these losses are to the residential building category. Refer to Figure 5.4.6-8 and Figure 5.4.6-9 that illustrate the density estimated building loss across Burlington County for these two events.

Because of differences in building 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. The damage counts include

buildings damaged at all severity levels from minor damage to total destruction. Total dollar damage reflects the overall impact to buildings at an aggregate level.

Annualized losses were also examined for Burlington County. A total of $5.8 million is estimated as the annualized loss for the entire County; see Table 5.4.6-15 above. Please note that annualized loss does not predict what losses will occur in any particular year.

To estimate potential building exposure to storm surge, the SLOSH inundation zones were used. The estimated total general building stock exposure to the Category 1 through 4 inundation zones is summarized in Table 5.4.6-16 and Table 5.4.6-17 by municipality.

Table 5.4.6-14. 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
Bass River Township	$1,027,917,130	$158,298,365	15.4%	$660,059,671	64.2%	$720,105,461	70.1%	$851,567,867	82.8%
Beverly City	$471,487,138	$0	0.0%	$0	0.0%	$0	0.0%	$0	0.0%
Bordentown City	$1,244,995,904	$0	0.0%	$0	0.0%	$0	0.0%	$0	0.0%
Bordentown Township	$2,820,041,247	$3,557,712	0.1%	$3,557,712	0.1%	$3,557,712	0.1%	$3,557,712	0.1%
Burlington City	$3,215,233,092	$2,924,761	0.1%	$2,924,761	0.1%	$2,924,761	0.1%	$55,924,247	1.7%
Burlington Township	$8,013,259,672	$4,721,750	0.1%	$4,721,750	0.1%	$25,476,505	0.3%	$193,652,531	2.4%
Chesterfield Township	$2,443,294,418	$0	0.0%	$0	0.0%	$0	0.0%	$0	0.0%
Cinnaminson Township	$5,703,895,752	$316,061	0.0%	$316,061	0.0%	$1,216,651	0.0%	$184,269,672	3.2%
Delanco Township	$1,422,201,479	$0	0.0%	$0	0.0%	$0	0.0%	$2,029,502	0.1%
Delran Township	$5,145,622,596	$19,748,928	0.4%	$19,784,149	0.4%	$19,784,149	0.4%	$23,731,659	0.5%
Eastampton Township	$1,687,017,512	$0	0.0%	$0	0.0%	$0	0.0%	$0	0.0%
Edgewater Park Township	$2,307,285,215	$409,975	0.0%	$409,975	0.0%	$409,975	0.0%	$409,975	0.0%
Evesham Township	$14,666,082,424	$0	0.0%	$0	0.0%	$0	0.0%	$0	0.0%
Fieldsboro Borough	$139,371,126	$0	0.0%	$0	0.0%	$0	0.0%	$0	0.0%
Florence Township	$2,787,263,607	$0	0.0%	$0	0.0%	$0	0.0%	$0	0.0%
Hainesport Township	$3,447,208,735	$0	0.0%	$49,175,941	1.4%	$66,166,291	1.9%	$168,080,161	4.9%
Lumberton Township	$5,459,557,257	$0	0.0%	$25,769,841	0.5%	$29,675,257	0.5%	$156,132,285	2.9%
Mansfield Township	$4,056,501,589	$0	0.0%	$147,168	0.0%	$147,168	0.0%	$147,168	0.0%
Maple Shade Township	$4,385,500,913	$0	0.0%	$0	0.0%	$0	0.0%	$18,354,028	0.4%
Medford Lakes Borough	$1,280,050,871	$0	0.0%	$0	0.0%	$0	0.0%	$0	0.0%
Medford Township	$12,845,907,494	$0	0.0%	$0	0.0%	$0	0.0%	$1,385,744	0.0%
Moorestown Township	$10,108,801,626	$0	0.0%	$0	0.0%	$0	0.0%	$45,372,669	0.4%
Mount Holly Township	$3,498,352,996	$0	0.0%	$669,667	0.0%	$669,667	0.0%	$15,933,343	0.5%
Mount Laurel Township	$14,653,800,804	$0	0.0%	$9,110,792	0.1%	$9,178,026	0.1%	$15,271,999	0.1%
New Hanover Township	$3,022,835,486	$0	0.0%	$0	0.0%	$0	0.0%	$0	0.0%

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
North Hanover Township	$3,079,878,987	$0	0.0%	$0	0.0%	$0	0.0%	$0	0.0%
Palmyra Borough	$1,788,398,557	$316,731	0.0%	$496,314	0.0%	$19,205,603	1.1%	$778,171,913	43.5%
Pemberton Borough	$345,869,906	$0	0.0%	$0	0.0%	$0	0.0%	$0	0.0%
Pemberton Township	$9,374,914,679	$0	0.0%	$0	0.0%	$0	0.0%	$0	0.0%
Riverside Township	$2,039,139,951	$489,249	0.0%	$489,249	0.0%	$489,249	0.0%	$489,249	0.0%
Riverton Borough	$916,434,789	$41,731	0.0%	$41,731	0.0%	$2,971,394	0.3%	$489,758,472	53.4%
Shamong Township	$2,738,384,433	$0	0.0%	$0	0.0%	$0	0.0%	$0	0.0%
Southampton Township	$6,722,347,774	$0	0.0%	$0	0.0%	$0	0.0%	$0	0.0%
Springfield Township	$3,853,514,909	$0	0.0%	$0	0.0%	$0	0.0%	$0	0.0%
Tabernacle Township	$3,619,040,765	$0	0.0%	$0	0.0%	$0	0.0%	$0	0.0%
Washington Township	$597,426,933	$60,357,747	10.1%	$173,621,591	29.1%	$212,219,319	35.5%	$270,623,322	45.3%
Westampton Township	$4,269,433,407	$0	0.0%	$5,727,866	0.1%	$6,557,877	0.2%	$27,345,533	0.6%
Willingboro Township	$8,259,747,413	$3,430,398	0.0%	$3,430,398	0.0%	$3,430,398	0.0%	$11,859,768	0.1%
Woodland Township	$1,656,748,246	$0	0.0%	$0	0.0%	$0	0.0%	$0	0.0%
Wrightstown Borough	$411,963,035	$0	0.0%	$0	0.0%	$0	0.0%	$0	0.0%
Burlington County	**$165,526,729,867**	**$254,613,407**	**0.2%**	**$960,454,636**	**0.6%**	**$1,124,185,463**	**0.7%**	**$3,314,068,818**	**2.0%**

Source: FEMA 2012, Burlington County
Note: The SLOSH boundaries were overlaid on the custom general building stock inventory; the structures with their centroids within the hazard are were totaled for each municipality.

Table 5.4.6-15. 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
Bass River Township	1,863	217	11.6%	1,032	55.4%	1,203	64.6%	1,576	84.6%
Beverly City	964	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Bordentown City	1,219	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Bordentown Township	3,113	4	0.1%	4	0.1%	4	0.1%	4	0.1%
Burlington City	3,644	7	0.2%	7	0.2%	7	0.2%	43	1.2%
Burlington Township	7,757	2	0.0%	2	0.0%	14	0.2%	283	3.6%
Chesterfield Township	2,093	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Cinnaminson Township	6,358	1	0.0%	1	0.0%	2	0.0%	219	3.4%
Delanco Township	1,562	0	0.0%	0	0.0%	0	0.0%	9	0.6%
Delran Township	5,191	7	0.1%	8	0.2%	8	0.2%	15	0.3%
Eastampton Township	2,499	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Edgewater Park Township	2,567	2	0.1%	2	0.1%	2	0.1%	2	0.1%
Evesham Township	14,319	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Fieldsboro Borough	242	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Florence Township	2,522	0	0.0%	0	0.0%	0	0.0%	0	0.0%

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
Hainesport Township	2,747	0	0.0%	27	1.0%	29	1.1%	101	3.7%
Lumberton Township	4,009	0	0.0%	29	0.7%	38	0.9%	194	4.8%
Mansfield Township	2,798	0	0.0%	1	0.0%	1	0.0%	1	0.0%
Maple Shade Township	6,006	0	0.0%	0	0.0%	0	0.0%	27	0.4%
Medford Lakes Borough	1,909	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Medford Township	10,627	0	0.0%	0	0.0%	0	0.0%	3	0.0%
Moorestown Township	8,736	0	0.0%	0	0.0%	0	0.0%	77	0.9%
Mount Holly Township	4,573	0	0.0%	1	0.0%	1	0.0%	12	0.3%
Mount Laurel Township	12,900	0	0.0%	2	0.0%	3	0.0%	20	0.2%
New Hanover Township	1,964	0	0.0%	0	0.0%	0	0.0%	0	0.0%
North Hanover Township	2,901	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Palmyra Borough	2,713	2	0.1%	3	0.1%	8	0.3%	1,074	39.6%
Pemberton Borough	514	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Pemberton Township	13,511	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Riverside Township	2,868	3	0.1%	3	0.1%	3	0.1%	3	0.1%
Riverton Borough	1,274	1	0.1%	1	0.1%	2	0.2%	544	42.7%
Shamong Township	3,623	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Southampton Township	7,982	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Springfield Township	2,876	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Tabernacle Township	4,452	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Washington Township	939	111	11.8%	305	32.5%	372	39.6%	496	52.8%
Westampton Township	3,006	0	0.0%	4	0.1%	8	0.3%	34	1.1%
Willingboro Township	12,395	4	0.0%	4	0.0%	4	0.0%	13	0.1%
Woodland Township	1,323	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Wrightstown Borough	485	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Burlington County	**173,044**	**361**	**0.2%**	**1,436**	**0.8%**	**1,709**	**1.0%**	**4,750**	**2.7%**

Source: FEMA 2012, Burlington County
Note: The SLOSH boundaries were overlaid on the custom general building stock inventory; the structures with their centroids within the hazard are were totaled for each municipality.

Figure 5.4.6-11. Density of Losses for Structures (All Occupancies) for the 100-Year MRP Wind Event

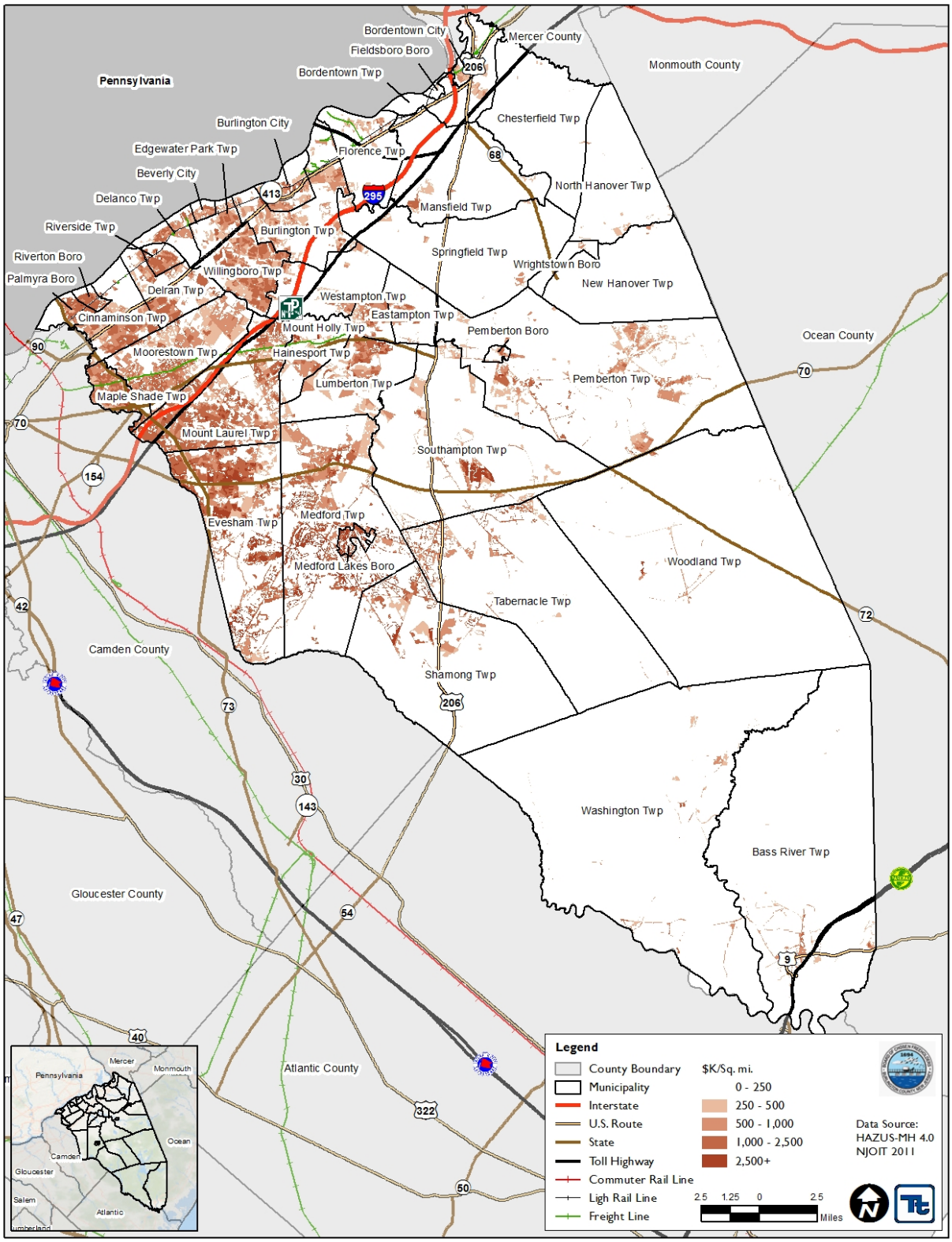
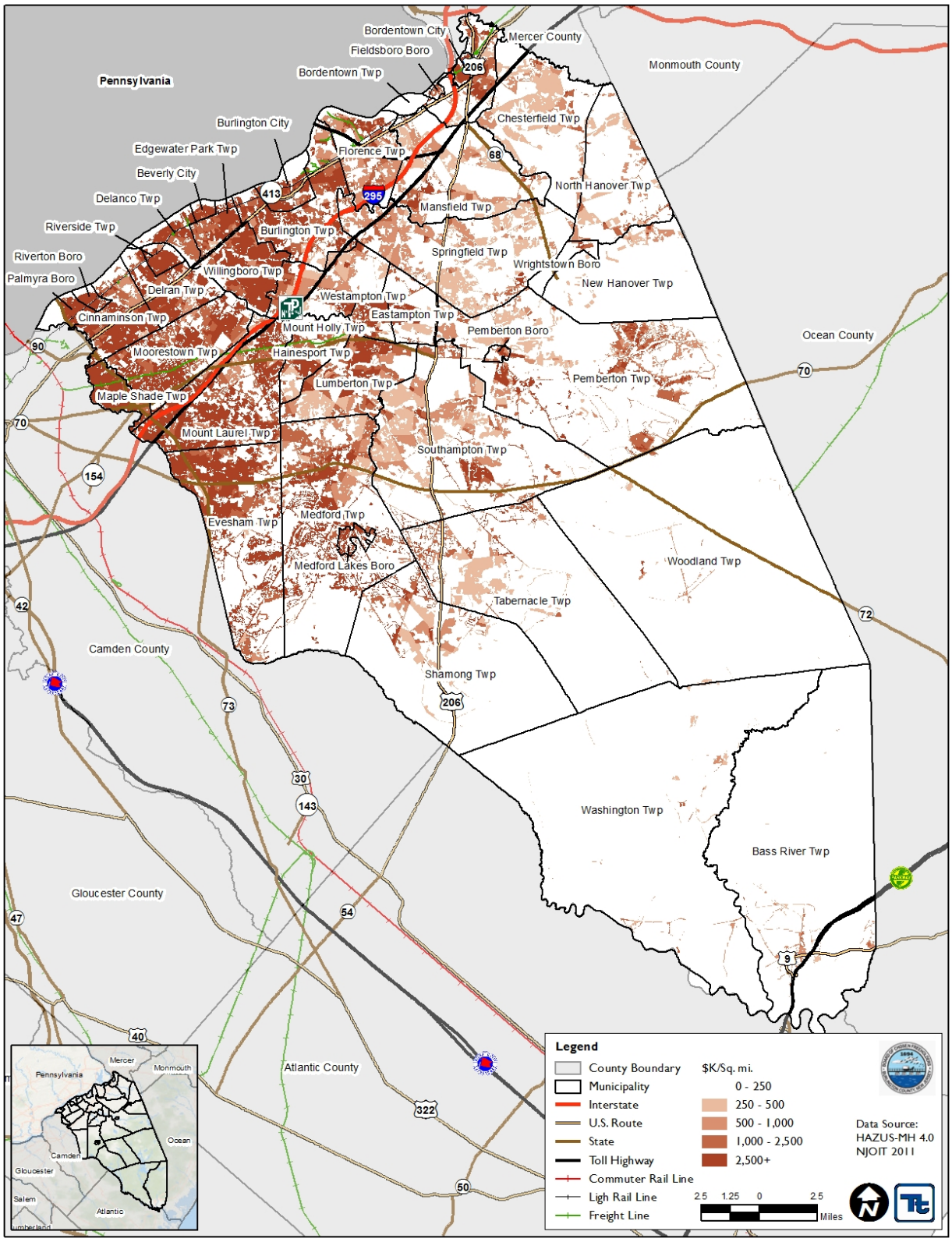


Figure 5.4.6-12. Density of Losses for Structures (All Occupancies) for the 500-Year MRP Wind Event



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. Loss of service can impact residents 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 impact other public utilities, including potable water and wastewater treatment and communications. In addition to public water services, property owners with private wells may not have access to potable water either until power is restored. Lack of power to emergency facilities, including police, fire, EMS, and hospitals, will inhibit a community's ability to effective respond to an event and maintain the safety of its citizens.

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, appliances, etc. Similarly, heavy snowfall and ice storms, associated with extreme cold temperature events, can cause power interruption as well. Backup power is recommended for critical facilities and infrastructure.

HAZUS-MH 4.0 estimates the probability that critical facilities (i.e., medical facilities, fire/EMS, police, EOC, schools, and user-defined facilities such as shelters and municipal buildings) may sustain damage as a result of 100-year and 500-year MRP wind-only events. Additionally, HAZUS-MH 4.0 estimates the loss of use for each facility in number of days. HAZUS-MH 4.0 estimates that critical facilities in Burlington 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. Table 5.4.6-19 summarizes the estimated impacts to critical facilities as a result of the 500-year MRP event.

At this time, HAZUS-MH 4.0 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.

The critical facilities and utilities located in the Category 1 through 4 inundation zones are summarized in Table 5.4.6-18 by municipality. Overall, County buildings and dams are the most exposed facility types for each of the SLOSH categories.

Table 5.4.6-16. Number of Critical Facilities Located in the SLOSH Inundation Zones

Municipality	Facility Types																				
	Airport	Business/Industry	Chemical	County	Dam	Daycare	EMS	EOC	Fire	Hazmat	Intermodal Transit	Library	Light Rail	Municipal Hall	Police	Potable Pump Station	School	Senior	Shelter	Substation	Tier II Facility	Wastewater Treatment Plant
Category 1																						
Bass River Township	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cinnaminson Township	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Washington Township	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0
Burlington County	**0**	**1**	**0**	**1**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**0**
Category 2																						
Bass River Township	0	0	1	10	0	0	0	1	1	0	0	1	0	1	0	0	1	0	1	0	0	0
Cinnaminson Township	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hainesport Township	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lumberton Township	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Washington Township	1	1	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	1	0	0	0
Burlington County	**2**	**1**	**1**	**10**	**3**	**0**	**0**	**1**	**1**	**0**	**0**	**1**	**0**	**2**	**1**	**0**	**1**	**0**	**2**	**0**	**0**	**0**
Category 3																						
Bass River Township	0	0	1	10	1	0	0	1	1	0	0	1	0	1	0	0	2	0	1	0	0	0
Burlington Township	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Cinnaminson Township	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hainesport Township	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lumberton Township	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Washington Township	1	1	0	0	2	0	1	0	2	0	0	0	0	1	1	0	0	0	4	0	0	0
Burlington County	**2**	**1**	**1**	**10**	**6**	**0**	**1**	**1**	**3**	**0**	**0**	**1**	**0**	**2**	**1**	**0**	**2**	**0**	**5**	**0**	**0**	**1**
Category 4																						
Bass River Township	0	0	1	10	1	0	0	1	1	0	0	1	0	1	0	0	2	0	1	0	0	0

Table 5.4.6-16. Number of Critical Facilities Located in the SLOSH Inundation Zones

Municipality	Facility Types																				
	Airport	Business/Industry	Chemical	County	Dam	Daycare	EMS	EOC	Fire	Hazmat	Intermodal Transit	Library	Light Rail	Municipal Hall	Police	Potable Pump Station	School	Senior	Shelter	Substation	Tier II Facility	Wastewater Treatment Plant
Burlington City	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0
Burlington Township	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Cinnaminson Township	0	0	3	0	3	0	0	0	0	0	2	0	1	0	0	0	0	0	0	1	0	1
Hainesport Township	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lumberton Township	1	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Medford Township	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Moorsetown Township	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mount Holly Township	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Mount Laurel Township	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Palmyra Borough	0	4	0	1	0	1	0	0	0	0	0	0	0	0	1	0	2	0	0	0	0	1
Riverton Borough	0	0	1	2	0	0	0	1	1	0	0	1	0	1	1	0	2	1	1	0	1	1
Washington Township	1	1	0	0	2	0	1	0	2	0	0	0	0	1	1	0	1	0	5	0	0	0
Burlington County	**2**	**5**	**6**	**14**	**9**	**1**	**1**	**2**	**5**	**1**	**2**	**2**	**1**	**3**	**3**	**1**	**7**	**1**	**7**	**1**	**2**	**5**

Source: FEMA 2012, Burlington County

Table 5.4.6-17. Estimated Impacts to Critical Facilities for the 500-Year Mean Return Period Hurricane-Related Winds

Facility Type	500-Year Event				
	Loss of Days	Percent-Probability of Sustaining Damage			
		Minor	Moderate	Severe	Complete
EOC	0	1-10	0-2	0	0
Medical	0	0-5	0-1	0	0
Police	0	2-10	0-2	0	0
Fire	0	0-5	0-1	0	0
Schools	0	0-9	1-6	0	0

Source: HAZUS-MH 4.0

Impact on Economy

Severe weather events can have impacts on the economy, including loss of business function and damage/loss of inventory. Business-owners may 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). The agricultural industry is most at risk in terms of economic impact and damage due to extreme temperature events. Extreme heat events can result in drought and dry conditions and directly impact livestock and crop production. See the Impact on the Economy section of the drought hazard profile (Section 5.4.2) for information regarding the impact on the agriculture as result of a drought in the county.

For the 100-year MRP wind event, HAZUS-MH 4.0 estimates approximately $1.3 million in business interruption costs (income loss, relocation costs, rental costs and lost wages) and less than $1,000 inventory losses. For the 500-year MRP wind only event, HAZUS-MH 4.0 estimates approximately $25.6 million in business interruption losses for the County, which includes loss of income, relocation costs, rental costs and lost wages, in addition to approximately $395 thousand in inventory losses.

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 4.0 also estimates the amount of debris that may be produced a result of the 100- and 500-year MRP wind events. HAZUS-MH 4.0 estimates that no debris will be generated as a result of the 100-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 5.4.6-20 summarizes debris production estimates for 500-year MRP wind events.

Table 5.4.6-18. Debris Production for 100- and 500-Year Mean Return Period Hurricane-Related Winds

Mean Return Period	Brick and Wood (tons)	Concrete and Steel (tons)	Tree (tons)	Eligible Tree Volume (cubic yards)
100-year MRP	3,340	0	94,923	117,837
500-year MRP	32,274	3	210,661	414,670

Source: HAZUS-MH 4.0

Future Growth and Development

As discussed and illustrated in Sections 4 and 9, areas targeted for future growth and development have been identified across the county. Any areas of growth could be potentially impacted by the severe weather hazard because the entire Planning Area is exposed and vulnerable to the impacts associated with these events. The development of new buildings in these areas must meet or exceed the standards in Section R301.2.1.1 of the International Building Code (IBC) which will assist with mitigating future potential damages and losses. Any areas of growth could be potentially impacted by the extreme temperature hazard because the entire county is exposed and vulnerable. Areas targeted for potential future growth and development in the next five (5) years have been identified across the county at the jurisdiction level. Refer to the jurisdictional annexes in Volume II of this HMP.

As for new development located in the SLOSH boundaries, there are 21 developments located in the Category 1 through Category 4 SLOSH boundaries; 7 properties in Category 1, 3 properties in Category 2, 2 properties in Category 3, and 9 properties in Category 4. Of the 21 developments, the Township of Mount Laurel has the most located in the Category 1 through Category 4 SLOSH boundaries with 4 developments exposed. Refer to Figure 5.4.6-13 for a map of proposed new development and the landslide susceptibility areas of Burlington County.

Effect of Climate Change on Vulnerability

Climate is defined not simply as average temperature and precipitation but also by the type, frequency and intensity of weather events. Both globally and at the local scale, climate change has the potential to alter the prevalence and severity of events like hurricanes. While predicting changes to the prevalence or intensity of hurricanes and the events affects 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).

Climate Change in New Jersey: Trends and Projections describes changes in temperature, precipitation, and sea level rise. Each section of the report summarizes observed recent changes in climate in New Jersey. Observations are based on recorded climate data collected by the ONJSC and other institutions, and on other reports summarizing climate change in the northeastern United States. Each section also presents a synthesis of the most current projections for future climate changes based on climate science modeling and techniques. The projections reflect potential average climate over a span of future years (2020, 2050, and 2080). The projections in the report illustrate the potential climate changes that could impact the northeastern United States based on future emissions scenarios (A2, A1B, and B1 – high, medium, and low scenarios). Each emissions scenario would result in a range of potential climate outcomes in the State (Rutgers 2013).

In the coming years, most studies project that the State of New Jersey can expect an increase in average annual temperature, and steady or increasing amounts of precipitation with more rain in the winter. More frequent extreme events are likely, including heat waves, short-term droughts, and extreme precipitation events with

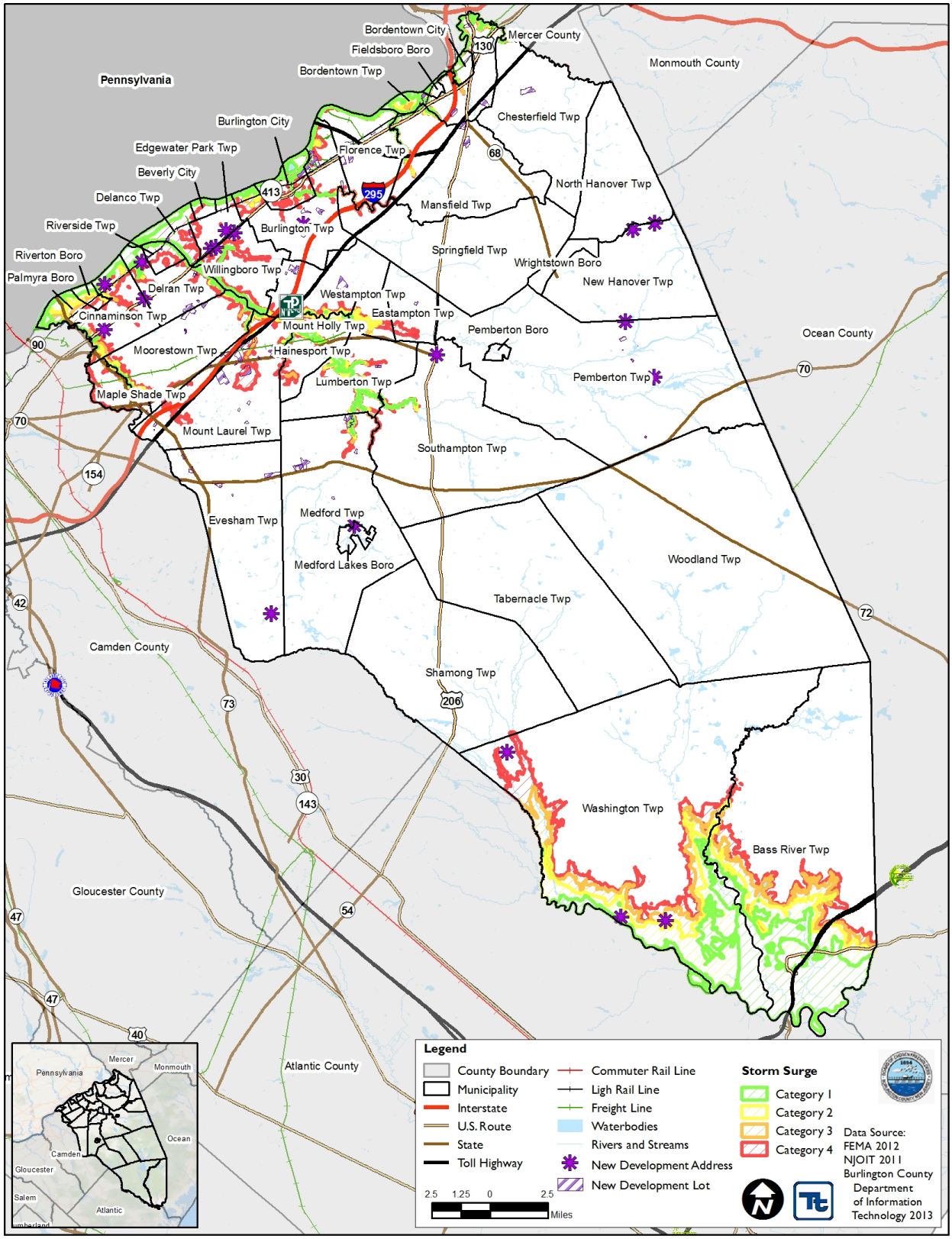
subsequent flooding. Sea level rise in New Jersey is already occurring faster than the global average rate because of land subsidence and ground water withdrawal, and a continued rate of rise is expected to lead to more frequent and more severe coastal flooding events, including those associated with hurricane and tropical storms (Rutgers 2013).

The increase in the number of extreme heat days will lead to more heat related illness. Also, with an increase in severe weather events there will be an increase in stormwater runoff which may be polluted and sicken individuals (Kaplan and Herb 2012). The effect on public health will likely increase the need for vulnerable population planning and may place heavier burdens on the healthcare system.

Change of Vulnerability Since 2014 HMP

Burlington County and its municipalities continue to be vulnerable to the hurricane and tropical storm hazard. However, there are several differences between the exposure and potential loss estimates between the 2019 HMP update and the results in the original 2014 HMP. Their differences are due to changes in the HAZUS-MH model and updated building stock and critical facility inventories. For this plan update, the HAZUS-MH 4.0 hurricane model was run for the entire county at the block level and results reported at the municipal level. HAZUS-MH version 4.0 was utilized for this plan update; the hurricane model has been enhanced since the 2014 HMP. Overall, this vulnerability assessment uses a more accurate and updated building inventory which provides more accurate estimated exposure and potential losses for Burlington County.

Figure 5.4.6-13. Potential New Development and SLOSH Hazard Boundaries



5.4.7 SEVERE WINTER WEATHER

The following section provides the hazard profile (hazard description, location, extent, previous occurrences and losses, probability of future occurrences, and impact of climate change) and vulnerability assessment for the severe winter weather hazard in Burlington County.

2019 HMP UPDATE CHANGES

- For the 2019 HMP update, the severe winter weather hazard groups together heavy snow, Nor'Easters, blizzards, freezing rain/sleet, and ice storms. The hazard profile has been significantly enhanced to include a detailed hazard description, location, extent, previous occurrences, probability of future occurrence, and potential change in climate and its impacts on the severe weather hazard is discussed.
- New and updated figures from federal and state agencies are incorporated.
- Previous occurrences were updated with events that occurred between 2013 and 2017.
- A vulnerability assessment was conducted for the severe winter weather hazard; it directly follows the hazard profile.

5.4.7.1 PROFILE

Hazard Description

A winter storm is a weather event in which the main types of precipitation are snow, sleet or freezing rain. They can be a combination of heavy snow, blowing snow, and/or dangerous wind chills. There are three basic components needed to make a winter storm. Below freezing temperatures (cold air) in the clouds and near the ground are necessary to make snow and ice. Lift, something to raise the moist air to form clouds and cause precipitation, is needed. Examples of this is warm air colliding with cold air and being forced to rise over the cold dome or air flowing up a mountainside. The last thing needed to make a winter storm is moisture to form clouds and precipitation. Air blowing across a body of water, such as a large lake or the ocean (National Severe Storms Laboratory 2018).

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 Burlington County, winter storms include blizzards, snow storms, freezing rain/sleet, Nor'Easters and ice storms.

Blizzards

A blizzard is a severe storm condition characterized by low temperatures, strong winds, and heavy snow. The difference between a blizzard and a snowstorm is the strength of the wind. The general definition of a blizzard is a storm with considerable falling or blowing snow and winds in excess of 35 mph and visibilities of less than ¼ mile for at least three hours (NWS 2011).

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°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 a snow crystals or snow

pallet, which then falls to the earth. Snow falls in different forms: 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, which are below freezing but remain a liquid. The cloud droplets then freeze to the crystals. Sleet is made up of drops of rain that freeze into ice as they fall through colder air layers. They are usually smaller than 0.30 inches in diameter (NSIDC 2018).

Freezing Rain / Sleet

Sleet is defined as pellets of ice composed of frozen or mostly frozen raindrops or refrozen partially melted snowflakes. These pellets of ice usually bounce after hitting the ground or other hard surfaces. Heavy sleet is a relatively rare event defined as an accumulation of ice pellets covering the ground to a depth of a ½" or more. Freezing rain is rain that falls as a liquid but freezes into glaze upon contact with the ground (NWS 2018).

Nor'Easters

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 (NWS 2018).

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)

Nor'Easters are a common winter occurrence in New Jersey. New Jersey may be impacted by 10 to 20 Nor'Easters each year, with approximately five to 10 of those having significant impact to the State. These storms repeatedly result in flooding, wave and erosion damage to structures, and erosion of natural resources, such as beaches, dunes, and coastal bluffs. The erosion of coastal features commonly results in greater potential for damage to shoreline development from future storms. While some of the most devastating effects of Nor'Easters are experienced in coastal areas (e.g. beach erosion, coastal flooding), the effects on inland areas, like Burlington County, may include heavy snow, strong winds and blizzards (Burlington County 2014).

Ice Storms

An ice storm is used to describe occasions when damaging accumulations of ice are expected during freezing rain situations. Significant accumulations of ice pull down trees and utility lines resulting in loss of power and communication. These accumulations of ice make walking and driving extremely dangerous. Significant ice accumulations are usually accumulations of a ¼" or greater (NWS 2018).

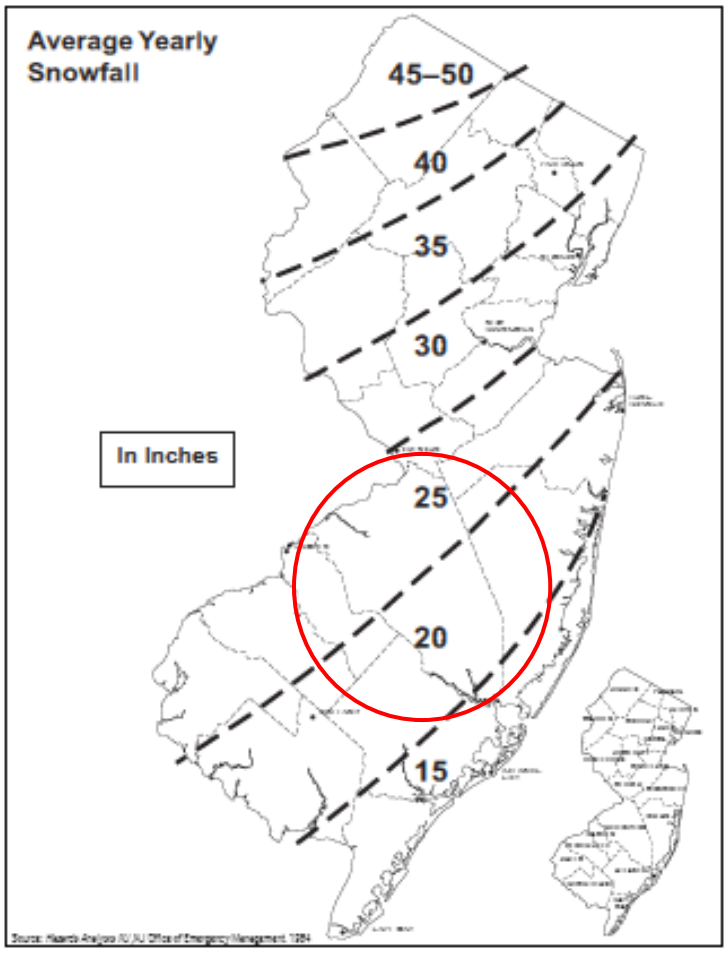
Location

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.

Severe winter weather events impact the entire county. Overall, normal seasonal snowfall in New Jersey ranges from 14.9 inches in Cape May County to over 40 inches in Sussex County (ONJSC 2018). For Burlington County, average annual snowfall ranges from a low of approximately 15 inches in the extreme southern portion of the county, to a high of roughly 25 inches in northwestern areas nearest the Delaware River (see Figure 5.4.7-1). This can vary greatly from one year to the next, particularly if several major extended-period storms impact the area (during which snowfall totals can approach or exceed annual averages) (Burlington County HMP, 2008).

Figure 5.4.7-1. Average Yearly Snowfall for New Jersey



Source: *NJOEM, 2012*
Note: *Red circle indicates approximate location of Burlington County*

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, and time of occurrence during the day (e.g., weekday versus weekend), and time of season.

The extent of a severe winter storm can be classified by meteorological measurements and by evaluating its societal impacts. NOAA's National Centers for Environmental Information (NCEI) is currently producing 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. It is 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) (NOAA-NCEI 2018). Table 5.4.7-1 presents the five RSI ranking categories.

Table 5.4.7-1. RSI Ranking Categories

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

Source: NOAA-NCEI 2018
RSI Regional Snowfall Index

The NWS operates a widespread network of observing 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 what will happen next, ranging from hours to days. The models are then analyzed by NWS meteorologists who then write and disseminate forecasts (NWS 2013).

The NWS uses winter weather watches, warnings and advisories to ensure that people know what to expect in the coming hours and days. A winter storm watch is issued by the National Weather Service when there is a potential for heavy snow or significant ice accumulations, usually at least 24 to 36 hours in advance. A watch is upgraded to a winter storm warning when a winter storm is producing or is forecast to produce heavy snow or significant ice accumulations. The criteria for a winter storm watch and winter storm warning can vary from place to place (NWS 2018). They are usually issued 12 to 24 hours before the event is expected to begin. Winter weather advisories are issued when a low-pressure system produces a combination of winter weather (snow, freezing rain, sleet, etc.) that present a hazard, but does not meet warning criteria. The NWS may also issue a blizzard warning when snow and strong winds combine and produce a blinding snow, deep drifts, and wind chill (NWS 2018).

Previous Occurrences and Losses

Many sources provided winter storm information regarding previous occurrences and losses associated with winter storm events throughout Burlington County. With so many sources reviewed for the purpose of this HMP update, loss and impact information for many events may 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, FEMA included the State of New Jersey in 10 winter-storm related major disaster (DR) or emergency (EM) declarations. These events were classified as one or a combination of the following incidents: severe winter storm, snowstorm, snow, severe winter coastal storm, high winds, flooding, blizzard, and ice conditions. Generally, these disasters cover a wide region of the State; therefore, they may have impacted many counties. Burlington County was included in nine of these declarations. Since the 2014 HMP, the County has been included in FEMA disaster declarations for two additional declarations. Table 5.4.7-2 lists FEMA DR and EM declarations from January 2012 to May 2019 for this HMP Update.

Table 5.4.7-2. FEMA Declarations Since 2012 for Severe Winter Storm Events in Burlington County

FEMA Declaration Number	Date(s) of Event	Event Type	Counties Included
DR-4264	January 22-24, 2016	Severe Winter Storm and Snowstorm	Atlantic, Bergen, Burlington, Camden, Cape May, Cumberland, Essex, Hudson, Hunterdon, Mercer, Middlesex, Monmouth, Morris, Ocean, Somerset, Union, and Warren
DR-4368	March 6-7, 2018	Severe Winter Storm and Snowstorm	Bergen, Burlington, Essex, Morris, Passaic, and Somerset

Source: FEMA 2018

Agriculture-related severe winter weather disasters are quite common. One-half to two-thirds of the counties in the U.S. have been designated as disaster areas in each of the past several years. The USDA Secretary of Agriculture 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 2012 and 2018, New Jersey has been included in two USDA winter weather-related declarations. Burlington County was included in one of these declarations, to date.

- S3487 – June-November 2012 – disaster declared as a result of the combined effects of drought, high winds (derecho), hail, excessive heat, excessive rain, flash flooding, Hurricane Sandy, a snowstorm, and a Nor'Easter; over $62,000 in claims filed in Burlington County

For this 2019 HMP update, winter weather events were summarized from 2013 to 2018. For events prior to 2013, refer to Appendix G (Supplementary Data). Known winter storm events, including FEMA disaster declarations, which have impacted Burlington County are identified in Table 5.4.7-3. For detailed information on damages and impacts for each municipality, refer to Section 9 (Annexes). Please note that not all events that have occurred in Burlington County are included due to the extent of documentation and the fact that not all sources may have been identified or researched. Loss and impact information 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.

Table 5.4.7-3. Severe Winter Weather Events in Burlington County, 2013 to 2018

Date(s) of Event	Event Type	FEMA Declaration Number (if applicable)	County Designated?	Losses / Impacts
January 6, 2013	Winter Weather	N/A	N/A	A return southwest flow of relatively milder air caused a light accumulating snow (near an inch) to occur along and just to the east of the Interstate 95 corridor in the central third of New Jersey during the early morning of the 6th. Less snow fell elsewhere in the state. The combination of the snow itself and temperatures falling to or below the freezing mark once the snow began falling caused slippery travel to occur mainly on untreated less traveled roadways as well as bridges and overpasses. The snow fell between 2 a.m. EST and 6 a.m. EST on the 6th. Representative snowfall included 0.8 inches in Moorestown Township (Burlington County) and 0.7 inches in Tabernacle Township (Burlington County).
January 21, 2013	Winter Weather	N/A	N/A	Snow showers, which were briefly heavy, followed a cold frontal passage and caused quick accumulations of 1 to 3 inches in central and southern New Jersey. The heaviest snowfall occurred along and to the east of the Interstate 95 corridor. Snow began falling between 630 p.m. EST and 8 p.m. EST that evening and fell heavy at times between 730 p.m. EST and 9 p.m. EST when visibilities were around one-quarter of a mile. The steady snow ended by 10 p.m. EST that evening. Temperatures quickly fell below freezing after the snow started and untreated roads were hazardous, especially bridges and overpasses. Numerous accidents were reported between 8 p.m. EST and 1030 p.m. EST in central New Jersey. Accidents were reported from the local Philadelphia area northeast through Middlesex County. Representative snowfall included 1.4 inches in Westampton Township (Burlington County) and 1.2 inches in Maple Shade Township (Burlington County).
January 2-3, 2014	Heavy Snow	N/A	N/A	A winter storm dropped 5 to 9 inches of snow across most of New Jersey, except around 10 inches in northern Ocean County and in Monmouth County. This caused hazardous traveling conditions for the evening commute on the 2nd and the morning commute on the 3rd. Governor Chris Christie declared a state of emergency in New Jersey. New Jersey State Police reported about 250 storm related accidents and 900 calls from stranded motorists. In Burlington County, snowfall totals ranged from 7.2 inches in Tabernacle Township to 8.8 inches in Mount Laurel Township.
January 22-24, 2016	Severe Winter Storm and Snowstorm	DR-4264	Yes	Snow began falling during the Friday afternoon commute on January 22nd, then continued, heavy at times, Friday night into early Sunday morning. Wind gusts up to 60 MPH produced blizzard conditions as visibilities dropped to one-quarter mile or less in spots. At one point during the storm, up to 270,000 customers were without power. Outages were concentrated closer to the coast where the strongest winds occurred. On February 11, 2016, Governor Christie requested a major disaster declaration due to the storm. On March 14, 2016, President Obama declared that a major disaster existed in New Jersey for 17 counties, including Burlington County. In Burlington County, snowfall totals of 22.5 inches in Florence Township were recorded. The County

Date(s) of Event	Event Type	FEMA Declaration Number (if applicable)	County Designated?	Losses / Impacts
				reported $4.7 million spent on snow removal with $279,000 spent in Evesham Township and $189,000 spent in Mount Laurel Township.
March 6-7, 2018	Severe Winter Storm and Snowstorm	DR-4368	Yes	Precipitation gradually overspread the region during the overnight hours of March 6th to the 7th. To the east of the NJ Turnpike/Interstate 95, precipitation began as rain or a mix of rain and snow. Further west, precipitation fell mainly as snow. The snow contained large amounts of liquid, making it heavy and wet. This resulted in downed trees, limbs, and wires, leading to numerous power outages across portions of New Jersey, especially where the heaviest snow was reported. There were numerous reports of lightning associated with the precipitation in New Jersey, mainly southeast of the Turnpike. This included thunderstorms with heavy rainfall closer to the coast, and thunder with heavy snowfall further inland. Governor Phil Murphy declared a state of emergency which went into effect at 8 PM Tuesday March 6th. Flights were cancelled at all the major airports due to the storm, and Amtrak cancelled at least some Wednesday service. Precipitation fell as, or mixed with, rain during much of the event, limiting snowfall amounts to under 6 inches in most locations. Less than one inch of snow fell in areas closer to the coast.

Source: NOAA-NCEI 2018, FEMA 2018
DR Major Disaster Declaration (FEMA)
EM Emergency Disaster Declaration (FEMA)
FEMA Federal Emergency Management Agency
Mph miles per hour
NOAA National Oceanic and Atmospheric Administration
NCEI National Center for Environmental Information

Probability of Future Occurrences

Severe winter weather is a common occurrence each winter season in New Jersey. The majority of the State will receive at least one measurable snow event during the winter months. The months of January, February, March, April, October, November and December are typically when a vast majority of New Jersey has been observed to receive measurable snow. Generally, counties in the northern region experience more snow events than those in the southern region. It is estimated that Burlington County will continue to experience the direct and indirect impacts of severe winter weather events annually that many induce secondary hazards such as: structural damage (snow and ice load), wind damage, impact to life safety, disruption of traffic, loss of productivity, economic impact, loss of ability to evacuate, taxing first-responder capabilities, service disruption (power, water, etc.), and communication disruption.

According to the NOAA-NCEI storm events database, between 1950 and 2018, Burlington County has been impacted by 289 winter weather-related events (blizzard, heavy snow, ice storm, winter storm and winter weather). These events resulted in $6.1 million in property damage. The table below shows the probability of future occurrences for each type of severe winter weather event to occur in Burlington County. Based on data from NOAA-NCEI, Burlington County can expect an average of 4 winter storm-related events each year.

Table 5.4.7-4. Probability of Future Occurrence of Severe Winter Weather Events

Hazard Type	Number of Occurrences Between 1950 and 2018	Annual Number of Events (average)	Recurrence Interval* (in years)	Probability of Event Occurring in Any Given Year	Percent Chance of Occurring in Any Given Year
Blizzard	4	0.06	17.25	0.06	5.8%
Heavy Snow	51	0.75	1.35	0.74	73.9%
Ice Storm	1	0.01	69.0	0.01	1.5%
Winter Storm	51	0.75	1.35	0.74	73.9%
Winter Weather	182	2.68	0.38	2.64	100%

Source: NOAA-NCEI 2018
**Estimate of the likelihood of an event to occur*

In Section 5.3, the identified hazards of concern for Burlington 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 severe winter weather in the county is considered 'frequent' (likely to occur within 25 years, as presented in Table 5.3-3).

Climate Change Impacts

In the State of New Jersey, 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) has been observed. 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).

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 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 2010).

5.4.7.2 VULNERABILITY ASSESSMENT

All of Burlington 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 summarizes the estimated potential impacts of severe winter storm events on the County. Refer to Section 5.1 for additional details on the methodology used to assess severe winter storm risk.

Impact on Life, Health and Safety

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).

Heavy snow can immobilize a region and paralyze a city, stranding commuters, stopping the flow of supplies, and disrupting emergency and medical services. Accumulations of snow can collapse buildings and knock down trees and power lines. In rural areas, homes and farms may be isolated for days, and unprotected livestock may be lost. In the mountains, heavy snow can lead to avalanches. The cost of snow removal, repairing damages, and loss of business can have large economic impacts on cities and towns (NSSL, 2006).

Heavy accumulations of ice can bring down trees, electrical wires, telephone poles and lines, and communication towers. Communications and power can be disrupted for days while utility companies work to repair the extensive damage. Even small accumulations of ice may cause extreme hazards to motorists and pedestrians. Bridges and overpasses are particularly dangerous because they freeze before other surfaces (NSSL, 2006).

For the purposes of this HMP, the entire population of Burlington County (450,236 people) is exposed to severe winter storm events (U.S. Census, 2016). Snow accumulation and frozen/slippery road surfaces increase the frequency and impact of traffic accidents for the general population, resulting in personal injuries. Refer to Section 4 (County Profile) for population statistics for each participating municipality.

The elderly are considered most susceptible to this hazard due to their increased risk of injuries and death from falls and overexertion and/or hypothermia from attempts to clear snow and ice. In addition, severe winter storm events can reduce the ability of these populations to access emergency services. Residents with low incomes may not have access to housing or their housing may be less able to withstand cold temperatures (e.g., homes with poor insulation and heating supply).

Impact on General Building Stock

The entire general building stock inventory is exposed and vulnerable to the severe winter storm hazard; however, properties in poor condition or in particularly vulnerable locations may be at risk to the most damage. In general, structural impacts include damage to roofs and building frames, rather than building content. Table 5.4.7-5 presents the total exposure value (structure only) for the general building stock for each participating municipality.

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 5.4.7-5 below summarizes the estimated loss to structures as a result of 1-, 5- and 10-percent loss. Given professional knowledge and the currently available information, the potential loss for this hazard is many times considered to be overestimated because of varying factors (building structure type, age, load distribution, building codes in place, etc.). Therefore, the following information should be used as estimates only for planning purposes with the knowledge that the associated losses for severe winter storm events vary greatly.

Table 5.4.7-5. General Building Stock Exposure and Estimated Losses from Severe Winter Storm Events

Municipality	Total (All Occupancies)	1% Damage Loss Estimate	5% Damage Loss Estimate	10% Damage Loss Estimate
Bass River Township	$592,479,667	$5,924,797	$29,623,983	$59,247,967
Beverly City	$307,500,140	$3,075,001	$15,375,007	$30,750,014
Bordentown City	$744,949,381	$7,449,494	$37,247,469	$74,494,938
Bordentown Township	$1,674,099,210	$16,740,992	$83,704,961	$167,409,921
Burlington City	$1,962,644,603	$19,626,446	$98,132,230	$196,264,460
Burlington Township	$5,000,155,300	$50,001,553	$250,007,765	$500,015,530
Chesterfield Township	$1,400,485,206	$14,004,852	$70,024,260	$140,048,521
Cinnaminson Township	$3,443,136,617	$34,431,366	$172,156,831	$344,313,662
Delanco Township	$918,559,858	$9,185,599	$45,927,993	$91,855,986
Delran Township	$3,217,120,782	$32,171,208	$160,856,039	$321,712,078
Eastampton Township	$1,060,270,313	$10,602,703	$53,013,516	$106,027,031
Edgewater Park Township	$1,457,974,255	$14,579,743	$72,898,713	$145,797,426
Evesham Township	$9,168,653,192	$91,686,532	$458,432,660	$916,865,319
Fieldsboro Borough	$84,982,564	$849,826	$4,249,128	$8,498,256
Florence Township	$1,673,982,403	$16,739,824	$83,699,120	$167,398,240
Hainesport Township	$2,080,207,178	$20,802,072	$104,010,359	$208,020,718
Lumberton Township	$3,424,896,916	$34,248,969	$171,244,846	$342,489,692
Mansfield Township	$2,285,414,884	$22,854,149	$114,270,744	$228,541,488
Maple Shade Township	$2,679,790,126	$26,797,901	$133,989,506	$267,979,013
Medford Lakes Borough	$837,422,542	$8,374,225	$41,871,127	$83,742,254
Medford Township	$7,999,936,346	$79,999,363	$399,996,817	$799,993,635
Moorestown Township	$6,109,599,449	$61,095,994	$305,479,972	$610,959,945
Mount Holly Township	$2,150,068,863	$21,500,689	$107,503,443	$215,006,886
Mount Laurel Township	$9,343,991,534	$93,439,915	$467,199,577	$934,399,153
New Hanover Township	$1,546,232,618	$15,462,326	$77,311,631	$154,623,262

Table 5.4.7-**5**. General Building Stock Exposure and Estimated Losses from Severe Winter Storm Events

Municipality	Total (All Occupancies)	1% Damage Loss Estimate	5% Damage Loss Estimate	10% Damage Loss Estimate
North Hanover Township	$1,729,559,019	$17,295,590	$86,477,951	$172,955,902
Palmyra Borough	$1,106,819,144	$11,068,191	$55,340,957	$110,681,914
Pemberton Borough	$207,432,867	$2,074,329	$10,371,643	$20,743,287
Pemberton Township	$5,772,021,833	$57,720,218	$288,601,092	$577,202,183
Riverside Township	$1,276,520,301	$12,765,203	$63,826,015	$127,652,030
Riverton Borough	$585,858,006	$5,858,580	$29,292,900	$58,585,801
Shamong Township	$1,696,218,832	$16,962,188	$84,810,942	$169,621,883
Southampton Township	$3,975,061,802	$39,750,618	$198,753,090	$397,506,180
Springfield Township	$2,223,461,090	$22,234,611	$111,173,055	$222,346,109
Tabernacle Township	$2,175,794,267	$21,757,943	$108,789,713	$217,579,427
Washington Township	$357,333,022	$3,573,330	$17,866,651	$35,733,302
Westampton Township	$2,487,347,035	$24,873,470	$124,367,352	$248,734,704
Willingboro Township	$5,281,247,833	$52,812,478	$264,062,392	$528,124,783
Woodland Township	$888,068,601	$8,880,686	$44,403,430	$88,806,860
Wrightstown Borough	$223,368,035	$2,233,680	$11,168,402	$22,336,804
Burlington County	**$101,150,665,635**	**$1,011,506,656**	**$5,057,533,282**	**$10,115,066,564**

Source: Burlington County

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 the flood hazard profile (Section 5.4.4). Generally, losses resulting from flooding associated with severe winter storms should be less than that associated with a 100-year flood. In addition, coastal areas are at high risk during winter storm events that involve high winds. Please refer to the Severe Storm (Section 5.4.6) profile 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.

Impact on Economy

The cost of snow and ice removal and repair of roads from the freeze/thaw process can drain local financial resources. Another impact on the economy includes impacts on commuting into, or out of, the area for work or school. Heavy snow can immobilize a region and paralyze a city, stranding commuters, stopping the flow of supplies, and disrupting emergency and medical services. Accumulations of snow and ice can collapse buildings and knock down trees and power lines. The loss of power and closure of roads can also prevent the commuter population traveling to work within and outside of the county. In rural areas, homes and farms may be isolated for days, and unprotected livestock may be lost. In the mountains, heavy snow can lead to avalanches. The cost

of snow removal, repairing damages, and loss of business can have large economic impacts on cities and towns (NSSL, 2006).

Future Growth and Development

As discussed in Sections 4 and 9, areas targeted for future growth and development have been identified across Burlington County. Any areas of growth could be potentially impacted by the severe winter storm hazard because the entire planning area is exposed and vulnerable. Please refer to the specific areas of development indicated in tabular form and/or on the hazard maps included in the jurisdictional annexes in Volume II, Section 9 of this plan.

Effect of Climate Change on Vulnerability

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-percent) greater than the average from 1895-1970. Southern New Jersey became two inches (5-percent) wetter late in the 20th century (Office of New Jersey State Climatologist). Average annual precipitation is projected to increase in the region by 5-percent by the 2020s and up to 10-percent by the 2050s. Most of the additional precipitation is expected to come during the winter months (New York City Panel on Climate Change [NPCC] 2009).

In terms of snowfall and ice storms in New Jersey, 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 2013). An increase in the frequency and severity of severe winter storms may result in an increase of snow loads on the County's building stock and infrastructure, putting each building at risk for structural damage. More frequent and severe events will also result in increased resources being spent to prepare for and clean-up after an event. However, as winter temperatures continue to rise, the increase in precipitation is likely to occur during the winter months as rain. Increased rain on snowpack or frozen or saturated soils may lead to increased flooding and related impacts on the County's assets. Future enhancements in climate modeling will provide an improved understanding of how the climate will change and impact the Northeast.

Change of Vulnerability Since the 2014 HMP

The entire county continues to be vulnerable to the severe winter weather hazard. The 2019 HMP update used the same methodology as the original plan, while providing updated damage estimates using an updated custom building stock based on Burlington County and MODIV tax assessment data. The updated vulnerability assessment provides a more current assessment for the county.

5.4.8 WILDFIRE

The following section provides the hazard profile (hazard description, location, extent, previous occurrences and losses, probability of future occurrences, and impact of climate change) and vulnerability assessment for the wildfire hazard in Burlington County.

2019 HMP UPDATE CHANGES

- The hazard profile has been significantly enhanced to include a detailed hazard description, location, extent, previous occurrences, probability of future occurrence, and potential change in climate and its impacts on the wildfire hazard is discussed.
- New and updated figures from federal and state agencies are incorporated. New Jersey Forest Fire Service (NJFFS) Wildfire Fuel Hazard data was used to identify wildfire fuel rankings in Burlington County. The 2010 NJFFS wildfire risk and fuel maps were also used to identify hazard areas in the county. U.S. 2010 Census data was incorporated, where appropriate.
- Previous occurrences were updated with events that occurred between 2013 and 2017.
- A vulnerability assessment was conducted for the wildfire hazard; it now directly follows the hazard profile. To determine exposure, a spatial analysis was conducted using the NJFFS Fuel Hazard Area guidelines.

5.4.8.1 PROFILE

Hazard Description

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, particular 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 2013).

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 5.4.4 (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 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 2017). Details regarding the number of fires in Burlington County were not included in these overall statistics.

NJFFS, a division of NJDEP, is responsible for protecting the 3.15 million acres of public and private wildland in the state. NJFFS is under the direction of the state fire warden and is headquartered in Trenton. It is broken up into three divisions (A, B, C). Each division is responsible for responding to wildfire events within their boundaries. Burlington County is located in Division B. 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.

Location

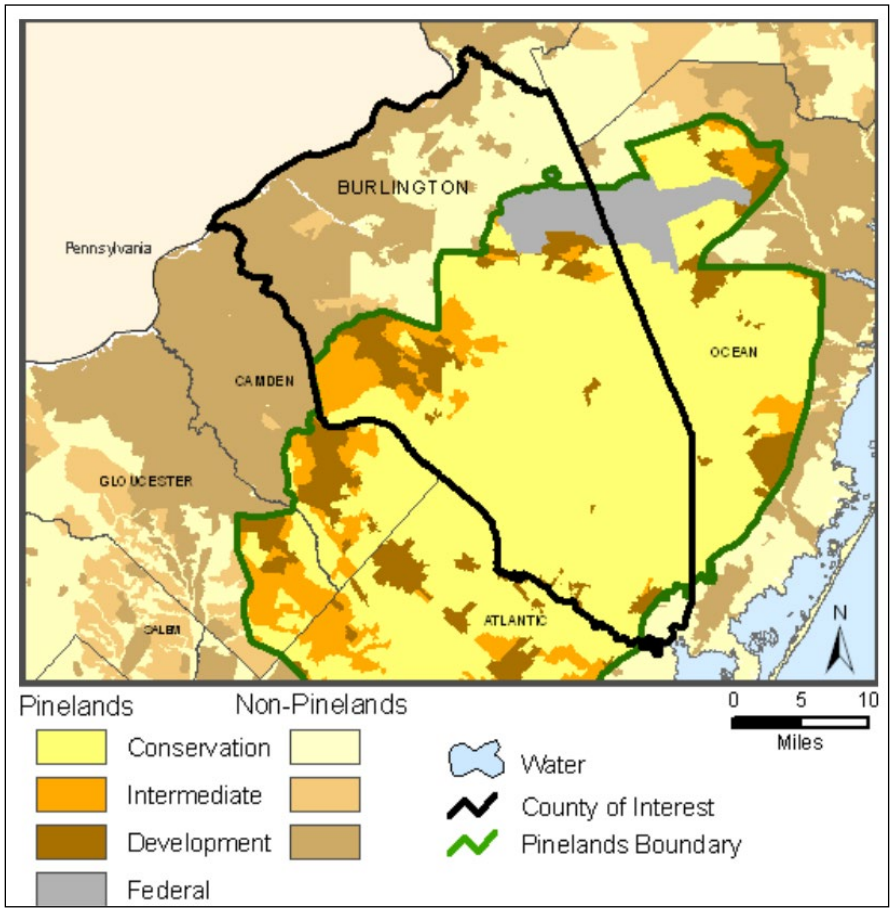
All of Burlington County is susceptible to wildfire and they can occur anywhere in the County. However, the greatest risk for wildfire is in the southeastern two thirds of the County which is located in the Pinelands National Reserve.

The Pinelands and Pine Barrens

The New Jersey Pine Barrens are characterized by low, dense forests of pine and oak, ribbons of cedar and hardwood swamps bordering drainage courses, pitch pine lowlands, and bogs and marshes combine to produce an expansive vegetative mosaic unsurpassed in the Northeast. The Pine Barrens was recognized as a nationally and internationally important ecological region when, in 1978, Congress created the Pinelands National Reserve, our country's first National Reserve and a U.S. Biosphere Reserve of the Man and the Biosphere Program. The Pinelands National Reserve encompasses approximately 1.1 million acres statewide, occupying 22% of New Jersey's land area and covering portions of seven counties and all or parts of 56 municipalities. It is the largest body of open space on the Mid-Atlantic seaboard between Richmond and Boston and is underlain by aquifers containing 17 trillion gallons of some of the purest water in the land. Through the creation of the Pinelands Commission, the State of New Jersey formed the necessary partnerships to preserve, protect and enhance the natural and cultural resources of the Pinelands (Burlington County HMP, 2008).

According to the New Jersey Pinelands Commission 2011-2012 Pinelands Long-Term Economic Monitoring Program, 35 percent of Burlington County's municipalities (or 14 of the 40 municipalities) are located within the Pinelands Area, as shown in Figure 5.4.8-1 below. Approximately 21 percent of Burlington County's 2010 population (93,385 residents) resided in the Pinelands Area. Approximately 20 percent of the county's housing units (35,141 housing units) and 64 percent of the county's total land area (334,250 acres) were also reported as located within the Pinelands Area (New Jersey Pinelands Commission, 2012).

Figure 5.4.8-1. Pinelands Management and Planning Areas in Burlington County



Source: New Jersey (State of) Pinelands Commission, 2012

Naturally occurring wildfires burning several thousands of acres per year have been a common occurrence in the Pinelands for many hundreds of years. Development of the unique flora of the Pinelands is closely related to the occurrence of fire, with many plant species relying on fire for a part of their reproductive cycle (Burlington County HMP, 2008).

Pinelands fires tend to burn extremely hot and spread rapidly. Crown fires here are fairly common (spreading from treetop to treetop). While Pinelands fires generally do not cause casualties due to the low population residing within its limits, property loss can run in the thousands of dollars per event, not including costs associated with emergency response and firefighting. Often, state roads have closed because of smoke conditions (Burlington County HMP, 2008).

Conditions conducive to forest fires are some of the most consistent and serious impacts of drought, a hazard profiled earlier in this plan. This applies particularly to the Pine Barrens, where drying conditions favor the combustion of forest fuels. Generally, a relative humidity of less than 40 percent, winds greater than 13 miles an hour, and precipitation of less than 0.01 inches during a month are ideal conditions for forest fires in the Pine Barrens. The season of greatest fire threat runs from March through May, though extensive fires have occurred in the summer and autumn months (NJOEM, 2012).

Wildfire Fuel Hazard Areas

NJFFS developed Wildfire Fuel Hazard data for the entire state based on NJDEP data. For details on the information was developed, refer to: https://www.state.nj.us/dep/gis/njfh.html. Figure 5.4.8-2 and Figure 5.4.8-3 illustrate the wildfire fuel hazard and wildfire risk for Burlington County. A majority of the county has extreme fuel hazard and moderate to high risk. With the exception of Fieldsboro, every municipality in Burlington County has at least a small portion of the community located within the high to extreme risk area, with Woodland Township having largest percentage of land within the high to extreme risk area (74.8%). Table 5.4.8-1 indicates the amount of land in each of the wildfire fuel hazard ranking zones for Burlington County. Table 5.4.8-2 summarizes the area within each hazard ranked area, specific to Burlington County jurisdictions.

Table 5.4.8-1. Area in the Wildfire Fuel Hazard Ranking Zones in Burlington County

Hazard Area	Area (Square Miles)
Extreme	195.75
Very High	11.95
High	106.32
Moderate	86.53
Low	165.69

Source: NJ Forest Fire Service

Note: The remainder of the County is classified as 'water', 'barren land', 'urban', or 'agriculture.'

Table 5.4.8-2. Approximate Area in Wildfire Fuel Hazard Ranking Zones in Burlington County

Municipality	Total Area (Square Miles)	New Jersey Forest Fire Service Risk Areas			
		Low to Moderate	% in Hazard Area	High to Extreme	% in Hazard Area
Bass River (T)	50,140	11,372	22.7%	35,840	71.5%
Beverly (C)	486	48	9.9%	3	0.7%
Bordentown (T)	5,926	2,225	37.5%	558	9.4%
Burlington (C)	2,426	605	24.9%	83	3.4%
Burlington (T)	8,992	3,142	34.9%	640	7.1%
Chesterfield (T)	13,736	5,718	41.6%	294	2.1%
Cinnaminson (T)	5,099	1,077	21.1%	240	4.7%
Delanco (T)	2,190	434	19.8%	105	4.8%
Delran (T)	4,654	1,203	25.8%	320	6.9%
Eastampton (T)	3,723	1,699	45.6%	92	2.5%
Edgewater Park (T)	1,976	515	26.1%	24	1.2%
Evesham (T)	18,943	6,846	36.1%	4,775	25.2%
Fieldsboro (B)	224	79	35.2%	0	0.1%
Florence (T)	6,559	2,223	33.9%	509	7.8%
Hainesport (T)	4,344	1,486	34.2%	768	17.7%
Lumberton (T)	8,327	3,422	41.1%	270	3.2%
Mansfield (T)	14,010	5,953	42.5%	494	3.5%
Maple Shade (T)	2,451	332	13.5%	60	2.5%
Medford (T)	812	108	13.3%	20	2.5%
Medford Lakes (B)	25,474	10,441	41.0%	7,203	28.3%
Moorestown (T)	9,585	3,393	35.4%	390	4.1%
Mt. Holly (T)	1,837	418	22.8%	40	2.2%
Mt. Laurel (T)	14,066	5,166	36.7%	808	5.7%
New Hanover (T)	14,483	4,846	33.5%	4,302	29.7%
North Hanover (T)	11,203	4,458	39.8%	482	4.3%
Palmyra (B)	1,673	314	18.8%	84	5.0%
Pemberton (B)	403	158	39.2%	53	13.1%
Pemberton (T)	40,171	15,654	39.0%	14,127	35.2%
Riverside (T)	1,048	118	11.3%	124	11.9%
Riverton (B)	614	62	10.1%	13	2.2%

Municipality	Total Area (Square Miles)	New Jersey Forest Fire Service Risk Areas			
		Low to Moderate	% in Hazard Area	High to Extreme	% in Hazard Area
Shamong (T)	28,791	9,155	31.8%	15,310	53.2%
Southampton (T)	28,446	14,630	51.4%	5,496	19.3%
Springfield (T)	18,924	9,618	50.8%	529	2.8%
Tabernacle (T)	31,688	8,249	26.0%	18,380	58.0%
Washington (T)	66,539	17,203	25.9%	46,795	70.3%
Westampton (T)	7,104	2,828	39.8%	513	7.2%
Willingboro (T)	5,175	1,062	20.5%	157	3.0%
Woodland (T)	61,001	11,603	19.0%	45,637	74.8%
Wrightstown (B)	1,146	439	38.3%	144	12.6%
Burlington County (Total)	**525,009**	**168,455**	**32.1%**	**205,714**	**39.2%**

Source: NJ Forest Fire Service

Note: The remainder of the County is classified as 'water', 'barren land', 'urban', or 'agriculture.'

Figure 5.4.8-2. Wildfire Fuel Hazard for Burlington County

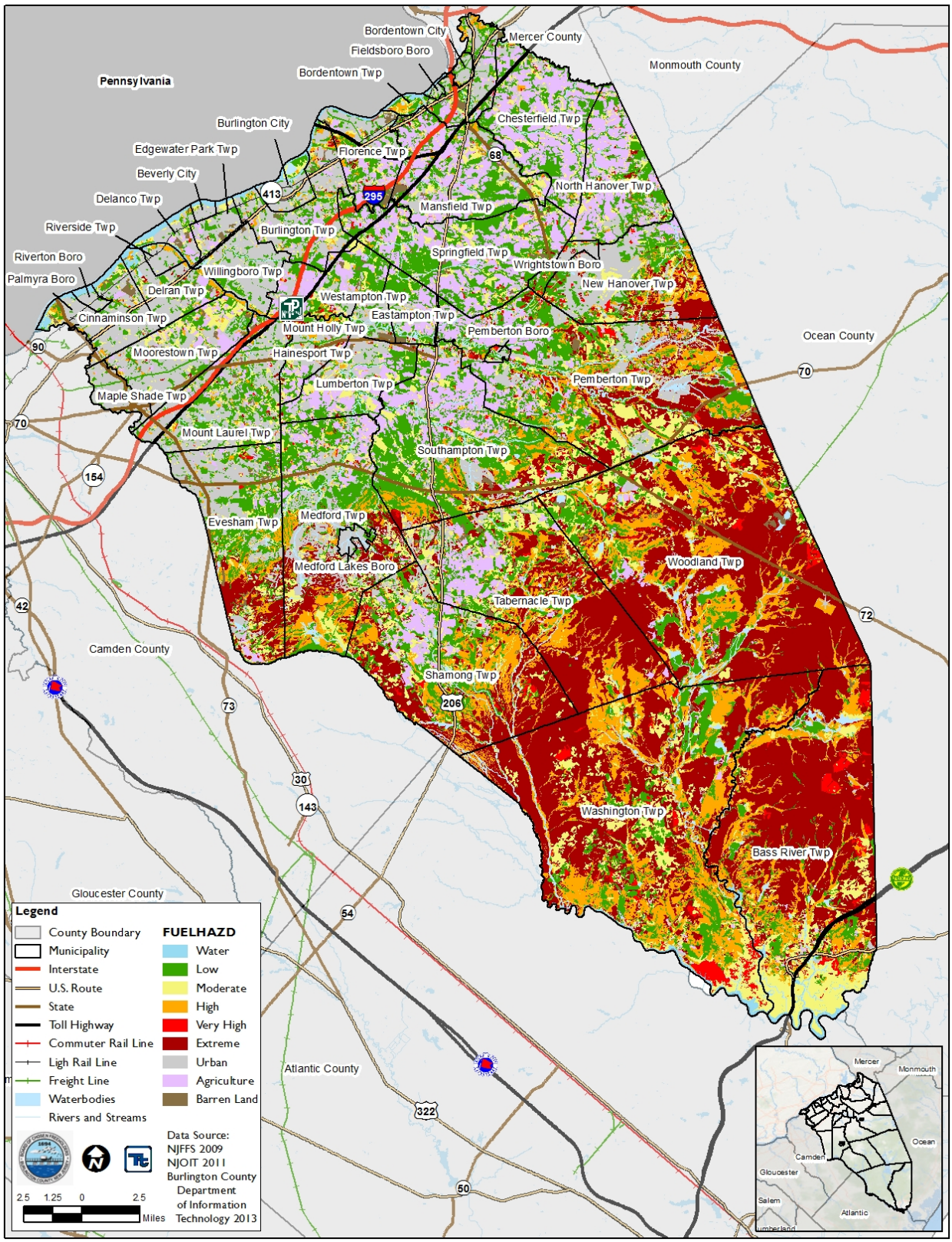
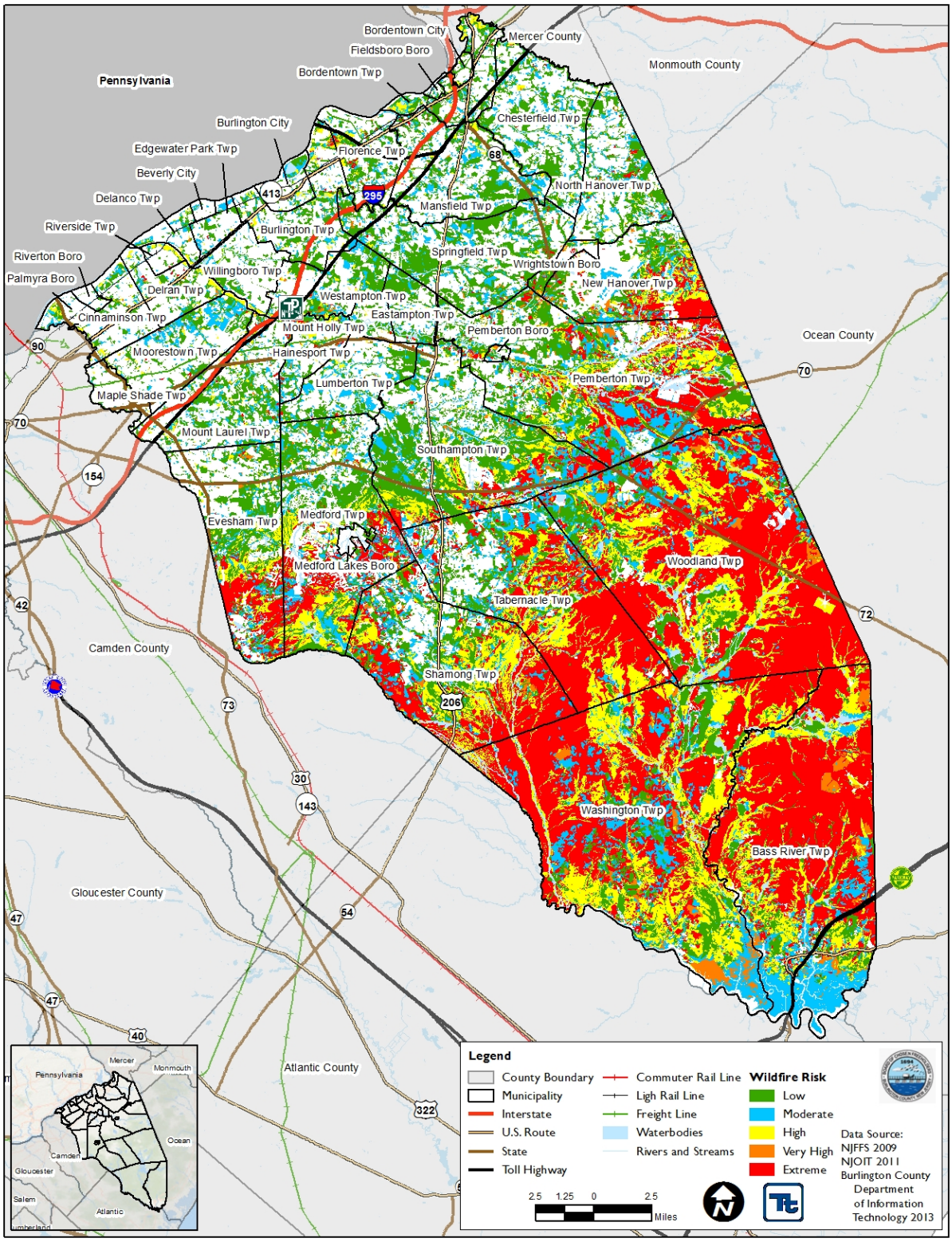


Figure 5.4.8-3. Wildfire Risk for Burlington County



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 System's 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. The NFDRS, with the NFFS color scheme, is as follows:

Table 5.4.8-3. 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 effective and safe control action is on the flanks until the weather changes or the fuel supply lessens.

Source: NJFFS 2018

Previous Occurrences and Losses

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. Burlington County was included in one FEMA FMA declaration (see Table 5.4.8-4).

Table 5.4.8-4. FEMA Declarations for Wildfire Events in Burlington County

FEMA Declaration Number	Date(s) of Event	Incident Type / Title	Declared Counties
FM-2695	May 15, 2007	Warren Gove Fire	Burlington and Ocean

Source: FEMA 2018

For this 2018 Plan update, wildfire events were summarized from 2013 to 2018. For events prior to 2013, refer to Appendix G (Supplementary Data). Known wildfire events, including FEMA disaster declarations, which have impacted Burlington County are identified in Table 5.4.8-5. Please note that not all events that have occurred in Burlington County are included due to the extent of documentation and the fact that not all sources may have been identified or researched. Loss and impact information 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.

Table 5.4.8-5. Wildfire Events in Burlington County, 2013 to 2018

Date(s) of Event	Event Type	FEMA Declaration Number (if applicable)	County Designated?	Losses / Impacts
April 6, 2013	Wildfire	N/A	N/A	A wildfire that started within Wharton State Forest in Shamong Township burned 150 acres of woodland.
April 6, 2014	Wildfire	N/A	N/A	A wildfire consumed approximately 1,600 acres of forest in Wharton State Forest. The smell of smoke moved across the state and even reached parts of New York City. Crews dropped water on the fire from airplanes and used backfires to contain the fire. No injuries or structural damages were associated with this wildfire.
April 19, 2014	Wildfire	N/A	N/A	A wildfire burned 25 wooded acres in Lumberton Township. Portions of westbound New Jersey State Route 38 and U.S. Route 206 were closed due to poor visibility.
April 25, 2014	Wildfire	N/A	N/A	250 acres of forest in Wharton State Forest in Shamong Township burned.
May 3, 2015	Wildfire	N/A	N/A	8 wildfires were reported in Burlington County. One fire consumed 80 acres in Pemberton Township.
May 7, 2015	Wildfire	N/A	N/A	Wildfire consumed 710 acres of forest in Shamong Township. Smoke forced the closure of U.S. Route 206 between U.S. Route 30 and Atsion Road. Evacuations were recommended for homes in the vicinity.
July 21, 2017	Wildfire	N/A	N/A	A 2,800-acre wildfire burned north of Batsto Village in Washington Township. It began during the early afternoon on the 20th about three miles north of the fire tower at Batsto. It burned in several directions

Date(s) of Event	Event Type	FEMA Declaration Number (if applicable)	County Designated?	Losses / Impacts
				overnight and into the morning of the 21st. Heavy smoke from the fire moved above Batsto Village and south along Route 542 and through Mullica and Hamilton Townships.
September 7, 2015	Wildfire	N/A	N/A	Wildfire consumed 1,012 acres of woodland along the Burlington and Ocean County borders starting in Woodland Township and spreading into Manchester Township.
April 22, 2018	Wildfire	N/A	N/A	During the afternoon of April 22nd, a wildfire was spotted by the Cedar Bridge and Batso fire towers. At first, about 50 acres were involved but a sea breeze caused the fire to quickly grow to 843 acres. The fire was located in Washington Township, just north of Lake Oswego. By April 23rd, the fire was 90% contained.

Source: NOAA-NCDC, 2018; FEMA, 2018

Probability of Future Occurrences

Estimating the approximate number of wildfires to occur in Burlington 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 Burlington 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. Although a definite prediction of future wildfire events cannot be noted, an analysis of the frequency of past occurrences can give professionals a rough guide as to how many potential events may occur each year if current trends continue.

For the purpose of this HMP update, the most up-to-date data was collected to calculate the probability of future occurrence. Information from the NJFFS and the 2014 New Jersey State HMP were used to identify the number of wildfires that occurred between 1950 and 2018. Using these sources ensures the most accurate probability estimates possible. The table below shows these statistics, as well as the annual average number of events and the estimated percent chance of a wildfire occurring in a given year. Based on these statistics, there is an estimated 100% chance of a wildfire occurring in any given year in Burlington County.

Table 5.4.8-6. Probability of Future Occurrence of Wildfire Events

Hazard Type	Number of Occurrences Between 1950 and 2015	Rate of Occurrence or Annual Number of Events (average)	Recurrence Interval (in years) (# Years/Number of Events)	Probability of Event in any given year	Percent chance of occurrence in any given year
Wildfire	924	13.59	0.07	13.39	100%

Source: Burlington County HMP 2013; NOAA-NCEI 2018; New Jersey State HMP 2014

In Section 5.3, the identified hazards of concern for Burlington 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' (likely to occur within 25 years, as presented in Table 5.3-3).

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 during while wildfires can burn during 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).

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). 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).

5.4.8.2 VULNERABILITY ASSESSMENT

A spatial analysis was conducted using the NJFFS Wildfire Fuel Hazard spatial layer. For the purposes of the vulnerability assessment, an asset (population, structures, critical facilities, and lifelines) is considered potentially vulnerable to the wildfire hazard if it is located in the 'extreme', 'very high' and 'high' areas. Refer to Section 5.1 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 business and 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 5.4.8-7 summarizes the estimated population exposed by municipality.

Based on the analysis, an estimated 92,172 people, or 20.5% of the county's population, are located in the high, very high and extreme wildfire hazards. Overall, the Township of Pemberton, Township of Evesham, and Township of Medford have the greatest number of individuals located in the extreme/very high/high hazard areas, while the Township of Washington, the Township of Woodland, and the Borough of Pemberton have the

greatest percent of population located in the extreme/very high/high hazard areas. Socially vulnerable populations (e.g. the elderly and low-income populations) are particularly vulnerable to a hazard event. Within the NJFFS Fuel Hazard boundaries, there are approximately 2,653 people over the age of 65 and 1,656 people considered low income populations.

Table 5.4.8-7. Estimated Population Located in the Wildfire Fuel Hazard Area in Burlington County

Municipality	US. Census 2010 Population	Estimated Population Exposed			
		Extreme, Very High and High	Percent of Total Population Exposed	Moderate and Low	Percent of Total Population Exposed
Bass River Township	1,443	205	14.2%	1,015	70.3%
Beverly City	2,577	0	0.0%	125	4.9%
Bordentown City	3,924	69	1.8%	603	15.4%
Bordentown Township	11,367	578	5.1%	2,447	21.5%
Burlington City	9,920	233	2.3%	1,035	10.4%
Burlington Township	22,594	130	0.6%	4,904	21.7%
Chesterfield Township	7,699	112	1.5%	4,098	53.2%
Cinnaminson Township	15,569	490	3.1%	2,684	17.2%
Delanco Township	4,283	82	1.9%	590	13.8%
Delran Township	16,896	94	0.6%	3,106	18.4%
Eastampton Township	6,069	7	0.1%	1,913	31.5%
Edgewater Park Township	8,881	0	0.0%	763	8.6%
Evesham Township	45,538	2,977	6.5%	10,831	23.8%
Fieldsboro Borough	540	0	0.0%	188	34.8%
Florence Township	12,109	208	1.7%	1,180	9.7%
Hainesport Township	6,110	558	9.1%	1,024	16.8%
Lumberton Township	12,559	467	3.7%	1,661	13.2%
Mansfield Township	8,544	227	2.7%	2,496	29.2%
Maple Shade Township	19,131	12	0.1%	1,819	9.5%
Medford Lakes Borough	4,146	67	1.6%	37	0.9%
Medford Township	23,033	3,582	15.6%	8,403	36.5%
Moorestown Township	20,726	104	0.5%	3,832	18.5%
Mount Holly Township	9,536	490	5.1%	1,701	17.8%
Mount Laurel Township	41,864	534	1.3%	10,430	24.9%
New Hanover Township	7,385	190	2.6%	371	5.0%
North Hanover Township	7,678	112	1.5%	2,069	26.9%
Palmyra Borough	7,398	0	0.0%	91	1.2%
Pemberton Borough	1,409	327	23.2%	199	14.1%
Pemberton Township	27,912	4,478	16.0%	4,362	15.6%
Riverside Township	8,079	95	1.2%	515	6.4%
Riverton Borough	2,779	0	0.0%	177	6.4%
Shamong Township	6,490	1,397	21.5%	3,053	47.0%
Southampton Township	10,464	1,626	15.5%	3,849	36.8%
Springfield Township	3,414	383	11.2%	1,838	53.8%
Tabernacle Township	6,949	1,399	20.1%	3,234	46.5%
Washington Township	687	501	72.9%	144	21.0%
Westampton Township	8,813	721	8.2%	2,650	30.1%

Table 5.4.8-7. Estimated Population Located in the Wildfire Fuel Hazard Area in Burlington County

Municipality	US. Census 2010 Population	Estimated Population Exposed			
		Extreme, Very High and High	Percent of Total Population Exposed	Moderate and Low	Percent of Total Population Exposed
Willingboro Township	31,629	31	0.1%	2,991	9.5%
Woodland Township	1,788	815	45.6%	341	19.1%
Wrightstown Borough	802	17	2.1%	103	12.8%
Burlington County	**448,734**	**23,318**	**5.2%**	**92,172**	**20.5%**

Source: 2010 US Census, NJFFS, 2009
Note: The NJFFS Fuel Hazard boundaries were overlaid on the U.S. Census block; the blocks with their centroids within hazard areas were totaled for each municipality.

Smoke and air pollution from wildfires can be a severe health hazard, especially for sensitive populations, including children, the elderly, and those with respiratory and cardiovascular diseases. Smoke generated by wildfire consists of visible and invisible emissions that contain particulate matter (soot, tar, water vapor, and minerals), gases (carbon monoxide, carbon dioxide, nitrogen oxides), and toxics (formaldehyde, benzene). Emissions from wildfires depend on the type of fuel, the moisture content of the fuel, the efficiency (or temperature) of combustion, and the weather. Public health impacts associated with wildfire include difficulty in breathing, odor, and reduction in visibility.

Impact on General Building Stock

The most vulnerable structures to wildfire events are those located within the NJFFS identified extreme, very high or high fuel hazard areas. 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 5.4.8-8 and Table 5.4.8-9 summarizes the estimated building stock inventory exposed by municipality. Approximately 25.9-percent ($266 million) of the County's building RCV is located in the extreme/very high/high hazard areas. Pemberton Township has the greatest number of buildings and RCV within wildfire hazard areas (358 structures).

Table 5.4.8-8. Estimated Replacement Cost Value Located in Wildfire Fuel Hazard Ranking Zones

Municipality	Total Replacement Cost Value (Structure and Contents)	Replacement Cost in Hazard Area			
		Extreme, Very High and High	Percent of Total Exposed	Moderate and Low	Percent of Total Exposed
Bass River Township	$1,027,917,130	$266,341,415	25.9%	$418,492,047	40.7%
Beverly City	$471,487,138	$0	0.0%	$9,975,457	2.1%
Bordentown City	$1,244,995,904	$0	0.0%	$27,088,344	2.2%
Bordentown Township	$2,820,041,247	$8,038,450	<1%	$338,345,056	12.0%
Burlington City	$3,215,233,092	$4,208,960	<1%	$280,531,607	8.7%
Burlington Township	$8,013,259,672	$81,719,940	1.0%	$1,114,832,310	13.9%
Chesterfield Township	$2,443,294,418	$32,219,051	1.3%	$911,284,555	37.3%
Cinnaminson Township	$5,703,895,752	$3,828,195	<1%	$749,892,697	13.1%
Delanco Township	$1,422,201,479	$1,117,160	<1%	$154,328,143	10.9%
Delran Township	$5,145,622,596	$13,364,332	<1%	$505,593,230	9.8%
Eastampton Township	$1,687,017,512	$2,886,276	<1%	$274,466,475	16.3%
Edgewater Park Township	$2,307,285,215	$4,201,130	<1%	$186,875,936	8.1%
Evesham Township	$14,666,082,424	$691,213,944	4.7%	$1,770,607,597	12.1%
Fieldsboro Borough	$139,371,126	$0	0.0%	$13,040,160	9.4%

Table 5.4.8-8. Estimated Replacement Cost Value Located in Wildfire Fuel Hazard Ranking Zones

Municipality	Total Replacement Cost Value (Structure and Contents)	Replacement Cost in Hazard Area			
		Extreme, Very High and High	Percent of Total Exposed	Moderate and Low	Percent of Total Exposed
Florence Township	$2,787,263,607	$80,818,969	2.9%	$804,140,438	28.9%
Hainesport Township	$3,447,208,735	$125,318,585	3.6%	$499,131,332	14.5%
Lumberton Township	$5,459,557,257	$41,156,082	<1%	$1,203,501,152	22.0%
Mansfield Township	$4,056,501,589	$96,584,672	2.4%	$1,202,821,773	29.7%
Maple Shade Township	$4,385,500,913	$0	0.0%	$296,908,255	6.8%
Medford Lakes Borough	$1,280,050,871	$1,171,001	<1%	$37,686,128	2.9%
Medford Township	$12,845,907,494	$869,929,438	6.8%	$3,496,164,727	27.2%
Moorestown Township	$10,108,801,626	$183,116,944	1.8%	$2,111,184,272	20.9%
Mount Holly Township	$3,498,352,996	$1,200,893	<1%	$76,759,469	2.2%
Mount Laurel Township	$14,653,800,804	$115,431,134	<1%	$1,540,465,533	10.5%
New Hanover Township	$3,022,835,486	$36,558,890	1.2%	$170,424,876	5.6%
North Hanover Township	$3,079,878,987	$12,769,977	<1%	$1,295,296,819	42.1%
Palmyra Borough	$1,788,398,557	$0	0.0%	$79,079,604	4.4%
Pemberton Borough	$345,869,906	$253,071	<1%	$5,783,540	1.7%
Pemberton Township	$9,374,914,679	$655,542,382	7.0%	$1,929,913,555	20.6%
Riverside Township	$2,039,139,951	$793,375	<1%	$72,652,276	3.6%
Riverton Borough	$916,434,789	$0	0.0%	$18,576,284	2.0%
Shamong Township	$2,738,384,433	$68,978,608	2.5%	$1,021,613,432	37.3%
Southampton Township	$6,722,347,774	$341,146,488	5.1%	$2,087,376,458	31.1%
Springfield Township	$3,853,514,909	$231,732,916	6.0%	$1,696,760,901	44.0%
Tabernacle Township	$3,619,040,765	$94,730,791	2.6%	$1,229,083,768	34.0%
Washington Township	$597,426,933	$44,640,482	7.5%	$350,673,830	58.7%
Westampton Township	$4,269,433,407	$127,122,403	3.0%	$1,009,630,768	23.6%
Willingboro Township	$8,259,747,413	$0	0.0%	$209,878,839	2.5%
Woodland Township	$1,656,748,246	$240,866,796	14.5%	$516,791,009	31.2%
Wrightstown Borough	$411,963,035	$0	0.0%	$10,811,288	2.6%
Burlington County	**$165,526,729,867**	**$4,479,002,749**	**2.7%**	**$29,728,463,939**	**18.0%**

Source: Burlington County, NJFFS 2009
Note: The NJFFS Fuel Hazard boundaries were overlaid on the custom general building stock inventory; the structures with their centroids within the hazard areas were totaled for each municipality.

Table 5.4.8-9. Estimated Number of Buildings Located in Wildfire Fuel Hazard Ranking Zones

Municipality	Total Number of Buildings	Number of Buildings in Hazard Area			
		Extreme, Very High and High	Percent of Total Exposed	Moderate and Low	Percent of Total Exposed
Bass River Township	1,863	208	11.2%	1,048	56.3%
Beverly City	964	0	0.0%	10	1.0%
Bordentown City	1,219	0	0.0%	25	2.1%
Bordentown Township	3,113	11	0.4%	249	8.0%
Burlington City	3,644	10	0.3%	94	2.6%
Burlington Township	7,757	37	0.5%	670	8.6%
Chesterfield Township	2,093	17	0.8%	950	45.4%
Cinnaminson Township	6,358	4	0.1%	255	4.0%

Table 5.4.8-9. Estimated Number of Buildings Located in Wildfire Fuel Hazard Ranking Zones

Municipality	Total Number of Buildings	Number of Buildings in Hazard Area			
		Extreme, Very High and High	Percent of Total Exposed	Moderate and Low	Percent of Total Exposed
Delanco Township	1,562	2	0.1%	97	6.2%
Delran Township	5,191	4	0.1%	304	5.9%
Eastampton Township	2,499	8	0.3%	297	11.9%
Edgewater Park Township	2,567	1	0.0%	193	7.5%
Evesham Township	14,319	267	1.9%	1,483	10.4%
Fieldsboro Borough	242	0	0.0%	21	8.7%
Florence Township	2,522	39	1.5%	511	20.3%
Hainesport Township	2,747	40	1.5%	406	14.8%
Lumberton Township	4,009	15	0.4%	872	21.8%
Mansfield Township	2,798	39	1.4%	936	33.5%
Maple Shade Township	6,006	0	0.0%	78	1.3%
Medford Lakes Borough	1,909	3	0.2%	27	1.4%
Medford Township	10,627	307	2.9%	2,385	22.4%
Moorestown Township	8,736	35	0.4%	1,436	16.4%
Mount Holly Township	4,573	5	0.1%	91	2.0%
Mount Laurel Township	12,900	45	0.3%	1,351	10.5%
New Hanover Township	1,964	23	1.2%	196	10.0%
North Hanover Township	2,901	14	0.5%	757	26.1%
Palmyra Borough	2,713	0	0.0%	22	0.8%
Pemberton Borough	514	2	0.4%	13	2.5%
Pemberton Township	13,511	358	2.6%	1,647	12.2%
Riverside Township	2,868	2	0.1%	39	1.4%
Riverton Borough	1,274	0	0.0%	17	1.3%
Shamong Township	3,623	39	1.1%	1,342	37.0%
Southampton Township	7,982	100	1.3%	2,611	32.7%
Springfield Township	2,876	27	0.9%	1,597	55.5%
Tabernacle Township	4,452	70	1.6%	1,557	35.0%
Washington Township	939	59	6.3%	558	59.4%
Westampton Township	3,006	25	0.8%	624	20.8%
Willingboro Township	12,395	0	0.0%	128	1.0%
Woodland Township	1,323	123	9.3%	583	44.1%
Wrightstown Borough	485	0	0.0%	10	2.1%
Burlington County	**173,044**	**1,939**	**1.1%**	**25,490**	**14.7%**

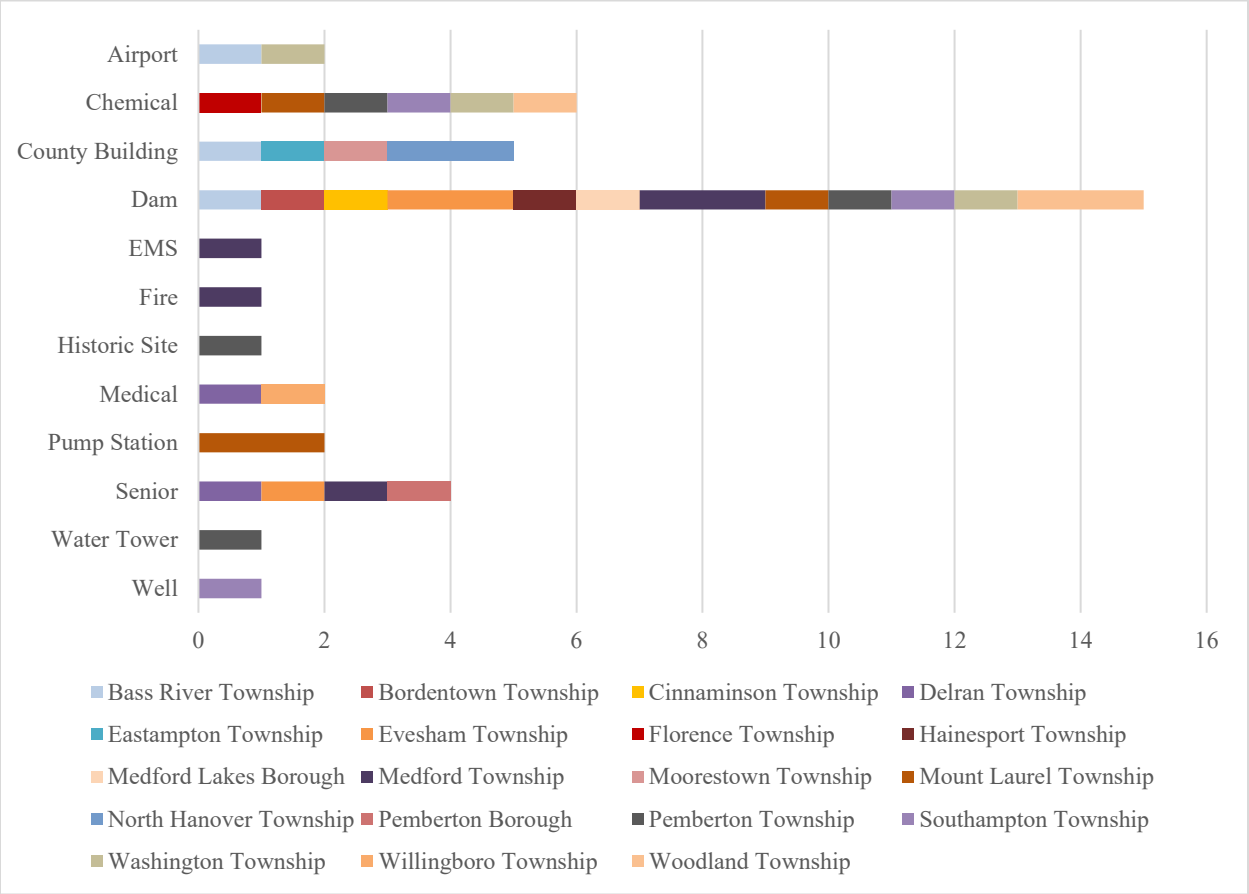
Source: Burlington County, NJFFS 2009
Note: The NJFFS Fuel Hazard boundaries were overlaid on the custom general building stock inventory; the structures with their centroids within the hazard areas were totaled for each municipality.

Impact on Critical Facilities

It is recognized that a number of critical facilities are located in the wildfire hazard area and are also vulnerable to the threat of wildfire. Many of these facilities are the locations for vulnerable populations (i.e., schools, senior facilities) and responding agencies to wildfire events (i.e., fire, police). Figure 5.4.8-4 displays the critical facilities located within the wildfire fuel hazard ranking zones by jurisdiction.

Roads and bridges in 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. Regarding facility types, dams have the greatest exposure; there are 15 dams in Burlington County's located within the wildfire hazard areas. Wildfires may not directly impact dams, but it can create conditions in which dams can be obstructed or damaged by falling tree debris.

Figure 5.4.8-4. Critical Facilities within the Wildfire Hazard Area in Burlington County



Source: Burlington County, NJFFS 2009

Note: Only communities with exposed critical facilities were included in the above figure.

Impact on 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 and decrease in tourism. 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. Route 206 which runs north to south through the county is located in portions of the wildfire hazard areas that are associated with the Pineland forests. This should be considered for evacuation route purposes since it serves as the major north/south corridor in the interior of the county. No major utilities such as power generation facilities are located in fire hazard areas.

Due to a lack of data regarding past structural and economic losses specific to Burlington County or its municipalities, it is not possible to estimate future losses due to wildfire events at this time.

Future Growth and Development

Areas targeted for potential future growth and development in the next five years have been identified across Burlington County at the municipal level. Refer to the jurisdictional annexes in Volume II of this HMP. As stated earlier, buildings constructed of wood or vinyl siding are generally more likely to be damaged by fire than are buildings constructed of brick or concrete. Major new developments located in the wildfire hazard area can be retrofitted with flame-resistant materials or adjacent communities can institute vegetation maintenance programs to reduce the risk of wildfires spreading into developed areas. 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 (refer to Figure 5.4.8-5 below).

There are 51 recent and proposed developments around the County exposed to the wildfire hazard areas; 30 of these developments are located within 'high' NJFFS Fuel Hazard areas, 10 are located within the 'very high' hazard area, and 11 are located within the 'extreme' hazard area. Mount Laurel Township has the most developments located in the hazard area (13 developments in all three of the NJFFS Fuel Hazard areas); this includes 8 located in the 'high' hazard area, 2 located in the 'very high' hazard area, and 3 located in the 'extreme' hazard area. Refer to each jurisdictional annex for the results of each exposure analysis on new development.

Effect of Climate Change on Vulnerability

According to the U.S. Fire Service (USFS), climate change will likely alter the atmospheric patterns that affect fire weather. Changes in fire patterns will, in turn, impact carbon cycling, forest structure, and species composition. Climate change associated with elevated greenhouse gas concentrations may create an atmospheric and fuel environment that is more conductive to large, severe fires. Under a changing climate, wildfires are expected to increase by 50-percent across the U.S. (USFS, 2013).

Fire interacts with climate and vegetation (fuel) in predictable ways. Understanding the climate/fire/vegetation interactions is essential for addressing issues associated with climate change that include:

- Effects on regional circulation and other atmospheric patterns that affect fire weather
- Effects of changing fire regimes on the carbon cycle, forest structure, and species composition, and
- Complications from land use change, invasive species and an increasing wildland-urban interface (USFS, 2011).

It is projected that higher summer temperatures will likely increase the high fire risk by 10 to 30-percent. Fire occurrence and/or area burned could increase across the U.S. due to the increase of lightning activity, the frequency of surface pressure and associated circulation patterns conductive to surface drying, and fire-weather conditions, in general, which is conductive to severe wildfires. Warmer temperatures will also increase the effects of drought and increase the number of days each year with flammable fuels and extending fire seasons and areas burned (USFS, 2011).

With temperatures anticipated to increase, 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. Climate change may also increase winds that spread fires. 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

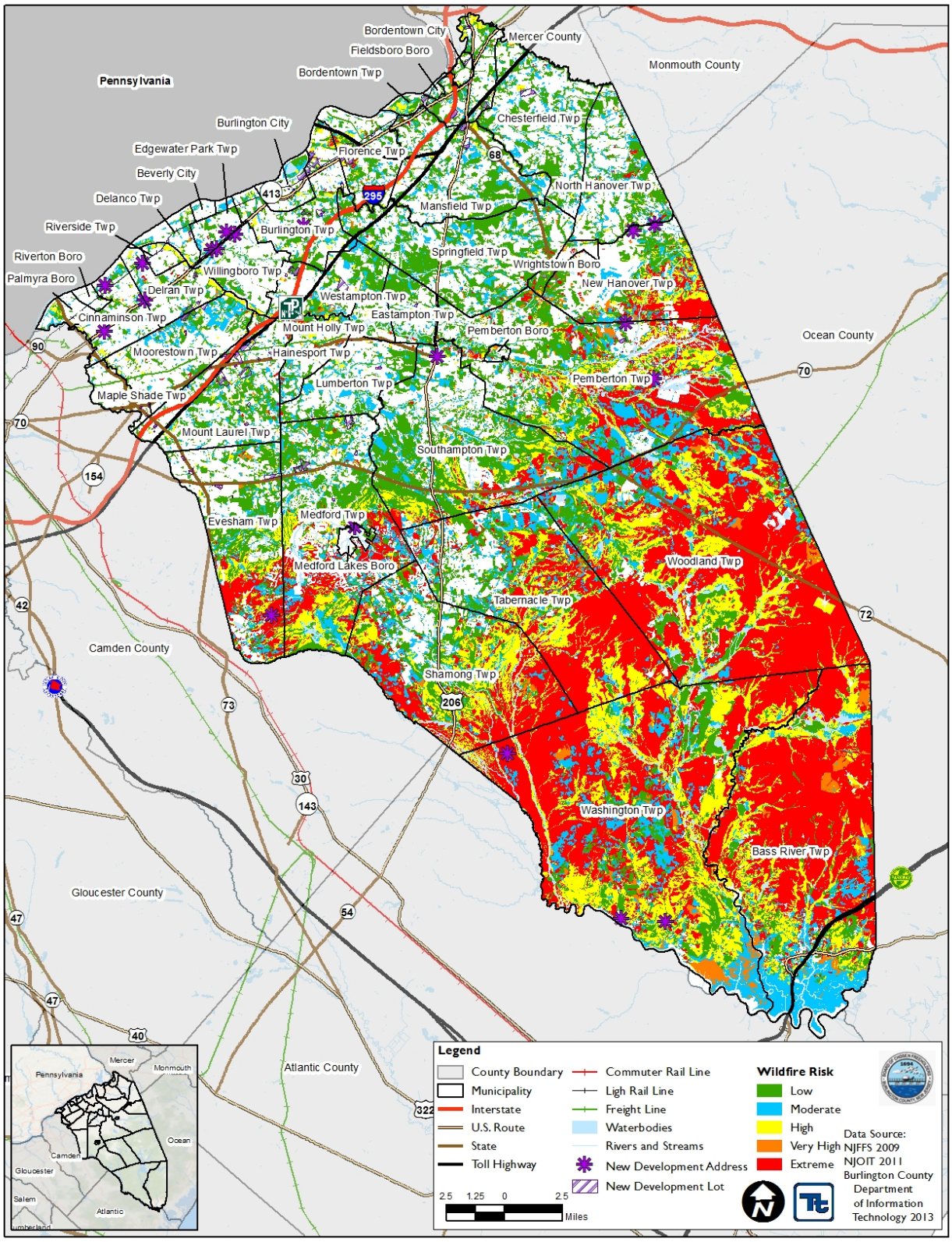
and built environment in the vicinity of the fire, and also indirectly affect those served by utility infrastructure that can be damaged by a fire.

Future changes in fire frequency and severity are difficult to predict. Global and regional climate changes associated with elevated greenhouse gas concentrations could alter large weather patterns, thereby affecting fire-weather conducive to extreme fire behavior (USFS, 2011).

Change of Vulnerability Since the 2014 HMP

Burlington County and all plan participants continue to be vulnerable to the wildfire hazard. Several differences exist between the 2014 Plan and this update. For this plan update, an updated general building stock based upon replacement cost value from MODIV tax assessment data and 2018 RS Means, and an updated critical facility inventory were used to assess the county's risk to the hazard areas. Due to differences in data used for the vulnerability assessment, a direct comparison could not be conducted to determine whether there has been a change in vulnerability since the last HMP. The updated vulnerability assessment provides a more current exposure analysis for the county.

Figure 5.4.8-5. Potential New Development and Wildfire Hazard Boundaries



Source: NJFFS 2009 and Burlington County

SECTION 6. MITIGATION STRATEGY

2019 HMP Update Changes

- The goals, and objectives were updated to align with the county and state's current mitigation priorities.
- A SWOO exercise was conducted for Burlington County and summarized in this section.
- The mitigation strategy evaluation and prioritization methodology was updated and expanded.

6.1 INTRODUCTION

This section presents mitigation actions for Burlington County to reduce potential exposure and losses identified as concerns in the Risk Assessment section of this 2019 HMP update. The Steering and Planning Committees reviewed the risk assessment to identify and develop these mitigation actions, which are presented herein.

This section includes:

1) Background and Past Mitigation Accomplishments
2) General Mitigation Planning Approach
3) Review and Update of Mitigation Goals and Objectives
4) Capability Assessment
5) Mitigation Strategy Development and Update

6.2 BACKGROUND AND PAST MITIGATION ACCOMPLISHMENTS

In accordance with the requirements of DMA 2000, detailed in Section 1 (Introduction), 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. Burlington 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 actions and projects include the following:

- In April 2019, 13 waterfront municipalities (Beverly, Bordentown City, Burlington City, Burlington Township, Cinnaminson, Delanco, Delran, Edgewater Park, Florence, Palmyra, Riverside, Riverton and Willingboro) along the Delaware River in Burlington County formed the Burlington County Coastal Communities Coalition. The group will meet regularly and discuss coastal issues they are facing, such as erosion, flooding, and infrastructure weakness. Cinnaminson Township became one of the first communities to adopt a resolution to become a member of the coalition.
- The county facilitated the development of the original and 2014 update of the Burlington County Hazards Mitigation Plan. The current planning process represents the regulatory five-year plan update process, which includes participation of 40 municipal governments in the county, along with key county and regional stakeholders.
- All municipalities, with the exception of the Borough of Fieldsboro, participating in this HMP update participate in the NFIP, which requires the adoption of FEMA floodplain mapping and certain minimum standards for building within the floodplain.
- Reports, plans, and studies relating to or including information on natural hazards or natural hazard policies affecting Burlington County have been reviewed and incorporated into this plan update as appropriate, as discussed in Section 3 (Planning Process).

- Municipalities have actively participated in available mitigation grant funding opportunities to implement mitigation projects. Details on these projects are presented in Section 9 (Jurisdictional Annexes) of this HMP update.
- Municipalities have incorporated hazard mitigation into their daily operations and planning mechanisms. A summary of current and future plan integration activities are presented in each municipality's annex in Section 9 (Jurisdictional Annexes) of this 2019 HMP update.

These past and ongoing activities have contributed to the county's understanding of its hazard preparedness and future mitigation activity needs, costs, and benefits. These efforts provide a foundation for the Planning Committee to use in developing this 2019 HMP update.

6.3 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:

- 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), April 2003.
- 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 later in this section:

- Section 6.4 – review and update mitigation goals and objectives
- Section 6.5 – identify mitigation capabilities and evaluate their capacity and effectiveness to mitigate and manage hazard risk
- Section 6.6 – prepare an implementation strategy, including:
    - Identify progress on previous county and local mitigation strategies.
    - Develop updated county and local mitigation strategies.
    - Prioritize projects and initiatives in the updated mitigation strategy.

6.4 REVIEW AND UPDATE OF MITIGATION GOALS AND OBJECTIVES

This section documents the efforts to update the hazard mitigation goals and objectives to reduce or avoid long-term vulnerabilities to the identified hazards.

6.4.1 Goals and Objectives

According to 44 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*." Further, FEMA mitigation planning guidance recommends establishing objectives to better tie mitigation goals to specific mitigation strategies (e.g. projects, activities, and initiatives).

For the purposes of this HMP update, goals are defined as follows:

Goals are general guidelines that explain what is to be achieved. They are usually broad, long-term, policy-type statements and represent global visions. Goals help define the benefits the HMP is trying to achieve. The success

of the HMP, 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).

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.

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.

During the 2019 plan update process, the Steering Committee reviewed the goals and objectives established in the 2014 HMP in consideration of the hazard events and losses since the 2014 plan, the updated hazard profiles and vulnerability assessment, the goals and objectives established in the State of New Jersey 2014 HMP, and county and local risk management plans. The update incorporates direct input for how the county and municipalities need to move forward to best manage their hazard risk. Amendments include additions and edits to goals and objectives to express the planning partnership's interests in integrating this plan with other planning mechanisms/programs and to support mitigation through the protection and preservation of natural systems, including particular reference to certain goals and objectives in the State of New Jersey 2014 HMP update, as identified in the table below.

As a result of this review process, the goals and objectives for the 2019 update were amended, as presented in Table 6-1. *Italicized* text indicates the updates for this plan.

Table 6-1. Burlington County Hazard Mitigation Plan Goals and Objectives

		Goals					
Obj. #	Objective Statement	Protect Life	Protect Property	Promote a Sustainable Economy	Protect the Environment	Increase Public Awareness	*Support continuity of operations*
O-1	Promote disaster-resistant development.	x	x	x	x		x
O-2	Build and support local capacity to enable the public to prepare for, respond to, and recover from disasters.	x	x	x		x	x
O-3	Reduce the possibility of damages to emergency facilities from natural hazards.	x	x	x			
O-4	Reduce the possibility of damage and losses due to natural hazards affecting the county and its municipalities.	x	x	x	x		x
O-5	Educate the public on the risk from natural and man-made hazards and increase their awareness of preparation, mitigation, response, and recovery activities.	x	x			x	x

Obj. #	Objective Statement	Goals					
		Protect Life	Protect Property	Promote a Sustainable Economy	Protect the Environment	Increase Public Awareness	*Support continuity of operations*
O-6	Increase communications before, during, and after natural hazard events.	x	x	x	x	x	x
O-7	Retrofit, acquire, or relocate vulnerable property in high hazard areas including those known to be subject to repetitive damages.	x	x	x	x		
O-8	Utilize the best available information on hazard exposure and vulnerability to support appropriate land use decisions within Burlington County.	x	x	x	x	x	x
O-9	*Increase local government official awareness regarding funding opportunities for mitigation and participating/contributing to future plan updates*	x	x	x		x	x

6.5 CAPABILITY ASSESSMENT

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. This assessment is an integral part of the planning process. The assessment process enables identification, review, and analysis of current local and state programs, policies, regulations, funding, and practices that could either facilitate or hinder mitigation.

During the original planning process, the county and participating municipalities 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 may exist on undertaking actions
- The range of local and/or state administrative, programmatic, regulatory, financial, and technical resources available to assist in implementing their mitigation actions
- Actions currently outside the scope of capabilities
- Types of mitigation actions that may 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.

County and municipal capabilities in the Planning and Regulatory, Administrative and Technical, and Fiscal arenas can be found in the Capability Assessment section of each jurisdictional annex in Section 9 (Jurisdictional Annexes). 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*). 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).

A summary of the various federal, state, county, and local planning and regulatory, administrative and technical, and fiscal programs available to promote and support mitigation and risk reduction in Burlington County are presented below.

6.5.1 Planning and Regulatory Capabilities – County and Local

Burlington County Highway Master Plan (October 2017)

Burlington County has grown by more than 50,000 residents and 25,000 jobs since the county last prepared a Highway Master Plan in 1989. An almost equal number of people and jobs are forecasted to be added by the Year 2040. The Delaware Valley Regional Planning Commission (DVRPC) was commissioned to update the Highway Master Plan to supply a vision and implementation framework for the county highway network that can sustainably complement long-term county growth patterns.

The County Route (CR) network is vital to everyday movement in the county, and it plays an important role in interconnecting with the New Jersey Turnpike and interstate highway system. The CR Network carries NJ Transit and BurLink bus routes, provides access to stations along the NJ Transit RiverLINE, and serves as a scenic route network in the Pinelands.

Burlington County Parks and Open Space Master Plan (2002)

The Burlington County Parks and Open Space Master Plan was prepared to set forth a short- and long-term strategy for the acquisition of open space and the development of a parks system that will meet the region's recreational needs. The plan provides a vision for the communities in the county and recommended policies, actions, and strategies to be implemented by the county, local, state and federal agencies, as well as private and non-profit sectors. The plan can be viewed online: http://www.co.burlington.nj.us/599/Future-Parks-Current-Projects

6.5.2 Planning and Regulatory Capabilities – State and Federal

National Flood Insurance Program (NFIP)

The U.S. Congress established the NFIP with the passage of the National Flood Insurance Act of 1968 (FEMA's 2002 National Flood Insurance Program (NFIP): Program 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. Please refer to the Flood Hazard Profile in Section 5.4.2 (Flood) for information on recent legislation related to reforms to the NFIP.

There are three components to the NFIP: flood insurance, floodplain management, and flood hazard mapping. Communities participate in the NFIP by adopting and enforcing floodplain management ordinances to reduce future flood damage. In exchange, the NFIP makes federally backed flood insurance available to homeowners, renters, and business owners in these communities. Community participation in the NFIP is voluntary. Flood

insurance is designed to provide an alternative to disaster assistance to reduce the escalating costs of repairing damage to buildings and their contents caused by floods. Flood damage in the United States is reduced by nearly $1 billion each year through communities implementing sound floodplain management requirements and property owners purchasing flood insurance. Additionally, buildings constructed in compliance with NFIP building standards suffer approximately 80 percent less damage annually than those not built in compliance (FEMA 2008).

Thirty-nine of the 40 municipalities in Burlington County actively participate in the NFIP. The Borough of Fieldsboro does not participate in the NFIP. As of September 30, 2018, there were 3,713 NFIP policies in Burlington County. There have been 2,991 claims made, totaling over $25.1 million for damages to structures and contents. There are 185 NFIP Repetitive Loss properties and 15 Severe Repetitive Loss properties in the county. Further details on the county's flood vulnerability can be found in the flood hazard profile in Section 5.4.4 (Flood).

The state and municipalities within the NFIP could adopt higher regulatory standards when implementing the provisions of the NFIP. Refer to Section 9 (Jurisdictional Annexes) for the NFIP standards for each participating jurisdiction. Specifically identified are the following:

Freeboard: By law, the State of New Jersey requires the lowest floor to be at least one feet above the New Jersey Flood Hazard Area Design Flood elevation. In cases where the New Jersey Flood Hazard Area Design Flood elevation does not exist, two feet above the FEMA Base Flood Elevation is required. Communities could go beyond this requirement, providing for additional freeboard.

Cumulative Substantial Improvements/Damages: The NFIP allows improvements valued at up to 50 percent of the building's pre-improvement value to be permitted without meeting the flood protection requirements. Over the years, a community could issue a succession of permits for different repairs or improvement to the same structures. This can greatly increase the overall flood damage potential for structures within a community. In New Jersey, all new construction, additions, improvements must meet current flood protection requirements. If more than 50-percent of a structure is replaced, the entire structure must meet new flood protection requirements. The community might wish to deem *substantial improvement* cumulatively so that once a threshold of improvement within a certain length of time is reached, the structure is considered to be substantially improved and must meet flood protection requirements.

NFIP Community Rating System (CRS)

As an additional component of the NFIP, the Community Rating System (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 (FEMA 2012). Municipalities, and the county as a whole, could expect significant cost savings on premiums if enrolled in the CRS program.

As of October 2018, the City of Burlington (Class 7) and the Borough of Palmyra (Class 7) are actively participating in the CRS program. Other communities in Burlington County noted they explored the possibility of participating, but the program savings would not be cost-beneficial in the long run.

State of New Jersey Hazard Mitigation Plan

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 Burlington County to promote mitigation. The State of New Jersey HMP was used as a resource in developing Burlington County's HMP update.

Critical Area Protection Policy

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.

Land Use Planning Policy

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 shall adopt and may 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.

6.5.3 Administrative and Technical Capabilities – County and Local

Burlington County Department of Public Safety

Seven divisions make up the Department of Public Safety: central communications, communications support division, emergency management, emergency services training center, fire marshal, forensics department, and information technology public safety division.

Office of Emergency Management

The Burlington County Office of Emergency Management (OEM) coordinates, maintains and administers emergency management and homeland security practices, through education in the areas of mitigation, preparedness, response, recovery, detection, prevention, and protection. The Burlington County OEM assists local agencies in the establishment of their emergency operations plan, which is then sent on to the NJOEM for final approval. The Burlington County OEM also files all municipal applications for state and/or federal disaster relief funding. The Burlington County OEM is leading the 2019 HMP update. As mitigation grant funding

becomes available, the Burlington County OEM distributes information to the local offices of emergency management at LEPC quarterly meetings.

The Burlington County Office of Emergency Management utilizes several services to notify the public of important and timely information. This information is disseminated by a variety of methods depending upon the type of information that is being given. The county uses Swift911 Emergency Notification System. This system is used to keep residents informed during fires, outages, floods, hurricanes, evacuations, road closures, etc. All notifications are delivered for the sole purpose of delivering emergency messages and public notifications that are time sensitive in order to increase the safety and security within Burlington County. The county also uses Nixle which keeps residents up-to-date with relevant information from local public safety departments and schools and used widely throughout Burlington County.

Register Ready is another tool Burlington County uses to allow county residents with disabilities or access and functional needs and their families, friends, caregivers and associates an opportunity to provide information to emergency response agencies so emergency responders can better plan to serve them in a disaster or other emergency.

The Office of Emergency Management division of the department provides information on their website that can assist with personal safety and preparedness efforts, and further identifies what it means to be prepared and how to do it effectively. They offer helpful guides and tools for what to do during natural and man-made hazard events and includes guidance on developing a family disaster plan. This information can be found here: http://www.co.burlington.nj.us/452/Emergency-Preparedness

Burlington County Department of Public Works

The Burlington County Department of Public Works is divided into five divisions: engineering, mosquito control, planning board, roads & bridges, and stormwater. Burlington County Department of Public Works Roads and Bridges Division maintains, repairs, and replaces the 364 bridges and 700 culverts throughout the county including guardrails, bridges, culverts, pipes, and dams. The division is also responsible for ice and snow removal of county roads and bridges. Additionally, the division is responsible for trimming limbs and removal of dead trees along county roads. The stormwater division maintains, inspects, and cleans the stormwater systems on county roads and within the right-of-way. The section also cleans and maintains roadside ditches on county roads. The engineering division is responsible for maintaining and improving the county's roadways and bridges including through the use of Intelligent Transportation System (ITS) technologies.

Sustainable Jersey

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 prestigious designation for municipal governments in New Jersey. Municipalities that achieve the certification are considered by their peers, by state government and by the experts and civic organizations in New Jersey, to be among the leading municipalities. 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.

Burlington County Bridge Commission

The Burlington County Bridge Commission was established in 1948. The Commission owns, operates, and maintains the Tacony-Palmyra and Burlington-Bristol Bridges, as well as six smaller bridges: Riverside-Delanco

Bridge, Pennsauken Creek Bridge, Route 73 Overpass, Pompeston Creek Bridge, and Twin Pipe Culvert. Additionally, the Commission provides economic development and regional planning to Burlington County. They coordinate planning at regional and local levels in Burlington County. Services provided include: professional services for regional planning in Burlington County; municipal planning services, (e.g. master plans, zoning ordinances, redevelopment); managing and analyzing data and information for industrial sectors and market analyses; and geographic information system mapping and analyses. The Commission works with various County departments, including the Department of Resource Conservation and the Engineering Division.

Delaware Valley Regional Planning Commission (DVRPC)

The Delaware Valley Regional Planning Commission (DVRPC) is the federally designated Metropolitan Planning Organization for a nine-county region in two states: Bucks, Chester, Delaware, Montgomery, and Philadelphia in Pennsylvania; and Burlington, Camden, Gloucester, and Mercer in New Jersey. DVRPC serves as the regional planning agency for these nine counties and provides guidance and assistance to local governments and partner agencies building sustainable, livable, and health communities.

In Burlington County, DVRPC has assisted multiple communities in development a variety of plans (e.g. coastal vulnerability assessments, environmental resource inventories, open space plans, and transportation studies). For details regarding the coastal vulnerability assessments, refer to Section 9 (Jurisdictional Annexes).

6.5.4 Administrative and Technical Capabilities – State and Federal

New Jersey State Police – Office of Emergency Management (NJOEM)

The Governor of New Jersey has the overall responsibility for emergency management activities in the state. The Superintendent of the New Jersey State Police is the State Director of the NJOEM. On behalf of the Governor, all activities and departments are coordinated, directed, and controlled from the NJOEM's Emergency Operations Center.

The State Director of Emergency Management supervises, directs, and appoints deputies and/or assistants to control the daily activities of NJOEM. The function and staffing of NJOEM is with the approval of the Attorney General. The State Hazard Mitigation Officer is the representative of state government acting as the primary point of contact with FEMA, other federal agencies, and county and local units of government in the planning and implementation of pre- and post-disaster mitigation programs and activities required under the Stafford Act.

Recovery Bureau

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.

The Public Assistance Unit accepts and reviews applications for funds for emergency work submitted by local individuals, households, and businesses, as well as from local governments during and immediately after a disaster. The 2013 reorganization of the Recovery Bureau added a dedicated Finance Unit to support the fiscal functions of both the Public Assistance and Mitigation Units. The Finance Unit ensures timely reimbursements and fiduciary responsibility.

Mitigation Unit

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.

Preparedness Bureau

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, accessible at http://ready.nj.gov/plan-prepare/index.shtml. The disaster preparedness and 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.

Hazard Mitigation Grant Program Administrative Plan

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.

New Jersey Department of Environmental Protection

Bureau of Dam Safety & Flood Control

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 provides assistance to communities participating in the NFIP and interested in joining CRS thru the NJDEP Community Assistance Program Unit.

NJDEP Dam Safety Section

The NJDEP Dam Safety Section under the Bureau of Dam Safety & 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. Eventually 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 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 the preparation of a comprehensive report (NJDEP 2012a).

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.

Division of Water Supply and Geoscience

The Division of Water Supply and Geoscience (Water Supply) 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. In addition, Water Supply staff act in a support role during an emergency situation to provide technical assistance, as needed to re-establish safe and adequate public water supplies.

Water Supply staff provides technical assistance to assist water systems during water supply emergencies 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 Infrastructure Trust funds. Additionally, Water Supply provides operator licensing and training support as well as financial assistance through the DWSRF program.

Water Resource Management

The Water Pollution Management Element is responsible for protecting New Jersey's surface and ground waters from pollution caused by improperly treated wastewater and its residuals. This is accomplished primarily through the implementation of the New Jersey Pollutant Discharge Elimination System (NJPDES) permit program. This includes publicly owned treatment facilities (e.g. sanitary sewerage plants) and privately owned facilities (e.g. industrial facilities) as well as facilities that discharge stormwater (e.g. municipalities and highway agencies) and stormwater related to development. The NJPDES program also regulates discharges to ground water (e.g. septic systems) and the proper management of any residuals that are generated as part of the treatment process. The varied ownership of infrastructure components is often a complicating factor in the regulation of these entities (e.g. ownership of a treatment facility by a public entity and sewer mains by a different municipal entity). The total universe of NJPDES permits includes over 7,500 permits. The Water Pollution Management Element engineering and environmental specialist staff provide technical assistance in the development, interpretation and implementation of permit conditions.

New Jersey Geological and Water Survey

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.

New Jersey Department of the State - Office of Planning Advocacy (OPA) – Business Action Center

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.

Rutgers University

Office of the New Jersey's State Climatologist

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 (NWS) Cooperative Weather Station data. These are daily 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.

New Jersey Climate Adaptation Alliance

The New Jersey Climate Adaptation Alliance (NJADAPT) was formed in response to a diverse group of stakeholders who came together on November 29, 2011, at Rutgers University to participate in the conference "Preparing New Jersey for Climate Change: A Workshop for Decision-Makers".

The Alliance 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) through:

- Conducting outreach and education of the general public and targeted sectoral leaders
- Developing recommendations for state and local actions through collaboration with policymakers at the state, federal and local levels
- Undertaking demonstration and pilot projects in partnership with the private sector, local governments, non-governmental organizations, and others
- Identifying science, research and data needs
- Developing capacity for implementation of preparedness measures and documentation of best practices (Rutgers University 2018)

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 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). NJADAPT can be accessed at http://www.njadapt.org/

6.5.5 Fiscal Capabilities – County and Local

Local Open Space Preservation Land Grant Program

Burlington County awards grants to municipalities and non-profit organizations to assist in the preservation of locally important open space, connected, recreational paths and greenways, woodlands, stream corridors, active or passive recreational areas, and environmentally sensitive areas such as wildlife habitat, floodprone areas, and wetland buffers. However, this program does not fund projects related to permanent protection of agricultural land (Burlington County Department of Parks 2002).

The program is funded a county trust fund and provides cost share funding toward the purchase price of a parcel of land, helping local governments leverage their own local open space tax dollars (Burlington County Department of Parks 2002).

Burlington County Open Space Trust Fund

The trust fund is supported by a dedicated tax of four cents per $100 of assessed valuation in any given year. This funding is estimated at about $8.6 million per year. The following 14 municipalities also have open space trust funds supported by a dedicated tax: Bordentown Township, Eastampton, Edgewater Park, Evesham, Hainesport, Lumberton, Mansfield, Medford, Moorestown, Mt. Laurel, North Hanover, Southampton, Springfield and Westampton.

6.5.6 Fiscal Capabilities – State and Federal

Federal Hazard Mitigation Funding Opportunities

Federal mitigation grant funding is available to all communities with a current HMP (this plan); however most of these grants require a "local share" in the range of 10-25 percent of the total grant amount. Details about grant programs and further descriptions of these opportunities can be found at: https://www.fema.gov/hazard-mitigation-assistance. The FEMA mitigation grant programs are described below.

Hazard Mitigation Grant Program (HMGP)

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).

Applicants who are eligible for the HMGP are state and local governments, certain nonprofit organizations or institutions that perform essential government services, and Indian tribes and authorized tribal organizations. Individuals or homeowners cannot apply directly for the HMGP; a local government must apply on their behalf. Applications are submitted to NJOEM, placed in rank order for available funding, and submitted to FEMA for

final approval. Eligible projects not selected for funding are placed in an inactive status and could be considered as additional HMGP funding becomes available.

Additional information regarding the HMGP is available on the FEMA website: https://www.fema.gov/hazard-mitigation-grant-program.

Flood Mitigation Assistance (FMA) Program

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

Pre-Disaster Mitigation (PDM) Program

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.

In some cases, whereby the local HMP is under development, but not formally approved by FEMA, the jurisdiction can request a Letter of Extraordinary Circumstance to enable consideration of the grant application. According to the FEMA Hazard Mitigation Assistance Guidance (2015), for Hazard Mitigation Grant Program (HMGP) project subawards, the FEMA Regional Administrator might grant an exception to the local mitigation plan requirement in extraordinary circumstances when justification is provided. If this exception is granted, a local mitigation plan must be approved by FEMA within 12 months of the award of the project subaward to that community. For Pre-Disaster Mitigation (PDM) and Flood Mitigation Assistance (FMA) project subawards, the FEMA Region could grant an exception to the local mitigation plan requirement in extraordinary circumstances.

The PDM program is detailed on the FEMA website: https://www.fema.gov/pre-disaster-mitigation-grant-program .

Extraordinary Circumstances

For PDM and FMA project subawards, the FEMA Region might apply extraordinary circumstances when justification is provided and with concurrence from FEMA Headquarters (Risk Reduction and Risk Analysis Divisions) prior to granting an exception. If this exception is granted, a local mitigation plan must be approved by FEMA within 12 months of the award of the project subaward to that community.

For HMGP, PDM, and FMA, extraordinary circumstances exist when a determination is made by the applicant and FEMA that the proposed project is consistent with the priorities and strategies identified in the State (Standard or Enhanced) Mitigation Plan and that the jurisdiction meets at least one of the criteria below. If the jurisdiction does not meet at least one of these criteria, the region must coordinate with FEMA Headquarters

(Risk Reduction and Risk Analysis Divisions) for HMGP; however, for PDM and FMA the region must coordinate and seek concurrence prior to granting an exception. The criteria are as follows:

- The jurisdiction meets the small impoverished community criteria (see Part VIII, B.2 of HMA Unified Guidance).
- The jurisdiction has been determined to have had insufficient capacity due to lack of available funding, staffing, or other necessary expertise to satisfy the mitigation planning requirement prior to the current disaster or application deadline.
- The jurisdiction has been determined to have been at low risk from hazards because of low frequency of occurrence or minimal damage from previous occurrences as a result of sparse development.
- The jurisdiction experienced significant disruption from a declared disaster or another event that impacts its ability to complete the mitigation planning process prior to award or final approval of a project award.
- The jurisdiction does not have a mitigation plan for reasons beyond the control of the state, federally-recognized tribe, or local community, such as Disaster Relief Fund restrictions that delay FEMA from granting a subaward prior to the expiration of the local or tribal mitigation plan.

For HMGP, PDM, and FMA, the applicant must provide written justification that identifies the specific criteria or circumstance listed above, explains why there is no longer an impediment to satisfying the mitigation planning requirement, and identifies the specific actions or circumstances that eliminated the deficiency.

When an HMGP project funding is awarded under extraordinary circumstances, the recipient shall acknowledge in writing to the Regional Administrator that a plan will be completed within 12 months of the subaward. The recipient must provide a work plan for completing the local or tribal mitigation plan, including milestones and a timetable, to ensure that the jurisdiction will complete the plan in the required time. This requirement shall be incorporated into the award (both the planning and project subaward agreements, if a planning subaward is also awarded).

Federal and State Disaster and Recovery Assistance Programs

Following a disaster, various types of assistance could be made available by local, state, and federal governments. The types and levels of disaster assistance depend on the severity of the damage and the declarations that result from the disaster event. The following sections detail the general types of assistance that might be provided should the President of the United States declare the event a major disaster.

Individual Assistance (IA)

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.

Public Assistance (PA)

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.

Small-Business Administration (SBA) Loans

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.

Department of Homeland Security Grant Program (HSGP)

The 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. The FY 2017 HSGP supports efforts to build and sustain core capabilities across the Prevention, Protection, Mitigation, Response, and Recovery mission areas. This includes two priorities: building and sustaining law enforcement terrorism prevention capabilities and maturation and enhancement of state and major urban area fusion centers (HSGP 2017). HSGP is comprised of three interconnected grant programs including the State Homeland Security Program (SHSP), Urban Areas Security Initiative (UASI), and the Operation Stonegarden (OPSG). Together, these grant programs fund a range of preparedness activities, including planning, organization, equipment purchase, training, exercises, and management and administration. Additional information regarding HSGP is available on the website: https://www.fema.gov/homeland-security-grant-program.

Community Development Block Grants (CDBG)

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/.

U.S. Economic Development Administration

The U.S. Economic Development Administration (USEDA) is an agency of the U.S. Department of Commerce that supports regional economic development in communities around the country. It provides funding to support

comprehensive planning and makes strategic investments that foster employment creation and attract private investment in economically distressed areas of the United States. Through its Public Works Program, USEDA invests in key public infrastructure, such as traditional public works projects, including water and sewer systems improvements, expansion of port and harbor facilities, brownfields, multitenant manufacturing and other facilities, business and industrial parks, business incubator facilities, redevelopment technology-based facilities, telecommunications facilities, and development facilities. Through its Economic Adjustment Program, USEDA administers its Revolving Loan Fund Program, which supplies small businesses and entrepreneurs with the gap financing needed to start or expand their business in areas that have experienced or are under threat of serious structural damage to the underlying economic base. Additional information is available on the USEDA website: https://www.eda.gov/.

Federal Highway Administration - Emergency Relief

The Federal Highway Administration Emergency Relief is a grant program that can be used for repair or reconstruction of Federal-aid highways and roads on Federal lands which have suffered serious damage as a result of a disaster. New Jersey serves as the liaison between local municipalities and FHWA. $30 Million in funding was released in October-November of 2012 for emergency repair work conducted in first 180 days following Hurricane Sandy. Another $220 Million in additional funding became available February 2013. For information regarding the FHWA Emergency Relief Program, please refer to: https://www.fhwa.dot.gov/programadmin/erelief.cfm

Federal Transit Administration - Emergency Relief

The Federal Transit Authority 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. Department of Transportation and directly allocated to 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.

New Jersey Green Acres Program

The Green Acres Program was created in 1961 to meet New Jersey's growing recreation and conservation needs. The program is committed to preserve the natural, historic, and cultural heritage of New Jersey. Hundreds of thousands of acres of conservation and recreation lands have been preserved, and hundreds of public parks have been developed with Green Acres funds (NJDEP 2019). The program administers four basic land preservation programs:

- State acquisition program (land preservation initiated by the state);
- Grants/Loans to municipal and county governments (to assist in specific land preservation and recreational development projects);
- Planning Incentive Grants program (provides grants/loans to county and municipal governments to fund preservation of land included in a detailed local open space preservation plan); and
- Nonprofit matching grants program (Green Acres provides nonprofit organization with a matching grant to help fund fee simple, easement purchases, or recreational development).

In Burlington County, the Green Acres Program offers up to 100-percent of a project's cost through grants and loans. Municipalities with a dedicated tax have the potential to receive a 50-percent grant from the Green Acres Program for each approved project location. The county encourages municipalities to apply for Green Acres funds to further leverage local and county preservation dollars. As of February 2019, Burlington County has a

total of over 380 parks and open space areas funded through the Green Acres Program (Burlington County Department of Parks 2002).

New Jersey Environmental Infrastructure Trust (NJEIT)

The New Jersey Environmental Infrastructure Trust (NJEIT) is an independent state financing authority that provides low-interest rate loans to qualified borrowers in New Jersey for water quality and infrastructure projects. The NJEIT, partnering with NJDEP, offers short-term financing (bridge loans) and long-term disaster-recovery loan assistance.

New Jersey Economic Development Authority (NJEDA)

The New Jersey Economic Development Authority (NJEDA) is an independent state agency that provides tax incentives to foster development and employment growth and retention, financing for small and mid-sized businesses, revitalizes communities through redevelopment initiatives, and supports entrepreneurial development by providing access to training and mentoring programs. With its large portfolio of some 30 varied programs and services, NJEDA can assist businesses, non-profits and developers to access capital, including tax-exempt and taxable bond financing, loans, loan guarantees, and business and tax incentives.

New Jersey Redevelopment Authority (NJRA)

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.

New Jersey Housing and Mortgage Finance Agency (NJHMFA)

The New Jersey Housing and Mortgage Finance Agency (NJHMFA) is an independent state financing authority that provides affordable home ownership and housing opportunities for New Jersey residents by funding affordable home mortgages for first-time home buyers, promoting construction and rehabilitation of rental housing, and encouraging mixed-income owner-occupied housing growth. NJHMFA provides low-interest financing and administers low-income housing tax credits for the State of New Jersey's low and moderate income communities.

New Jersey Department of Community Affairs (NJDCA)

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-DR funding recipient for the State of New Jersey.

New Jersey Department of Environmental Protection Grant and Loan Programs

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/

6.6 MITIGATION STRATEGY DEVELOPMENT AND UPDATE

6.6.1 Update of Municipal Mitigation Strategies

To evaluate progress on local mitigation actions, each municipality with actions in previous DMA 2000 or related plans, including those who participated in the 2014 HMP, was provided with a Mitigation Action Plan Review Worksheet. Each worksheet was pre-populated with those actions identified for their jurisdiction in the prior plan. For each action, municipalities were asked to indicate the status of each action (*No Progress/Unknown, In Progress/Not Yet Complete, Ongoing Capability, Completed, or Discontinued*), and provide review comments on each. Municipalities were requested to quantify the extent of progress, and provide reasons for the level of progress or why actions were discontinued. Each jurisdictional annex provides a table identifying their 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, have been removed from the updated strategies. Those local actions that municipalities identified as *No Progress/Unknown, In Progress/Not Yet Complete*, as well as certain actions/initiatives identified as *Continuous* or *Ongoing Capability*, have been carried forward in their jurisdiction's updated mitigation strategies if still deemed appropriate and a priority. Municipalities were asked to provide further details on these projects to help better define the projects, identify benefits and costs, and improve implementation.

Certain continuous or ongoing strategies represent programs that are, or since the 2014 HMP have become, fully integrated into the normal operational and administrative framework of the community. Such programs and initiatives have been identified within the Capabilities section of each annex, and removed from the updated mitigation strategy.

At the Kick-Off and during subsequent local-level planning meetings, all participating municipalities were further surveyed to identify mitigation activities completed, ongoing, and potential/proposed. As new additional 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 3 (Planning Process), communities were made aware of these either through direct communication (local meetings, email, phone) or via their draft municipal annexes.

To help support the selection of an appropriate, risk-based mitigation strategy, each annex provided a summary of hazard vulnerabilities identified during the plan update process, either directly by municipal representatives or through review of available county and local plans and reports, and through the hazard profiling and vulnerability assessment process.

Beginning in September 2017, members of the Planning Committee and the planning consultant worked directly with each community (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).

Concerted efforts were made to assure that municipalities develop updated mitigation strategies that included activities and initiatives covering the range of mitigation action types described in recent FEMA planning guidance (FEMA's *Local Mitigation Planning Handbook* March 2013). This specifically includes:

- ***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 also involves projects to construct man-made structures to reduce the impact of hazards.
- ***Natural Systems Protection*** – These are actions that minimize damage and losses, and also 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 may also include participation in national programs, such as the NFIP and CRS, StormReady (NOAA) and Firewise (NFPA) Communities.

A mitigation strategy workshop was conducted by NJOEM and FEMA Region II representatives on March 1, 2018 for all participating jurisdictions to support the identification, evaluation, and prioritization of local mitigation strategies, as well as how to present and document this process within the plan. The following significant modifications to the mitigation strategy identification, update, and documentation process were made:

- An overarching effort has been made to better focus local mitigation strategies to clearly defined, readily actionable projects and initiatives that meet the definition or characteristics of mitigation.
- Per NJOEM's advice, broadly defined mitigation objectives were maintained if the community felt it were appropriate to ensure eligibility in the future. For example, if a community has numerous RL properties however specific projects/property-owner interest is not solidified at this time, a general action was maintained to ensure future eligibility.
- Certain continuous or ongoing strategies that represent programs that are, or since the 2014 HMP have become, 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.
- Where applicable, mitigation projects have been documented with an action worksheet, based on FEMA's Action Worksheet templates and within recent guidance documents. These action worksheets and prioritization tables appear at the end of each jurisdiction's annex.

Overall a comprehensive-range of specific mitigation initiatives were considered by each plan participant to pursue in the future to reduce the effects of hazards. Some of these initiatives may be previous actions carried forward for this plan update. These initiatives are dependent upon available funding (grants and local match availability) and may be modified or omitted at any time based on the occurrence of new hazard events and changes in municipal priorities. Both the four FEMA mitigation action categories and the six CRS mitigation action categories are listed in the table below to further demonstrate the wide-range of activities and mitigation measures selected. Table 6-2 lists the common mitigation actions identified across a majority of the communities.

Table 6-2. Comprehensive Range of Mitigation Actions

Jurisdiction	Preventative	Property Protection	Natural Resource Protection	Emergency Services	Structural Projects	Public Information
Burlington County	X	X	X	X	X	X
Township of Bass River	X	X		X	X	X
City of Beverly	X	X	X	X	X	X
City of Bordentown	X	X	X	X	X	X

Jurisdiction	Preventative	Property Protection	Natural Resource Protection	Emergency Services	Structural Projects	Public Information
Township of Bordentown	X	X	X	X	X	X
City of Burlington	X	X	X	X	X	X
Township of Burlington	X	X			X	X
Township of Chesterfield	X	X		X		X
Township of Cinnaminson	X	X	X	X	X	X
Township of Delanco	X	X	X	X	X	X
Township of Delran	X	X	X	X		X
Township of Eastampton	X	X	X	X	X	X
Township of Edgewater Park	X		X	X	X	X
Township of Evesham	X	X	X	X		X
Borough of Fieldsboro	X			X		X
Township of Florence	X	X		X	X	X
Township of Hainesport	X	X		X		X
Township of Lumberton	X	X	X		X	X
Township of Mansfield	X			X		X
Township of Maple Shade	X	X				X
Township of Medford	X	X	X	X	X	X
Borough of Medford Lakes	X	X			X	X
Township of Moorestown	X	X				X
Township of Mount Holly	X	X		X	X	X
Township of Mount Laurel	X	X		X	X	X
Township of New Hanover	X			X		X
Township of North Hanover	X	X		X	X	X
Borough of Palmyra		X			X	
Borough of Pemberton	X			X	X	X
Township of Pemberton	X	X			X	X
Township of Riverside	X	X	X	X	X	X
Borough of Riverton		X		X		
Township of Shamong	X	X		X		X
Township of Southampton	X	X	X	X	X	
Township of Springfield	X	X				X
Township of Tabernacle	X	X				X
Township of Washington	X	X		X	X	X

Jurisdiction	Preventative	Property Protection	Natural Resource Protection	Emergency Services	Structural Projects	Public Information
Township of Westampton	X	X			X	X
Township of Willingboro	X			X		X
Township of Woodland	X	X		X		X
Borough of Wrightstown	X	X				

6.6.2 Strengths, Weaknesses, Opportunities, and Obstacles (SWOO)

In March 2018, one Strengths, Weaknesses, Opportunities, and Obstacles (SWOO) session was held with the Planning Committee. The purpose of this session was to identify strengths, weaknesses, opportunities and obstacles in hazard mitigation within Burlington County through a facilitated brainstorming session on risks, vulnerabilities, and capabilities. These meetings were the basis for considering and selecting mitigation actions.

All information shared during these sessions were recorded and used to prepare a catalog representing a comprehensive range of mitigation alternatives to be used by the Planning Committee in preparing their individual jurisdictional annexes, as well as complying with Step 7 of the CRS 10-step process. Many of the strategies (such as community outreach) identified in the catalog could be applied to multiple hazards. This 2019 HMP update identifies strategies for multiple hazards for Burlington County and each jurisdictional annex for participating jurisdictions (Section 9).

The Planning Committee generated a mitigation catalog which includes a comprehensive list of mitigation actions (see Appendix H – Mitigation Catalog) to be considered that met the following objectives:

- Use information obtained from the public involvement strategy
- Use information provided in the risk assessment
- Seek mitigation actions consistent with the goals and objectives for the Burlington County HMP
- Create catalogs of mitigation actions to be used as a tool by the Planning Committee in selection of mitigation actions

Catalog of Mitigation Alternatives

Based on information gathered during the SWOO session, a catalog of mitigation alternatives was created listing initiatives that could manipulate the hazard, reduce exposure to the hazard, reduce vulnerability to the hazard, and to increase the ability to respond to or be prepared for a hazard (Appendix F). In addition, the catalog indicates responsibility for implementation (i.e., who would most likely implement the initiative: personal property owners, private sector business, or government) and what the alternative would accomplish. Based on the risk assessment, the hazards included in the catalog are deemed to be those to which the planning area is most vulnerable.

The catalog is not meant to be exhaustive or site-specific but rather to inspire thought and provide members of the Planning Committee a baseline of initiatives backed by a planning process, consistent with the goals and objectives of the planning area, and within the capabilities of the participants. The Planning Committee was not bound to these actions. They had the opportunity to add further actions subsequent to the SWOO workshops. Actions in the catalog that were not selected by the partners to include in their jurisdictional annexes were not selected based on the following:

- Action is currently outside the scope of capabilities (funding)

- The jurisdiction is not vulnerable to the hazard
- Action is already being implemented

All proposed mitigation actions were identified in relation to the goals and objectives presented above. The mitigation actions include a range of options in line with the four types of mitigation actions described in FEMA guidance (FEMA's *Local Mitigation Planning Handbook* March 2013); discussed further below.

6.6.3 Update of County Mitigation Strategies

The update of the county-level mitigation strategies included a review of progress on the actions/initiatives identified in the 2014 HMP using a process similar to that used to review municipal mitigation strategy progress. The county, through their various department representatives, was provided with a Mitigation Action Plan Review Worksheet identifying all county-level actions and initiatives from the 2014 plan. The county reviewed each action and provided progress. For each action, relevant county representatives were asked to indicate the status of each action (*No Progress/Unknown*, *In Progress/Not Yet Complete*, *Continuous*, *Completed*, or *Discontinued*), and provide review comments on each.

Projects/initiatives identified as "*Complete*", as well as those actions identified as *Discontinued*, have been removed from this plan update. Those actions the county has identified as *No Progress/Unknown*, *In Progress/Not Yet Complete,* or *Continuous* have been carried forward in the county's updated mitigation strategy. Actions considered ongoing capabilities were marked as *Discontinued* and included in the plan as ongoing capabilities.

Throughout the course of the 2019 HMP update process, additional regional and county mitigation actions have been identified. These were identified through:

- Review of the results and findings of the updated risk assessment
- Review of the findings of the SWOO
- Review of available regional and county plans, reports, and studies
- Direct input from county departments, including:
    - Department of Public Safety's Office of Emergency Management
    - Department of Public Works - Engineering
    - Department of Planning

6.6.4 Mitigation Strategy Evaluation and Prioritization

Section 201.6(c)(3)(iii) of the 44 CFR requires an action plan describing how the identified actions will be prioritized. Recent FEMA planning guidance (March 2013) identifies a modified Social, Technical, Administrative, Political, Legal, Economic, and Environmental (STAPLEE) mitigation action evaluation methodology that uses a set of 10 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 particular mitigation action.

Based on this guidance, the Steering and Planning Committees have developed and applied an action evaluation and prioritization 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 2019 HMP update process are:

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 municipality 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)? Or 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 or 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 all mitigation actions identified in the 2019 HMP update (previously identified actions that were carried forward and new mitigation actions). 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 brief summary of the rationale behind the numeric rankings assigned, as applicable. The numerical results of this exercise were then used by each jurisdiction to help prioritize the action or strategy as *Low, Medium*, or *High*. While this provided a consistent, systematic methodology to support the evaluation and prioritization of mitigation actions, jurisdictions may have additional considerations that could influence their overall prioritization of mitigation actions.

For the 2019 HMP update there has been an effort to develop more clearly defined and action-oriented mitigation strategies. These local strategies include projects and initiatives that have been well-vetted, and are seen by the community as the most effective approaches to advance their local mitigation goals and objectives within their capabilities. As such, many of the initiatives in the updated mitigation strategy were ranked as *High* or *Medium* priority, as reflective of the community's clear intent to implement, available resources not-withstanding. In

general, initiatives that would have had *Low* priority rankings were appropriately screened out during the local action evaluation process.

6.6.5 Benefit/Cost Review

Section 201.6(c)(3)(iii) of the 44 CFR requires the prioritization of the action plan to emphasize the extent to which benefits are maximized according to a benefit/cost 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 for the evaluation and prioritization of projects and initiatives in this 2019 HMP 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 grant programs. For all actions identified in the local strategies, jurisdictions have identified both the costs and benefits associated with a project, action, or initiative.

Costs are the total cost for the action or project, and may 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 may include life-safety, structure and infrastructure damages, loss of service or function, and economic and environmental damage and losses.

When available, jurisdictions were asked to identify the actual or estimated dollar value for project costs and associated benefits. Having defined costs and benefits allows a direct comparison of benefits versus costs, and a quantitative evaluation of project cost-effectiveness. Often, however, numerical costs and/or benefits have not been identified, or may be impossible to quantitatively assess.

For the purposes of this planning process, jurisdictions were tasked with evaluating project cost-effectiveness with both costs and benefits assigned to "High," "Medium," and "Low" ratings. Where quantitative estimates of costs and benefits were available, ratings/ranges were defined as:

- 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 definitions presented in Table 6-3 were used.

Table 6-3. 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, etc.) are considered cost-beneficial and are prioritized accordingly. The action plan was prioritized according to the benefit/cost analysis, funding availability and the immediacy of the need for each project (CRS Step 8).

For some of the Burlington County initiatives identified, the Planning Committee may seek financial assistance under FEMA's HMGP or 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 Committee 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 Committee reserves the right to define "benefits" according to parameters that meet its needs and the goals and objectives of this HMP.

SECTION 7. PLAN MAINTENANCE

2019 HMP Update Changes

- A plan maintenance matrix has been added to summarize maintenance tasks over the performance period of the 2019 HMP.
- The BATool[SM] has been introduced as a tool to report mitigation action progress.
- A modified safe growth check list has been incorporated as a tool for municipalities to use to document how they are utilizing and incorporating the Burlington County HMP into their day-to-day operations and planning and regulatory processes.
- A subsection discussion grant monitoring and coordination has been included in the plan maintenance strategy.

7.1 INTRODUCTION

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.	July to 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 municipal 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 and municipal 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	Finalized progress report completed by	Steering Committee; Plan Maintenance element	Jurisdictional points of contacts identified in Section 9

Task	Approach	Timeline	Lead Responsibility	Support Responsibility
	support to assess the effectiveness of the plan; compile and finalize the Annual Progress Report	September 30 of each year		(Jurisdictional Annexes)
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	Burlington County HMP Coordinator	Jurisdictional points of contacts identified in Section 9 (Jurisdictional Annexes)

7.2 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 Planning Committee and be the 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 Burlington County HMP Coordinator is designated as:

Kevin Shoppas, Emergency Management Coordinator
Burlington County Department of Public Safety
1 Academy Drive, Westampton, NJ 08060
Email: kshoppas@co.burlington.nj.us

7.2.1 Monitoring

The planning partnership (Steering and Planning Committees) 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 adoption, Burlington County and 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. They will be responsible for contacting persons responsible for initiating and/or overseeing the mitigation projects.

In the first year of the 2019 HMP performance period, the BATool[SM] will be used to document mitigation action progress by municipal and county representatives. The status of each project, successes or obstacles to implementation, and the addition and/or deletion of projects will be documented directly in the program. The HMP Coordinator will notify participating partners to update progress on a quarterly basis, 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 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 Steering and Planning Committee 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,
- Progress on the implementation of mitigation actions, including efforts to obtain outside funding,
- Obstacles or impediments to implementation of actions,
- Additional mitigation actions believed to be appropriate and feasible, and
- Public and stakeholder input.

Plan monitoring for years 2 through 4 of the plan performance period will be similarly addressed via the BATool[SM] or manually.

7.2.2 Integration Process of the HMP into Municipal Planning Mechanisms

Hazard mitigation is sustained action taken to reduce or eliminate the long-term risk to human life and property from natural hazards. Integrating hazard mitigation into a community's existing plans, policies, codes, and programs leads to development patterns that do no increase risk from known hazards or leads to redevelopment that reduces risk from known hazards. The Burlington 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 municipality. During this process, many municipalities recognized the importance and benefits of incorporating hazard mitigation into future municipal planning and regulatory processes.

The Planning Partnership representatives will incorporate mitigation planning as an integral component of daily government operations. 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 (Section 2 – 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, Master 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.

During the HMP annual review process, each participating municipality will be asked to document how they are utilizing and incorporating the Burlington County HMP into their day-to-day operations and planning and regulatory processes. Additionally, each municipality 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 municipalities 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 activities will evolve into an ongoing culture within the county and its municipalities.

Table 7-2. Safe Growth Check List

Planning Mechanisms	Do you Do This? Yes	No	Notes: How is it being done or how will this be utilized in the future?
Operating, Municipal 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.			
• Annually, during adoption process, the municipality 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 municipality 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?			

Planning Mechanisms	Do you Do This? Yes	No	Notes: How is it being done or how will this be utilized in the future?
• 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			
• 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?			
Comprehensive/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?			

Planning Mechanisms	Do you Do This? Yes	No	Notes: How is it being done or how will this be utilized in the future?
• 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?			
• 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.			
Municipal Ordinances			
• When updating municipal 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 municipality have any public outreach mechanisms / programs in place to inform citizens on natural hazards, risk, and ways to protect themselves during such events?			

7.2.3 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 Planning Committee, 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 HMP Coordinator will advise Planning Committee members of the meeting date, agenda and expectations of the members.

The 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 or municipal 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 Committee will review the mitigation goals, objectives, and activities using performance-based indicators, including:

- New agencies/departments
- Project completion
- Under/over spending
- Achievement of the goals and objectives
- Resource allocation
- Timeframes
- Budgets
- Lead/support agency commitment
- Resources
- Feasibility

Finally, the Planning Committee 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
- Parks and recreation
- Land use/zoning
- Public education and outreach
- Transportation
- Redevelopment plans (e.g. Brownfields)

The Planning Committee 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 E – FEMA Worksheets). Further, the Planning Committee 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 HMP Coordinator shall be responsible for preparing an Annual HMP Progress Report for each year, based on the information provided by the local Planning Committee members information presented at the annual Planning Committee 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 Committee 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 Burlington County Department of Public Safety website to keep the public apprised of the plan's implementation (http://www.co.burlington.nj.us/462/All-Hazards-Mitigation-Plan). 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 Committee will strive to complete the review process and prepare an Annual HMP Progress Report by the end of September 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 5.4 (Hazard Profiles) of this plan has been collected to facilitate the risk assessment. This is an opportunity to increase each community's disaster resistance and build a better and stronger community.

7.2.4 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 DMA 2000. It is the intent of the Burlington County HMP Planning Committee to update this plan on a five-year cycle from the date of initial plan adoption.

To facilitate the update process, the HMP Coordinator, with support of the planning partnership, shall use the second annual update meeting to develop and commence the implementation of a detailed plan update program. The 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 Committee shall determine what resources will be needed to complete the update. The 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 Committee members and the New Jersey State Hazard Mitigation Officer.

7.2.5 Grant Monitoring and Coordination

Burlington 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 municipal partner as part of their annual progress reporting. The HMP Coordinator will keep the planning partners apprised of Hazard Mitigation Assistance grant openings and assist in developing letters of intent for grant opportunities when practicable.

Burlington 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, Burlington 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.

The *Capability Assessment* section of Section 6 (Mitigation Strategy) 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").

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

The HMP Coordinator will strive to identify additional policies, programs, practices, and procedures that could be modified to accommodate hazard mitigation actions and include these findings and recommendations in the Progress Reporting.

7.4 CONTINUED PUBLIC INVOLVEMENT

Burlington 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.co.burlington.nj.us/462/All-Hazards-Mitigation-Plan). 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.
- 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 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 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 plan.
- Appropriate links to the Burlington County Hazard Mitigation Plan website (http://www.co.burlington.nj.us/462/All-Hazards-Mitigation-Plan) are included on municipal websites.
- Public notices are made as appropriate to inform the public of the availability of the plan, particularly during plan update cycles.

The 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 Burlington 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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