2015 All-Hazards Mitigation Plan Update for New Castle County, Delaware

(includes municipalities and the University of Delaware)

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TABLE OF CONTENTS

TABLE OF CONTENTS

TABLE OF CONTENTS

TABLE OF CONTENTS

6.2 LOCALLY-SPECIFIC MITIGATION ACTIONS

7. PLAN MAINTENANCE PROCEDURES

8. APPENDIX

All Hazard Mitigation Plan – Acknowledgements

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1. INTRODUCTION

1.1 Introduction

In an effort to reduce the Nation's mounting losses from natural disasters, the United States Congress passed the Disaster Mitigation Act of 2000 (DMA 2000) to provide new and revitalized approaches to mitigation planning. Section 322 of DMA 2000 emphasizes the need for state and local entities to closely coordinate mitigation planning and makes the development of a hazard mitigation plan a specific eligibility requirement for any local government applying for Federal mitigation grant funds. These funds include the Hazard Mitigation Grant Program (HMGP) and the newly created Pre-Disaster Mitigation (PDM) program, both of which are administered by the Federal Emergency Management Agency (FEMA). Communities with an adopted and Federally approved hazard mitigation plan thereby become pre-positioned and more apt to receive available mitigation funds before and after the next disaster strikes.

This 2015 Plan Update is conducted in coordination with the Federal Emergency Management Agency (FEMA) and the Delaware Emergency Management Agency (DEMA) to ensure that it meets all applicable DMA 2000 planning requirements. A Local Mitigation Plan Review Tool, located in this document, provides a summary of FEMA's current minimum standards of acceptability and notes the location within the Plan where each planning requirement is met.

This Chapter provides a general introduction to the 2015 New Castle County Multi-jurisdictional All Hazard Mitigation Plan Update. It is comprised of the following sections: Background, Purpose, Scope, Authority, and Organization of the Plan.

1.2 Background

The occurrence of natural hazards, such as floods, tornadoes and severe winter storms is inevitable, and while there is little that can be done to control their force and intensity, a lot can be done to be better prepared to face these hazards.

New Castle County is vulnerable to a wide range of natural hazards, including flooding, tornadoes, tropical storms and hurricanes, and winterstorms. It is also vulnerable to a variety of human-caused hazards, including chemical releases, spills or explosions associated with the fixed storage or mobile transport of hazardous materials. These hazards threaten the life and safety of county residents, and have the potential to damage or destroy both public and private property and disrupt the local economy and overall quality of life.

While the threat from hazardous events can never be fully eliminated, there is much we can do to lessen their potential impact upon our community and our citizens. By minimizing the impact of hazards upon our built environment, we can prevent such events from becoming disasters.

The concept and practice of reducing risks to people and property from known hazards is generally referred to as hazard mitigation. Hazard Mitigation is defined by the Federal Emergency Management Agency (FEMA) as "sustained action taken to reduce or eliminate long-term risk to

people and property from hazards and their effects". The hazard mitigation planning process involves the coordination of actions taken to reduce injuries, deaths, property damage, economic losses, and degradation of natural resources caused by natural and man-made disasters.

Hazard mitigation is one of four phases in the emergency management cycle. Others include: emergency preparedness, emergency response, and recovery.

- Hazard mitigation activities involve actions that reduce or eliminate the probability of an occurrence or reduce the impact of a disaster. The goal of the mitigation phase is to make communities more resistant to disasters and thereby decrease the need for a response. Mitigation planning occurs long before a disaster occurs.
- Preparedness activities include planning and preparing for when a disaster strikes and includes response capability actions to ensure an effective and efficient use of resources and efforts to minimize damage. Preparedness occurs just before a disaster occurs.
- Emergency response activities include providing emergency assistance to victims and minimizing property loss. The response phase begins during or immediately after the onset of a disaster occurs.
- Recovery activities include short- and long-term activities that help return individuals and communities to normalcy as soon as possible. Recovery actions involve clean-up efforts, temporary housing, and replacement of infrastructure. Recovery activities typically commence several days or weeks after a disaster occurs and are long-term in nature.

Hazard mitigation techniques include both structural measures, such as strengthening or protecting buildings and infrastructure from the destructive forces of potential hazards, and non-structural measures, such as the adoption of sound land use policies and the creation of public awareness programs. It is widely accepted that the most effective mitigation measures are implemented at the local government level, where decisions on the regulation and control of development are ultimately made. A comprehensive mitigation approach addresses past and future hazard vulnerabilities, making it essential for future growth to take place in a manner that decreases a community's overall hazard vulnerability.

One of the most effective means that a community can implement a comprehensive approach to hazard mitigation is to develop, adopt, and update a local hazard mitigation plan. A mitigation plan establishes the broad community vision and guiding principles for reducing hazard risk, and proposes specific mitigation actions to eliminate or reduce identified vulnerabilities.

The New Castle County Multi-jurisdictional All Hazard Mitigation Plan Update (hereinafter referred to as "Hazard Mitigation Plan Update" or "Plan Update"1) is a continued step toward continuing to incorporate hazard mitigation principles and practices into the routine government activities and functions of New Castle County and its municipalities. The Plan Update recommends specific actions to combat the forces of nature and/or human-caused threats and protect its residents from

[1] Reference to the "Plan" throughout this document will refer to the "New Castle County Multi-Jurisdictional Hazard Mitigation Plan".

losses to those hazards that pose the greatest risk. These mitigation actions go beyond simply recommending structural solutions to reduce existing vulnerability, such as elevation, retrofitting and acquisition projects. Local policies on community growth and development, incentives for natural resource protection, and public awareness and outreach activities are examples of other actions considered to reduce New Castle County's future vulnerability to identified hazards.

The Plan Update is designed to be a living document, with implementation and evaluation procedures included to help achieve meaningful objectives and successful outcomes. The original Plan, created in 2004 and promulgated in January 2005, was updated first in 2009 and is subsequently being updated in 2015.

1.3 Purpose

The purpose of this Hazard Mitigation Plan Update is:

- To protect life, safety and property by reducing the potential for future damages and economic losses that result from natural or human-caused hazards
- To qualify for additional grant funding, in both the pre-disaster and post-disaster environment
- To speed recovery and redevelopment following future disaster events
- To demonstrate a firm local commitment to hazard mitigation principles
- To comply with Federal legislative requirements for local hazard mitigation plans.

Various hazards and vulnerabilities have been investigated and mitigation actions revisited, as part of this Plan Update. The Plan Update is intended to enable the County and its municipalities to effectively respond to hazards as they occur and reduce the potential risks of these hazards to the health, safety and welfare of the residents and to continue to allow New County and its municipalities to be eligible for a range of financial assistance following hazard events.

The 2015 Plan Update consists of a thorough review of the 2009 Plan, which was used as a base document. Each chapter in the 2015 version has been updated and a summary is included at the beginning of each chapter to indicate how this Plan was updated from the 2009 version.

- The Plan Update involves the review of data on potential hazards and reprioritization of these hazards in terms of frequency and severity.
- The Plan Update includes a review of mitigation actions, which were revised, deleted, or modified to address the high priority hazards.
- The Plan Update includes Plan Maintenance and Monitoring sections.

1.4 Scope

In November of 2014, the New Castle County Emergency Management Agency contracted with the Vision Planning and Consulting Team (comprised of Vision Planning and Consulting from Fulton, Maryland, and the Eastern Shore Regional GIS Cooperative from Salisbury University in Salisbury, Maryland) to develop the Plan Update in compliance with the requirements of the Disaster Mitigation Act of 2000. The Hazard Mitigation Plan Update was funded by Hazard Mitigation Assistance (HMA) funds from the Federal Emergency Management Agency (FEMA) and administered by the Delaware Emergency Management Agency (PEMA).

Note: Future funding for mitigation projects will be contingent upon having each jurisdiction in New Castle County adopt the 2015 Plan Update after the County has adopted it. Any jurisdiction that does not adopt the 2015 Plan Update will become ineligible for pre- and post-disaster mitigation funds.

The overall planning area for the Plan Update includes the following jurisdictions, the University of Delaware campuses located within New Castle County (Wilmington and Newark campuses) and all unincorporated areas of New Castle County:

- Arden, Village of
- Ardencroft, Village of
- Ardentown, Village of
- Bellefonte, Town of
- Delaware City, City of
- Elsmere, Town of
- Middletown, Town of
- New Castle, City of
- Newark, City of
- Newport, Town of
- Odessa, Town of
- Townsend, Town of
- Wilmington, City of
- University of Delaware
- Unincorporated areas

This Plan Update addresses those hazards determined to be “high risk” and “moderate risk” through a detailed hazard risk assessment for New Castle County (see Section 4: Risk Assessment). Other hazards that pose a low or negligible risk will continue to be evaluated during future updates to the Plan, but they will not be fully addressed until they are determined to be of high or moderate risk to New Castle County.

Note: The Town of Smyrna and Clayton has portions of territory that are within New Castle County; however, the majority of these towns are located within Kent County. Therefore, their plan components are encompassed under the Kent County Mitigation Plan.

1.5 Authority

This Plan Update has been adopted by the New Castle County Council under the authority granted to counties under Title 9 (Counties) of the Delaware Code. This Plan Update has also been adopted by New Castle County's participating incorporated jurisdictions under the authority granted to municipalities under Title 22 of the Delaware Code (Municipalities). Copies of all local resolutions to adopt the Plan are included in Appendix A.

This Plan was developed in accordance with current Federal rules and regulations governing local hazard mitigation plans and shall be routinely monitored to maintain compliance with the following legislation:

> Section 322, Mitigation Planning, of the Robert T. Stafford Disaster Relief and Emergency Assistance Act, as enacted by Section 104 of the Disaster Mitigation Act of 2000 (P.L. 106-390) and by FEMA's Interim Final Rule published in the Federal Register on February 26, 2002, at 44 CFR Part 201.

1.6 Organization of the Plan

The 2015 Plan Update comprises seven chapters. Chapter 1 provides an introduction to the Plan Update process and includes the background, scope, process, and authority. Chapter 2 includes an overview and update of the socio-economic and demographic characteristics. Chapter 3 discusses the planning process. Chapter 4 comprises the hazard identification and risk assessment and examines vulnerability and the potential losses from the top priority hazards. Chapter 4 also includes a historic profile of hazard types and associated losses, and a vulnerability assessment, which analyzes the potential for future damages due to the hazards identified. Chapter 5 contains a capability assessment, including a review of existing plans and ordinances from the counties and municipalities. Chapter 6 discusses the mitigation strategy including updated mitigation goals and objectives, mitigation actions, and the method for prioritization and implementation of mitigation actions. Chapter 7 outlines how the County and its municipalities will implement the Plan once it is adopted and ways to monitor progress and ensure continued public involvement.

2. PLANNING PROCESS

2.1 Introduction

This Chapter describes the planning process undertaken by New Castle County and the Contractor, Vision Planning and Consulting, for the preparation of the 2015 All Hazard Mitigation Plan Update. Specific topics in this Chapter include:

- Overview of hazard mitigation planning
- Preparing the Plan Update
- The Steering Committee
- Meetings and workshops
- Involving the public
- Involving stakeholders
- Multi-Jurisdictional participation.

2.2 Overview of Hazard Mitigation Planning

Local hazard mitigation planning is the process of organizing community resources, identifying and assessing hazard and risks, and determining how to best minimize or manage those risks. This process results in a Plan that identifies specific mitigation actions, each designed to achieve both short-term planning objectives and a long-term vision. Responsibility for each mitigation action is assigned to a specific individual, department or agency along with a schedule for its implementation. Plan maintenance procedures are established for the routine monitoring of implementation progress, as well as the evaluation and enhancement of the mitigation plan. These plan maintenance procedures ensure that it remains a dynamic and functional planning document over time.

Mitigation planning offers many benefits, including: saving lives and property; saving money; speeding recovery following disasters; reducing future vulnerability through wise development and post-disaster recovery and reconstruction; expediting the receipt of pre-disaster and post-disaster grant funding and demonstrating a firm commitment to improving community health and safety.

Typically, mitigation planning is described as having the potential to produce long-term and recurring benefits by breaking the repetitive cycle of disaster loss. A core assumption of hazard mitigation is that pre-disaster investments will significantly reduce the demand for post-disaster assistance by lessening the need for emergency response, repair, recovery and reconstruction. Furthermore, mitigation practices will enable local residents, businesses and industries to re-establish themselves in the wake of a disaster, getting the community economy back on track sooner and with less interruption.

The benefits of mitigation planning go beyond solely reducing hazard vulnerability. Measures such as the acquisition or regulation of land in known hazard areas can help achieve multiple community goals, such as preserving open space, maintaining environmental health and enhancing recreational opportunities. Thus, it is vitally important that any local mitigation planning process be integrated with other concurrent local planning efforts, and any proposed mitigation strategies must take into account other existing community goals or initiatives that will help complement or hinder their future implementation.

44 CFR 201.6(c)(1): The plan shall include documentation of the planning process used to develop the plan, including how it was prepared, who was involved in the process and how the public was involved.

2.3 Preparing the Plan

The Plan Update process included six major tasks that were completed over the course of four months. Each of these planning tasks listed below resulted in critical elements, which collectively comprise the 2015 New Castle County Plan Update Process:

Task 1: Organize Resources – Planning Process

- Participation in planning process meetings which included the public, neighboring communities, agencies, businesses, academia, nonprofits and other interested parties involved in the process.
- Communication with key stakeholders and agencies to obtain information on any related mitigation efforts: Delaware Emergency Management Agency, Delaware Office of State Planning, Delaware Department of Natural Resources and Environmental Control, Delaware Department of Transportation, Delaware Geological Survey, and University of Delaware, among others.
- Mitigation strategy workshop with the Committee and municipalities to update existing and identify new mitigation strategies.
- Review and update of the Community Profile and integration with the Land Use Plan.
- Update of the status of existing plans, studies, reports, and technical information.

Task 2: Hazard Identification and Risk Assessment

- Review and update of the hazard analysis for incidents since 2009.
- Update of hazard vulnerability.
- Identification of development trends and areas that may be proposed for intense development that are located in high hazard areas.

Task 3: Goals and Objectives

- Review and update of mitigation goals and objectives of the current plan to reduce or avoid long term vulnerabilities to the identified hazards.

Task 4: Mitigation Strategy

- Reissue of the mitigation capability assessment to identify how the fiscal, administrative, and local mitigation capabilities have changed since 2009 to illustrate each jurisdiction's overall hazard risk in comparison to their overall capacity.
- Mitigation strategy workshop to update existing and collect new mitigation strategies.
- Update of the mitigation actions to include 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 including actions related to continued compliance with the National Flood Insurance Program (NFIP).
- Update of the action plan describing how the actions will be prioritized, implemented, and administered by the local jurisdiction.
- Identification of the completed, deleted or deferred mitigation actions as a benchmark for progress, and if activities are unchanged or deferred.

Task 5: Plan Maintenance

- Update of the method and schedule of monitoring, evaluation, and update of the mitigation plan within a five-year cycle.
- Review and update of the process by which local governments incorporate the requirements of the mitigation plan into other planning mechanisms such as comprehensive or capital improvements plans, when appropriate.
- Identification of any additional local planning mechanisms available for incorporating the mitigation requirements of the mitigation plan.
- Continued public participation.

Task 6: Plan Adoption

- Submittal of the draft Plan Update to the Delaware Emergency Management Agency (DEMA) and the Federal Emergency Management Agency (FEMA).
- Draft Plan Update approval by FEMA Region III.
- Plan adoption by the County, municipalities, and University of Delaware.

2.4 Hazard Mitigation Steering Committee

New Castle County reconvened its Steering Committee for the purpose of this Plan Update. Stakeholders, residents, and local government officials played a major role in reviewing the Plan. Table 2.1 includes the members of the New Castle County Steering Committee. The Committee's composition was similar to that of the previous Plan Update (i.e. same offices represented), especially for those communities with multiple representatives. Those members who were no longer with the County or municipality were replaced on the Committee.

Steering Committee Meeting held on 3 February 2015 at the Sweeney Building in New Castle, DE

Table 2.1 – New Castle County 2015 Hazard Mitigation Steering Committee

Name	Agency	Department/Function
Danny Schweers	Arden	Town Assembly Chair
Ray Seigfried	Arden	Community Planning Chair
Pat Toman	Ardencroft	Town Chair
Eugenia Hall	Ardencroft	Town Secretary
Annie Gutsche	Ardentown	Town Chair
Terri Hansen	Ardentown	Town Secretary
Scott MacKenzie	Bellefonte	President
Richard Cathcart	Delaware City	City Manager
Stanley Green	Delaware City	Mayor
John Giles	Elsmere	Town Manager
Morris Deputy	Middletown	Town Manager
William Barthel	New Castle	City Administrator
John Lloyd	New Castle	Code Enforcement Officer
George O'Neal	New Castle	Supervisor of Public Works
Paul Tiernan	Newark	Chief of Police
Carol Houck	Newark	City Manager
Wendy King	Newport	Town Manager
Kathy Harvey	Odessa	Mayor
Jermaine Hatton	Townsend	Mayor
Dawson Green	Townsend	Town Manager
George Giles	Wilmington	Emergency Management Director
Mark Seifert	University of Delaware	Public Safety
Kevin Donnelly	New Castle Conservation District	Executive Director
Laurence Irelan	New Castle Conservation District	
Tigist Zegeye	Wilmapco	Executive Director
James Kendra	Disaster Research Center	Director
Dave Carlson	DEMA	State Hazard Mitigation Officer
Don Knox	DEMA	Natural Hazards Supervisor
Michael Powell	DNREC	State NFIP Coordinator
Greg Williams	DNREC	State CRS/Floodplain Coordinator
Dwayne Day	DelDOT	
Thomas Gordon	NCC	Executive
Joseph Bryant	NCC	Director of Public Safety
Dave Carpenter	NCC	Emergency Management Coordinator
Sophia Hanson	NCC	Community Services

Eileen Fogarty	NCC	Land Use GM
John Gysling	NCC	Land Use Floodplain Manager
Wayne Merritt	NCC	Special Services Acting GM
Anthony Schiavi	NCC	Special Services Operations Manager
Michael Scott	ESRGC	Consultant
Deepa Srinivasan	Vision Planning & Consulting	Consultant

2.5 Community Meetings and Workshops

The planning process for the most part, was similar to the process followed during the 2009 Plan Update as it was deemed effective. The 2015 Plan Update process comprised series of meetings and workshops for facilitating discussion and initiating data collection efforts with state and local municipal and county officials as well as stakeholders. Two Steering Committee meetings and one public meeting were held for the County and municipalities. Additionally, one mitigation planning workshop was held at the University of Delaware. Below is a summary of the meetings and workshops that took place.

Initial Project Kickoff Meeting

The initial kick off meeting was held 30th October 2014 with the New Castle County Emergency Management Coordinator, Dave Carpenter. The purpose of this meeting was to finalize the contract as well as discuss the specific steps in the project including schedule and deliverables.

Steering Committee Meeting held on 3 February 2015 at the Sweeney Building in New Castle, DE

Steering Committee Meeting #1

The first Steering Committee meeting was held on 3rd December 2014 at the County's Public Safety Building in New Castle. At this meeting, VPC Consultants:

- Reviewed sections of the 2009 Plan with the Committee and identified sections that needed to be updated
- Reviewed data on the hazard identification
- Solicited input on risks from various hazards and ranked them
- Discussed data from the hazard vulnerability and risk assessment
- Reviewed goals and objectives
- Discussed mitigation actions.

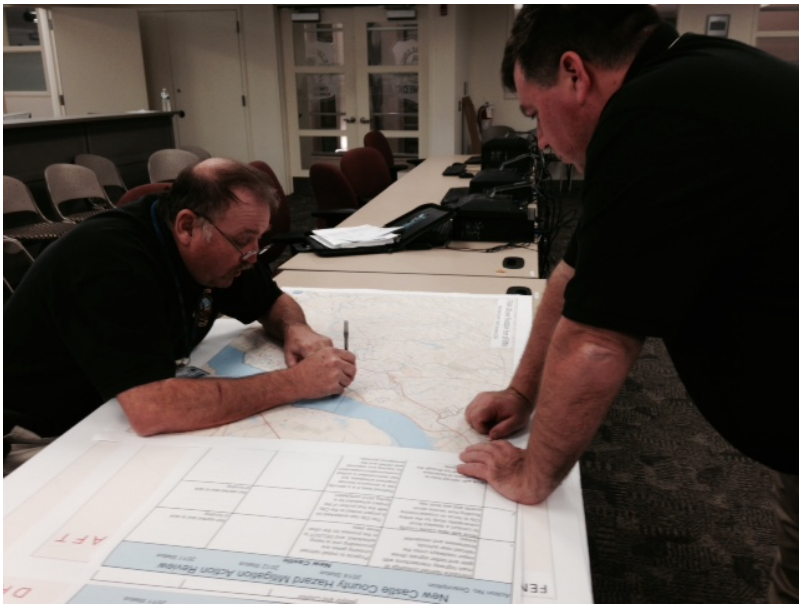
Steering Committee Meeting #2

The second Committee Meeting was held on 3rd February 2015 at the New Castle County The Paul J. Sweeney Public Safety Building in New Castle. At this meeting, VPC Consultants:

- Discussed loss estimates
- Prioritized mitigation actions
- Developed an implementation strategy for each mitigation action.

Municipal Workshop

Meeting invitations and reminders for the Municipal Mitigation Workshop were sent via e-mail and follow up calls were made to further urge municipal participation. The Municipal Mitigation Workshop was held at the Paul Sweeney Building in New Castle on the same evening as the first Steering Committee Meeting and was facilitated by the Consultants, providing an opportunity for municipal officials to attend and become educated about the Plan Update, planning process, hazard identification, and vulnerability assessment.



Municipal Workshop held on 3 December 2014 at the Sweeney Building in New Castle, DE

A series of exhibits were developed for the workshop including maps of county – northern, central, and southern segments. Attendees were encouraged to stimulate discussion and mark up maps to indicate updated or missing data. Examples of potential

mitigation projects were shared and municipalities were encouraged to recommend additional mitigation projects based on past hazard experiences.

At the workshop, municipal officials:

- Reviewed maps and identified high-hazard areas by marking up maps
- Identified critical facilities within their municipality
- Discussed risks and vulnerabilities within their municipality
- Identified past mitigation projects and discussed potential mitigation projects
- Discussed future participation opportunities and next steps.

University of Delaware Hazard Mitigation Workshop

A Hazard Mitigation Workshop was held by the University of Delaware on 9 January 2015. At this meeting, hazards, goals, and mitigation planning initiatives at the University of Delaware were discussed. University representatives:

- Reviewed the risk assessment
- Identified critical facilities
- Discussed risks and vulnerabilities
- Discussed past goals, objectives, and mitigation projects
- Identified potential mitigation projects
- Discussed next steps.

Hazard Mitigation Workshop held on 9 January 2015 at the University of Delaware, Newark Campus

2.6 Involving the Public

44 CFR Part 201.6(b) (1: The planning process shall include an opportunity for the public to comment on the plan during the drafting stage and prior to plan approval.

Community-based input provides the team with a greater understanding of local concerns and ensures a higher degree of mitigation success by developing community "buy-in" from those directly affected by the decisions of public officials. As citizens become more involved in decisions that affect their safety, they are more likely to gain greater knowledge of the natural hazards present in their community and take personal steps to reduce their potential impact. Public awareness is a key component of an overall mitigation strategy aimed at making a home, neighborhood, school, business, or city safer from the potential effects of natural hazards.

Public Meeting

The Planning Board Public Meeting was held on 3rd February 2015 in the Gilliam Building. At this meeting, an overview of the planning process was presented and the hazard concerns, risk assessment, and mitigation actions for the County and municipalities were discussed and comments were solicited. The meeting was advertised through local television and radio in addition to newspaper notices and FaceBook feeds.

Public Meeting held on 3 February 2015 at the Gilliam Building in New Castle, DE

Following the release of the draft, it was made available for public review comment through the New Castle County and University of Delaware websites. Copies of the Draft Plan were also available in the public library and with the Office of Emergency Management.

Neighboring jurisdictions were made aware of the planning process and given opportunities to communities to comment. Contact with these neighboring jurisdictions was made via email and through the Consultants who were conducting concurrent plan updates in these communities.

Public Meeting held on 3 February 2015 at the Gilliam Building in New Castle, DE

2.7 Involving Stakeholders

44 CFR Part 201.6(b)(2): The planning process shall include an opportunity for neighboring communities, local and regional agencies involved in hazard mitigation activities, and agencies that have authority to regulate development, as well as businesses, academia and other private and non-profit interests to be involved in the planning process.

The coordination of local plans also facilitated the assistance of several state agencies in order to obtain input on their activities with respect to hazard mitigation. They included: Delaware Emergency Management Agency, Office of State Planning Coordination, Department of Natural Resources and Environmental Control, Delaware Department of Transportation, Office of the Delaware State Climatologist and Department of Environment Observing System, University of Delaware - Department of Campus and Public Safety Services, and American Red Cross A summary of each of these departments' services related to mitigation activities is elaborated below:

Office of State Planning Coordination

The Office of State Planning Coordination has been involved in planning activities as well as a neighborhood buyout project in New Castle County. This Office is responsible for developing the State comprehensive plan as well as the comprehensive plans for the three counties, and these plans are used to provide guidelines for development and growth throughout the State. These plans were, and continue to be sources of information for the local hazard mitigation plans. This Office has a very strong interest in being involved in the mitigation planning process. They have conducted several environmental and other studies, and developed plans that could be valuable resources for local mitigation planning and be used to develop mitigation strategies and activities. The Office also has a successful working relationship with the Department of Natural Resources and Environmental Control and the Department of Transportation, two important stakeholders in mitigation activities around the State.

Department of Natural Resources and Environmental Control (DNREC)

DNREC has worked closely with the State on various mitigation activities, as well as being responsible for floodplain mapping activities. DNREC provided the necessary information regarding National Flood Insurance Program (NFIP) compliance, and repetitive loss information for the Local Mitigation Plans. DNREC's primary mitigation activities include overseeing NFIP ordinances and regulations, and guiding local jurisdictions on developing and adopting regulations to manage development in floodplains. They also conduct inspections of construction in floodplains to ensure compliance with NFIP guidelines. Specifically, DNREC worked with DelDOT on a FEMA funded buy-out of several properties that were demolished and turned in to open space, where DelDOT then became the landowner. DNREC is interested in having an active role in the development of the current mitigation plans, on the development of their hazard identification and risk assessments, and mitigation strategies, as well as providing any available NFIP data. The Department is also looking forward to continuing a successful and cooperative relationship with other state agencies they have worked with in the past.

Office of the Delaware State Climatologist and the Delaware Environmental Observing System

The Office of the Delaware State Climatologist works with various State agencies including DEMA, DelDOT and DNREC on mitigation projects and activities. The Office of the Delaware State Climatologist also monitors and maintains the Delaware Environmental Observing System (DEOS). DEOS is a support tool for decision makers involved with emergency management, natural resource monitoring, transportation, and other activities throughout the State of Delaware. Their primary goal is to provide state agencies and the citizens of Delaware with immediate information about environmental conditions in and around the State. DEOS also archives data for historical environmental studies and research. This agency has been invaluable in categorizing and quantifying rainfall, flood, and wind activities during storms. Some of this information is reflected in Vulnerability Assessment section of this plan. This information has also been critical to justifying many of the mitigation projects and actions completed in the past.

University of Delaware

The Department of Campus and Public Safety Services at the University of Delaware completed its Disaster Resistant University Plan in 2011 and has since become more actively involved in mitigation on a campus and statewide level. Because the University has campuses and properties in each of the three counties, the goal of the University has been to work closely with the Counties on the development of their plans and the University's plan, ensuring a free flow of valuable information and resources. To this effect, the University of Delaware made a decision in December 2014, to join the County in its efforts with the 2015 Hazard Mitigation Plan Update. As such, the Wilmington and Newark campus located within the County are included in the New Castle County Plan Update. The Lewes and Georgetown campuses will be included in the 2015 Sussex County Hazard Mitigation Plan Update.

American Red Cross

While the primary role of the Red Cross is to serve as a source of information and education, the organization participates in mitigation, wherever possible. The Red Cross was involved during the buyout of the Glenville neighborhood following numerous flooding events. The Red Cross also participates in mitigation through the creation and distribution of preparedness brochures to educate the public and teach the importance of being prepared, and the steps to take before a hazardous event such as a flood or a hurricane. The Red Cross indicated a continued interest in being involved in the hazard mitigation planning process.

Delaware Geological Survey

Delaware Geological Survey provides funding for coastal monitoring and the development of alert systems for the City of Bowers Beach in Kent County. They also monitor stream gauges on the Red Clay and White Clay creeks and the Brandywine River that provide real time information on flood stages, water quality, and potential drought conditions. Due to limited staffing and time constraints, the Delaware Geological Survey is unable to take on an in-depth role in the current mitigation planning process. However, they are interested in providing technical assistance and input during the planning process by reviewing sections in the document that address flood, drought, and earthquakes. Delaware Geological Survey has worked closely with DEMA and other State agencies on mitigation and continues to indicate an interest in being involved in the hazard mitigation process.

2.8 Multi-jurisdictional Participation

44 CFR Part 201.6(a) (3): Multi-jurisdictional plans may be accepted as long as each jurisdiction has participated in the planning process.

The New Castle County All Hazard Mitigation Plan is multi-jurisdictional and includes the participation of New Castle County and all of its incorporated municipalities including the City of Wilmington. These participants are listed in the Introduction chapter.

In order to involve the municipalities in the planning process as well as to satisfy the multi-jurisdictional participation requirements, the local jurisdictions were required to perform the following tasks as part of the 2015 Plan Update. The degree of participation varied during the planning process and is documented in Table 2.2.

- Update the local Capability Assessment
- Attend the Municipal workshop
- Attend the Steering Committee and Public meetings
- Update municipal actions
- Review the draft plan
- Adopt the Hazard Mitigation Plan Update, once the County has adopted the Plan Update.

Each municipality was asked to review their goals and mitigation actions from the 2009 Plan and provide updates to them. These actions were revisited at the municipal workshop and discussed with the Consultants and modified as necessary, based on their risk. New actions were also added as deemed necessary.

Table 2.2 – Municipal Participation in the Planning Process

	Capability Assessment Review	Mitigation Actions Review	Attendance at Municipal Workshop	Draft Plan Review
Arden, Village of		X		
Ardencroft, Village of		X		
Ardentown, Village of	No changes	X		
Bellefonte, Town of		X	X	
Delaware City, City of	X	X	X	
Elsmere, Town of	X	No changes	X	
Middletown, Town of	X	X	X	
New Castle, City of	X	X	X	
Newark, City of	X	X	X	
Newport, City of		No changes		
Odessa, Town of	X	X		
Townsend, Town of		X		
Wilmington, City of	No changes	X	X	
University of Delaware	X	x	X	X

3. COMMUNITY PROFILE

3.1 Introduction

This Chapter provides a general overview of New Castle County and its incorporated municipal jurisdictions in the following areas:

- Geography and the Environment
- Population and Demographics
- Housing, Infrastructure and Land Use
- Employment and Industry
- Disaster Declarations

3.2 Geography and the Environment

New Castle County is the northernmost county in Delaware and is bordered by Pennsylvania to the north, Maryland to the west, Kent County, Delaware to the south, and approximately 40 miles of Delaware Bay to the east. The County's location affords easy access to the major metropolitan areas of the Northeast United States; the cities of Baltimore, New York, Philadelphia and Washington, D.C. are all within a two-hour drive. The County seat for New Castle County is the City of Wilmington, Delaware's most populous city of 71,525 residents.

New Castle County is the smallest county in Delaware with a total area of 426 square miles. The area's topography is generally flat, ranging from sea level along the shores of Delaware Bay to 448 feet above sea level near Ebright Road in north Wilmington.

New Castle County has a moderate climate, with an average annual temperature of 54 degrees Fahrenheit, and a mean daily temperature ranges from 31 degrees in January to 77 degrees in July. The County's normal annual precipitation is 43 inches per year, including approximately 20 inches of snowfall.

New Castle County has a total water area of 67 square miles, and has numerous waterways flowing through it; including the Delaware River, the Chesapeake and Delaware Canal (C&D Canal), the Christina River, the Appoquinimink River, the Brandywine Creek and the Red and White Clay Creeks. The largest dam in New Castle County is the Hoopes Dam, which holds a reservoir of two billion gallons of water. Adequate surface and groundwater is available to meet the projected demand for fresh water.

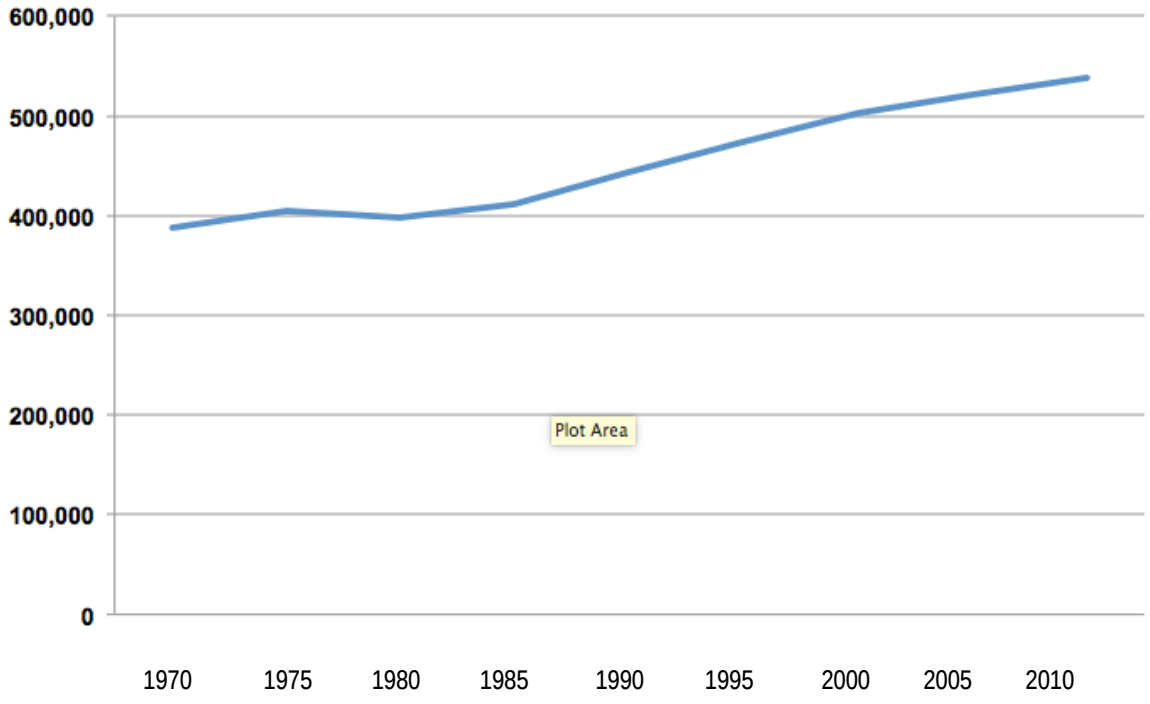
Almost all of New Castle County lies within the Delaware River Basin, which drains 13,539 square miles in Delaware, New Jersey, New York and Pennsylvania. The River's main stem is 330 miles long and extends from the confluence of its east and west branches at Hancock, New York to the mouth of the Delaware Bay just south of Wilmington. It is the longest free-flowing (un-dammed) river east of the Mississippi.

Geologically, New Castle County is a part of the "Coastal Plain Province" and the Piedmont the Coastal Plain is an area composed of overlapping beds of unconsolidated or semi-consolidated clay, silt, sand and gravel. The Piedmont consists of metasedimentary and metaigneous rocks. The Fall Line runs across the northern part of New Castle County, dividing Piedmont and Coastal Plain Provinces. Delaware Bay is the area's most marked natural feature. About one-third of the region is wooded with about equal divisions between soft and hard woods.

3.3 Population and Demographics

Recent data from 2013 U.S. Census estimates and other sources has been included where available. Population growth in New Castle County had actually begun to slow down during the 1970s, but in recent decades the population has again been steadily climbing. Figure 3.1 shows the population growth of New Castle County from 1900 to 2000.The 2013 estimate for New Castle County was 529,641 persons, a 5.9 percent increase from the 2000 population figure of 500,625 persons. In comparison, the State's population has increased by 11.4 percent during this period. New Castle County's high growth rate in the 1990s and 2000 is projected to steadily decline over the next 25 years. According to the Delaware Population Consortium (DPC), New Castle County is expected to gain an additional 98,659 people by 2030, a rate of 20 percent over the entire timeframe. However, the growth rate of 13 percent between 1990 and 2000 is projected to slow to approximately 4 percent between 2020 and 2030.

Figure 3.1
Population of New Castle County, 1970 - 2010



Source: U.S. Census Bureau

There are 13 incorporated municipalities in New Castle County. The City of Wilmington is the largest in terms of population with a total land area of 10.85 square miles and a population of 71,252 persons (2013 estimate), which is 13.0 percent of the total county population. Wilmington's population indicated a 0.9 percent increase between 2010 and 2013.

Table 3.1 shows the population for each of the municipalities in New Castle County and the unincorporated area according to U.S. Census 2010.

Table 3.1
Municipal Populations for New Castle County, 2013

Jurisdiction	Population
Arden, Village of	477
Ardencroft, Village of	235
Ardentown, Village of	268
Bellefonte, Town of	1,198
Delaware City, City of	1,725
Elsmere, Town of	6,164
Middletown, Town of	19,600
Newark, City of	32,549
New Castle, City of	5,385
Newport, Town of	1,057
Odessa, Town of	369
Townsend, Town of	2,076
Wilmington, City of	71,525
Unincorporated Areas	407,056
Total	549,684

Source: U.S. Census Bureau

As of 2013, there were 549,684 people residing in New Castle County, a 4.8 percent increase from 2006. Regional growth was experienced between 2000 and 2010. Most notably, the population of Middletown grew 206.3 percent during this period. This growth is attributed with new housing developments around the Town's center attracting families from Baltimore, Wilmington, Philadelphia, New Jersey, and New York City. Middletown's smaller neighboring jurisdiction, Townsend, experienced a 600 percent increase during the same time period. Unincorporated areas within the County grew by 8 percent.

The median age of New Castle County residents is 35 years, the same as the national average, and lower than the median age of 36.7 for Delaware in 2010. In 2010, 32.5 percent of households had children under 18 years of age and 25.7 percent of households have members 65 years and over. By 2030, over 27 percent of New Castle County's residents will be over the age of 60. Similarly, the racial composition of the County has become increasingly diverse and will become even more diverse over the next 25 years (source: 2007 Comprehensive Development Plan for New Castle County and US Census Bureau).

3.4 Housing, Infrastructure and Land Use

There were 217,632 housing units in 2010, a 2.4 percent increase from 2007 (212,420 housing units). In 2007, the County's housing units account for approximately 53.6 percent of the State's housing units (405,885). Between 2007 and 2010, approximately 5,212 housing units were constructed. The median

household income in 2010 was $52,419 compared with that of the State ($50,152). In New Castle County, the average household size was 3.33 in 1970; by 2010, this number had decreased to 2.62, slightly lower than the national average of 2.63. In 2010, the median home values in New Castle County were the highest in Delaware at $198,000 for owner-occupied units.

New Castle County is a hub of transportation ways. Many travelers cross through New Castle County on their daily commutes to New Jersey, Pennsylvania, New York and Maryland. These include Interstates 95, 295 and 495; U.S. Routes 1, 13, 40 and 202; and State Routes 141 and 2.

The Delaware Memorial Bridge, the world's longest twin suspension bridge, links Delaware and New Jersey in twin suspension spans that soar high above the Delaware River, just north of the mouth of the Delaware Bay. The twin spans touch down in New Castle, Delaware, and in Pennsville, New Jersey. The bridge is a self-supporting toll bridge operated by the Delaware River and Bay Authority, a bi-state agency. Today, more than 80,000 vehicles cross the twin spans on their combined total of eight lanes daily.

Other major transportation facilities in New Castle County include train stations for Amtrak in Newark and Wilmington (85 trains per weekday), and the New Castle Airport, which readily accommodates commercial and corporate aircraft. At 1,250 acres, New Castle Airport has three major runways, 10 taxiways and several aircraft parking ramps. Approximately 50 business jets and 220 propeller aircraft are based here. The South Eastern Pennsylvania Transportation Authority (SEPTA) has commuter service along Amtrak rails between Newark and Philadelphia Pennsylvania.

The first inbound port along the Delaware River, the Port of Wilmington, is located at the mouth of the Christina River, roughly 65 miles from Atlantic shipping lanes. The Port is located within one-quarter mile of Interstate 495 for immediate access to East Coast markets, and is 25 miles from I-76, one of the region's major east/west arteries. Rail access to the Port is available via Norfolk Southern and the CSX, with railcar loading docks located next to every terminal warehouse.

New Castle County has undergone significant growth over the past few decades and typical land use patterns are no longer predominately agricultural as they were in the earlier part of the 1900s. The density (as of 2010) of New Castle County is by far the highest of Delaware's three counties with approximately 1,264 persons per square mile (the State average is 464 persons per square mile).

Data from the 2007 New Castle County Comprehensive Development Plan indicates that the top three land uses in the County were agricultural (45%), forest (25%), and residential (13%). By 2002, the residential proportion had risen to 28 percent, agriculture was 29 percent, and the remaining 15 percent was forest cover.

In the last 10 years, there has been evidence of a lot of new construction in unincorporated New Castle County taking place south of the canal as available open land becomes more difficult to find. Based upon the current trend, in the next 25 years the area south of the canal will continue to grow. As the consumption of larger quantities of land grows to serve the projected population the current growth map and trend also result in greater demands upon the transportation network. With the continued development of large tract single-family housing, and minimal employment opportunities outside of the developed areas of northern New Castle County, residents of southern New Castle County to continue to commute long distances for employment and other service needs.

The 2012 Comprehensive Plan addresses future growth for the County in the Land Use section. It offers the following goals to guide development:

- Goal 1: Continue to designate those locations appropriate for growth and the densities best suited to meet present and future needs.
- Goal 2: Continue to manage growth to fulfill sustainable housing and employment needs of present and future citizens while preserving vital resources.
- Goal 3: Continue to ensure that new development and redevelopment allow flexibility for innovative planning while reflecting the design of existing surrounding communities - incorporate these "Smart Growth" and "New Urbanist" concepts within their design.

3.5 Employment and Industry

Delaware has the strongest state economy in the region and remains an above average performer in comparison to the national economy. With lower than average unemployment, a fair and equitable tax system and a well-trained workforce, the State's economic climate has shown dramatic improvement since the early 1980s, partially in response to stable fiscal policies, careful debt management, conservative spending programs, and personal income tax reductions. Delaware's economy continues to have increasing levels of job growth, although more moderate than in previous years.

In 2013, the median household income for New Castle County was $62,474 in comparison to the State's figure of $59,878 that year. The County's median household income increased by 4.3 percent between 2007 ($59,871) and 2013. The per capita income was $31,220 compared with a statewide average of $29,819. In 2013, New Castle County had an employed labor force of 256,271 and an unemployment rate of 6.7 percent, compared with a statewide average of 6.4 percent. New Castle County's poverty rate increased from 10.1 percent of persons below poverty in 2007 to 10.7 percent of persons below poverty in 2013. The statewide average in 2013 was 11.7 percent (increase from 10.3 percent in 2007).

New Castle County sustains a diversified economy, with most employment being concentrated in the Services sector: Finance and Insurance; Healthcare and Social Assistance; and Government sectors (over 12% in each). Retail Trade comprises the next largest services sector (11.1 percent). Table 3.2 provides an overview of employment in New Castle County by sector.

Table 3.2
Employment by Sector for New Castle County, 2014

Sector	Number of Employees	Percent of Total
Construction	12,340	4.6%
Manufacturing	11,780	4.4%
Wholesale trade	8,349	3.1%
Retail trade	29,619	11.1%
Transportation and warehousing	5,786	2.2%
Information	4,341	1.6%
Finance and insurance	32,896	12.3%
Professional and technical services	22,799	8.5%
Management of companies and enterprises	6,978	2.6%
Administrative and waste services	15,824	5.9%
Educational services	3,899	1.5%
Health care and social assistance	40,032	15.0%
Arts, entertainment, and recreation	4,654	1.7%
Accommodation and food services	20,296	7.6%
Other services, except public administration	8,788	3.3%
Real estate	3,302	1.2%
Utilities	1,447	0.5%
Government	33,425	12.5%
Total	266,766	100.0

Source: QCEW Bureau of Labor Statistics, and Delaware Dept. of Labor

New Castle County's largest employers constitute banks and healthcare-related industries such as the DuPont Institute, AstraZeneca, Bank of America, and Chase Bank, to name a few. Table 3.3 lists New Castle County's top 10 employers in alphabetical order.

Table 3.3
New Castle County's Top Ten Employers, 2008

Employer
Alfred I DuPont Institute
AstraZeneca
Bank of America
Chase Bank USA
Christiana Care
Comcast Cable
DuPont Company
J P Morgan
Wilmington Trust Company
Siemens Healthcare Diagnostic Incorporated

Source: Delaware Economic Development Office

3.6 Disaster Declarations

Since 1965, New Castle County has experienced a total of eleven presidential disaster declarations, which are shown in Table 3.4. Two of these disaster declaration occurred in 2003 (Tropical Storm Henri and Hurricane Isabel). After Hurricane Katrina, a state of emergency was declared in the State of Delaware. Emergency protective measures, including direct Federal assistance, were provided at 100 percent Federal funding.

In November 2004, Federal disaster funds were allocated to Delaware to help communities in New Castle County recover from the remnants of Hurricane Jeanne. The declaration made New Castle County became eligible for Federal funds to pay the State and affected local governments and certain private non-profit organizations 75 percent of the approved costs for the restoration of damaged facilities. The funding also covered eligible state and local government costs for debris removal and emergency services related to the disaster. In addition, Federal funding was also available to the State on a cost-shared basis for approved projects that reduce future disaster risks.

Prior to 1965, any presidential declarations did not have county designations. The County has also experienced additional emergencies and disasters that were not severe enough to require Federal disaster relief through a presidential declaration. This includes a devastating blizzard in March 1993 that resulted in an emergency declaration (3111-EM) for New Castle County that made limited Federal assistance available through the Public Assistance program for snow removal.

Table 3.4
Presidential Disaster Declarations for New Castle County, 1965– 2014

Event	Declaration Date	Type of Assistance	Declaration Number
Water Shortage	08/15/65	Individual Assistance Public Assistance	DR-207
Blizzard of '96 (Severe Snow Storm)	01/12/96	Public Assistance	DR-1082
Hurricane Floyd	09/21/99	Individual Assistance Public Assistance	DR-1297
Hurricane Isabel	09/20/03	Individual Assistance Public Assistance	DR-1494
Tropical Storm Henri	09/23/03	Individual Assistance Public Assistance	DR-1495
Hurricane Jeanne	11/15/04	Individual Assistance Public Assistance	DR-1572
Hurricane Katrina	09/30/05	Individual Assistance Public Assistance	DR-3263
Severe Storms and Flooding	06/23/06	Individual Assistance Public Assistance	DR- 1654
Severe Winter Storms and Snow	02/05/11	Individual Assistance Public Assistance	DR-1896
Hurricane Irene	08/26/11	Individual Assistance Public Assistance	DR - 4037
Hurricane Sandy	10/27/12	Individual Assistance Public Assistance	DR-4090

Source: Federal Emergency Management Agency

4.1 HAZARD IDENTIFICATION

4.1.1 Introduction

The United States and its communities are vulnerable to a wide array of natural and human-caused hazards that threaten life and property. These hazards include:

Natural

- Flood
- Hurricanes and Coastal Storms
- Severe Thunderstorms and Tornadoes
- Wildfire
- Drought/Extreme Heat
- Winter Storms and Freezes
- Hail
- Erosion
- Dam/Levee Failure
- Earthquakes, Sinkholes and Landslides
- Tsunami
- Volcano

Human-caused

- Terrorism
- Hazardous Materials (HazMat)
- Energy Pipeline Failures

Some of these hazards are interrelated (i.e., hurricanes can cause flooding and tornadoes), and some consist of hazardous elements that are not listed separately (i.e., severe thunderstorms can cause lightning; hurricanes can cause coastal erosion). In addition, terrorist-related incidents or accidents involving chemical, radiological or biological agents can coincide with natural hazard events, such as flooding caused by destruction of a dam or an accidental chemical release caused by a tornado. It should also be noted that some hazards, such as severe winter storms, may impact a large area yet cause little damage, while other hazards, such as a tornado, may impact a small area yet cause extensive damage. This section provides a general description for each of the hazards listed above along with their hazardous elements, written from a national perspective.

4.1.2 Flood

Flooding is the most frequent and costly natural hazard in the United States, a hazard that has caused more than 10,000 deaths since 1900. Nearly 90 percent of presidential disaster declarations result from natural events in which flooding was a major component.

Floods are generally the result of excessive precipitation, and can be classified under two categories: general floods, precipitation over a given river basin for a long period of time; and flash floods, the product of heavy localized precipitation in a short time period over a given location. The severity of a flooding event is determined by the following: a combination of stream and river basin topography and physiography; precipitation and weather patterns; recent soil moisture conditions; and the degree of vegetative clearing.

General floods are usually long-term events that may last for several days. The primary types of general flooding include riverine, coastal, and urban flooding. Riverine flooding is a function of excessive precipitation levels and water runoff volumes within the watershed of a stream or river. Coastal flooding is typically a result of storm surge, wind-driven waves, and heavy rainfall produced by hurricanes, tropical storms, nor'easters, and other large coastal storms. Urban flooding occurs where man-made development has obstructed the natural flow of water and decreased the ability of natural groundcover to absorb and retain surface water runoff.

A total of 534 counties in nine states were declared for federal disaster aid as a result of the Midwest Floods in June 1994. Homes, businesses and personal property were all destroyed by the high flood levels; 168,340 people registered for federal assistance. (FEMA News Photo)

Flash flooding events usually occur from a dam or levee failure within minutes or hours of heavy amounts of rainfall, or from a sudden release of water held by an ice jam. Most flash flooding is caused by slow-moving thunderstorms in a local area or by heavy rains associated with hurricanes and tropical storms. Although flash flooding occurs often along mountain streams, it is also common in urbanized areas where much of the ground is covered by impervious surfaces. Flash flood waters move at very high speeds—"walls" of water can reach heights of 10 to 20 feet. Flash flood waters and the accompanying debris can uproot trees, roll boulders, destroy buildings, and obliterate bridges and roads.

The periodic flooding of lands adjacent to rivers, streams, and shorelines (land known as floodplain) is a natural and inevitable occurrence that can be expected to take place based upon established recurrence intervals. The recurrence interval of a flood is defined as the average time interval, in years, expected between a flood event of a particular magnitude and an equal or larger flood. Flood magnitude increases with increasing recurrence interval.

Floodplains are designated by the frequency of the flood that is large enough to cover them. For example, the 10-year floodplain will be covered by the 10-year flood and the 100-year floodplain by the 100-year flood. Flood frequencies such as the 100-year flood are determined by plotting a graph of the size of all known floods for an area and determining how often floods of a particular size occur. Another way of expressing the flood frequency is the chance of occurrence in a given year, which is the percentage of the probability of flooding each year. For example, the 100-year flood has a 1 percent chance of occurring in any given year.

Table 4.1-1 shows flood damage values by fiscal year from a national perspective.

Table 4.1-1
National Flood Damage by Fiscal Year (Oct.-Sept.) 1983 - 2013

Fiscal Year	Damage (Billions of Current Dollars)	Inflation Adjustment	Damage (Billions of 2013 Dollars)	U.S. Population (Millions)	Damage Per Capita (2013 Dollars)
1983	4.014	2.34	9.392	233.79	40.17
1984	3.866	2.24	8.635	235.82	36.62
1985	0.524	2.17	1.137	237.92	4.78
1986	6.261	2.13	13.337	240.13	55.54
1987	1.526	2.05	3.129	242.29	12.91
1988	0.242	1.97	0.476	244.5	1.94
1989	1.190	1.88	2.236	246.82	9.06
1990	1.855	1.78	3.302	249.62	13.23
1991	1.961	1.71	3.354	252.98	13.26
1992	0.880	1.66	1.461	256.51	5.70
1993	18.63	1.61	29.997	259.92	115.41
1994	1.259	1.57	1.977	263.13	7.51
1995	5.829	1.53	8.918	266.28	33.49
1996	7.026	1.48	10.399	269.39	38.60
1997	9.866	1.45	14.306	272.65	52.47
1998	2.816	1.43	4.027	275.85	14.60
1999	6.119	1.40	8.596	279.04	30.81
2000	1.521	1.35	2.054	282.16	7.28
2001	8.334	1.32	11.001	284.97	38.60
2002	1.371	1.29	1.769	287.63	6.15
2003	2.787	1.27	3.540	290.11	12.20
2004	15.241	1.23	18.746	292.81	64.02
2005	45.264	1.19	53.864	295.52	182.27
2006	3.976	1.16	4.612	298.38	15.46
2007	2.552	1.12	2.858	301.23	9.49
2008	6.082	1.08	6.569	304.09	21.60
2009	0.982	1.09	1.070	306.77	3.49
2010	5.108	1.07	5.466	309.33	17.67
2011	8.521	1.04	8.862	311.59	28.44
2012	0.511	1.01	0.516	313.59	1.65
2013	2.152	1.00	2.152	316.98	6.79

Source: Hydrologic Information Center, National Weather Service

4.1.3 Hurricanes and Coastal Storms

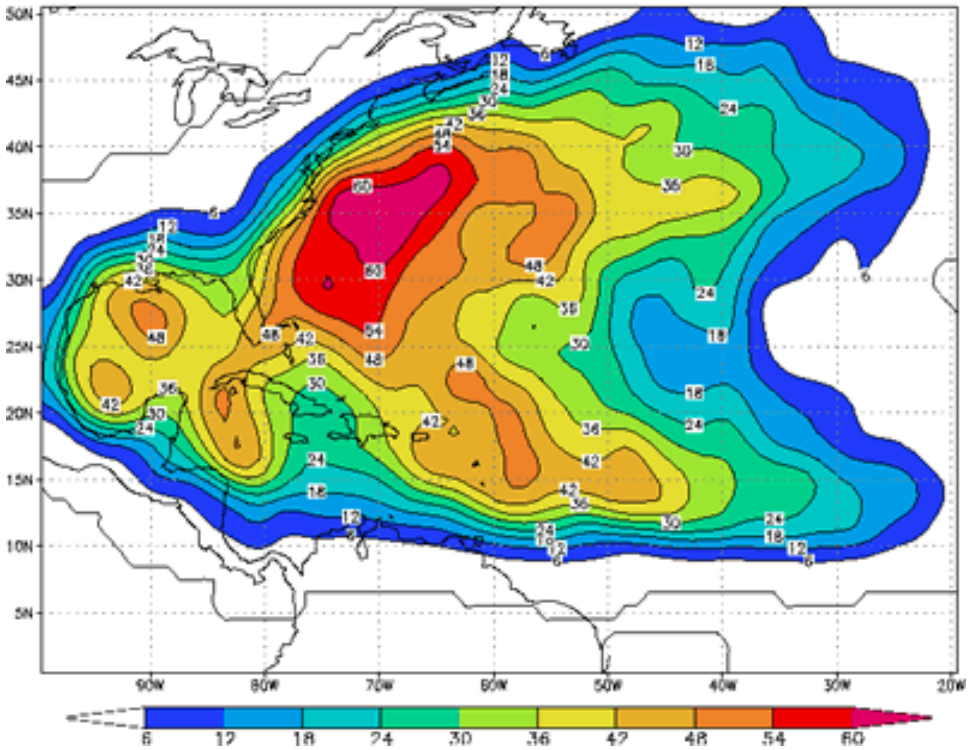
Hurricanes, tropical storms, nor'easters and typhoons, also classified as cyclones, are any closed circulation developing around a low-pressure center in which the winds rotate counter-clockwise in the Northern Hemisphere (or clockwise in the Southern Hemisphere) and whose diameter averages 10 to 30 miles across. A tropical cyclone refers to any such circulation that develops over tropical waters. Tropical cyclones act as a "safety-valve," limiting the continued build-up of heat and energy in tropical regions by maintaining the atmospheric heat and moisture balance between the tropics and the pole-ward latitudes. The primary damaging forces associated with these storms are high-level sustained winds, heavy precipitation, and tornadoes. Coastal areas are also vulnerable to the additional forces of storm surge, wind-driven waves, and tidal flooding which can be more destructive than cyclone wind.

The key energy source for a tropical cyclone is the release of latent heat from the condensation of warm water. Their formation requires a low-pressure disturbance, warm sea surface temperature, rotational force from the spinning of the earth, and the absence of wind shear in the lowest 50,000 feet of the atmosphere. The majority of hurricanes and tropical storms form in the Atlantic Ocean, Caribbean Sea, and Gulf of Mexico during the official Atlantic hurricane season, which encompasses the months of June through November. The peak of the Atlantic hurricane season is in early to mid-September and the average number of storms that reach hurricane intensity per year in this basin is about six (6).

Wind and rain from Hurricane Lili damage road signs along I-10 in Louisiana October 3, 2002. (Photo by Lauren Hobart/FEMA News Photo)

Figure 4.1-1 shows for any particular location what the chance is that a tropical storm or hurricane will affect the area sometime during the whole June to November Atlantic hurricane season. The figure was created by the National Oceanic and Atmospheric Administration's Hurricane Research Division using data from 1944 to 1999 and counting hits when a storm or hurricane was within approximately 100 miles (165 km) of each location.

Figure 4.1-1
Empirical Probability of a Named Storm



Source: National Oceanic and Atmospheric Administration, Hurricane Research Division

As an incipient hurricane develops, barometric pressure (measured in Millibars or inches) at its center falls and winds increase. If the atmospheric and oceanic conditions are favorable, it can intensify into a tropical depression. When maximum sustained winds reach or exceed 39 miles per hour, the system is designated a tropical storm, given a name, and is closely monitored by the National Hurricane Center in Miami, Florida. When sustained winds reach or exceed 74 miles per hour the storm is deemed a hurricane. Hurricane intensity is further classified by the Saffir-Simpson Scale, which rates hurricane intensity on a scale of 1 to 5, with 5 being the most intense. The Saffir-Simpson Scale was slightly modified in 2012 in order to "resolve awkwardness with conversions among the various units used for wind speed in advisory products" (NHC).

The Saffir-Simpson Scale is shown in Table 4.1-2.

Table 4.1-2
Saffir-Simpson Wind Scale

Category	Maximum Sustained Wind Speed (mph)
1	74-95 mph
2	96-110 mph
3	111-129 mph
4	130-156 mph
5	157 mph or higher

Source: National Hurricane Center

The Saffir-Simpson Scale categorizes hurricane intensity linearly based upon maximum sustained winds, barometric pressure, and storm surge potential, which are combined to estimate potential damage. Categories 3, 4, and 5 are classified as "major" hurricanes, and while hurricanes within this range comprise only 20 percent of total tropical cyclone landfalls, they account for over 70 percent of the damage in the United States. Table 4.1-3 describes the damage that could be expected for each category of hurricane.

Table 4.1-3
Hurricane Damage Classification

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

Source: National Hurricane Center

A storm surge is a large dome of water often 50 to 100 miles wide and rising anywhere from four to five feet in a Category 1 hurricane up to 20 feet in a Category 5 storm. The storm surge arrives ahead of the storm's actual landfall and the more intense the hurricane is, the sooner the surge arrives. Water rise can be very rapid, posing a serious threat to those who have not yet evacuated flood-prone areas. A storm surge is a wave that has outrun its generating source and become a long period swell. The surge is always highest in the right-front quadrant of the direction in which the hurricane is moving. As the storm approaches shore, the greatest storm surge will be to the north of the hurricane eye. Such a surge of high water topped by waves driven by hurricane force winds can be devastating to coastal regions, causing severe beach erosion and property damage along the immediate coast.

Storm surge heights, and associated waves, are dependent upon the shape of the continental shelf (narrow or wide) and the depth of the ocean bottom (bathymetry). A narrow shelf, or one that drops steeply from the shoreline and subsequently produces deep water close to the shoreline, tends to produce a lower surge but higher and more powerful storm waves.

Damage during hurricanes may also result from spawned tornadoes and inland flooding associated with heavy rainfall that usually accompanies these storms. Hurricane Floyd, as an example, was at one time a Category 4 hurricane racing towards the North Carolina coast. As far inland as Raleigh, the state capital located more than 100 miles from the coast, communities were preparing for extremely damaging winds exceeding 100 miles per hour. However, Floyd made landfall as a Category 2 hurricane and will be remembered for causing the worst inland flooding disaster in North Carolina's history. Rainfall amounts were as high as 20 inches in certain locales and 67 counties sustained damages.

Hurricane Floyd brought a devastating 15 feet of storm surge that damaged or destroyed hundreds of houses along the ocean front of Long Beach on Oak Island, North Carolina in September 1999. A prime example of successful hazard mitigation, the elevated home (right) survived while the older, ground-level block foundation of the home on the left was crushed. (Photo by Dave Gatley/FEMA News Photo)

Similar to hurricanes, nor'easters are ocean storms capable of causing substantial damage to coastal areas in the Eastern United States due to their associated strong winds and heavy surf. Nor'easters are named for the winds that blow in from the northeast and drive the storm up the East Coast along the Gulf Stream, a band of warm water that lies off the Atlantic coast. They are caused by the interaction of the jet stream with horizontal temperature gradients and generally occur during the fall and winter months when moisture and cold air are plentiful.

Nor'easters are known for dumping heavy amounts of rain and snow, producing hurricane-force winds, and creating high surfs that cause severe beach erosion and coastal flooding. There are two main components to a nor'easter: (1) a Gulf Stream low-pressure system (counter-clockwise winds) generated off the southeastern U.S. coast, gathering warm air and moisture from the Atlantic, and pulled up the East Coast by strong northeasterly winds at the leading edge of the storm; and (2) an Arctic high-pressure system (clockwise winds) which meets the low-pressure system with cold, arctic air blowing down from Canada. When the two systems collide, the moisture and cold air produce a mix of precipitation and have the potential for creating dangerously high winds and heavy seas. As the low-pressure system deepens, the intensity of the winds and waves will increase and cause serious damage to coastal areas as the storm moves northeast.

Table 4.1-4 shows an intensity scale proposed for nor'easters that is based upon levels of coastal degradation.

Table 4.1-4
Dolan-Davis Nor'easter Intensity Scale

Storm Class	Beach Erosion	Dune Erosion	Overwash	Property Damage
1 (Weak)	Minor changes	None	No	No
2 (Moderate)	Modest; mostly to lower beach	Minor	No	Modest
3 (Significant)	Erosion extends across beach	Can be significant	No	Loss of many structures at local level
4 (Severe)	Severe beach erosion and recession	Severe dune erosion or destruction	On low beaches	Loss of structures at community-scale
5 (Extreme)	Extreme beach erosion	Dunes destroyed over extensive areas	Massive in sheets and channels	Extensive at regional-scale; millions of dollars

Source: North Carolina Division of Emergency Management

4.1.4 Severe Thunderstorms and Tornadoes

According to the National Weather Service, more than 100,000 thunderstorms occur each year, though only about 10 percent of these storms are classified as "severe." Although thunderstorms generally affect a small area when they occur, they are very dangerous because of their ability to generate tornadoes, hailstorms, strong winds, flash flooding, and damaging lightning. While thunderstorms can occur in all regions of the United States, they are most common in the central and southern states because atmospheric conditions in those regions are most ideal for generating these powerful storms.

Multiple cloud-to-ground and cloud-to-cloud lightning strokes observed during a nighttime thunderstorm. (Photo courtesy of NOAA Photo Library, NOAA Central Library; OAR/ERL/ National Severe Storms Laboratory)

Thunderstorms are caused when air masses of varying temperatures meet. Rapidly rising warm moist air serves as the "engine" for thunderstorms. These storms can occur singularly, in lines, or in clusters. They can move through an area very quickly or linger for several hours.

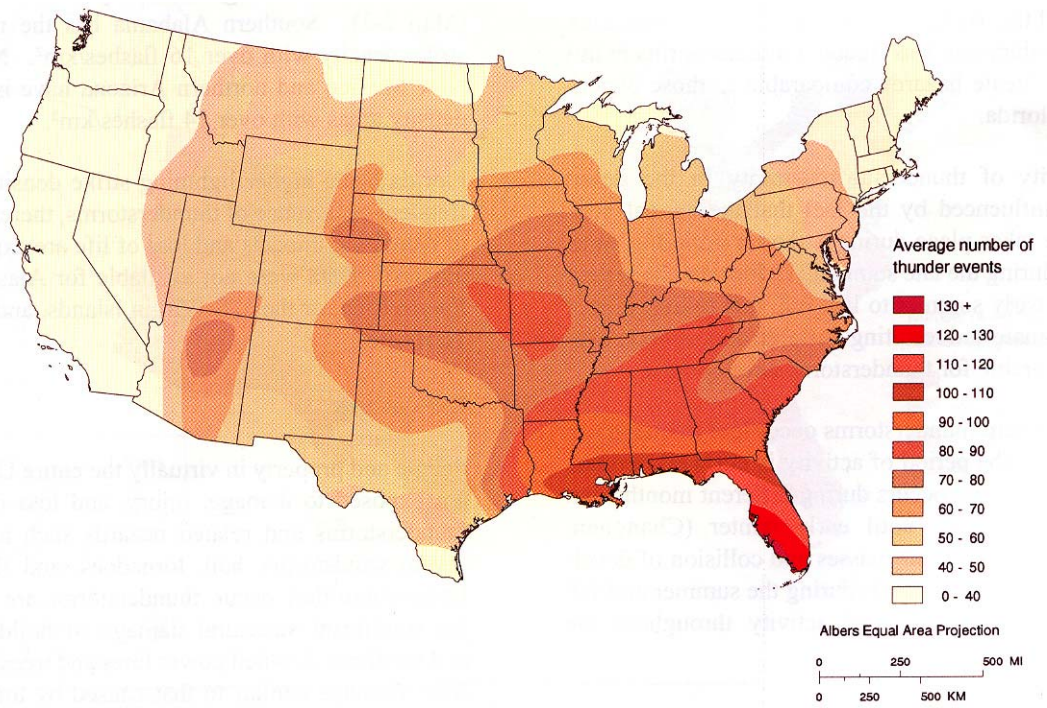
Lightning is a discharge of electrical energy resulting from the buildup of positive and negative charges within a thunderstorm, creating a "bolt" when the buildup of charges becomes strong enough. This flash of light usually occurs within the clouds or between the clouds and the ground. A bolt of lightning can reach temperatures approaching 50,000 degrees Fahrenheit. Lightning rapidly heats the sky as it flashes but the surrounding air cools following the bolt. This rapid heating and cooling of the surrounding air causes thunder. On average, 89 people are killed each year by lightning strikes in the United States.

The National Weather Service collected data for thunder days, number and duration of thunder events, and lightening strike density for the 30-year period from 1948 to 1977. A series of maps was generated showing the annual

average thunder event duration, the annual average number of thunder events, and the mean annual density of lightning strikes.

Figure 4.1-2 illustrates thunderstorm hazard severity based on the annual average number of thunder events from 1948 to 1977.

Figure 4.1-2
Annual Average Number of Thunder Events



Source: Federal Emergency Management Agency

A tornado is a violent windstorm characterized by a twisting, funnel-shaped cloud extending to the ground. Tornadoes are most often generated by thunderstorm activity (but sometimes result from hurricanes and other coastal storms) when cool, dry air intersects and overrides a layer of warm, moist air forcing the warm air to rise rapidly. The damage caused by a tornado is a result of the high wind velocity and wind-blown debris, also accompanied by lightning or large hail. According to the National Weather Service, tornado wind speeds normally range from 40 to more than 300 miles per hour. The most violent tornadoes have rotating winds of 250 miles per hour or more and are capable of causing extreme destruction and turning normally harmless objects into deadly missiles.

The most comprehensively observed tornado in history, this tornado south of Dimmitt, Texas developed June 2, 1995 curving northward across Texas Highway 86 where it entirely removed 300 feet of asphalt from the road tossing it more than 600 feet into an adjacent field. It also caused F4 damage at an isolated rural residence just north of the road. (NOAA Photo Library, NOAA Central Library; OAR/ERL/National Severe Storms Laboratory)

Each year, an average of over 800 tornadoes is reported nationwide, resulting in an average of 80 deaths and 1,500 injuries (NOAA, 2002). They are more likely to occur during the spring and early summer months of March through June and can occur at any time of day, but are likely to form in the late afternoon and early evening. Most tornadoes are a few dozen yards wide and touch down briefly, but even small short-lived tornadoes can inflict tremendous damage. Highly destructive tornadoes may carve out a path over a mile wide and several miles long.

Waterspouts are weak tornadoes that form over warm water and are most common along the Gulf Coast and southeastern states. Waterspouts occasionally move inland, becoming tornadoes that cause damage and injury. However, most waterspouts dissipate over the open water causing threats only to marine and boating interests. Typically a waterspout is weak and short-lived, and because they are so common, most go unreported unless they cause damage.

The destruction caused by tornadoes ranges from light to inconceivable depending on the intensity, size, and duration of the storm. Typically, tornadoes cause the greatest damages to structures of light construction such as residential homes (particularly mobile homes), and tend to remain localized in impact. The Fujita-Pearson Scale for Tornadoes was updated to the Enhanced-Fujita scale on February 1, 2007. The Enhanced-Fujita (EF) Scale is still a set of wind estimates based on damage, however takes into account construction quality, provides damage indicators, and a definitive correlation between damage and wind speed. The EF-Scale (Table 4.1-5) consists of 28 damage indicators consisting of buildings, structures and trees. For each Damage Indicator (DI), several Degrees of Damage (DODs) are identified. The DODs are sequenced so each one requires a higher expected wind speed than the previous one. Damage ranges from the initiation of visible damage to complete destruction of the particular DI. A benefit of this approach is that, in the future, additional DIs can be added to the current list as new information becomes available.

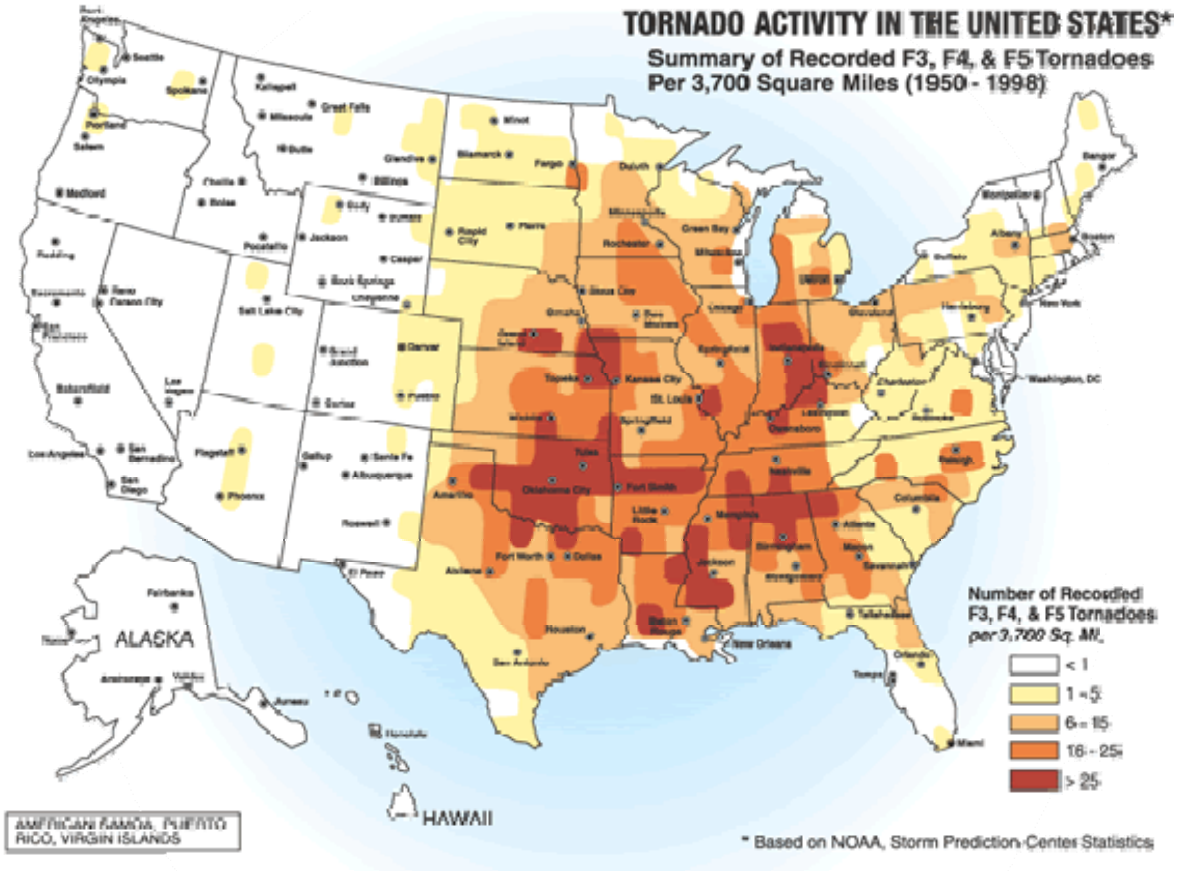
Table 4.1-5
Enhanced Fujita Scale for Tornadoes

EF-Scale Number	3 Second Gust (mph)	Type of Damage Done
EF0	65-85	Light Damage: Peels surface off some roofs; some damage to gutters or siding; branches broken off trees; shallow-rooted trees pushed over.
EF1	86-110	Moderate Damage: Roofs severely stripped; mobile homes overturned or badly damaged; loss of exterior doors; windows and other glass broken.
EF2	111-135	Considerable Damage: Roofs torn off well-constructed houses; mobile homes demolished; large trees snapped or uprooted; light object missiles generated; cars lifted off ground.
EF3	136-165	Severe Damage: Entire stories of well-constructed houses destroyed; severe damage to large buildings such as shopping malls; trains overturned; trees debarked; heavy cars lifted off the ground and thrown; structures with weak foundations blown away some distance.
EF4	166-200	Devastating Damage: Whole frame houses, well-constructed houses and whole frame houses completely leveled; cars thrown and small missiles generated.
EF5	>200	Incredible Damage: Strong frame houses leveled off foundations and swept away; automobile-sized missiles fly through the air in excess of 100m (109 yd); high-rise buildings have significant structural deformation; incredible phenomena will occur.

Source: NOAA's NWS Storm Prediction Center

According to the NOAA Storm Prediction Center (SPC), the highest concentration of tornadoes in the United States has been in Oklahoma, Texas, Kansas and Florida respectively. Although the Great Plains region of the Central United States does favor the development of the largest and most dangerous tornadoes (earning the designation of "tornado alley"), Florida experiences the greatest number of tornadoes per square mile of all U.S. states (SPC, 2002). Figure 4.1-2 shows tornado activity in the United States based on the number of recorded F3, F4 and F5 tornadoes per 3,700 square miles between 1950 and 1998.

Figure 4.1-2
Tornado Activity in the United States

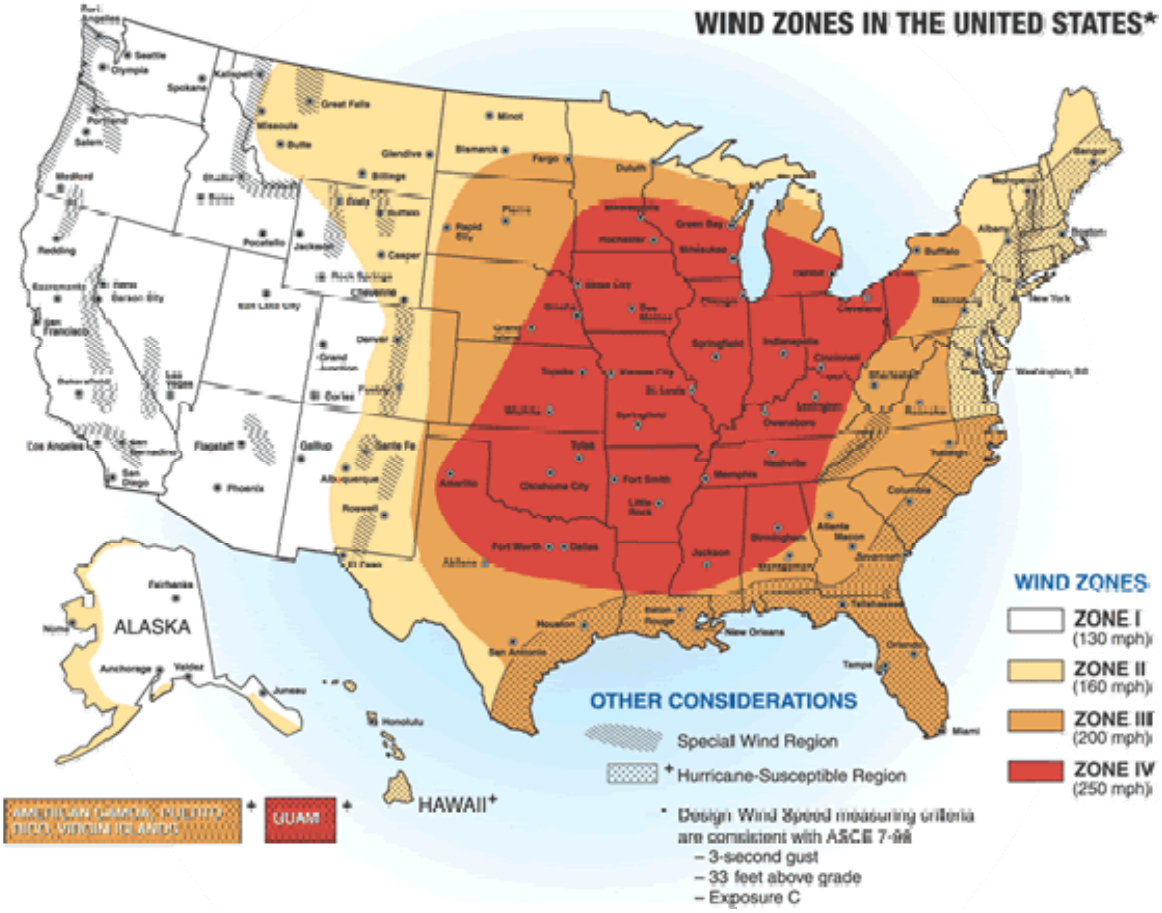


Source: American Society of Civil Engineers

The tornadoes associated with tropical cyclones are most frequent in September and October when the incidence of tropical storm systems is greatest. This type of tornado usually occurs around the perimeter of the storm, and most often to the right and ahead of the storm path or the storm center as it comes ashore. These tornadoes commonly occur as part of large outbreaks and generally move in an easterly direction.

Figure 4.1-3 shows how the frequency and strength of extreme windstorms vary across the United States. The map was produced by the Federal Emergency Management Agency and is based on 40 years of tornado history and over 100 years of hurricane history. Zone IV, the darkest area on the map, has experienced both the greatest number of tornadoes and the strongest tornadoes. As shown by the map key, wind speeds in Zone IV can be as high as 250 MPH.

Figure 4.1-3
Wind Zones in the United States



Source: Federal Emergency Management Agency

4.1.5 Wildfire

A wildfire is any fire occurring in a wildland area (i.e. grassland, forest, brush land) except for fire under prescription.[1] Wildfires are part of the natural management of the Earth's ecosystems, but may also be caused by natural or human factors. Over 80 percent of forest fires are started by negligent human behavior such as smoking in wooded areas or improperly extinguishing campfires. The second most common cause for wildfire is lightning.

There are three classes of wildland fires: surface fire, ground fire, and crown fire. A surface fire is the most common of these three classes and burns along the floor of a forest, moving slowly and killing or damaging trees. A ground fire (muck fire) is usually started by lightning or human carelessness and burns on or below the forest floor. Crown fires spread rapidly by wind and move quickly by jumping along the tops of trees. Wildland fires are usually signaled by dense smoke that fills the area for miles around.

State and local governments can impose fire safety regulations on home sites and developments to help curb wildfire. Land treatment measures such as fire access roads, water storage, helipads, safety zones, buffers, firebreaks, fuel breaks, and fuel management can be designed as part of an overall fire defense system to aid in fire control. Fuel management, prescribed burning, and cooperative land management planning can also be encouraged to reduce fire hazards.

On Sunday, August 6, 2000, several forest fires converged near Sula, Montana, forming a firestorm that overran 100,000 acres and destroyed 10 homes. Temperatures in the flame front were estimated at more than 800 degrees. Note the elk gathering near the East Fork of the Bitterroot River. (Photo by John McColgan/U.S. Forest Service Firefighter)

Fire probability depends on local weather conditions, outdoor activities such as camping, debris burning, and construction, and the degree of public cooperation with fire prevention measures. Drought conditions and other natural disasters (tornadoes, hurricanes, etc.) increase the probability of wildfires by producing fuel in both urban and rural settings. Forest damage from hurricanes and tornadoes may block interior access roads and fire breaks, pull down overhead power lines, or damage pavement and underground utilities.

Many individual homes and cabins, subdivisions, resorts, recreational areas, organizational camps, businesses, and industries are located within high fire hazard areas. The increasing demand for outdoor recreation places more people in wildlands during holidays, weekends, and vacation periods. Unfortunately, wildland residents and visitors are rarely educated or prepared for the inferno that can sweep through the brush and timber and destroy property in minutes.

[1] Prescription burning, or "controlled burn," undertaken by land management agencies is the process of igniting fires under selected conditions, in accordance with strict parameters.

4.1.6 Drought/Extreme Heat

Drought is a natural climatic condition caused by an extended period of limited rainfall beyond that which occurs naturally in a broad geographic area. High temperatures, high winds, and low humidity can worsen drought conditions, and can make areas more susceptible to wildfire. Human demands and actions can also hasten drought-related impacts.

Droughts are frequently classified as one of following four types:

- Meteorological
- Agricultural
- Hydrological
- Socio-economic.

Meteorological droughts are typically defined by the level of "dryness" when compared to an average, or normal amount of precipitation over a given period of time. Agricultural droughts relate common characteristics of drought to their specific agricultural-related impacts. Emphasis tends to be placed on factors such as soil water deficits, water needs based on differing stages of crop development, and water reservoir levels. Hydrological drought is directly related to the effect of precipitation shortfalls on surface and groundwater supplies. Human factors, particularly changes in land use, can alter the hydrologic characteristics of a basin. Socio-economic drought is the result of water shortages that limit the ability to supply water-dependent products in the marketplace.

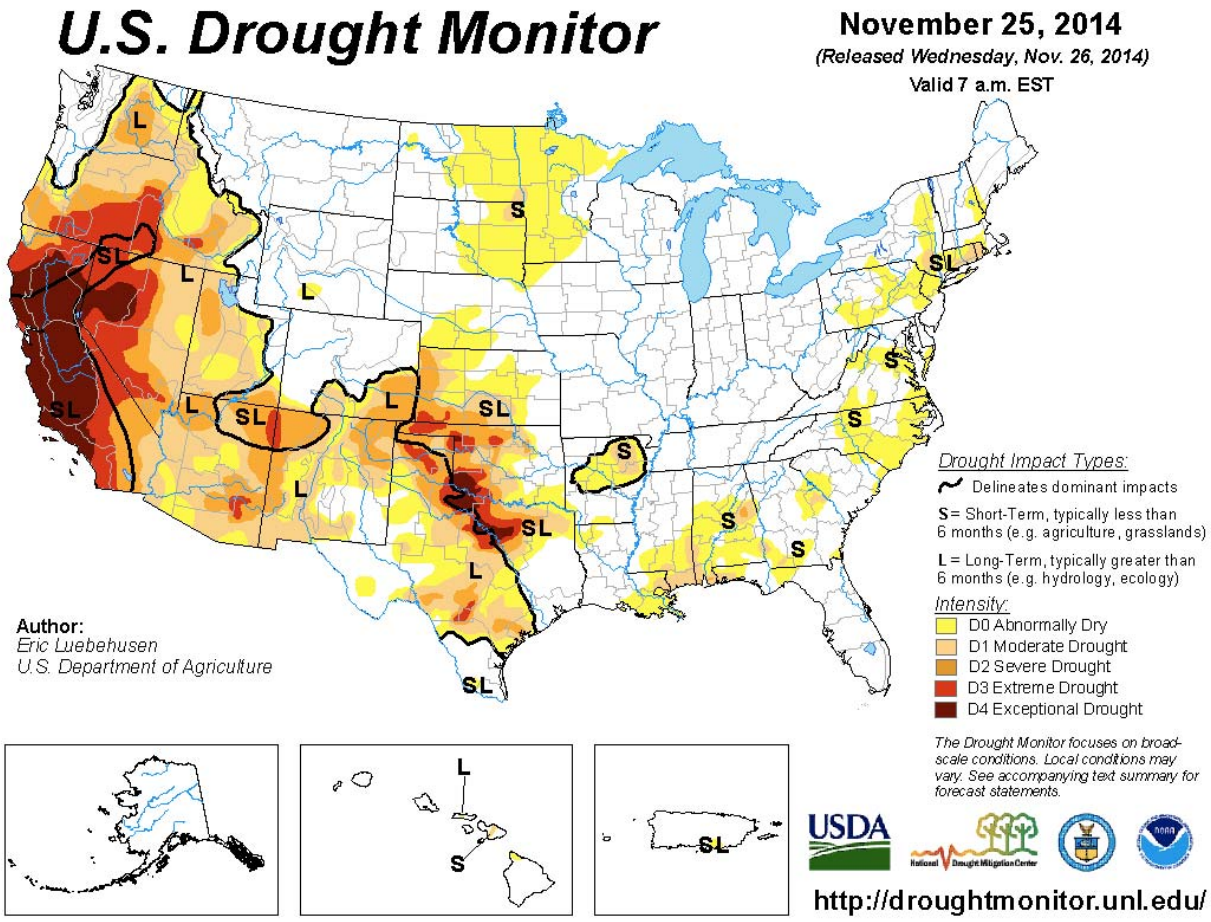
A USGS streamflow gaging station at the Ogeechee River near Eden, Georgia in July 2000 illustrates the drought conditions that can severely affect water supplies, agriculture, stream water quality, recreation, navigation, and forest resources. (Photo courtesy of the United States Geological Survey)

While drought mostly impacts land and water resources, extreme heat can pose a significant risk to humans. Extreme heat can be defined as temperatures that hover 10 degrees or more above the average high temperature for the region, last for prolonged periods of time, and are often accompanied by high humidity. Under normal conditions, the human body's internal thermostat produces perspiration that evaporates and cools the body. However, in extreme heat and high humidity, evaporation is slowed and the body must work much harder to maintain a normal temperature. Elderly persons, young children, persons with respiratory difficulties, and those who are sick or overweight are more likely to become victims of extreme heat. Because men sweat more than women, they are more susceptible to heat-related illness because they become more quickly dehydrated. Studies have shown that a significant rise in heat-related illness occurs when excessive heat persists for more than two days. Spending at least two hours per day in air conditioning can significantly reduce the number of heat-related illnesses.

Extreme heat in urban areas can create health concerns when stagnant atmospheric conditions trap pollutants, thus adding unhealthy air to excessively hot temperatures. In addition, the "urban heat island effect" can produce significantly higher nighttime temperatures because asphalt and concrete (which store heat longer) gradually release heat at night.

Figure 4.1-4 shows a U.S. Drought Monitor summary map from the United States Department of Agriculture for November 25, 2014. Drought Monitor summary maps identify general drought areas and label droughts by intensity, with D1 being the least intense and D4 being the most intense.

Figure 4.1-4
U.S. Drought Monitor



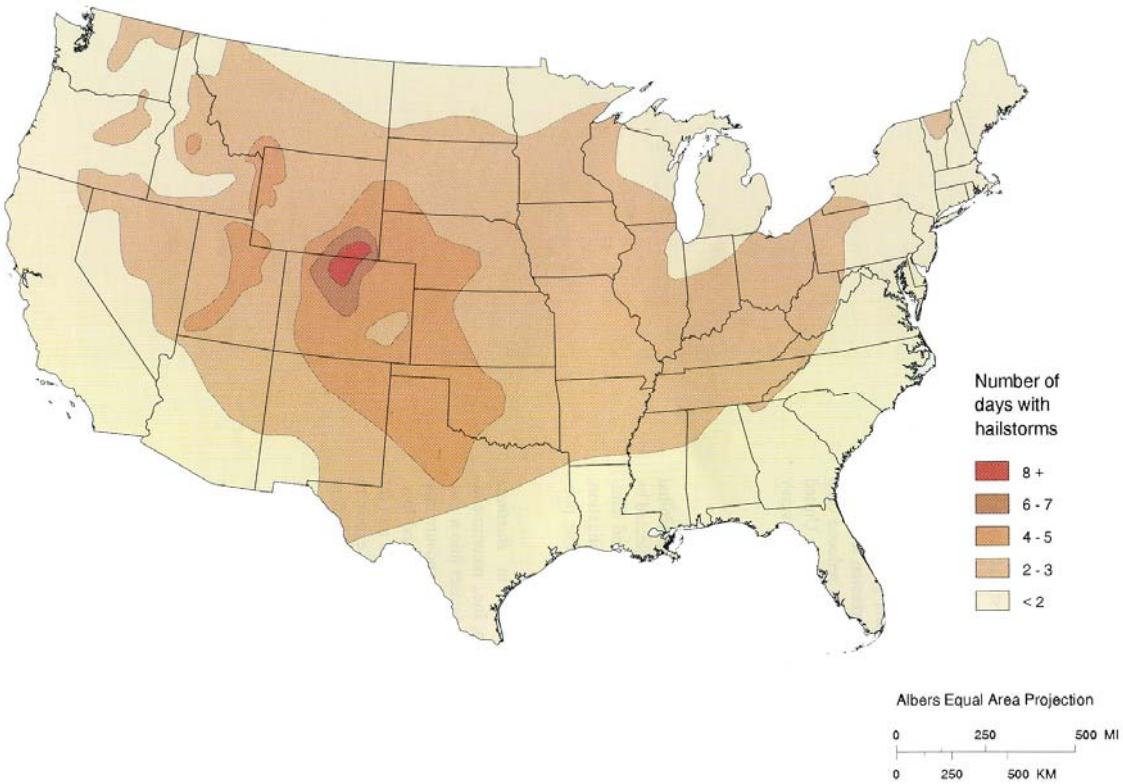
Weekly-updated maps may be obtained online from The Drought Monitor Web site, maintained by the National Drought Mitigation Center, located at the following Web address: http://drought.unl.edu/dm.

4.1.7 Hail

Hailstorms are an outgrowth of severe thunderstorms. Early in the developmental stages of a hailstorm, ice crystals form within a low-pressure front due to the rapid rising of warm air into the upper atmosphere and the subsequent cooling of the air mass. Frozen droplets gradually accumulate on the ice crystals until, having developed sufficient weight, they fall as precipitation — as balls or irregularly shaped masses of ice greater than 0.75 in. (1.91 cm) in diameter. The size of hailstones is a direct function of the size and severity of the storm. High velocity updraft winds are required to keep hail in suspension in thunderclouds. The strength of the updraft is a function of the intensity of heating at the Earth's surface. Higher temperature gradients relative to elevation above the surface result in increased suspension time and hailstone size. Figure 4.1-5 shows the annual frequency of hailstorms in the United States.

Large hail collects on streets and grass during a severe thunderstorm. Larger stones appear to be nearly two to three inches in diameter. (NOAA Photo Library, NOAA Central Library; OAR/ERL/National Severe Storms Laboratory)

Figure 4.1-5
Annual Frequency of Hailstorms in the United States



Source: Federal Emergency Management Agency

4.1.8 Winter Storms and Freezes

A winter storm can range from a moderate snow over a period of a few hours to blizzard conditions with blinding wind-driven snow that lasts for several days. Some winter storms may be large enough to affect several states, while others may affect only a single community. Many winter storms are accompanied by low temperatures and heavy and/or blowing snow, which can severely impair visibility.

Winter storms may include snow, sleet, freezing rain, or a mix of these wintry forms of precipitation. Sleet – raindrops that freeze into ice pellets before reaching the ground – usually bounce when hitting a surface and do not stick to objects; however, sleet can accumulate like snow and cause a hazard to motorists. Freezing rain is rain that falls onto a surface with a temperature below freezing, forming a glaze of ice. Even small accumulations of ice can cause a significant hazard, especially on power lines and trees. An ice storm occurs when freezing rain falls and freezes immediately upon impact. Communications and power can be disrupted for days, and even small accumulations of ice may cause extreme hazards to motorists and pedestrians.

A heavy layer of ice was more weight than this tree in Kansas City, Missouri could withstand during a January 2002 ice storm that swept through the region bringing down trees, power lines and telephone lines. (Photo by Heather Oliver/FEMA News Photo)

A freeze is weather marked by low temperatures, especially when below the freezing point (zero degrees Celsius or thirty-two degrees Fahrenheit). Agricultural production is seriously affected when temperatures remain below the freezing point.

4.1.9 Erosion

Erosion is the gradual breakdown and movement of land due to both physical and chemical processes of water, wind, and general meteorological conditions. Natural, or geologic, erosion has occurred since the Earth's formation and continues at a very slow and uniform rate each year.

There are two types of soil erosion: wind erosion and water erosion. Wind erosion can cause significant soil loss. Winds blowing across sparsely vegetated or disturbed land can pick up soil particles and carry them through the air, thus displacing them. Water erosion can occur over land or in streams and channels. Water erosion that takes place over land may result from raindrops, shallow sheets of water flowing off the land, or shallow surface flow, which is concentrated in low spots. Stream channel erosion may occur as the volume and velocity of water flow increases enough to cause movement of the streambed and bank soils. Major storms such as hurricanes may cause significant erosion by combining high winds with heavy surf and storm surge to significantly impact the shoreline.

An area's potential for erosion is determined by four factors: soil characteristics, vegetative cover, topography climate or rainfall, and topography. Soils composed of a large percentage of silt and fine sand are most susceptible to erosion. As the content of these soils increases in the level of clay and organic material, the potential for erosion decreases. Well-drained and well-graded gravels and gravel-sand mixtures are the least likely to erode. Coarse

gravel soils are highly permeable and have a good capacity for absorption, which can prevent or delay the amount of surface runoff. Vegetative cover can be very helpful in controlling erosion by shielding the soil surface from falling rain, absorbing water from the soil, and slowing the velocity of runoff. Runoff is also affected by the topography of the area including size, shape and slope. The greater the slope length and gradient, the more potential an area has for erosion. Climate can affect the amount of runoff, especially the frequency, intensity and duration of rainfall and storms. When rainstorms are frequent, intense, or of long duration, erosion risks are high. Seasonal changes in temperature and rainfall amounts define the period of highest erosion risk of the year.

During the past 20 years, the importance of erosion control has gained the increased attention of the public. Implementation of erosion control measures consistent with sound agricultural and construction operations is needed to minimize the adverse effects associated with increasing settling out of the soil particles due to water or wind. The increase in government regulatory programs and public concern has resulted in a wide range of erosion control products, techniques, and analytical methodologies in the United States. The preferred method of erosion control in recent years has been the restoration of vegetation.

4.1.10 Dam/Levee Failure

Worldwide interest in dam and levee safety has risen significantly in recent years. Aging infrastructure, new hydrologic information, and population growth in floodplain areas downstream from dams and near levees have resulted in an increased emphasis on safety, operation and maintenance.

There are about 80,000 dams in the United States today, the majority of which are privately owned. Other owners include state and local authorities, public utilities, and federal agencies. The benefits of dams are numerous: they provide water for drinking, navigation, and agricultural irrigation. Dams also provide hydroelectric power, create lakes for fishing and recreation, and save lives by preventing or reducing floods.

Dam failure can result from natural events, human-induced events, or a combination of the two. Failures due to natural events such as hurricanes, earthquakes or landslides are significant because there is generally little or no advance warning. The most common cause of dam failure is prolonged rainfall that produces flooding. (Photo: Michael Baker Corporation)

Though dams have many benefits, they also can pose a risk to communities if not designed, operated, and maintained properly. In the event of a dam failure, the energy of the water stored behind even a small dam is capable of causing loss of life and great property damage if development exists downstream of the dam. If a levee breaks, scores of properties are quickly submerged in floodwaters and residents may become trapped by this rapidly rising water. The failure of dams and levees has the potential to place large numbers of people and great amounts of property in harm's way.

4.1.11 Earthquakes, Sinkholes and Landslides

Earthquake

An earthquake is the motion or trembling of the ground produced by sudden displacement of rock in the Earth's crust. Earthquakes result from crustal strain, volcanism, landslides, or the collapse of caverns. Earthquakes can affect hundreds of thousands of square miles; cause damage to property measured in the tens of billions of dollars; result in loss of life and injury to hundreds of thousands of persons; and disrupt the social and economic functioning of the affected area.

Most property damage and earthquake-related deaths are caused by the failure and collapse of structures due to ground shaking. The level of damage depends upon the amplitude and duration of the shaking, which are directly related to the earthquake size, distance from the fault, site and regional geology. Other damaging earthquake effects include landslides, the down-slope movement of soil and rock (mountain regions and along hillsides), and liquefaction, in which ground soil loses the ability to resist shear and flows much like quick sand. In the case of liquefaction, anything relying on the substrata for support can shift, tilt, rupture, or collapse.

Many roads, including bridges and elevated highways, were damaged by the 6.7 magnitude earthquake that impacted the Northridge, California area January 17, 1994. Approximately 114,000 structures were damaged and 72 deaths were attributed to the event. Damage costs were estimated at $25 billion. (FEMA News Photo)

Most earthquakes are caused by the release of stresses accumulated as a result of the rupture of rocks along opposing fault planes in the Earth's outer crust. These fault planes are typically found along borders of the Earth's ten tectonic plates. These plate borders generally follow the outlines of the continents, with the North American plate following the continental border with the Pacific Ocean in the west, but following the mid-Atlantic trench in the east. As earthquakes occurring in the mid-Atlantic trench usually pose little danger to humans, the greatest earthquake threat in North America is along the Pacific Coast.

The areas of greatest tectonic instability occur at the perimeters of the slowly moving plates, as these locations are subjected to the greatest strains from plates traveling in opposite directions and at different speeds. Deformation along plate boundaries causes strain in the rock and the consequent buildup of stored energy. When the built-up stress exceeds the rocks' strength, a rupture occurs. The rock on both sides of the fracture is snapped, releasing the stored energy and producing seismic waves, generating an earthquake.

Earthquakes are measured in terms of their magnitude and intensity. Magnitude is measured using the Richter Scale, an open-ended logarithmic scale that describes the energy release of an earthquake through a measure of shock wave amplitude (see Table 4.1-5). Each unit increase in magnitude on the Richter Scale corresponds to a ten-fold increase in wave amplitude, or a 32-fold increase in energy. Intensity is most commonly measured using the Modified Mercalli Intensity (MMI) Scale based on direct and indirect measurements of seismic effects. The scale levels are typically described using roman numerals, with a I corresponding to imperceptible (instrumental) events, IV corresponding to moderate (felt by people awake), to XII for catastrophic (total destruction). A detailed description of the Modified Mercalli Intensity Scale of earthquake intensity and its correspondence to the Richter Scale is given in Table 4.1-6.

Table 4.1-5
Richter Scale

Richter Magnitudes	Earthquake Effects
Less than 3.5	Generally not felt, but recorded.
3.5-5.4	Often felt, but rarely causes damage.
Under 6.0	At most slight damage to well-designed buildings. Can cause major damage to poorly constructed buildings over small regions.
6.1-6.9	Can be destructive in areas up to about 100 kilometers across where people live.
7.0-7.9	Major earthquake. Can cause serious damage over larger areas.
8 or greater	Great earthquake. Can cause serious damage in areas several hundred kilometers across.

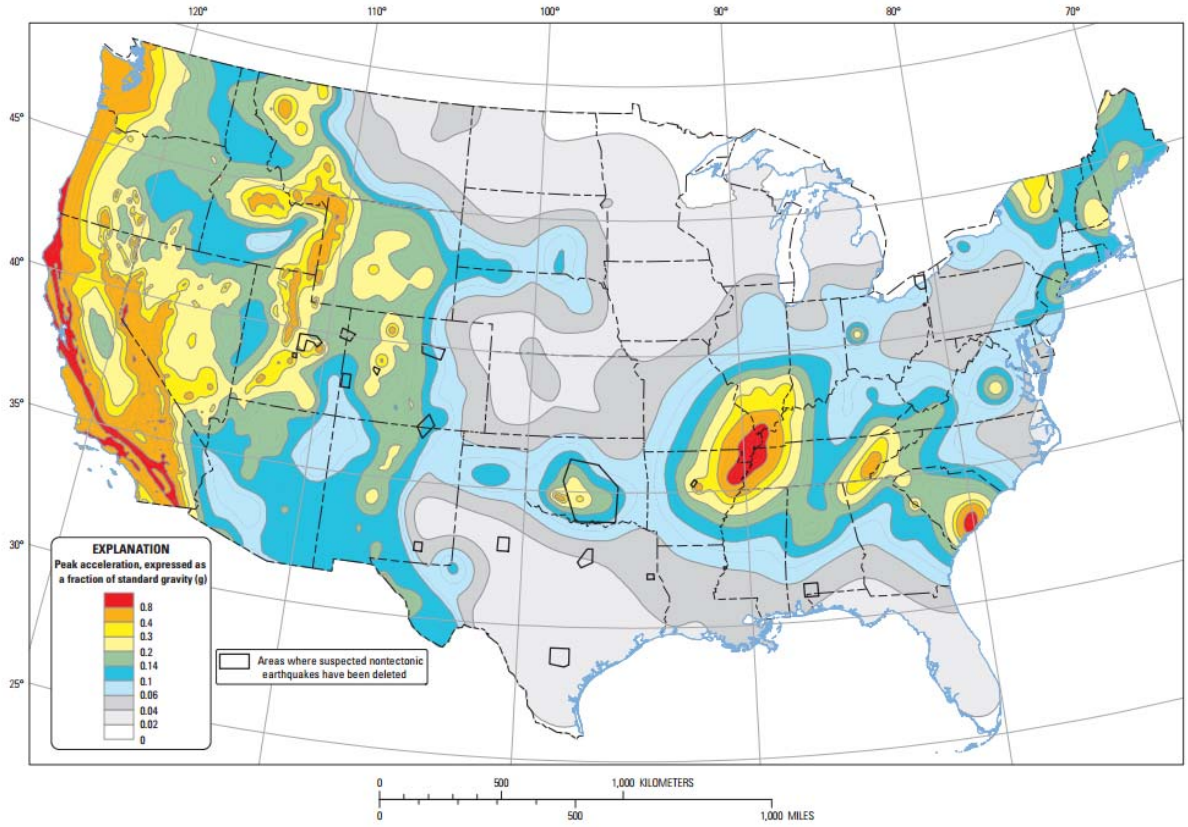
Table 4.1-6
Modified Mercalli Intensity Scale for Earthquakes

Scale	Intensity	Description of Effects	Corresponding Richter Scale Magnitude
I	Instrumental	Detected only on seismographs	
II	Feeble	Some people feel it	<4.2
III	Slight	Felt by people resting; like a truck rumbling by	
IV	Moderate	Felt by people walking	
V	Slightly Strong	Sleepers awake; church bells ring	<4.8
VI	Strong	Trees sway; suspended objects swing, objects fall off shelves	<5.4
VII	Very Strong	Mild Alarm; walls crack; plaster falls	<6.1
VIII	Destructive	Moving cars uncontrollable; masonry fractures, poorly constructed buildings damaged	
IX	Ruinous	Some houses collapse; ground cracks; pipes break open	<6.9
X	Disastrous	Ground cracks profusely; many buildings destroyed; liquefaction and landslides widespread	<7.3
XI	Very Disastrous	Most buildings and bridges collapse; roads, railways, pipes and cables destroyed; general triggering of other hazards	<8.1
XII	Catastrophic	Total destruction; trees fall; ground rises and falls in waves	>8.1

Source: North Carolina Division of Emergency Management

Figure 4.1-4 shows the probability that ground motion will reach a certain level during an earthquake in the Eastern US. The data show peak horizontal ground acceleration (the fastest measured change in speed, for a particle at ground level that is moving horizontally due to an earthquake) with a 2 percent probability of exceedance in 50 years. The map was compiled by the U.S. Geological Survey (USGS) Geologic Hazards Team, which conducts global investigations of earthquake, geomagnetic, and landslide hazards.

Figure 4.1-4
2% probability of exceedance in 50 years map of peak ground acceleration



Source: United States Geological Survey,2014

Sinkholes

Sinkholes are a natural and common geologic feature in areas with underlying limestone and other rock types that are soluble in natural water. Most limestone is porous, allowing the acidic water of rain to percolate through their strata, dissolving some limestone and carrying it away in solution. Over time, this persistent erosional process can create extensive underground voids and drainage systems in much of the carbonate rocks. Collapse of overlying sediments into the underground cavities produces sinkholes.

The three general types of sinkholes are: subsidence, solution, and collapse. Collapse sinkholes are most common in areas where the overburden (the sediments and water contained in the unsaturated zone, surficial aquifer system,

and the confining layer above an aquifer) is thick, but the confining layer is breached or absent. Collapse sinkholes can form with little warning and leave behind a deep, steep sided hole. Subsidence sinkholes form gradually where the overburden is thin and only a veneer of sediments is overlying the limestone. Solution sinkholes form where no overburden is present and the limestone is exposed at land surface.

Sinkholes occur in many shapes, from steep-walled holes to bowl or cone shaped depressions. Sinkholes are dramatic because the land generally stays intact for a while until the underground spaces get too big. If there is not enough support for the land above the spaces, then a sudden collapse of the land surface can occur. Under natural conditions, sinkholes form slowly and expand gradually. However, human activities such as dredging, constructing reservoirs, diverting surface water, and pumping groundwater can accelerate the rate of sinkhole expansions, resulting in the abrupt formation of collapse sinkholes.

Although a sinkhole can form without warning, specific signs can signal potential development:

- Slumping or falling fence posts, trees, or foundations
- Sudden formation of small ponds
- Wilting vegetation
- Discolored well water
- Structural cracks in walls, floors.

Sinkhole formation is aggravated and accelerated by urbanization. Development increases water usage, alters drainage pathways, overloads the ground surface, and redistributes soil. According to the Federal Emergency Management Agency (FEMA), the number of human-induced sinkholes has doubled since 1930, insurance claims for damages as a result of sinkholes has increased 1,200 percent from 1987 to 1991, costing nearly $100 million.

Collapses, such as the sudden formation of sinkholes, may destroy buildings, roads, and utilities. (Photo: Bettmann)

Landslides

A landslide is the downward and outward movement of slope-forming soil, rock, and vegetation, which is driven by gravity. Landslides may be triggered by both natural and human-caused changes in the environment, including heavy rain, rapid snow melt, steepening of slopes due to construction or erosion, earthquakes, volcanic eruptions, and changes in groundwater levels.

There are several types of landslides: rock falls, rock topple, slides, and flows. Rock falls are rapid movements of bedrock, which result in bouncing or rolling. A topple is a section or block of rock that rotates or tilts before falling to the slope below. Slides are movements of soil or rock along a distinct surface of rupture, which separates the slide material from the more stable underlying material. Mudflows, sometimes referred to as mudslides, mudflows, lahars or debris avalanches, are fast-moving rivers of rock, earth, and other debris saturated with water. They develop when water rapidly accumulates in the ground, such as heavy rainfall or rapid snowmelt, changing the soil into a flowing river of mud or "slurry." Slurry can flow rapidly down slopes or through channels, and can strike with little or no warning at avalanche speeds. Slurry can travel several miles from its source, growing in size as it picks up trees, cars, and other materials along the way. As the flows reach flatter ground, the mudflow spreads over a broad area where it can accumulate in thick deposits.

Landslides are typically associated with periods of heavy rainfall or rapid snow melt and tend to worsen the effects of flooding that often accompanies these events. In areas burned by forest and brush fires, a lower threshold of precipitation may initiate landslides. Some landslides move slowly and cause damage gradually, whereas others move so rapidly that they can destroy property and take lives suddenly and unexpectedly.

Among the most destructive types of debris flows are those that accompany volcanic eruptions. A spectacular example in the United States was a massive debris flow resulting from the 1980 eruptions of Mount St. Helens, Washington. Areas near the bases of many volcanoes in the Cascade Mountain Range of California, Oregon and Washington are at risk from the same types of flows during future volcanic eruptions.

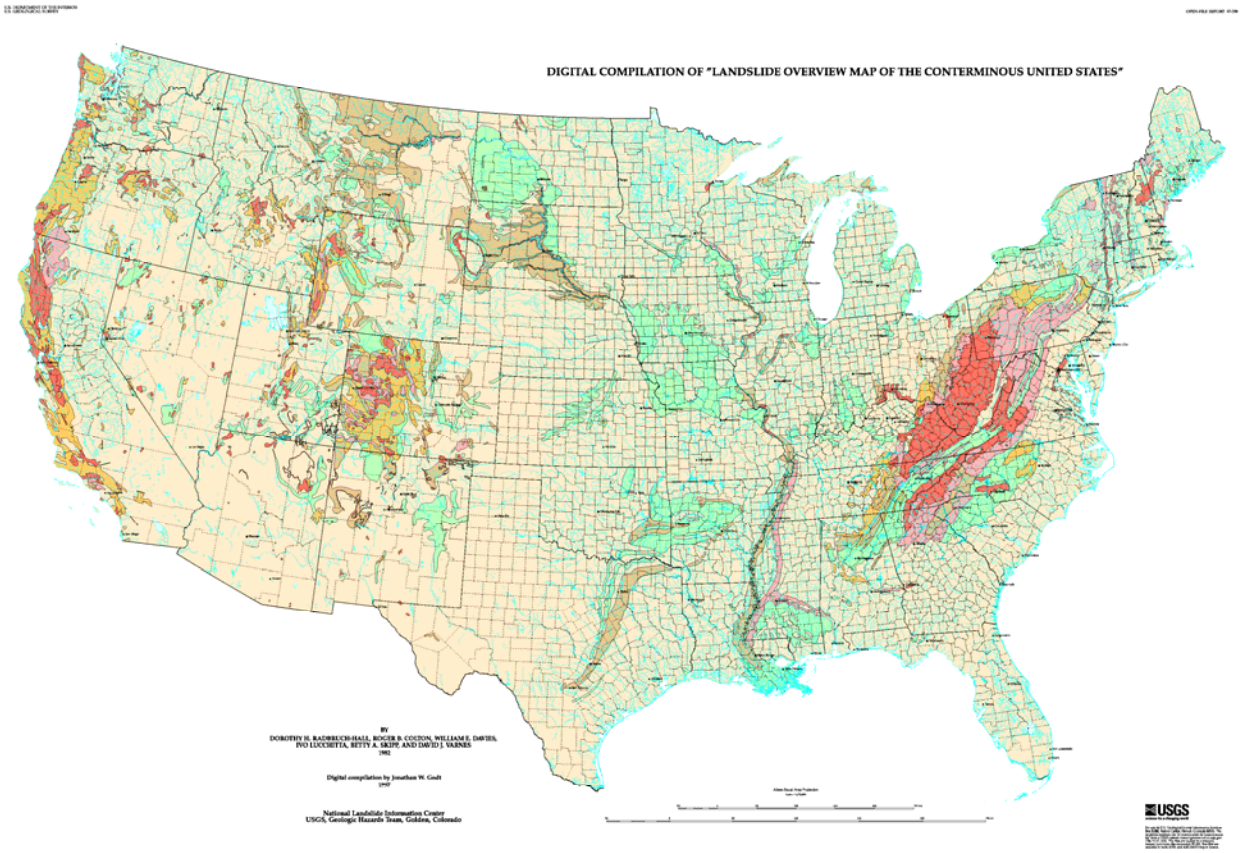
Areas that are generally prone to landslide hazards include previous landslide areas; the bases of steep slopes; the bases of drainage channels; and developed hillsides where leach-field septic systems are used. Areas that are typically considered safe from landslides include areas that have not moved in the past; relatively flat-lying areas away from sudden changes in slope; and areas at the top or along ridges, set back from the tops of slopes.

Landslides can damage or destroy roads, railroads, pipelines, electrical and telephone lines, mines, oil wells, buildings, canals, sewers, bridges, dams, seaports, airports, forests, parks, and farms. (Photo by Lynn Forman)

In the United States, it is estimated that landslides cause up to $2 billion in damages and from 25 to 50 deaths annually. Globally, landslides cause billions of dollars in damage and thousands of deaths and injuries each year.

Figure 4.1-5 delineates areas where large numbers of landslides have occurred and areas, which are susceptible to landsliding in the conterminous United States. This map layer is provided in the U.S. Geological Survey Professional Paper 1183, Landslide Overview Map of the Conterminous United States, available online at http://landslides.usgs.gov/html_files/landslides/nationalmap/national.html.

Figure 4.1-5
Landslide Overview Map of the Conterminous United States



EXPLANATION

LANDSLIDE INCIDENCE

- Low (less than 1.5% of area involved)
- Moderate (1.5%-15% of area involved)
- High (greater than 15% of area involved)

LANDSLIDE SUSCEPTIBILITY/INCIDENCE

- Moderate susceptibility/low incidence
- High susceptibility/low incidence
- High susceptibility/moderate incidence

Susceptibility not indicated where same or lower than incidence. Susceptibility to landsliding was defined as the probable degree of response of [the areal] rocks and soils to natural or artificial cutting or loading of slopes, or to anomalously high precipitation. High, moderate, and low susceptibility are delimited by the same percentages used in classifying the incidence of landsliding. Some generalization was necessary at this scale, and several small areas of high incidence and susceptibility were slightly exaggerated.

Source: United States Geological Survey

4.1.12 Tsunami

The word tsunami is Japanese and means "harbor wave." A tsunami is a series of great waves that are created by undersea disturbances such as earthquakes or volcanic eruptions. From the area of disturbance, tsunami waves will travel outward in all directions. Tsunamis can originate hundreds or even thousands of miles away from coastal areas.

The time between wave crests may be five to 90 minutes and the open ocean wave speed may average 450 miles per hour. As tsunami waves approach shallow coastal waters, they appear normal size and the speed decreases until the waves near the shoreline, where it may grow to great height and crash into the shore. Areas at greatest risk are less than 50 feet above sea level and within one mile of the shoreline. Rapid changes in the ocean water level may indicate that a tsunami is approaching. Most deaths during a tsunami are the result of drowning. Associated risks include flooding, polluted water supplies, and damaged gas lines.

Tsunami Hazard Zone *signs are posted at coastal access points or other low-lying areas that would clearly be vulnerable to a large, locally generated tsunami. Signs are placed at locations agreed upon by local and state governmental authorities.* Tsunami Evacuation Route *markers are used to designate the evacuation routes established by local jurisdictions in cooperation with emergency management officials. (Photos courtesy of Washington State Department of Transportation)*

In the United States, tsunamis have historically affected the West Coast, but the threat of tsunami inundation is also possible on the Atlantic Coast. Pacific Ocean tsunamis are classified as local, regional, or Pacific-wide. Regional tsunamis are most common. Pacific-wide tsunamis are much less common, with the last one being recorded in 1964, but are larger waves, which have high potential to cause destruction.

In 1949 the Pacific Tsunami Warning Center was established at Ewa Beach, Hawaii to monitor conditions in the Pacific Ocean and to provide warnings in case of tsunamis. According to the Pacific Tsunami Warning Center Laboratory in Novosiirsk, 796 tsunamis were observed or recorded in the Pacific Ocean between 1900 and 2001. Approximately 117 caused casualties and damage and at least nine caused widespread destruction throughout the Pacific. The greatest number of tsunamis during any one-year was 19 in 1938, but all were minor and caused no damage. There was no single year of the period that was free of tsunamis.

4.1.13 Volcanoes

Over 75 percent of the Earth's surface above and below sea level, including the seafloors and some mountains, originated from volcanic eruption. Emissions from these volcanoes formed the Earth's oceans and atmosphere. Volcanoes can also cause tsunamis, earthquakes, and dangerous flooding.

A volcano is a vent in the Earth's crust that emits molten rock and steam. They are evidence that the physical makeup of our planet is ever-changing. Volcanoes are relatively site specific, but the molten rock, steam, and other gases they release can have an impact on much larger areas.

Lahar is the mudflow of debris and water caused by a volcano. It is also known as debris flow or volcanic mudflow. Lahar is most often triggered by rainfall washing down the debris from the slopes of volcanoes. However, lahar flows can also be triggered by rapidly melting snow and ice, debris avalanches and breakouts of lakes that were dammed by volcanic debris.

Tephra is the general term used to describe the ash and other materials that are released into the air after a volcanic eruption. Tephra ranges in size from fine powder to larger rock-sized particles. Volcanic ash can contaminate water supplies, cause electrical storms, and collapse roofs, and can affect people hundreds of miles away.

The May 18, 1980 eruption of Mount St. Helens created an eruptive cloud that rose to an altitude of more than 12 miles in 10 minutes. The swirling ash particles in the eruptive cloud generated lightning which in turn ignited forest fires. Other fires were ignited by the initial blasts and later pyroclastic flows. Nearly 550 million tons of ash fell over a 22,000 square mile area. (Photo courtesy of Department of Natural Resources, State of Washington)

Volcanic explosions which are directed sideways are called lateral blasts. Lateral blasts can throw large pieces of rock at very high speeds for several miles. These explosions can kill by impact, burial, or heat and may have enough force to knock down entire forests of trees. The majority of deaths attributed to the Mount St. Helens volcano were a result of lateral blast and tree blow-down.

There are more than 500 active volcanoes in the world. More than half of these volcanoes are part of the "Ring of Fire," a region that encircles the Pacific Ocean. More than 50 volcanoes in the United States have erupted one or more times in the past 200 years. The most volcanically active regions of the nation are in Alaska, Hawaii, California, Oregon and Washington. The danger area around a volcano covers approximately a 20-mile radius. Some danger may exist 100 miles or more from a volcano.

4.1.14 Terrorism

The Federal Emergency Management Agency, in its guidance on integrating human-caused hazards into state and local hazard mitigation plans (FEMA Publication 386-7), has established a set of categories that can be applied to the profiling of intentional acts of terrorism. These categories are: contamination; energy release (i.e., explosives, arson, etc.); and disruption of a service.

4.1.15 Contamination

Contamination, as it relates to terrorist activity, refers to the intentional release of chemical, biological or radiological agents, as well as nuclear hazards. Contamination can apply to human and animal life, a geographic area, agriculture/food supplies (as in "agriterrorism"), and even the electronic world of computers and information via the Internet and e-mail (as in "cyberterrorism.")

Cleanup of hazardous materials and contaminated debris following a terrorist attack can be an arduous 24-hour-a-day operation, as captured in this photo of debris removal from Ground Zero of the 9/11 attack to the Staten Island landfill. (Photo by Andrea Booher/FEMA News Photo)

According to Jane's Chem-Bio Handbook, chemical agents are liquid or aerosol contaminants that can be dispersed using sprayers or other aerosol generators, by liquids vaporizing from puddles or containers, or munitions. Chemical agents may pose viable threats for hours to weeks depending on the agent used and the conditions which exist at the exposed area. This type of hazard is especially volatile as contamination can be carried beyond the initial target zone by persons, vehicles, water and even the wind. Chemicals may also be corrosive or otherwise damaging *over time*, if not dealt with appropriately. Biological agents are liquid or solid contaminants that can be dispersed using sprayers or aerosol generators, or by point or line sources such as munitions, covert deposits or moving sprayers. Biological hazards may pose a danger for a period of hours to years, depending on the type of agent used and the conditions in which it exists. Contamination can be spread via water and/or wind, and infection can be spread via humans and/or animals.

FEMA's Radiological Emergency Management Course states that radiological agents can also be dispersed using sprayers or aerosol generators, or by point or line sources such as munitions, covert deposits and moving sprayers. Radiological contaminants may remain hazardous for seconds to years depending on the material used. The initial effects of a radiological attack are likely to be localized to the site of the attack; however, depending on meteorological conditions, the subsequent behavior of contaminants may become more dynamic. Nuclear hazards include the detonation of a nuclear device underground, on the Earth's surface, in the air, or at a high altitude. Heat flashes and blast waves resulting from a detonation would last for seconds, however nuclear radiation and fallout hazards can continue on for years. In addition, an electromagnetic pulse, resulting from a high-altitude detonation and lasting for a few seconds, can affect unprotected electronic systems. The initial light, heat and blast effects of a subsurface, ground or air burst are static and are determined by the device's characteristics. The fallout of radioactive contaminants may be dynamic depending on meteorological conditions.

Cyberterrorism is a relatively new concept. According to the National Strategy for Homeland Security, terrorists may seek to cause widespread disruption and damage, including casualties, by attacking electronic and computer

networks which are linked to critical infrastructures such as energy, financial and securities networks. In addition, terrorist groups are known to exploit information technology and the Internet to plan attacks, raise funds, circulate propaganda, gather information and communicate. In terms of hazard mitigation, cyberterrorism is often explored as a component in business continuity planning.

4.1.16 Energy Release

Energy release refers primarily to the use of explosive devices, such as conventional bombs, and incendiary operations such as arson attacks. The detonation of an explosive device whether on or near a target has an instantaneous effect, which can be compounded and/or prolonged by the use of multiple devices. The extent of damage caused by an explosion is, of course, determined by the type and quantity of explosive used. It should be noted that explosive incidents can result in cascading effects, such as the incremental failure of a structure or system.

Arson and other incendiary attacks refer to the initiation of fire (which can be of an explosive nature) on or near a target. This type of event can last for minutes or hours, and possibly longer depending on the type and quantity of device or accelerant used and the materials (fuels) present at the location of the attack. This type of attack can also result in cascading failures of structures or systems.

4.1.17 Disruption of Service

Disruption of service refers to the interruption, failure or denial of a service due to terrorist attack, such as the sabotage or designed breakdown of infrastructure as with an attack on transportation facilities, utilities and other public services. While the Federal Bureau of Investigation found no evidence of terrorism or criminal activity in its investigation of the August 2003 blackout in the Northeast United States, and the paralyzing blackout in London, England the same month has been labeled a “freak event,” it is clear to see the potential damage and disruption that could be caused by intentional terrorist attack on a nation’s power grids.

4.1.18 Weapons of Mass Destruction

The term “Weapons of Mass Destruction” (WMD) has various definitions, however common to all is the assumption that WMDs may consist of any of the agents discussed above: chemical, biological, radiological, nuclear, explosive or incendiary. The purpose of a WMD is to cause death or serious injury to persons or significant damage to property, typically assumed to be of a scale which has the potential to overwhelm the capabilities of many local and state governments.

4.1.19 Hazardous Materials (HazMat)

Hazardous materials (HazMat) incidents can apply to fixed facilities as well as mobile, transportation-related accidents in the air, by rail, on the Nation's highways and on the water. Approximately 6,774 HazMat events occur each year, 5,517 of which are highway incidents, 991 are railroad incidents and 266 are due to other causes (FEMA, 1997). In essence, HazMat incidents consist of solid, liquid and/or gaseous contaminants that are released from fixed or mobile containers, whether by accident or by design as with an intentional terrorist attack. A HazMat incident can last hours to days, while some chemicals can be corrosive or otherwise damaging over longer periods of time. In addition to the primary release, explosions and/or fires can result from a release, and contaminants can be extended beyond the initial area by persons, vehicles, water, wind and possibly wildlife as well.

Propane tanks, gasoline, oil and other hazardous materials and debris in Princeville, North Carolina were cleaned up by Environmental Protection Agency crews following Hurricane Floyd in September 1999. The town remained off limits to residents for some time due to health-related concerns. (Photo by Dave Saville/FEMA News Photo)

HazMat incidents can also occur as a result of or in tandem with natural hazard events, such as floods, hurricanes, tornadoes and earthquakes, which in addition to causing incidents can also hinder response efforts. In the case of Hurricane Floyd in September 1999, communities along the Eastern United States were faced with flooded junkyards, disturbed cemeteries, deceased livestock, floating propane tanks, uncontrolled fertilizer spills and a variety of other environmental pollutants that caused widespread toxological concern.

4.1.20 Energy Pipeline Failures

The energy infrastructure of the United States is comprised of many components, including the physical network of pipes for oil and natural gas, electricity transmission lines, and other means for transporting energy to the Nation's consumers. This infrastructure also includes facilities that convert raw natural resources into energy products, as well as the rail network, trucking lines and marine transportation. (U.S. Department of Energy, 2003) Much of this infrastructure is aging, and in addition to the challenges of keeping the infrastructure up-to-date with the latest technological advances and consumer needs, the potential for an energy pipeline failure to become a hazard in-and-of-itself must be considered.

Virtually all natural gas in the United States is moved via pipeline. (Photo courtesy of the Department of Energy)

The two million miles of oil pipelines in the United States are the principal mode for transporting oil and petroleum products such as gasoline, and virtually all natural gas in the United States is moved via pipeline as well. (DOE, 2003) Much of this oil pipeline infrastructure is old, requiring regular safety and environmental reviews to ensure its safety and reliability. The potential risk of

pipeline accidents is a significant national concern.

The energy infrastructure is vulnerable to physical and cyber disruption, either of which could threaten its integrity and safety. (DOE, 2003) Disruptions could originate with natural events such as geomagnetic storms and earthquakes, or could result from accidents, equipment failures or deliberate interference. In addition, the Nation's transportation and power infrastructures have grown increasingly complex and interdependent—consequently, any disruption could have far-reaching consequences.

Data Sources

The maps, figures, and identification information about the hazards included in this section were compiled from the following sources:

American Society of Civil Engineers (ASCE), "Facts About Windstorms."
Web site: www.windhazards.org/facts.cfm

Bureau of Reclamation, U.S. Department of the Interior
Web site: www.usbr.gov

Federal Emergency Management Agency (FEMA)
Web site: www.fema.gov

National Climatic Data Center (NCDC), U.S. Department of Commerce, National Oceanic and Atmospheric Administration
Web site: http://lwf.ncdc.noaa.gov/oa/ncdc.html

National Drought Mitigation Center, University of Nebraska-Lincoln
Web site: www.drought.unl.edu/index.htm

National Severe Storms Laboratory (NSSL), U.S. Department of Commerce, National Oceanic and Atmospheric Administration
Web site: www.nssl.noaa.gov

National Weather Service (NWS), U.S. Department of Commerce, National Oceanic and Atmospheric Administration
Web site: www.nws.noaa.gov

Storm Prediction Center (SPC), U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Weather Service
Web site: www.spc.noaa.gov

The Tornado Project, St. Johnsbury, Vermont
Web site: www.tornadoproject.com

United States Geological Survey (USGS), U.S. Department of the Interior
Web site: www.usgs.gov

4.2 HAZARD ANALYSIS

4.2.1 Introduction

The *Hazard Analysis* Chapter provides information on historical hazard occurrences in New Castle County for the hazards listed below. This listing differs slightly in terminology, order and grouping from the *Hazard Identification* section as those hazards affecting New Castle County are more fully explored.

Natural

- Flood
  - Storm Surge/Tide
  - Coastal Flooding
- Severe Winds
  - Hurricanes
  - Coastal Storms
- Thunderstorms
- Tornadoes
- Wildfire
- Drought/Extreme Heat
- Hail
- Winter Storms
- Coastal Erosion
- Dam/Levee Failure
- Earthquakes
- Tsunami
- Volcano

Human-caused

- Terrorism
- Hazardous Materials (HazMat)
- Energy Pipeline Failures

Historical records, such as those available from the National Oceanic and Atmospheric Administration's National Climatic Data Center (NCDC), are used to identify the level of risk. The methodological assumption is that the data sources cited are the best data available, however not always complete. To the extent possible, other sources have been used to supplement NCDC records.

4.2.2 Flood

According to the National Climatic Data Center, 182 flood events were reported in New Castle County between March 4, 1993 and July 31, 2014. These 182 events included flash flooding, flood, coastal flood, and storm surge/tide events and resulted in four (4) deaths, six (6) injuries and a total of approximately $27.16 million in property damage (NCDC, 2014). Descriptions of major flooding events that have impacted people, property and the environment are below

Flood waters rush by the Faith Harvest Worship Center on Del. 4 near Newport during flooding that occurred September 18, 2003, largely as a result of remnants of Tropical Storm Henri. (Photo courtesy of The News Journal/Ginger Wall)

Flooding

Flash flooding events that have impacted people, property and the environment:

Countywide, April 30, 2014

Heavy rain caused considerable poor drainage and major river and creek flooding in New Castle County. Some of the crests were the highest since Tropical Storm Irene on August 28, 2011. Within Wilmington alone, five roadways were flooded and closed. The Christina River at Cooch's Bridge had major flooding crested at 12.67 feet at 1015 p.m. EDT on the 30th. This was historically the 6th highest crest on record for the river. Other rivers/creeks that had near-record flood levels were White Clay Creek at Newark and at Delaware Park, and Red Clay Creek at Wooddale and at Stanton. The Brandywine Creek at Wilmington had major flooding, cresting at 20.70 feet, a new record. Event precipitation totals included 5.15 inches in Prices Corner, 5.10 inches in Newark, 4.76 inches in Newport, 4.60 inches at the Wilmington Airport and 4.50 inches in Odessa.

Countywide, August 28, 2011

Hurricane Irene produced heavy flooding rain, widespread tropical storm force wind gusts, a confirmed tornado near Lewes in Sussex County, moderate to severe coastal flooding and beach erosion and caused two flooding related deaths, forced evacuations near the coast over the weekend of August 27th and 28th in Delaware. About 100,000 people were evacuated from the Atlantic Coast. Numerous roadways were flooded and closed and thousands of trees were knocked down. About 100,000 utility customers lost power. In addition, chickens were killed by flooding and agricultural crops were damaged by the flooding. Delaware received federal disaster declaration. The damage estimates from the state were broken down to $2.8 million in New Castle County, $832,000 in Kent County and $1.9 million in Sussex County. Damages were due to tidal flooding as significant wave action resulted during multiple high tide cycles, due to increasing onshore winds prior to landfall. Damages were also due in part to inland flooding caused by excessive rainfall, as up to 10 inches of rain were reported. In addition, high winds resulted in many trees and wires coming down statewide. This created 100,000 power outages and resulted in many road closures due to downed trees and flooding. The hardest hit county was New Castle County. All power was restored by November 2nd. No direct deaths or injuries were reported in Delaware due to the storm and the overall number of traffic accidents was low because of driving restrictions.

Countywide, April 16, 2011

The strong southeast wind up the Delaware Bay and River combined with the already high astronomical tides associated with the full moon and fresh water runoff from heavy rain to produce severe tidal flooding along the Delaware River and tidal sections of its tributaries during the evening high tide cycle on the 16th in New Castle

County. The high tide at Reedy Point established an all-time record high. In Wilmington, tidal flooding affected the South Bridge area of the city. In New Castle, tidal flooding reached up to homes on The Strand. In Delaware City, tidal flooding occurred along both the Delaware River and the Chesapeake and Delaware Canal. Flooding was reported around the 5th Street Bridge. About five homes in that vicinity had knee deep flood waters into their first floor. Flood waters surrounded homes in a trailer park off of 7th Street. The strong southeast winds persisted and reached its peak as the high tide was working its way up the Delaware Bay and Delaware River. The surface winds shifted to the west just around the time high tide was occurring. Minor tidal flooding also occurred during the overnight high tide cycles on the 17th and 18th in New Castle County. Farther southeast along coastal Delaware, tidal flooding on the evening of the 16th lessened toward the ocean. At Breakwater Harbor in Sussex County, only minor tidal flooding occurred. The high tide reached 6.68 feet above mean lower low water.

Countywide, October 1, 2010

Flooding started early in the morning on October 1st. Governor Jack Markell declared a limited state of emergency in Delaware because of the flooding in Edgemoor. The worst flood damage occurred in Edgemoor when the Shellpot Creek flooded and tore away a small bridge and gas lines on Colony Boulevard between 2 a.m. EDT and 3 a.m. EDT on the 1st and trapped about 1000 residents in their homes at the Summit Chase Colony North and Las Casas Apartments. In Christina, flooding along the Christina River forced the evacuation of about 25 families along East Main Street. Nineteen families were evacuated from the Kingsmill Mobile Home Park in Kirkwood after a small creek flooded. In Hockessin, houses near Mill Creek had basement flooding. Dozens of roads throughout the county flooded and there were numerous water rescues that included ones in Stanton, Newport and Wilmington. A mudslide closed Delaware State Route 141 near Newport. Two school districts closed for the day. The Brandywine Creek at Wilmington was above its 16.5 foot flood stage from 335 a.m. EDT through 1122 p.m. EDT on the 1st. It crested at 17.69 feet at 6 p.m. EDT. The Christina River at Coochs Bridge had major flooding, had its fourth highest crest on record and was the highest crest since September of 2004 with the remnants of Hurricane Jeanne. The river was above its 10.5 foot flood stage from 112 a.m. EDT through 1002 a.m. EDT on the 1st. It crested at 13.06 feet at 615 a.m. EDT. The Red Clay Creek at Wooddale had major flooding and tied the fourth highest crest on record. It was the highest crest since June of 2006. The creek was above its 7 foot flood stage from 210 a.m. EDT through 1057 a.m. EDT on the 1st. It crested at 10.91 feet at 745 a.m. EDT. Farther downstream, the Red Clay Creek at Stanton had moderate flooding and its fourth highest crest on record. It was its highest crest since September of 2004 with the remnants of Hurricane Jeanne. The creek was above its 15 foot flood stage from 123 a.m. EDT through 1252 p.m. EDT on the 1st. It crested at 19.84 feet at 845 a.m. EDT. The White Clay Creek at Newark was above its 13 foot flood stage from 133 a.m. EDT through 136 p.m. EDT on the 1st. It crested at 16.0 feet at 445 a.m. EDT. Event precipitation totals included 9.32 inches in Claymont, 7.89 inches in Newport, 7.83 inches in Middletown and 7.58 inches at the New Castle County Airport.

Holly Oak, July 14, 2010

Thunderstorms with torrential downpours caused flash flooding in and around Wilmington. The flooding forced the safe evacuation of nearly three dozen infant and toddlers at an Elsmere day care center on Kirkwood Highway. The highway had up to four feet of water on it and was closed between Maple Avenue and Saunders Road. A bakery was also damaged by the flooding as were about 14 vehicles at the Veterans Affair Medical Center. In Wilmington, fire fighters made three water rescues. A man in his 50s was injured trying to rescue a woman stuck in flood waters. Three major roadways were closed including Governor Printz Boulevard. Elsewhere flooding along the Nonesuch Creek near New Castle flooded Airport Road and several vehicles were stuck in high water in New Castle. The two day Doppler Radar storm total estimates reached 6 to 8 inches in the area.

Countywide, June 20, 2003, 1:35 p.m. through June 21, 2003

A slow moving low pressure system at both the surface and aloft helped trigger very heavy rain across New Castle County from the late morning into the afternoon of the 20th. Storm totals ranged from 1.5 inches in the southern part of the county to four (4) inches in the northern part, most of which fell during the afternoon hours. Without any thunder, New Castle County Airport received 1.1 inches of rain in one hour from 3:23 p.m. until 4:23 p.m. The heavy rain led to widespread poor drainage flooding as well as flooding of most of the gaged rivers and streams in the county. The Delaware Department of Traffic closed about 16 main roads throughout the county, running short on high water signs. Southbound U.S. Route 13 near U.S. Route 40 was at a standstill through the evening commute. Throughout the county, cars were stranded in high water. Flooding forced the evacuation of three families from the Brack-Ex development after Conectiv cut off power. The water saturated soil and the flooding caused trees to fall. About 14,000 Conectiv customers lost power. No serious injuries were reported. The Christina River at Cooch's Bridge was above its nine foot flood stage from 2:35 p.m. on the 20th through 2:47 a.m. on the 21st. It crested at 12.01 feet at 8:30 p.m. on the 20th. The White Clay Creek at Newark was above its 13 foot flood stage from 4:13 p.m. on the 20th through 4:55 a.m. on the 21st. It crested at 14.97 feet at 8:15 p.m. on the 20th. The Red Clay Creek at Wooddale was above its 5.5 foot flood stage from 4 p.m. on the 20th through 4:41 a.m. on the 21st. It crested at 9.98 feet at 7:45 p.m. on the 20th. Farther downstream, the Red Clay Creek at Stanton was above its 15 foot flood stage from 4:15 p.m. on the 20th through 5:04 a.m. on the 21st. It crested at 18.46 feet at 10:30 p.m. on the 20th. The Brandywine Creek in Wilmington was above its 11 foot flood stage from 5:11 a.m. through 2:07 p.m. on the 21st. It crested at 11.81 feet at 2 p.m. on the 21st. Storm totals included 3.59 inches at the New Castle County Airport, 3.3 inches in Newark and 2.63 inches in Bear. On a county-weighted average, June monthly precipitation totals averaged 9.5 inches in New Castle County — normal is around 3.6 inches. The June monthly precipitation total of 9.9 inches at the New Castle County Airport was the wettest on record. The wet spring weather led to a whole different set of problems from the drought of the previous year.

Countywide, February 22, 2003

A large swath of moderate to heavy rain with embedded thunderstorms moved across the Delmarva Peninsula during the day on the 22nd. Rainfall totals averaged around two-thirds of an inch per hour during the thunderstorms and storm totals across New Castle County averaged between two and three inches. The combination of the heavy rain and melting snow produced widespread roadway flooding and ponding of water in poor drainage areas. Flooding also reached the first floor of several apartments and homes. It also led to flooding along the Christina River Basin. The weight of the snow and rain on area roofs led to several building collapses. During the afternoon near New Castle, the roof of a beer distributor collapsed. The roof of a pipe and tubing distribution center also collapsed. A building in Wilmington was evacuated after a partial roof collapse. No serious injuries were reported. Major roadways were flooded in the county including Delaware State Routes 1 and 9. Roadway ponding reached as high as five feet north of Wilmington. The heavy rain led to about 1,600 Conectiv customers losing power. The Christina River at Cooch's Bridge was above its nine foot flood stage from 12:36 p.m. on the 22nd through 9:06 a.m. on the 24th. It crested at 12.2 feet at 7:30 p.m. on the 22nd. The low pressure system responsible for the heavy rain developed along the Gulf Coast states on the 21st and moved northeast into the Tennessee Valley the morning of the 22nd and into Pennsylvania the morning of the 23rd. The strongest surge of warm, unstable air preceding its warm front occurred during the day on the 22nd. For the month of February, the precipitation total of 5.21 inches at the New Castle County Airport was the eighth wettest February on record.

Northern New Castle County, December 25, 2002

A very wet autumn left saturated soil conditions across northern Delaware and made the Christina River susceptible to flooding with any moderate or heavy rain. The river was already running high from precipitation events on the 11th, 13th and 20th. A nor'easter on Christmas Day brought heavy rain into Delaware and caused flooding along the Christina River Basin. The Christina River at Cooch's Bridge reached its nine foot flood stage at 11:23 a.m. on the

25th, crested at 11.03 feet at 2:30 p.m. and was back within its banks at 6:59 p.m. that day. The storm totals at the New Castle County Airport and Wilmington were both 1.09 inches. No serious damages or injuries were reported.

Cooch's Bridge, December 20, 2002

A very wet autumn left saturated soil conditions across northern Delaware and made the Christina River susceptible to flooding with any moderate or heavy rain. The river was already running high from precipitation events on the 11th and 13th and even though storm totals were less than one inch during the day of the 20th, it flooded again. The Christina River at Cooch's Bridge was above its nine foot flood stage from 1:22 p.m. through 3:34 p.m. on the 20th. It crested at 9.47 feet at 2:30 p.m. on the 20th. The storm total at the New Castle County Airport was 0.73 inches (0.30 inches fell between 10 a.m. and 11 a.m.) and in Wilmington was 1.04 inches. No serious injuries or property damages were reported.

Cooch's Bridge, December 13, 2002, 11:06 p.m. through December 14, 2002

A very wet autumn left saturated soil conditions across northern Delaware and made the Christina River susceptible to flooding with any moderate or heavy rain. The river was already running high from the heavy rain on the 11th and even though storm totals were less than one inch during the evening of the 13th, it flooded again. The Christina River at Cooch's Bridge reached its nine foot flood stage at 11:06 p.m. on the 13th, crested at 9.23 feet at 1:10 a.m. on the 14th and was back within its banks at 1:28 a.m. on the 14th. The storm total was 0.75 inches in Wilmington and Newark and 0.61 inches at the New Castle County Airport. No serious injuries or property damages were reported.

Northern New Castle County, December 11 through December 12, 2002

Heavy rain falling between 1 p.m. and 4 p.m. caused flooding along the Christina River in New Castle County. There was also poor drainage flooding elsewhere across the county. Carpenter Station Road was closed in Brandywine Hundred. The Christina River at Cooch's Bridge was above its nine foot flood stage from 3:28 p.m. on the 11th through 12:01 a.m. on the 12th. It crested at 11.49 feet at 6:30 p.m. on the 11th. At the New Castle County Airport, 0.93 inches of rain fell between 1 p.m. and 4 p.m. on the 11th. The storm total was 1.39 inches. No serious injuries or property damages were reported.

Northern New Castle County, June 19, 2002

Slow moving thunderstorms with heavy rain dropped a Doppler Radar-estimated three to four inches of rain within two hours across extreme northwest New Castle County and adjacent locations of Chester County in Pennsylvania. This caused poor drainage and stream flooding in northern parts of Mill Creek and Christina Hundreds. No injuries or property damages were reported.

Countywide, September 16, 1999, 6 a.m. through September 17, 1999

Hurricane Floyd battered New Castle County on September 16th, bringing torrential rains and damaging winds. The hurricane caused widespread flash flooding as storm totals averaged around nine inches, most of which fell in a 12-hour period from the early morning through the afternoon on the 16th. These were the first hurricane-related deaths in the state since Hurricane Hazel in 1954. A number of stations broke the old state record of 7.83 inches set on June 27, 1938, including the New Castle County Airport (8.29 inches). Based on Doppler Radar storm total estimates, the heaviest rain in the state fell across southern New Castle County. The torrential downpours associated with Hurricane Floyd exceeded the 100-year flood return period for the county as record crests were set on many rivers and streams. Hundreds of roads and bridges were closed. Approximately 300 residents of New Castle and Sussex counties were evacuated to shelters. The combination of winds funneling into Delaware Bay and the runoff from inland waterways produced minor tidal flooding at the times of high tide in New Castle County. Strong winds uprooted hundreds of trees across the state, especially in the wooded areas of New Castle County. All of the

44 homes sustaining major damage as well as the 33 condemned homes were located in New Castle County. The hardest hit community within the county was Glenville (near Stanton) along the Red and White Clay Creek. About 100 homes were flooded with up to six feet of water. During the height of the storm 40 roads and bridges were closed including sections of Delaware State Routes 1 and 9. The highest wind gusts included a report of 60 MPH at the Delaware Bay Buoy and 46 MPH at the New Castle County Airport.

Northern New Castle County, August 26, 1999, 9 p.m. through August 27, 1999

Thunderstorms accompanied by torrential downpours caused urban and poor drainage flooding during the evening and the night of the 26th in New Castle County as well as flooding along the Christina River. As heavy rain began falling in the county at 9 p.m., streams and rivers quickly responded. The Christina River at Cooch's Bridge reached its nine foot flood stage at 10 p.m. on the 26th, it crested at 10.5 feet at 11 p.m., and was back within its banks at 3 a.m. on the 27th. Storm totals included 2.82 inches in Wilmington and 1.90 inches in Newark. No serious damages or injuries were reported.

Northern New Castle County, May 24, 1999

A series of three thunderstorms brought too much heavy rain for area streams and rivers to process. During the late afternoon, the third thunderstorm of the day caused flooding along the Christina River. At Cooch's Bridge, the Christina River reached its nine foot flood stage from 5 p.m. through 7:30 p.m. It crested at 9.65 feet at 6 p.m. Storm totals averaged between two (2) and three (3) inches and in addition to the stream flooding caused considerable highway and poor drainage flooding. Storm totals included 2.76 inches in Wilmington, 2.29 inches at the New Castle County Airport and 2 inches at Newark. No serious injuries or damages were reported.

Northern New Castle County, March 21, 1999, 9 p.m. through March 22, 1999

Heavy rain affected the Delmarva Peninsula during the late afternoon and evening of the 21st. This caused flooding along the Christina River and significant (but within banks) rises on some of the other major streams and creeks in New Castle County. The Christina River at Cooch's Bridge reached its flood stage of nine feet at 9 p.m. on the 21st, crested at 11.63 feet at 12:30 a.m. on the 22nd and was back within its banks at 8 a.m. on the 22nd. This was the highest crest at Cooch's Bridge on the Christina River since the January 19, 1996 crest of 11.8 feet. Storm totals included 2.2 inches in Newark, 2.03 inches in Wilmington and 1.98 inches at the New Castle County Airport. The low pressure system responsible for the heavy rain moved northeast from Atlanta, Georgia the morning of the 21st to Albany, New York the morning of the 22nd. No serious damages or injuries were reported.

Cooch's Bridge, February 23, 1998, 8:13 p.m. through February 24, 1998

Another nor'easter brought heavy rain and strong winds to Delaware on the 23rd and 24th. The onshore flow also brought some minor tidal flooding during the time of high tide on the morning of the 24th. Because this nor'easter moved rapidly, it was only a one tide cycle event and no major damage was reported. Rain overspread Delaware the morning of the 23rd and became heavy during the afternoon and early evening. While rain lingered well into the 24th, it was not as heavy. Enough heavy rain fell to cause flooding along the Christina River in New Castle County during the evening of the 23rd. The Christina River at Cooch's Bridge was above its nine foot flood stage from about 8:15 p.m. to midnight. It crested at 9.6 feet at 10 p.m. on the 23rd. The heavy rain caused the usual urban and poor drainage flooding; no other serious flooding was reported. The counterclockwise circulation around the nor'easter produced wind gusts as strong as 40 to 50 MPH during the afternoon and evening of the 23rd. No serious damages or injuries were reported. Storm totals in New Castle County included 1.92 inches in Odessa, 1.5 inches in Newark and 1.39 inches at the New Castle County Airport. The peak wind gust at the New Castle County Airport was 46 MPH on the 23rd. The nor'easter responsible for this wet weather was located near New Orleans the morning of February 22nd. It moved northeast and reached Myrtle Beach, South Carolina the morning of February 23rd, was about 150 miles east of Atlantic City at daybreak on the 24th and moved to the Gulf of Maine the morning of the 25th.

Countywide, December 13, 1996, 10 p.m. through December 14, 1996

Heavy rain associated with a low pressure system near Delaware fell on already saturated soil the night of the 13th causing flooding along most of the streams and creeks in New Castle County. In Newport, a woman and two children were rescued from their flooded vehicle on Airport Road. Numerous other underpasses as well as sections of Delaware State Route 9 were badly flooded. The heavy rain also contributed to an automobile accident in Brandywine in which an 18-year-old male hit a tree head-on. At the New Castle County Airport 1.4 inches of rain fell between 7 p.m. on the 13th and 5 a.m. on the 14th. This was part of a 48-hour precipitation event in which 3.5 to 4.5 inches of rain fell across New Castle County. Storm totals included 4.31 inches in Odessa, 3.76 inches in Newark and 3.61 inches at the New Castle County Airport.

Northern New Castle County, December 6, 1996

Heavy rain associated with a deepening low pressure system off the New Jersey and Delaware coasts caused flooding along the Christina River in New Castle County. At Cooch's Bridge, the river was above its nine foot flood stage from 4:30 a.m. until 9:30 a.m. on the 6th. It crested at 10.3 feet at 6:45 a.m. on the 6th. Storm totals included 1.55 inches in Pennyhill, 1.2 inches in Price's Corner and 1.05 inches at the New Castle County Airport. No serious damage was reported.

Northern New Castle County, December 2, 1996

Rain that fell during the afternoon of December 1 with especially heavy rain following the morning of the 2nd caused flooding along the Christina River. The Christina River at Cooch's Bridge crested at 10.6 feet at 5:15 a.m. on the 2nd. It was above its nine foot flood stage from 2 a.m. through 8:30 a.m. on the second. Storm totals included 2.2 inches in Pennyhill, 1.87 inches at the New Castle County Airport and 1.6 inches in Odessa. No serious damages or injuries were reported.

Northern New Castle County, November 26, 1996

Heavy rain associated with a low pressure system that developed near the Gulf of Mexico on the 25th and which moved through eastern Pennsylvania the morning of the 26th caused flooding along the Christina River in New Castle County. The river at Cooch's Bridge reached its nine foot flood stage at 8 a.m. on the 26th, crested at 10.5 feet at 10:45 a.m. on the 26th and was back within its banks by the early afternoon of the 26th. Storm precipitation totals included 1.35 inches at the New Castle County Airport and 1.1 inches in Pennyhill.

Northern New Castle County, November 8, 1996

Showers and thunderstorms along with very heavy rain caused flooding along the Christina River. The river at Cooch's Bridge exceeded its nine foot flood stage at about 11 p.m. on the 8th and crested at 9.5 feet at 1 a.m. on the 9th. The river was back within its banks by 3 a.m. that morning. Storm totals included two (2) inches in Odessa and 1.33 inches at the New Castle County Airport. No serious damages or injuries were reported.

Northern New Castle County, October 19, 1996

Heavy rainfall caused the flash flooding of several streams in the northern half of New Castle County. The Christina River at Cooch's Bridge reached its nine foot flood stage at 2:30 a.m., crested at 11.7 feet at 9:15 a.m., and was back within its banks at 3:15 p.m. The White Clay Creek near Newark reached its 13 foot flood stage at 5:30 a.m., crested at 14.9 feet at 9 a.m., and was back within its banks during the early afternoon of the 19th. The Red Clay Creek at Wooddale reached its 5.5 foot flood stage at 6:30 a.m. on the 19th, crested at seven (7) feet at 11 a.m., and was below flood stage again at 3 p.m. Tropical moisture associated with Hurricane Lili farther east in the Atlantic was a contributing factor to this storm system. Representative storm totals included 3.4 inches in Newark, 3.05 inches in Odessa, 2.06 inches in Wilmington and 2 inches in Prices Corner. No serious damages or injuries were reported.

Northern New Castle County, October 8, 1996
Heavy rains associated with the remnants of Tropical Storm Josephine caused flash flooding along the Christina River. At Cooch's Bridge, the river reached its nine-foot flood stage at 6:30 p.m., crested at 10.6 feet at 9:45 p.m., and was back within its banks by 11 p.m. Storm totals included 1.9 inches in Newark, 1.8 inches in Pennyhill, 1.5 inches in Odessa, 1.44 inches in Wilmington and 1.4 inches in Prices Corner. No serious injuries or damages were reported, but there were several water rescues of individuals trapped in cars.

Central New Castle County, August 13, 1996
A low pressure system that developed along the Gulf Coast states the morning of the 12th moved northeast and passed through the Delmarva Peninsula the morning of the 13th. It tapped the abundant moisture over the South and consequently produced heavy rain across all of Delaware. The heavy rain in turn caused flooding of a number of streams and rivers in the northern half of New Castle County. The Christina River at Cooch's Bridge reached its flood stage of nine feet at 3:30 a.m. on the 13th. No serious injuries or damages were reported.

Countywide, July 13, 1996
Heavy rain associated with Tropical Storm Bertha caused flooding along the Christina River in northern New Castle County. At Cooch's Bridge, the river reached its flood stage of nine feet at 7:35 a.m., crested at 10.9 feet at 11 a.m., and was back within its banks at 2:20 p.m. Storm totals included 2.69 inches in Wilmington, 1.81 inches in Odessa and 1.70 inches in Pennyhill. No serious injuries or damages were reported.

Northern New Castle County, June 11, 1996
Thunderstorms with heavy rain dropped an estimated 1.5 to 2 inches of rain within the drainage basin of the Christina River, most of it within one hour. This caused the river to reach its flood stage of nine feet at 5 p.m. It crested at 10.35 feet at 8:15 p.m. and was within its banks again at 10 p.m. Minor flooding also occurred along the Red and White Clay Creeks. No significant damage or injuries were reported.

Northern New Castle County, April 16, 1996
Heavy rain averaging around two (2) inches in the headwater region of the Christina River Basin in Chester and New Castle counties caused the flooding of several streams including the Christina. Most of the heavy rain fell between 11 p.m. on the 15th and 6 a.m. on the 16th. The Christina River reached its flood stage of nine feet at 6:30 a.m., crested at 10.8 feet at 9 a.m., and was back within its banks by noon. Three young boys had to be rescued by boat from the trees they were clinging to after they waded into water and were swept downstream into the river. Storm totals included 2.2 inches in Honey Brook, 2.23 inches in Glenmoore, 1.55 inches in Chadds Ford, 1.4 inches in Newark and 1.09 inches in Wilmington. A slow moving cold front was responsible for the heavy rain. Weak low pressure systems moving north along the frontal boundary enhanced the heavy rain across southeastern Pennsylvania and northern Delaware. No serious damage or injuries was reported.

Northern New Castle County, April 1, 1996, 8:10 p.m. through April 2, 1996
A slow moving cold front and a separate low pressure system that moved off the Mid-Atlantic Coast combined to produce heavy rain. About 1.5 inches of rain fell in a basin-wide average across the Christina River, the heaviest of which occurring between 6 and 9 p.m. on the 1st. The heavy rain pushed the Christina out of its banks a little after 8 p.m. It crested at 10.6 feet at 11:15 p.m. (flood stage is nine feet) and was back within its banks by 3 a.m. on the 2nd. No serious injuries or damage was reported.

Northern New Castle County, March 19, 1996, 8:45 p.m. through March 20, 1996
One to 1.5 inches of rain fell on saturated soils across the Christina River Basin. This pushed the river above its flood stage of nine feet at Cooch's Bridge. The river crested at 10.6 feet just past midnight on the 20th and was within its banks by 3 a.m. No serious injuries or property damage was reported.

Countywide, January 19, 1996
A combination of snowmelt from the previous week's two snowstorms, unseasonably warm temperatures, and one to two inches of additional rainfall produced flash flooding of roads and streams in the northern half of New Castle County. The Christina River reached flood stage at 9 a.m. on the 19th. After a squall line moved through the region around noon, a steady stream of cars became stranded in high water. A dramatic rescue occurred at 4 p.m. when a Hickory Hill woman and her two children were rescued near the flooded Red Clay Creek. Numerous roads were closed including Delaware State Route 82 and Delaware State Route 273 in Christina. Ice jams compounded the flooding along the Brandywine Creek. Thirteen Wilmington residents were made temporarily homeless by the flooding.

Northern New Castle County, October 28, 1995
Thunderstorms with heavy rain dropped between two (2) and three (3) inches of rain across New Castle County, beginning the evening of the 27th. This, combined with other recent heavy rainfall, caused flooding of the Christina River the morning of the 28th. No serious injuries or damage was reported.

Countywide, March 8, 1995, 8:30 p.m. through March 9, 1995
A slow moving cold front with a series of low pressure systems moving northeast along it caused 1.5 to two inches of rainfall across New Castle County. The 1.8 inches of rain that fell at New Castle County Airport established a new record. Most of the heavy rain fell during the evening of the 8th and caused the flooding of small streams and rivers within the county. The Christina River at Cooch's Bridge reached its flood stage of nine feet at 8:30 p.m. No flood-related damage or injuries were reported.

Countywide, November 28, 1993
Eight to 10 hours of continuous rain dumped two (2) to five (5) inches of rain across New Castle County, producing flash flooding across most of the county. High water closed roads and low bridges, and resulted in $5,000 in reported property damages.

Countywide, March 13, 1993, 12 p.m. through March 14, 1993
A major winter storm that had developed in the Gulf of Mexico moved northeast across the Mid-Atlantic region on the 13th and 14th producing a variety of weather and caused minor coastal flooding at times of high tide Saturday and early Sunday morning. Blizzard conditions were produced over a large part of Virginia, Maryland, the District of Columbia, and the eastern Panhandle of West Virginia. Snowfall amounts ranged from one (1) to three (3) inches in the coastal plane from southern Delaware across to southeast parts of Maryland and Virginia. Three to 15 inches of snow was recorded from northeast Delaware, across east and central Maryland and the District of Columbia, into south-central Virginia with a few higher readings. Coastal areas received heavy rain, and sleet fell at times from the coast into central locations. The storm dropped more than a foot of snow on the northern half of the state. Heavy snow turned to rain and sleet in many parts of Delaware that Saturday afternoon. The combination of heavy snow and strong winds caused blowing snow and snow drifts which closed a portion of U.S. Highway 13, north of Harrington. Winds gusted to around 60 MPH and caused scattered damage and fallen trees and power lines.

4.2.3 Hurricanes and Tropical Storms[1]

Severe wind events resulting from hurricanes, tropical storms and nor'easters can cause widespread damage and loss life, as evidenced by the numerous coastal events that have impacted the State of Delaware. Although Delaware has not experienced a direct strike from a major hurricane in more than two decades (a fact often attributed to the geographic position of North Carolina), Delaware has experienced the effects of as many as 22 hurricanes and at least one significant tropical storm since the 1920s. Details of these events are presented below. Figure 4.2-1 graphically illustrates the path of 3 storms that passed directly through New Castle County in 1934, 1945, and Hurricane Sandy in 2012.

Hurricane Sandy (2012)

Post Tropical Storm Sandy caused an estimated $5.5 million dollars of damage across the three counties in Delaware. The damage estimates from the state were broken down to $2.8 million in New Castle County, $832,000 in Kent County and $1.9 million in Sussex County. Damages were due to tidal flooding as significant wave action resulted during multiple high tide cycles, due to increasing onshore winds prior to landfall. Damages were also due in part to inland flooding caused by excessive rainfall, as up to 10 inches of rain were reported. In addition, high winds resulted in many trees and wires coming down statewide. This created 100,000 power outages and resulted in many road closures due to downed trees and flooding. The hardest hit county was New Castle County. All power was restored by November 2nd. No direct deaths or injuries were reported in Delaware due to the storm and the overall number of traffic accidents was low because of driving restrictions.

Battery Park in City of New Castle. Much of the brunt of Sandy was felt along the banks of the Delaware River, especially in the City of New Castle, where four dikes were overtopped and suffered breaches. (Photo courtesy of The News Journal/DEMA)

Hurricane Irene (2011)

Hurricane Irene Hurricane Irene produced heavy flooding rain, widespread tropical storm force wind gusts, a confirmed tornado near Lewes in Sussex County, moderate to severe coastal flooding and beach erosion and caused two flooding related deaths, forced evacuations near the coast over the weekend of August 27th and 28th in Delaware. About 100,000 people were evacuated from the Atlantic Coast. Numerous roadways were flooded and closed and thousands of trees were knocked down. About 100,000 utility customers lost power. In addition, chickens were killed by flooding and agricultural crops were damaged by the flooding. Delaware received federal disaster declaration.

Tropical Storm Hanna (2008)

Tropical Storm Hanna brought heavy rain and strong winds in Delaware and some minor tidal flooding in Delaware Bay on the 6th. Rain moved into the region during the morning, fell heavy at times in the afternoon and ended during the early evening. Storm totals ranged from around

[1] Photos courtesy of the National Aeronautics and Space Administration (NASA). Historic hurricane track graphics courtesy of the National Hurricane Center.

1 to around 3.5 inches. The strongest winds occurred during the late morning and afternoon with peak gusts as high as 53 mph. About 10,000 homes and businesses lost power on the Delmarva Peninsula. All power was restored by the 7th. Minor tidal flooding occurred in Delaware Bay during the afternoon as the surge averaged two to three feet. Many planned outdoor activities were cancelled. The heavy rain caused minor roadway and low lying area flooding. The unseasonably dry weather leading into Hanna prevented stream and river flooding from occurring. The pounding surf caused about a three foot vertical cut to occur at Rehoboth Beach. Peak wind gusts included 44 mph in Dover (Kent County).

Hurricane Isabel (2003)

Isabel developed as a tropical storm September 6 about 600 miles west of the Southern Cape Verde Islands. The following day the storm was upgraded to a hurricane and within five days Isabel became the first Category 5 hurricane in the Atlantic since Hurricane Mitch in 1998. Isabel made landfall along the U.S. East Coast on September 18 as a Category 2 storm. Seven federal disaster declarations were issued as a result of Isabel, including the State of Delaware. Isabel may become best known for the wide-spread power outages it caused. Two days after Isabel lashed Delaware with wind and rain, approximately 60,000 of Conectiv's 280,000 customers were without power. About 28,000 customers were without power in the company's New Castle County region (which also includes Cecil and Harford counties in Maryland). A spokesperson for the power company said that trees falling across power lines caused most of the outages.

Tropical Storm Henri (Remnants—2003)

The National Weather Service reported that over a two-day period remnants of Tropical Storm Henri dumped eight (8) to 10 inches of rain in a narrow, slow-moving band that included northern Delaware, with 7.08 inches reported in Hockessin over a period of a few hours. Much of the region already had received above-normal rainfall in recent weeks. One example of damage caused by Henri focuses on an estimated 145 of 194 homes in the Glenville subdivision in New Castle County that were declared unsafe following record floods that cascaded down the Red Clay Valley and into Stanton on September 15—severely damaging homes, flooding cars and prompting a massive evacuation of residents by boat. (Hurricane Isabel caused additional flooding in this same area several days later.) In less than a month, half of the homes were returned to habitable status; however, more than 30 homes sustained severe structural damage.

Rescuers launch boats to evacuate residents from the Glenville development near Newport following flooding that occurred as a result of remnants of Tropical Storm Henri. An estimated 145 homes were affected. (Photo courtesy of The News Journal/Ginger Wall)

Tropical Storm Allison (Remnants—2001)

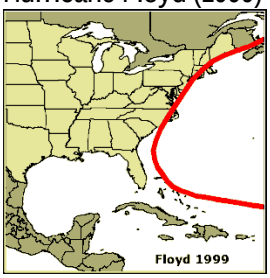
Showers and thunderstorms associated with the remnants of Tropical Storm Allison dropped heavy rain across New Castle County from the mid afternoon through the early evening of the 16th. The heavy rain caused flooding on some of the smaller steams in the county as well as some urban and poor drainage flooding. As the low moved east of the New Jersey coast during the morning of the 17th, heavy rain fell again for a couple of hours near dawn. Storm totals averaged between two (2) and four (4) inches and

included 3.58 inches at the New Castle County Airport, 2.3 inches in Newark, 2.94 inches in Wilmington and 2.14 inches at the Wilmington Porter Reservoir. No serious damages or injuries were reported.

Hurricane Gordon (Remnants—2000)

Remnants of Hurricane Gordon dropped heavy rain across the northern two-thirds of New Castle County and caused minor flooding along the Christina River as well as poor drainage flooding in low-lying areas. The rain was not unusually heavy, but came after what was already an unseasonably wet September and summer. Most of the heavy rain fell between 2 p.m. and 4 p.m. The Christina River at Cooch's Bridge was above its nine foot flood stage from 5 p.m. until 6 p.m. on the 19th. It crested at 9.13 feet at 5:30 p.m. Storm totals included 1.82 inches in Newark and 1.54 inches at the New Castle County Airport. No serious damages or injuries were reported.

Hurricane Floyd (1999)



According to the National Climatic Data Center, one notable hurricane has impacted the State of Delaware in recent history—Hurricane Floyd, which brought torrential rains and damaging winds on September 16, 1999. The hurricane caused widespread flash flooding as storm totals averaged around nine inches (10.58 inches in Sussex County). Most of this rain fell within a 12-hour period establishing a new state record. A total of $8 million in property damage was reported, along with two fatalities—the first hurricane-related deaths in the state since Hurricane Hazel in 1954. In addition, there were a number of injuries, at least two of which were serious. Overall, the event most heavily affected New Castle County. (NCDC, 2003)

Hurricane Dennis (1999)

The combination of swells from Hurricane Dennis and a stiff northeast flow caused by a strong high pressure system building over the New England States produced rip currents and minor tidal flooding. Rip currents from Dennis started along the Delaware Beaches on Sunday August 29th. About 100 rescues occurred and a few minor injuries were reported. On the 30th, swimming was banned at most of the Delaware Beaches. As Dennis pulled east of North Carolina on the 31st and weakened, the rip currents slowly ceased. A major contributing factor to the winds and rip currents was a very strong high pressure system that built into eastern Canada and the New England States on the 30th and 31st. The northeast flow around it and Hurricane Dennis produced wind gusts up to 50 MPH on the 30th and caused some minor tidal flooding from around noon on the 30th into the afternoon of the 31st. Minor tidal flooding extended into the back bays and inlets as the northeast winds prevented the tide from receding. On the 30th, the waves and tide reached the dune lines and under the boardwalk at Rehoboth Beach. The water also reached the bulkhead at one end of Bethany Beach and caused flooding along Pennsylvania Avenue, a frequently flooded location. As both Dennis and the high pressure system weakened, tides subsided after the afternoon of the 31st. The constant pounding and strong winds did cause beach erosion. Ocean Drive in South Bethany was sand covered because of the strong winds. The highest tide at Lewes reached 6.6 feet above mean lower low water around 1 a.m. on the 31st.

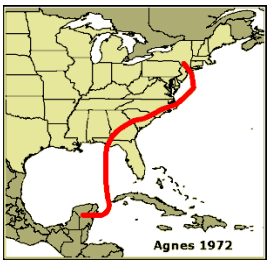
Hurricane Edouard (1996)

On August 30, 1996, a hurricane watch and tropical storm warning was issued from Cape Lookout, North Carolina northward to Cape Henlopen, Delaware (including the Pamlico and Albermarle Sounds) in preparation for the approach of Hurricane Edouard. The hurricane watch was extended northward the following day to include north of Cape Henlopen, Delaware to Plymouth, Massachusetts. Early on September 2, Edouard veered sharply toward the northeast and the center of the hurricane passed about 75 nautical miles southeast of Nantucket Island, its closest point of approach to the United States.

Tropical Storm Bertha (1996)

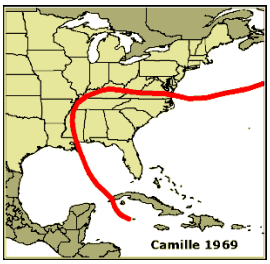
A weakening Tropical Storm Bertha passed across the state on July 13, 1996. While the long trip over land from Wilmington, North Carolina through Virginia to Delaware did weaken Bertha, some wind-related damage did occur in Sussex and Kent counties to the south of New Castle. The only tidal flooding reported was minor and occurred on Delaware State Route 54 near Fenwick Island, one of the most flood-prone roads in the state. Beach erosion was minor. The storm dropped between 1.5 and three inches of rain across most of the state, with locally higher amounts of around four inches reported in Sussex County. This caused some poor drainage flooding, but the only river to flood was the Christina in New Castle County. (NCDC, 2003)

Hurricane Agnes (1972)



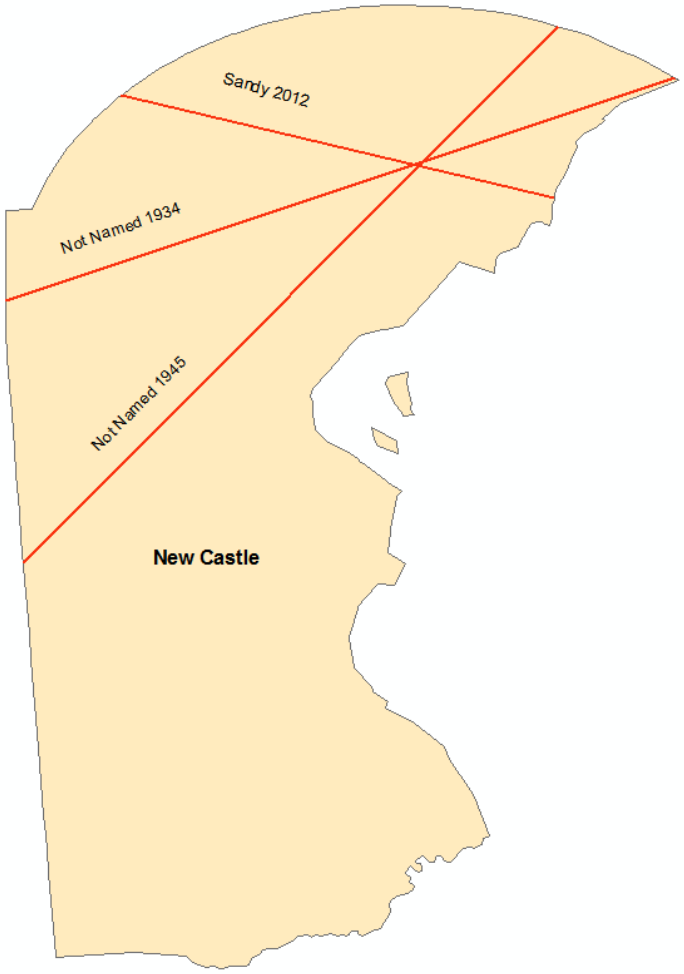
No description/details available.

Hurricane Camille (1969)



No description/details available.

Figure 4.2-1
Historical Coastal Storm Tracks Directly Through New Castle County



4.2.4 Thunderstorms

According to the National Climatic Data Center, New Castle County experienced 347 thunderstorm events including high wind, lightning, strong wind, and thunderstorm wind for the period January 1950 through July 2014. These events resulted in one (1) death, six (6) injuries and a total of approximately $15million in property damage (NCDC, 2014). Table 4.2-1 provides a breakdown of this thunderstorm activity.

Table 4.2-1
Summary of Thunderstorm Activity in New Castle County (1964-2014)

Storm Location	Date	Time	Type	Magnitude	Deaths	Injuries	Property Damage
Countywide	04/02/1970	1321	Thunderstorm/Wind	55 kts.	0	0	0
Countywide	06/18/1970	1645	Thunderstorm/Wind	0 kts.	0	0	0
Countywide	07/15/1970	2200	Thunderstorm/Wind	0 kts.	0	0	0
Countywide	01/26/1971	1200	Thunderstorm/Wind	50 kts.	0	0	0
Countywide	05/25/1971	1840	Thunderstorm/Wind	0 kts.	0	0	0
Countywide	11/28/1973	1620	Thunderstorm/Wind	0 kts.	0	0	0
Countywide	06/19/1975	2100	Thunderstorm/Wind	0 kts.	0	0	0
Countywide	07/03/1975	1440	Thunderstorm/Wind	0 kts.	0	0	0
Countywide	07/10/1975	1745	Thunderstorm/Wind	0 kts.	0	0	0
Countywide	08/04/1975	1645	Thunderstorm/Wind	0 kts.	0	0	0
Countywide	03/13/1976	1048	Thunderstorm/Wind	62 kts.	0	0	0
Countywide	03/21/1976	1300	Thunderstorm/Wind	0 kts.	0	0	0
Countywide	03/21/1976	1302	Thunderstorm/Wind	59 kts.	0	0	0
Countywide	03/21/1976	1310	Thunderstorm/Wind	0 kts.	0	0	0
Countywide	08/10/1977	1830	Thunderstorm/Wind	0 kts.	0	0	0
Countywide	08/17/1977	1245	Thunderstorm/Wind	0 kts.	0	0	0
Countywide	11/17/1977	1615	Thunderstorm/Wind	0 kts.	0	0	0
Countywide	06/07/1978	1245	Thunderstorm/Wind	0 kts.	0	0	0
Countywide	06/29/1978	1638	Thunderstorm/Wind	53 kts.	0	0	0
Countywide	08/02/1979	1430	Thunderstorm/Wind	0 kts.	0	0	0
Countywide	06/29/1980	1500	Thunderstorm/Wind	0 kts.	0	0	0
Countywide	05/15/1981	1545	Thunderstorm/Wind	0 kts.	0	0	0
Countywide	06/16/1982	2210	Thunderstorm/Wind	0 kts.	0	0	0

Storm Location	Date	Time	Type	Magnitude	Deaths	Injuries	Property Damage
Countywide	05/15/1983	1400	Thunderstorm/Wind	0 kts.	0	0	0
Countywide	05/22/1983	1930	Thunderstorm/Wind	0 kts.	0	0	0
Countywide	07/17/1983	2000	Thunderstorm/Wind	0 kts.	0	0	0
Countywide	07/19/1983	1805	Thunderstorm/Wind	50 kts.	0	0	0
Countywide	07/21/1983	1830	Thunderstorm/Wind	0 kts.	0	0	0
Countywide	05/08/1984	1612	Thunderstorm/Wind	62 kts.	0	0	0
Countywide	07/10/1985	1034	Thunderstorm/Wind	0 kts.	0	0	0
Countywide	07/31/1985	1445	Thunderstorm/Wind	0 kts.	0	0	0
Countywide	07/26/1987	1330	Thunderstorm/Wind	57 kts.	0	0	0
Countywide	08/17/1988	1730	Thunderstorm/Wind	0 kts.	0	0	0
Countywide	03/18/1989	1400	Thunderstorm/Wind	0 kts.	0	0	0
Countywide	11/16/1989	0915	Thunderstorm/Wind	0 kts.	0	0	0
Countywide	11/16/1989	0935	Thunderstorm/Wind	0 kts.	0	1	0
Countywide	11/16/1989	0940	Thunderstorm/Wind	78 kts.	0	0	0
Countywide	06/08/1990	1708	Thunderstorm/Wind	0 kts.	0	0	0
Countywide	06/09/1990	1800	Thunderstorm/Wind	0 kts.	0	0	0
Countywide	08/29/1990	1730	Thunderstorm/Wind	52 kts.	0	0	0
Countywide	10/18/1990	1630	Thunderstorm/Wind	0 kts.	0	0	0
Countywide	10/29/1990	1730	Thunderstorm/Wind	0 kts.	0	0	0
Countywide	12/04/1990	0530	Thunderstorm/Wind	0 kts.	0	0	0
Countywide	05/06/1991	1630	Thunderstorm/Wind	0 kts.	0	0	0
Countywide	06/16/1991	1650	Thunderstorm/Wind	0 kts.	0	0	0
Countywide	06/16/1991	1947	Thunderstorm/Wind	0 kts.	0	0	0
Countywide	09/17/1991	1730	Thunderstorm/Wind	0 kts.	0	0	0
Countywide	07/01/1992	1615	Thunderstorm/Wind	0 kts.	0	0	0
Countywide	07/15/1992	1600	Thunderstorm/Wind	0 kts.	0	0	0
Countywide	07/15/1992	1626	Thunderstorm/Wind	0 kts.	0	0	0
Countywide	07/15/1992	1626	Thunderstorm/Wind	0 kts.	0	0	0
Countywide	07/15/1992	1700	Thunderstorm/Wind	0 kts.	0	0	0
Countywide	08/11/1992	1450	Thunderstorm/Wind	0 kts.	0	0	0

Storm Location	Date	Time	Type	Magnitude	Deaths	Injuries	Property Damage
Countywide	08/28/1992	1725	Thunderstorm/Wind	52 kts.	0	0	0
Countywide	03/13/1993	0900	High Winds	0 kts.	0	0	$50,000
Countywide	09/27/1993	1410	Thunderstorm Winds	N/A	0	0	$5,000
Newark	04/09/1995	1945	Thunderstorm Winds	N/A	0	0	0
Countywide	07/16/1995	0225	Thunderstorm Winds	N/A	1	0	0
Wilmington	10/21/1995	0630	Thunderstorm Winds	N/A	0	0	0
Countywide	11/11/1995	1900	High Wind	0 kts.	0	0	0
Countywide	01/19/1996	08:00 AM	High Wind	52 kts.	0	0	0
Countywide	01/27/1996	12:00 PM	High Wind	0 kts.	0	0	0
Countywide	02/24/1996	10:00 AM	High Wind	0 kts.	0	0	0
Countywide	03/19/1996	05:10 PM	High Wind	0 kts.	0	0	0
Countywide	03/06/1997	05:00 AM	High Wind	0 kts.	0	0	0
Countywide	03/31/1997	08:00 AM	Wind	N/A	0	0	0
Countywide	04/01/1997	12:00 AM	Wind	N/A	0	0	0
Wilmington	06/13/1997	12:20 PM	Thunderstorm/Wind	0 kts.	0	0	0
Countywide	02/04/1998	01:00 PM	Wind	N/A	0	0	0
Countywide	02/25/1998	06:00 AM	Wind	N/A	0	0	0
Brandywine	06/01/1998	12:04 AM	Thunderstorm/Wind	56 kts.	0	0	0
Hockessin	06/02/1998	07:55 PM	Thunderstorm/Wind	50 kts.	0	0	0
Greenville	06/12/1998	07:48 AM	Thunderstorm/Wind/Hail	0 kts.	0	0	0
Red Lion	06/13/1998	04:45 PM	Thunderstorm/Wind	50 kts.	0	0	0
Wilmington	07/21/1998	05:50 PM	Thunderstorm/Wind	0 kts.	0	0	0
Newark	08/18/1998	02:45 PM	Thunderstorm/Wind	50 kts.	0	0	0
New Castle	08/18/1998	02:50 PM	Thunderstorm/Wind	50 kts.	0	0	0
Townsend	08/18/1998	04:20 PM	Thunderstorm/Wind	50 kts.	0	0	0
Countywide	12/22/1998	07:00 AM	Wind	N/A	0	0	0
Countywide	12/30/1998	07:00 AM	Wind	N/A	0	0	0
Countywide	01/03/1999	05:00 AM	High Wind	53 kts.	0	0	0
Countywide	01/18/1999	04:10 PM	High Wind	0 kts.	0	0	0
Countywide	03/04/1999	04:00 AM	Wind	N/A	0	0	0

Storm Location	Date	Time	Type	Magnitude	Deaths	Injuries	Property Damage
Countywide	03/07/1999	04:00 AM	Wind	N/A	0	0	0
Countywide	03/18/1999	09:00 AM	Wind	N/A	0	0	0
St. Georges	04/09/1999	06:40 PM	Thunderstorm/Wind	0 kts.	0	0	0
Newark	05/24/1999	02:15 PM	Thunderstorm/Wind	52 kts.	0	0	0
Wilmington Airport	05/24/1999	02:27 PM	Thunderstorm/Wind	53 kts.	0	0	0
Wilmington	08/14/1999	04:00 PM	Thunderstorm/Wind	0 kts.	0	0	0
Countywide	09/16/1999	03:00 AM	High Wind	57 kts.	0	0	0
Countywide	11/02/1999	02:00 PM	High Wind	50 kts.	0	0	0
Countywide	12/10/1999	07:00 PM	Wind	N/A	0	0	0
Countywide	01/11/2000	11:00 AM	Wind	N/A	0	0	0
Countywide	01/13/2000	01:00 PM	Wind	N/A	0	0	0
Countywide	01/16/2000	09:00 PM	Wind	N/A	0	0	0
Wilmington	03/11/2000	09:30 PM	Thunderstorm/Wind/Hail	0 kts.	0	0	0
Countywide	04/08/2000	11:00 AM	Wind	N/A	0	0	0
Countywide	04/09/2000	04:00 AM	Wind	N/A	0	0	0
Bear	05/13/2000	07:10 PM	Thunderstorm/Wind	59 kts.	0	0	0
Brandywine	09/14/2000	11:15 PM	Lightning	N/A	0	0	$100,000
Countywide	12/12/2000	08:30 AM	High Wind	50 kts.	0	0	0
Countywide	12/17/2000	03:00 AM	Wind	N/A	0	0	0
Countywide	02/10/2001	06:00 AM	Wind	N/A	0	0	0
Yorklyn	06/11/2001	09:30 PM	Thunderstorm/Wind	50 kts.	0	0	0
Pleasant Hill	08/10/2001	02:00 PM	Thunderstorm/Wind	52 kts.	0	0	0
Newark	09/04/2001	05:10 PM	Thunderstorm/Wind	52 kts.	0	0	0
Countywide	01/13/2002	07:00 AM	Wind	N/A	0	0	0
Countywide	02/01/2002	12:00 PM	Wind	N/A	0	0	0
Countywide	02/04/2002	03:00 PM	Wind	N/A	0	0	0
Countywide	02/11/2002	07:00 AM	Wind	N/A	0	0	0
Countywide	03/10/2002	06:00 AM	Wind	N/A	0	0	0
Countywide	03/21/2002	08:00 PM	Wind	N/A	0	0	0

Storm Location	Date	Time	Type	Magnitude	Deaths	Injuries	Property Damage
Odessa	04/09/2002	06:30 AM	Lightning	N/A	0	0	$50,000
Middletown	05/13/2002	03:40 PM	Thunderstorm/Wind	52 kts.	0	0	0
Christiana	05/13/2002	04:10 PM	Thunderstorm/Wind	52 kts.	0	0	0
Bellefonte	05/14/2002	05:40 PM	Thunderstorm/Wind	50 kts.	0	0	0
Hockessin	05/27/2002	04:43 PM	Thunderstorm/Wind	52 kts.	0	0	0
Arden	05/27/2002	05:15 PM	Thunderstorm/Wind	57 kts.	0	0	0
Odessa	06/06/2002	03:45 PM	Thunderstorm/Wind	50 kts.	0	0	0
Newark	06/18/2002	05:15 PM	Thunderstorm/Wind	52 kts.	0	0	0
Hockessin	06/24/2002	07:00 PM	Thunderstorm/Wind	52 kts.	0	0	0
Newark	07/09/2002	08:30 PM	Thunderstorm/Wind	50 kts.	0	0	0
Hockessin	08/01/2002	05:55 PM	Thunderstorm/Wind	52 kts.	0	0	0
Claymont	08/24/2002	07:02 PM	Thunderstorm/Wind	52 kts.	0	0	0
Hockessin	09/11/2002	09:00 AM	Wind	N/A	0	0	0
Hockessin	02/04/2003	01:00 PM	Strong Wind	N/A	0	0	$1,000
Hockessin	02/12/2003	08:00 AM	Strong Wind	N/A	0	0	$1,000
Hockessin	02/23/2003	12:00 PM	Strong Wind	N/A	0	0	$1,000
Hockessin	05/12/2003	11:00 AM	Strong Wind	N/A	0	0	$5,000
Newark	06/12/2003	06:50 PM	Thunderstorm/Wind	52 kts.	0	0	0
Newark	06/13/2003	08:30 PM	Lightning	N/A	0	0	$50,000
Port Penn	07/09/2003	07:00 PM	Lightning	N/A	0	0	$100,000
Countywide	09/18/2003	04:00 PM	High Wind	50 kts	0	0	$9,500,000
Countywide	11/13/2003	07:00 AM	High Wind	51 kts	0	1	$430,000
Hockessin	06/17/2004	08:00 PM	Lightning	N/A	0	0	$500,000
Countywide	12/01/2004	09:00 AM	Strong Wind	46 kts	0	0	$70,000
Middletown	07/27/2005	06:30 PM	Lightning	N/A	0	0	$50,000
Townsend	05/13/2006	06:45 AM	Lightning	N/A	0	0	$100,000
Countywide	09/01/2006	05:00 PM	Strong Wind	41 kts	0	0	$100,000
Newark	07/10/2007	03:00 PM	Lightning	N/A	0	0	$200,000
Kirkwood	07/23/2008	12:15 AM	Lightning	N/A	0	0	$500,000
Kentmere	08/10/2008	05:35 PM	Thunderstorm Wind	52 kts	0	0	$100,000

Storm Location	Date	Time	Type	Magnitude	Deaths	Injuries	Property Damage
Wilmington	06/02/2009	02:28 PM	Thunderstorm Wind	66 kts	0	0	$250,000
Bear	07/01/2009	11:05 PM	Lightning	N/A	0	0	$125,000
Newark	08/09/2009	05:35 PM	Thunderstorm Wind	56 kts	0	0	$500,000
Countywide	02/19/2011	11:00 AM	High Wind	50 kts	0	0	$50,000
Countywide	02/25/2011	03:00 PM	High Wind	50 kts	0	0	$125,000
Hockessin	08/09/2011	11:22 AM	Thunderstorm Wind	52 kts	0	0	$250,000
Chalfonte	08/09/2011	11:40 PM	Thunderstorm Wind	52 kts	0	0	$50,000
LancasterVlg	08/09/2011	11:43 PM	Thunderstorm Wind	52 kts	0	0	$100,000
Countywide	12/07/2011	09:00 PM	Strong Wind	40 kts	0	0	$35,000
Glasgow	06/22/2012	06:21 PM	Thunderstorm Wind	54 kts	0	0	$100,000
Newark	06/29/2012	10:57 PM	Thunderstorm Wind	65 kts	0	0	$100,000
Belvidere	08/03/2012	03:05 PM	Lightning	N/A	0	4	$0
Countywide	10/29/2012	04:00 PM	High Wind	58 kts	0	0	$500,000
Countywide	06/24/2013	06:47 PM	Thunderstorm Wind	52 kts	0	0	$80,000
Countywide	07/08/2014	07:22 PM	Thunderstorm Wind	52 kts	0	0	$90,000
				Totals	1	6	$14,942,000

Source: National Climatic Data Center

4.2.5 Tornadoes

In an assessment conducted by the National Weather Service Storm Prediction Center covering the 30 year period from 1980 to 2009, the State of Delaware ranked #45 in the Nation for number of tornadoes (31), #30 in number of fatalities (2), #36 in number of F2 or greater tornadoes (7)

Independent of the Storm Prediction Center state-ranking project, the National Climatic Data Center indicates that the geographic area of the State of Delaware experienced 60 tornado events from January 1, 1950 through July 31, 2014. NCDC data supports the statistics of two deaths and (74) injuries, and reflects a total of approximately $13 million in property damage, with an additional $5,000 in crop damage. In addition, The Tornado Project (www.tornadoproject.com) has identified 16 tornadoes that occurred prior to 1950, dating as far back as 1789.

Table 4.2-2 lists 21 tornadoes that were reported to the National Climatic Data Center as having touched down in New Castle County. These events are responsible for seven injuries and $7,160,000 in property damages in the county.

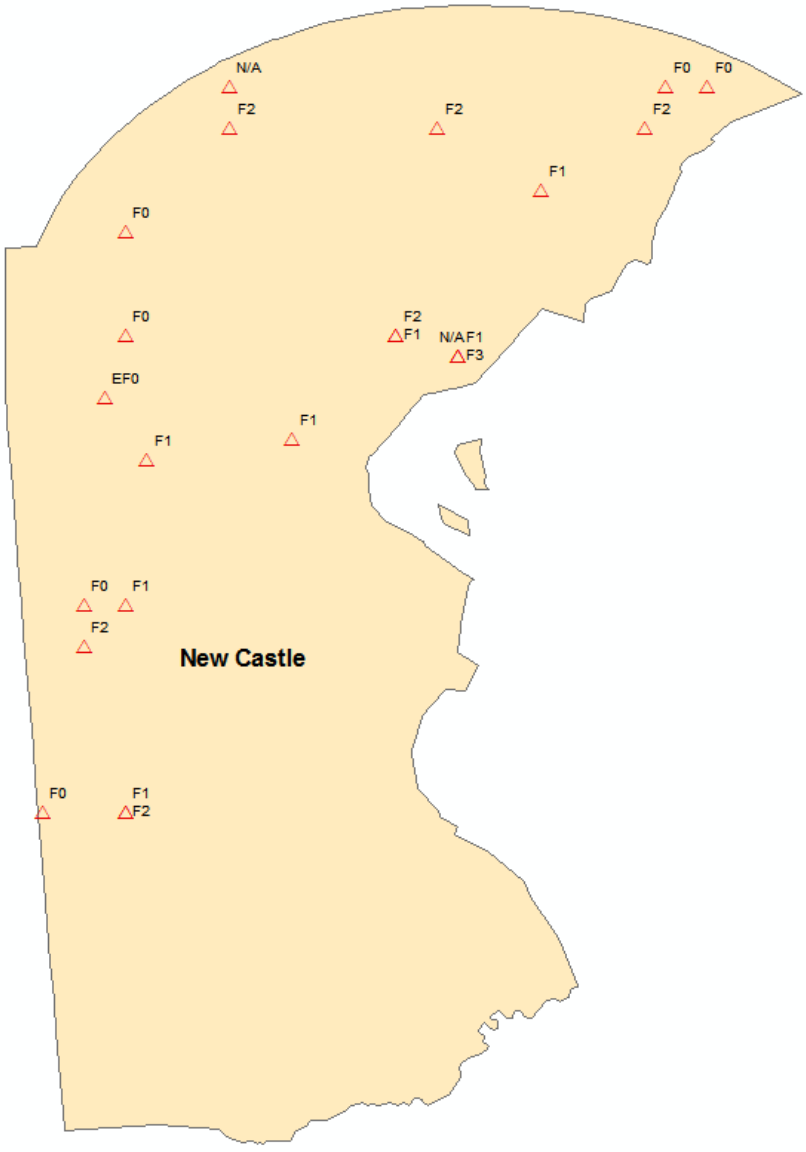
Table 4.2-2
Summary of Tornado Activity in the New Castle County (1964-2014)

Tornado Location	Date	Time	Type	Magnitude	Deaths	Injuries	Property Damage	Crop Damage
County	08/27/1967	1330	Tornado	F0	0	0	$3,000	0
County	10/18/1967	1615	Tornado	F1	0	0	$3,000	0
County	10/18/1967	1715	Tornado	F1	0	0	0	0
County	06/28/1973	1250	Tornado	F0	0	0	0	0
County	07/14/1975	0640	Tornado	F0	0	0	0	0
County	08/10/1979	1930	Tornado	F1	0	0	$250,000	0
County	09/05/1979	1945	Tornado	F2	0	5	$250,000	0
County	06/07/1988	1410	Tornado	F1	0	0	$2,500,000	0
County	07/21/1988	1745	Tornado	F0	0	0	0	0
County	06/09/1989	1710	Tornado	F2	0	1	$2,500,000	0
County	11/16/1989	0930	Tornado	F1	0	1	$250,000	0
County	10/18/1990	1600	Tornado	F2	0	0	$250,000	0
Mount Pleasant	09/27/1993	1355	Tornado	F2	0	0	$50,000	$5,000
County	09/27/1993	1400	Tornado	F1	0	0	$50,000	0
Glasgow	05/25/1995	1900	Tornado	F0	0	0	0	0
Bellefonte	01/18/1999	04:30 PM	Waterspout	N/A	0	0	0	0
Wilmington	09/28/2004	03:14 PM	Tornado	F2	0	0	$1,000,000	0
Cooch	06/10/2013	03:47 PM	Tornado	EF0	0	0	0	0
				TOTALS:	0	7	$7,160,000	$5,000

Source: National Climatic Data Center

Figure 4.2-2 illustrates graphically historical tornado occurrences within New Castle County.

Figure 4.2-2
Historical Tornado Occurrences



4.2.6 Wildfire

According to the Delaware Fire Service, the greatest wildfire danger is in those marshes along the Delaware Bay that contain large amounts of phragmites. One such example is the 1,400 acre fire that occurred at Prime Hook in Sussex County in 2002. Otherwise, the climate, forest types and terrain (flat, interspersed with cropland, ditches, roads, etc.) in Delaware do not promote large wildfires. Most of the wildfires within the state are small, ground fires that are fairly easily extinguished and seldom do much damage. (Austin Short, Delaware Forest Service, austin.short@state.de.us). No significant wildfire events have been recorded in New Castle County for the period 1950-2014 (NCDC, 2014).

4.2.7 Drought

According to the National Climatic Data Center, the State of Delaware has experienced 207 reported droughts and/or periods of unseasonably dry weather from 1950 through July 2014, most of which affected the entire forecast zone of New Castle (49), Kent (53) and Sussex (105) counties.

All crop damage reported for this period ($29.1 million statewide) is tied to a single event—the drought that gripped the Middle Atlantic States throughout much of the growing season of 1999, which eased in mid-August of that year. Normal, and in some cases heavier than normal, rainfall returned, and on September 8 Governor Thomas Carper lifted the mandatory watering restrictions in northern Delaware. The drought, for all intents and purposes, ended with the arrival of the record-breaking rain associated with Hurricane Floyd on September 16. As much as 10.5 inches of rain (or about three months worth of normal rainfall) fell from Floyd across Delaware. The drought emergency was lifted by Governor Carper on September 21, however the heavy rain came too late to help farmers. Agricultural losses throughout the state were estimated at $29.1 million. The 1999 corn harvest was 2.6 million bushels less than 1998 and the smallest crop since 1988. The soybean harvest in 1999 was 1.9 million bushels less than 1998 and the smallest harvest since 1995. The drought also greatly affected pastures and produced a later and smaller than usual pumpkin crop.

4.2.8 Extreme Temperature

According to the National Climatic Data Center, New Castle County experienced 95 extreme temperature events, including cold/wind chill, excessive heat, freezing fog, frost/freeze, and heat, from 1995 through July 2014. These heat waves and cold snaps have caused five (5) deaths and thirty eight (38) injuries.

The combination of high temperatures near 90F and excessive humidity levels caused eight persons to suffer heat exhaustion during a day-long country music festival in Frawley Stadium near Wilmington on 8 June 1996.

The weekend of August 16th and 17th brought some of the hottest and most humid air of the summer into Delaware. High temperatures in most places reached around 100 degrees, while dew point temperatures (an indication of how humid the air mass is) were well into the 70s. Three heat related illnesses were reported in New Castle County. The hot weather continued to stress growing conditions across the state. The highest temperatures this weekend (on Saturday the 16th for most locations) included 100 degrees in Bridgeville, Dover, Georgetown and Lewes, 97 degrees at the New Castle County Airport and 95 degrees in Prices Corner. The high of 100 degrees in Dover set a new record, surpassing the previous record of 98 degrees set in 1954. The high of 97 degrees at the New Castle

County Airport fell one degree short of tying the record for the date. The hot spell ended abruptly as a strong cold front moved through the region early on the 18th.

A two day hot spell brought some of the highest temperatures of the summer to the Delmarva Peninsula and ended abruptly with severe thunderstorms during the late afternoon and early evening of the 26th of June 1998. The excessive heat caused the death of an 84-year-old Wilmington woman. The highest temperatures occurred on the 26th and included 95 degrees in Greenwood and Georgetown (both Sussex County), 94 degrees in Bridgeville (Sussex County) and Wilmington (New Castle County) and 93 degrees at the New Castle County Airport.

A heat wave affected Delaware during the work week of July 20th 1998. The hottest day for the heat wave and the summer (in central and southern Delaware) was the 22nd. There were at least eight heat related injuries throughout the state. A weak trough brought in slightly cooler air on the 23rd. A strong cold front that moved through the Delmarva Peninsula early in the day on the 24th brought in a much drier and cooler air mass for the upcoming weekend (July 25th and 26th). The highest temperatures included 100 degrees in Lewes (Sussex County), 99 degrees in Georgetown (Sussex County), 98 degrees in Bridgeville (Sussex County), 96 degrees in Dover (Kent County), 94 degrees in Odessa (New Castle County) and 92 degrees at the New Castle County Airport. For three consecutive days, customers of Delmarva Power and Light set power usage records and reached 3,053 megawatts at 6 p.m. EDT on the 22nd.

There were five heat related illnesses reported in Wilmington on the 7th. Many schools in the state had early dismissals on the 8th of June 1999. A fan drive was initiated for the elderly within Wilmington and the city's Department of Health and Social Service Division of Public Health issued safety and health related warnings. People were not the only ones to suffer, the Automobile Association of America (AAA) responded to about 180 calls of disabled vehicles throughout the state on the 7th.

A very strong and oppressive high pressure system that extended from the surface to aloft gave Delaware a brutal heat wave that included the entire Independence Day weekend in 1999. There were four heat related deaths, two in New Castle County, two in Sussex County. There were also about 10 heat related injuries reported. High temperatures reached the 90s for the first time on the 3rd, but sweltering humidity and record breaking maximum temperatures of around 100 degrees occurred from Independence Day through the 6th. The combination of the temperature and humidity produced heat indices of around 110 degrees during the afternoon of each day. A cold front moved through the region early in the morning on the 7th. While high temperatures continued to reach the 90s from the 7th through the 9th, humidity levels were lower. A stronger cold front moved through the region during the morning and afternoon of the 10th and brought in an even cooler and drier air mass. So after some places in central and southern Delaware had high temperatures in the 90s on the 10th, the run of 90 degree highs ended everywhere on the 11th.

A run of consecutive days with high temperatures in the 90s started in Delaware on July 23rd 1999. It lasted as long as 16 days in some areas through August 7th. Dispersed within this run were two periods of both excessive heat and humidity: from July 23rd through July 25th and again from July 29th through August 1st. A cold front moved through the area on the 25th and brought in drier air. High temperatures still reached into the 90s from the 26th through the 28th. The humidity and even higher temperatures returned on the 29th. A strong cold front moved through the region the afternoon and evening of August 1st. This brought in considerably drier air, the driest air since mid July. Because of the extremely dry ground conditions, high temperatures kept reaching around 90 degrees through the 7th. That day a stronger cold front brought in a cooler air mass from Canada into the northeastern United States.

Delmarva hospitals reported a few cases of heat related injuries. The continued excessive heat and lack of rain parched non-irrigated farms across the state.

The heat and humidity took its toll on two Dover, Delaware area men, who were in their mid 50s. They died on August 2nd 2006 due to the excessive heat. They were both outside when they died, and at least one of the men had some pre-existing health conditions. At least four people were treated for heat stroke in Wilmington, Delaware on August 1st. In Delaware City (New Castle County), the extreme heat contributed to the collapse of a refinery worker. Also on August 1st, Police in Wilmington rescued a child who locked himself in a car with the windows rolled up.

The combination of a strong northwest flow around an arctic high pressure system and because this high originated near the North Pole produced the coldest morning in two years across most of Delaware on the 26th of January 2007. Most low temperatures were around 10F. Wind chill factors were below zero. The extreme cold helped cause the death of a 64-year-old homeless man who was found dead under a Wilmington railroad viaduct a couple of days later. Actual low temperatures included 8F in Wilmington (New Castle County), 10F at the New Castle County Airport, 11F in Dover (Kent County), 14F in Blackbird (New Castle County), Sandtown (Kent County), Prime Hook (Sussex County) and Georgetown (Sussex County).

Unseasonably hot weather for early June culminated on the 9th of June 2011 with high temperatures in the upper 90s and afternoon heat indices of around 105F in Delaware. While high temperatures were nearly the same on the 8th, humidity levels were higher on the 9th. A cold front that triggered strong to severe thunderstorms during the night of the 9th moved through the state during the first half of the day on the 10th and lowered both temperature and humidity levels. There were a couple of heat related illnesses throughout the state. Fans were distributed in Dover (Kent County). The highest temperatures included 99 degrees in Dover (Kent County) and 97 degrees at the New Castle County Airport and Georgetown (Sussex County).

The most oppressive hot spell of the summer season affected Delaware from July 15th through the 20th 2013. Widespread high temperatures reached into the mid 90s and the most oppressive days (combination of heat and humidity) occurred on the 18th and 19th. Morning lows those days were only around 80 degrees in highly urbanized areas. Afternoon heat indices reached 105 to 110 degrees. There was one heat related death reported in New Castle (New Castle County). A 55-year-old man was found outdoors and unresponsive. To combat the heat, many municipalities opened or extended hours of cooling centers. Highest temperatures included 96 degrees in Georgetown, Redden and Bethany Beach in Sussex County, 95 degrees in Dover (Kent County) and the New Castle County Airport and 92 degrees in Blackbird (New Castle County). A stalling front brought an end to the excessive heat on the 21st and to 90 degree high temperatures by the 22nd in the northern part of the state and the 23rd in the southern part of the state.

4.2.9 Hail

According to the National Climatic Data Center, New Castle County experienced 53 hail events from 1950 through July 2014 (see Table 4.2-3), with some hail stones exceeding 1.75 inches in diameter. These events total approximately $5,000 in property damage (NCDC, 2014).

Table 4.2-3
Hail Activity in New Castle County (1964-2014)

Location	Date	Time	Type	Magnitude	Deaths	Injuries	Property Damage
Countywide	06/05/1970	1630	Hail	1.50 in.	0	0	0
Countywide	07/06/1977	1540	Hail	0.75 in.	0	0	0
Countywide	05/31/1980	1930	Hail	1.75 in.	0	0	0
Countywide	06/03/1980	1430	Hail	0.75 in.	0	0	0
Countywide	06/25/1981	1703	Hail	1.00 in.	0	0	0
Countywide	04/05/1984	1600	Hail	0.75 in.	0	0	0
Countywide	04/05/1984	1615	Hail	0.75 in.	0	0	0
Countywide	08/02/1986	1520	Hail	0.75 in.	0	0	0
Countywide	09/22/1987	1401	Hail	0.75 in.	0	0	0
Countywide	07/05/1990	1425	Hail	0.75 in.	0	0	0
Smyrna	04/01/1993	2115	Hail	1.75 in.	0	0	$5,000
Newark	05/01/1997	04:55 PM	Hail	0.75 in.	0	0	0
Newark	05/24/1999	02:15 PM	Hail	1.75 in.	0	0	0
Newark	05/10/2000	05:08 PM	Hail	0.75 in.	0	0	0
Middleton	04/09/2001	07:40 PM	Hail	0.75 in.	0	0	0
Wilmington	06/11/2001	09:35 PM	Hail	0.88 in.	0	0	0
Bear	05/27/2002	04:10 PM	Hail	0.75 in.	0	0	0
Armstrong	07/01/2004	03:40 PM	Hail	1.00 in.	0	0	0
Wilmington	05/15/2006	05:25 PM	Hail	0.75 in.	0	0	0
Townsend	07/16/2007	06:49 PM	Hail	0.75 in.	0	0	0
Roseville Park	06/27/2008	03:40 PM	Hail	1.00 in.	0	0	0
Bear	07/27/2008	01:22 PM	Hail	0.75 in.	0	0	0
Wilmington	08/10/2008	09:20 AM	Hail	1.00 in.	0	0	0
Bear	08/10/2008	05:45 PM	Hail	0.88 in.	0	0	0
Wilmington	03/29/2009	05:20 PM	Hail	0.88 in.	0	0	0
Wilmington	06/02/2009	02:42 PM	Hail	0.75 in.	0	0	0
Hockessin	07/24/2009	05:38 PM	Hail	1.00 in.	0	0	0
Newark	05/14/2010	06:10 PM	Hail	0.75 in.	0	0	0
Bear	05/14/2010	06:17 PM	Hail	1.00 in.	0	0	0

Location	Date	Time	Type	Magnitude	Deaths	Injuries	Property Damage
Countywide	05/14/2010	06:20 PM	Hail	0.88 in.	0	0	0
Hockessin	05/14/2010	08:55 PM	Hail	0.88 in.	0	0	0
Talleyville	05/27/2010	07:27 PM	Hail	1.00 in.	0	0	0
Wilmington	05/27/2010	07:38 PM	Hail	1.00 in.	0	0	0
Newark	06/22/2010	05:33 PM	Hail	1.00 in.	0	0	0
Bear	06/22/2010	05:40 PM	Hail	1.25 in.	0	0	0
Newark	06/22/2010	08:09 PM	Hail	0.75 in.	0	0	0
Claymont	08/09/2011	11:44 AM	Hail	1.25 in.	0	0	0
Wilmington	08/09/2011	11:45 AM	Hail	1.00 in.	0	0	0
Bear	08/09/2011	11:45 AM	Hail	1.00 in.	0	0	0
Claymont	08/18/2011	06:45 PM	Hail	1.00 in.	0	0	0
Countywide	09/11/2011	09:45 PM	Hail	1.00 in.	0	0	0
Bear	06/22/2012	06:29 PM	Hail	0.75 in.	0	0	0
Countywide	06/22/2012	06:45 PM	Hail	0.75 in.	0	0	0
Middletown	06/29/2012	10:55 PM	Hail	0.75 in.	0	0	0
Newark	06/29/2012	11:15 PM	Hail	1.75 in.	0	0	0
Wilmington	06/29/2012	11:20 PM	Hail	0.88 in.	0	0	0
Countywide	06/29/2012	11:21 PM	Hail	0.75 in.	0	0	0
Townsend	08/03/2012	03:35 PM	Hail	0.88 in.	0	0	0
Newark	06/17/2013	05:13 PM	Hail	0.75 in.	0	0	0
Bear	06/17/2013	05:24 PM	Hail	0.75 in.	0	0	0
Brandywine	05/22/2014	03:32 PM	Hail	1.00 in.	0	0	0
Hare's Corner	05/22/2014	03:37 PM	Hail	2.50 in.	0	0	0
Hare's Corner	05/22/2014	03:39 PM	Hail	1.75 in.	0	0	0
				TOTALS:	0	0	$5,000

Source: National Climatic Data Center

A detailed map illustrating historical occurrences is presented in the *Vulnerability Assessment* Chapter along with indicators of countywide vulnerability.

4.2.10 Winter Storms

According to the National Climatic Data Center, New Castle County experienced 141 distinct winter storm events, including blizzards, heavy snow, ice storm, winter storm, and winter weather, from 1993 through July 2014 (see Table 4.2-4). In recent history, the three most powerful and costly storms to affect Delaware were the Blizzard of 1996, a storm over President's Day Weekend 2003, and the winter storm on February 9, 2010. The 141 New Castle County events resulted in $5,350,000 in property damage, (4) deaths, and (76) reported injuries.

Table 4.2-4
Winter Storm Activity in New Castle County (1993-2014)

Location	Date	Time	Type	Deaths	Injuries	Property Damage
Countywide	01/07/1996	01:00 AM	Blizzard	0	0	$1,000,000
Countywide	01/12/1996	06:00 AM	Heavy Snow	0	0	0
Countywide	02/02/1996	06:00 PM	Heavy Snow	0	0	0
Countywide	02/16/1996	06:00 AM	Heavy Snow	0	0	0
Countywide	03/08/1996	01:00 AM	Heavy Snow	0	0	0
Countywide	01/01/1997	07:00 PM	Freezing Drizzle	0	0	0
Countywide	01/11/1997	01:00 AM	Snow	0	0	0
Countywide	01/22/1997	05:00 AM	Black Ice	0	0	0
Countywide	02/08/1997	06:00 AM	Heavy Snow	0	0	0
Countywide	02/14/1997	12:00 AM	Wintry Mix	0	0	0
Countywide	03/31/1997	01:00 PM	Heavy Snow	0	0	0
Countywide	04/01/1997	12:00 AM	Heavy Snow	0	0	0
Countywide	12/23/1998	04:00 PM	Snow	0	0	0
Countywide	01/02/1999	10:00 PM	Wintry Mix	0	0	0
Countywide	01/08/1999	08:00 AM	Wintry Mix	0	0	0
Countywide	01/13/1999	11:00 PM	Winter Storm	0	0	0
Countywide	03/14/1999	11:00 AM	Heavy Snow	0	0	0
Countywide	01/07/2000	05:30 AM	Black Ice	0	0	0
Countywide	01/20/2000	04:00 AM	Heavy Snow	0	30	0
Countywide	01/25/2000	01:00 AM	Winter Storm	0	20	0
Countywide	01/30/2000	02:00 PM	Winter Storm	0	0	0
Countywide	02/03/2000	03:00 PM	Snow	0	0	0
Countywide	02/18/2000	06:00 AM	Snow	0	0	0
Countywide	04/09/2000	02:30 AM	Snow	0	0	0

Location	Date	Time	Type	Deaths	Injuries	Property Damage
Countywide	12/19/2000	09:00 PM	Snow	0	0	0
Countywide	01/05/2001	11:00 AM	Snow	0	0	0
Countywide	01/16/2001	06:00 AM	Black Ice	0	0	0
Countywide	01/20/2001	09:00 PM	Wintry Mix	0	0	0
Countywide	02/12/2001	09:00 PM	Wintry Mix	0	0	0
Countywide	02/22/2001	12:00 PM	Heavy Snow	0	0	0
Countywide	03/04/2001	07:00 AM	Wintry Mix	0	0	0
Countywide	03/26/2001	03:00 AM	Snow	0	0	0
Countywide	01/19/2002	09:30 AM	Winter Storm	0	0	0
Countywide	12/05/2002	02:00 AM	Heavy Snow	0	0	0
Countywide	12/11/2002	04:00 AM	Winter Weather/Mix	0	0	0
Countywide	01/05/2003	11:00 AM	Heavy Snow	0	0	0
Countywide	01/29/2003	03:00 AM	Winter Weather/Mix	0	0	0
Countywide	02/06/2003	08:30 PM	Heavy Snow	0	0	0
Countywide	02/10/2003	08:00 AM	Winter Weather/Mix	0	0	0
Countywide	02/15/2003	12:00 AM	Winter Weather/Mix	0	0	0
Countywide	02/16/2003	03:00 AM	Winter Storm	0	0	$1,300,000
Countywide	02/27/2003	03:00 PM	Winter Weather/Mix	0	0	0
Countywide	04/07/2003	07:00 AM	Winter Weather/Mix	0	0	0
Countywide	02/13/2007	07:00 AM	Winter Storm	1	0	0
Countywide	02/25/2007	01:00 PM	Winter Storm	2	0	0
Countywide	02/12/2008	12:00 PM	Winter Weather	0	6	0
Countywide	01/18/2009	05:15 PM	Winter Weather	0	10	0
Countywide	01/27/2009	04:00 AM	Winter Storm	0	10	$50,000
Countywide	02/09/2010	04:30 PM	Winter Storm	1	0	$3,000,000
Countywide	02/10/2010	12:00 AM	Blizzard	0	0	0
Countywide	02/15/2010	5:00 PM	Winter Weather	0	0	0
Countywide	02/16/2010	7:00 AM	Winter Weather	0	0	0
Countywide	02/25/2010	5:00 AM	Winter Storm	0	0	0
Countywide	12/16/2010	1:00 PM	Winter Weather	0	0	0
Countywide	12/26/2010	12:00 PM	Winter Weather	0	0	0

Location	Date	Time	Type	Deaths	Injuries	Property Damage
Countywide	01/07/2011	5:00 AM	Winter Weather	0	0	0
Countywide	01/08/2011	6:00 AM	Winter Weather	0	0	0
Countywide	01/11/2011	3:00 PM	Heavy Snow	0	0	0
Countywide	01/17/2011	8:00 PM	Winter Weather	0	0	0
Countywide	01/21/2011	12:30 AM	Winter Weather	0	0	0
Countywide	01/26/2011	4:00 AM	Winter Storm	0	0	0
Countywide	02/01/2011	1:00 AM	Winter Weather	0	0	0
Countywide	02/01/2011	11:00 PM	Ice Storm	0	0	0
Countywide	02/09/2011	10:00 PM	Winter Weather	0	0	0
Countywide	02/21/2011	8:00 PM	Heavy Snow	0	0	0
Countywide	10/29/2011	10:00 AM	Winter Weather	0	0	0
Countywide	01/04/2012	10:00 PM	Winter Weather	0	0	0
Countywide	01/21/2012	12:30 AM	Winter Weather	0	0	0
Countywide	02/11/2012	12:00 AM	Winter Weather	0	0	0
Countywide	02/11/2012	4:00 PM	Winter Weather	0	0	0
Countywide	12/29/2012	10:00 AM	Winter Weather	0	0	0
Countywide	01/06/2013	2:00 AM	Winter Weather	0	0	0
Countywide	01/21/2013	6:30 PM	Winter Weather	0	0	0
Countywide	01/25/2013	2:30 PM	Winter Weather	0	0	0
Countywide	01/28/2013	6:30 AM	Winter Weather	0	0	0
Countywide	02/01/2013	5:30 AM	Winter Weather	0	0	0
Countywide	02/02/2013	7:00 PM	Winter Weather	0	0	0
Countywide	03/25/2013	4:00 AM	Winter Weather	0	0	0
Countywide	12/08/2013	11:00 AM	Winter Weather	0	0	0
Countywide	12/10/2013	7:00 AM	Winter Weather	0	0	0
Countywide	12/14/2013	2:00 PM	Winter Weather	0	0	0
Countywide	01/02/2014	5:00 PM	Heavy Snow	0	0	0
Countywide	01/05/2014	5:00 AM	Winter Weather	0	0	0
Countywide	01/10/2014	6:00 AM	Winter Weather	0	0	0
Countywide	01/21/2014	9:00 AM	Heavy Snow	0	0	0
Countywide	01/25/2014	10:00 AM	Winter Weather	0	0	0

Location	Date	Time	Type	Deaths	Injuries	Property Damage
Countywide	01/28/2014	11:00 PM	Winter Weather	0	0	0
Countywide	02/03/2014	11:00 AM	Winter Weather	0	0	0
Countywide	02/04/2014	11:00 PM	Ice Storm	0	0	0
Countywide	02/09/2014	4:30 PM	Winter Weather	0	0	0
Countywide	02/12/2014	8:00 PM	Winter Storm	0	0	0
Countywide	02/15/2014	1:00 PM	Winter Weather	0	0	0
Countywide	02/18/2014	2:00 AM	Winter Weather	0	0	0
Countywide	02/26/2014	5:00 AM	Winter Weather	0	0	0
Countywide	03/03/2014	1:00 AM	Winter Storm	0	0	0
Countywide	03/16/2014	6:00 PM	Heavy Snow	0	0	0
Countywide	03/25/2014	2:00 PM	Winter Weather	0	0	0
Countywide	01/02/2014	5:00 PM	Winter Weather	0	0	0
			TOTALS	4	76	$5,350,000

Source: National Climatic Data Center

4.2.11 Coastal Erosion

An evaluation of erosion hazards in the United States was conducted as a collaborative project of The H. John Heinz III Center for Science, Economics and the Environment in April 2000, a study prepared for the Federal Emergency Management Agency (www.heinzcenter.org). The Heinz Center evaluation provides an assessment of coastal erosion and the potential loss of property along U.S. shorelines.

In 1990, the State of Delaware had an estimated 1,000 people living within 500 feet of the Atlantic shoreline, according to data derived from analyzing U.S. Census Block Groups. Sussex County, south of New Castle County and one of the 18 counties studied in The Heinz Center's evaluation, is known to experience an average annual erosion rate of three (3) to four (4) feet per year. And, according to the study, an estimated 25 percent of those homes within 500 feet of U.S. coastlines and Great Lakes coastlines are likely to be lost to erosion by 2060.

Figure 4.2-3 shows one Delaware community, South Bethany in Sussex County, and the expectation that the beach will erode inland approximately 60 feet over the next 60 years resulting in the hypothetical loss of three rows of housing.

Figure 4.2-3
The Heinz Center Evaluation of Erosion Hazards (Delaware)

A further, separate study of sea level and the resulting coastal erosion was not conducted as part of this Hazard Mitigation Plan Update. With regard to the sea level rise impact on flooding, the hazard and vulnerability analysis conducted for riverine and coastal flooding will suffice goes above and beyond all reasonable estimates of the sea level rise, and therefore creating mitigation actions that deal with periodic flooding will also benefit those areas vulnerable to sea level rise. With regard to the coastal erosion impacts, a separate analysis was conducted as part of the preparation of the report *Preparing for Tomorrow's High Tide: Sea Level Rise Vulnerability Assessment for the State of Delaware* in 2012. Many of the mitigation actions from that report from DNREC have been incorporated into this plan by reference.

4.2.12 Dam/Levee Failure

According to the National Inventory of Dams, there are 19 dams in New Castle County. Four (4) of these are considered to be High Risk, two (2) are Significant Risk and 13 are Low Risk. Overall, nearly 85 percent of the dams within the state are considered to be high or significant hazard facilities.

Dam hazard definitions, as accepted by the National Interagency Committee on Dam Safety, are as follows:

1. Low Hazard Potential — Dams assigned the low hazard potential classification are those where failure or misoperation results in no probable loss of human life and low economic and/or environmental losses. Losses are principally limited to the owner's property.

2. Significant Hazard Potential — Dams assigned the significant hazard potential classification are those dams where failure or misoperation results in no probable loss of human life but can cause economic loss, environment damage, disruption of lifeline facilities, or impact other concerns. Significant hazard potential classification dams are often located in predominantly rural or agricultural areas but could be located in areas with population and significant infrastructure.

3. High Hazard Potential — Dams assigned the high hazard potential classification are those where failure or misoperation will probably cause loss of human life.

Table 4.2-5
County Dam Hazard Data

Name of Dam	General Location	Owner	Year Built	Hazard Potential
Denoname12	Delaware River Offstream	N/A	N/A	Low
Denoname11	Delaware River Offstream	City Of Wilmington	N/A	Low
Denoname10	Delaware River Offstream	City Of Wilmington	N/A	Low
Denoname6	Mill Creek	N/A	N/A	Significant
Tailing Pond No.1 Dam,Getty Oil	Delaware River Offstream	Getty Oil	1960	Low
Tailings Pond No.2 Dam Getty Oil	Delaware River Offstream	Getty Oil	1960	Low
Wiggins Mill Pond Dam	Appoquinimink River	Retirement Living Inc.	1965	Low
Tailings Pond No.3 Dam,Getty Oil	Delaware River Offstream	Getty Oil	1960	Low
Silver Lake Dam	Deep Creek Appoquinimink	Delaware Department Of Transportation	1945	Low
Edgemoor Reservoir	Offstream Shellpot Creek	Wilmington Suburban Water Company	1908	High
Bellevue Lake Dam	Stoney Creek	Wilmington Suburban Water Corporation	1933	Low
Porter Reservoir	Offstream Matson Run	City of Wilmington	1909	High
Cool Spring Reservoir Dam	Brandywine	City of Wilmington	1878	High
Edgar M. Hoopes Dam	Old Mill Stream-Red Clay Creek	City of Wilmington	1931	High
Christiana Lake Dam	Christina River	Wilmington Suburban Water Corporation	1907	Low
Noxontown Pond Dam	Appoquinimink River	Delaware Department Of Transportation	1966	Low
Sunset Lake Dam	Muddy Run- Christina River	Newark Anglers Association	1900	Significant
Brandywine Creek Dam =9	Brandywine Creek	Bissell-Vinton Association,	1800	Low

Name of Dam	General Location	Owner	Year Built	Hazard Potential
		Inc.		
Canal Farms Dam	St George's Ck Offstream	Port Penn Hunting Club, Inc.	1995	Low
Newark Reservoir Dam	White Clay Creek	City of Newark	2005	N/A
Rock Manor Golf Course Dam	Matson Run	City of Wilmington	2007	N/A

Source: National Inventory of Dams, USACE

4.2.13 Earthquakes

According to the Delaware Geological Survey, 58 earthquakes have been impacted the State of Delaware during a period from 1638 through 2014. The greatest of these, in terms of the Modified Mercalli Intensity (MMI) scale for earthquakes, was the October 9, 1871 earthquake reported to have had an intensity of VII on the MMI scale in New Castle County. An event registering 7 would correspond to a ranking between 5.4 and 6.1 on the Richter Scale, and would be considered a "very strong" earthquake. The lower end of the spectrum for Delaware consists of several earthquakes classified as a II on the MMI scale, for instance the October 20, 1985 earthquake documented in the City of Wilmington in New Castle County. No damage estimates are currently available for these events. Also notable was the Virginia earthquake in 2011. Measured at a magnitude 5.8 and a MMI of VII, this earthquake's epicenter was located about 60 miles northeast of Richmond, Virginia but was felt over a very wide area, including New Castle County.

Table 4.2-6 lists all recorded earthquakes in the State of Delaware for the period 1638 through 2014, along with their intensity. For some events, the intensity appears as a range due to variations in distances across the impacted areas.

Table 4.2-6
Recorded Earthquakes in the State of Delaware (1638-2014)

Date of Occurrence	Felt Area	Modified Mercalli Intensity (If Known)
October 9, 1871	Wilmington	VII
March 25, 1879	Dover	IV-V
May 8, 1906	Seaford	IV
December 3, 1937	Georgetown	IV
January 8, 1944	Wilmington	< V
July 14, 1971	SW Wilmington	III-IV
December 29, 1971	SW Wilmington	IV-V
January 2, 1972	SW Wilmington	III-IV
January 2, 1972	SW Wilmington	III-IV
January 6, 1972	SW Wilmington	III-IV
January 22, 1972	SW Wilmington	III-IV
January 22, 1972	SW Wilmington	III-IV

Date of Occurrence	Felt Area	Modified Mercalli Intensity (If Known)
January 23, 1972	SW Wilmington	III-IV
February 10, 1972	ENE Newark	V
February 11, 1972	SW Wilmington	III
August 13, 1972	SW Wilmington	III-IV
August 13, 1972	SW Wilmington	III-IV
November 25, 1972	SW Wilmington	III-IV
November 27, 1972	SW Wilmington	III-IV
February 28, 1973	Entire State	V-VI
March 1, 1973	Claymont	I
March 2, 1973	Claymont	I
March 2, 1973	Claymont	I
March 3, 1973	Claymont	I
March 3, 1973	Claymont	I
March 3, 1973	Claymont	I
March 3, 1973	Claymont	I
July 10, 1973	Wilmington-Claymont	IV
April 28, 1974	Wilmington	V
February 10, 1977	Wilmington	V
June 5, 1977	Georgetown	-
August 2, 1977	Georgetown	-
February 25, 1980	Wilmington	I
November 17, 1983	Trolley Square area of Wilmington	V
November 17, 1983	Trolley Square area of Wilmington	-
December 12, 1983	NW Wilmington	IV
December 12, 1983	NW Wilmington	I-II
January 19, 1984	Wilmington	I-II
January 19, 1984	Wilmington	IV
February 15, 1984	N Wilmington	I-II
October 10, 1985	N Wilmington	III-IV
October 20, 1985	Wilmington	III-IV
November 8, 1993	Wilmington	I-II
February 11, 1994	Wilmington Area	II
April 23, 1994	Wilmington	II-III
October 16, 1995	Wilmington	I-II
October 17, 1995	Wilmington	II-III
December 20, 1995	Wilmington	I-II

Date of Occurrence	Felt Area	Modified Mercalli Intensity (If Known)
June 13, 1996	Wilmington	II-III
June 23, 1996	Wilmington	I-II
January 28, 1997	Wilmington	II
April 15, 1997	Wilmington	III-IV
March 15, 1998	Wilmington	III
March 19, 1998	Wilmington	I-II
March 19, 1998	Wilmington	III
October 27, 1998	Near Montchanin	II
August 13, 2003	Near Newark	II
April 9, 2005	North Wilmington	I-II

Source: Delaware Geological Survey

4.2.14 Landslides and Sinkholes

Landslides and sinkholes, discussed in the *Hazard Identification* section, were not analyzed in detail due to extremely low probability of occurrence within the State of Delaware.

4.2.15 Tsunami

Though tsunamis are more likely to affect Pacific Rim states, historical evidence does show that tsunamis have affected the Eastern United States and Gulf of Mexico, including Delaware. Forty tsunamis and tsunami-like waves have been documented in the Eastern United States since 1600. To cite one commonly referred to example in terms of Atlantic tsunamis, a severe earthquake (7.2 on the Richter Scale) on November 18, 1929 in the Grand Banks of Newfoundland generated a tsunami that caused considerable damage and loss of life at Placentia Bay, Newfoundland and is also known to have impacted upon the Maine shoreline to some degree. Due to the relatively low probability of a tsunami significantly impacting the State of Delaware, no further analysis or vulnerability assessment will be conducted for this hazard at this time.

4.2.16 Volcanoes

There are no active volcanoes in the State of Delaware, thus no historical evidence of volcanic eruption exists within the planning area. There is also no indication that this hazard is a significant enough threat to the state to warrant further analysis or a vulnerability assessment at this time.

4.2.17 Terrorism

Because of the relevantly recent, or heightened, focus being placed on managing terrorism and consequences of terrorism in the United States, no historical database is currently available for cataloging acts of terrorism. However, at the time of this Plan's development, no significant historical occurrences of terrorism were known to have taken place within the New Castle County planning area. Under a DHS Terrorism Preparedness Grant, New Castle County and others participate in the State's Preparedness Report and the Threat Identification and Risk Assessment

(THIRA) prepared for US Dept. of Homeland Security. This information is sensitive in nature and not included in this Plan.

4.2.18 Hazardous Materials (HazMat)

Table 4.2-7 shows Nuclear Regulatory Commission (NRC) data for New Castle County with regard to number of incidents, injuries, deaths and damages incurred as the result of hazardous materials incidents.

Table 4.2-7
NRC HazMat Data for New Castle County

Year	Type of Incident							Injuries	Fatalities	Damages
	Fixed	Mobile	Rail	Tank	Vessel	Pipeline	Other			
2009	36	6	4	12	11	0	1	1	4	0
2010	23	8	6	9	6	1	1	0	1	0
2011	59	5	10	8	8	1	3	1	3	$20,000
2012	29	5	10	15	7	1	2	9	1	$50,000
2013	25	4	9	12	7	1	1	2	4	0
Total	172	28	39	56	39	4	8	13	13	$70,000

4.2.19 Energy Pipeline Failures

A history of hazards is not currently available for energy pipeline failures in New Castle County.

4.2.20 Probability of Future Events in New Castle County

The final step of any hazard analysis is calculating the likelihood of future events. Given the number of events that have occurred in the past and the time period over which those events have occurred, one can calculate the number of events that occur per year. This gives a sense of the probability of future occurrences. The results of this calculation for New Castle County are presented in Table 4.2-8. For floods, the events that are tallied are generally nuisance events without a great deal of damage. The probability of a 100-year flood (and its predicted extent) is 1% in any given year. Earthquakes require a similar explanation. While 58 total events have taken place according to the historical record, only one of those was capable of causing any damage at all, however slight. Finally, there is no historical record of occurrence for several hazards.

4.2.21 University of Delaware Hazard Analysis Summary

While the University of Delaware has experienced hazard events, most recently significant snowfall in February 2010, damage to University assets has not been significant enough to necessitate tracking and monetization. In September 2003, the University weathered Tropical Storm Isabel and as a result had water intake in Gilbert Residence Hall. One of the oldest residence halls on the Main Campus in Newark, this facility was demolished in May 2010 to make way for a larger, more advanced residence hall that opened in the fall of 2013. The University did have costs associated with the snow storms of 2010, mostly snow removal costs, but there was no significant damage to property or facilities.

Based on the data analyzed, the conclusion of the Steering Committee is that the University has had no significant, traceable damage to facilities or assets in recent hazard events.

Table 4.2-8
Probability of Future Events (All Hazards)

Hazard	Number of Events	Time Period	Events per Year	Probability of Future Occurrence
Flood	182	1993 – 2014	8.67/0.0100	High/Low
Tropical Storm	24	1877 – 2014	0.175	Low
Severe Thunderstorm	347	1950 – 2014	5.42	High
Tornado	21	1950 –2014	0.33	Medium
Wildfire	3	1993 – 2014	0.14	Low
Drought	49	1995 – 2014	2.58	High
Extreme Temperature	95	1995 – 2014	5	High
Hail	53	1950 – 2014	0.83	Medium
Winter Storm	141	1993 – 2014	6.71	High
Coastal Erosion	Unknown	N/A	Unknown	Low
Dam Failure	Unknown	N/A	Unknown	Low
Earthquake	58 (1 MMI >= VI)	1871 – 2014	0.406/0.007	Medium/Low
Sinkhole/Landslide	Unknown	N/A	Unknown	Low
Tsunami	Unknown	N/A	Unknown	Low
Volcano	Unknown	N/A	Unknown	Low
Terrorism	Unknown	N/A	Unknown	Low
Hazardous Material Release	346	2009-2013	69.2	High
Energy Pipeline Failure	Unknown	N/A	Unknown	Low

Data Sources

The frequency and magnitude information about the hazards included in this analysis were compiled from the following sources:

American Society of Civil Engineers (ASCE), "Facts About Windstorms."
Web site: www.windhazards.org/facts.cfm

Bureau of Reclamation, U.S. Department of the Interior
Web site: www.usbr.gov

Federal Emergency Management Agency (FEMA)
Web site: www.fema.gov

National Climatic Data Center (NCDC), U.S. Department of Commerce, National Oceanic and Atmospheric Administration
Web site: http://lwf.ncdc.noaa.gov/oa/ncdc.html

National Geophysical Data Center, "Tsunamis and Tsunami-Like Waves of the Eastern United States"
Web site: http://www.ngdc.noaa.gov/seg/hazard/tsu.shtml

National Inventory of Dams, U.S. Department of the Interior
Web site: http://crunch.tec.army.mil/nid/webpages/nid.cfm

National Hurricane Center, National Oceanic & Atmospheric Administration (NOAA)
Web site: http://www.nhc.noaa.gov/http://www.nhc.noaa.gov/HAW2/english/history/opal_1995_map.gif

National Severe Storms Laboratory (NSSL), U.S. Department of Commerce, National Oceanic and Atmospheric Administration
Web site: www.nssl.noaa.gov

National Weather Service (NWS), U.S. Department of Commerce, National Oceanic and Atmospheric Administration
Web site: www.nws.noaa.gov

Storm Prediction Center (SPC), U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Weather Service
Web site: www.spc.noaa.gov

The Tornado Project, St. Johnsbury, Vermont
Web site: www.tornadoproject.com

United States Geological Survey (USGS), U.S. Department of the Interior
Web site: www.usgs.gov

4.3 VULNERABILITY ASSESSMENT

4.3.1 Introduction

High-level, detailed vulnerability assessments were completed for New Castle County for flood (riverine and coastal), severe winds (hurricanes and coastal storms), thunderstorms, tornadoes, drought, hail, winter storms, dam/levee failure, earthquakes, terrorism, hazardous materials and energy pipeline failures, due to the higher level of risk for these hazards compared to others. It is important to note that the risk assessments for the county are based on best available data and represent a base-level assessment for the planning area. Additional work will be needed on an ongoing basis to enhance, expand and further improve the accuracy of the baseline established here.

The loss estimates provided in this section have resulted in an *approximation* of risk. These estimates should be used to understand relative risk from hazards and potential losses. However, it is important to understand that uncertainties are inherent in any loss estimation methodology, arising in part from incomplete scientific knowledge concerning natural hazards and their effects on the built environment. Uncertainties also result from approximations and simplifications that are necessary for a comprehensive analysis (such as abbreviated inventories, demographics or economic parameters).

To conduct the risk assessment effort, two distinct hazard risk assessment methodologies were applied; utilizing both HAZUS-MH® version 2.2 (FEMA's loss estimation software) and a statistical risk assessment methodology. Both approaches provide estimates for the potential impact by using a common, systematic framework for evaluation.

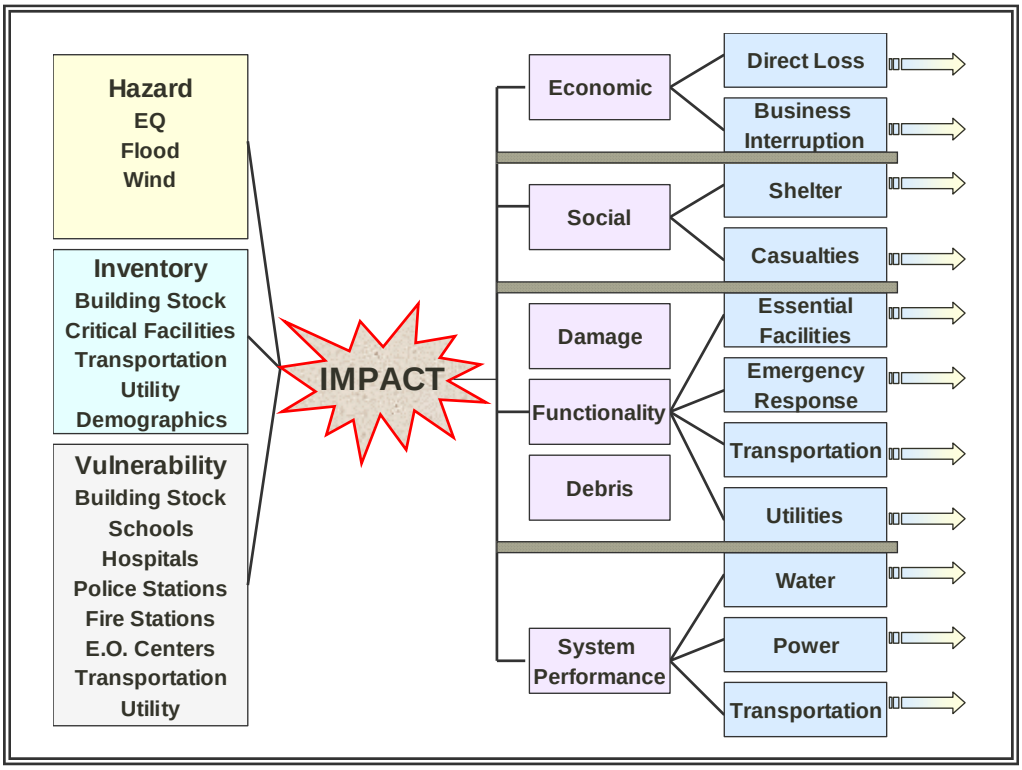
The HAZUS-MH risk assessment methodology is parametric, in that distinct hazard and inventory parameters (for example, wind speed and building types) were modeled using the HAZUS-MH software to determine the impact (damages and losses) on the built environment. The HAZUS-MH software was used to estimate losses from wind (hurricane and tornado) and flood hazards.

The second methodology, a statistical risk assessment methodology, was applied to analyze hazards of concern that are outside the scope of the HAZUS-MH software. The HAZUS-driven methodology uses a statistical approach and mathematical modeling of risk to predict a hazard's frequency of occurrence and estimated impacts based on recorded or historic damage information.

4.3.2 Explanation of HAZUS-MH Risk Assessment Methodology

HAZUS-MH is FEMA's standardized loss estimation software program, built upon an integrated geographic information system (GIS) platform (Figure 4.3-1). This risk assessment applied HAZUS-MH to produce regional profiles and estimate losses for three of the seven hazards addressed in this section: flood, hurricane winds and earthquake.

Figure 4.3-1
Conceptual Model of HAZUS-MH Methodology



4.3.3 Explanation of Regional Vulnerability Assessment Methodology

Vulnerabilities associated with other natural hazards were analyzed using a regional assessment methodology developed and used specifically for this effort. This approach is based on the principal that any spatially-nonspecific hazard event is essentially a random occurrence within a region and had just as much chance of occurring within the study area as outside. Historical data for each hazard are used and statistical evaluations are performed using manual calculations. The general steps used in the statistical vulnerability assessment methodology are summarized below:

- Buffer the study area to determine the regional assessment area;
- Compile hazard occurrence data for the regional area from national and local sources;
- Categorize hazard parameters for each hazard to be modeled (e.g., tornado);
- Calculate the annualized occurrence and loss estimates for each regional subdivision;
- Normalize the annualized occurrence and loss estimates by land area and number of housing units respectively; and
- Determine the overall regional average of annualized occurrence and loss

The economic loss results are presented here using two interrelated risk indicators:

1) The Annualized Loss (AL), which is the estimated long-term value of losses to the general building stock in any single year in a specified geographic area (i.e., county)

2) The Annualized Loss Ratio (ALR), which expresses estimated annualized loss as a fraction of the building inventory replacement value, also referred to as the total exposure to the hazard.

The estimated Annualized Loss (AL) addresses the two key components of risk: the probability of the hazard occurring in the study area and the consequences of the hazard, largely a function of building construction type and quality, and of the intensity of the hazard event. By annualizing estimated losses, the AL factors in historic patterns of frequent smaller events with infrequent but larger events to provide a balanced presentation of the risk.

The Annualized Loss Ratio (ALR) represents the AL as a fraction of the replacement value of the local building inventory. This ratio is calculated using the following formula:

"ALR = ANNUALIZED LOSSES / TOTAL EXPOSURE AT RISK"

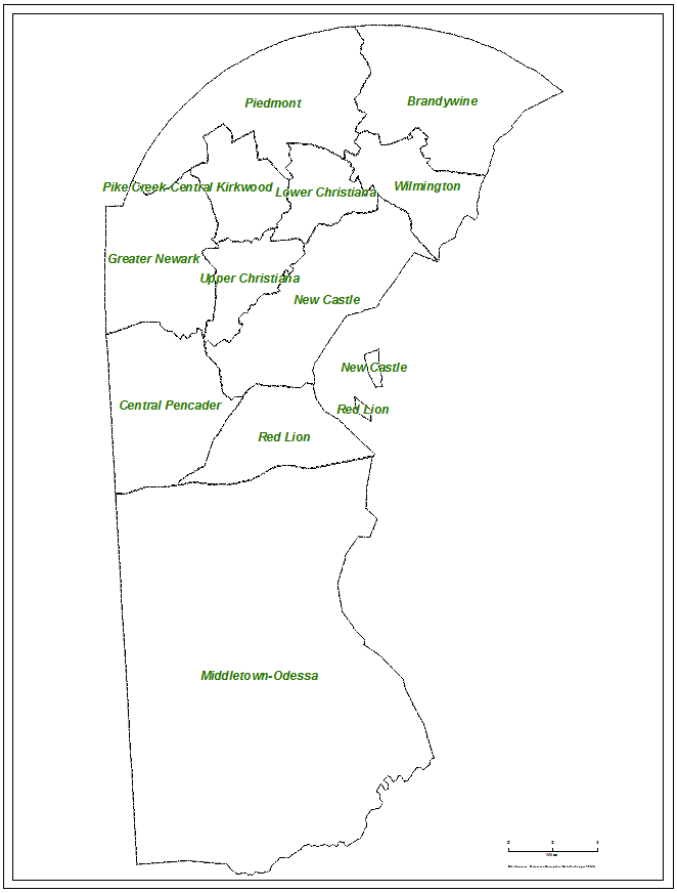
The annualized loss ratio gauges the relationship between average annualized loss and building replacement value. This ratio can be used as a measure of relative risk between areas and, since it is normalized by replacement value, it can be directly compared across different geographic units such as metropolitan areas or counties.

It is important to note that HAZUS-MH was used to produce "worst case scenario" results. The outputs in this document are considered to be the result of a worst case scenario event for each hazard, and it is understood that any smaller events which could occur would most likely create fewer losses than those calculated here.

Census County Divisions (CCDs)

Many of the tables presented in the Vulnerability Assessment use Census County Divisions (CCDs), which are defined by the US Census Bureau as areas delineated in cooperation with state, tribal, and local officials for statistical purposes. CCDs have no legal function and are not governmental units. CCD boundaries usually follow visible features and usually coincide with census tract boundaries. The name of each CCD is based on a place, county, or well-known local name that identifies its location (illustrated right). CCDs are recognized by the U.S. Census Bureau and are a national standard by which HAZUS-MH results are prepared (due in part to the reliance of HAZUS on U.S. Census data.)

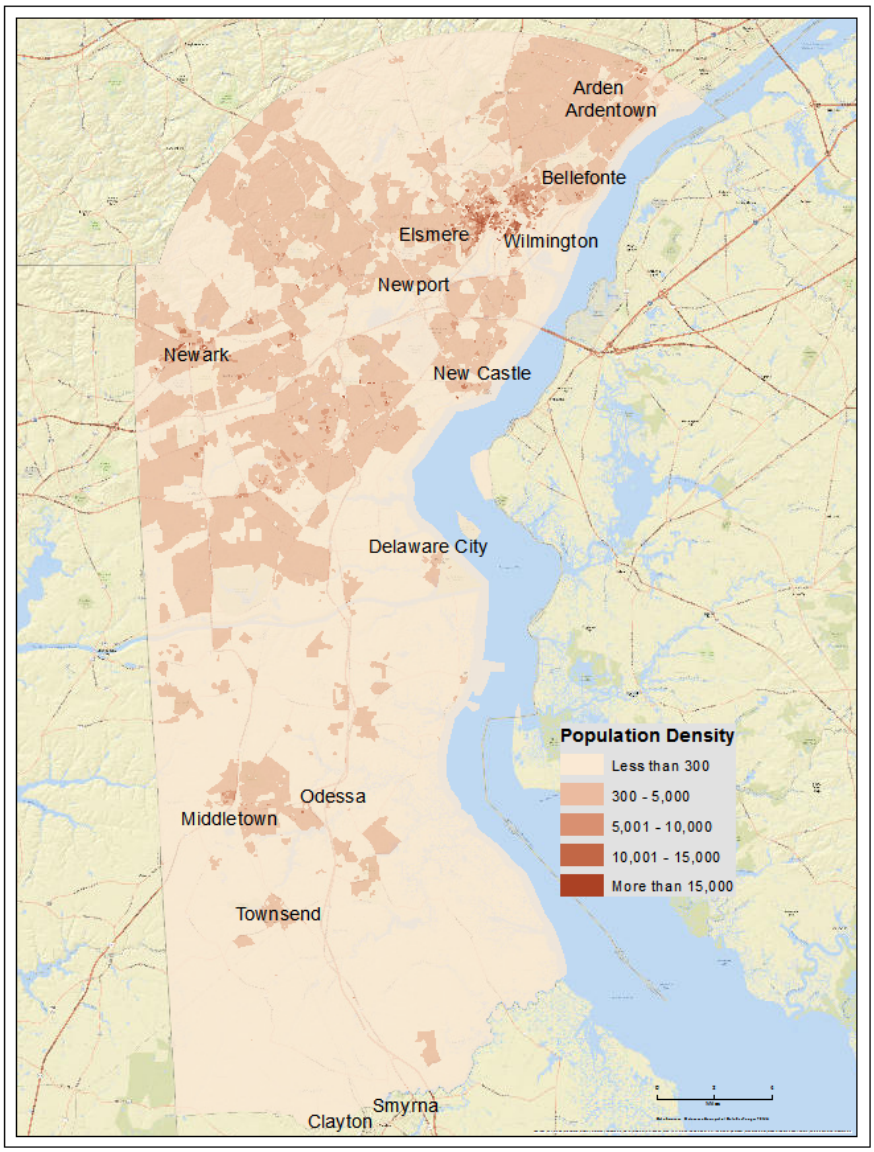
In the studies conducted for New Castle County, cities—such as Wilmington and New Castle for example—are separated from the CCDs in jurisdiction-level analyses. This was done in order to provide a more detailed cross section of the planning area and eliminate tendencies to double-count available information.



New Castle County Overview

According to the U.S. Census Bureau, the total population of New Castle County in 2010 was 538,479. (The total population in 2010 for the state of Delaware as a whole was 897,934.) The population of New Castle County grew 7.2% from 2000. The most densely populated areas of the county are in the northern half, particularly in and around the City of Wilmington (Figure 4.3-3)

Figure 4.3-2
Population Distribution (U.S. Census 2010)



The latest value from HAZUS-MH of total dollar exposure within New Castle County is estimated to be approximately $74,602,783,000. This modeled estimate consists of single-family residential buildings, multi-family residential buildings and commercial facilities. Fortunately, for the flood vulnerability analysis, actual tax parcel boundaries and their assessed valuations were available to be used. Using the data from the New Castle County Government, the actual total dollar exposure in the county is $17,681,893,434. It was the consensus of the Steering Committee, however, that the assessed valuations are, in some cases, considerably lower than the actual market value of the property. A sampling of parcel values in the county compared to market values from Zillow.com yields a multiplier of between 3.0 and 3.3 from assessed to market values. Using the most conservative estimate, an actual total dollar exposure value of $53 billion may be more accurate.

Development Trends

The resident population of the State of Delaware is projected to increase from 899,673 in 2010 to approximately 1,068,155 by 2040 (Delaware Population Consortium, October 2014). From April 1, 2000 to April 1, 2010, Delaware's rate of population change was 14.6% and rate of change in housing units was 18.3% (U.S. Census Bureau). These trends demonstrate that Delaware's population is increasing, and consequently the number of residential structures and the associated exposure of residential buildings will increase as well. Assuming a multiplier of 1.008[1], the total residential exposure of New Castle County could reach an estimated dollar value of $19,148,470,494 by 2025. This estimate does not of course take into account many other development factors, such as available land for new residential construction. Future Plan updates will address development trends in more detail, in particular for hazards with a physical hazard boundary (i.e., flood, storm surge, etc.). Once a year, the County Planner and Floodplain Coordinator will meet to discuss current and emerging development trends. The Steering Committee will also review these trends during the annual update and determine if additional mitigation actions need to be added to address these trends.

Critical Facilities

For the purposes of this risk assessment, the label "critical facility" refers to five categories of locations that will be very important during the response and recovery phase of a hazard event. Those categories are: Medical Care Facilities, Emergency Operations Centers, Fire Departments, Police Departments and Schools. According to HAZUS-MH 2.2, there are a total of 261 critical facilities in New Castle County, Delaware. Additionally, the University of Delaware defines their critical facilities in the UD Disaster Resistant University Hazard Mitigation Plan of 2011 as "public facilities that are vital to maintaining or restoring normal University services in the wake of a disaster, a facility that stores hazardous material, or a facility that houses a large number of occupants (p. 74)."

Specific information on the analysis of these buildings can be found in Appendix 1 of the UD Disaster Resistant University Hazard Mitigation Plan of 2011. The University of Delaware determined which buildings would be assessed based on building use, probability of a hazard affecting the facility and the impact on the facility. Perkins Student Center, the Public Safety Building, laurel Hall, and Facilities Operations buildings are strategic buildings that would affect the overall operations and infrastructure of the University (the student center is the main Emergency Operations Center). Any building with infant, pre-school, and school-age children were included as well as general use laboratories.

[1] Based on the percent change in housing units for a two-year period and weighted for New Castle County.

Table 4.3-1
University of Delaware Critical Facilities

Campus	Building ID	Building Name	Building Use	Construction Date	Square Footage	Estimated Capactiy
Wilmington	1	Arsht Hall	Academic	1992	42,000	1,356
Newark Main	4	Public Safety 413 Academy	Public Safety	2001	28,000	280
Newark Main	5	Facilities Operations	Facilities	1929	25,755	258
Newark Main	6	Perkins Student Center	Student Services	1957	157,981	1,580
Newark Main	7	McKinley Lab	Research / Academic	1978	118,235	1,180
Newark Main	8	Laurel Hall	Health Services	1955	27,265	118
Newark Main	9	Morris Library	Library	1963	274,095	2,741
Newark East	10	Materials and Management Facility	Materials Storage	1991	2,195	22
Newark East	11	Early Learning Center	Child Care		27,010	540
Newark East	12	Lab School / College School	Elementary School	1990	11,659	540
Newark East	13	Computing Services	Administrative	1977	29,607	156
Newark East	14	Institute for Energy Conversion	Research	1982	40,000	261
Newark South	15	Townsend Hall	Academic	1950	90,000	580
Newark North	16	Christiana Towers	Residential	1972		1,328
Newark North	17	Clayton Hall	Conference / Administrative	1972	63,386	3,632

Flood

In May 2014, FEMA released a new coastal flood study of New Castle County, complete with a 1% chance per year depth grid that was created with state-of-the-art methods. Because this data was available and determined by the Hazard Mitigation Plan Update Steering Committee to be authoritative, it was directed to be used as the basis for the flood vulnerability assessment. Because only coastal flooding depths were predicted in the May 2014 study, additional analysis was conducted, using the HAZUS-MH Flood Information Tool and the Digital Flood Insurance Rate Maps, to calculate the predicted depths from a 1% chance per year riverine flooding event. Unfortunately, only a 1% chance per year flood depth grid was available, rather than the typical range of various return periods.

Because the actual property parcels with assessed values were available from New Castle County, there was an opportunity to examine the potential damage from flooding at the parcel level, rather than the census tract level available in HAZUS-MH. The GIS process used to accomplish this is:

1. Select all of the property parcels in New Castle County that intersect the 1% chance per year flood extent.

2. Reduce the assessed value of the parcel's structures by the percentage that the parcel is flooded. This assumes that the impact of a flood would be even across a parcel. This is a best practice in GIS analysis generally when the specific configuration of buildings on a parcel is not known.
3. Convert the raster flood depth grid into polygons for every 6" of flood depth.
4. For each property parcel, determine the flood depth polygon with the greatest intersecting area. In other words, pick the flood depth polygon value that intersects each property parcel the most.
5. Using the type of property, assume the height of the building foundation and remove this value from the flood depth. For example, if a parcel is predicted to be flooded by 3 ft of water in a 1% chance per year scenario, and the primary structure is assumed to have an 18 inch foundation (crawl space), then one can assume 1.5 ft of flood water impacting the structure.
6. Finally, use the depth-damage curves from HAZUS-MH to relate the depth of the floodwater to the percent damaged. This damage percent, for both the building and its content, is multiplied by the reduced assessed value to calculate the estimated damage amount.

The result of this process is parcel-based map of the potential flood damage from both riverine and coastal flood events in New Castle County. This parcel-based vulnerability map may now be used to identify which properties are the most at risk from flooding in the County, what are their characteristics, and whom to contact to discuss potential mitigation options. It could also now be used to track the change in vulnerability over time as either the data regarding individual properties improves, or more up-to-date assessment valuations are considered.

Approximately 21.3% of New Castle County land area falls within the 1% chance per year flood zone (Figure 4.3-3). Also, 7.532 out of 193,425 property parcels (3.9%) intersect the flood zone. The predicted depth of flood water is between 0 and 59.9 ft (Figure 4.3-4). However, the upper end of the predicted depths includes portions of the grid that lie just inside the boundary of the Chesapeake & Ohio Canal or the Port of Wilmington, exaggerating the depths. The deepest values on land are found in the southern coastal part of the county and average about 7 ft deep.

Figure 4.3-3
FEMA 1% chance per year Flood Zone in New Castle County

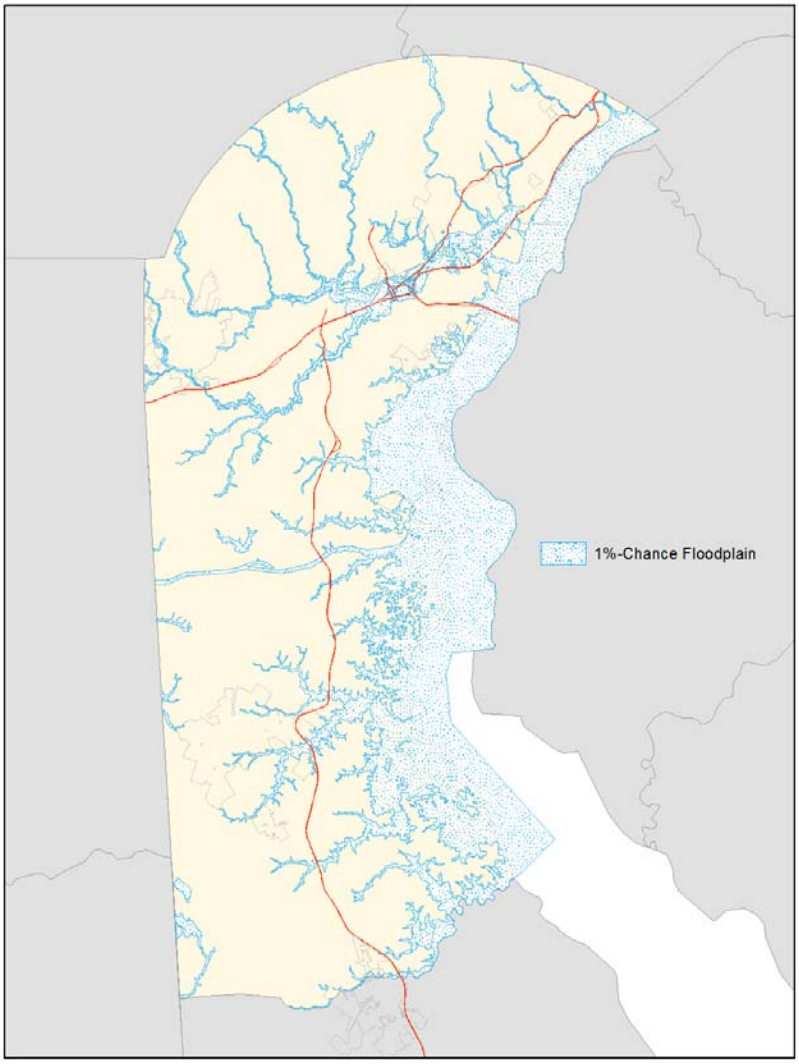
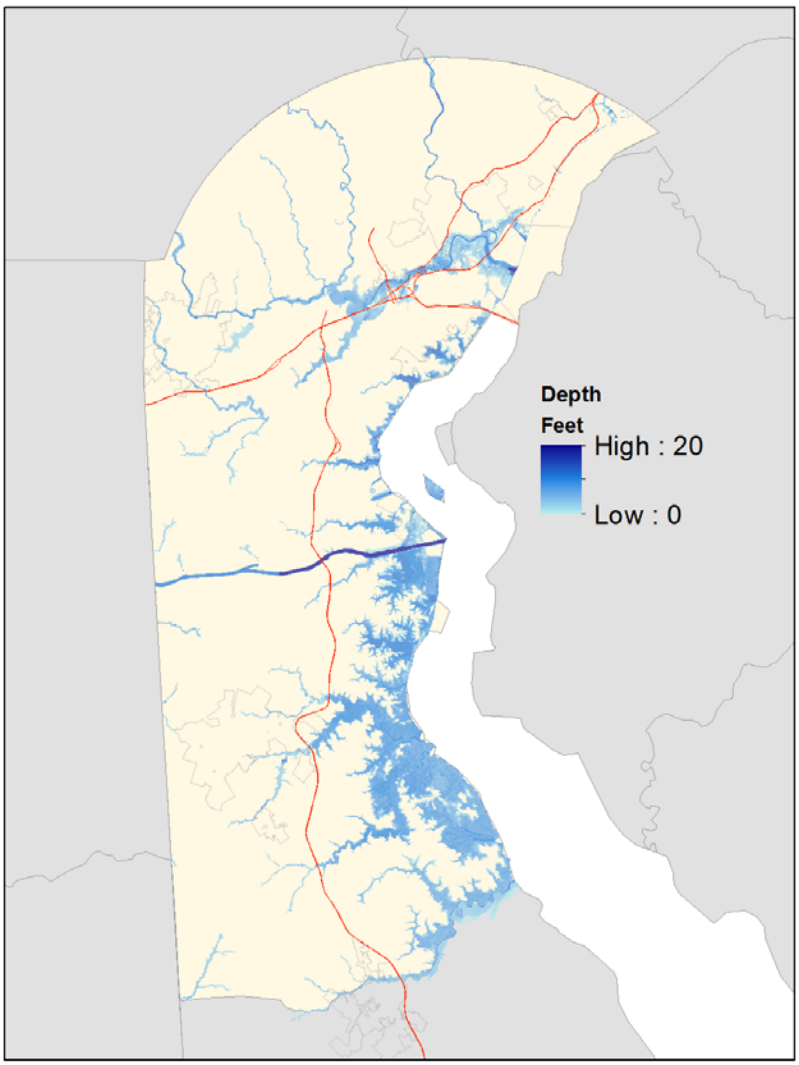


Figure 4.3-4
FEMA 1% chance per year Flood Depth in New Castle County

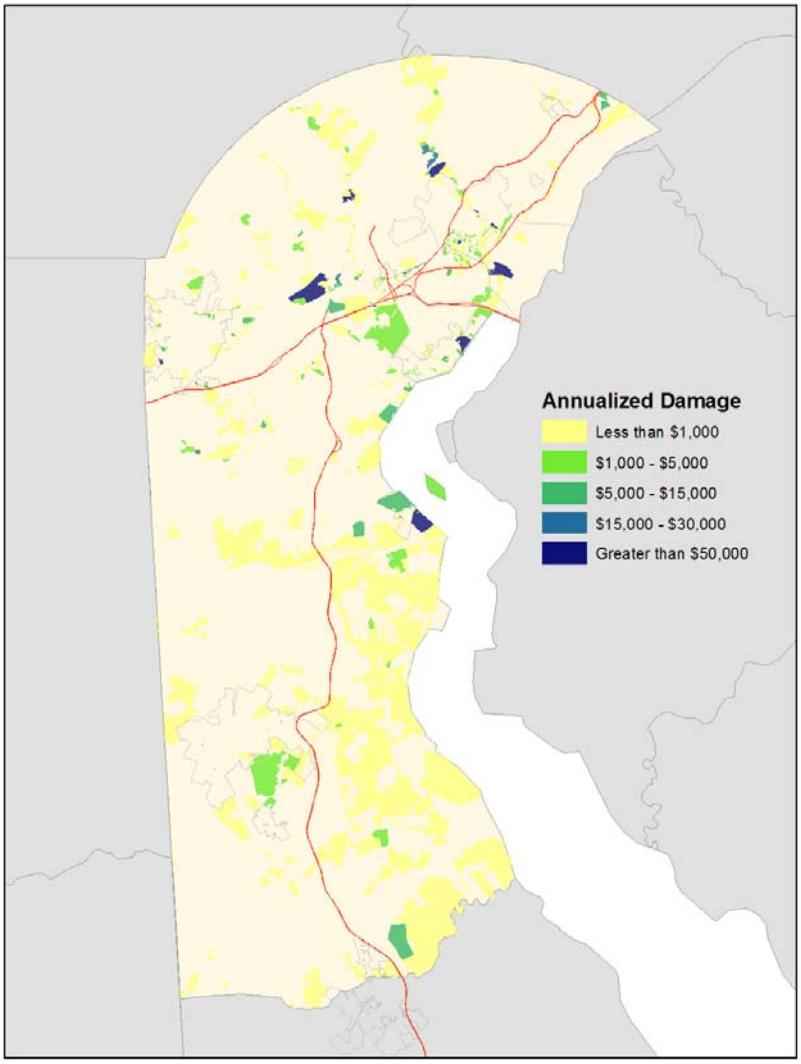


The total built property exposure (both building and contents) in the county is $463,917,051 (Table 4.3-2). The total estimated annualized losses equal $2,118,163, yielding a loss ratio of 0.0046. Loss ratios in the county's municipalities range from 0.0037 in Delaware City to 0.0434 in Newport. Among the CCDs, Piedmont is most vulnerable to flooding (0.0072). Again, this analysis has only used a 1% chance per year flood; including the 10%, 4%, 2%, and 0.2% chance per year flood depths would increase the loss ratio significantly.

Table 4.3-2
Potential Annualized Losses from Flood by Jurisdiction

Jurisdiction	Total Exposure	Estimated Losses	Loss Ratio
Arden	$20,613	$85	0.0041
Ardencroft	---	---	---
Ardentown	$64,920	$350	0.0054
Bellefonte	---	---	---
CCD Brandywine	$12,002,336	$79,340	0.0066
CCD Central Pencader	$17,293,948	$54,530	0.0032
CCD Greater Newark	$36,335,978	$115,606	0.0032
CCD Lower Christiana	$7,725,031	$25,744	0.0033
CCD Middletown-Odessa	$19,709,192	$107,342	0.0054
CCD New Castle	$41,095,783	$185,869	0.0045
CCD Piedmont	$13,487,179	$98,068	0.0072
CCD Pike Creek-Central Kirkwood	$19,281,133	$112,527	0.0058
CCD Red Lion	$13,875,426	$74,101	0.0053
CCD Upper Christiana	$10,241,926	$63,162	0.0062
CCD Wilmington	$1,206,506	$999	0.0008
Clayton	---	---	---
Delaware City	$10,175,797	$37,438	0.0037
Elsmere	---	---	---
Middletown	$431,498	$1,664	0.0039
New Castle	$31,438,553	$179,271	0.0057
Newark	$31,330,022	$115,388	0.0057
Newport	$904,979	$39,274	0.0434
Odessa	$54,461	$257	0.0047
Smyrna	$321,035	$2,178	0.0068
Townsend	$60,558	$410	0.0068
UD Wilmington Campus	---	---	---
UD Newark Campus	$204,100	$184	0.0009
Wilmington	$188,722,177	$760,502	0.0040
TOTAL	$463,917,051	$2,118,163	0.0046

Figure 4.3-5
Losses per Parcel from 1% chance per year Flood in New Castle County



Another means of gauging the vulnerability within New Castle County to flooding was determined to be the vulnerability of critical facilities to the 1% chance per year flood return periods. Within the county, 261 critical facilities were assessed with regard to flood risk (Table 4.3-3). In summary, during a 1% chance per year flood event, only 2 facility (Delaware City Fire Station #15 and the Governor Bacon Health Center in Delaware City) are predicted to sustain slight damage (1 to 5 percent damage) and 3 facilities (St. Peter Catholic School and Multiple Alterative Program School in New Castle and Elbert-Palmer Intermediate School in Wilmington) are predicted to sustain moderate damage (5 to 30 percent damage). Additionally, the UD Newark campus has 2 critical facilities subject to flood, namely Townsend Hall and Morris Library.

Table 4.3-3
Potential Damage to Critical Facilities from Flood by Jurisdiction

Jurisdiction	Total Number of Critical Facilities	100-year Flood		
		Moderate Damage*	Slight Damage	Negligible Damage
Arden	N/A	N/A	N/A	N/A
Ardencroft	N/A	N/A	N/A	N/A
Ardentown	N/A	N/A	N/A	N/A
Bellefonte	2	0	0	0
Clayton	N/A	N/A	N/A	N/A
Delaware City	2	0	2	0
Elsmere	4	0	0	0
CCD Brandywine	41	0	0	0
CCD Central Pencader	10	0	0	0
CCD Greater Newark	16	0	0	0
CCD Lower Christiana	14	0	0	0
CCD Middletown-Odessa	5	0	0	0
CCD New Castle	28	0	0	0
CCD Piedmont	17	0	0	0
CCD Pike Creek-Central Kirkwood	20	0	0	0
CCD Red Lion	5	0	0	0
CCD Upper Christiana	12	0	0	0
CCD Wilmington	2	0	0	0
Middletown	9	0	0	0
New Castle	6	2	0	0
Newark	13	0	0	0
Newport	3	0	0	0
Odessa	1	0	0	0
Smyrna	N/A	N/A	N/A	N/A
Townsend	N/A	N/A	N/A	N/A
UD Wilmington Campus	1	0	0	0
UD Newark Campus	16	0	1	1
Wilmington	48	1	0	0
TOTAL	261	3	3	1

*Moderate: 5 to 30 percent damage, Slight: 1 to 5 percent damage, Negligible: less than 1 percent damage

A repetitive loss property is an NFIP-insured property that has had at least four paid flood losses of more than $1,000, or has had two paid flood losses within 10 years that, in aggregate, equal or exceed the value of the property, or has had three or more paid losses that, in aggregate, equal or exceed the value of the property. Addressing repetitive loss properties through the implementation of specific mitigation projects represent one of the most effective ways to reduce future flood losses. Table 4.3-4 contains a tally of the number of repetitive loss properties in the County and individual municipalities, the number of flood insurance policies currently in force (as of June 30, 2013), and the percentage of current policies that represent repetitive loss properties. Of the nine repetitive loss properties in New Castle County, seven are single-family residential properties, one is a multi-family residential property, and one is a non-residential property. The one repetitive loss property in the City of New Castle is a single-

family residential property. Table 4.3-5 contains the same information but for the severe repetitive loss properties in New Castle. A severe repetitive loss property is one that has had at least four claim payments greater than $5,000, or the cumulative amount of the four payments exceeds $20,000, or has had two cumulative claim payments that exceed the value of the property. Of the 16 severe repetitive loss properties in New Castle County, four are single-family residential properties and 12 are non-residential properties. Both of the severe repetitive loss properties in the Town of Elsmere and the City of Wilmington are non-residential properties. The location of the repetitive loss properties can be found in Figure 4.3-6.

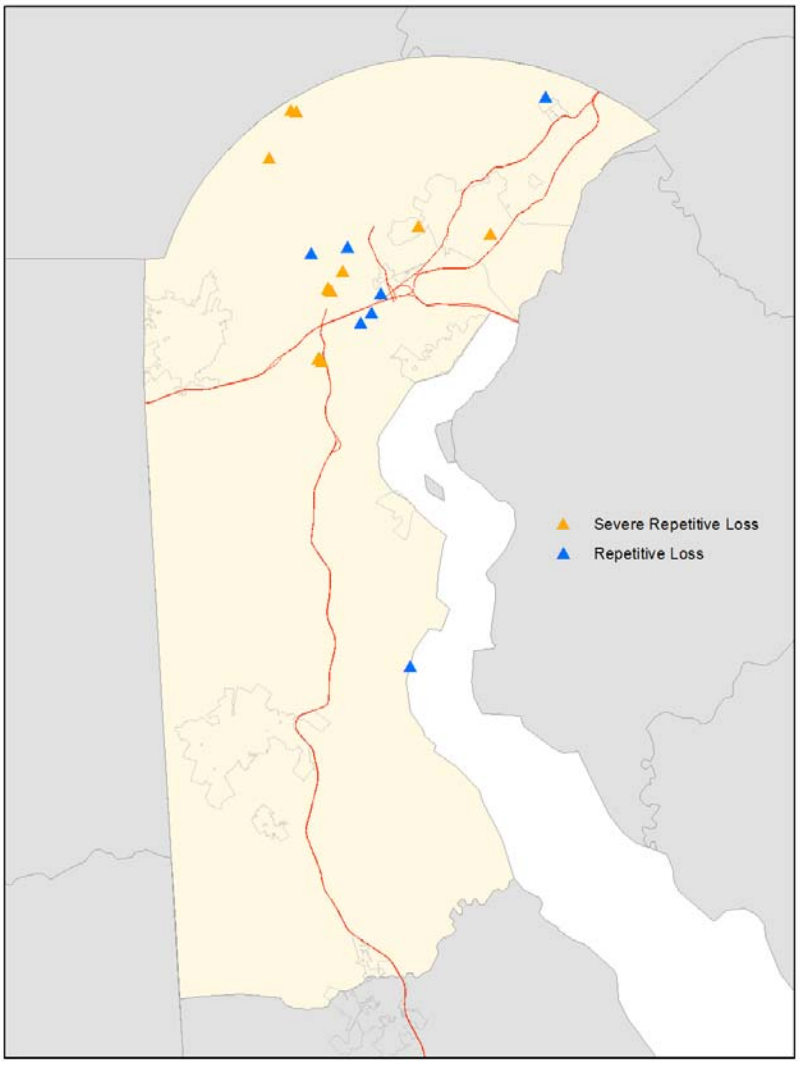
Table 4.3-4
Repetitive Loss Properties as of June 30, 2013

Jurisdiction	Number of Properties	Total Number of Policies per Jurisdiction	Total Payments	Average Payment per Claim
New Castle County	9	1,789	$1,229,427	$61,471
City of New Castle	1	243	$152,234	$76,117

Table 4.3-5
Severe Repetitive Loss Properties as of June 30, 2013

Jurisdiction	Number of Properties	Total Number of Policies per Jurisdiction	Total Payments	Average Payment per Claim
New Castle County	16	1,789	$17,548,034	$147,463
Town of Elsmere	1	129	$197,518	$49,379
City of Wilmington	1	848	$784,250	$37,345

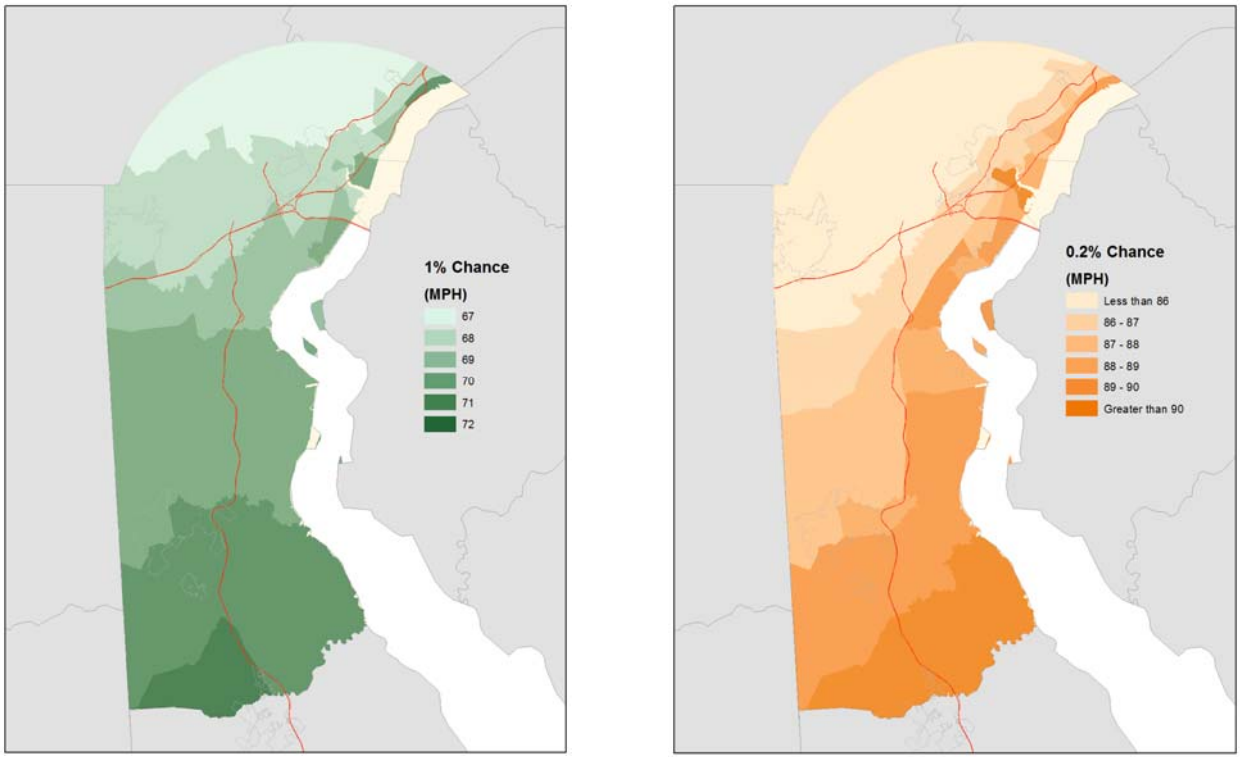
Figure 4.3-6
Repetitive Loss Properties in New Castle County as of June 30, 2013



Coastal Wind

Historical evidence shows that the State of Delaware is vulnerable to severe, hurricane and tropical storm-force winds. The approach for determining vulnerability to coastal winds included a number of factors. HAZUS-MH was used for wind speed data as well as an inventory and in-house damage functions, which were used in estimating losses. The potential hurricane wind gusts that could affect the area range from 67 to 72 mph for a 1% chance per year event to 85 to 91mph for a 0.2% chance per year event, with the stronger winds being in the southern and eastern quadrants of the county (Figure 4.3-7).

Figure 4.3-6
Potential Hurricane Wind Gusts for 1% and 0.2% per year Wind Events



Modeled from HAZUS-MH, the total built property exposure to coastal winds (both building and contents) in the county is $122,795,802,000 (Table 4.3-7). Comparing this to the total building assessed value from the County's property data (around $17 billion), it seems that HAZUS-MH's estimates of exposure are quite a bit higher than one would expect. Thus, the total estimated annualized losses of $4,025,139 need to be understood in context as also being extraordinarily elevated. The standardized loss ratio of 0.000033 (or 100x less potential annual damage from wind as flooding) makes more sense given historical loss records. Loss ratios in the county's municipalities range from 0.000021 in Wilmington to 0.000079 in Townsend. Among the CCDs, Middletown-Odessa is most vulnerable to coastal wind (0.000068).

Table 4.3-7
Potential Annualized Losses from Hurricane Winds by Jurisdiction

Jurisdiction	Total Exposure	Estimated Losses	Loss Ratio
Arden	$135,669,188	$3,601	0.000027
Ardencroft	$47,922,219	$1,272	0.000027
Ardentown	$148,210,674	$4,247	0.000029
Bellefonte	$134,744,469	$6,564	0.000049
CCD Brandywine	$19,126,064,153	$528,892	0.000028
CCD Central Pencader	$8,234,081,785	$369,098	0.000045
CCD Greater Newark	$8,694,846,990	$224,189	0.000026
CCD Lower Christiana	$6,362,702,756	$184,112	0.000029
CCD Middletown-Odessa	$8,405,063,364	$571,877	0.000068
CCD New Castle	$14,362,687,844	$519,608	0.000036
CCD Piedmont	$8,425,132,906	$271,588	0.000032
CCD Pike Creek-Central Kirkwood	$8,949,241,553	$258,582	0.000029
CCD Red Lion	$1,753,258,036	$89,372	0.000051
CCD Upper Christiana	$6,663,834,728	$209,675	0.000031
CCD Wilmington	$113,754,523	$3,233	0.000028
Clayton	$4,837,479	$295	0.000061
Delaware City	$78,845,891	$3,801	0.000048
Elsmere	$966,705,845	$26,348	0.000027
Middletown	$1,660,306,406	$96,048	0.000058
New Castle	$1,539,178,937	$65,009	0.000042
Newark	$3,282,505,923	$78,213	0.000024
Newport	$260,847,194	$6,627	0.000025
Odessa	$139,482,226	$7,968	0.000057
Smyrna	$18,931,451	$1,175	0.000062
Townsend	$37,032,229	$2,933	0.000079
UD Wilmington Campus	$112,020,854	$2,337	0.000021
UD Newark Campus	$1,822,479,960	$43,425	0.000024
Wilmington	$21,306,880,643	$444,493	0.000021
TOTAL	$122,795,802,000	$4,025,139	0.000033

Another means of gauging the vulnerability within New Castle County to coastal wind was the vulnerability of critical facilities to the 1% chance per year and 0.2% chance per year wind return periods. During a 1% chance per year wind event, no critical facilities had more than a 50% chance of sustaining minor, moderate, or severe damage. In a 0.2% chance per year wind event, 5 facilities have a better than 50% chance of sustaining severe (10 to 50% damage, namely Alfred I DuPont Hospital in the Brandywine area, Delaware Psychiatric Center in the New Castle area, Christiana Hospital in the Upper Christiana area, and Wilmington Hospital and St. Francis Hospital in the City of Wilmington (Table 4.3-8).

Table 4.3-8
Potential Damage to Critical Facilities from Hurricane Winds by Jurisdiction[2]

Jurisdiction	Total Number of Critical Facilities	1% chance per year Wind			0.2% chance per year Wind		
		> 50 % Chance of Minor Damage	> 50 % Chance of Moderate Damage	> 50 % Chance of Severe Damage	> 50 % Chance of Minor Damage	> 50 % Chance of Moderate Damage	> 50 % Chance of Severe Damage
Arden	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Ardencroft	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Ardentown	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Bellefonte	2	0	0	0	0	0	0
Clayton	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Delaware City	2	0	0	0	0	0	0
Elsmere	4	0	0	0	0	0	0
CCD Brandywine	41	0	0	0	0	0	1
CCD Central Pencader	10	0	0	0	0	0	0
CCD Greater Newark	16	0	0	0	0	0	0
CCD Lower Christiana	14	0	0	0	0	0	0
CCD Middletown-Odessa	5	0	0	0	0	0	0
CCD New Castle	28	0	0	0	0	0	1
CCD Piedmont	17	0	0	0	0	0	0
CCD Pike Creek-Central Kirkwood	20	0	0	0	0	0	0
CCD Red Lion	5	0	0	0	0	0	0
CCD Upper Christiana	12	0	0	0	0	0	1
CCD Wilmington	2	0	0	0	0	0	0
Middletown	9	0	0	0	0	0	0
New Castle	6	0	0	0	0	0	0
Newark	13	0	0	0	0	0	0
Newport	3	0	0	0	0	0	0
Odessa	1	0	0	0	0	0	0
Smyrna	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Townsend	N/A	N/A	N/A	N/A	N/A	N/A	N/A
UD Wilmington Campus	1	0	0	0	0	0	0
UD Newark Campus	16	0	0	0	0	0	0
Wilmington	48	0	0	0	0	0	2
TOTAL	261	0	0	0	0	0	5

Based on previous disaster data, no critical facilities on either of the University's campuses have had damage from tropical storm force winds. However, the analysis from the UD Disaster Resistant University Hazard Mitigation Plan

[2] The definitions used are as follows. Minor: less than 2 percent damage. Moderate: 3 to 10 percent damage. Severe: 10 to 50 percent damage.

determined that all 17 of the critical facilities assessed may in fact be susceptible to high winds due to construction type, exterior features (such as canopies, chimneys, stairs, wall-mounted lights) of rooftop equipment.

Tornado

Historical evidence shows that New Castle County is vulnerable to tornadic activity. This particular hazard may result from severe thunderstorm activity or may occur during a tropical storm or hurricane. Because it cannot be predicted where a tornado may touch down, all buildings and facilities are considered to be exposed to this hazard and could potentially be impacted. It is also not possible to estimate the number of residential, commercial, and other buildings or facilities that may experience losses.

Therefore, the approach to determining the County's vulnerability to a tornado is to examine not just tornado events in the County boundary, but to look at all of the events of the neighboring counties within 25 miles of the boundary of the County as well. A tornado that impacts Cecil County, MD (to the west of New Castle County) could have just as easily impacted New Castle County instead. The actual location of the tornado at this scale of analysis is simply a matter of luck rather than any of the County's unique geographical factors. Because the neighboring jurisdictions are of differing sizes and densities, the results for must be scaled appropriately. For example, Kent County had 0.4 tornado events per year, compared to New Castle County's 0.38 events per year. But, Kent County is bigger than New Castle – one would expect the larger county to have more tornado events. In fact, New Castle County is 61.7% the size of Kent County. Therefore, a county the size of Kent would have been impacted by 0.25 events per year if the county had been the same size as New Castle. The annualized losses are scaled similarly, but use numbers of housing units as a proxy for differences in building exposure.

Table 4.3-9 shows the number of events in New Castle County and those counties within 25 miles of New Castle County. Table 4.3-10 shows the number of annual events and the amount of annual loss in New Castle County and those counties within 25 miles of the County after the appropriate scale factor has been applied. Table 4.3-11 shows annualized expected losses from tornado events by jurisdiction within New Castle County. The total estimated annualized losses for the county equal $188,607 or a loss ratio of 0.000011.

Table 4.3-9
Potential Annualized Losses from Tornadoes

Jurisdiction	Events	Losses	Years	Annual Events	Annual Loss
New Castle County	23	$7,413,000	60	0.38	$123,550
Kent County, DE	20	$5,158,000	50	0.40	$103,160
Cecil County, MD	14	$3,355,000	47	0.30	$71,383
Kent County, MD	4	$503,000	64	0.06	$7,859
Chester County, PA	26	$13,008,000	61	0.43	$213,246
Delaware County, PA	4	$5,300,000	41	0.10	$129,268
Salem County, NJ	4	$750,000	54	0.07	$13,889
Gloucester County, NJ	9	$675,000	54	0.17	$12,500
TOTAL	13.0	$4,520,250	53.9	0.24	$84,357

Table 4.3-10
Normalized Occurrences and Losses from Tornadoes

Jurisdiction	Annual Events	Area Scale Factor	Scaled Events	Annual Loss	HU Scale Factor	Scaled Annual Loss
New Castle County	0.38	1.000	0.38	$123,550	1.000	$123,550
Kent County, DE	0.40	0.617	0.25	$103,160	3.329	$343,421
Cecil County, MD	0.30	1.181	0.35	$71,383	5.292	$377,748
Kent County, MD	0.06	1.191	0.07	$7,859	20.619	$162,046
Chester County, PA	0.43	0.650	0.28	$213,246	1.130	$241,000
Delaware County, PA	0.10	2.587	0.26	$129,268	0.976	$126,142
Salem County, NJ	0.07	1.325	0.09	$13,889	7.933	$110,188
Gloucester County, NJ	0.17	1.465	0.25	$12,500	1.981	$24,763
TOTAL	0.24	1.252	0.24	$84,357	5.283	$188,607

The location and magnitude of past tornado events within the county, in relation to population density, is presented in Figure 4.3-8.

Drought

Although the State of Delaware as a whole is vulnerable to drought, estimated potential losses are somewhat difficult to calculate because drought causes little damage to the built environment, mostly affecting crops and farmland. Therefore, it is assumed that all buildings and facilities are exposed to drought but would experience negligible damage in the occurrence of a drought event.

The approach used to determine vulnerability within New Castle County consisted of a number of factors. Statistical data for the past 100 years from the University of Nebraska, developed based on Palmer Drought and Crop Severity Indices, was analyzed. Drought event frequency/impact was then determined for New Castle County. Also used was USDA agriculture data from 1997. Drought impact on the non-irrigated agriculture products profile was then determined. Table 4.3-12 shows annualized expected losses from drought events by jurisdiction within New Castle County. The total estimated annualized losses for the county equal $58,824 and an annualized loss ratio of 0.004.

Table 4.3-11
Potential Annualized Losses from Tornadoes by Jurisdiction

Jurisdiction	Total Exposure	% of Total Exposure	Estimated Losses
Arden	$11,567,574	0.065	$123
Ardencroft	$5,103,988	0.029	$55
Ardentown	$7,066,279	0.040	$75
Bellefonte	$24,569,935	0.139	$262
CCD Brandywine	$2,806,719,294	15.875	$29,941
CCD Central Pencader	$1,122,990,192	6.352	$11,980
CCD Greater Newark	$1,052,191,261	5.951	$11,224
CCD Lower Christiana	$811,440,151	4.590	$8,657
CCD Middletown-Odessa	$930,360,422	5.262	$9,924
CCD New Castle	$1,816,453,386	10.274	$19,377
CCD Piedmont	$1,649,302,577	9.328	$17,593
CCD Pike Creek-Central Kirkwood	$1,153,163,203	6.522	$12,301
CCD Red Lion	$299,475,953	1.694	$3,195
CCD Upper Christiana	$1,110,753,207	6.282	$11,848
CCD Wilmington	$6,841,075	0.039	$74
Clayton	$6	0.000	$0
Delaware City	$33,781,002	0.191	$360
Elsmere	$98,268,900	0.556	$1,048
Middletown	$568,591,086	3.216	$6,065
New Castle	$222,084,090	1.256	$2,369
Newark	$800,704,810	4.525	$8,541
Newport	$43,987,199	0.249	$470
Odessa	$12,032,448	0.068	$128
Smyrna	$1,134,141	0.006	$11
Townsend	$51,692,007	0.292	$551
UD Wilmington Campus	$13,574,222	0.077	$145
UD Newark Campus	$444,559,278	2.518	$4,742
Wilmington	$2,581,879,399	14.603	$27,543
TOTAL	$17,680,287,098	100.0	$188,607

Figure 4.3-8
Location and Magnitude of Past Tornado Events in Relation to Population Density

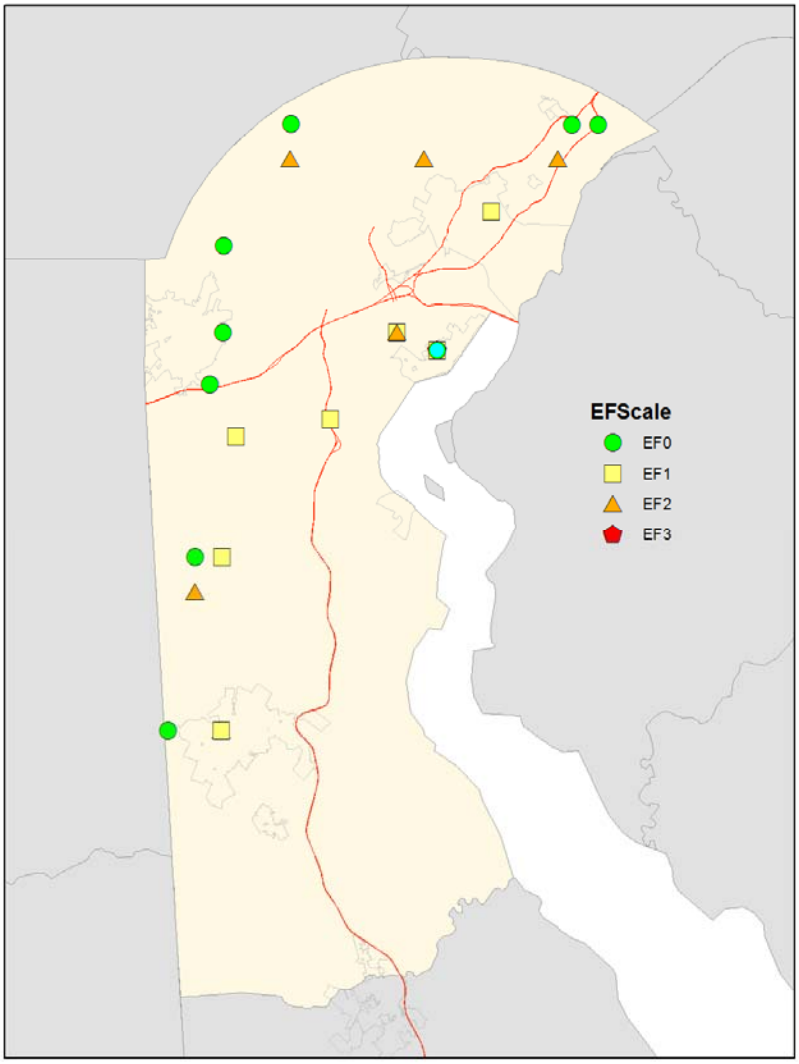
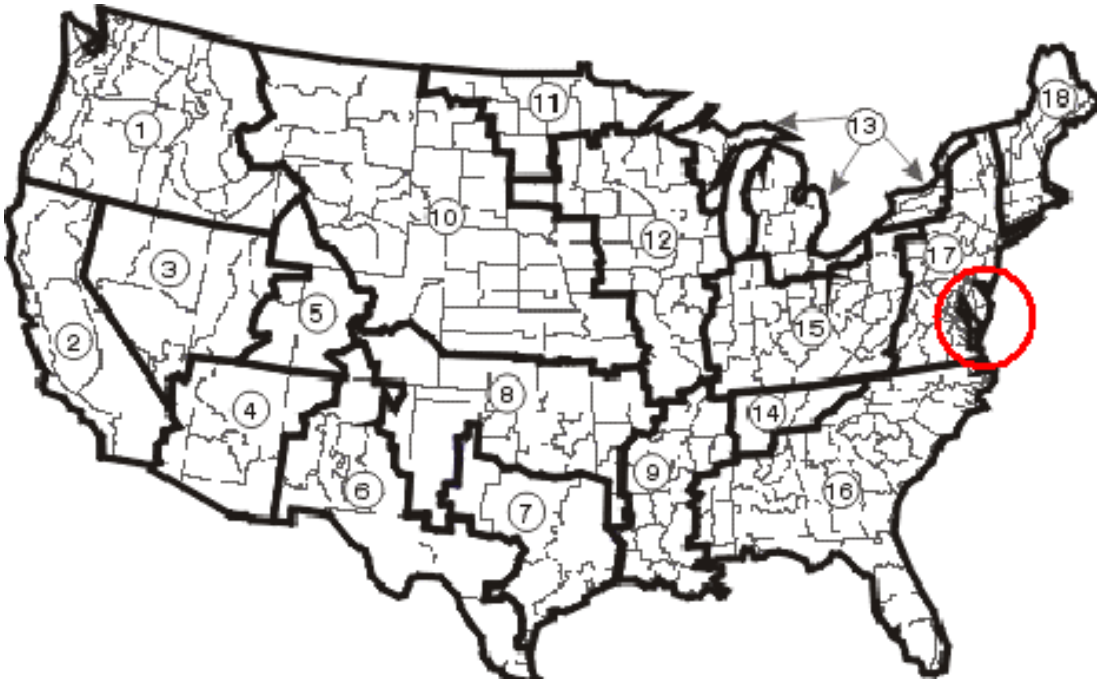


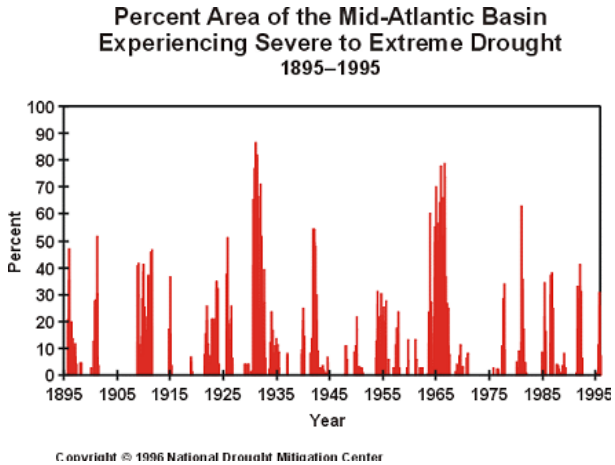
Table 4.3-12
Potential Annualized Losses from Drought by Jurisdiction

Jurisdiction	Total Exposure	% of Total Exposure	Estimated Losses
Arden	---	---	---
Ardencroft	---	---	---
Ardentown	---	---	---
Bellefonte	---	---	---
CCD Brandywine	$1,023,904	6.969	$4,099
CCD Central Pencader	$605,290	4.120	$2,243
CCD Greater Newark	$346,719	2.360	$1,388
CCD Lower Christiana	---	---	---
CCD Middletown-Odessa	$6,946,728	47.279	$27,811
CCD New Castle	$271,998	1.851	$1,089
CCD Piedmont	$4,402,063	29.960	$17,624
CCD Pike Creek-Central Kirkwood	$34,884	0.237	$139
CCD Red Lion	$902,678	6.144	$3,614
CCD Upper Christiana	$59,929	0.408	$240
CCD Wilmington	---	---	---
Clayton	---	---	---
Delaware City	---	---	---
Elsmere	---	---	---
Middletown	$51,733	0.352	$207
New Castle	$34,493	0.235	$138
Newark	---	---	---
Newport	---	---	---
Odessa	---	---	---
Smyrna	$12,693	0.086	$51
Townsend	---	---	---
UD Wilmington Campus	---	---	---
UD Newark Campus	---	---	---
Wilmington	---	---	---
TOTAL	$14,693,137	100.0	$58,824

Figure 4.3-9 shows the hazard profile for drought in the geographic area surrounding New Castle County[3].

Figure 4.3-9
Hazard Profile for Drought In and Around New Castle County





Hail

[3] This information was obtained from the National Drought Mitigation Center (www.drought.unl.edu), which helps people and institutions develop and implement measures to reduce societal vulnerability to drought, stressing preparedness and risk management rather than crisis management.

The State of Delaware is minimally vulnerable to hail storms. Hail does occur in the Mid-Atlantic but is usually not large enough nor widespread enough to cause any significant damage to the built environment. It does, however, have the potential of harming crops in the agricultural areas of New Castle County.

The approach to determining vulnerability to hail is similar to that used for severe thunderstorm wind. Historical hail loss data from the National Oceanic and Atmospheric Administration (NOAA) was gathered for New Castle County and the neighboring counties within 25 miles of the boundary of the County. All historical losses were scaled to account for inflation, and average historic losses were calculated (Table 4.3-13). As with tornadoes (above), because the neighboring jurisdictions are of differing sizes and densities, the results must be normalized appropriately using the method described previously (Table 4.3-14). Because the total estimated annualized losses for the county is negligible ($8,256), annualized expected losses from hail events by jurisdiction were not calculated. The annualized loss ratio is 0.00056.

Table 4.3-13
Potential Annualized Losses from Hail

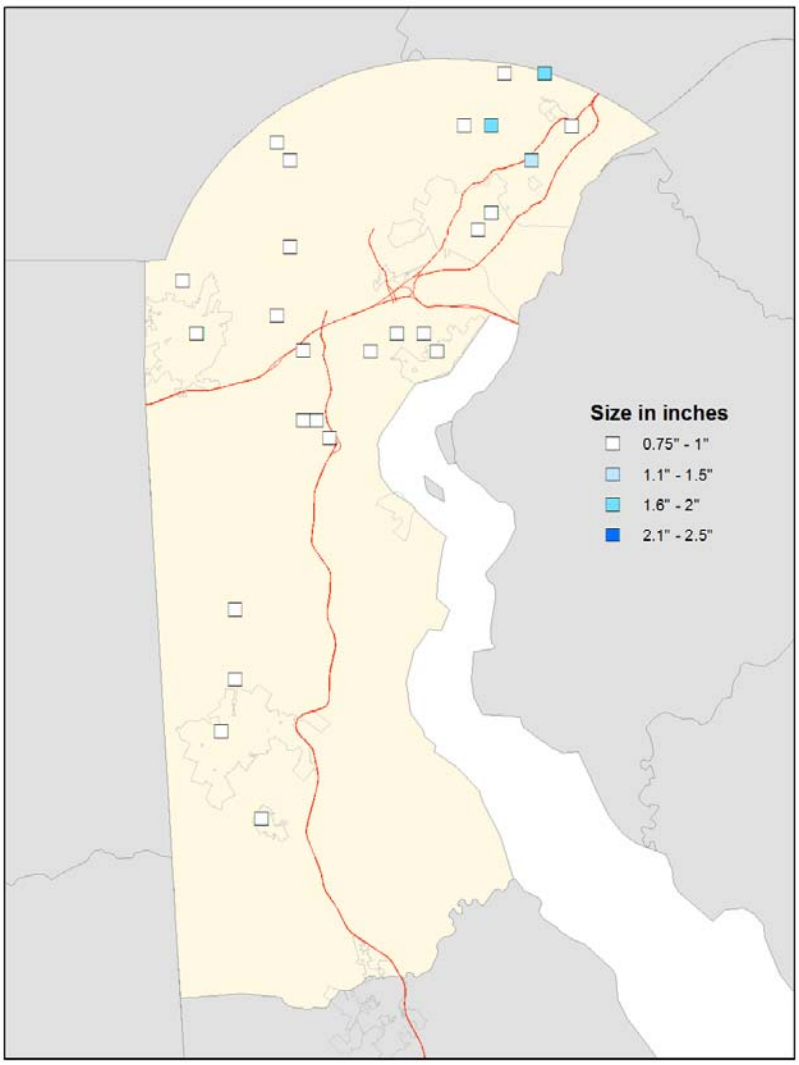
Jurisdiction	Events	Losses	Years	Annual Events	Annual Loss
New Castle County	53	$5,000	44	1.20	$114
Kent County, DE	24	$105,000	46	0.52	$2,283
Cecil County, MD	21	$0	45	0.47	---
Kent County, MD	15	$0	39	0.38	---
Chester County, PA	76	$100	47	1.62	$2
Delaware County, PA	36	$0	57	0.63	---
Salem County, NJ	18	$250,000	34	0.53	$7,353
Gloucester County, NJ	40	$0	27	1.48	---
TOTAL	35.4	$45,013	42.4	0.855	$1,219

Table 4.3-14
Normalized Occurrences and Losses from Hail

Jurisdiction	Annual Events	Area Scale Factor	Scaled Events	Annual Loss	HU Scale Factor	Scaled Annual Loss
New Castle County	1.20	1.000	1.20	$114	1.000	$114
Kent County, DE	0.52	0.617	0.32	$2,283	3.329	$7,600
Cecil County, MD	0.47	1.181	0.56	---	5.292	---
Kent County, MD	0.38	1.191	0.45	---	20.619	---
Chester County, PA	1.62	0.650	1.05	$2	1.130	$2
Delaware County, PA	0.63	2.587	1.63	---	0.976	---
Salem County, NJ	0.53	1.325	0.70	$7,353	7.933	$58,334
Gloucester County, NJ	1.48	1.465	2.17	---	1.981	---
TOTAL	0.855	1.252	1.01	$1,219	5.283	$8,256

Figure 4.3-10 shows recorded hail activity by hailstone size, relative to population distribution within the county.

Figure 4.3-10
Recorded Hail Activity by Hailstone Size in Relation to Population Distribution



Winter Storms

Historical evidence shows that New Castle County is quite vulnerable to winter storms, with several occurring each year. Because winter storms generally impact large areas, all buildings and facilities are considered to be exposed to this hazard and could potentially be impacted. It is also not possible to estimate the number of residential, commercial, and other buildings or facilities that may experience losses. Additionally, it is important to note that for winter storms, some factors that contribute to a community's actual and perceived losses are not reflected in this analysis, such as removal of snow from roadways, debris clean-up, some indirect losses from power outages, etc.

The approach to determining vulnerability to winter storms is similar to that used for tornadoes. Historical winter storm loss data from the National Oceanic and Atmospheric Administration (NOAA) was gathered for New Castle County and the neighboring counties within 25 miles of the boundary of the County. All historical losses were scaled

to account for inflation, and average historic losses were calculated (Table 4.3-15). As with tornadoes (above), because the neighboring jurisdictions are of differing sizes and densities, the results must be normalized appropriately using the method described previously (Table 4.3-16). Table 4.3-17 shows annualized expected losses from winter storm events by jurisdiction within New Castle County. The total estimated annualized losses for the county equal $490,501 and an annualized loss ratio of 0.000028.

Table 4.3-15
Potential Annualized Losses from Winter Storms

Jurisdiction	Events	Losses	Years	Annual Events	Annual Loss
New Castle County	141	$5,350,000	18	7.83	$297,222
Kent County, DE	110	$3,650,000	18	6.11	$202,778
Cecil County, MD	117	$1,350,000	18	6.50	$75,000
Kent County, MD	102	$125,000	18	5.67	$6,944
Chester County, PA	66	$50,000	2	33.00	$25,000
Delaware County, PA	138	$4,950,000	18	7.67	$275,000
Salem County, NJ	125	$3,800,000	18	6.94	$211,111
Gloucester County, NJ	135	$4,000,000	18	7.50	$222,222
TOTAL	116,7	$2,909,375	16.0	10.153	$164,410

Table 4.3-16
Normalized Occurrences and Losses from Winter Storms

Jurisdiction	Annual Events	Area Scale Factor	Scaled Events	Annual Loss	HU Scale Factor	Scaled Annual Loss
New Castle County	7.83	1.000	7.86	$297,222	1.000	$297,222
Kent County, DE	6.11	0.617	3.77	$202,778	3.329	$675,050
Cecil County, MD	6.50	1.181	7.67	$75,000	5.292	$396,889
Kent County, MD	5.67	1.191	6.75	$6,944	20.619	$143,179
Chester County, PA	33.00	0.650	21.43	$25,000	1.130	$28,254
Delaware County, PA	7.67	2.587	19.85	$275,000	0.976	$268,349
Salem County, NJ	6.94	1.325	9.19	$211,111	7.933	$1,674,835
Gloucester County, NJ	7.50	1.465	10.99	$222,222	1.981	$440,232
TOTAL	10.153	1.252	10.94	$164,410	5.283	$490,501

Table 4.3-17
Potential Annualized Losses from Winter Storms by Jurisdiction

Jurisdiction	Total Exposure	% of Total Exposure	Estimated Losses
Arden	$11,567,574	0.065	$319
Ardencroft	$5,103,988	0.029	$142
Ardentown	$7,066,279	0.040	$196
Bellefonte	$24,569,935	0.139	$682
CCD Brandywine	$2,806,719,294	15.875	$77,867
CCD Central Pencader	$1,122,990,192	6.352	$31,157
CCD Greater Newark	$1,052,191,261	5.951	$29,190
CCD Lower Christiana	$811,440,151	4.590	$22,514
CCD Middletown-Odessa	$930,360,422	5.262	$25,810
CCD New Castle	$1,816,453,386	10.274	$50,394
CCD Piedmont	$1,649,302,577	9.328	$45,754
CCD Pike Creek-Central Kirkwood	$1,153,163,203	6.522	$31,990
CCD Red Lion	$299,475,953	1.694	$8,309
CCD Upper Christiana	$1,110,753,207	6.282	$30,813
CCD Wilmington	$6,841,075	0.039	$191
Clayton	$6	0.000	$0
Delaware City	$33,781,002	0.191	$937
Elsmere	$98,268,900	0.556	$2,727
Middletown	$568,591,086	3.216	$15,775
New Castle	$222,084,090	1.256	$6,161
Newark	$800,704,810	4.525	$22,213
Newport	$43,987,199	0.249	$1,221
Odessa	$12,032,448	0.068	$334
Smyrna	$1,134,141	0.006	$29
Townsend	$51,692,007	0.292	$1,432
UD Wilmington Campus	$13,574,222	0.077	$377
UD Newark Campus	$444,559,278	2.518	$12,333
Wilmington	$2,581,879,399	14.603	$71,629
TOTAL	$17,680,287,098	100.0	$490,501

For the University of Delaware, there is a significant concern regarding winter storm events and the accumulation of snow and ice on the flat roofs of some of the University's critical facilities. The University of Delaware Disaster Resistant University Hazard Mitigation Plan of 2011 lists seven buildings that are vulnerable to collapse from the weight from snow and ice:

- Christiana Towers
- Clayton Hall
- Computing Center

- Facilities Operations
- Materials Management Facility
- Morris Library
- Perkins Student Center

Thunderstorm Wind

New Castle County, according to historical records, is affected by severe thunderstorms several times a year. The strong winds and lightning generated from severe thunderstorms pose a threat to the residents, the built environment, and particularly the trees within the County. However, because severe thunderstorms are not spatially-constrained, one must consider the entire County at risk. In addition, the extent of damage from severe thunderstorm wind may be either localized or widespread but it is rarely consistent across space. Therefore, it is impossible to predict if certain areas of the county may be more vulnerable than others and even to estimate the number of buildings that may suffer loss from a severe thunderstorm wind.

The approach to determining vulnerability to severe thunderstorms is similar to that used for tornadoes. Historical severe thunderstorm loss data from the National Oceanic and Atmospheric Administration (NOAA) was gathered for New Castle County and the neighboring counties within 25 miles of the boundary of the County. All historical losses were scaled to account for inflation, and average historic losses were calculated (Table 4.3-18). As with tornadoes (above), because the neighboring jurisdictions are of differing sizes and densities, the results must be normalized appropriately using the method described previously (Table 4.3-19). Table 4.3-20 shows annualized expected losses from severe thunderstorm events by jurisdiction within New Castle County. The total estimated annualized losses for the county equal $131,124 and an annualized loss ratio of 0.0000074.

Table 4.3-18
Potential Annualized Losses from Severe Thunderstorms

Jurisdiction	Events	Losses	Years	Annual Events	Annual Loss
New Castle County	304	$3,711,000	54	5.63	$68.722
Kent County, DE	254	$2,593,000	56	4.54	$46,304
Cecil County, MD	263	$1,717,000	45	5.84	$38,156
Kent County, MD	228	$119,000	46	4.96	$2,587
Chester County, PA	434	$8,154,000	57	7.61	$143,053
Delaware County, PA	317	$3,554,000	57	5.56	$62,351
Salem County, NJ	353	$1,231,000	39	9.05	$31,564
Gloucester County, NJ	438	$2,818,000	57	7.68	$49,439
TOTAL	323.9	$2,987,125	51.4	6.360	$55,278

Table 4.3-19
Normalized Occurrences and Losses from Severe Thunderstorms

Jurisdiction	Annual Events	Area Scale Factor	Scaled Events	Annual Loss	HU Scale Factor	Scaled Annual Loss
New Castle County	5.63	1.000	5.63	$68.722	1.000	$68,722
Kent County, DE	4.54	0.617	2.80	$46,304	3.329	$154,147
Cecil County, MD	5.84	1.181	6.90	$38,156	5.292	$201,916
Kent County, MD	4.96	1.191	5.91	$2,587	20.619	$53,342
Chester County, PA	7.61	0.650	4.94	$143,053	1.130	$161,671
Delaware County, PA	5.56	2.587	14.39	$62,351	0.976	$60,843
Salem County, NJ	9.05	1.325	11.99	$31,564	7.933	$250,411
Gloucester County, NJ	7.68	1.465	11.25	$49,439	1.981	$97,941
TOTAL	6.360	1.252	7.98	$55,278	5.283	$131,124

Earthquake

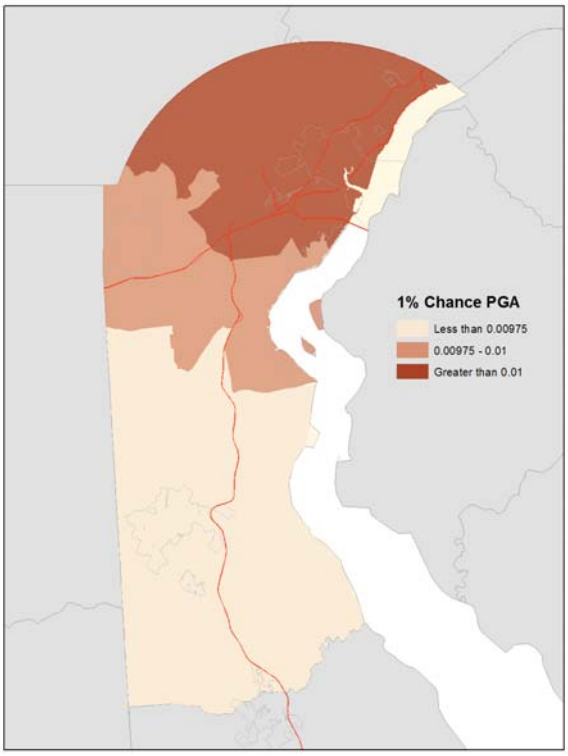
Figure 4.3-11 shows the potential ground motion for a 1% chance per year and 0.2% chance per year earthquake. While New Castle County has felt earthquakes every so often, none have been significant enough to cause any damage for well over 100 years. The coastal plain of the Mid-Atlantic is notorious for being a seismically quiet zone. However, if a serious earthquake were to occur, the losses would likely be significant. This explains the amount of potential annualized losses for the county of $722,082 (Table 4.3-21) or an annualized loss ratio of 0.0000097. Table 4.3-22 shows potential damage to critical facilities from earthquake events by jurisdiction within New Castle County. None are predicted to suffer more than negligible damage in either a 1% or 0.2% chance per year earthquake.

Table 4.3-20
Potential Annualized Losses from Thunderstorms by Jurisdiction

Jurisdiction	Total Exposure	% of Total Exposure	Estimated Losses
Arden	$11,567,574	0.065	$85
Ardencroft	$5,103,988	0.029	$38
Ardentown	$7,066,279	0.040	$52
Bellefonte	$24,569,935	0.139	$182
CCD Brandywine	$2,806,719,294	15.875	$20,815
CCD Central Pencader	$1,122,990,192	6.352	$8,329
CCD Greater Newark	$1,052,191,261	5.951	$7,803
CCD Lower Christiana	$811,440,151	4.590	$6,019
CCD Middletown-Odessa	$930,360,422	5.262	$6,900
CCD New Castle	$1,816,453,386	10.274	$13,472
CCD Piedmont	$1,649,302,577	9.328	$12,231
CCD Pike Creek-Central Kirkwood	$1,153,163,203	6.522	$8,552
CCD Red Lion	$299,475,953	1.694	$2,221
CCD Upper Christiana	$1,110,753,207	6.282	$8,237
CCD Wilmington	$6,841,075	0.039	$51
Clayton	$6	0.000	$0
Delaware City	$33,781,002	0.191	$250
Elsmere	$98,268,900	0.556	$729
Middletown	$568,591,086	3.216	$4,217
New Castle	$222,084,090	1.256	$1,647
Newark	$800,704,810	4.525	$5,938
Newport	$43,987,199	0.249	$326
Odessa	$12,032,448	0.068	$89
Smyrna	$1,134,141	0.006	$8
Townsend	$51,692,007	0.292	$383
UD Wilmington Campus	$13,574,222	0.077	$101
UD Newark Campus	$444,559,278	2.518	$3,297
Wilmington	$2,581,879,399	14.603	$19,148
TOTAL	$17,680,287,098	100.0	$131,124

Figure 4.3-11
Peak Ground Acceleration (Ground Motion) for 1% and 0.2% chance per year Events

1% chance per year Ground Motion



0.2% chance per year Ground Motion

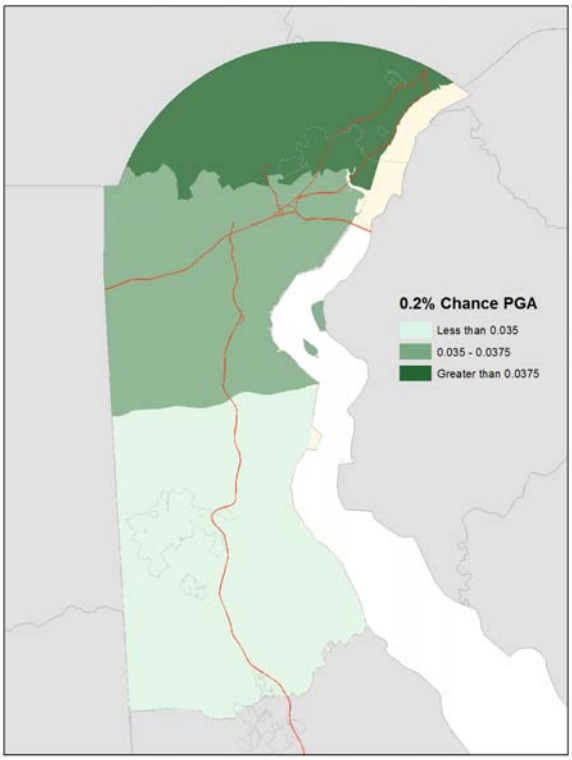


Table 4.3-21
Potential Annualized Losses from Earthquake per Jurisdiction

Jurisdiction	Total Exposure	Estimated Losses	Loss Ratio
Arden	$86,383,215	$824	0.0000095
Ardencroft	$30,512,695	$291	0.0000095
Ardentown	$94,307,349	$897	0.0000095
Bellefonte	$82,392,867	$824	0.0000100
CCD Brandywine	$11,735,892,751	$118,462	0.0000101
CCD Central Pencader	$5,202,975,384	$42,499	0.0000082
CCD Greater Newark	$5,403,089,013	$50,330	0.0000093
CCD Lower Christiana	$3,793,598,677	$39,039	0.0000103
CCD Middletown-Odessa	$5,371,553,737	$36,094	0.0000067
CCD New Castle	$8,857,142,753	$83,481	0.0000094
CCD Piedmont	$5,293,482,980	$51,238	0.0000097
CCD Pike Creek-Central Kirkwood	$5,619,194,399	$54,976	0.0000098
CCD Red Lion	$1,088,833,573	$8,774	0.0000081
CCD Upper Christiana	$4,001,589,216	$40,456	0.0000101
CCD Wilmington	$68,591,969	$715	0.0000104
Clayton	$2,896,734	$19	0.0000066
Delaware City	$47,248,715	$404	0.0000086
Elsmere	$580,186,919	$5,859	0.0000101
Middletown	$1,048,483,689	$7,273	0.0000069
New Castle	$909,897,644	$8,928	0.0000098
Newark	$1,983,845,150	$19,705	0.0000099
Newport	$148,774,696	$1,620	0.0000109
Odessa	$87,583,603	$601	0.0000069
Smyrna	$11,505,613	$75	0.0000065
Townsend	$24,129,331	$131	0.0000054
UD Wilmington Campus	$62,351,749	$720	0.0000115
UD Newark Campus	$1,101,450,573	$10,940	0.0000099
Wilmington	$11,859,588,794	$136,863	0.0000115
TOTAL	$74,602,783,000	$722,082	0.0000097

Table 4.3-22
Potential Damage to Critical Facilities from Earthquake per Jurisdiction[4]

Jurisdiction	Total Number of Critical Facilities	100-year Earthquake			500-year Earthquake		
		Moderate Damage	Slight Damage	Negligible Damage*	Moderate Damage	Slight Damage	Negligible Damage*
Arden	N/A	0	0	N/A	0	0	N/A
Ardencroft	N/A	0	0	N/A	0	0	N/A
Ardentown	N/A	0	0	N/A	0	0	N/A
Bellefonte	2	0	0	2	0	0	2
Clayton	N/A	0	0	N/A	0	0	N/A
Delaware City	2	0	0	2	0	0	2
Elsmere	4	0	0	4	0	0	4
CCD Brandywine	41	0	0	41	0	0	41
CCD Central Pencader	10	0	0	10	0	0	10
CCD Greater Newark	16	0	0	16	0	0	16
CCD Lower Christiana	14	0	0	14	0	0	14
CCD Middletown-Odessa	5	0	0	5	0	0	5
CCD New Castle	28	0	0	28	0	0	28
CCD Piedmont	17	0	0	17	0	0	17
CCD Pike Creek-Central Kirkwood	20	0	0	20	0	0	20
CCD Red Lion	5	0	0	5	0	0	5
CCD Upper Christiana	12	0	0	12	0	0	12
CCD Wilmington	2	0	0	2	0	0	2
Middletown	9	0	0	9	0	0	9
New Castle	6	0	0	6	0	0	6
Newark	13	0	0	13	0	0	13
Newport	3	0	0	3	0	0	3
Odessa	1	0	0	1	0	0	1
Smyrna	N/A	0	0	N/A	0	0	N/A
Townsend	N/A	0	0	N/A	0	0	N/A
UD Wilmington Campus	1	0	0	1	0	0	1
UD Newark Campus	16	0	0	16	0	0	16
Wilmington	48	0	0	48	0	0	48
TOTAL	261	0	0	261	0	0	261

[4] The definitions used are as follows. Negligible: less than 1 percent damage. Slight: 1 to 5 percent damage. Moderate: 5 to 30 percent damage. Extensive (where applicable): 30 to 60 percent damage.

Dam/Levee Failure

The approach for determining vulnerability to dam and/or levee failure consists of a number of factors. Data from the USACE National Inventory of Dams (NID)[5] in addition to the HAZUS-MH demographic inventory was used, with an assumption that dam breaks most likely will occur at the time of maximum capacity.[6] The affected population was then calculated. Table 4.3-23 shows estimated exposure of people to dam failure.

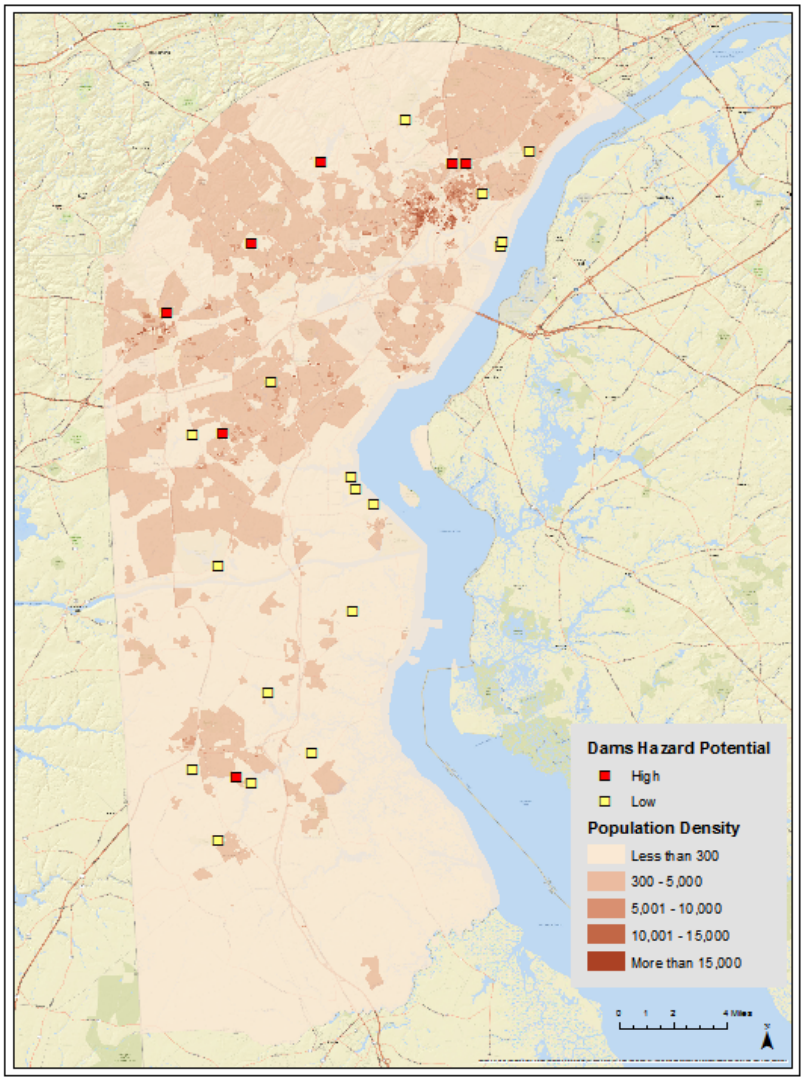
Table 4.3-23
Estimated Exposure of People to Dam Failure

Dam Name	Nearest City/Town	Potential People at Risk
Edgar M. Hoopes Dam	Wooddale Area	2,311
Christiana Lake Dam	Christiana	2,105
Bellevue Lake Dam	Holly Creek-Claymont	373
Brandywine Creek Dam 9	Wilmington	148
Porter Reservoir	Wilmington	136
Silver Lake Dam	Odessa	86
Noxontown Pond Dam	Odessa	83
Edgemoor Reservoir	Wilmington	55
Wiggins Mill Pond Dam	Townsend	54

Figure 4.3-12 shows the location of dams within New Castle County, along with their hazard ranking (high, significant or low), in relation to population density.

[5] With the National Dam Inspection Act of 1972, the U.S. Congress authorized the U.S. Army Corps of Engineers (USACE) to inventory dams located in the United States. The Water Resources Development Act of 1986 authorized USACE to maintain and periodically publish an updated National Inventory of Dams (NID).
[6] Downstream quarter-circle buffer proportional to the maximum capacity of dams are assumed to represent the maximum impact area.

Figure 4.3-12
Location of Dams (With Hazard Ranking) in Relation to Population Density



Weapons of Mass Destruction

Using FEMA Publication 426—Reference Manual to Mitigate Potential Terrorist Attacks in High Occupancy Buildings—as a basis, a vulnerability assessment was conducted for Weapons of Mass Destruction (WMDs) in order to expand the scope of the hazard mitigation planning process in the State of Delaware to include vulnerability to acts of terrorism. The methodology used employs a vulnerability ranking of 1 to 5 for certain transportation, water/hydrology, emergency and public safety, and utility elements. The sum total for each element is then multiplied against a value for that asset (also on a 1 to 5 scale) and multiplied against a factor representing the Department of Homeland Security Threat Level. For the purposes of this Plan, the Threat Level is assumed to be Orange (High). This part of the assessment is the same for all three counties in Delaware. In the final analysis, the total risk for each county is multiplied by a unique weighted factor to arrive at county-specific scores. For New Castle County, a weighted factor of 1.15 was used. Abbreviated findings of this methodology are presented in Table 4.3-24.

Table 4.3-24
Assessment of Vulnerability to Weapons of Mass Destruction

	Based on FEMA 426: Reference Manual to Mitigate Potential Terrorist Attacks in High Occupancy Buildings																
	Asset Visibility	Target Value to Pot. Threat Element	Asset Accessability	Asset Mobility	Target Threat of CBR Hazard	Collateral Damage Potential	Site Population/Capacity	Pot. for Collateral Mass Casualties	SUM		Asset Value of Target Site		Homeland Security Threat Condition		Risk		New Castle
																X	1.15
Transportation																	
Major bridges	5	4	5	5	0	2	1	0	**22**	X	**4**	X	**6**	=	**528**	:	**607**
Airports	4	4	3	5	0	1	2	0	**19**	X	**4**	X	**6**	=	**456**	:	**524**
Water / Hydrology																	
Reservoirs	3	5	3	5	1	3	1	0	**21**	X	**5**	X	**6**	=	**630**	:	**725**
Dams	4	5	2	5	1	4	1	0	**22**	X	**5**	X	**6**	=	**660**	:	**759**
Emergency and Public Safety																	
Hospitals	4	3	4	5	4	2	2	2	**26**	X	**5**	X	**6**	=	**780**	:	**897**
Military Facilities	2	4	1	5	4	3	3	2	**24**	X	**5**	X	**6**	=	**720**	:	**828**
Schools	4	4	4	5	1	1	2	1	**22**	X	**3**	X	**6**	=	**396**	:	**455**
Utilities																	
Gas LNG plant	3	3	3	5	2	3	1	2	**22**	X	**3**	X	**6**	=	**396**	:	**455**
Electric substations	3	2	3	5	1	2	1	0	**17**	X	**2**	X	**6**	=	**204**	:	**235**

In order to give some perspective to these findings, the final scores for each element in Table 4.3-24 were compared to the maximum score defined in FEMA Publication 426 (Table 4.3-25). This comparison shows hospitals, military facilities and day care centers to have the three highest rankings compared to all other elements. These three elements are the focal point of the chemical and radiological agents sections.

Table 4.3-25
Comparison of New Castle County and FEMA 426 Model

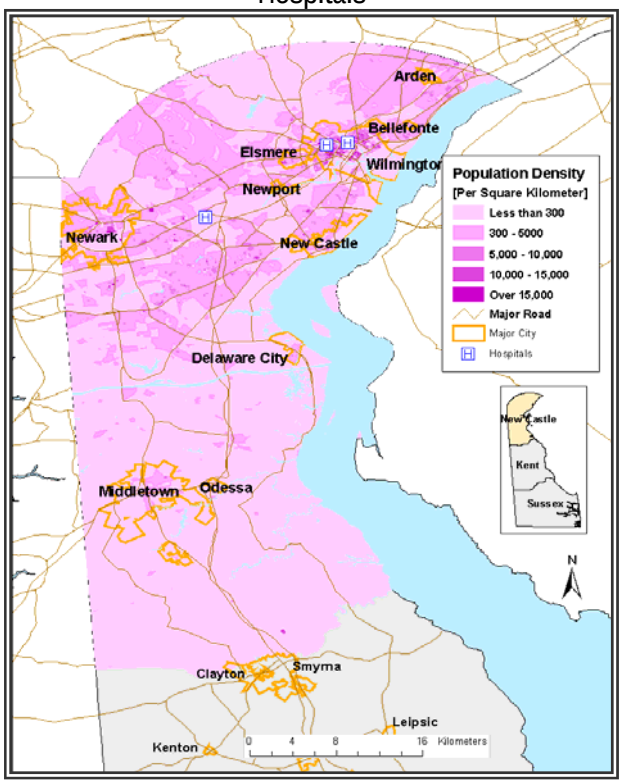
Facility	Threat	Percent Comparison
Maximum Score in FEMA 426 Model	14.400	100%
Hospitals	8.970	62%
Military Facilities	8.280	58%
Day Care Centers	7.935	55%
Hazardous Material Sites	7.590	53%
Dams	7.590	53%
Reservoirs	7.245	50%
Major Bridges	6.072	42%
All Gas Pipelines	1.173	8%
U.S. Roads	1.104	8%
State Roads	1.104	8%

Chemical Agents

In planning for the possible release of a chemical agent as an act of terrorism, New Castle County identified seven (7) hospitals and 193 day care facilities throughout the county as potential targets. Figure 4.3-13 graphically illustrates the locations of these facilities.) In order to create a more complete assessment of the damage that would be inflicted should such an attack occur, New Castle County also determined the surrounding population and building stock within both an 8-mile radius of the target (the "Immediate Response Zone") and a 20-mile radius (the "Protective Action Zone"). This approach is believed to more accurately represent the overall exposure of the county and its communities to the threat of a chemical agent. Tables 4.3-26 and 4.3-27 offer the results of this analysis. In order to keep this planning document brief, only the top four day care facilities in terms of affected population are included in Table 4.3-18. It is worth noting that the top 186 day care facilities—out of a total of 286 for the state—are all in New Castle County and all have a potential affected population of greater than 100,000 people within the Immediate Response Zone (8-mile radius from the target).

Figure 4.3-13
Location of Day Care Facilities and Hospitals in New Castle County

Hospitals



Day Care Facilities

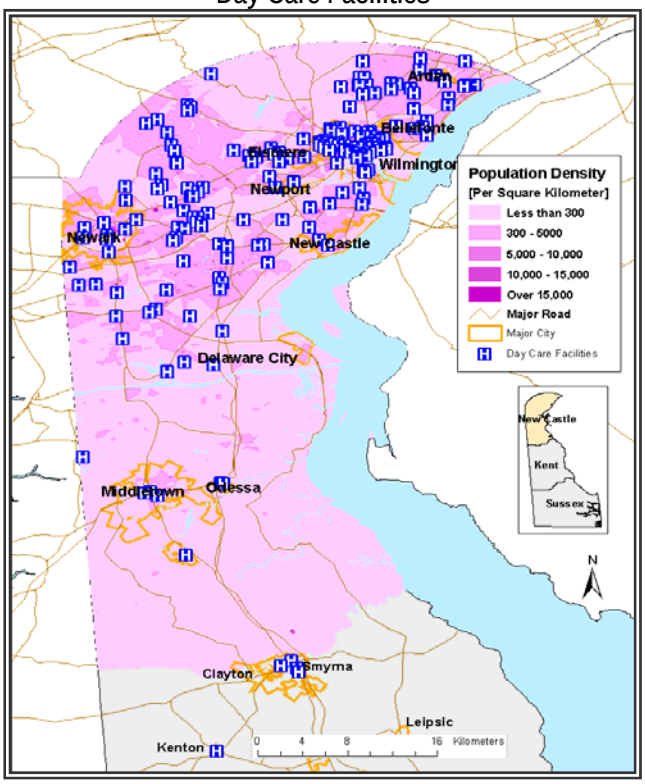


Table 4.3-26
Hospitals and Surrounding Exposure

Name of Hospital	City	Immediate Response Zone (IRZ) 8 miles from each hospital		Protective Action Zone (PAZ) 20 miles from each hospital	
		Population	Buildings	Population	Buildings
Delaware Psychiatric Center	New Castle	352,027	145,823	527,146	209,982
Meadow Wood Behavioral Health	New Castle	354,847	146,236	527,811	210,236
Christiana Hospital	Newark	400,733	159,514	527,245	210,010
Rockford Center	Newark	248,195	94,597	530,680	211,270
Alfred/Dupont Hospital	Wilmington	295,829	123,433	510,858	204,125
St. Francis Hospital	Wilmington	349,645	146,567	516,922	206,044
Veterans Affairs Medical Center	Wilmington	386,409	159,098	520,701	207,472

Table 4.3-27
Day Care Facilities and Surrounding Exposure

Name of Day Care Facility	City	Immediate Response Zone (IRZ) 8 miles from each hospital		Protective Action Zone (PAZ) 20 miles from each hospital	
		Population	Buildings	Population	Buildings
Cavalier Day Care & Kindergarten	Newark	402,042	159,609	527,913	210,274
Mary Cooper Daycare	Wilmington	402,434	161,042	525,896	209,505
Kids Korner Day Care	Wilmington	400,089	160,094	526,622	209,788
Greenbank Child Development Center	Wilmington	398,559	159,576	523,660	208,639

Radiological Agents

In planning for the possible release of a radiological agent as an act of terrorism, New Castle County identified seven (7) hospitals and eight (8) military facilities throughout the county as potential targets. (Figure 4.3-14 graphically illustrates the locations of these facilities.) In order to create a more complete assessment of the damage that would be inflicted should such an attack occur, New Castle County also determined the surrounding population and building stock within both an 8-mile radius of the target (the "Immediate Response Zone") and a 20-mile radius (the "Protective Action Zone"). This approach is believed to more accurately represent the overall exposure of the county and its communities to the threat of a radiological agent. Tables 4.3-28 and 4.3-29 offer the results of this analysis.

Figure 4.3-14
Location of Hospitals and Military Facilities in New Castle County

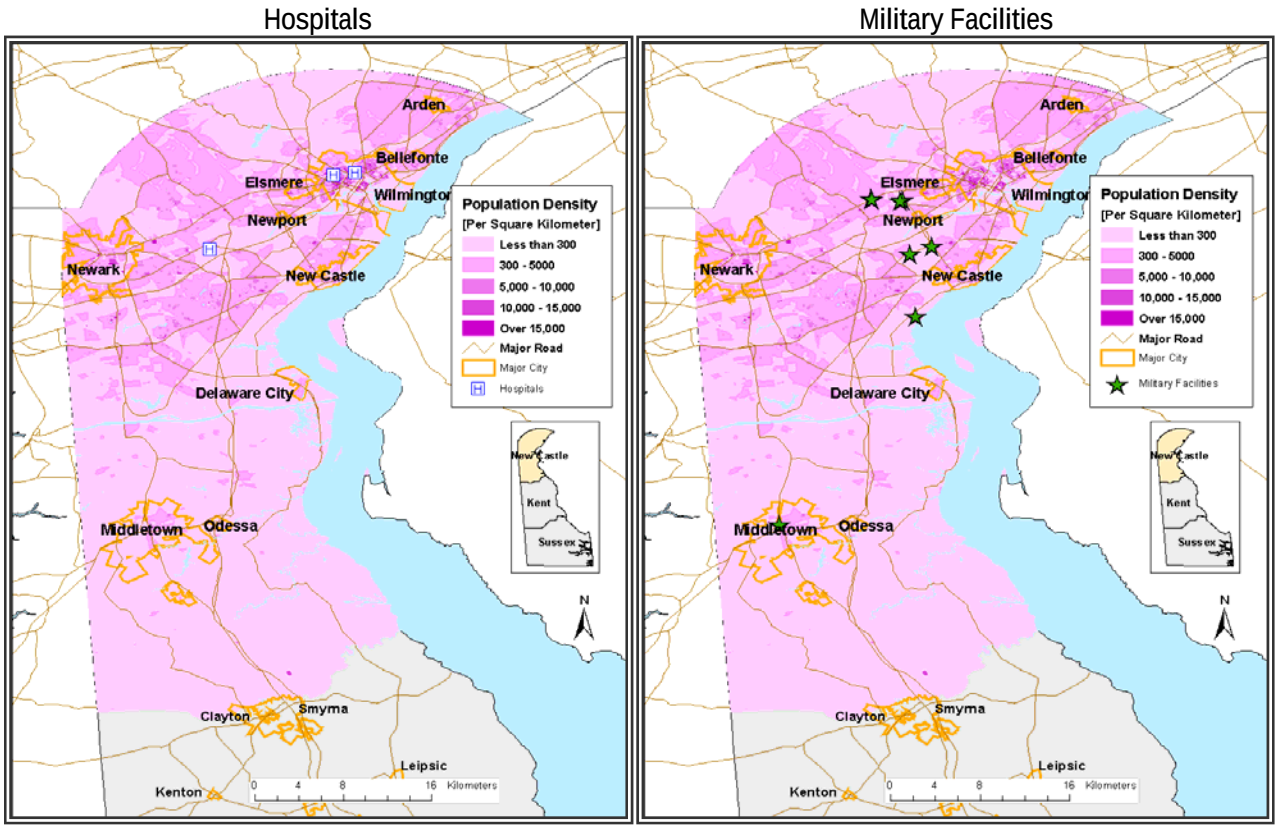


Table 4.3-28
Hospitals

Name of Hospital	City	Immediate Response Zone (IRZ) 8 miles from each hospital		Protective Action Zone (PAZ) 20 miles from each hospital	
		Population	Buildings	Population	Buildings
Delaware Psychiatric Center	New Castle	458,795	184,054	654,670	259,188
Meadow Wood Behavioral Health	New Castle	457,678	182,860	655,674	259,559
Christiana Hospital	Newark	451,607	179,802	653,293	258,630
Rockford Center	Newark	321,158	122,504	656,900	259,993
Alfred/Dupont Hospital	Wilmington	352,454	146,697	637,591	252,335
St. Francis Hospital	Wilmington	411,127	169,728	647,875	256,434
Veterans Affairs Medical Center	Wilmington	463,833	187,009	649,292	257,013

Table 4.3-29
Military Facilities

Name of Military Facility	Immediate Response Zone (IRZ) 8 miles from each hospital		Protective Action Zone (PAZ) 20 miles from each hospital	
	Population	Buildings	Population	Buildings
Army Reserve Center	462,130	184,969	650,489	257,478
Navy/Marine Reserve Center	462,460	185,086	650,567	257,508
Stern Armory	471,630	189,486	650,964	257,676
National Guard Armory	471,454	189,389	650,964	257,676
Air National Guard	466,237	185,934	655,130	259,367
Army National Guard	455,626	181,501	655,588	259,529
National Guard Training Site	405,556	160,615	667,858	264,521
National Guard	434,581	161,534	699,121	277,193

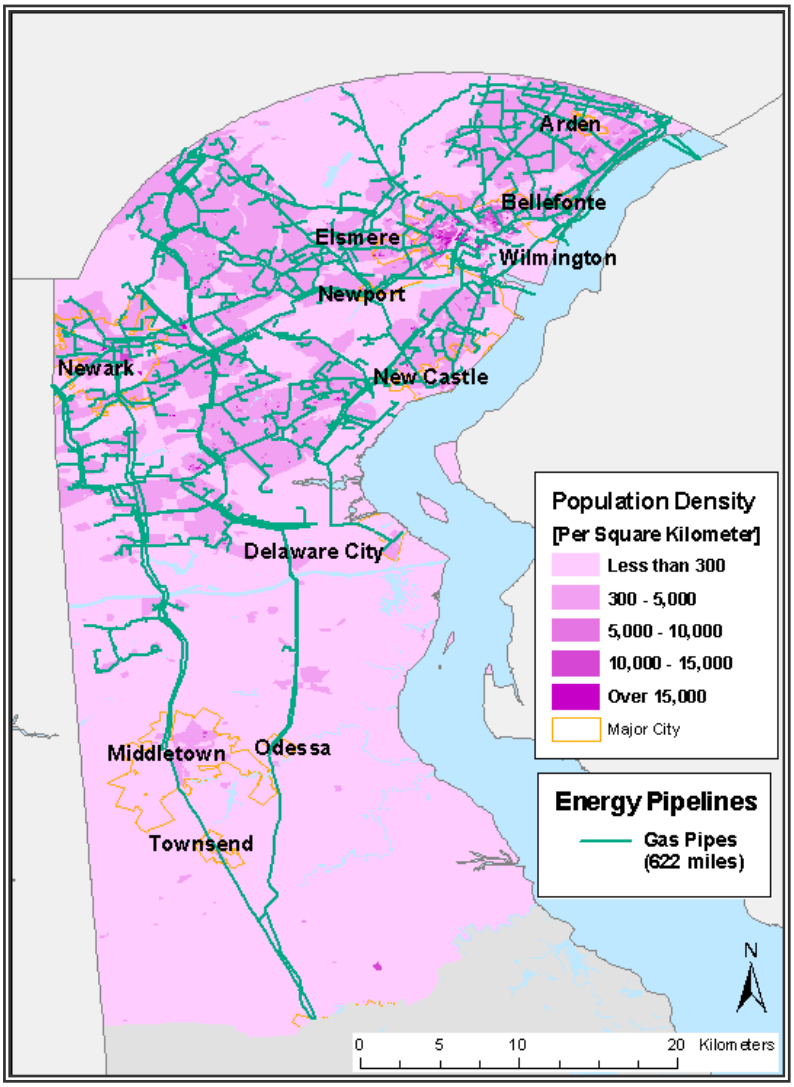
Biological Agents

The relative risk of New Castle County to Delaware in terms of the release of a biological agent is 90.31 percent. This is based on a risk formula of "VULNERABILITY x HAZARD x EXPOSURE." Vulnerability in this case is a measure of the speed at which infection will spread among the population. Population was studied based on general occupancy class: residential, commercial, industrial, education, government, agricultural and religious. The hazard component was considered to be a measure of the introduction of the disease among the population. This also was broken down by occupancy class, in this case residential, commercial, industrial, education, government and religious. The exposure was determined using HAZUS-MH data.

Energy Pipelines

Energy pipelines cross most of the state of Delaware, and much of New Castle County. If any of these energy pipelines, oil or gas, were to rupture, such an event could endanger property and lives in the immediate area (within less than half a mile radius). Figure 4.3-15 shows the location of 622 miles of energy pipelines within the county's boundaries in relation to population density and municipalities. [Editorial note: This map was inserted erring on the side of inclusion. New Castle County officials may wish to determine whether or not it is appropriate to keep this graphic in the Plan due to the sensitive nature of energy pipelines on a national level.]

Figure 4.3-15
Energy Pipelines



Hazardous Materials (HazMat)

Assessing vulnerability to a hazardous materials (HazMat) release on a countywide scale can consist of a number of factors, such as the type(s) of hazardous materials present, the potential for mass casualties, potential consequences for the surrounding area, accessibility, public awareness, and the likelihood of being a terrorist target. The assessment conducted for New Castle County focuses on the first three of these factors, and a comprehensive study was undertaken to document information for 73 identified hazardous material sites from State of Delaware exposure data[7]. High consequence events were then selected (high material toxicity and population density), and ALOHA[8] was used for calculating the impact area. Affected population (based on Census 2010) and exposure value (HAZUS-MH) was then reported per selected events.

Table 4.3-30 offers the results of this analysis. In order to keep this planning document brief, only the top five HazMat facilities in terms of potential population at risk are included in Table 4.3-30.

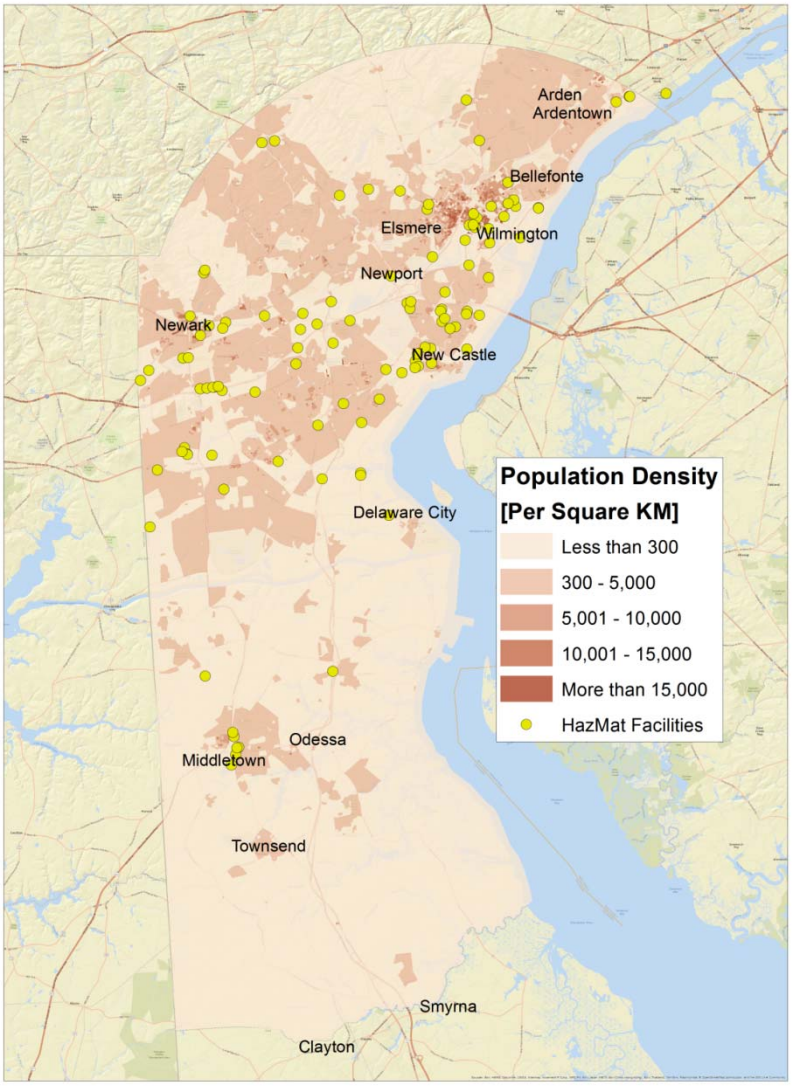
Table 4.3-30
Hazardous Materials Facilities

Facility Name	City	Chemical Name	Potential Residential Population at Risk	Clean-up Area (square miles)
GMC NAO Wilmington Assembly Plant	Wilmington	Certain Glycol Ethers	41,761	23.00
Du Pont Edge Moor	Edgemoor	Chlorine	36,075	26.93
Metachem Prods. L.L.C.	New Castle	1,2,4-Trichlorobenzene	27,781	43.55
Metachem Prods. L.L.C.	New Castle	1,4-Dichlorobenzene	28,955	42.78
Daimlerchrysler Co. Newark Assembly Plant	Newark	Certain Glycol Ethers	24,645	29.61

Figure 4.3-16 shows the location of hazardous materials facilities in New Castle County in relation to population density.

[7] If a facility houses more than one hazardous material, it is treated as a separate entry in this table, partially due to the fact that potential population at risk and projected clean-up area could vary depending on the chemical.
[8] ALOHA (Areal Locations of Hazardous Atmospheres) is a computer program that uses information provided by its operator and physical property data from its extensive chemical library to predict how a hazardous gas cloud might disperse in the atmosphere after an accidental chemical release.

Figure 4.3-16
Location of Hazardous Materials Facilities in Relation to Population Density



Other Hazards

Though communities in the State of Delaware recognize that the state is vulnerable to other hazards such as wildfire, erosion, sinkholes, landslides and tsunamis, a high-level detailed risk assessment was not completed for New Castle County due to the low level of risk and/or vulnerability for these hazards within the area as a whole as compared with other hazards.

Conclusions on Hazard Risk

Table 4.3-31 summarizes the annualized expected losses presented for each natural hazard in this section. Based upon the methodologies described in the beginning of this section, the risk from natural hazards in New Castle County can be rated on a scale of Low, Moderate or High for each identified natural hazard based upon these annualized losses and an annualized loss ratio (Table 4.3-32). Because of the nature of human-caused hazards and the nature in which risk and vulnerability is presented for human-caused hazards, it is not possible to rank them fairly in direct comparison with natural hazards. In summary, all human-caused hazards addressed in this section—terrorism (chemical, radiological and biological agents), hazardous materials incidents (HazMat), and energy pipeline failures—warrant an overall rating of low risk for New Castle County.

Table 4.3-31
Potential Annualized Loss Rates per Jurisdiction

Jurisdiction	Flooding	Coastal Wind	Tornado	Drought	Hail	Winter Storm	Thunder-storm	Earthquake
Arden	0.0041	0.000027	0.000011	---	---	0.000028	0.0000074	0.0000095
Ardencroft	---	0.000027	0.000011	---	---	0.000028	0.0000074	0.0000095
Ardentown	0.0054	0.000029	0.000011	---	---	0.000028	0.0000074	0.0000095
Bellefonte	---	0.000049	0.000011	---	---	0.000028	0.0000074	0.0000100
Clayton	0.0066	0.000028	0.000011	---	---	0.000028	0.0000074	0.0000101
Delaware City	0.0032	0.000045	0.000011	---	---	0.000028	0.0000074	0.0000082
Elsmere	0.0032	0.000026	0.000011	---	---	0.000028	0.0000074	0.0000093
CCD Brandywine	0.0033	0.000029	0.000011	0.004	0.00056	0.000028	0.0000074	0.0000103
CCD Central Pencader	0.0054	0.000068	0.000011	0.004	0.00056	0.000028	0.0000074	0.0000067
CCD Greater Newark	0.0045	0.000036	0.000011	0.004	0.00056	0.000028	0.0000074	0.0000094
CCD Lower Christiana	0.0072	0.000032	0.000011	---	---	0.000028	0.0000074	0.0000097
CCD Middletown-Odessa	0.0058	0.000029	0.000011	0.004	0.00056	0.000028	0.0000074	0.0000098
CCD New Castle	0.0053	0.000051	0.000011	0.004	0.00056	0.000028	0.0000074	0.0000081
CCD Piedmont	0.0062	0.000031	0.000011	0.004	0.00056	0.000028	0.0000074	0.0000101
CCD Pike Creek-Central Kirkwood	0.0008	0.000028	0.000011	0.004	0.00056	0.000028	0.0000074	0.0000104
CCD Red Lion	---	0.000061	0.000011	0.004	0.00056	0.000028	0.0000074	0.0000066
CCD Upper Christiana	0.0037	0.000048	0.000011	0.004	0.00056	0.000028	0.0000074	0.0000086
CCD Wilmington	---	0.000027	0.000011	---	---	0.000028	0.0000074	0.0000101
Middletown	0.0039	0.000058	0.000011	0.004	0.00056	0.000028	0.0000074	0.0000069
New Castle	0.0057	0.000042	0.000011	0.004	0.00056	0.000028	0.0000074	0.0000098
Newark	0.0057	0.000024	0.000011	---	---	0.000028	0.0000074	0.0000099
Newport	0.0434	0.000025	0.000011	---	---	0.000028	0.0000074	0.0000109
Odessa	0.0047	0.000057	0.000011	---	---	0.000028	0.0000074	0.0000069
Smyrna	0.0068	0.000062	0.000011	0.004	0.00056	0.000028	0.0000074	0.0000065
Townsend	0.0068	0.000079	0.000011	---	---	0.000028	0.0000074	0.0000054
UD Wilmington Campus	---	0.000021	0.000011	---	---	0.000028	0.0000074	0.0000115
UD Newark Campus	0.0009	0.000024	0.000011	---	---	0.000028	0.0000074	0.0000099
Wilmington	0.0040	0.000021	0.000011	---	---	0.000028	0.0000074	0.0000115
TOTAL	0.0046	0.000033	0.000011	0.004*	0.00056*	0.000028	0.0000074	0.0000097

* Both Drought and Hail loss ratios were calculated from the amount of assessed value of farm properties in the county and therefore are not directly comparable to the other hazards

Table 4.3-32
Estimated Level of Risk by Hazard for New Castle County (High, Moderate, Low)

Flood	Coastal Wind	Tornado	Drought	Hail	Winter Storm	Thunder-storm	Earthquake
High	High	Moderate	Moderate	Low	Moderate	Moderate	Moderate

It should be noted that although some hazards may show Medium or Low risk, hazard occurrence is still possible. Also, any hazard occurrence could potentially cause a great impact and losses could be extremely high (e.g. an F5 tornado or a Category 5 hurricane).

Table 4.3-33 provides an overall ranking of risk by hazard for New Castle County.

Table 4.3-33
Overall Risk Ranking for New Castle County

Hazard	Rank
Flood	1
Coastal Wind	2
Winter Storm	3
Thunderstorm	4
Tornado	5
Earthquake	6
Drought	7
Hail	8

City of Wilmington

According to the US Census Bureau, the population of the City of Wilmington was 70,851 in 2010. The total population in 2010 for New Castle County and the state of Delaware as a whole was 538,479 and 897,934, respectively.

Table 4.3-34
Estimated Level of Risk by Hazard for the City of Wilmington (High, Moderate, Low)

Flood	Coastal Wind	Tornado	Drought	Hail	Winter Storm	Thunder-storm	Earthquake
High	Moderate	Low	Low	Low	Moderate	Moderate	Moderate

The total assessed value of exposure in the City of Wilmington is $188,722,177 with a total potential damage of $1,463,858.

Because of the nature of human-caused hazards and the nature in which risk and vulnerability is presented for human-caused hazards, it is not possible to rank them fairly in direct comparison with natural hazards. In summary, all human-caused hazards addressed in this section—terrorism (chemical, radiological and biological agents), hazardous materials incidents (HazMat), and energy pipeline failures—warrant an overall rating of low risk for the City of Wilmington.

The final risk ranking demonstrates that flooding and storms, with the potential for power failure, are the two most critical threats to the City of Wilmington population and built environment

University of Delaware Hazard Risks

Table 4.3-36
Estimated Level of Risk by Hazard for the University of Delaware (High, Moderate, Low)

Jurisdiction	Flood	Coastal Wind	Tornado	Drought	Hail	Winter Storm	Thunder-storm	Earthquake
Newark Campus	Minor	Minor	Minor	Negligible	Negligible	Negligible	Negligible	Negligible
Wilmington Campus	Negligible	Minor	Minor	Negligible	Negligible	Negligible	Negligible	Negligible

Table 4.3-37
Overall Risk Ranking for the University of Delaware
Newark and Wilmington Campuses, New Castle County

Rank	Based on Likelihood of Occurrence	Based on Impact to the University
1	Thunderstorm	Flood
2	Power Failure	Hazmat Incident
3	Flood	Terrorism
4	Winter Storm	Pipeline Failure
5	Pipeline Failure	Fire
6	Fire	Coastal Wind
7	Tornado	Tornado
8	Hazmat Incident	Power Failure
9	Coastal Wind	Winter Storm
10	Extreme Temperatures	Thunderstorm
11	Terrorism	Extreme Temp
12	Drought	Drought
13	Dam Failure	Dam Failure
14	Earthquake	Earthquake

The Wilmington Campus is not subject to flooding as determined using the FEMA Digital Flood Insurance Rate Map (DFIRM) Flood Boundary. The Newark Campus may experience a minor amount of flooding from a small tributary of White Clay Creek, near Library Road. Based on a review of coastal flooding, the risk to the Wilmington and Newark campuses is negligible.

Because of the nature of human-caused hazards and the nature in which risk and vulnerability is presented for human-caused hazards, it is not possible to rank them fairly in direct comparison with natural hazards. In summary, all human-caused hazards addressed in this section—terrorism (chemical, radiological and biological agents), hazardous materials incidents (HazMat), and energy pipeline failures—warrant an overall rating of low risk. The final risk ranking demonstrates that flooding and severe storms, with the potential for power failure, are the two most critical threats to the University of Delaware population and built environment.

5. CAPABILITY ASSESSMENT

5.1 Introduction

This Chapter of the Plan Update discusses the capability of New Castle County and the participating municipal jurisdictions to implement hazard mitigation activities. The capability assessment helps identify existing gaps, conflicts and/or shortcomings that may need to be addressed through future mitigation actions and helps to ensure that proposed mitigation actions are practical, while considering the County's and municipalities' capacity to implement these actions. It also examines completed or in-progress actions that merit continued support and enhancement through future efforts. The mitigation capability assessment comprises two components:

1. Municipal Capability Assessment, which includes an analysis of the municipalities' capacity from a planning, policy, staffing, and training standpoint.
2. Document Review, which includes a review of the County's and municipalities' existing plans and ordinances and suggestions for incorporation of mitigation principles in these documents.

5.2 What is a Municipal Capability Assessment?

The purpose of conducting a capability assessment is to determine the ability of a local jurisdiction to implement a mitigation strategy, and to identify potential opportunities for establishing or enhancing specific mitigation policies, programs or projects.[1] As in any planning process, it is important to try to establish which goals, objectives and actions are feasible, based on an understanding of the organizational capacity of those agencies or departments tasked with their implementation. A capability assessment helps to determine which mitigation actions are practical and likely to be implemented over time given the fiscal, technical, administrative and political framework of the community.

A capability assessment has two primary components: an inventory of a local jurisdiction's relevant plans, programs or policies already in place; and an analysis of its capacity to carry them out. Careful examination of local capabilities will detect any existing gaps, shortfalls or weaknesses with ongoing government activities that could hinder proposed mitigation activities and possibly exacerbate community hazard vulnerability. A capability assessment also highlights the positive mitigation measures already in place or being implemented at the local government level, which should continue to be supported and enhanced if possible through future mitigation efforts.

The capability assessment completed for New Castle County serves as a critical part of the foundation for designing an effective hazard mitigation strategy. Coupled with the *Risk Assessment*, the *Capability Assessment* helps identify and target meaningful mitigation actions for incorporation in the *Mitigation Strategy* portion of the All Hazard Mitigation Plan. It not only helps establish the goals and objectives for New Castle County to pursue under this Plan, but also ensures that those goals and objectives are realistically achievable under given local conditions.

[1] While the Final Rule for implementing the Disaster Mitigation Act of 2000 does not require a local capability assessment to be completed for local hazard mitigation plans, it is a critical step to develop a mitigation strategy that meets the needs of each jurisdiction while taking into account their own unique abilities. The Rule does state that a community's mitigation strategy should be "based on existing authorities, policies, programs and resources, and its ability to expand on and improve these existing tools" (44 CFR, Part 201.6(c)(3)).

5.3 Capability Assessment Update

Requirement §201.6(b)(3): The planning process must include a review and incorporation, if appropriate, of existing plans, studies, reports, and technical information.

A Capability Assessment survey was developed during the initial planning process in 2003, which asked specific questions about existing local plans, policies, programs or ordinances that contribute to and/or hinder the community's ability to implement hazard mitigation actions. Questions were asked concerning each jurisdiction's technical, fiscal, administrative and political capabilities to implement mitigation actions. The survey results provided an extensive inventory of existing local plans, policies, programs and ordinances and required local officials to conduct a self-assessment of their jurisdiction's specific capabilities.

The information provided by the participating jurisdictions in response to the survey questionnaire was incorporated into a database for further analysis. A general scoring methodology was then applied to quantify and rank each jurisdiction's overall capability relative to one another. According to the scoring system, each plan, policy, ordinance or program was assigned a point value based on its relevance to hazard mitigation. Additional points were added based on each jurisdiction's self-assessment of their own fiscal, technical, administrative and political capability. A total score and general capability rating (High, Moderate or Limited) was then determined according to the total number of points received. The survey results also serve as a good source of introspection for those jurisdictions wishing to improve their capability, as identified gaps, weaknesses or conflicts may be recast as opportunities for specific mitigation actions. During the 2009 Plan Update process the *Capability Assessment Survey* was redistributed to the municipalities.

During the 2015 Plan Update process the *Capability Assessment Survey* was redistributed to the municipalities and have been updated by municipal officials and areas where plans, ordinances, and political, fiscal, or administrative and technical capability had changed since 2009.

In addition to the results of the *Capability Assessment Survey*, an inventory of some previously completed hazard mitigation projects in New Castle County is included as part of this assessment. This inventory provides information on past mitigation efforts taken in New Castle County to reduce the effect of identified hazards. Documenting past mitigation measures can also serve to help assess the degree to which local governments are willing to adopt future mitigation actions.

5.4 Capability Assessment Findings

The findings of the capability assessment are summarized in this Plan to provide insight into relevant capacity of New Castle County's jurisdictions to implement hazard mitigation activities. All information is based upon the responses from the municipalities.

Table 5.1 provides a summary of the local plans and programs in place for New Castle County's participating local governments. An "X" indicates that the given plan or program is currently in place and being implemented by the local jurisdiction.
Note: Those Relevant Plans and Programs denoted with an asterisk before them in the section below are elaborated in the Document Review section at the end of this chapter.

Table 5.1
Relevant Plans and Programs in Place

Jurisdiction	HMP	DRP	CLUP	FMP	SMP	EOP	COOP	REP	SARA	TRANS	CIP	REG-PL	HPP	ZO	SO	FDPO	NFIP	CRS	BC
New Castle County	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X
Arden, Village of	X		X	X				X	X			X	X	X					X
Ardencroft, Village of	X		X	X				X	X			X	X	X					X
Ardentown, Village of	X		X	X	X			X	X			X	X			X	X		X
Bellefonte, Town of	X		X		X			X	X				X	X	X		X		X
Delaware City, City of	X		X	X	X			X	X	X		X	X	X	X	X	X	X	X
Elsmere, Town of	X		X	X	X	X		X	X					X	X	X	X	X	X
Middletown, Town of	X		X		X			X	X				X	X	X	X	X		X
New Castle, City of	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Newark, City of	X	X	X	X	X	X	X	X	X	X			X	X	X	X	X	X	X
Newport, City of	X		X	X	X			X	X	X	X	X		X	X	X	X		X
Odessa, Town of	X		X	X	X			X	X	X			X	X	X	X			X
Townsend, Town of	X		X	X	X	X		X	X		X	X		X	X	X			X
University of Delaware	X	X				X	X	X		X	X								X
Wilmington, City of	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X

Key to Table 5.1

HMP – Hazard Mitigation Plan
DRP – Disaster Recovery Plan
CLUP – Comprehensive Land Use Plan
FMP – Floodplain Management Plan / Flood Mitigation Plan
SMP – Stormwater Management Plan
EOP – Emergency Operations Plan
COOP – Continuity of Operations Plan
REP – Radiological Emergency Plan
SARA – SARA Title III Emergency Response Plan
TRANS – Transportation Plan
CIP – Capital Improvements Plan (that regulates infrastructure in hazard areas)
REG-PL – Regional Planning
HPP – Historic Preservation Plan
ZO – Zoning Ordinance
SO – Subdivision Ordinance
FDPO – Flood Damage Prevention Ordinance
NFIP – National Flood Insurance Program
CRS – Community Rating System
BC – Building Codes

Emergency Management Capabilities

Hazard mitigation is widely recognized as one of the four primary phases of emergency management. Other phases include preparedness, response and recovery. In reality, each phase is interconnected with hazard mitigation as Figure 5.1 suggests. Planning for each phase is a critical part of a comprehensive emergency management program and a key to the successful implementation of hazard mitigation actions. As a result, the *Capability Assessment Survey* asked several questions across a range of emergency management plans in order to assess the jurisdiction's willingness to plan and their level of technical planning proficiency.

Figure 5.1
The Four Phases of Emergency Management

**Hazard Mitigation Plan*: A hazard mitigation plan represents a community's blueprint for how they intend to reduce the impact of natural and human-caused hazards on people and the built environment. The essential elements of a hazard mitigation plan include a risk assessment, capability assessment and mitigation strategy.

- Survey results indicate that five (5) jurisdictions have a hazard mitigation plan.
- The Town of Elsmere recently developed a Hazard Mitigation Plan, The City of Newark completed a Snow and Ice Control Plan. The City of Wilmington amended their Flood Prevention and Damage Ordinance and is working on a plan to reduce localized flooding in the region. The State of Delaware's 2012 Hazard Mitigation Plan highlights flood awareness and preparation and supporting local jurisdictions.

Disaster Recovery Plan: A disaster recovery plan serves to guide the physical, social, environmental and economic recovery and reconstruction process following a disaster. In many instances, hazard mitigation principles and practices are incorporated into local disaster recovery plans with the intent of capitalizing on opportunities to break the cycle of repetitive disaster losses.

- Survey results indicate that four (4) jurisdictions have a disaster recovery plan.
- Many of the municipal officials indicated that their jurisdiction relies on the County for pre-disaster planning and post-disaster response and recovery operations.

**Emergency Operations Plan*: An emergency operations plan outlines responsibilities and the means by which resources are deployed following an emergency or disaster.

- Survey results indicate that six (6) jurisdictions have an emergency operations plan.
- Many of the municipal officials indicated that their jurisdiction relies on the County for emergency operations planning and management, and receive copies of the County's EOP on a regular basis.
- New Castle County's Emergency Operations Plan (EOP) was first adopted in 1989 and was last amended in 2013. The City of New Castle has an Emergency Operations Plan for snow removal and is completing a similar plan for hurricanes. The City of Newark rewrote and adopted their Emergency Operations Plan in 2007 and added a Snow and Ice Control Plan. The Town of Townsend's Emergency Operations Plan was completed by the local volunteer fire department.

**Continuity of Operation Plan*: A continuity of operations plan establishes a chain of command, line of succession and plans for backup or alternate emergency facilities in case of an extreme emergency.

- Survey results indicate that four (4) jurisdictions have a continuity of operations plan (COOP)
- New Castle County has a COOP, which aims to provide guidance to recovery/continue business operations after a disaster incident, including support, command and control for crisis and disaster situations.

Radiological Emergency Plan: A radiological emergency plan delineates roles and responsibilities for assigned personnel and the means to deploy resources in the event of a radiological accident.

- Survey results indicate that four (4) jurisdictions have a radiological emergency plan. New Castle County follows the State of Delaware Radiological Emergency Plan that was adopted in 1983 and last amended in 2001.

SARA Title III Emergency Response Plan: A SARA Title III Emergency Response Plan outlines the procedures to be followed in the event of a chemical emergency such as the accidental release of toxic substances. These plans are required by federal law under Title III of the Superfund Amendments and Re-authorization Act (SARA), also known as the Emergency Planning and Community Right-to-Know Act (EPCRA).

- The New Castle County Office of Emergency Preparedness also prepared the Delaware City—Community Awareness and Emergency Response Plan (DC-CAER). The Plan is a comprehensive emergency response plan to deal with a chemical emergency at the chemical industrial complex located in Delaware City.

General Planning Capabilities

The implementation of hazard mitigation activities often involves agencies and individuals beyond the emergency management profession. Other stakeholders may include local planners, public works officials, economic development specialists and others. In many instances, concurrent local planning efforts will help to achieve or complement hazard mitigation goals even though they are not designed as such. Therefore, the *Capability*

Assessment Survey also asked questions regarding each jurisdiction's general planning capabilities and to what degree hazard mitigation is integrated into other ongoing planning efforts.

Regional Planning: Regional planning refers to any type of planning effort that involves a community working in conjunction with neighboring jurisdictions. For example, the development of this All Hazard Mitigation Plan is a regional planning effort.

- Survey results indicate that nine (9) jurisdictions participate in regional planning decisions, most notably through the Wilmington Area Planning Council (WILMAPCO). WILMAPCO is the designated Metropolitan Planning Organization (MPO) for the region that includes New Castle County, Delaware, and Cecil County, Maryland. The organization is primarily responsible for coordinating transportation plans of local governments within the region, including towns and cities, counties, and states.

**Comprehensive Plan*: A comprehensive plan establishes the overall vision for what a community wants to be and a guide to future governmental decision-making. Typically a comprehensive plan is comprised of demographic conditions, land use, transportation elements and community facilities. Given the broad nature of the plan and its regulatory standing in many communities, the integration of hazard mitigation measures into the comprehensive plan can enhance the likelihood of achieving risk reduction goals, objectives and actions.

- The State of Delaware requires its counties to adopt and regularly update comprehensive plans in conformity with the Quality of Life Act of 1988. The Act requires the plans to include the following elements: Economic Development, Housing, Conservation (including Agriculture), Historic Preservation, Recreation and Open Space, Accomplishments, Intergovernmental Coordination, Mobility, Water and Sewer, Community Facilities, and Future Land Use. An optional element is Community Design.
- New Castle County's Comprehensive Development Plan was completed in 1998 and last updated in 2012. The update was also reviewed and certified under the Livable Delaware guidelines.
- Delaware City is currently updating portions of their Comprehensive Plan and received a five (5) year extension for a complete update from the State.
- The Comprehensive Development Plan for Wilmington includes a City-Wide Plan for Land Use.
- New Castle County has a Capital Program and Budget extending from 2015 to 2020.

Table 5.2 shows the progress made as of 2009 by the municipal jurisdictions in New Castle County to update their comprehensive plans.

Table 5.2
Local Comprehensive Plan Updates

Jurisdiction	Plan Status
Arden, Village of	Under County Jurisdiction
Ardencroft, Village of	Under County Jurisdiction
Ardentown, Village of	Under County Jurisdiction
Bellefonte, Town of	Under County Jurisdiction
Delaware City, City of	Certified (2008)
Elsmere, Town of	Completed 2010
Middletown, Town of	Complete (2001)
New Castle, City of	Certified (2009)
Newark, City of	Certified (2013)
Newport, City of	Certified (2003)
Odessa, Town of	Complete (2006)
Townsend, Town of	Certified (2003)
Wilmington, City of	Certified (2009)

Source: Delaware Office of State Planning Coordination

- The City of Newark's Comprehensive Plan addresses stormwater management and floodplain protection, and according to local officials has been effective in reducing hazard impacts.

Transportation Plan: A transportation plan identifies the means to gauge transportation demands and the options to meet those needs, while considering the social, economic and environmental characteristics of the area. The development of transportation networks can significantly impact the amount, type and location of future growth. As a result, transportation planning can have a dramatic effect on future hazard vulnerability.

- Survey results indicate that six (6) jurisdictions have their own transportation plan. Transportation planning (including emergency evacuation planning) is commonly addressed as an element to the local comprehensive plans and in coordination with the Delaware Department of Transportation and WILMAPCO.

- Survey results indicate that five (5) jurisdictions have capital improvement plans that regulate the provision or extension of infrastructure in hazard areas.

Historic Preservation Plan: A historic preservation plan is intended to preserve historic structures or districts within a community. An aspect of the historic preservation plan that is often overlooked is the assessment of buildings and sites located in areas subject to natural hazards to include the identification of the most effective way to reduce future damages.[2] This may involve retrofitting or relocation techniques that account for the need to protect buildings that do not meet current building standards or are within a historic district that cannot easily be relocated out of harms way.

[2] See Protecting the Past from Natural Disasters. 1989. Nelson, Carl. National Trust for Historic Preservation: Washington, D.C.

- Survey results indicate that 10 jurisdictions have historic preservation plans.

Zoning Ordinances: Zoning represents the means by which land use is controlled by local governments. As part of a community's police power, zoning is used to protect the public health, safety and welfare of those in a given jurisdiction that maintains zoning authority. A zoning ordinance is the mechanism through which zoning is typically implemented. Since zoning regulations enable municipal governments to limit the type and density of development, it can serve as a powerful tool when applied in identified hazard areas.

- Survey results indicate that 13 jurisdictions have a zoning ordinance.

Subdivision Ordinances: A subdivision ordinance is intended to regulate the development of housing, commercial, industrial or other uses, including associated public infrastructure, as land is subdivided into buildable lots for sale or future development. Subdivision design that accounts for natural hazards can dramatically reduce the exposure of future development.[3]

- Survey results indicate that 11 jurisdictions have a subdivision ordinance.

Building Codes, Permitting and Inspections: Building Codes regulate construction standards. In many communities, permits are issued for, and inspections of work take place on, new construction. Decisions regarding the adoption of building codes (that account for hazard risk), the type of permitting process required both before and after a disaster, and the enforcement of inspection protocols all affect the level of hazard risk faced by a community.

- Survey results indicate that all jurisdictions have adopted a local building code.
- At the City of Newark's Inspections Department, all inspectors are currently ICC certified.
- The Town of Elsmere switched from using the BOCA and COBO building code to the ICC International Building Code 2000 edition.
- New Castle County adopted the Unified Development Code in December 1997. The most recent amendment to the Code was in November 2009.
- The County has a Building and Structures Code that was amended on 1 January 2009. The Code adopts the International Building, Residential, Mechanical, Plumbing, Fuel Gas, Existing Building Code, and Energy Conservation Codes.

In addition to using survey results, the adoption and enforcement of building codes by local jurisdictions was assessed using the Building Code Effectiveness Grading Schedule (BCEGS) program developed by the Insurance

[3] For additional information regarding the use of subdivision regulations in reducing flood hazard risk, see Subdivision Design in Flood Hazard Areas. 1997. Morris, Marya. Planning Advisory Service Report Number 473. American Planning Association: Washington, D.C.

Services Office, Inc. (ISO).[4] Under the BCEGS program, ISO assesses the building codes in effect in a particular community and how the community enforces its building codes, *with special emphasis on mitigation of losses from natural hazards*. The results of BCEGS assessments are routinely provided to ISO's member private insurance companies, which in turn may offer ratings credits for new buildings constructed in communities with strong BCEGS classifications. The concept is that communities with well-enforced, up-to-date codes should demonstrate better loss experience, and insurance rates can reflect that.

In conducting the assessment, ISO collects information related to personnel qualification and continuing education as well as number of inspections performed per day. This type of information, combined with local building codes, is used to determine a grade for that jurisdiction. The grades range from 1 to 10, with the lower grade being more ideal. A BCEGS grade of 1 represents exemplary commitment to building code enforcement, and a grade of 10 indicates less than minimum recognized protection.

BCEGS grades for each of New Castle County's local jurisdictions are listed in Table 5.3.

Table 5.3
BCEGS Grades for New Castle County Jurisdictions

Jurisdiction	BCEGS Grade
New Castle County	4
Arden, Village of	9*
Ardencroft, Village of	9*
Ardentown, Village of	9*
Bellefonte, Town of	9*
Delaware City, City of	9*
Elsmere, Town of	7
Middletown, Town of	*Declined Participation*
New Castle, City of	9*
Newark, City of	4
Newport, City of	9
Odessa, Town of	9*
Townsend, Town of	*Not Evaluated*
Wilmington, City of	*Not Evaluated*

* Building code administered and enforced by New Castle County.

Source: Insurance Services Office, Inc.

Floodplain Management Capability

Flooding represents the greatest natural hazard facing the nation. At the same time, the tools available to reduce the impacts associated with flooding are among the most developed when compared to other hazard-specific mitigation techniques. In addition to approaches that cut across hazards, such as education, outreach, and the training of local officials, the *National Flood Insurance Program* (NFIP) contains specific regulatory measures that enable government

[4] Participation in BCEGS is voluntary and may be declined by local governments if they do not wish to have their local building codes evaluated.

officials to determine where and how growth occurs relative to flood hazards. Participation in the NFIP is voluntary for local governments, but the program is promoted by FEMA and DEMA as a first basic step for implementing and sustaining an effective hazard mitigation program. It is therefore used as a key indicator for measuring local capability as part of this assessment.

In order for a county or municipality to join the NFIP, they must adopt a local flood damage prevention ordinance that requires jurisdictions to follow established minimum building standards in the floodplain. These standards require that all new buildings and substantial improvements to existing buildings will be protected from damage by the 100-year flood, and that new floodplain development will not aggregate existing flood problems or increase damage to other properties.

Another key service provided by the NFIP is the mapping of identified flood hazard areas. Once prepared, the Flood Insurance Rate Maps (FIRMs) are used to assess flood hazard risk, regulate construction practices and set flood insurance rates. FIRMs are an important source of information to educate residents, government officials and the private sector about the likelihood of flooding in their community.

Table 5.4 summarizes NFIP participation for each of New Castle County's local jurisdictions.

Table 5.4
NFIP Participation in New Castle County

Jurisdiction	NFIP Entry Date	Current Effective Map
New Castle County	12/03/71	02/04/2015
Arden, Village of	Expected to join NFIP in April 2015	N/A
Ardencroft, Village of	Expected to join NFIP in April 2015	N/A
Ardentown, Village of	1/28/97	02/04/2015
Bellefonte, Town of	Not in NFIP	N/A
Delaware City, City of	2/16/77	02/04/2015
Elsmere, Town of	12/31/76	02/04/2015
Middletown, Town of	1/07/77	02/04/2015
New Castle, City of	12/26/75	02/04/2015
Newark, City of	3/29/74	02/04/2015
Newport, City of	6/15/78	02/04/2015
Odessa, Town of	Not in NFIP	N/A
Townsend, Town of	Not in NFIP	N/A
Wilmington, City of	5/5/1977	02/04/2015

Source: Federal Emergency Management Agency

An additional indicator of floodplain management capability is the number of participants in the *Community Rating System* (CRS). The CRS is an incentive-based program that encourages counties and municipalities to undertake defined flood mitigation activities that go beyond the minimum requirements of the NFIP, adding extra local measures to provide protection from flooding. All of the 18 creditable CRS mitigation activities are assigned a range of point values. As points are accumulated and reach identified thresholds, communities can apply for an improved CRS

class. Class ratings, which run from 10 to 1, are tied to flood insurance premium reductions as shown in Figure 5.2. As class ratings improve (decrease), the percent reduction in flood insurance premiums for NFIP policy holders in that community increases.

Figure 5.2
CRS Premium Discounts, By Class

CRS Class	Premium Reduction
1	45%
2	40%
3	35%
4	30%
5	25%
6	20%
7	15%
8	10%
9	5%
10	0

Source: FEMA

Community participation in the CRS is voluntary. Any community that is in full compliance with the rules and regulations of the NFIP may apply to FEMA for a CRS classification better than class 10. The CRS application process has been greatly simplified over the past several years based on community comments to make the CRS more user friendly as possible, and extensive technical assistance is also available for communities who request it.

Table 5.5 lists the current CRS communities in New Castle County.

Table 5.5
CRS Communities in New Castle County

Jurisdiction	CRS Entry Date	Current CRS Class
New Castle, City of	10/1/94	8
Newark, City of	10/1/92	7
Delaware, City of	10/1/94	8
Unincorporated areas of County	05/01/13	8

Source: FEMA

Floodplain Management Plan: A floodplain management plan (or a flood mitigation plan) provides a framework for action regarding the corrective and preventative measures in place to reduce flood-related impacts.

- Survey results indicate that 13 jurisdictions have a floodplain management plan or flood mitigation plan.

Stormwater Management Plan: A stormwater management plan is designed to address flooding associated with stormwater runoff. The stormwater management plan is typically focused on design and construction measures that are intended to reduce the impact of more frequently occurring minor urban flooding.

- Survey results indicate that 12 jurisdictions have stormwater management plans. Many of the municipalities in New Castle County coordinate their stormwater management efforts with the New Castle County Conservation District and the Delaware Department of Natural Resources and Environmental Control.

- Section 5101 of the Sediment and Stormwater Regulation identifies ways to reduce effects of stormwater runoff on the water and lands of the State of Delaware. It is administered by the Division of Watershed Stewardship, Department of Natural Resources and Environmental Control.

Environmental Protection Measures

- A Riparian Buffer Area (RBA) consists of land, which forms a transition zone between aquatic and terrestrial environments. The RBA in New Castle County includes: 100 feet on either side of perennial and intermittent streams, lakes and tidal wetlands; all of the floodplain, plus an additional fifty (50) feet of adjacent land; all of a non-tidal wetland greater than twenty thousand (20,000) square feet in area, plus an additional fifty (50) feet of adjacent land; and all of any size nontidal wetland classified as a Piedmont Stream Valley Wetland, as defined in the 1997 New Castle County Comprehensive Plan Update.

- New Castle County has a program to preserve land by providing a density bonus to developers. Development rights may be used on site, or they may be transferred to another site.

- The Wildlife Action Plan seeks to maintain the full range of our native species so they do not become endangered. By advocating protection of a “green infrastructure” of interconnected forests, uplands, and wetlands, the Plan seeks to prevent habitat loss, fragmentation, and degradation caused by residential, commercial, and industrial development and the spread of invasive species.

County and Municipal Self Assessment

In addition to the inventory and analysis of existing plans, programs and policies, the *Capability Assessment Survey* required each local jurisdiction to conduct a self assessment of its capability to implement hazard mitigation activities. As part of this process, county and municipal officials were encouraged to consider the barriers implementing mitigation strategies in addition to the mechanisms that could further such strategies. In response to the survey questionnaire local officials classified the following capabilities as either “limited,” “moderate” or “high”:

- Technical capability

- Fiscal capability
- Administrative capability
- Political capability

Table 5.6 summarizes the results of the self-assessment process for technical, fiscal and administrative capabilities. An "L" indicates limited capability; an "M" indicated moderate capability; and an "H" indicates high capability. In some instances no response was provided (intentionally left blank). Further descriptions and discussions on each are provided below, in addition to some of general findings on political capability.

Table 5.6
Self-Assessment of Local Capability

Jurisdiction	Technical Capability	Fiscal Capability	Administrative Capability
New Castle County	H	L	M
Arden, Village of	L	M	L
Ardencroft, Village of	L	L	L
Ardentown, Village of	L	L	L
Bellefonte, Town of	L	L	L
Delaware City, City of	L	L	M
Elsmere, Town of	L	L	L
Middletown, Town of	H	M	M
New Castle, City of	H	M	M
Newark, City of	L	M	M
Newport, City of	L	L	L
Odessa, Town of	L	L	L
Townsend, Town of	L	M	L
Wilmington, City of	H	M	H

Technical Capability

Technical capability can be defined as possessing the skills and tools needed to improve decision making, including the development and implementation of sound mitigation actions. For purposes of gauging the technical capability of New Castle County's local jurisdictions for mitigation planning purposes, the *Capability Assessment Survey* focused on the local availability and application of Geographic Information Systems (GIS).

The analysis of the responses to the *Capability Assessment Survey* indicated that there is generally a *limited* technical capability of New Castle County's jurisdictions to implement mitigation strategies. Ten (10) of the 15

jurisdictions surveyed indicated they had limited technical capability, while only four (4) indicated they had high technical capability. Most of the cities and towns don't employ GIS staff or have direct access to GIS systems due to financial limitations, and many indicated that they rely on New Castle County for GIS data and management services. Many local officials indicated that they are interested in gaining better access to GIS and related technical resources for their jurisdiction.

Recommendations: While there is a wide range of technical resources across the county and municipal governments, the development of a systematic protocol for sharing resources could significantly increase the level of technical capability to analyze natural hazards and develop meaningful actions to reduce their impact. This includes additional training to undertake GIS-driven risk assessments to identify potential mitigation projects and enhancing the ability to use information technologies to facilitate the formulation, development, implementation and monitoring of mitigation plans. The development of cooperative, countywide mitigation actions should also be used to assist in this effort.

Fiscal Capability

The ability to take action is often closely associated with the amount of money available to implement policies and projects.[5] This may take the form of grants received or state and locally-based revenue. The costs associated with policy and project implementation vary widely. In some cases, policies are tied primarily to staff costs associated with the creation and monitoring of a given program. In other cases, money is linked to an actual project, like the acquisition of flood-prone homes, which can require a substantial commitment from local, state and federal funding sources.

The analysis of the responses to the *Capability Assessment Survey* indicated that there is a *limited to moderate* fiscal capability of New Castle County's jurisdictions to implement mitigation strategies. Eight (8) jurisdictions indicated they had limited fiscal capability, while six (6) indicated they had moderate fiscal capability. Some jurisdictions have the ability to generate revenue for mitigation purposes, such as charging stormwater utility fees for clearing drainage systems and completing flood mitigation projects (in fact, most communities in New Castle County do pay for drainage system maintenance through their own internal funding sources). However, most jurisdictions in New Castle County do not have access to such dedicated revenue streams and rely heavily upon monies available through state and federal grant programs.

Under the NCC Capital Budget for FY 2015-2020, the County Council is required to approve a capital program and adopt a capital budget before it ordains the annual operating budget. The program is required to detail each capital improvement project. Each project indicates the amount of appropriations that have been expended or are to be expended and the funding sources. This ranking is then related to the County's ability to pay for the projects over time.

The results of the local capability assessment should be used as a general guide to help craft mitigation actions that are achievable. When considering the effect of fiscal capability on the implementation of mitigation policies and projects, jurisdictions should consider whether the actions require monetary commitment or staff resources. If so,

[5] Gaining access to federal, state or other sources of funding is often an overriding factor driving the development of hazard mitigation plans. However, an important objective of local governments seeking a more sustainable future is the concept of self reliance. Over time, counties and municipalities should seek the means to become less dependent on federal assistance, developing a more diversified approach that assesses the availability of federal, state and locally-generated funding to implement mitigation actions. Additional assistance may be available from the business and corporate sector as well as certain non-profit groups. This should be coupled with an attempt to identify mitigation measures that cost little or no money, yet may compliment the larger array of actions identified in the Plan.

consideration should be given to available grant funding sources, or perhaps combining resources with the county or other municipalities to offset costs of implementation. Consideration should also be made as to whether the jurisdiction is willing to commit local revenue on a sustained or one-time basis.

In most cases, in order to implement mitigation projects and policies, some monetary commitment or staff resources will be required. This may take the form of a non-federal match requirement or the costs associated with staff time devoted to policy development, implementation and monitoring. The identification of eligible Pre-Disaster Mitigation projects, as well as other federal funding sources identified in the New Castle County Mitigation Plan, enables communities to compete nationally for available funding. The county and municipal governments should consider, whenever possible, combining financial and staff resources to address hazards, most of which tend to impact regions rather than individual jurisdictions.

Finally, if local governments have access to an ongoing source of revenue, rather than a strict reliance on grant funds, a more comprehensive and sustained mitigation effort can be achieved. Examples include the development of a stormwater utility fee or the development of a budgetary line item that specifically addresses hazard mitigation.

Administrative Capability

Administrative capability was evaluated by reviewing county and municipal staffing and the existing organizational structure for local governments to implement mitigation strategies. The ability of a local government to develop and implement mitigation projects, policies and programs is directly tied to its ability to direct staff time and resources for that purpose.

The analysis of the responses to the *Capability Assessment Survey* indicated that there is generally a *limited to moderate* administrative capability of New Castle County's jurisdictions to implement mitigation strategies. Eight (8) jurisdictions indicated they had limited administrative capability, while six (6) indicated they had moderate administrative capability. Local municipal jurisdictions in New Castle County indicated that they work cooperatively with the county on many activities, helping to offset their administrative and staff limitations. Most municipal police and fire departments have mutual aid agreements in place with the county covering response and recovery operations, but not mitigation activities. The villages of Arden, Ardencroft and Ardentown work cooperatively with each other and the county on many local activities. Some municipalities in fact credit their small staff size to facilitating close intergovernmental cooperation.

The implementation of mitigation actions are assigned to special services and/or contractors. Municipal actions are completed by the municipality. Both county and municipal actions are often completed in coordination with the Conservation District. Other mitigation actions are identified within the departments and handled by specific departments.

Recommendations: The results of the administrative capability assessment demonstrate that the county and larger municipalities tend to possess a stronger administrative capability than smaller communities. This is primarily due to fiscal limitations, as smaller jurisdictions by nature have a limited tax base to support local government services. The development of local administrative capability may best be achieved through enhanced intergovernmental cooperation, outreach, training and mentoring for smaller jurisdictions as well as the sharing of resources, when appropriate. Local governments wishing to improve their local internal staff's emergency management expertise should consider sending staff to the free or low-cost training seminars available through DEMA's Training Program and FEMA's Emergency Management Institute. In preparing local mitigation strategies, local governments should look to integrate hazard mitigation activities into routine governmental functions whenever possible.

Political Capability

One of the most difficult capabilities to evaluate involves the political will of a jurisdiction to enact meaningful policies and projects designed to reduce the impact of future hazard events. Hazard mitigation may not be a local priority or could mistakenly be seen by local officials as an impediment to other goals of the community, such as growth and economic development. The local political climate must be considered in designing mitigation strategies as it could be the most difficult hurdle to overcome in accomplishing their adoption or implementation.

The analysis of responses to the *Capability Assessment Survey* indicated that there is generally a *moderate* political capability of New Castle County's jurisdictions to implement mitigation strategies. Many jurisdictions cited plans or programs in place that support hazard mitigation principles, such as restrictive development codes and specific mitigation projects. Others highlighted the implementation of aggressive yet controversial policies or programs in their jurisdiction.

Recommendations: Increasing local political capability to implement mitigation strategies is most often achieved through a coordinated approach to loss reduction that includes: (1) gaining community support from a wide range of local interest groups (particularly those that may be affected by proposed actions); and (2) informing and educating the elected and executive officials of the community in advance of the formal decision making process.

Community support should be generated by identifying key stakeholders early in the process of designing and proposing mitigation strategies. For example, in considering the regulation of construction in floodplains of other hazard areas, the local building and development industry should be brought in to share their ideas and concerns for crafting mitigation strategies that can work. This will help eliminate or minimize potential impediments to acceptance before strategies become drafted or officially proposed.

The City of Newark works closely with the University of Delaware and Aetna Emergency Management training, excercises, and response to build community support, harness local resources, and further education in Emergency Management and Hazard Mitigation.

Local elected and executive officials should become informed and educated on mitigation strategies in advance of any formal considerations or decisions. This will facilitate a greater understanding of specific mitigation objectives and expected outcomes, and lead to and indication as to whether proposed actions may need to be revised before moving forward. The information presented and shared with local officials should specifically target any known issues of concern and seek to alleviate those concerns.

University of Delaware 2011 Capability Assessment

The Capability Assessment from the 2011 University of Delaware Hazard Mitigation Plan included a questionnaire to help document community agencies/departments/organizations and their missions, functions, programs, plans, policies, regulations, funding, etc. of each group, in order to create an inventory of resources that can be brought to bear on mitigation efforts. The questions were intended to help departments identify the regulatory, administrative, technical, and fiscal capacities and capabilities and were based on FEMA's capability assessment questionnaire. The Capability Assessment content was revisited for the by the following departments and updated as necessary. The departments were contacted via phone, email and during a mitigation workshop held on 9 January 2015. The following departments were involved as part of this assessment. The results of this effort and an assessment of gaps and capabilities of these departments are included in Appendix C of this Plan Update.

- Campus and Public Safety, Emergency Management

- College of Earth, Ocean, and Environment
- Delaware Geological Survey
- Employee Labor Relations
- Facilities Custodial and University Services
- Facilities Maintenance and Operations
- Facilities Planning and Construction
- Facilities/Science, Technology, and Advanced Research (STAR) Campus
- Finance and Risk Management
- Human Resources
- Information Technology
- Office of Communications and Marketing
- Office of Residence Life
- Department of Public Safety, University Police
- Office of the Provost
- Office of Student Conduct
- Student Health Services
- Office of Student Life

Previously Implemented Mitigation Measures

The success of future mitigation efforts in a community can be gauged by past efforts. Previously implemented mitigation measures indicate that there is, or has been, a desire to reduce the effects of natural hazards. Past success of these projects can also be influential in building support for new mitigation efforts.

Hazard Mitigation Grant Program (HMGP) Projects

The Federal Emergency Management Agency's Hazard Mitigation Grant Program provides competitive funding to states and local governments for the implementation of long-term hazard mitigation measures following a presidential disaster declaration. Based on data from DEMA, there has been one HMGP project completed in New Castle County since 2009 totaling $100,673 in Federal HMGP funds.

Pre-Disaster Mitigation Program

FEMA's Pre-Disaster Mitigation (PDM) program, authorized and established under the Disaster Mitigation Act of 2000, is designed to provide states and communities with annual funding to implement cost-effective hazard mitigation activities. Based on data from DNREC, there are 14 PDM projects (completed and ongoing) in New Castle County since 2009, totaling $ $7,763,749.

Flood Mitigation Assistance Program

In the State of Delaware, the Department of the Environment and Natural Resources (DNREC) administers the FEMA Flood Mitigation Assistance program (FMA). The FMA is an annual pre-disaster mitigation grant program that provides funding for projects and plans that are aimed at reducing the number of insured properties that have incurred repetitive flood losses. Based on data from DNREC, one FMA project has been completed in New Castle County since 2009, totaling $250,000.

Table 5.7
New Castle County Hazard Mitigation Assistance Projects (HMA) Completed since 2009

Project	Description	Completion Date	Funding Source	Federal Grant	Federal Funds	Total Costs
Tide Gate Project		June 2009	DR-1654	$31,976	$100,673	
New Castle County Christiana Hospital Flood Mitigation	Dig a storm water retention pond and two floodwalls to protect Christiana Hospital's pharmacy loading dock and emergency power facilities.	May 2009	PDM 2007	PDM	$1,036,462	$1,382,160
Buttonwood Tide Gate Project	Install new tide gates in the Buttonwood area of New Castle	February 2009	HMGP 1654	HMGP	$31,976	$102,788
Metroform Medical Center Floodproofing	Floodproof the Metroform Medical Center	July 2009	FMA 2008	FMA	$195,000	$260,000
Shone Lumber Floodproofing Project	Floodproof Shone Lumber	October 2010	FMA 2009	FMA	$562,500	$750,000
Mitigation Plan Update	Update the City of Wilmington, New Castle County, Kent County, and Sussex County plans.	June 2010	PDM 2007	PDM	$83,888	$111,850
Newark Hazard Mitigation	Relocate two sewer lines that run above the Christina river into the streambed.	September 2012	PDM 2007	PDM	$1,054,689	$1,406,252
Union Church Rd Acquisition	Acquire flood prone home on Union Church Rd	March 2013	HMGP 1896	HMGP	$153,935	$205,247
3419 Faulkland Road Buyout	Acquire flood prone home on Faulkland Road	July 2012	FMAP 2009	FMAP	$172,500	230,000
NVF Corporate Office Buyout	Acquire flood prone business in Yorklyn area.	March 2013	FMAP 2009	FMAP	$1,640,250	$2,187,000
Barley Mill Rd Floodproofing	Flood proof a flood prone residence on Barley Mill Rd	April 2013	PDM 2011	PDM	$75,000	$124,993
Marsh Rd Acquisition	Acquire a flood prone home on Marsh Rd	On Going	HMGP 4037	HMGP	$214,959	$286,612
Wilmington EOC Floodproofing	Place a flood wall around the City of Wilmington EOC	On Going	PDM 2010	PDM	$260,730	$347,640
Newark Booster Retrofit	Retrofit potable water booster station	On Going	PDM 2010	PDM	$225,000	$325,000
Public Assistance Mitigation	Install riprap along a walkway in the City of New Castle.	On-going	PA 4090	PA	$6,179	$8,239
Acquisition and Demolition of a Flood Prone Property	A flood prone repetitive loss structure located near Hyde Run was purchased and demolished.	2009			$250, 000	

Source: Delaware Department of the Environment and Natural Resources, Delaware Emergency Management Agency

5.5 Conclusions on Local Capability

The capability of local governments in New Castle County varies greatly from jurisdiction to jurisdiction. However, much of this variation can be accounted for when assessing the size of each locality. According to the scoring methodology utilized for this assessment, the county and the larger municipalities tended to score higher, while smaller, more rural communities reported more limited capability. Table 5.10 shows the results of the capability assessment using the scoring methodology that was developed in the initial Plan. Based on the updated information received from the County and municipalities, there is no change to the capability ratings in any of the jurisdictions.

Points System for Capability Ranking

46 points max:

0-14 points = Limited overall capability
15-29 points = Moderate overall capability
30-46 points = High overall capability

Yes=3 points No=0 points
Hazard Mitigation Plan
Radiological Emergency Plan
SARA Title III/Hazardous Material Facility Emergency Response Plan
Participate in CRS Program
BCEGS Grade of 1 to 5

Yes=2 points No=0 points
Emergency Operations Plan
Comprehensive Plan (that addresses natural hazards)
Disaster Recovery Plan
Continuity of Operations Plan
Regional Planning
Stormwater Management Plan
Participate in NFIP
Floodplain Management Plan
BCEGS Grade of 6 to 9

Yes=1 point No=0 points
Any of the above plans under County Jurisdiction

Yes=1 point No=0 points
Comprehensive Plan (but does not address natural hazards)
Transportation Plan
Capital Improvements Plan
Historic Preservation Plan
Zoning Ordinance
Subdivision Ordinance
Adopted building code

High=2 points Moderate=1 points Low=0 points (Self-ranked by jurisdiction)
Technical Capability

Fiscal Capability
Administrative Capability
Political Capability

No points
Flood Damage Prevention Ordinance (required if participate in NFIP)

****This methodology is based on best available information. If a jurisdiction does not provide information on any of the above items, a point value of zero (0) will be assigned for that item.*

Table 5.8
Capability Assessment Results

Jurisdiction	Capability Score	Capability Rating
New Castle County	37	High
Arden, Village of	17	Moderate
Ardencroft, Village of	16	Moderate
Ardentown, Village of	19	Moderate
Bellefonte, Town of	15	Moderate
Delaware City, City of	29	Moderate
Elsmere, Town of	26	Moderate
Middletown, Town of	23	Moderate
New Castle, City of	35	High
Newark, City of	36	High
Newport, City of	22	Moderate
Odessa, Town of	18	Moderate
Townsend, Town of	27	Moderate
Wilmington, City of	37	High
University of Delaware	39	High

One of the most significant findings was the widespread existence of several planning initiatives, programs and tools in place in New Castle County. For example, local and intergovernmental planning is widely applied to response-related activities via the development and implementation of Emergency Operations Plans, Continuity of Operations Plans, Radiological Emergency Plans and SARA Title III planning through the Local Emergency Planning Committee (LEPC). As a result, jurisdictions are familiar with the concept and importance of pre-disaster planning.

An important consideration for New Castle County's local governments should be to work with each other to apply this planning experience to hazard mitigation. This Plan Update provides the vehicle to begin this process to obtain local buy-in and long-term success by implementing achievable mitigation actions (as listed in this Plan's *Mitigation Strategy*) that will facilitate continued intergovernmental coordination not only across the county, but with state and regional agencies as well.

Linking the Capability Assessment, Risk Assessment and Mitigation Strategy

The conclusions of the *Capability Assessment* and *Risk Assessment* serve as the foundation for a meaningful hazard mitigation strategy. During the process of identifying the goals, objectives and mitigation actions, each jurisdiction must consider not only their level of hazard risk but also their existing capability to minimize or eliminate that risk. Figure 5.3 shows a "Risk Versus Capability Matrix" that is used to illustrate each jurisdiction's overall hazard risk[6] in comparison to their overall capability. This matrix has been completed (with an "X") for each of New Castle County's participating jurisdictions and is included in each jurisdiction's distinct *Mitigation Action Plan in Chapter 6.2 of this document*.

Figure 5.3
Risk versus Capability Matrix

		HAZARD RISK		
		Limited	Moderate	High
OVERALL CAPABILITY	High			
	Moderate			
	Limited			

In jurisdictions where the overall hazard risk is considered to be HIGH, and local capability is considered LIMITED, then specific mitigation actions that account for these conditions should be considered. This may include less costly actions such as minor ordinance revisions or public awareness activities. Further, if necessary, specific capabilities may need to be improved in order to better address recurring threats. Similarly, in cases where the hazard vulnerability is LIMITED and overall capability is HIGH, more emphasis can be placed on actions that may impact future vulnerability such as guiding development away from known hazard areas. In general, the overal capabilities for the county and jurisdictions have remained unchanged since the 2009 Plan Update.

5.6 Document Review

Requirement §201.6(b): Review and incorporate, if appropriate, existing plans, studies, reports, and technical information.

The purpose of a plan/ordinance review as part of this planning process is tri-fold:

- To provide an inventory and review of sample plans and ordinances and identify sections in these documents that address hazard mitigation-related issues; and
- To provide a platform to integrate plans and other documents so recommendations and strategies are not in contradiction with one another (e.g., between the hazard mitigation plan and comprehensive plan).

[6] Overall hazard risk was determined for each jurisdiction using the results of the risk assessment (estimated losses for all natural hazards) combined with specific information on the following factors: total population, population growth rate, land area, historical disaster declarations, NFIP participation, unique hazard risks and coastal hazard vulnerability. More information on the methodology used to determine overall hazard risk is available through New Castle County upon request.

- To offer suggestions for incorporation of hazard mitigation principles into the County's and municipalities' existing plans and ordinances and offer options for integration.

Several plans and ordinances at the county and municipal level have been reviewed and a summary and options to integrate hazard mitigation principles into other planning mechanisms are included. Examples of departments and areas for coordination are listed below:

Department	Relevant Documents
Planning Department	Comprehensive Plan/Land Use Plan, Zoning/Subdivision Regulations, Floodplain Ordinance
Public Works/Transportation Department	Stormwater Management (SWM) Plan, Sediment and Erosion Control Plan, Culvert and Bridge Maintenance Plans Long Range Transportation Plan
Emergency Management Department	Evacuation Plan, Emergency Operations/Response Plan
Environmental Planning	Climate Change Plan, Dam Safety Regulations, Wetland Regulations
Parks and Recreation	Open Space Plan

Each year, when the jurisdictions provide an annual update of their actions, they should be encouraged to indicate how and where these mitigation efforts are being implemented and integrated.

Comprehensive Emergency Management Plan, New Castle County, Oct 2013

Overview: The New Castle County CEMP describes the basic strategies, assumptions, operational objectives, and mechanisms by which the County will mobilize resources and conduct preparedness, response, recovery, and mitigation activities. To facilitate effective operations, the CEMP adopts a functional approach that aligns with the 15 Federal Emergency Support Functions (ESFs) and is operationally managed using the Incident Command System (ICS) command structure.

Plan Strengths:
Page vii-x - The Plan was widely distributed to the County Executive's Office, New Castle County Departments, Libraries, Volunteer Fire Companies, municipalities, and other partners and organizations including hospitals, the US Army Corps of Engineers, Philadelphia District, and the Delaware River and Bay Authority.
Page 1 - The following goals from the CEMP pertain to mitigation: Reduce the vulnerability of New Castle County to human injury, loss of life, and environmental or property damage resulting from natural, technological or manmade emergencies, catastrophes, or civil disturbances. Promote risk-based analyses to drive decisions on long-term preparedness, prevention and mitigation measures directed at specific hazards.
Page 2 - The CEMP is divided into three main sections: 1. Basic Plan - establishes the framework for the Emergency Management Cycle (i.e. Preparedness, Protection, Response & Recovery) 2. Functional Annexes - focus on critical operational functions and identify responsible parties for implementation; and 3. Hazard Specific Annexes - focus on the special planning needs generated by the subject hazard.

Page 6 - The Plan refers to the County's Hazard Identification, Analysis, and Vulnerability Assessment, completed in August 2009, that identified 9 natural and three human related hazards that have the greatest potential to adversely affect the County as well as the 2010 All Hazards Mitigation Plan in January 2010.
Page 10 - The Plan includes an assumption that New Castle County will be proactive in its efforts to mitigate the consequences of, prepare for, respond to, and recover from the hazards identified in this Plan. The Plan references the Multi-jurisdictional Hazard Mitigation Plan and includes it as an Annex to the CEMP.
Page 25 - The Plan identifies Primary and Support areas of responsibility for each County agency, by ESF.

Options for Integration into the Hazard Mitigation Plan

- Consider joint participation of community staff in plan exercises (e.g., COOP, Comprehensive Emergency Management Plan [CEMP], emergency operations center [EOC], shelter, evacuation, housing, mitigation, recovery, comprehensive planning charettes).

New Castle County Continuity of Operations Plan

Overview – The County's Continuity of Operations Plan (COOP) provides guidance and documentation on which to base crisis management and business continuity efforts. The scope of this COOP is to provide guidance to recovery/continue business operations after a disaster incident, including support, command and control for crisis and disaster situations. The existence of this plan, and the coordinated crisis and recovery planning efforts, recognizes and affirms the importance of information to the organization, and the responsibility of each manager and employee for safeguarding information assets. The objectives of this COOP are to: 1. Ensure the ability to recover; 2. Ensure the timely resumption of operations 24-48 hours; 3. Decrease the impacts of the disaster incident on customer confidence, lost revenues, etc.; and 4. Minimize disruption of services. The COOP identifies recovery tasks by function as well as reports for equipment inventory, facilities, personnel, software inventory, vital records inventory, etc. The COOP includes the Comprehensive Emergency Plan as an appendix.

Options for Integration into the Hazard Mitigation Plan

- The COOP should which departments would be involved for specific functions, such as shelter operations, damage assessment, and flood control for various hazards.
- The COOP should include actions to collect valuable data (e.g., high water marks) after a recent hazard event. This type of information can be essential to preparing hazard mitigation project applications for FEMA funding.
- The COOP should identify mitigation opportunities for public facilities that are at high risk.

2012 New Castle County Comprehensive Plan

Overview: Topic meetings were held with staff of the New Castle County Department of Land Use and the general public. The purpose of these meetings was to focus on specific topics. In addition to this, comprehensive plan survey, visual preference survey and transportation visual preference survey was held.

To preserve New Castle County as a strong community, where residents can grow up and grow old in a healthy and safe environment, by encouraging environmentally and economically sustainable use of land, which protects the county's natural, cultural, agricultural, and historic resources.

Four core principles of community planning include:
1. Support blending and connecting of new growth to existing communities.

2. Emphasize the need to locate appropriate new growth areas and support redevelopment in established communities as a method of preserving valuable, limited resources while controlling infrastructure costs.
3. Require the coordinated delivery of public and private sector services to meet the needs of residents.
4. Recognize that an equitable sharing of the costs and benefits of growth comes by expecting that growth in infrastructure or services should pay for itself.

Page 1-6 Growth challenges - Many of the challenges that New Castle County faces are not the County's alone but require the coordination and cooperation of different levels of government, private sector interests and non-profits. In the past, this coordination has at times been inconsistent and piecemeal. For comprehensive planning to work at its best, it is critical that all involved parties take their respective places at the table, not only during the planning but also throughout the implementation.

Options to incorporate hazard mitigation principles in the goals, objectives and strategies.

Chapter 3: Land Use
3.4 Goals, Objectives and Strategies
Goal 1: Continue to designate those locations appropriate for growth and the densities best suited to meet present and future needs…add at end of sentence "*with consideration of hazard areas".*
Goal 2: Continue to manage growth to fulfill sustainable housing and employment needs of present and future citizens while preserving vital resources… add at end of sentence "*such as floodplains, steep slopes, wetlands, etc."*
Goal 3: Continue to ensure that new development and redevelopment allow flexibility for innovative planning while reflecting the design of existing surrounding communities - incorporate these "Smart Growth" and "New Urbanist" concepts within their design …add '*Safe Growth'* after "Smart Growth".

Objectives that incorporate hazard mitigation principles:
1. Continue to manage new growth consistent with Smart Growth Principles that require adequate facilities and concurrency as well as protection of important resources.
2. Continue to guide new development to Northern New Castle County to achieve greater use of existing infrastructure and public resources
3. Continue to guide mixed use, mobility-oriented growth and infill into the Commercial/Office/Industrial Development Areas.
4. Continue to support infill and growth in the Existing Community Areas
9. Continue to minimize new development within New Castle County in the Resource and Rural
11. Continue to encourage redevelopment and infill projects that complement and enhance existing neighborhoods and restore older commercial centers as vital components in the community.
13. Continue to provide support and assistance to distressed communities in the Existing Community Area and reduce the number of vacant or under-maintained residential properties in the Existing Community Area
16. Create a new Open Space district for parks and dedicated open space areas to permanently preserve and protect from future development.
17. Add "*Ensure that all new development is resistant to current and future hazards."*

Strategies that incorporate hazard mitigation principles
1. Build sustainable communities by:

e. Ensuring safety aspects in all parts of the comprehensive plan.

2. Continue to adopt the most recent ICC Building Codes to ensure that new construction is built to current standards, with materials found to ensure safe structures and with energy efficient (green building) incentives – add language on wind and snow loads

Chapter 4 – Mobility and Transportation
4.6 Goals, Objectives, and Strategies
Goals:

1. Continue to facilitate mobility, accessibility and transportation alternatives to provide for safe, efficient, and environmentally sensitive movement of people and goods.
4. Continue working to improve transportation system performance.
Add goal "Develop transportation policies with consideration of hazard areas".

Strategy

3. Add strategy "*Develop the transportation network in a manner that provides redundancy (i.e., alternate routes) if certain key nodes or routes are affected by a disaster".*
4. Add "*Develop policies to protect transportation facilities, such as airports, from hazard events and to locate them outside of high-hazard areas?".*
5. Add "*Examine highways and local streets to ensure they are designed with capacity to accommodate community-wide evacuations".*

Chapter 5: Water & Sewer
5.1.2 Goals, Objectives, and Strategies
Goals:
1. Continue to ensure water services and potable water supplies are sufficient to meet and exceed future demand.
Add goal *"Consider hazards and safety while designing and siting water systems to protect these facilities during hazard events and for their continued operation after a hazard event."*
Objectives:
1. Continue to ensure adequate water distribution infrastructure facilities to serve the needs of all properties within a franchised area including the residences, businesses, industries, as well as the ancillary needs of the fire protection network.
Add "*Develop water resources infrastructure in the Town with the consideration of hazard areas".*

Sanitary Systems
Goals:
1. Continue to provide efficient and cost effective sanitary sewer service in the existing sewer district and to new users through expansion of the sewer system
Add goal *"Consider hazards and safety while designing and siting sanitary systems to protect these facilities during hazard events and for their continued operation after a hazard event."*

Objectives:
1. Continue to provide capacity in sewer service areas to meet demands for existing and additional development.

4. Continue to improve the efficiency of the existing sewer system by increasing capacity through the reduction of infiltration and inflow of stormwater and illicit discharges into the sewer network.
6. Implement a system maintenance funding strategy that protects the County's facilities investment by implementing a routine infrastructure replacement program.

Chapter 6: Conservation and Natural Resources

The 'safe' element discusses minimizing impacts of flooding as being essential to New Castle County. Related ways to minimize flooding potential include:

- Focusing on outcomes at the watershed-level instead of individual sites.
- Placing more emphasis on green technology.
- Allowing more flexibility to address stormwater management based on impact and location.
- Protecting wetlands, which safely hold up to one million gallons of water per acre.
- Razing/removing structures in flood prone areas.

6.1.2 Goals, Objectives, and Strategies

Goals:
4. Minimize flooding impacts through best management practices for stormwater management.

Objectives:
10. Continue to prepare for emerging challenges through education and public outreach

Strategies
4. Establish standards for measuring and monitoring stormwater to ensure the utilization of best management practices.
11. Complete the evaluation of stormwater management techniques and continue to investigate the feasibility of a stormwater utility.
14. Investigate the feasibility of developing floodplain maps based on projected build out.
15. Add a strategy on flood.

6.3 Stormwater Management

Goals:
1. Facilitate the provision and maintenance of an efficient and effective stormwater management system.

Objectives
1.Assess and mitigate stormwater runoff from a watershed perspective.
2. Continue to utilize Green Technology Best Management Practices (GTBMPs) to address stormwater management.
3. Ensure that regulations and procedures governing drainage and water management are comprehensive and reflect the latest information and technology
6. Provide for economical maintenance of stormwater management facilities.
7. Add *"Consider low impact development techniques to manage storm water by incorporating techniques such as bio-retention areas, dry wells, infiltration trenches, filter/buffer strips, vegetated swales, rain barrels, and cisterns. This will reduce the impact of flooding in flood-prone areas within the County.*

Chapter 7: Historic Preservation
Goals:
1.Preserve the County's significant historic and prehistoric resources for the benefit of current and future residents.
Objectives:
2. Broaden the concept of historic resource preservation in the County Code to include landscapes and context.
Add: *"Preserve the integrity of the County's historic landmarks, sites, structures or districts while minimizing loss and damage from hazard events".*

Strategies

10. Inventory and survey abandoned/neglected properties with potential historic significance.

11. Add any other strategy if relevant.

Chapter 8: Housing

8.9 Goals, Objectives, and Strategies
Goals:
4. Work with the appropriate agencies to identify at-risk communities and methods on how to strengthen communities.
Objectives
3. Promote reinvestment and revitalization in older communities while preserving the traditional character of the area.
8. Maintain or improve the condition of all housing stock throughout the County, without causing displacement.
Add: *"Consider retrofitting public and publicly subsidized housing to reduce vulnerability during a disaster."*

Chapter 9: Economic Development
Goals:
1. Continue to promote a strong and sustainable economy.

Objectives:
1. Continue to ensure the availability of sufficient land for employment growth in a variety of industry sectors.
2. Continue to promote redevelopment of existing or underutilized properties.
3. Add: "*Provide infrastructure including water sewer and roads to designated employment and mixed use areas with consideration of hazard areas".*

Chapter 10: Community Design
Goals:
1. Promote design which is compatible with the community and its surroundings
2. Goal: Add *"Encourage and support the long-term protection of historically or architecturally significant buildings to preserve neighborhood and community character".*

Objectives:

1. Create compact mixed-use development opportunities in areas appropriate for such development, especially within urban and urban-transition areas

Strategies:

1. Land Use:

b. Reduction of activities that encroach upon nature through:

Guiding development to existing developed areas and minimizing development in outlying, undeveloped areas, add at end: *"while considering natural hazards".*

Housing

c. Reduction of activities that encroach upon nature, through:

Reuse of existing buildings and sites for development,

Compact and clustered residential development, including reduced minimum lot sizes,

Add " *Preservation of high hazard areas as open space".*

7. Growth Management:

- Development near existing transport systems; minimizing need for new road and highway construction. Add at end: *"while taking natural hazards into consideration".*
- Development patterns that respect natural systems such as watersheds and wildlife corridors.

8. Floodplain Management:

Reduce activities that encroach upon nature by:

- Guiding development away from floodplains,
- Guiding development away from barrier beaches, and
- Preserving or restoring wetland areas along rivers for natural flood control.

9. Watershed Planning:

- Reduce activities that encroach upon nature, such as:
- Preservation and enhancement of water quality,
- Reduction in water use,
- Recharge of groundwater basins,
- Use of flood control and stormwater techniques that enhance and restore natural habitats, and prevention of wetlands destruction; restoration of degraded wetlands.

Chapter 11 – Intergovernmental Coordination

Goals:

1. Coordinate government programs and services at all levels to increase efficient use of governmental and non-governmental resources to improve the quality of life for citizens.

Objectives:

1. Increase intergovernmental coordination and planning between Federal, regional, State, County and municipal agencies as well as non-governmental groups.

Strategies:

1. Identify areas for sub-regional plans to coordinate growth strategies.

2. Coordinate with the State agencies on sub-regional planning efforts, develop an intergovernmental monitoring system to track development and provide infrastructure when

needed.
3. Develop closer working relationships with appropriate State and municipal agencies regarding coordination of respective capital improvement programs as well as annexation policies.

Chapter 12: Intra-Governmental Coordination / Public Services

1. Goals:
1. Coordinate government programs and services at all levels to increase efficient use of governmental and non-governmental resources to improve the quality of life for citizens.
2. Objectives:
   1. Establish and maintain a close working relationship between County departments to advance the goal of a safe and healthy working and living environment.
   2. Coordinate infrastructure and service strategies to provide for sustainability.
3. Strategies:
   1. Identify areas for sub-regional plans to coordinate growth strategies.
   2. Coordinate with the State agencies on sub-regional planning efforts, develop an intergovernmental monitoring system to track development and provide infrastructure when needed.
   3. Develop closer working relationships with appropriate State and municipal agencies regarding coordination of respective capital improvement programs as well as annexation policies.

Options for Incorporating Hazard Mitigation Principles into the Comprehensive Plan

- Listed in italics in the individual elements above.

5101 Sediment and Stormwater Regulations – Division of Watershed Stewardship, Department of Natural Resources and Environmental Control

Overview: The purpose of this regulation is to enhance and extend the present erosion and sediment control activities and programs of the State for both rural and urban lands and to provide for control and management of stormwater runoff consistent with sound water and land use practices. These activities will reduce, to the maximum extent practicable, adverse effects of stormwater runoff on the water and lands of the State of Delaware.

1.4.2 Developments or construction that disturbs less than 5,000 square feet. Individual disturbances of less than 5,000 square feet that accumulate to exceed 5,000 square feet are not exempt and may be subject to the provisions of these regulations as determined by the Department or Delegated Agency on a case-by-case basis.

a. Use of standard details from the Delaware Erosion and Sediment Control Handbook for design of construction site stormwater management BMPs is limited to sites where no more than 20 acres draining to a common discharge point will be disturbed at one time.

b. Construction site stormwater management BMPs intended to manage areas greater than 20 acres shall have supporting design computations, including but not limited to storage, conveyance, stability, and treatment capabilities.

c. The area of disturbance draining to a common discharge point cannot exceed 20 acres and grading of subsequent sections within that drainage area cannot proceed unless temporary or permanent stabilization has been accomplished such that the 20-acre limit of disturbance is maintained.

d. All plans are required to include a limit of disturbance line (L.O.D.) establishing the maximum necessary extent of land disturbance required to implement and accomplish the permitted site construction for land disturbing activities subject to these Regulations.

10.0 Criteria for Implementation of a Stormwater Utility

10.2 The financing of a stormwater utility must be reasonable and equitable so that each user within the stormwater utility jurisdiction, including state agencies, contributes to the financing according to the users' pro rata share of runoff.

10.3 The intent of the utility must be clearly defined regarding program components that are to be funded through the utility. Those components may include but are not limited to the following: program administration, planning and engineering, maintenance operations, regulation and enforcement, and capital construction.

Options for Incorporating Hazard Mitigation Principles into the Stormwater Management Regulations

1. Consider adding a provision into stormwater management regulations that does not allow concrete channels in basins.
2. Consider adding provisions to require retention not detentions basins in areas where basins are needed to control stormwater.

Unified Development Code - Chapter 40

Sec. 40.10.313. - Regulations pertaining to activities in the floodplain are elaborated below. This Section is predicated on minimizing building or filling in the floodplain.

A. No development or structures shall be permitted in the floodplain; however, the Department may approve development or structures in the floodplain for approved uses or as approved as a beneficial use.

B. No new residential lots shall be created in the floodplain without sufficient buildable area outside of the floodplain.

C. Neither the gross floor area nor the footprint of existing structures located in the floodplain shall be expanded.

D. Floodplain permit applications for land disturbing activities and structures in the floodplain will only be reviewed for uses listed as L (limited use), I (environmental impact assessment), S (special use) and Y (permitted uses) in or as approved as a Beneficial Use.

E. Regulations pertaining to activities in the Zone A floodplain or Zone AE flood fringe:

1. Filling shall not be used as a means of increasing the site capacity on the subject parcel(s).

2. All uses and development occurring within a floodplain in areas/properties determined to be a Brownfield are permitted only upon approval of the Department with the consent of County Council by resolution.

3. All new construction or substantial improvements to nonresidential structures located in a Brownfield area shall meet the following:

a. Substantial improvements to structural buildings associated with an existing operational petroleum underground storage tank (UST) or above ground storage tank (AST) facility are permitted, provided the impetus for the owner of said UST or AST facility in upgrading or replacing all or a portion of the UST or

AST system is to achieve compliance with the State Regulations Governing Underground Storage Tank Systems and Regulations Governing Aboveground Storage Tanks.

b. All new construction or substantial improvements to nonresidential structures located in a designated Brownfield area must have the lowest floor elevation equal to or above the base flood elevation or must be flood proofed to the base flood elevation.

Sec. 40.10.314. - Filling in the floodplain.

Where permitted by Table 40.10.210 or as approved as a Beneficial Use, the following criteria shall apply to all land disturbing activities in the floodplain:

A. No net fill is permitted in the floodplain; however, the Department may approve development or structures in the Zone AE floodfringe or Zone A floodplain for approved uses.

B. In Zone A floodplain, Zone AE flood fringe, and nondelineated floodplain areas, no land disturbing activity is approved unless the applicant demonstrates that the activity, when combined with all other existing and proposed land uses, will not increase the water surface elevation of the one hundred (100) year flood at any point in the community.

C. No proposal to fill should result in a net loss of floodplain storage on the subject parcel(s).

D. The total area of floodplain on a parcel(s) cannot not be reduced by more than ten (10) percent in conjunction with channel improvements, flood storage, and detention which would have the effect of reducing the floodplain elevation.

E. All filling are required meet the following construction requirements:

1. The fill should be protected against erosion by riprap, vegetative cover, sheet piling, or other approved practices to prevent erosion.

2. The fill is required to be clean and compacted to minimize erosion potential.

3. Hydraulic openings, where not subject to State or federal design criteria, shall be designed to convey the one hundred (100) year flow unimpeded.

F. Any filling in the FEMA floodplain in conflict with the FEMA FIRM panel, whether previously authorized or unauthorized, will not be recognized by the Department until FEMA certifies a new floodplain limit so that no development occurs in violation of this Chapter.

G. Where homes existing as of the date of adoption of this Article can be protected from existing flooding conditions by filling and grading activity not exceeding twenty (20) cubic yards per lot, such filling may be permitted by the Department provided all the requirements are met.

Sec. 40.10.315. - Standards for beneficial uses in floodplains.

B. Any other occupied residential space is required have its lowest floor, including basement, and lowest opening at least eighteen (18) inches above the flood elevation. All service and utility connections such as

water, sewer, gas, and electrical and heating equipment shall be similarly located or buried with adequate cover to prevent erosion.

C. New nonresidential construction or substantial improvement of any commercial, industrial, or other nonresidential structures, is required have the lowest floor, including basement, elevated a minimum of eighteen (18) inches above the base flood elevation or, together with attendant utility and sanitary facilities, be floodproofed so that below the base flood elevation the structure is watertight with walls substantially impermeable to the passage of water and with structural components having the capability of resisting hydrostatic and hydrodynamic loads and effects of buoyancy.

D. Storage, material, and equipment:

1. Storage of other material or equipment is no allowed if not subject to major damage by floods, if firmly anchored to prevent flotation, or if readily removable from the area within the time available after a flood warning.

- Sec. 40.10.316. - Criteria for building in and near the floodplain.

In reviewing an application, the Department shall consider and/or require the following:

A. No structures for human habitation shall be permitted in the floodplain except:

1. Where approved as a beneficial use per Section 40.10.315 and Division 40.31.600
2. Replacement of existing nonconforming structures and uses in the Zone A floodplain, Zone AE flood fringe, or non-delineated floodplain (Section 40.10.311).

B. New construction, expansion or substantial improvement to residential and nonresidential structures is required to have the lowest floor, including basement, elevated not less than eighteen (18) inches above the one hundred (100) year flood elevation within or adjacent to a floodplain.

1. All new and replacement water and sanitary sewer facilities and systems is required to be located, designed and constructed to minimize or eliminate flood damages and the infiltration of flood waters.
2. Sanitary sewer facilities and systems are required to be designed to prevent the discharge of untreated sewage into floodwaters.
3. No part of any on-site sewage system can be located within any identified floodplain area except in strict compliance with all State and local regulations for such systems. If any such system is permitted, it shall be located so as to avoid harm or contamination during a flood.

C. Wet flood proofing that allows the free flow of floodwaters through the areas of a structure above its lowest floor will not be permitted/

D. For all new construction and substantial improvements, fully enclosed areas below the lowest floor area that are useable solely for parking of vehicles, building access or storage in an area other than a basement and which are subject to flooding shall be designed to automatically equalize hydrostatic flood forces on exterior walls by allowing for the entry and exit of floodwaters. Designs must meet or exceed the following minimum criteria:

1. A minimum of two (2) openings having a total net area of not less than one (1) square inch for every square foot of enclosed area subject to flooding should be provided.

2. The bottom of all openings can be no higher than one (1) foot above grade.
3. Openings may be equipped with screens, louvers or other coverings or devices provided they permit the automatic entry and exit of floodwaters.

F. All structures, residential and nonresidential, are required to be:
1. Designed and adequately anchored to prevent flotation, collapse or lateral movement of the structure.
2. Constructed with materials and utility equipment resistant to flood damage.
3. Constructed by methods and practices that minimize flood damage.

G. If fill is used to raise the lowest floor to the base flood elevation:
1. Fill is required to extend beyond a structure for a sufficient distance to provide acceptable access.
2. Fill material should be compacted to provide the necessary stability and resistance to erosion, scouring and settling.
3. The grading of earthen fill shall be used only to the extent to which it does not adversely affect adjacent properties.

H. A FEMA NFIP Elevation Certificate must be submitted to the Department for any building constructed, substantially improved or horizontally expanded in the FEMA floodplain before the certificate of occupancy is issued.

Section 40.10317
G. Manufactured homes are required to be placed on a permanent foundation and shall have the lowest floor elevated not less than eighteen (18) inches above the one hundred (100) year flood level and anchored to resist floatation, collapse and lateral movement.

Options for Incorporating Hazard Mitigation Principles into the Floodplain Ordinance

1. Encourage the municipalities to use LIMWA (limited wave action) to adjust mitigation projects to a higher code to protect communities from future sea level rise conditions and for new projects in A zones.
2. Consider adding provisions to require retention not detentions basins in areas where basins are needed to control stormwater.

New Castle County Capital Program and Budget – 2015 to 2020

Overview: The New Castle County Reorganization Act requires the Chief Administrative Officer (CAO) to prepare an annual Capital Program and Budget under the direction of the County Executive. In preparing the Capital Program and Budget, the CAO is required to confer with the Department of Land Use to ascertain that the proposed program is in accordance with the County Comprehensive Development Plan. The Budget Office within the Office of Finance is the principal agency responsible for assisting the CAO in the coordination and preparation of the Capital Program and Capital Budget. By April 1 each year, the County Executive is required to recommend to County Council, a capital program for the ensuing six years and a capital budget for the ensuing year. This is then submitted to the Department of Land Use for its review and recommendations to County Council. The County Executive is also required to submit it to the Planning Board for the sole purpose of determining if it is in accordance with the Comprehensive Development Plan. By the first day of June of each year, the County Council is required to approve a capital program and adopt a capital budget before it ordains the annual operating budget. The program is required to detail each capital project.

Each project indicates the amount of appropriations that have been expended or are to be expended and the funding sources.

One of the basic purposes of capital improvement programming is to coordinate physical and fiscal planning in order that the greatest possible benefits can be realized from the County's existing and anticipated financial resources. In order to accomplish this, a ranking of desired public improvements is established by assigning a need-based priority to each project. This ranking is then related to the County's ability to pay for the projects over time.

Options for Incorporating Hazard Mitigation Principles into the CIP:

1. Similar to the close coordination between the Comprehensive Planning Process and the CIP, consider a unified approach to integrate efforts between the Hazard Mitigation Plan, Consider submitting the CIP to the HMP Steering Committee for determining if it is in accordance with the Hazard Mitigation Plan.
2. Consider including a staff member who is knowledgeable about hazard mitigation, to be involved in the CIP planning.

2004 City of Newark, Delaware Comprehensive Development Plan

Sustainable Community: A community that will be sustainable, both economically and environmentally, for generations to come, to include aspirations such as:

- Promoting transit and other alternative transportation modes for reduced dependence on
- fossil fuels.
- Stream valley/watershed protection.
- Energy conservation and recycling.
- Air and water quality.
- Diverse economic base.
- Preserving historical resources
- Add: "*Improving the resiliency of the community to face disasters".*

Public Utilities and Infrastructure
Maintain and invest in infrastructure to provide high-quality services to existing residents and businesses, as well as to efficiently provide for future growth. At end of sentence add: "*while limiting access to natural hazard areas".*
Strategic Issues:

- Proactively maintain and manage stormwater-management infrastructure and develop a sustainable funding source to address aging infrastructure and flooding issues.
- Meet or exceed the state and federal requirements of National Pollutant Discharge Elimination System (NPDES) permit and Stormwater Management Plan.
- Meet or exceed Delaware's new sediment and stormwater regulations
- Add: "*Develop an Emergency Access and Evacuation Network map that identifies the roadways in the city that must be maintained for emergency access and emergency evacuation in case of a major hazard event such as a fire, flood, or hazardous materials release".*

Housing & Community Development
Provide diverse housing choices that contribute to attractive and unique places to live, work, play, and attend school.
Strategic Issues:

- Complete a comprehensive analysis of housing needs to evaluate supply of rental housing and other housing types needed.
- Review and evaluate existing code regulations to protect the rights of tenants and landlords while maintaining and promoting safe and attractive housing stock and balancing quality-of-life issues.
- Explore incentives and policies to create pathways to homeownership.
- Evaluate and remove impediments to fair housing.
- Add: "*Retrofit or replace public and publicly subsidized affordable housing to reduce vulnerability to natural disasters".*

Transportation
Improve the transportation network to encourage a healthy lifestyle, promote environmental and economic sustainability, and provide feasible transportation choices for all citizens. Add to end of sentence *while guiding growth to safe locations.*
Strategic Issues:

- Advance a multimodal transportation network that accommodates the needs of uses of all ages and abilities, including motorists, pedestrians, transit, bicyclists, and commercial and emergency vehicles.
- Manage and increase the supply of parking available in Downtown Newark both for automobiles and bicycles.
- Establish a Transportation Improvement District (TID) along Newark's Downtown core.
- Add: "*Use transportation projects to determine the location and density patterns of future growth*".

Environmental Quality & Natural Resources
Preserve and protect Newark's natural resources and wildlife to ensure that future generations have access to high-quality land, water, and air.

Economic Development
Promote a sustainable economic future for the City by encouraging a diversified local economy, creating a quality place for people to live and work, and attracting a highly qualified workforce.
Strategic Issues:

- Develop and maintain Newark as a diversified business and employer destination.
- Enhance and maintain downtown Newark's physical and economic vitality.
- Continue to leverage the assets of being the home of a major research university

Land Development
Effectively manage neighborhood preservation and high-quality development and redevelopment that meets the City's housing, employment, transportation, and recreational needs.
Strategic Issues:

- Proactively plan for sites expected to develop or redevelop in order to better anticipate environmental, housing, transportation, and growth issues and opportunities.
- Manage land resources to provide adequate and sustainable options for housing, employment, recreation, commerce, and entertainment.
- Add: "*Identify potential problems that may arise from various densities of development in hazard-prone areas, determine what densities are appropriate, and establish standards to direct development away from high-hazard areas".*

Growth and Annexation

Promote orderly growth that protects the environment and minimizes the financial burden on the city, residents, and businesses.
Strategic Issues:

- Expand the City's municipal boundaries in a way that is environmentally and financially sustainable and beneficial.
- Coordinate expansion of the City's municipal boundaries with relevant state and county agencies, as well as with planning documents such as the state's Strategies for State.

Coordination and Implementation

- Add: "*Include a planner in the review of capital improvement projects to identify hazard mitigation opportunities".*
- *Add: "Incorporate recommendations from the letter from the Office of State Planning Coordination dated September 2013 which includes comments from various state agencies".*

2012 Town of Middletown Comprehensive Plan

Add Goal*: "Create a disaster-resistant community that can prepare for hazard impacts, and thrive after a hazard event".*
Add Objective*: "While evaluating development proposals or changes to zoning consider Comprehensive Plan policies, Zoning and Subdivision Ordinance standards, existing land uses, environmental impacts, and, social, economic, and community concerns as well as natural hazards and their impacts on the community".*

10-2a. Strategies for State Policies and Spending

- Add: *"Ensure that the Capital Improvement Plan limits or prohibits expenditures on projects that would encourage new development or additional development in areas vulnerable to natural hazards".*
- Add: *"Develop infrastructure policies that limit extension of existing infrastructure, facilities, and/or services that would encourage development in areas vulnerable to natural hazards".*

10-5. Land Use Recommendations

- Add: "*Ensure that the future Land Use Plan takes into account high-hazard areas and identifies adequate space for projected future growth outside of these high-hazard areas".*
- Add: *"Include policies for existing structures and facilities to be strengthened, elevated, or relocated during the redevelopment process".*

10-6. Growth and Annexation

- Add: "*Include safety explicitly in the plan's growth and development policies".*
- Add: "*Include growth management techniques, such as land conservation, buffering, and clustering of development to protect and conserve natural resources".*

11-2. Recommendations for Consideration

Community Character and Design Considerations

- Encourage including hazard mitigation measures in architectural design for new structures and in redevelopment scenarios.

Community Services and Infrastructure Considerations

- To optimize the utilization of water resources through provision of stormwater management for the community which reduces damage and inconvenience from flooding, improves and protects water quality in surface and ground waters, and protects the functions of wetlands in urban areas.

Housing Considerations

- Provide outreach and education to encourage developers to include hazard mitigation measures for new construction and redevelopment - latest building code, floodplain ordinance, etc.

Transportation Considerations

- Work with DelDOT on planned road improvements especially Route 299. Ensure evacuation issues are addressed.

Economic Development Considerations

- Maintain and expand a viable downtown business district by creating a business-friendly regulatory environment and cultivating an accessible and inviting downtown destination atmosphere. Keep safety from natural hazard in mind while developing policies.
- ·Encourage redevelopment of underutilized and infill locations. Keep safety from natural hazard in mind while developing policies.
- Ensure that sufficient land is zoned for commercial and industrial uses to provide opportunities for existing employers to expand and new employers to locate in Middletown. Ensure high hazard areas are not zoned for high intensity uses.

Environmental Resources

- Continue utilizing Subdivision Regulations to protect environmental resources.

Parks and Open Space

- Continue preserving open space and natural resources though subdivision and plan-review practices.

Land Use and Growth Management Considerations

- Build on design standards already in place with by incorporating contemporary design practices while keeping hazard considerations in mind.
- Continue reviewing existing land uses to identify additional areas suitable for mixed use especially in the downtown area and Westown while ensuring that development is not planned in high hazard areas.

Preparing for Tomorrow's High Tide 2014 Sea Level Rise – 2014 Sea Level Rise Workshop Proceedings and Interim Implementation Plan

Overview: This document contains the results of the workshop held in March 2014 titled "Preparing for Tomorrow's High Tide: Implementing the Recommendations of the Sea Level Rise Advisory Committee." The purpose of the workshop was to develop specific implementation actions for the sea level rise adaptation recommendations

published by the Sea Level Rise Advisory Committee in September 2013. The document includes a list of specific actions for implementation by the Sea Level Rise Advisory Committee to guide efforts for sea level rise adaptation.

Options for integration into the Hazard Mitigation Plan

The following activities suggested in this document directly or indirectly relate to hazard mitigation principles.

Activity 1: Identify specific regulatory barriers for sea level rise adaptation projects - the need for consistency in local floodplain regulations. A comprehensive review of key regulations and procedures is necessary to understand where barriers and conflicts exist, particularly for emergency repairs and critical infrastructure.

Partners: DNREC, DEMA, DelDOT, FEMA, USACE, NOAA, Delaware Division of Historic and Cultural Affairs and Local Governments

Activity 2: Create an adaptation clearinghouse to help local communities to provide the public information to make educated decisions about adapting to sea level rise in their communities. This clearinghouse should have a link to a technical team that can answer any questions local communities have that are not being answered by the clearinghouse.

Partners: USACE, DNREC, Delaware Division of Historical and Cultural Affairs, NOAA, FEMA, DEMA and Delaware Sea Grant

Activity 3: Make elevation surveys available to the public - Providing the local communities with elevation surveys done by DelDOT, DNREC and private companies will limit the cost to local communities for adaptation project design. It will also minimize the workload some of these communities will have when addressing sea level rise. Community participation in sea level rise awareness and preparedness will increase if costs can be minimized.

Partners: Delaware Sea Grant, University of Delaware, DNREC, DEMA, DelDOT, Realtors, Private surveyors

Activity 4: Develop a regional inventory of sea level rise activities – A regional inventory could provide new ideas or improve existing ideas that Delaware has for adapting to sea level rise. The Mid-Atlantic Regional Council on the Ocean completed a regional inventory that could be encouraged to update it, benefitting Delaware and all of the Mid-Atlantic states.

Partners: Mid-Atlantic Regional Council on the Ocean, United States Fish and Wildlife Service, NOAA, NASA, DNREC

Activity 5: Host an annual regional meeting on sea level rise - A regional meeting about sea level rise could provide a venue for states to share their experiences and ideas about vulnerability and adaptation and to improve networks of regional experts. It could also provide an opportunity for implementers to share what has worked and what has not worked.

Partners: Sea Grant, University of Delaware, DNREC, DEMA, Local Governments, DelDOT, Mid-Atlantic Council on the Ocean, other state agencies

Activity 6: Include sea level rise considerations in municipal multi-jurisdictional master plans - The Delaware Office of State Planning Coordination is encouraging towns and counties to begin Master Planning processes. Master Plans are more specific than the required Comprehensive Development Plans and can be coordinated between towns and

counties. Bridgeville, Georgetown and Southern New Castle County have initiated master planning projects. These master plans could be a venue for identifying on-the-ground sea level rise adaptation strategies, particularly for flooding issues that cross municipal boundaries.

Partners: Sea Grant, University of Delaware, DNREC, DEMA, Local Governments, DelDOT, Utility Companies, Office of State Planning Coordination

Recommendation: Incorporate sea level rise considerations into the Strategies for State Policies and Spending Land-use decisions in Delaware are made at the local level, but the bulk of infrastructure and service that support these decisions are funded by the state. The Strategies for State Policies and Spending set forth clear advisory policies (including maps) about where the state will allocate financial resources for conservation, infrastructure improvements, and social services and are updated every five years. Incorporation of sea level rise into the suite of issues considered when the strategies are updated would provide an opportunity for coordination between agencies and local governments regarding sea level rise and may help further ensure wise use of state funding.

Recommendation: Consider incorporation of sea level rise considerations into municipal and county comprehensive development plans - State law requires that every municipality in Delaware develop, and periodically update, a comprehensive development plan. These plans contain a municipal development strategy that includes expansion of boundaries, future plans for residential and commercial growth, and future infrastructure investments, among others. They also contain environmental and demographic information. Consideration of sea level rise impacts and potential adaptation actions would ensure that all municipalities in the state are proactively taking into account potential sea level rise impacts in their future plans for growth and development and may allow for increased communication about sea level rise between municipal, county and state governments.

Activity 7: Update the PLUS Checklist - Workshop participants suggested adding sea level rise as a component of the checklist that is filled out by developers for the state mandated Preliminary Land Use Service (PLUS) application. Adding a field for sea level rise would ensure that local governments were taking into account information about sea level rise prior to making land use decisions.

Partners: Office of State Planning Coordination, DNREC, DNREC Delaware Coastal Programs, Local Governments, Delaware Sea Grant, DEMA, Center of the Inland Bays, Partnership for the Delaware Estuary

Activity 8: Create model language for sea level rise in comprehensive development plans - Developing model language about sea level rise for comprehensive development plans would help local governments incorporate these concerns into their plans and would help keep language pertaining to sea level rise consistent between all plans.

Partners: Office of State Planning Coordination, DNREC, DNREC Delaware Coastal Programs, Local Governments, Delaware Sea Grant, DEMA, FEMA, Center of the Inland Bays, Partnership for the Delaware Estuary

Activity 9: Provide sea level rise educational opportunities during the comprehensive development plan process - Similar to above, language and content should be expanded to demonstrate the tangible benefits of planning for sea level rise.

Partners: Office of State Planning Coordination, DNREC, DNREC Delaware Coastal Programs, Local Governments, Delaware Sea Grant, DEMA, FEMA, Center of the Inland Bays, Partnership for the Delaware Estuary

Activity 10: Include incentives for inclusion of sea level rise into comprehensive development plans - Providing financial or other incentives to county and municipal governments could provide the impetus required for voluntary incorporation of sea level rise considerations into comprehensive development plans. Incentives could be grants or funding to help develop the comprehensive plan or it could be criteria to qualify for other programs or funding. Note, the DNREC Delaware Coastal Programs offers an annual grant program for this purpose; the intent of this activity would be to expand upon those efforts.

Partners: Office of State Planning Coordination, DNREC, DNREC Delaware Coastal Programs, Local Governments, Delaware Sea Grant, DEMA, FEMA, Center of the Inland Bays, Partnership for the Delaware Estuary

Activity 11: Develop specific community sea level rise adaptation plans - Comprehensive development plans must be updated by municipalities every ten years. There was a feeling among workshop participants that updating the plans more frequently (for example, every 5 years) would provide the community with an opportunity to utilize up to date and reliable information for adaptation decisions. Absent that, communities should be encouraged to develop specific sea level rise adaptation plans, which can be updated as new data becomes available. Funding and technical assistance should be provided for this purpose.

Partners: Office of State Planning Coordination, DNREC, DNREC Delaware Coastal Programs, Local Governments, Delaware Sea Grant, DEMA, FEMA, Center of the Inland Bays, Partnership for the Delaware Estuary

Recommendation: Provide education and outreach for impacted communities and citizens – Communities that may be the most impacted by sea level rise should be provided with up-to-date information on seal level rise scenarios and be informed of adaption measures that can reduce the impact to their homes and communities. Residents of these areas should be made aware of available information of short- and long-term adaptation measures, benefits and risks of various adaptation measures, combination of risk factors (e.g. drainage and stormwater, coastal storms and sea level rise) and changes occurring in the insurance industry that may impact insurance availability and cost.

Activity 12: Create a centralized web resource for coastal hazard and sea level rise information; link it to county and municipal websites. There should be a centralized Delaware specific website for coastal hazard and sea level rise information. It could be managed at one of the colleges or universities. The site should be linked from county and municipal websites so that the information is more accessible and available to all citizens. Communities should also be provided with links to interactive mapping sites.

Partners: Delaware Sea Grant, University of Delaware, DNREC, DEMA, Local Governments, DelDOT, FEMA, Local Politicians.

Activity 13: Create a brochure to better inform homebuyers
Delaware Sea Grant currently has a Homebuyer's Brochure but it is still in draft format and has not been released to the public. This document would need to be updated but could better inform home buyers if it explained the risks, flood insurance, and the state's current actions and stance on sea level rise.
Partners: Delaware Sea Grant, University of Delaware, DNREC, DEMA, and Realtors.

Activity 14: Provide outreach and education to realtors
Provide targeted outreach to realtors regarding flooding, sea level rise and insurance issues so that they can better answer questions about these subjects for their clients. This can be through presentations, training courses, brochures or websites.
Partners: Delaware Sea Grant College Program, DNREC, DEMA, Delaware Association of Realtors

Activity 15: Incorporate sea level rise information into Delaware State Housing Authority Housing Counseling Programs

The Delaware State Housing Authority and their partners offer housing education classes for potential homebuyers. Flooding, flood insurance and sea level rise could become a part of their curriculum. They could also provide sea level rise specific classes for homebuyers, homeowners, and realtors. The more information that is provided to new homebuyers the better informed and prepared they will be for any sea level rise based problems. The Homebuyers Fair that is held every year would also be a great event for this information to be shared and received by a large audience in a minimal amount of time and effort.
Partners: Delaware Sea Grant, University of Delaware, DNREC, DEMA, Realtors, DelDOT, Delaware State Housing Authority

Activity 16: Improve access to state agency data for use by local governments
Workshop participants identified issues obtaining information and data that would allow them to easily assess their vulnerability and plan resiliency projects. Road, culvert and outfall elevations held by DelDOT were specifically cited, but communities also have difficulty accessing basic geographic data, including sea level and floodplain data. Community participants emphasized that they are paying large amounts of money to have studies done to collect information that may have already been collected by a state agency, but cannot be found or shared.
Partners: DelDOT, DNREC, counties and municipalities, Delaware State Housing Authority

Activity 17: Create a team in each county to help develop projects for hazard mitigation and sea level rise
Participants wanted to create a team of knowledgeable professionals that could provide assistance in developing projects for hazard mitigation and sea level rise. This team could consist of county floodplain managers, infrastructure professionals, public works professionals, and environmental scientists. This group could assess projects, gather information, and help develop projects in a coordinated way.
Partners: County officials, Local Business owners, DNREC, DelDOT, DEMA

Activity 18: Include sea level rise and natural hazards in Comprehensive Land Use Planning Process
Including sea level rise and natural hazards in the Comprehensive Land Use Planning Process is a natural step to introduce sea level rise into future planning for communities. Communities should incorporate sea level rise into these plans so they can prepare and so that any future infrastructure will consider sea level rise before it is constructed.
Partners: Community Planning Boards, DNREC, DelDOT, Office of State Planning Coordination.

Activity 19: Provide model zoning code language for sea level rise
Model zoning code language reflecting best practices for sea level rise could be developed and provided to interested municipalities for adoption. Developing model language for zoning code improvements saves municipal governments from the expense of developing their own language while increasing the potential for consistency between local and county governments.
Partners: Delaware Office of State Planning Coordination, DNREC Delaware Coastal Programs, DNREC Delaware Division of Energy and Climate, Delaware Office of Management and Budget, Delaware Office of the Governor, Delaware Division of Facilities Management, League of Local Governments, University of Delaware Institute for Public Administration.

Activity 20: Educate Communities about sea level rise
Workshop participants felt it was necessary to work alongside DelDOT to educate communities about Sea Level Rise and how to plan for the future. In the same efforts, the participants wanted work with local governments to address Sea Level Rise. In order to reach the communities in a more consistent manner, the group suggested creating a guidance document that incorporates all agencies regarding flooding and sea level rise. This would be easier and

cheaper than actually visiting the communities, until specific needs arise.
Cost: $100,000 – 1M
Partners: DelDOT, municipalities, counties

Activity 21: Assess construction material suitability for sea level rise and flooding
Some materials used in construction (concrete and compressed sand blocks) can be subject to erosion. Participants discussed the idea of conducting an analysis of materials used for construction and design to determine their suitability for use in flood prone areas. Results could be added to design manuals.
Cost: $10,000 – 100,000
Partners: No partners were discussed.

Activity 22: Update FEMA maps with sea level rise
Participants thought better maps and modeling were needed (instead of bathtub models) and that FEMA floodplain maps should be updated to incorporate sea level rise.
Cost: $100,000 – 1M
Partners: No partners were discussed.

Activity 23: Create disincentives for construction in sea level rise zones
Disincentives should be developed for new buildings that would be located in an area expected to be inundated by sea level rise. Designating these areas as vulnerable by classifying them as Level 4 would discourage state support for infrastructure and other services. Retreat strategies can, and should, be included for these projects. Local governments should be educated on the utility of flood management tools that can deter development in flood prone areas. These disincentive areas can capture projects that fall outside local flood ordinances and do not require flood insurance.
Partners: DNREC, local governments
Prerequisite: Develop new Delaware specific floodplain and sea level rise maps, as called for by EO 41.

Activity 24: Develop community-based vulnerability maps
Maps to identify the vulnerability of water infrastructure to both storm events and sea level rise should be developed. These maps should include facilities and associated pipelines. These maps would help to target areas for communities to focus their sea level rise adaptation efforts. Development of these maps will require additional information about the heights of the facilities, the depths and locations of pipelines, along with potential sea level rise and flood levels. Maps that include this type of information can be included in Comprehensive Land Use Plans and other long-range planning documents as well.
Partners: Delaware Municipalities

Activity 25: Comprehensive Land Use Plans
Counties have information about county run wastewater systems. County and municipal land use plans can include information about sea level rise scenarios and areas where wastewater systems may need to accommodate for sea level rise.
Partners: Delaware Counties and Municipalities, Delaware Office of Management and Budget, DNREC

City of New Castle, 2009 Comprehensive Plan Update

The 2009 Plan the City has concentrated ins planning resources on modifications to respond to state agency comments through a pre-Preliminary Land Use Service review to provide a more strategic planning approach to assure the recommendations are implemented.

Page 18 Goal 2: Develop New Castle's remaining undeveloped parcels, brownfields, and redevelopment areas harmoniously with nearby land uses.
Strategy: Add: "*Identify areas that are high hazard in nature (floodplain, steep slopes, etc.) and promote these areas as passive recreation areas"*.

Page 19 Goal 3: Develop and adopt long-term redevelopment vision plans for the Ferry Cut-off and the 7th and South Street areas.
Strategy: Add: "*Use sound construction methods to build this mixed use development to withstand wind and water hazards".*

Page 25 Annexation
Goal 3: Encourage the development of areas outside but adjacent to New Castle or under consideration for annexation, in a harmonious manner with nearby uses
Strategy: Add:
Strategy: Work with New Castle County to enact appropriate zoning changes and other development controls. Add: "*Protect all new development in the City by enforcing existing planning mechanisms such as zoning ordinance, building code, and subdivision ordinance, to ensure existing and new development is resistant to hazards."*

Page 25 Relationship to State and Regional Plans
The overall goals of the Infrastructure Plan appear to be generally consistent with the infrastructure goals of the New Castle County 2007 Comprehensive Development Plan Update (Goal VII, Page 99). This annexation plan, which suggests that the City of New Castle could help direct and control growth and development through annexation, also strongly encourages cooperation and coordination between the county and the City in matters of annexation.

Page 30 – Relationship to State and Regional Plans
The overall goals of the Infrastructure Plan appear to be generally consistent with the infrastructure goals of the New Castle 2007 Comprehensive Development Plan Update (Goal VII, Page 99)
The overall goals of the Infrastructure Plan appear to be consistent with Goal #8 of Delaware Strategies for State Policies and Spending. The Infrastructure Plan is also consistent with the State of Delaware's Strategies for State Policies and Spending recommended "water and wastewater" strategies for Nurturing Communities.

Page 33 – Transportation Goal 2 – Clarify regional and local traffic patterns throughout the City
Add strategy: *"Develop an emergency access and evacuation network map that identifies the roadways in the City that must be maintained for emergency access and emergency evacuation in case of a major hazard event."*

Page 35 – Relationship to State and Regional Plans
The Transportation Plan is highly congruent with other plans for New Castle. The WILMAPCO 2030 Regional Transportation Plan, the Delaware Strategies for state Policies and Spending and Livable Delaware plans emphasize improving motorized and non-motorized transportation in traditional centers such as New Castle, a goal reinforced in this plan. Many ideas for improvement outlined in this plan are found in the New Castle Transportation Plan prepared with WILMAPCO in 1999.

Page 40 – Historic Preservation
Add goal: *"Preserve the integrity of the City's historic landmarks, sites, structures or districts while minimizing loss and damage from hazard events."*

Page 40 – Relationship to State and Regional Plans

The overall goals of the Historic and Cultural Resources Plan appear to be generally consistent with the historic resource goals provided in Section IV C of the New Castle County 2007 Comprehensive Development Plan Update which encourage he protection of historic buildings, adaptive use of under-utilized historic buildings, etc.

Page 43 – Community Design Goal 1: Incorporate detailed urban design standards into the City's development controls to assure that high quality new development
Add strategy: "*Design new neighborhoods and appropriate infill and redevelopment based on sound place-making principles for hazard vulnerability and site vulnerability".*

Page 48 – Economic Development
Add goal and strategy
"*Provide infrastructure, including water, sewer, and roads, in designated employment areas with consideration of hazard areas."*

Page 48 – Relationship to State and Regional Plans
The overall goals of the Economic Development appear to be generally consistent with the Goal 2 of Section VI B of the New Castle County 2007 Comprehensive Development Plan Update. The overall goals of the Economic Development Plan appear to be consistent with Goals 1, 6, 7 and 8 of Delaware Strategies fro State Policies and Spending recommended "Economic development" Strategies for Nurturing Communities, which recommends the aggressive identification and marketing of underused, abandoned or brownfields sites.

Page 52 Housing Goal 3: Improve the integrity of the housing stock through rehabilitation.
Add strategy: "*Build housing by providing for and encouraging redevelopment with consideration of hazard areas."*

Page 53 – Relationship to State and Regional Plans
Several of the States eleven goals apply to the housing goals outlined in the City of New Castle Comprehensive Plan Update 2008. The housing goals for New Castle specifically comply with WILMAPCO;s Regional Transportation Plan 2030 goal by discouraging new housing construction in non-developed areas, and promoting the protection and preservation of historic housing resources through financial and educational incentives.
All the goals of the City of New Castle Plan Update are consistent with the county goal by increasing affordable opportunities for home ownership, and facilitating redevelopment of the existing housing stock in need of rehabilitation.

Page 56 – Environmental Protection Goal 1 – Preserve the capacity of the floodplain to carry floodwaters
Goal 2: Improve drainage and stormwater management throughout the City.
Goal 3: Conserve State Resource Areas

Page 58 – Relationship to State and Regional Plans
The overall goals of this section appear to be consistent with the Goals, Objectives and strategies of the Natural Resources and Open Space Section (IVA) of the New Castle County 2007 Comprehensive Plan Update. The overall goals appear to be consistent with Goals 2 and 8 of Shaping Delaware's Future: Managing Growth in the 21st Century Delaware – Strategies for State Policies and Spending.

Page 62 Open Space, Parks and Recreation Goal 3: Explore the development and potential funding of new community-wide recreation facilities including greenway and multi-use trail system expansion
Strategy 2 – Coordinate expansion of greenways, bikeways, and multi-use trails with state and local road improvement projects

Add Strategy – "*Consider policies to utilize land that is otherwise unsuitable for development for recreational purposes, thereby lowering the county's risk.*"

Page 62 – Relationship to State and Regional Plans
The overall goals of this section appear to be consistent with the County goal in section VIIG of the New Castle County 2007 Comprehensive Plan Update and Goal 8 of Delaware's Strategies for State Policies and Spending.

Page 64 – Intergovernmental Coordination Goal 1: Establish and maintain cooperative relationships with state and local agencies
Add strategy: *"Limit or prohibit expenditures on projects in the CIP that would encourage new development or additional development in areas vulnerable to natural hazards."*

A Citywide Plan for Land Use - A Component of the Comprehensive Development Plan for Wilmington, Delaware

Page 29 - The Regional Plan includes a comprehensive and coordinated set of Goals, Objectives and Strategies which are consistent with federal, state and local plans and legislation, and which guide in the selection of transportation investments, services and policies for the region. They are as follows:
b. To Transport People and Goods
At end of sentence above, add: "in a safe and efficient manner"
(1) Improve Transportation System Performance
(a) Maintain the existing system to maximize the effective life span of transportation investments.
(b) Manage the existing system to maximize performance, including the use of new technologies.
(c) Expand transportation system capacity where necessary to support existing centers, planned growth areas, and increased demand for goods movement.
(2) Promote Accessibility, Mobility, and Transportation Alternatives
(a) Plan for an integrated multi-modal transportation system, including roadways, rail and bus services, bicycle and pedestrian facilities, and air and water transportation.
(3) Add*: Provide for emergency access to all parts of the city and safe evacuation routes.*
(a) Update the evacuation routes map that identifies the roadways in the City that must be maintained for emergency access and emergency evacuation in case of a major disaster.

Page 32 – Economic Development Vision

2013 State of Delaware Hazard Mitigation Plan

Page 46 – The Capability Assessment documents mitigation accomplishments from New Castle County that specifically identified in the local mitigation plan. Where these accomplishments support stated mitigation goals or actions, those goals and actions are listed. DEMA's summer intern was tasked to coordinate with all municipalities in the State to ascertain the status of their mitigation actions, document completed mitigation actions, and identify potential new mitigation actions.

Page 2 Section 6 – Goals – All the goals in the State Plan are applicable for the New Castle County Plan

Goal 1: Implement mitigation actions that improve the protection of human life, health, and safety from the adverse effects of disasters.
Goal 2: Implement mitigation actions that improve the protection of continuity of government and essential services safely from the adverse effects of disasters.
Goal 3: Implement mitigation actions that improve the protection of public and private property, with emphasis on Severe Repetitive Loss and Repetitive Loss properties, from the adverse effects of disasters.
Goal 4: Implement mitigation actions that improve the protection of communities from the adverse effects of disasters.
Goal 5: Support and enhance the emergency preparedness, response and recovery posture of the State of Delaware and its local jurisdictions.

The State Plan's goals and objectives are reviewed as part of the regular plan review process and in conjunction with the review/approval process of local hazard mitigation plans. This helps to ensure that state and local hazard mitigation plans complement each other and that both state and local governments are working together to accomplish the mitigation goals of the State of Delaware. Additionally, proposed mitigation projects are reviewed to determine how mitigation projects help state and local governments meet established goals and objectives.

Page 2: Section 6.2 Mitigation Actions

The Mitigation Actions section identifies State of Delaware active mitigation actions, identifies completed mitigation actions, provides a status on all mitigation actions, and list specific local mitigation actions that have been completed that support this plan. This section includes mitigation actions that have a direct or indirect impact on local governments from a policy standpoint:

- Develop stringent State flood hazard real estate disclosure requirements.
- The State of Delaware will consider flood hazard vulnerability when identifying "designated growth areas" in certified comprehensive plans.
- Continue to prohibit the use of fill in order to remove the property from the floodplain or to support re-mapping.
- Strongly encourage riparian buffer requirements. Recommend environmentally sensitive development such as greenways and trails as opposed to commercial and residential development.
- Encourage greenways "zoning" along river corridors.
- Strongly encourage that all new construction of wastewater treatment plants occur outside of the 100-year floodplain.
- Pursue the strategy of co-locating general population, unattended minors, medical needs and companion animals in single shelter facilities. Complete shelter facility identification, facilitate engineering structural study of identified shelters and establish memoranda of understanding with appropriate agencies, school districts and emergency management coordinators.
- Strongly encourage the disaster resistance of shelters through the implementation of measures identified in existing and new studies.
- Strongly encourage sewer line check valves for new construction or the repair of sewer lines in the 100 and 500-year floodplain.
- Develop inter-agency agreements with the Office of State Planning, and the University of Delaware Disaster Research Center and the Delaware Geological Survey to assist with hazard data collection and analysis.
- Develop Memorandum of Understanding with the University of Delaware Disaster Research Center to provide staff and graduate students to assist the Delaware Emergency Management Agency address hazard mitigation – related research questions.

- Increase the number of CRS communities in the State of Delaware.
- Lower the CRS rating among participating communities by one point per year for the next two years. After two years, a re-evaluation should occur that determines the benefit of continued class rating reductions versus the time and effort necessary to make this happen.
- Use Community Development Block Grant (CDBG) funds to relocate or elevate low to moderate-income households that are located in the floodplain.
- Consider the use of shoreline protection measures, including inlet stabilization, beach nourishment and dune enhancement.
- Retrofit existing schools and other identified public/community buildings to address any structural and/or system deficiencies limiting the facilities use as a shelter
- Install video cameras in and around all school buildings.
- Encourage local governments to continue to relocate shoreline buildings outside the Special Flood Hazard Area (SFHA), when elevation is not a cost effective alternative.
- Encourage local governments to continue to elevate or acquire flood-prone residential buildings where cost effective. (Acquisition should be the first consideration as it removes the property from the SFHA.)
- Encourage local governments to continue to floodproof or acquire commercial or public buildings where cost effective. (Acquisition should be the first consideration as it removes the property from the SFHA.)
- Require the flood-proofing of on-site residential septic systems located in the 100-year floodplain.
- Encourage the acquisition of land in flood-prone areas.
- Research the feasibility to remove dead trees that pose a threat to power lines, road right of ways and property. Trees prone to wind damage should be replaced with more appropriate species, if possible.
- Conduct vulnerability assessment of hospital back-up power sources.
- Assess the accuracy of current digital Flood Insurance Rate Maps and aerial base maps and prioritize improvements to both based on flood hazard vulnerability and development patterns.
- Conduct all-hazard assessment of critical healthcare system facilities and services (both public and private) to include: nursing homes and long-term facilities, hospitals, free-standing surgery and emergency centers, State public health clinics and State service centers, Federally Qualified Health Centers, EMS facilities and dialysis centers.
- Develop model drainage code for county and local governments.
- Assist communities with the enforcement of state stormwater management regulations.
- Assess the vulnerability of access and egress routes to hospitals within the State.
- Support the training of local government officials on the use of electronic grantsmanship to speed the process of grant writing, review and approval of Flood Mitigation Assistance grants, Hazard Mitigation Grant Program grants and Pre-Disaster Mitigation grant programs.
- Train State and local floodplain managers in the use of GIS-based digital floodplain maps.
- Develop coordinated community-level disaster education initiative involving State, county and non-governmental organizations.
- Integrate repetitive loss list and severe repetitive loss list structural targeting into local, regional, and state mitigation planning and grant implementation property targeting.
- Formalize assistance to Delaware communities in developing community resiliency plans and integrating hazard mitigation into local plans.
- Develop/compile/maintain a list of model hazard and adaptation policies/ordinances, best practices, and examples of suggested mitigation/adaptation/preparedness measures to be shared and considered for adoption by local governments.

City of Newark, Delaware, Emergency Operations Plan

The Newark Emergency Operations Plan (NEOP) establishes policies and procedures that represent a coordinated effort to manage potential disasters that may affect the City of Newark. This plan is applicable to the City of Newark, all government departments and to other agencies engaged in or in support of emergency operations prior to, during, and after a disaster - whether the result of natural causes, technological failure, or acts of foreign or domestic terrorism.

The EOP consists of: 1) a basic plan which contains its purpose, certain situations and assumptions used as a basis for planning and response; and 2) departmental and functional annexes that serve as operational guides for specific functions. This plan combines the four phases of Emergency Management: Mitigation; Preparedness; Response; and Recovery.

The EOP references the vulnerability assessment in the Hazard Mitigation Plan that was completed for the City of Newark for the following hazards: riverine floods; severe winds (hurricanes and coastal storms); thunderstorms; tornadoes; winter storms; and earthquakes. The document refers to HAZUS-MH as the loss estimation software used for the earthquake and hurricane risk assessments. The EOP concludes that the City is moderately vulnerable to riverine flooding (caused by hurricanes and coastal storms), severe thunderstorms and winter storm hazards and is least vulnerable to the tornado and earthquake hazards. The document identifies organizations and their responsibilities during an emergency situation.

Options for Integration into the Hazard Mitigation Plan

- The EOP should identify which departments would be involved for specific functions, such as shelter operations, damage assessment, etc.
- The EOP should include actions to collect valuable data (e.g., high water marks) after a recent hazard event. This type of information can be essential to preparing hazard mitigation project applications for FEMA funding.
- The EOP should identify mitigation opportunities for public facilities that are at high risk.

6.1 MITIGATION STRATEGY

6.1.1 Update Process Summary

Based on the issues identified in the Hazard Identification and Risk Assessment, gaps identified in the mitigation capability analysis, input from the Steering Committee on goals in the 2009 Plan, the goals were revised.

In order to improve the level of coordination between state and local governments within the State of Delaware, the State Plan discusses the linking of local and state planning goals an important first step. The goals established through the State Plan and County Plan updates were developed independently but have been found to be similar due to the shared objectives of both the State of Delaware Mitigation Plan and the County Plan Updates. In New Castle County, this was aided by the attendance of several State Officials from DEMA, DELDOT, and DNREC at the County Steering Committee meeting in December 2014. Goals were revised, added, and vetted by various State agencies. Had the goals of state and county-level plans differed significantly, a resolution would have been reached during the meeting.

6.1.2 Introduction

The intent of the *Mitigation Strategy* is to provide New Castle County and participating jurisdictions with the tools necessary to continue to reduce the impact of natural hazards. In order to achieve these aims, this section was separated into the following components:

- Mission Statement
- Mitigation Goals
- Identification and Analysis of Mitigation Measures
- Mitigation Action Plan

The New Castle County All Hazard Mitigation Plan Update provides a comprehensive review of hazards and identifies far-reaching policies and projects intended to not only reduce the future impacts of hazards, but also assist the county and municipalities achieve compatible economic, environmental and social goals. In addition, the plan is strategic, in that all policies and projects are linked to departments or individuals responsible for their implementation. When possible, funding sources are identified that can be used to assist in project implementation.

The Mitigation Action Plan lists specific prioritized actions, agency(ies) responsible for their implementation, potential funding sources that may be used, and an estimated target date for completion. Each action was listed with the accompanying information. This approach provides those in charge of the Plan's implementation with a clear roadmap that serves as an important monitoring tool. The collection of actions also serves as an easily understood menu of policies and projects for those decision makers who want to quickly review the Plan.

Planning Approach

Goals are intended to meet the intent of the mission statement. Mitigation actions serve to provide clear, measurable tasks. Actions may include policies or projects designed to reduce the impacts of future hazard events. Each step is intended to provide a clearly defined set of policies and projects based on a rational framework for action. The components of the planning framework are explained in greater detail below.

Mission Statement: Provides guiding principles of the All Hazard Mitigation Plan.

Goals:	Goals represent broad statements that are achieved through the implementation of more specific, action-oriented objectives. Goals provide the framework for achieving the intent of the mission statement.
Hazard Mitigation Policies:	Policies are defined as a course of action agreed to by members of the Planning Team.
Hazard Mitigation Projects:	Projects are defined as specific actions taken to address defined vulnerabilities to existing buildings or systems. Potential funding sources are listed for each project.
Mitigation Action Plan:	Prioritized listing of actions (policies and projects), including a categorization of mitigation technique, hazards addressed, individual or organization responsible for implementation, estimated timeline for completion and list of potential funding sources.

6.1.3 Mission Statement

Develop and maintain a comprehensive hazard mitigation program guided by the effective use of technology and data, improved communications and warning, the purchase of necessary equipment, sound planning, the adoption of codes, leading to the creation of policies and projects designed to reduce the vulnerability of people and property within New Castle County to the negative effects of natural hazards.

6.1.4 Mitigation Goals

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 following goals and mitigation actions of the New Castle County Hazard Mitigation Plan were updated at the Committee meeting on 3 December 2014 and represent a comprehensive approach taken by the County and its municipalities. The goals have remained unchanged for the most part since the 2009 Plan. However, the goals have been reworded to focus on natural hazards rather than natural and human caused hazards. A new goal (goal #11) has been added to the list of existing goals.

Goal #1 New Castle County and its municipalities will continue to maximize the use of technology (GIS, remote sensing, etc.) and data to develop sound mitigation policies and projects.

Goal #2 New Castle County and its municipalities will continue to emphasize the use of sound planning practices to reduce the impacts of natural hazards.

Goal #3 New Castle County and its municipalities will continue to acquire or upgrade existing equipment to improve disaster readiness and implement hazard mitigation measures.

Goal #4 New Castle County and its municipalities will continue to improve communication and warning systems to better protect lives and property from the potential impacts of natural hazards.

Goal #5 New Castle County and its municipalities will continue to enhance and implement local codes and ordinances at higher standards to reduce the impacts of natural hazards while considering a holistic approach as well as at the project level.

Goal #6 New Castle County and its municipalities will continue to adopt transportation-related measures to improve evacuation, sheltering and security concerns.

Goal #7 New Castle County and its municipalities will continue to enhance education and outreach strategies to improve the dissemination of information to the public regarding hazards, including the steps that can be taken to reduce hazard impacts.

Goal#8 New Castle County and its municipalities will continue to adopt mitigation measures that better protect critical facilities and infrastructure from the impacts of natural hazards.

Goal#9 New Castle County and its municipalities will continue to identify and implement sound hazard mitigation projects.

Goal#10 New Castle County and its municipalities will ensure that sound stormwater management principles are implemented throughout the County.

Goal #11 New Castle County and its municipalities will continue to identify potential funding sources and partnerships for projects.

The following goals and mitigation actions of the New Castle County Hazard Mitigation Plan were updated at the Committee meeting on 9 January 2015 and represent a comprehensive approach taken by the University and its departments. One objective has been deleted, 3 old actions have been moved to the goals and objectives section from the 2011 Disaster Resistant University Plan.

Goals and Objectives

Goal #1 - Protect the health, safety and wellbeing of our student body, faculty and staff from negative impacts of a disaster through the implementation of mitigation projects at all our campuses

- Objective 1.1: Support funding reasonable mitigation projects which look to improve all aspects of safety on UD campuses

Goal #2 – Protect UD property from the adverse affects of disasters through mitigation projects at all our campuses

- Objective 2.1: Support funding reasonable mitigation projects which look to reduce loss to the University
- Objective 2.2: Encourage the incorporation of reasonable mitigation projects and concepts into new construction on UD campuses
- Objective 2.3: Ensure the redundancy of power systems that affect buildings, equipment, and research projects.

Goal #3 – Incorporate mitigation aspects into existing University partnerships with the State of Delaware, County of New Castle, and the City of Newark

- Objective 3.1: Partner with various levels of government on disaster related awareness, education and outreach initiatives to multiple audiences

Goal #4 – Help reinforce and augment the University's mission to prepare for, respond to and recover from disaster events affecting any of our campuses

- Objective 4.1: Encourage emergency response planning on both the academic and administrative sides of the University
- Objective 4.2: Continue to foster existing emergency planning and response partnerships with all levels of government

Goal #5 – Incorporate mitigation planning into University-sponsored construction.

- Objective 5.1: Increase the overall preparedness level of the University community through outreach and training of both the student and the employee population
- Objective 5.2: Work with the University Facilities Planning and Construction Unit to ensure hazard considerations are included in all new facility planning

6.1.5 Identification and Analysis of Mitigation Measures

In reformulating the New Castle County Mitigation Strategy, a wide range of activities were considered in order to help achieve the goals of participating jurisdictions. All actions chosen by county and municipal government officials fell into one of the broad categories of mitigation techniques: preventive measures, natural resources and open space protection, outreach and coordination, and other (includes emergency services).

Mitigation Techniques

1. Prevention

   Preventive activities are intended to keep hazard problems from getting worse. They are particularly effective in reducing a community's future vulnerability, especially in areas where development has not occurred or capital improvements have not been substantial. Examples of preventative activities include:

   - Planning and zoning
   - Hazard mapping
   - Building codes
   - Floodplain regulations
   - Stormwater management
   - Capital improvements programming
   - Shoreline / riverine / fault zone setbacks

2. Natural Resources and Open Space Protection

   Natural resource protection activities reduce the impact of hazards by preserving or restoring the function of natural systems. Examples of natural systems that can be classified as high hazard areas include floodplains, wetlands and barrier islands. Thus, natural resource protection can serve the dual purpose of protecting lives and property while enhancing environmental goals such as improved water quality or recreational

opportunities. Parks, recreation or conservation agencies and organizations often implement these measures. Examples include:

- Floodplain protection
- Beach and dune preservation
- Riparian buffers
- Fire resistant landscaping
- Erosion and sediment control
- Wetland restoration
- Habitat preservation
- Slope stabilization

3. Outreach and Coordination

Outreach and coordination activities are used to advise residents, business owners, potential property buyers, and visitors about hazards and mitigation techniques they can use to protect themselves and their property. Examples of measures used to educate and inform the public include:

- Outreach and education
- Training
- Speaker series, demonstration events
- Real estate disclosure
- Hazard expositions

4. Other (including property protection, emergency services and structural projects)

Property protection measures enable structures to better withstand hazard events, remove structures from hazardous locations, or provide insurance to cover potential losses. Examples include:

- Acquisition
- Relocation
- Building elevation
- Critical facilities protection
- Retrofitting (i.e., wind proofing, flood proofing, seismic design standards, etc.)
- Insurance
- Safe room construction

Structural mitigation projects are intended to lessen the impact of hazards by modifying the environment or hardening structures. Structural projects are usually designed by engineers and managed or maintained by public works staff. Examples include:

- Reservoirs
- Levees, dikes, floodwalls, or seawalls
- Detention and retention basins
- Channel modification
- Beach nourishment
- Storm sewer construction

Emergency services minimize the impact of a hazard on people and property. Actions taken immediately prior to, during, or in response to a hazard event include:

- Warning systems
- Search and rescue
- Evacuation planning and management
- Flood fighting techniques

6.1.6 Mitigation Techniques in the New Castle County Planning Area

County and municipal officials reviewed the findings of the *Capability Assessment* and *Risk Assessment* in order to determine feasible and effective mitigation techniques. The Mitigation Matrix (Table 6.1) assists local governments make sure they addressed, at a minimum, those hazards posing the greatest threat. Mitigation techniques, including prevention, property protection, natural resource protection, structural projects, emergency services and public information and awareness were noted in the matrix if adopted by a participating jurisdiction. It is important to note that local Mitigation Action Plans in the New Castle County planning area include an array of actions, not just those addressing high and moderate risk hazards.

Requirement: §201.6(c)(3)(ii): [The mitigation strategy] must also address the jurisdiction's participation in the National Flood Insurance Program (NFIP), and continued compliance with NFIP requirements, as appropriate.

Participation in the NFIP is based on a voluntary agreement between a community and FEMA. Compliance with the NFIP, however, extends beyond mere participation in the program. The three basic components of the NFIP include: 1) floodplain identification and mapping risk, 2) responsible floodplain management and 3) flood insurance. Table 6.1.1 includes a list of compliance actions conducted by the County, based on a checklist developed by DEMA.

Note: DEMA has developed a Flood Smart brochure that addresses the availability of flood insurance and is distributed to every library in the State.
Note: In terms of NFIP compliance from the municipalities, New Castle County handles planning and zoning issues for most of the smaller towns in the County other than Middletown, New Castle, Newark, and Wilmington.

Table 6.1.1 – National Flood Insurance Program Checklist for New Castle County

1. Floodplain Identification and Mapping.		
Requirement	Yes/No	Municipality Action
a. Does the municipality maintain a copy effective FIRM (flood insurance rate map) maps and FIS (flood insurance study) that is accessible to the public?	yes	The Department of Land Use (DLU) maintains several sets of paper FIRM with the FIS and maintains a GIS-based data layer on its website: nccde.org
b.Has the municipality adopted the most current DFIRM or FIRM and FIS?	yes	Reference 40.10.302 of the Unified Development Code
c. Does the municipality support request for map updates?	yes	Through the land development process, the DLU supports, evaluates and verifies map updates utilizing the LOMC process
d. Does the municipality share with FEMA any new technical or scientific data that could result in map revisions within 6 months of creation or identification of new data?	yes	NCC is currently working through DNREC and FEMA to pursuant to FEMA's Discovery process. Stream miles are being identified for new detailed studies, limited detail studies and model backed A zone studies.
e. Does the municipality provide assistance with local floodplain determinations?	yes	DLU provides this service for residents and other users through dedicated personnel (Engineer of the Week) and lead John Gysling, PE, CFM
f. Does the municipality maintain a record of approved Letters of Map Change?	yes	DLU maintains a notebook of all LOMC and updates the website accordingly. LOMA are mapped on the GIS layer and LOMR are updated as shape files become available.
2. Floodplain Management		
Requirement	Yes/No	Municipality Action
a. Has the municipality adopted a compliant floodplain management ordinance that at a minimum regulates the following:	yes	
(1) Does the municipality issue permits for all proposed development in the SFHA?	yes	The UDC and Building Code requires building permits and floodplain development permits for all proposed development within the SFHA. See UDC 40.10.320 A.
(2) Does the municipality Obtain, review and utilize any Base Flood Elevation and floodway data, and require BFE data for subdivision proposals and other development proposals larger than 50 lots or 5 acres?		Through the land development process, the UDC requires BFE data for all subdivision proposals and development projects larger than 5 lots or 5 acres (See UDC 40.10.310)
(3) Does the municipality Identify measures to keep all new and substantially improved construction reasonably safe from flooding to or above the Base Flood Elevation, including anchoring, using flood resistant materials, designing or locating utilities and service facilities to prevent water damage?		The Building Code requires all new or substantially improved structures to elevated not less than 18 inches. Building Code revisions not yet adopted.
(4) Does the municipality document and maintain records of elevation data that document lowest floor elevation for new or substantially improved structures.		All permit holders building or substantially improving structures in the floodplain are notified that elevation certificates are required prior to issuance of the certificate of occupancy. Completed elevation certificates are kept in the building permit file. See UDC 40.10.313 A.
b. If a compliant floodplain ordinance was adopted, does the municipality enforce the ordinance by monitoring compliance and taking remedial action to correct violations?		Complaints are investigated and violation notices issued upon a finding of violation during the investigation. Rule to Show Cause hearings are held to hear violations. Written decisions are issued which may includes fines and deadlines for compliance.
c. Has the municipality considered adoption of activities that extend beyond the minimum requirements, including those identified for participation in the Community Rating System, freeboard, prohibition of production or storage of chemicals in SFHA, prohibition of certain types of structures such as: hospitals, nursing homes, jails, prohibition of certain types of residential housing such as manufactured homes, and finally floodplain ordinances that prohibit any new residential or non-residential structures in the SFHA.		NCC floodplain ordinance in Article 10 of the UDC regulates development in floodplains and along riparian corridors that go beyond minimum NFIP standards. The ordinance provides riparian buffers areas, requires enclosures below lowest floor to be used only for parking, building access and limited storage, prohibits production and storage of chemicals in the SFHA and prohibits all new structures designed for human habitation except under the Beneficial Use Process. See UDC 40.10.320 A. Note all requirements for construction in the floodplain are to be within the Building Code.
3. Flood Insurance.		
Requirement	Yes/No	Municipality Action
a. Does the municipality educate community members about the availability and value of flood insurance?		
b. Does the municipality inform community property owners about changes to the DFIRM/FIRM that would impact their insurance rates?	yes	NCC requires that the applicant's engineer provide notice to property owners about changes to DFIRM/FIRM as part of the LOMR process.
c. Does the municipality provide general assistance to community members relating to insurance issues?	yes	DLU provides this service for residents and other users through dedicated personnel (Engineer of the Week) and lead John Gysling, PE, CFM

6.2 LOCALLY-SPECIFIC MITIGATION ACTIONS

6.2.1 Review of Current and Completed Hazard Mitigation Actions

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.

Requirement: §201.6(c)(3)(ii): [The mitigation strategy] must also address the jurisdiction's participation in the National Flood Insurance Program (NFIP), and continued compliance with NFIP requirements, as appropriate.

The Cost-Benefit Review

The Cost Benefit Review comprises an analysis that compares the project cost to both tangible and non-tangible benefits. Tangible benefits are those benefits that could be considered in a comprehensive Benefit-Cost Analysis (BCA). Non-tangible benefits include public support, political will, and life safety.

The Benefit-Cost Analysis (BCA)

All mitigation projects that are considered for FEMA's Hazard Mitigation Assistance (HMA) program funding will have a comprehensive BCA completed using FEMA approved BCA software. Both the State Hazard Mitigation Officer (SHMO) and the Flood Mitigation Assistance program coordinator can provide assistance with the BCA. This analysis will be the basis by which the County, municipality, or University either pursues a FEMA grant or seeks funding elsewhere. Only cost-effective eligible projects will be submitted for funding under the HMA program.

The mitigation actions from the 2009 Plan were reviewed at the County and Municipal Steering Committee Meeting held on 3 December 2014 and edited as necessary. The mitigation actions from the 2011 University Plan were updated at a workshop held at the University on 9 January 2015. In addition to the meetings, the County, municipalities, University and DEMA were contacted via phone and email and requested to review and update the actions from previous plan updates. Tables 6.2.1 and 6.2.2 provide a listing of all mitigation actions, their adoption status, and timeline for completion, priority, and status. Table 6.2.1 identifies actions that were either completed or cancelled since the last Plan Update and 6.2.2 lists the previous and newly developed actions that need to be implemented.

6.2.2 Review of Current and Completed Hazard Mitigation Actions

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.

Table 6.2.1 – Completed or Cancelled Mitigation Actions

Action	Adopted	Status (Completed or Cancelled)
	Arden	
1	Initiate tree maintenance program.	Completed
	Ardencroft	
1	Investigate appropriate mitigation measures to protect 16 leaseholders adjacent to creek.	
2	Preserve irreplaceable historic documents via electronic copy and place originals in vault storage or State archives.	Completed
	Ardentown	
1	Acquire 3 flood prone properties.	Completed
	Delaware City	
1	Join Community Rating System.	Completed
2	Purchase equipment (heavy equipment, grinders, etc.) or contract services to manage disaster-generated debris.	Completed
3	Establish coastal flood warning and notification system.	Completed
4	Include citizen preparedness information on Delaware City's website and incorporate specific actions that residents can take to reduce the impacts of natural hazards.	Completed
5	Distribute letters to all property owners in Delaware City regarding potential flood hazards as required for participation in the Community rating System (CRS).	Completed
6	Utilize the media for distribution and publication of hazard information to residents.	Completed
7	Locate a hazard resource center in the Delaware City Town Hall and library. The center will act as a repository for information on local hazards, preparedness, and mitigation strategies.	Completed
8	Replace the tide gate and re- engineer outfall into Delaware	Cancelled - lack of funding
9	Floodproof to Delaware City Community Shelter for potential use as a shelter.	Completed

10	Acquire NOAA weather radios for key City and fire company personnel so they can provide timely notice to the public on the changing weather conditions.	Completed - Police Chief and Fire Department have NOAA radios.
11	Develop an emergency evacuation plan.	Completed - Delaware City has an emergency evacuation plan.
12	Work with the County to conduct a detailed flood vulnerability study for the entire City.	A flood vulnerability study of Delaware City was completed in January 2014 with a grant from the University of Delaware Sea Grant Program.
13	Purchase emergency generator.	Completed - two generators have been purchased.
14	Develop warning system call- out.	Completed - Delaware City uses New Castle County reverse 911
	Middletown	
1	Replace existing reservoir with underground pipes that will send water from wells directly to treatment and distribution facilities.	Building, piping upgrades and reservoir upgrades are complete
2	Increase security at water plants with a combination of alarms and motion detectors/acoustic surveillance.	Completed.
3	Implement an alternate site location at the Armory location (Cass Street) to serve as a base of operations for Public Works and/or Townhall in the event of a disaster scenario	Fiber link established; basic networking components and basic networking infrastructure in place. Completed.
	Newark	
1	River at Washington and Harbor Streets.	
2	Retrofit the Curtis Treatment Plant to enable pumping of finished water and treated drinking water during flood.	Cancelled - Not feasible - it may require filling of the floodplain if it is within the floodplain.
3	Floodproof the sewer lift stations at Cooch's Bridge and Rodel.	Completed
4	Floodproof the South Well field pump station.	Completed
5	Flood proof Northwest Booster Station.	Completed
6	Install physical security measures at the entrance to City Hall.	Completed
	Odessa	
1	Develop a plan to floodproof evacuation routes.	Cancelled by Town.
2	Integrate floodplain standards into relevant local ordinances.	Completed - Integrated into the building code. Was a requirement to participate in the NFIP.
3	Identify owners of properties in high hazard areas (including those who own historic properties) and conduct an intensive outreach campaign regarding mitigation and disaster preparedness.	Completed - property owners are aware of risks and vulnerabilities.

4	Ensure building codes meet high wind standards.	Completed - The state adopted new standards relevant for all Towns.
5	Develop public water distribution center.	Cancelled - not applicable
	Wilmington	
1	Develop relocation plan for non-essential personnel (i.e., finance, law, public works, etc.) in the event that the City/County building is unusable.	Completed
2	Develop off-site backup of computer network.	Completed
3	Amend Flood Damage Prevention Ordinance to include provision that limits future development in the floodplain.	Completed
4	Continue to remove trees identified as highest priority for removal in 2002 street tree inventory. Replace trees with native, wind-resistant species.	Completed
5	Investigate the possibility of further restricting the passage of certain hazardous materials through the City.	Completed
6	Coordinate with the State to develop an evacuation and sheltering plan specifically for the area bounded by East 12th Street, Marsh Lane, and I-495 to Rosemont.	Completed, ongoing
7	Develop subdivision ordinance limiting the amount of impervious surface allowed in new development projects.	Completed
8	Slow down and control storm water on 113 acres of the southeast corner of the Porky Oliver Golf Course - headwaters for Silverbrook Run on 2nd and Webb Streets.	Completed. Built new water control system and retention area.
9	Mitigate flooding at 35th Street and Northeast Boulevard.	Completed
10	Develop a detailed LIDAR dataset for the entire City/water district to include trees and buildings.	Completed 2013
11	Hazard proof the Emergency Operations Centers/Emergency Facilities.	Completed 2013
12	Construct new Emergency Operations Center Facility.	Completed 2012

13	Evaluate critical emergency operations facilities; prepare necessary designs for mitigation actions and implementation.	Completed 2012/2013
University of Delaware - Wilmington and Newark Campuses		
1	Reconfigure Drake Lab's supply and exhaust to eliminate possible exhaust fumes from Drake Lab into the adjacent Brown Lab.	Completed
2	Install new chilled water line from Perkins Student Center to Kent Dining Hall.	Completed
3	Abate Mold in Alison Hall	Building renovated in 2013-2014. Completed
4	Incorporate mitigation planning into the University-sponsored construction on the Chrysler property.	Cancelled - not applicable
5	Work with the University Facilities Planning and Construction Unit to ensure hazard considerations are included in all new facility planning.	Cancelled - moved to objectives
6	Delaware Homeowners Handbook to Prepare for Natural Hazards	Completed
7	Update individual departments' disaster prepared plans and emergency action plans. Focus on educating departments on the importance of keeping these plans current. Rethink unit planning – scale and process and consider combining plans.	Completed
8	Purchase a tanker system to prevent catastrophic overflow of 1.2 million gallon manure storage tank to avoid potential uncontrolled manure overflow in the event of high precipitation events	Completed - purchased
9	Renovate McDowell Hall Elevator P22.	Cancelled - not applicable
Unincorporated Areas of the County		
1	Conduct an evaluation of the County's critical facilities (wastewater treatment plants, pumping stations, etc.) and shelters to identify the ones that need to be hazard-proofed.	Completed (all WWTP's and PS's are flood-proofed by design)
2	Retrofit the last stormwater management basin - Genderwood stormwater management facility (MS4).	Completed
3	Implement channel improvements and/or construct a stormwater management basin to reduce flooding in the Shellpot Creek Watershed.	Completed
4	Place copies of Updated Hazard Mitigation Plan in all County libraries.	Completed
5	Identify properties from the New Castle Flood Mitigation Plan for possible acquisition.	Completed/Ongoing
6	Explore the feasibility of joining the Community Rating System	Completed 2013 Acceptance

7	Explore expanding the capabilities of the Reverse 9-1-1 system.	Completed
8	Floodproof Shone Lumber in the Stanton area.	Completed
9	Floodproof the Openlander Property on of Barley Mill Road.	Completed
10	Maintain a digital copy of the floodplain data and make it available online and upload it onto a network that County employees can access.	Completed in GIS Maps
11	Acquire flood-prone properties (185-200 homes) in the Glenville area.	Completed
12	Create a database of critical facilities in New Castle County in order to execute homeland security measures according to National Threat Levels.	Completed
13	Centralize all heavy equipment (Churchman's Complex) for rapid deployment to emergency personnel following a disaster.	Completed
14	Implement channel excavation and improvements to reduce flooding from Kirkwood Highway to the railroad yard near Elsmere.	Completed
15	Develop backup plan should power go down at county facilities.	Completed

Table 6.2.2 – Ongoing Mitigation Actions

Action	Description	Priority	Status (Started, Not Started, In Progress)
Arden			
1	Work closely with the County and continue to improve public outreach within the community to include distributing informative pamphlets and other outreach materials and workshops to educate citizens about hazard awareness.		
2	Establish emergency notification procedures for rail and Interstate HAZMAT incidents and chemical facilities.		
3	Retrofit Guild Hall so that it can be used as a temperory shelter		
Ardencroft			
1	Investigate appropriate miitgation measures to protect 16 lease holders adjacent to the creek.		
2	Develop and implement an information awareness system to include notification, mail outs, recorded messages, and email during and after an event.		

3	Ensure adequate training and resources for emergency organizations and personnel.		
4	Conduct Community Emergency Response Team (CERT) classes for emergency response personnel		
5	Increase the number of trained citizen emergency responders.		
6	Conduct a vegetative vulnerability assessment to determine what plant types pose a wind, water, or snow hazard to private and public property.		
7	Conduct an assessment to determine the vulnerablity if Perkins Run overtops its banks (Due to increased population growth, development, and encroachment).		
Ardentown			
1	Conduct a structural evaluation to determine the possibility of using the Candlelight Theater as a shelter in the event of a disaster. Consider using the newly opened assisted living facility (Ivy Gables) as a shelter.		
2	Develop a call out database to notify residents in the event of a disaster.		Ongoing
3	Marsh Road Property Acquisition Project		Ongoing
Bellefonte			
1	Work closely with and obtain assistance from the County to implement an information awareness system to include notification, mail outs, recorded messages, and email during and after an event. Continue to send out hazard notifications via the State/County Police Alert System and through the Brandywine Hundred Fire Company.		Ongoing
Delaware City			
1	Create displays for use at public events (health fair, public awareness day, county fair, etc.).		

2	Construct flood barrier, drainage improvements, and wetlands enhancements for Dragon Run.		-City received a $50K grant from Delaware Coastal Program matching grant and Delaware City Refinery provided a $20K matching grant. NCC Conservation District provided a $5K grant for engineering study of Dragon Run Tide Gate. Work has been completed. -Received a $500,000 grant from DNREC for Dragon Run and installation of check valve on Monroe Street Outlet. -Construction of Horseshoe berm from Monroe Street behind houses on Solomon Place, which will address the 50-year flood. Cost $320,000. - Delaware City was awarded a $920,000 FEMA Grant to address the Washington Street flooding issues. City also received $500,000 funding from DNREC, funds in the state FY15 budget, which provides $1,475,000 to address flooding issues on Washington Street and Monroe and Madison Streets.
3	Evaluate solutions for flooding of Route 9 at Dragon Run which is a major evacuation route out of Delaware City.		Ongoing. See above action
4	Provide training for Delaware City Town Council on the CRS program and encourage residents to participate.		Mayor and Council Meetings were held at various times throughout the year advising Council Members and the Public of Flood Plain information. All meetings are posted at five (5) places around Town and on our website.

5	Construct flood barrier and drainage improvements along C&D Canal and evaluate wetlands enhancements.		Ongoing. Installed flood barrier and gates along river and canal. Working with UD for rising sea level solutions.
6	Develop a Phragmites elimination program.		Ongoing. A continuous program has been established and Delaware City is paying for the elimination program. We are working with the Division of Forestry.
7	Replace or eliminate tidal flushing pipe and valve at Old Locks.		Not started. This project has been engineered and Delaware City is now working on applying for a grant to complete project.
8	Washington Street Flood Mitigation Project		Ongoing
	Elsmere		
1	Implement stormwater study recommendations.		"The benefits of the mitigation would be that it reduces the number of flooding events thereby reducing repetitive losses." No Progress. No funding available.
2	Increase the storage capacity of the Little Mill, Chestnut Run, Silverbrook, Derrickson Run and other creeks throughout the Town.		The benefits of the mitigation would be that increasing capacity reduces the number of flooding events thereby reducing repetitive losses. No progress due to lack of funding.
3	Evaluate storm water management infrastructure.		
4	Study and recommend solutions to alleviate the periodic flooding threat on Chestnut Run at Kirkwood Hwy (SR-2).		Not started.
	Middletown		
1	Conduct a vulnerability assessment of the Town's water distribution system, to identify measures designed to reduce the potential impacts of natural hazards.		Ongoing. Tightened reservoir security measures; Secured chlorine facility; will continue to look for new ways to improve security.

2	Develop a water restriction policy that can be implemented during drought conditions.		Ongoing. Website and Code Red urgent release asking residents to conserve water when water levels are low.
3	Develop evacuation policy for the Town.		Ongoing. Integrated with EOP which is under development.
4	Develop a website to notify residents of important information before, during and after emergencies, storms, etc. (include links to other major sources of information: DEMA, FEMA, DELDOT and the weather channel).		Ongoing. There are links to the area's emergency services. 'Code Red' emergency alert and notifications available on website.
5	Perform Sharondale outfall rehabilitation to eliminate erosive velocities of stormwater runoff in the outfall.		Ongoing. The Town is currently in the planning phase with this project. Sources of funding are being earmarked and sought.
New Castle			
1	Introduce railroad crossings at main highway intersections with gate and better signals (three major roadways cross the railroad near schools, businesses and residential areas).		Projects to install railroad crossing gates are proceeding one is being scheduled, and DELDOT is in the process for the other three sites.
2	Develop a detailed flood vulnerability study for the entire City along the Delaware River and Bay to focus on coastal/riverine flooding from severe storm events and sea level rise.		The City has embarked on a project limited to the City, with the first portion of the project scheduled for a spring 2015 completion.
3	Work with railroad lines to notify citizens of hazardous shipments that run through the City of New Castle.		Railroad feels it is a security risk to announce hazmat shipment schedules, but has demonstrated a unified communication/cooperation for training and response with DEMA.
4	Enhance building code.		The building code is scheduled for an update to match the County's code. Overall reduction of the number of flat roofs appears unwarranted.
Newark			

1	Assess damages sustained to city property following a disaster.		
2	Retrofit storm sewer system.		
3	Preserve riparian buffer along White Clay Creek.		
4	Inspect stormwater outfalls and maintain stormwater management facilities annually.		
5	Conduct six inspections of creek annually.		
6	Improve storm drain spill response.		
7	Initiate tree maintenance program.		
8	Own generation back up power at varied voltages and place at critical loads and substations.		
9	Develop storage area at designated parkland for debris composting.		
10	Keep Christina Creek clear of obstruction, including 11 bridge culverts.		
11	Clean catch basins and grates three times a year.		
12	Routinely inspect all construction E & S measures.		
13	Study and recommend solutions to alleviate the periodic flooding threat on the Christina River at Nottingham Road (SR-273), Barksdale Road, near the Christina River at the Newark CSX rail line and Cashno Mill Road, on the Christina River at W Chesnut Hill Road/Rittenhouse Park, on the Christina River at Welsh Track Road, and on White Clay Creek at Paper Mill Road.		Not started
14	Support cost effective property acquisitions through Federal grants.		
Newport			
1	Initiate wetlands protective measures along the Christiana River.		
2	Work with the County to conduct a detailed flood vulnerability study for the entire Town.		
3	Study and recommend solutions to alleviate the periodic flooding threat on the Christina River at Interstate 95/US 202.		Not started
Odessa			
1	Establish a comprehensive all- hazards warning system.		
2	Educate residents on hazards that can impact the community.		
3	Develop an evacuation policy for the Town.		
4	Update the local Flood Damage Prevention Ordinance.		Ongoing. Update should be complete Feb. - Mar. 2015
5	Encourage citizens to purchase flood insurance.		Ongoing. Once update is complete in Feb.-Mar. a new notice will be posted.
6	Identify and evaluate shelters.		Not started
7	Study and recommend solutions to alleviate the periodic flooding threat on Appoquinimink River at Main Street (SR-299)		Not started

Townsend			
1	Develop an educational and outreach program for residents, business owners and government employees to include specific actions that can be taken to reduce the impact of natural hazards.		Not started
Wilmington			
1	Educate and encourage citizens to purchase and install backflow preventers in flood-prone homes.		Not Started
2	Continue to increase public education—people should be ready to survive for three days without power.		Ongoing
3	Continue to increase public education for all hazards.		Ongoing
4	Evaluate the adequacy of existing code to address potential wind-related damages—particularly damage caused by flying glass in downtown area.		Not started
5	Reduce the likelihood of sewer overflow during flood events through real-time control (RTC).		Ongoing public work project to improve water run off and reduce amount of flow to sewage/street run off system
6	Develop building construction code requiring shatter-proof glass for new city buildings.		Not complete
7	Establish a citywide disaster recovery/business continuity plan.		Ongoing
8	Coordinate with the Department of Public Works to apply traffic flow study to evacuation procedures.		Ongoing
9	Evaluate Comprehensive Plan to check for hazard mitigation elements.		Ongoing. No funding
10	Ensure NIMS training for all appropriate City personnel and engage in table top exercises.		Ongoing. Project with personnel changing job assignments and new employees.
11	On South Wilmington Wetland Park - Reestablish wetland to process stormwater from South Wilmington Area east of Walnut Street, south of A street; Partial separation of stormwater in SouthBridge and from Garaches Lane.		Plan to reduce flooding
12	Reestablish drainage along RR property between New Castle Avenue and Christiana Avenue to relieve street flooding on New Castle Avenue and to create a drainage path for the redevelopment of the Southbridge Extension area.		Plan to reduce flooding
13	Develop an Emergency Management GIS training program (including hardware and software).		Ongoing
14	Study and recommend solutions to alleviate the periodic flooding threat on Brandywine Creek at E 12th Street/Wilmington Industrial Park and on Shellpot Creek at Governor Printz Blvd (US 13).		Not started

University of Delaware - Wilmington and Newark Campuses			
1	Develop a strategy to abate asbestos campus-wide.		Not started
2	Alleviate the water infiltration/flooding taking place within four University buildings on the Newark campus: New Castle Hall, Kent Hall, Sussex Hall, and Robinson Hall.		Not started
3	Utilize university administrative and academic resources for emergency management related projects.		Not started
4	Add utility meters at the building level for water, steam, chilled water, gas, and electricity on all buildings on the Newark campus		Ongoing
5	Increase the occurrence of joint trainings and exercises between the State of Delaware, New Castle County, the City of Newark and the University of Delaware to strengthen the response partnership between these agencies.		Ongoing
6	Increase the overall preparedness level of the University Community through outreach and training of both the student and the employee population.		Ongoing
7	Develop an informational website which would be linked to the main site for Emergency Management. This site could be combined with the University and departmental social media tools (i.e. Facebook, Twitter, etc.).		Not started
8	Update individual departments' disaster preparedness plans and emergency action plans. Focus on educating departments on the importance of keeping these plans current and rethink unit planning – scale and process and consider combining plans.		Ongoing
9	Improve access to required annual safety trainings for faculty, staff and students as well as tracking laboratory activities such as lab inspections, chemical inventory, etc.		Ongoing
10	Consider integrating effective mitigation practices and concepts into other relevant University plans (Examples include: the University Strategic Planning Initiative, Facilities Design Guidelines, Critical Incident Management Plan, etc.)		Not started
11	Continue to work closely with the State of Delaware, New Castle County and the City of Newark to ensure that the mitigation actions are coordinated effectively and are in harmony with that of the State, County and City. Collaborate with the local governments to improve the University's and the community's disaster resistance by conducting regular meetings with them to identify mitigation funds.		Ongoing
12	Develop procedures and documentation for the Information Technology recovery staff to ensure seamless operation of the Disaster Recover site thereby facilitating uninterrupted computer operations university-wide.		Not started

13	Procure advanced emergency notification systems to include an exterior Public Address System; an in-classroom emergency notification system in academic buildings and a dedicated non-University redundant website for emergency notifications in the event the www.udel.edu site becomes overwhelmed during a disaster situation.		Not started
14	Update the University Continuity of Operations Plan.		Not started
	Unincorporated Areas of the County		
1	Continue public education and outreach program to educate residents and business owners (who possess hazardous chemicals and compounds) about the protective actions that can be taken to eliminate or reduce property loss and injury.		Ongoing
2	Conduct annual training exercises based on the actions recommended in the revised New Castle County Comprehensive Emergency Management Plan (CEMP) to comply with FEMA CPG 101 version 2, and HSEEP guidelines		Ongoing
3	Implement phase II of channel improvements to reduce the identified flooding problems in Little Mill Creek.		Ongoing
4	Develop a Countywide uniform GIS database and use County data as a baseline. Share GIS data among the levels of government and update with all agency GIS Technicians.		Ongoing
5	Conduct a study to determine the vulnerability of the CRFM sewage along the Christiana River that stretches 10 miles from I-95 to Wilmington.		Ongoing
6	Update the critical facilities database every three years. Identify critical infrastructure that would pose issues to evacuation and communications.		Ongoing/In need of update
7	Revise the New Castle Emergency Operations Plan to comply with FEMA's CPG 101 v.2, and coordinate risk based planning from holistic to project level with involvement from all stakeholders.		Ongoing/In Progress of Major Revision 2014-2015
8	Implement culvert improvements in coordination with DelDOT culvert and bridge improvements to reduce flooding in the Forest hills Park area.		
9	Reduce pollution discharges via storm water systems throughout New Castle County.		
10	Elevate homes within the Bayview Beach community as funding allows.		Grant Awarded for 8 of 9 homes applied for to FEMA
11	Identify critical locations for additional environmental monitoring to aid in mitigation and response.		New Action for 2015
12	Integrate Functional and Access Needs into Emergency Plans and Identify mitigation measures consistent with this population.		New Action for 2015

13	Evaluate the following potential projects for various mitigation measures: Rockland Mills Community Flooding (Flood proofing, Channel improvements, etc.); DuRoss Heights properties for acquisition/elevation; Town of Christiana properties for acquisition/elevation; Port Penn Dike and properties for elevation.		New Action for 2016
14	Study and recommend solutions to alleviate the periodic flooding threat at the following locations: • Near Shellpot Creek at Governor Printz Blvd (US 13) & Merchants Square Shopping Center.• Christina River at Interstate 95/US 202 near Coppers Island.• White Clay Creek at Stanton Christiana Road (SR-4, SR-7), near the Delaware Park Racetrack. • Nonesuch Creek at Airport Road. • Christina River at Churchmans Road (SR-58). • Christina River at Churchmans Road (SR-58). • Christina River at the intersection of S Old Baltimore Pike and W Main St (SR-7). • Muddy Run at Salem Church Road.• Red Lion Creek at River Road (SR-9). • Back Creek at the intersection of Churchtown Road and Clayton Manor Drive. • Delaware City Port Penn Road just north of the village of Port Penn.• Augustine Creek at Saint Augustine Road.• Silver Run at Silver Run Road. • Appoquinimink River at Silver Run Road. • Drawyer Creek at Marl Pit Road.• A tributary of the Appoquinimink River at Old Corbitt Road.		Not started
15	Study and recommend solutions to alleviate the stormwater flooding threat on Fox Run Shopping Center on Pulaski Highway near Glasgow.		Not started
16	Support cost effective acquisition, elevation, and wet/dry floodproofing projects for all municipalities and unincorporated areas in the County.		
17	Evaluate solutions for flooding of Route 72 between the refinery and Route 13 which is major evacuation route out of Delaware City.		Ongoing
18	Implement the 25 specific recommendations by the Delaware Sea Level Rise Advisory Committee per the 2014 Report, for all municipalities.		New Action for 2015
19	Encourage all municipalities to use the LIMWA (Limited Wave Action) to adjust mitigation projects to a higher elevation level in A zones, for sea level rise and better protection. Ordinance 14-126 requires structures built within the LimWA be constructed to Coastal High Hazard or V zone standards per 40.10.320 E		New Action for 2015
20	Evaluate and develop actions to mitigate the following areas that are vulnerable to flooding: Delmarva Power, Christina Crescent, Dupont on Powder Mill Road, Delaware Steeplechase Racetrack Property, Port of Wilmington, 350 Anchor Mill Road, 115 Christina Landing, 1237 Sussex Avenue, and 1301 E Twelfth Street.		New Action for 2015

21	Develop outreach programs to promote awareness of thunderstorm dangers. Include driver safety strategies for severe weather events that can be addressed by driver safety/education classes and by the media. Emphasize the importance of designing public and private buildings with structural bracing, shutters, laminated glass in window panes, and hail-resistant roof shingles or flashing to minimize damage.		New Action for 2015
22	Identify areas where power lines can be buried underground in order to offer the security of uninterrupted power during and after storms. However, consideration needs to be made for maintenance and repair, particularly in cold climates where soil freezes.		New Action for 2015
23	Develop outreach programs to promote the importance of strengthening public and private structures against severe wind damage by encouraging wind engineering measures and construction techniques - structural bracing, straps and clips, anchor bolts, laminated or impact-resistant glass, reinforced pedestrian and garage doors, window shutters, waterproof adhesive sealing strips, or interlocking roof shingles.		New Action for 2015
24	Develop outreach efforts to promote such items as noncombustible roof covering, fire safe construction, and the importance of clearing brush and grass away from buildings. Emphasize how the damage potential can be reduced by ensuring that structures are surrounded by defensible space or buffer zones (generally 30 to 100 feet and cleared of combustible materials).		New Action for 2015
25	Encourage the adoption of building codes to require residential sprinkler systems installed in new construction.		New Action for 2015
26	Identify areas where power lines can be buried underground in order to offer the security of uninterrupted power during and after winterstorms. However, consideration needs to be made for maintenance and repair, particularly in cold climates where soil freezes.		New Action for 2015
27	Ensure regular training in and compliance with all safety procedures and systems related to the manufacture, storage, transport, use, and disposal of hazardous materials.		New Action for 2015

6.2.3 Prioritization

Once the mitigation actions and implementation plan were finalized, the Steering Committee developed a set of criteria: Social Considerations, Administrative Considerations, and Economic Considerations. The following questions were asked to evaluate criteria for project prioritization.

Social Considerations – Life/Safety Impact

- Will the project have minimal/direct/or significant impact on the safety of businesses, residents, and properties?
- Will the proposed action adversely affect one segment of the population?

- Will the project be a proactive measure to reducing flood risk?

Administrative Considerations – Administrative/Technical Assistance

- Is there sufficient staff currently to implement the project?
- Is training required for the staff to implement this project?

Economic Considerations – Project Cost

- What is the approximate cost of the project?

For each criterion, the level of importance (high, medium, or low) was determined based on the total number of points.

Prioritization Categories

- High priority – Total score of 14+
- Medium priority – Total score between 10 and 13
- Low priority – Total score >10

Prioritization Criteria						
Criteria	Points (High Score)	High Score (H)	Points (Medium Score)	Medium Score (M)	Points (Low Score)	Low Score (L)
Life/ Safety Impact	**10**	Significant impact on public safety for businesses, residents, properties	6	Direct impact on businesses, residents, properties	2	Minimal/negligible impact on businesses, residents, properties
Administrative/ Tech Assistance	**5**	No additional staff or technical support needed to implement action	3	and technical support needed to implement action	1	Significant administrative and technical support needed to implement action
Project Cost	**5**	(<$25,000)	3	implement ($25,000-	1	implement (>$100,000)

Table 6.3 – Prioritized Mitigation Actions

Action	Description	Life Safety	Admin/ Technical	Cost	Total Score	Priority
Arden						
1	Work closely with the County and continue to improve public outreach within the community to include distributing informative pamphlets and other outreach materials and workshops to educate citizens about hazard awareness.					
2	Establish emergency notification procedures for rail and Interstate HAZMAT incidents and chemical facilities.					

3	Retrofit Guild Hall so that it can be used as a temperory shelter					
Ardencroft						
1	Investigate appropriate miitgation measures to protect 16 lease holders adjacent to the creek.					
2	Develop and implement an information awareness system to include notification, mail outs, recorded messages, and email during and after an event.					
3	Ensure adequate training and resources for emergency organizations and personnel.					
4	Conduct Community Emergency Response Team (CERT) classes for emergency response personnel					
5	Increase the number of trained citizen emergency responders.					
6	Conduct a vegetative vulnerability assessment to determine what plant types pose a wind, water, or snow hazard to private and public property.					
7	Conduct an assessment to determine the vulnerablity if Perkins Run overtops its banks (Due to increased population growth, development, and encroachment).					
Ardentown						
1	Conduct a structural evaluation to determine the possibility of using the Candlelight Theater as a shelter in the event of a disaster. Consider using the newly opened assisted living facility (Ivy Gables) as a shelter.	6	3	3	12	Medium
2	Develop a call out database to notify residents in the event of a disaster.	6	1	5	12	Medium
3	Marsh Road Property Acquisition Project	2	1	1	4	Low
Bellefonte						
1	Work closely with and obtain assistance from the County to implement an information awareness system to include notification, mail outs, recorded messages, and email during and after an event. Continue to send out hazard notifications via the State/County Police Alert System and through the Brandywine Hundred Fire Company.					
Delaware City						
1	Create displays for use at public events (health fair, public awareness day, county fair, etc.).	2	5	5	12	Medium
2	Construct flood barrier, drainage improvements, and wetlands enhancements for Dragon Run.	10	5	1	16	High

3	Evaluate solutions for flooding of Route 9 at Dragon Run which is a major evacuation route out of Delaware City.	10	5	3	18	High
4	Provide training for Delaware City Town Council on the CRS program and encourage residents to participate.	2	5	5	12	Medium
5	Construct flood barrier and drainage improvements along C&D Canal and evaluate wetlands enhancements.	10	1	1	12	Medium
6	Develop a Phragmites elimination program.	6	3	3	12	Medium
7	Replace or eliminate tidal flushing pipe and valve at Old Locks.	10	1	1	12	Medium
8	Washington Street Flood Mitigation Project	10	1	1	12	Medium
Elsmere						
1	Implement stormwater study recommendations.					
2	Increase the storage capacity of the Little Mill, Chestnut Run, Silverbrook, Derrickson Run and other creeks throughout the Town.	6	3	1	10	Medium
3	Evaluate storm water management infrastructure.	6	3	2	11	Medium
4	Study and recommend solutions to alleviate the periodic flooding threat on Chestnut Run at Kirkwood Hwy (SR-2).	6	3	2	11	Medium
Middletown						
1	Conduct a vulnerability assessment of the Town's water distribution system, to identify measures designed to reduce the potential impacts of natural hazards.	6	3	3	12	Medium
2	Develop evacuation policy for the Town.	6	3	5	14	High
3	Develop a website to notify residents of important information before, during and after emergencies, storms, etc. (include links to other major sources of information: DEMA, FEMA, DELDOT and the weather channel).	2	5	5	12	Medium
4	Perform Sharondale outfall rehabilitation to eliminate erosive velocities of stormwater runoff in the outfall.	2	3	3	8	Low
New Castle						
1	Introduce railroad crossings at main highway intersections with gate and better signals (three major roadways cross the railroad near schools, businesses and residential areas).	10	3	1	14	High
2	Develop a detailed flood vulnerability study for the entire City along the Delaware River and Bay to focus on coastal/riverine flooding from severe storm events and sea level rise.	10	3	1	14	High

3	Work with railroad lines to notify citizens of hazardous shipments that run through the City of New Castle.	10	3	3	16	High
4	Enhance building code.	10	1	5	16	High
	Newark					
1	Assess damages sustained to city property following a disaster.	10	5	5	20	High
2	Retrofit storm sewer system.	6	1	1	8	Low
3	Preserve riparian buffer along White Clay Creek.	2	5	5	12	Medium
4	Inspect stormwater outfalls and maintain stormwater management facilities annually.	6	5	5	16	Medium
5	Conduct six inspections of creek annually.	2	5	5	12	Medium
6	Improve storm drain spill response.	6	5	5	16	High
7	Initiate tree maintenance program.	6	5	5	16	High
8	Own generation back up power at varied voltages and place at critical loads and substations.	6	5	5	16	High
9	Develop storage area at designated parkland for debris composting.	2	5	5	12	Medium
10	Keep Christina Creek clear of obstruction, including 11 bridge culverts.	6	5	5	16	High
11	Clean catch basins and grates three times a year.	6	5	5	16	High
12	Routinely inspect all construction E & S measures.	2	5	5	12	Medium
13	Study and recommend solutions to alleviate the periodic flooding threat on the Christina River at Nottingham Road (SR-273), Barksdale Road, near the Christina River at the Newark CSX rail line and Cashno Mill Road, on the Christina River at W Chesnut Hill Road/Rittenhouse Park, on the Christina River at Welsh Track Road, and on White Clay Creek at Paper Mill Road.	10	1	1	12	Medium
14	Support cost effective property acquisitions through Federal grants.	2	3	1	6	Low
	Newport					
1	Initiate wetlands protective measures along the Christiana River.	6	3	5	14	High
2	Work with the County to conduct a detailed flood vulnerability study for the entire Town.	10	3	5	18	High
3	Study and recommend solutions to alleviate the periodic flooding threat on the Christina River at Interstate 95/US 202.					
	Odessa					
1	Establish a comprehensive all- hazards warning system.	10	1	1	12	Medium
2	Educate residents on hazards that can impact the community.	10	3	1	14	High

3	Develop an evacuation policy for the Town.	2	1	1	4	Low
4	Update the local Flood Damage Prevention Ordinance.	10	1	1	12	Medium
5	Encourage citizens to purchase flood insurance.	2	1	1	4	Low
6	Identify and evaluate shelters.	10	3	1	14	High
7	Study and recommend solutions to alleviate the periodic flooding threat on Appoquinimink River at Main Street (SR-299)	10	3	1	14	High
	Townsend					
1	Develop an educational and outreach program for residents, business owners and government employees to include specific actions that can be taken to reduce the impact of natural hazards.					
	Wilmington					
1	Educate and encourage citizens to purchase and install backflow preventers in flood-prone homes.	6	3	1	10	Medium
2	Continue to increase public education—people should be ready to survive for three days without power.	10	1	5	16	High
3	Continue to increase public education for all hazards.	10	1	5	16	High
4	Evaluate the adequacy of existing code to address potential wind-related damages—particularly damage caused by flying glass in downtown area.	2	3	3	8	Low
5	Reduce the likelihood of sewer overflow during flood events through real-time control (RTC).	6	3	1	10	Medium
6	Develop building construction code requiring shatter-proof glass for new city buildings.	2	3	5	10	Medium
7	Establish a citywide disaster recovery/business continuity plan.	6	3	5	14	High
8	Coordinate with the Department of Public Works to apply traffic flow study to evacuation procedures.	6	5	5	16	High
9	Evaluate Comprehensive Plan to check for hazard mitigation elements.	6	5	5	16	High
10	Ensure NIMS training for all appropriate City personnel and engage in table top exercises.	2	5	5	12	Medium

11	On South Wilmington Wetland Park - Reestablish wetland to process stormwater from South Wilmington Area east of Walnut Street, south of A street; Partial separation of stormwater in SouthBridge and from Garaches Lane.	10	1	1	12	Medium
12	Reestablish drainage along RR property between New Castle Avenue and Christiana Avenue to relieve street flooding on New Castle Avenue and to create a drainage path for the redevelopment of the Southbridge Extension area.	2	3	3	8	Low
13	Develop an Emergency Management GIS training program (including hardware and software).	6	3	3	12	Medium
14	Study and recommend solutions to alleviate the periodic flooding threat on Brandywine Creek at E 12th Street/Wilmington Industrial Park and on Shellpot Creek at Governor Printz Blvd (US 13).	2	3	1	6	Low
University of Delaware - Wilmington and Newark Campuses						
1	Develop a strategy to abate asbestos campus-wide.	6	3	1	10	Medium
2	Alleviate the water infiltration/flooding taking place within four University buildings on the Newark campus: New Castle Hall, Kent Hall, Sussex Hall, and Robinson Hall.	6	3	1	10	Medium
3	Utilize university administrative and academic resources for emergency management related projects.	2	3	5	10	Medium
4	Add utility meters at the building level for water, steam, chilled water, gas, and electricity on all buildings on the Newark campus	2	3	1	6	Low
5	Increase the occurrence of joint trainings and exercises between the State of Delaware, New Castle County, the City of Newark and the University of Delaware to strengthen the response partnership between these agencies.	2	5	5	12	Medium
6	Increase the overall preparedness level of the University Community through outreach and training of both the student and the employee population.	2	3	5	10	Medium
7	Develop an informational website which would be linked to the main site for Emergency Management. This site could be combined with the University and departmental social media tools (i.e. Facebook, Twitter, etc.).	2	5	5	12	Medium

8	Update individual departments' disaster preparedness plans and emergency action plans. Focus on educating departments on the importance of keeping these plans current and rethink unit planning – scale and process and consider combining plans.	2	3	3	8	Low
9	Improve access to required annual safety trainings for faculty, staff and students as well as tracking laboratory activities such as lab inspections, chemical inventory, etc.	2	3	1	6	Low
10	Consider integrating effective mitigation practices and concepts into other relevant University plans (Examples include: the University Strategic Planning Initiative, Facilities Design Guidelines, Critical Incident Management Plan, etc.)	2	3	5	10	Medium
11	Continue to work closely with the State of Delaware, New Castle County and the City of Newark to ensure that the mitigation actions are coordinated effectively and are in harmony with that of the State, County and City. Collaborate with the local governments to improve the University's and the community's disaster resistance by conducting regular meetings with them to identify mitigation funds.	2	3	5	10	Medium
12	Develop procedures and documentation for the Information Technology recovery staff to ensure seamless operation of the Disaster Recover site thereby facilitating uninterrupted computer operations university-wide.	2	3	3	8	Medium
13	Procure advanced emergency notification systems to include an exterior Public Address System; an in-classroom emergency notification system in academic buildings and a dedicated non-University redundant website for emergency notifications in the event the www.udel.edu site becomes overwhelmed during a disaster situation.	10	3	1	14	High
14	Update the University Continuity of Operations Plan.	2	3	3	8	Medium
Unincorporated Areas of the County						
1	Continue public education and outreach program to educate residents and business owners (who possess hazardous chemicals and compounds) about the protective actions that can be taken to eliminate or reduce property loss and injury.	2	5	5	12	Medium
2	Conduct annual training exercises based on the actions recommended in the revised New Castle County Comprehensive Emergency Management Plan (CEMP) to comply with FEMA CPG 101 version 2, and HSEEP guidelines	6	5	5	16	High

3	Implement phase II of channel improvements to reduce the identified flooding problems in Little Mill Creek.	6	1	1	8	Low
4	Develop a Countywide uniform GIS database and use County data as a baseline. Share GIS data among the levels of government and update with all agency GIS Technicians.	6	3	1	10	Medium
5	Conduct a study to determine the vulnerability of the CRFM sewage along the Christiana River that stretches 10 miles from I-95 to Wilmington.	10	1	1	12	Medium
6	Update the critical facilities database every three years. Identify critical infrastructure that would pose issues to evacuation and communications.	6	5	5	16	High
7	Revise the New Castle Emergency Operations Plan to comply with FEMA's CPG 101 v.2, and coordinate risk based planning from holistic to project level with involvement from all stakeholders.	10	3	5	18	High
8	Implement culvert improvements in coordination with DelDOT culvert and bridge improvements to reduce flooding in the Forest Hills Park area.					
9	Reduce pollution discharges via storm water systems throughout New Castle County.	6	1	3	10	Medium
10	Elevate homes within the Bayview Beach community as funding allows.	10	3	3	16	High
11	Identify critical locations for additional environmental monitoring to aid in mitigation and response.	2	3	3	8	Medium
12	Integrate Functional and Access Needs into Emergency Plans and Identify mitigation measures consistent with this population.	6	3	5	14	High
13	Evaluate the following potential projects for various mitigation measures: Rockland Mills Community Flooding (Flood proofing, Channel improvements, etc.); DuRoss Heights properties for acquisition/elevation; Town of Christiana properties for acquisition/elevation; Port Penn Dike and properties for elevation.	6	3	3	12	Medium

14	Study and recommend solutions to alleviate the periodic flooding threat at the following locations: • Near Shellpot Creek at Governor Printz Blvd (US 13) & Merchants Square Shopping Center.• Christina River at Interstate 95/US 202 near Coppers Island.• White Clay Creek at Stanton Christiana Road (SR-4, SR-7), near the Delaware Park Racetrack. • Nonesuch Creek at Airport Road. • Christina River at Churchmans Road (SR-58). • Christina River at Churchmans Road (SR-58). • Christina River at the intersection of S Old Baltimore Pike and W Main St (SR-7). • Muddy Run at Salem Church Road.• Red Lion Creek at River Road (SR-9). • Back Creek at the intersection of Churchtown Road and Clayton Manor Drive. • Delaware City Port Penn Road just north of the village of Port Penn.• Augustine Creek at Saint Augustine Road.• Silver Run at Silver Run Road. • Appoquinimink River at Silver Run Road. • Drawyer Creek at Marl Pit Road.• A tributary of the Appoquinimink River at Old Corbitt Road.	10	1	1	12	Medium
15	Study and recommend solutions to alleviate the stormwater flooding threat on Fox Run Shopping Center on Pulaski Highway near Glasgow.	6	3	1	10	Medium
16	Support cost effective acquisition, elevation, and wet/dry floodproofing projects for all municipalities.	6	1	1	8	Medium
17	Evaluate solutions for flooding of Route 72 between the refinery and Route 13 which is major evacuation route out of Delaware City.	10	3	3	16	High
18	Implement the 25 specific recommendations by the Delaware Sea Level Rise Advisory Committee per the 2014 Report, for all municipalities.	10	3	3	16	High
19	Encourage all municipalities to use the LIMWA (Limited Wave Action) to adjust mitigation projects to a higher elevation level in A zones, for sea level rise and better protection. Ordinance 14-126 requires structures built within the LimWA be constructed to Coastal High Hazard or V zone standards per 40.10.320 E	10	3	3	16	High
20	Evaluate and develop actions to mitigate the following areas that are vulnerable to flooding: Delmarva Power, Christina Crescent, Dupont on Powder Mill Road, Delaware Steeplechase Racetrack Property, Port of Wilmington, 350 Anchor Mill Road, 115 Christina Landing, 1237 Sussex Avenue, and 1301 E Twelfth Street.	6	5	3	14	High

21	Develop outreach programs to promote awareness of thunderstorm dangers. Include driver safety strategies for severe weather events that can be addressed by driver safety/education classes and by the media. Emphasize the importance of designing public and private buildings with structural bracing, shutters, laminated glass in window panes, and hail-resistant roof shingles or flashing to minimize damage.	2	3	1	6	Low
22	Identify areas where power lines can be buried underground in order to offer the security of uninterrupted power during and after winterstorms. However, consideration needs to be made for maintenance and repair, particularly in cold climates where soil freezes.	6	3	3	12	Medium
23	Develop outreach programs to promote the importance of strengthening public and private structures against severe wind damage by encouraging wind engineering measures and construction techniques - structural bracing, straps and clips, anchor bolts, laminated or impact-resistant glass, reinforced pedestrian and garage doors, window shutters, waterproof adhesive sealing strips, or interlocking roof shingles.	6	5	5	16	High
24	Develop outreach efforts to promote such items as noncombustible roof covering, fire safe construction, and the importance of clearing brush and grass away from buildings. Emphasize how the damage potential can be reduced by ensuring that structures are surrounded by defensible space or buffer zones (generally 30 to 100 feet and cleared of combustible materials).	2	1	1	4	Low
25	Encourage the adoption of building codes to require residential sprinkler systems installed in new construction.	10	1	1	12	Medium
26	Identify areas where power lines can be buried underground in order to offer the security of uninterrupted power during and after storms. However, consideration needs to be made for maintenance and repair, particularly in cold climates where soil freezes.	2	3	1	6	Low
27	Ensure regular training in and compliance with all safety procedures and systems related to the manufacture, storage, transport, use, and disposal of hazardous materials.	6	1	3	10	Medium
28	Review floodplain ordinances on an annual basis to determine if improvements/revisions are needed.	1	3	5	9	Low

Table 6.2.4 - Completed Hazard Mitigation Grant Program (HMGP) Projects

Project Category	Project	Date	Disaster	Amount	Total Amount
EOC Relocation	Relocate Delaware EOC from Delaware City to Penns Way.	June 1997	DR-933	$14,509	$63,187
			DR-976	$4,729	
			DR-1017	$43,949	
Flood Mitigation Planning	Developed Flood Mitigation Plans for New Castle and Sussex Counties, and Bethany Beach, Dewey Beach, Lewes, Wilmington and Delaware City.	November 1999	DR-933	$114,986	$177,887
			DR-976	$62,901	
Fire Weather Monitoring Stations	Install fire-weather monitoring stations at Redden State Forest and Blackbird State Forest to allow Forest Service to monitor and predict forest fire potential.	December 1998	DR-1017	$22,495	$22,495
Newark Acquisition Project	Acquisition of flood prone property located at Rahway Drive in Newark, DE.	May 2002	DR-1297	$129,443	$129,443
Wilmington Public Sewer	Construct diesel storage tank enclosure to protect sewer-pumping station during flooding events.	July 2002	DR-1297	$30,262	$30,262
Delaware City Structural Barrier	Retrofit existing bulkhead, revetment and elements in Battery Park to the 100-year flood elevation. Install soil berm near Dragon run.	In progress (85% complete)	DR-1297	$482,648	$482,648
Acquisition Project	Acquisition of a flood prone property located at Longview Drive in Newark, DE.	April 2006	DR-1494	$179,922	$239,897
Acquisition Project	Acquisition of a flood prone property located at Longview Drive in Newark, DE.	April 2006	DR-1495	$435,239	$580,318

Table 6.2.5 - Completed Flood Mitigation Assistance (FMA) Projects

Project	Project Description	Date	Amount
Bell Plumbing Supply Floodproofing	Floodproof a plumbing supply store and warehouse to the 50-year flood level.	2001	$150,000
Riverwalk Apartment Flood Levee	Build protective levee around flood-prone apartment complex.	2001	$175,000
Delaware City Seawall	Extend existing seawall vertically to provide 100-year flood protection to downtown area.	2002 (Ongoing)	$800,000
Acquisition and Demolition of Flood Prone Properties	Nine flooded properties were purchased and demolished in the Glenville Subdivision.	2003	$1.1 Million

Yorklyn Center for Creative Arts Floodproofing	Floodproof basement and first floor of private non-profit community art center.	2004 (Ongoing)	$140,000
Acquisition and Demolition of Flood Prone Properties	Ten flooded properties were purchased and demolished in the Glenville Subdivision.	2004	$1.1 Million
Standard Technologies Floodproofing	Standard Technologies, a repetitive loss commercial property, was dry floodproofed.	2005	$320,00
Acquisition and Demolition of Flood Prone Property	A repetitive loss structure located on Kiamensi Road, Newark was purchased and demolished.	2006	$300,000
Metroform Building Floodproofing	A repetitive loss outpatient medical facility, Metroform, was dry floodproofed.	2007	$280,000
Shone Lumber Floodproofing	A repetitive loss commercial structure, Shone Lumber, was dry floodproofed.	2008	$560,000

Adoption status – 'Yes', if the action was included in the 2009 County Plan and 2011 University Plan and 'No' if it is an action included after these Plans was adopted.
Timeline for completion – Not applicable for completed actions.
Priority – High, medium, or low. Not applicable for completed actions.
Status - Delayed, started, in progress, completed, ongoing, or cancelled.

6.2.4 Mitigation Action Plan

Requirement: §201.6(c)(3)(iii): [The mitigation strategy section shall include] an action plan describing 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.

A detailed implementation plan for each mitigation action in Table 6.2.5 is included below. Each action identifies:

a. Community Name: Jurisdiction

b. Action Item: Specific actions that, if accomplished, will reduce vulnerability and risk in the impact area. Actions are linked to the mitigation goals and objectives.

c. Hazard(s): The hazard(s) the action attempts to mitigate.

d. Lead Agency/ Department Responsible: The local agency, department or organization that is best suited to accomplish this action.

e. Estimated Cost: The approximate cost to accomplish the mitigation action.

f. Funding Method: How the cost to complete the action will be funded. For example, funds may be provided from existing operating budgets (General Revenue), a previously established contingency fund (Contingency/Bonds), or a federal or state grant (External Sources).

g. Implementation Schedule: When the action will begin, and when the action is expected to be completed.

h. Priority: 1) High priority—short-term immediate—reducing overall risk to life and property; 2) Moderate priority—an action that should be implemented in the near future due to political or community support or ease of implementation; 3) Low priority—an action that should be implemented over the long term that may depend on the availability of funds.

Requirement §201.6(c)(3)(iv): For multi-jurisdictional plans, there must be identifiable action items specific to the jurisdiction requesting FEMA approval or credit of the plan.

Local Mitigation Action Plans are organized alphabetically by individual jurisdiction. Mitigation actions are categorized by priority (high, moderate or low) within each jurisdiction. Mitigation actions listed within each prioritization category are not rank ordered. Table 6.2.6 indicates the total number of actions for municipalities, unincorporated areas, and the University.

Table 6.2.6 - Total Mitigation Actions

Jurisdiction	Page Number	Status
New Castle County (unincorporated areas)	234	27 actions
Arden	245	3 actions
Ardencroft	247	7 actions
Ardentown	250	3 actions
Bellefonte	252	1 action
Delaware City	253	8 actions
Elsmere	258	4 actions
Middletown	260	4 actions
New Castle	262	4 actions
Newark	264	17 actions
Newport	270	3 actions
Odessa	272	7 actions
Townsend	275	1 action
Wilmington	276	14 actions
University of Delaware (Wilmington and Newark campuses)	281	14 actions

New Castle County (Unincorporated Areas)

		HAZARD RISK		
		Low	Moderate	High
OVERALL CAPABILITY	High			X
	Moderate			
	Limited			

New Castle County Mitigation Action 1	Continue public education and outreach program to educate residents and business owners (who possess hazardous chemicals and compounds) about the protective actions that can be taken to eliminate or reduce property loss and injury.
Category:	Outreach and Coordination
Hazard(s) Addressed:	All Hazards
Priority (High, Moderate, Low):	High
Estimated Cost:	$13,000 per year
Potential Funding Sources:	Local funds, FEMA – Hazardous Materials Assistance Program, FEMA – Emergency Management Performance Grants, Citizen Corp, FEMA and Red Cross educational materials available free of charge
Lead Agency/Department Responsible:	New Castle County Department of Public Safety
Implementation Schedule:	Ongoing

New Castle County Mitigation Action 2	Conduct annual training exercises based on the actions recommended in the revised New Castle County Comprehensive Emergency Management Plan (CEMP) to comply with FEMA CPG 101 version 2, and HSEEP guidelines.
Category:	Other (Emergency Services)
Hazard(s) Addressed:	All
Priority (High, Moderate, Low):	High
Estimated Cost:	$10,000 per year
Potential Funding Sources:	Department of Justice – State and Local Preparedness Technical Assistance, Department of Justice - State and Local Domestic Preparedness Training Program, Department of Justice - State and Local Domestic Preparedness Exercise Support, FEMA – Emergency Management Performance Grants
Lead Agency/Department Responsible:	New Castle County Office of Emergency Management
Implementation Schedule:	Conduct exercise annually

New Castle County Mitigation Action 3	Implement Phase II of channel improvements to reduce the identified flooding problems in Little Mill Creek.
Category:	Prevention
Hazard(s) Addressed:	Flood
Priority (High, Moderate, Low):	High
Estimated Cost:	$500,000
Potential Funding Sources:	Natural Resource Conservation Service – Watershed Protection and Flood Prevention Program, Hazard Mitigation Grant Program, Flood Mitigation Assistance Program, US Army Corp of Engineers – Small Flood Control Projects, Pre Disaster Mitigation Program, 406 Public Assistance (following federally declared disaster),
Lead Agency/Department Responsible:	Special Services Department
Implementation Schedule:	60 months

New Castle County Mitigation Action 4	Develop a Countywide uniform GIS database and use County data as a baseline. Share GIS data among the levels of government and update with all Agency GIS Technicians.
Category:	Prevention
Hazard(s) Addressed:	All Hazards
Priority (High, Moderate, Low):	Moderate
Estimated Cost:	$10,000
Potential Funding Sources:	Pre Disaster Mitigation Grant Program, Hazard Mitigation Grant Program, Department of the Interior - National Cooperative Geologic Mapping Program, Department of Transportation - National Pipeline Mapping System, ESRI
Lead Agency/Department Responsible:	GIS Department
Implementation Schedule:	12 months

New Castle County Mitigation Action 5	Conduct a study to determine the vulnerability of the CRFM sewage along the Christiana River that stretches 10 miles from I-95 to Wilmington.
Category:	Other (Structural Projects)
Hazard(s) Addressed:	Flood
Priority (High, Moderate, Low):	High
Estimated Cost:	$40,000-$60,000
Potential Funding Sources:	
Lead Agency/Department Responsible:	Special Services Department
Implementation Schedule:	24 months

New Castle County Mitigation Action 6	Update the critical facilities database every three years. Identify critical infrastructure that would pose issues to evacuation and communications.
Category:	Other (Emergency Services)
Hazard(s) Addressed:	All hazards
Priority (High, Moderate, Low):	High
Estimated Cost:	Staff time
Potential Funding Sources:	No funding required
Lead Agency/Department Responsible:	Emergency Services
Implementation Schedule:	36 months

New Castle County Mitigation Action 7	Revise the New Castle Emergency Operations Plan to comply with FEMA's CPG 101 v.2, and coordinate risk based planning from holistic to project level with involvement from all stakeholders.
Category:	Other (Emergency Management)
Hazard(s) Addressed:	All Hazards
Priority (High, Moderate, Low):	High
Estimated Cost:	To be determined
Potential Funding Sources:	Emergency Management Performance Grant
Lead Agency/Department Responsible:	New Castle County Emergency Management
Implementation Schedule:	24 months

New Castle County Mitigation Action 8	Implement culvert improvements in coordination with DelDOT culvert and bridge improvements to reduce flooding in the Forest Hills Park area.
Category:	Other (Structural Projects)
Hazard(s) Addressed:	Flooding
Priority (High, Moderate, Low):	High
Estimated Cost:	To be determined
Potential Funding Sources:	PDM
Lead Agency/Department Responsible:	DelDOT, New Castle County Emergency Management
Implementation Schedule:	36 months

New Castle County Mitigation Action 9	Reduce pollution discharges via stormwater systems throughout New Castle County.
Category:	Natural Resource Protection
Hazard(s) Addressed:	Flooding
Priority (High, Moderate, Low):	High
Estimated Cost:	To be determined
Potential Funding Sources:	PDM
Lead Agency/Department Responsible:	New Castle County Department of Special Services
Implementation Schedule:	36 months

New Castle County Mitigation Action 10	Elevate homes within the Bayview Beach community as funding allows.
Category:	Other (Property Protection)
Hazard(s) Addressed:	Flood
Priority (High, Moderate, Low):	High
Estimated Cost:	To be determined
Potential Funding Sources:	PDM
Lead Agency/Department Responsible:	New Castle County Department of Emergency Management
Implementation Schedule:	48 months

New Castle County Mitigation Action 11	Identify critical locations for additional environmental monitoring to aid in mitigation and response.
Category:	Other (Emergency Management)
Hazard(s) Addressed:	Flooding
Priority (High, Moderate, Low):	Medium
Estimated Cost:	To be determined
Potential Funding Sources:	To be determined
Lead Agency/Department Responsible:	Public Works, Emergency Management
Implementation Schedule:	18 months

New Castle County Mitigation Action 12	Integrate Functional and Access Needs into Emergency Plans and Identify mitigation measures consistent with this population.
Category:	Other (Emergency Management)
Hazard(s) Addressed:	All hazards
Priority (High, Moderate, Low):	High
Estimated Cost:	To be determined
Potential Funding Sources:	Emergency Management Performance Grant
Lead Agency/Department Responsible:	Emergency Management
Implementation Schedule:	24 months

New Castle County Mitigation Action 13	Evaluate the following potential projects for various mitigation measures: Rockland Mills Community Flooding (Flood proofing, Channel improvements, etc.); DuRoss Heights properties for acquisition/elevation; Town of Christiana properties for acquisition/elevation; Port Penn Dike and properties for elevation.
Category:	Other (Structural)
Hazard(s) Addressed:	Flood
Priority (High, Moderate, Low):	Medium
Estimated Cost:	To be determined
Potential Funding Sources:	FEMA – Pre-disaster Mitigation Grant and Hazard Mitigation Grant Program
Lead Agency/Department Responsible:	Emergency Management
Implementation Schedule:	48 months

New Castle County Mitigation Action 14	Study and recommend solutions to alleviate the periodic flooding threat at the following locations: • Near Shellpot Creek at Governor Printz Blvd (US 13) & Merchants Square Shopping Center.• Christina River at Interstate 95/US 202 near Coppers Island.• White Clay Creek at Stanton Christiana Road (SR-4, SR-7), near the Delaware Park Racetrack. • Nonesuch Creek at Airport Road. • Christina River at Churchmans Road (SR-58). • Christina River at Churchmans Road (SR-58). • Christina River at the intersection of S Old Baltimore Pike and W Main St (SR-7). • Muddy Run at Salem Church Road.• Red Lion Creek at River Road (SR-9). • Back Creek at the intersection of Churchtown Road and Clayton Manor Drive. • Delaware City Port Penn Road just north of the village of Port Penn.• Augustine Creek at Saint Augustine Road.• Silver Run at Silver Run Road. • Delaware Turnpike/Airport Road Interchange, Appoquinimink River at Silver Run Road. • Drawyer Creek at Marl Pit Road.• A tributary of the Appoquinimink River at Old Corbitt Road.
Category:	Other (Structural)
Hazard(s) Addressed:	Flood
Priority (High, Moderate, Low):	Medium
Estimated Cost:	To be determined
Potential Funding Sources:	FEMA – Pre-disaster Mitigation Grant and Hazard Mitigation Grant Program
Lead Agency/Department Responsible:	New Castle County Conservation District, New Castle County Emergency Management, DelDOT
Implementation Schedule:	72 months

New Castle County Mitigation Action 15	Study and recommend solutions to alleviate the stormwater flooding threat on Fox Run Shopping Center on Pulaski Highway near Glasgow.
Category:	Other (Structural Projects)
Hazard(s) Addressed:	Flooding
Priority (High, Moderate, Low):	Medium
Estimated Cost:	To be determined
Potential Funding Sources:	FEMA – Pre-disaster Mitigation Grant and Hazard Mitigation Grant Program
Lead Agency/Department Responsible:	Conservation District, Emergency Management
Implementation Schedule:	36 months

New Castle County Mitigation Action 16*	Develop cost effective acquisition, elevation, and wet/dry floodproofing projects for all municipalities.
Category:	Other (Structural Project)
Hazard(s) Addressed:	Flooding
Priority (High, Moderate, Low):	Medium
Estimated Cost:	To be determined
Potential Funding Sources:	FEMA – Pre-disaster Mitigation Grant and Hazard Mitigation Grant Program
Lead Agency/Department Responsible:	Conservation District, Emergency Management
Implementation Schedule:	48 months

New Castle County Mitigation Action 17*	Evaluate solutions for flooding of Route 72 between the refinery and Route 13 which is major evacuation route out of Delaware City.
Category:	Prevention
Hazard(s) Addressed:	Flooding
Priority (High, Moderate, Low):	High
Estimated Cost:	To be determined
Potential Funding Sources:	FEMA – Emergency Management Performance Grant
Lead Agency/Department Responsible:	Conservation District, Emergency Management
Implementation Schedule:	36 months

New Castle County Mitigation Action 18*	Implement the 25 specific recommendations by the Delaware Sea Level Rise Advisory Committee per the 2014 Report.

Category:	Prevention
Hazard(s) Addressed:	Flooding
Priority (High, Moderate, Low):	Medium
Estimated Cost:	To be determined
Potential Funding Sources:	To be determined
Lead Agency/Department Responsible:	New Castle County Conservation District, New Castle County Emergency Management, municipalities
Implementation Schedule:	18 months

New Castle County Mitigation Action 19*	Encourage all municipalities to use the LIMWA (Limited Wave Action) to adjust mitigation projects to a higher elevation level in A zones, for sea level rise and better protection. Ordinance 14-126 requires structures built within the LimWA be constructed to Coastal High Hazard or V zone standards per 40.10.320 E
Category:	Prevention
Hazard(s) Addressed:	Flooding
Priority (High, Moderate, Low):	Medium
Estimated Cost:	No funding needed
Potential Funding Sources:	Staff time
Lead Agency/Department Responsible:	Emergency Management
Implementation Schedule:	18 months

New Castle County Mitigation Action 20*	Evaluate and develop actions to mitigate the following areas that are vulnerable to flooding: Delmarva Power, Christina Crescent, Dupont on Powder Mill Road, Delaware Steeplechase Racetrack Property, Port of Wilmington, 350 Anchor Mill Road, 115 Christina Landing, 1237 Sussex Avenue, and 1301 E Twelfth Street.
Category:	Prevention
Hazard(s) Addressed:	Flooding
Priority (High, Moderate, Low):	High
Estimated Cost:	To be determined
Potential Funding Sources:	FEMA - Hazard Mitigation Planning Grant, Pre-disaster Mitigation Grant
Lead Agency/Department Responsible:	New Castle County Emergency Management
Implementation Schedule:	36 months

New Castle County Mitigation Action 21*	Develop outreach programs to promote awareness of thunderstorm dangers. Include driver safety strategies for severe weather events that can be addressed by driver safety/education classes and by the media. Emphasize the importance of designing public and private buildings with structural bracing, shutters, laminated glass in window panes, and hail-resistant roof shingles or flashing to minimize damage.
Category:	Outreach and Coordination
Hazard(s) Addressed:	Thunderstorms
Priority (High, Moderate, Low):	High
Estimated Cost:	$10,000
Potential Funding Sources:	County funds
Lead Agency/Department Responsible:	New Castle County Emergency Management, DelDOT
Implementation Schedule:	12 months

New Castle County Mitigation Action 22*	Identify areas where power lines can be buried underground in order to offer the security of uninterrupted power during and after storms. However, consideration needs to be made for maintenance and repair, particularly in cold climates where soil freezes.
Category:	Prevention
Hazard(s) Addressed:	Thunderstorms
Priority (High, Moderate, Low):	High
Estimated Cost:	To be determined
Potential Funding Sources:	Staff time
Lead Agency/Department Responsible:	Emergency Management, Public Works
Implementation Schedule:	12 months

New Castle County Mitigation Action 23*	Develop outreach programs to promote the importance of strengthening public and private structures against severe wind damage by encouraging wind engineering measures and construction techniques - structural bracing, straps and clips, anchor bolts, laminated or impact-resistant glass, reinforced pedestrian and garage doors, window shutters, waterproof adhesive sealing strips, or interlocking roof shingles.
Category:	Outreach and Coordination
Hazard(s) Addressed:	Tornadoes
Priority (High, Moderate, Low):	High
Estimated Cost:	$10,000
Potential Funding Sources:	County funds
Lead Agency/Department Responsible:	Emergency Management
Implementation Schedule:	12 months

New Castle County Mitigation Action 24*	Develop outreach efforts to promote such items as noncombustible roof covering, fire safe construction, and the importance of clearing brush and grass away from buildings. Emphasize how the damage potential can be reduced by ensuring that structures are surrounded by defensible space or buffer zones (generally 30 to 100 feet and cleared of combustible materials).
Category:	Outreach and Coordination
Hazard(s) Addressed:	Wildfire
Priority (High, Moderate, Low):	High
Estimated Cost:	$10,000
Potential Funding Sources:	County funds
Lead Agency/Department Responsible:	New Castle County
Implementation Schedule:	12 months

New Castle County Mitigation Action 25*	Encourage the adoption of building codes to require residential sprinkler systems installed in new construction.
Category:	Prevention
Hazard(s) Addressed:	Wildfire
Priority (High, Moderate, Low):	High
Estimated Cost:	Staff time
Potential Funding Sources:	No funding needed
Lead Agency/Department Responsible:	Planning
Implementation Schedule:	12 - 24 months

New Castle County Mitigation Action 26*	Identify areas where power lines can be buried underground in order to offer the security of uninterrupted power during and after winterstorms. However, consideration needs to be made for maintenance and repair, particularly in cold climates where soil freezes.
Category:	Other (Structural Projects)
Hazard(s) Addressed:	Winterstorms
Priority (High, Moderate, Low):	High
Estimated Cost:	$20,000
Potential Funding Sources:	County funds
Lead Agency/Department Responsible:	New Castle County Emergency Management, Private and Municipal Utilities.
Implementation Schedule:	12 - 24 months

New Castle County Mitigation Action 27*	Ensure regular training in and compliance with all safety procedures and systems related to the manufacture, storage, transport, use, and disposal of hazardous materials.
Category:	Outreach and Coordination
Hazard(s) Addressed:	Hazardous Materials
Priority (High, Moderate, Low):	Medium
Estimated Cost:	To be determined
Potential Funding Sources:	To be determined
Lead Agency/Department Responsible:	Emergency Management
Implementation Schedule:	24 – 48 months

New Castle County Mitigation Action 28*	Review floodplain ordinances on an annual basis to determine if improvements/revisions are needed..
Category:	Prevention
Hazard(s) Addressed:	Flood
Priority (High, Moderate, Low):	Low
Estimated Cost:	Staff time
Potential Funding Sources:	No funding required
Lead Agency/Department Responsible:	Emergency Management
Implementation Schedule:	12– 24 months

Note: * indicates mitigation actions that involve the county's unincorporated areas as well as the municipalities.

Arden, Village of

		HAZARD RISK		
		Low	Moderate	High
OVERALL CAPABILITY	High			
	Moderate			
	Limited		X	

Arden Mitigation Action 1	Work closely with the County and continue to improve public outreach within the community to include distributing informative pamphlets and other outreach materials and workshops to educate citizens about hazard awareness.
Category:	Outreach and Coordination
Hazard(s) Addressed:	All hazards
Priority (High, Moderate, Low):	High
Estimated Cost:	$10,000 annually
Potential Funding Sources:	Local funds, FEMA - Pre-Disaster Mitigation Grant Program
Lead Agency/Department Responsible:	Village of Arden
Implementation Schedule:	Ongoing

Arden Mitigation Action 2	Establish emergency notification procedures for rail and Interstate HAZMAT incidents and chemical facilities.
Category:	Other (Emergency Preparedness)
Hazard(s) Addressed:	HAZMAT
Priority (High, Moderate, Low):	High
Estimated Cost:	Staff time
Potential Funding Sources:	Not required
Lead Agency/Department Responsible:	Village of Arden
Implementation Schedule:	Ongoing

Arden Mitigation Action 3	Retrofit Guild Hall so that it can be sued as an emergency shelter.
Category:	Other (Emergency Preparedness)
Hazard(s) Addressed:	All hazards
Priority (High, Moderate, Low):	Medium
Estimated Cost:	To be determined
Potential Funding Sources:	PDM
Lead Agency/Department Responsible:	Village of Arden
Implementation Schedule:	2-5 years

Ardencroft, Village of

		HAZARD RISK		
		Low	Moderate	High
OVERALL CAPABILITY	High			
	Moderate			
	Limited		X	

Ardencroft Mitigation Action 1	Investigate appropriate mitigation measures to protect 16 leaseholds adjacent to creek.
Category:	Prevention, Property Protection
Hazard(s) Addressed:	Flood
Priority (High, Moderate, Low):	High
Estimated Cost:	Cost based on mitigation measures used
Potential Funding Sources:	US Army Corps of Engineers – Floodplain Management Services, Natural Resource Conservation Service – Watershed Protection and Flood Prevention Program, Environmental Protection Agency – Water Quality Cooperative Agreements, Environmental Protection Agency – Non point Source Grant Program, Small Business Administration – Pre-Disaster Mitigation Loans, Hazard Mitigation Grant Program, Pre-Disaster Mitigation Grant Program, Community Development Block Grant Program
Lead Agency/Department Responsible:	Ardencroft
Implementation Schedule:	12 months

Ardencroft Mitigation Action 2	Develop and implement an information awareness system to include notification, mail outs, recorded messages, and e-mail during and after an event.
Category:	Outreach and Coordination
Hazard(s) Addressed:	All Hazards
Priority (High, Moderate, Low):	High
Estimated Cost:	$5,000
Potential Funding Sources:	General funds, FEMA - Citizen Corps, FEMA - Community Emergency Response Teams, FEMA -Emergency Management Performance Grant
Lead Agency/Department Responsible:	Ardencroft
Implementation Schedule:	Each year for 5 years as a pilot

Ardencroft Mitigation Action 3	Ensure adequate training and resources for emergency organizations and personnel.
Category:	Emergency Services
Hazard(s) Addressed:	All Hazards
Priority (High, Moderate, Low):	High
Estimated Cost:	Unknown
Potential Funding Sources:	FEMA - Community Emergency Response Teams, FEMA - Emergency Management Performance Grant, Department of Justice - State and Local Domestic Preparedness Training Program, Emergency Management Institute -Training Assistance, Emergency Management Institute - First Responder Counter-Terrorism Training Assistance
Lead Agency/Department Responsible:	Ardencroft
Implementation Schedule:	Annually

Ardencroft Mitigation Action 4	Conduct Community Emergency Response Team (CERT) classes for emergency response personnel.
Category:	Emergency Services
Hazard(s) Addressed:	All Hazards
Priority (High, Moderate, Low):	Moderate
Estimated Cost:	$10,000
Potential Funding Sources:	FEMA - Community Emergency Response Teams, FEMA - Emergency Management Performance Grant
Lead Agency/Department Responsible:	Ardencroft
Implementation Schedule:	Annually

Ardencroft Mitigation Action 5	Increase the number of trained citizen emergency responders.
Category:	Emergency Services
Hazard(s) Addressed:	All Hazards
Priority (High, Moderate, Low):	Moderate
Estimated Cost:	$10,000
Potential Funding Sources:	FEMA - Community Emergency Response Teams, FEMA - Emergency Management Performance Grant, Department of Justice - State and Local Domestic Preparedness Training Program, Emergency Management Institute -Training Assistance, Emergency Management Institute - First Responder Counter-Terrorism Training Assistance
Lead Agency/Department Responsible:	Ardencroft
Implementation Schedule:	Annually

Ardencroft Mitigation Action 6	Conduct a vegetative vulnerability assessment to determine what plant types pose a wind, water or snow hazard to private and public property.
Category:	Prevention
Hazard(s) Addressed:	Wind, Water, Snow
Priority (High, Moderate, Low):	Moderate
Estimated Cost:	$10,000
Potential Funding Sources:	FEMA – Hazard Mitigation Grant Program, Pre-disaster Mitigation Program, Flood Mitigation Assistance Program, Fire Management Assistance Grant, Bureau of Land Management - Wildland Urban Interface Community and Rural Fire Assistance
Lead Agency/Department Responsible:	Ardencroft
Implementation Schedule:	Annually

Ardencroft Mitigation Action 7	Conduct an assessment to determine the vulnerability if Perkins Run overtops its banks (due to increased population growth, development and encroachment).
Category:	Property Protection
Hazard(s) Addressed:	Floods
Priority (High, Moderate, Low):	Moderate
Estimated Cost:	Unknown
Potential Funding Sources:	FEMA – Map Modernization Program, FEMA – Flood Hazard Mapping Program, FEMA – Flood Recovery Mapping, Hazard Mitigation Grant Program, Pre-disaster Mitigation, Flood Mitigation Assistance Program
Lead Agency/Department Responsible:	DNREC
Implementation Schedule:	2-5 years

Ardentown, Village of

		HAZARD RISK		
		Low	Moderate	High
OVERALL CAPABILITY	High			
	Moderate			
	Limited	X		

Ardentown Mitigation Action 1	Conduct a structural evaluation to determine the possibility of using the Candlelight Theater as a shelter in the event of a disaster.
Category:	Other (Emergency Services, Structural Project)
Hazard(s) Addressed:	All Hazards
Priority (High, Moderate, Low):	High
Estimated Cost:	$5,000 - $40,000 depending on the structural integrity of the building
Potential Funding Sources:	FEMA – All Hazards Emergency Operational Planning, FEMA – Emergency Management Performance Grants, Pre-Disaster Mitigation Grant Program, FEMA – Assistance to Firefighters Grant, Hazard Mitigation Grant Program, Red Cross provides shelter guidelines free of charge
Lead Agency/Department Responsible:	Public Works and Safety Commission
Implementation Schedule:	In progress

Ardentown Mitigation Action 2	Develop a call out database to notify residents in the event of a disaster.
Category:	Outreach and Coordination
Hazard(s) Addressed:	All Hazards
Priority (High, Moderate, Low):	High
Estimated Cost:	$10,000
Potential Funding Sources:	FEMA –Hazard Mitigation Grant Program
Lead Agency/Department Responsible:	Ardencroft
Implementation Schedule:	In progress

Ardentown Mitigation Action 3	Marsh Road Acquisition Project
Category:	Other (Property Protection0
Hazard(s) Addressed:	Flood
Priority (High, Moderate, Low):	High
Estimated Cost:	$287,000
Potential Funding Sources:	FEMA –Hazard Mitigation Grant Program – Disaster 4037
Lead Agency/Department Responsible:	Ardencroft
Implementation Schedule:	In progress

Bellefonte, Town of

		HAZARD RISK		
		Low	Moderate	High
OVERALL CAPABILITY	High			
	Moderate			
	Limited		X	

Bellefonte Mitigation Action 1	Work closely with and obtain assistance from the County to implement an information awareness system to include notification, mail outs, recorded messages, and email during and after an event. Continue to send out hazard notifications via the State/County Police Alert System and through the Brandywine Hundred Fire Company.
Category:	Outreach and Coordination
Hazard(s) Addressed:	All Hazards
Priority (High, Moderate, Low):	High
Estimated Cost:	$1,000
Potential Funding Sources:	General funds, FEMA - Citizen Corps, FEMA - Community Emergency Response Teams, FEMA -Emergency Management Performance Grant
Lead Agency/Department Responsible:	Town of Bellafonte
Implementation Schedule:	12 months

Delaware City, City of

		HAZARD RISK		
		Low	Moderate	High
OVERALL CAPABILITY	High			
	Moderate		X	
	Limited			

Delaware City Mitigation Action 1	Create displays for use at public events (health fair, public awareness day, county fair etc.).
Category:	Outreach and Coordination
Hazard(s) Addressed:	All Hazards
Priority (High, Moderate, Low):	High
Estimated Cost:	$5,000
Potential Funding Sources:	American Red Cross, FEMA – Citizen Corps, FEMA – Emergency Management Performance Grant, FEMA - Community Emergency Response Team
Lead Agency/Department Responsible:	City of Delaware City
Implementation Schedule:	18 months

Delaware City Mitigation Action 2	Construct a flood barrier, drainage improvements, and wetlands enhancements for Dragon Run.
Category:	Other (Structural Project)
Hazard(s) Addressed:	Flood / Fire
Priority (High, Moderate, Low):	High
Estimated Cost:	$1,000,000. City received $50,00 grant from Delaware Coastal Program and Delaware City Refinery did a $20,000 matching grant. Received a $500,000 grant from DNREC for Dragon Run and installation of check valve on Monroe Street Outlet. Construction of Horseshoe berm from Monroe Street behind houses on Solomon Place - Cost $320,000. Delaware City was awarded a $920,000 FEMA Grant to address the Washington Street flooding issues and received $500,000 funding from DNREC, funds in the state FY15 budget, which provides $1,475,000 to address our flooding issues on both Washington Street and Monroe and Madison Streets.
Potential Funding Sources:	Hazard Mitigation Grant Program, Pre-Disaster Mitigation Program, Flood Mitigation Assistance Program, United States Department of Agriculture Natural Resources Conservation Service - Watershed Protection and Flood Prevention, United States Department of Agriculture Natural Resources Conservation Service - Wetlands Reserve Program, United States Department of Agriculture Natural Resources Conservation Service – Emergency Watershed Protection, US Army Corps of Engineers – Clearing and Snagging Projects, US Army Corps of Engineers – Small Flood Control Projects, Department of the Interior - Coastal Wetlands Planning, Department of the Interior - Protection and Restoration Act, Department of the Interior - North American Wetlands Conservation Fund, Environmental Protection Agency - Wetland Program Development Grants
Lead Agency/Department Responsible:	DNREC /Delaware City / Private Sector
Implementation Schedule:	2 years

Delaware City Mitigation Action 3	Evaluate solutions for flooding of Route 9 at Dragon Run, which is a major evacuation route out of Delaware City.
Category:	Other (Structural Project and Emergency Services)
Hazard(s) Addressed:	Flood
Priority (High, Moderate, Low):	High
Estimated Cost:	$1,500,000. Received a $500,000 grant from DNREC for Dragon Run and installation of check valve on Monroe Street Outlet.
Potential Funding Sources:	DOT, FEMA – Emergency Management Performance Grants, State and Local All Hazards Emergency Operations Planning, Hazard Mitigation Grant Program, Flood Mitigation Assistance Program, United States Department of Agriculture Natural Resources Conservation Service - Watershed Protection and Flood Prevention, United States Department of Agriculture Natural Resources Conservation Service - Wetlands Reserve Program, United States Department of Agriculture Natural Resources Conservation Service – Emergency Watershed Protection, US Army Corps of Engineers – Clearing and Snagging Projects, US Army Corps of Engineers – Small Flood Control Projects, Department of the Interior - Coastal Wetlands Planning, Department of the Interior - Protection and Restoration Act, Department of the Interior - North American Wetlands Conservation Fund, Environmental Protection Agency - Wetland Program Development Grants
Lead Agency/Department Responsible:	DelDOT
Implementation Schedule:	5 years

Delaware City Mitigation Action 4	Provide training for Delaware City Town Council on the CRS program and encourage residents to participate.
Category:	Property Protection
Hazard(s) Addressed:	Flood
Priority (High, Moderate, Low):	High
Estimated Cost:	$4,000
Potential Funding Sources:	FEMA - Community Assistance Program-State Support Services Element (CAP-SSSE), General funds
Lead Agency/Department Responsible:	Delaware City
Implementation Schedule:	2 – 3 Years

Delaware City Mitigation Action 5	Construct flood barrier and drainage improvements along C&D Canal and evaluate wetlands enhancements.
Category:	Structural Project and National Resource Protection
Hazard(s) Addressed:	Flood / Fire
Priority (High, Moderate, Low):	High
Estimated Cost:	$1,200,000
Potential Funding Sources:	FEMA - -Hazard Mitigation Grant program, Pre-Disaster Mitigation Program, Flood Mitigation Assistance Program, USDA Natural Resources Conservation Service - Watershed Protection and Flood Prevention, USDA Natural Resources Conservation Service - Wetlands Reserve Program, Department of the Interior - Coastal Wetlands Planning, Department of the Interior - Protection and Restoration Act, Department of the Interior - North American Wetlands Conservation Fund, Environment Protection Agency - Wetland Program Development Grants, US Army Corps of Engineers – Small Flood Control Projects
Lead Agency/Department Responsible:	Corp of Engineers, DNREC, Delaware City, University of Delaware
Implementation Schedule:	2 Years

Delaware City Mitigation Action 6	Develop a Phragmites elimination program.
Category:	Natural Resource Protection
Hazard(s) Addressed:	Wildfire
Priority (High, Moderate, Low):	Moderate
Estimated Cost:	$5,000 annually (costs associated with the purchase and application of herbicides or the physical removal of plant species)
Potential Funding Sources:	Delaware Coastal Management Program, The Nature Conservancy Wildland Weed Management and Research Program
Lead Agency/Department Responsible:	
Implementation Schedule:	Ongoing

Delaware City Mitigation Action 7	Replace or eliminate tidal flushing pipe and valve at Old Locks.
Category:	Other (Structural Project)
Hazard(s) Addressed:	Flood
Priority (High, Moderate, Low):	High
Estimated Cost:	To be determined
Potential Funding Sources:	FEMA - Hazard Mitigation Grant Program, Pre Disaster Mitigation
Lead Agency/Department Responsible:	Delaware City
Implementation Schedule:	12 months

Delaware City Mitigation Action 8	Washington Street Flood Mitigation Project
Category:	Other (Structural Project)
Hazard(s) Addressed:	Flood
Priority (High, Moderate, Low):	High
Estimated Cost:	$ 920,000
Potential Funding Sources:	FEMA - - Pre-Disaster Mitigation Program 2013
Lead Agency/Department Responsible:	Delaware City
Implementation Schedule:	In progress

Elsmere, Town of

		HAZARD RISK		
		Low	Moderate	High
OVERALL CAPABILITY	High			
	Moderate			
	Limited		X	

Elsmere Mitigation Action 1	Implement stormwater study recommendations.
Category:	Prevention and Property Protection
Hazard(s) Addressed:	Flood
Priority (High, Moderate, Low):	High
Estimated Cost:	$2,000,000
Potential Funding Sources:	US Army Corps of Engineers – Floodplain Management Services, US Army Corps of Engineers – Planning Assistance to States, Natural Resources Conservation Services – Emergency Watershed Protection Program, Hazard Mitigation Grant Program, Pre-Disaster Mitigation Grant Program
Lead Agency/Department Responsible:	Town of Elsmere (with assistance from New Castle County Government, State Government, DEMA, FEMA, Conservation District and Army Corps of Engineers)
Implementation Schedule:	5 years

Elsmere Mitigation Action 2	Increase the storage capacity of the Little Mill, Chestnut Run, Silverbrook, Derrickson Run and other creeks throughout the Town.
Category:	Prevention and Property Protection
Hazard(s) Addressed:	Flood
Priority (High, Moderate, Low):	High
Estimated Cost:	Unknown
Potential Funding Sources:	US Army Corps of Engineers – Floodplain Management Services, US Army Corps of Engineers – Planning Assistance to States, US Army Corps of Engineers – Small Flood Control Projects, US Army Corps of Engineers – Clearing and Snagging Projects, Natural Resources Conservation Services – Emergency Watershed Protection Program, Hazard Mitigation Grant Program, Pre-Disaster Mitigation Grant Program
Lead Agency/Department Responsible:	Town of Elsmere (with assistance from New Castle County Government, State Government, DEMA, FEMA, Conservation District and Army Corps of Engineers)
Implementation Schedule:	5 years

Elsmere Mitigation Action 3	Evaluate stormwater management infrastructure.
Category:	Natural Resource Protection
Hazard(s) Addressed:	Flood
Priority (High, Moderate, Low):	High
Estimated Cost:	To be determined
Potential Funding Sources:	FEMA Hazard Mitigation Grant Program, Pre-Disaster Mitigation Grant Program
Lead Agency/Department Responsible:	Town of Elsmere, County Conservation District
Implementation Schedule:	24 months

Elsmere Mitigation Action 4	Study and recommend solutions to alleviate the periodic flooding threat on Chestnut Run at Kirkwood Hwy (SR-2).
Hazard(s) Addressed:	Flood
Priority (High, Moderate, Low):	High
Estimated Cost:	To be determined
Potential Funding Sources:	FEMA – Hazard Mitigation Grant Program, PDM
Lead Agency/Department Responsible:	Town of Elsmere
Implementation Schedule:	36 months

Middletown, Town of

		HAZARD RISK		
		Low	Moderate	High
OVERALL CAPABILITY	High			
	Moderate			
	Limited		X	

Middletown Mitigation Action 1	Conduct a vulnerability assessment of the Town's water distribution system, to identify measures designed to reduce the potential impacts of natural hazards.
Category:	Prevention
Hazard(s) Addressed:	All Hazards, including terrorism
Priority (High, Moderate, Low):	High
Estimated Cost:	$10,000
Potential Funding Sources:	Environmental Protection Agency - Water Protection Grants to the States, Environmental Protection Agency - Vulnerability Assessments and Related Security Improvements at Large Drinking Water Utilities
Lead Agency/Department Responsible:	Town of Middletown in cooperation with Artesian Water
Implementation Schedule:	Ongoing

Middletown Mitigation Action 2	Develop an evacuation policy for the Town
Category:	Emergency Services
Hazard(s) Addressed:	All Hazards
Priority (High, Moderate, Low):	Moderate
Estimated Cost:	Staff time and resources
Potential Funding Sources:	FEMA – Hurricane Local Grant Program, FEMA – Emergency Management Performance Grant, Hazard Mitigation Grant Program, FEMA – Emergency Performance Grants, FEMA – All Hazards Operational Planning, FEMA – Hazardous Materials Assistance Program. FEMA – Fire Management Assistance Grants
Lead Agency/Department Responsible:	Town of Middletown
Implementation Schedule:	12 months

Middletown Mitigation Action 3	Develop a website to notify residents of important information before, during and after emergencies, storms, etc. and include links to other major sources of information: DEMA, FEMA, DELDOT and the weather channel.
Category:	Outreach and Coordination
Hazard(s) Addressed:	All hazards
Priority (High, Moderate, Low):	High
Estimated Cost:	Staff time
Potential Funding Sources:	No funding needed
Lead Agency/Department Responsible:	Town of Middletown
Implementation Schedule:	12 months

Middletown Mitigation Action 4	Perform Sharondale outfall rehabilitation to eliminate erosive velocities of stormwater runoff in the outfall.
Category:	Other (Property Protection)
Hazard(s) Addressed:	Floods
Priority (High, Moderate, Low):	High
Estimated Cost:	To be determined
Potential Funding Sources:	FEMA – Hazard Mitigation Grant Program, Predisaster Mitigation
Lead Agency/Department Responsible:	Town of Middletown
Implementation Schedule:	36 months

New Castle, City of

		HAZARD RISK		
		Low	Moderate	High
OVERALL CAPABILITY	High		X	
	Moderate			
	Limited			

New Castle Mitigation Action 1	Introduce railroad crossings at main highway intersections with gate and better signals (three major roadways cross the railroad near schools, businesses and residential areas).
Category:	Other (Emergency Services)
Hazard(s) Addressed:	Human-caused
Priority (High, Moderate, Low):	Moderate
Estimated Cost:	$50,000
Potential Funding Sources:	Delaware Department of Transportation – Grants-in-Aid for Railroad Safety, Federal Railroad Administration – Railroad Safety
Lead Agency/Department Responsible:	Highway Department, Railroad
Implementation Schedule:	Ongoing

New Castle Mitigation Action 2	Work with New Castle County to conduct a detailed flood vulnerability study for the entire City to focus on coastal/riverine flooding from severe storm events and sea level rise.
Category:	Property Protection
Hazard(s) Addressed:	Flood, Storm Surge
Priority (High, Moderate, Low):	High
Estimated Cost:	$30,000
Potential Funding Sources:	Hazard Mitigation Grant Program, Pre-Disaster Mitigation Grant Program, Flood Mitigation Assistance Program
Lead Agency/Department Responsible:	City of New Castle
Implementation Schedule:	24 months

New Castle Mitigation Action 3	Work with railroad lines to notify citizens of hazardous shipments that run through the City of New Castle.
Category:	Outreach and Coordination
Hazard(s) Addressed:	Human caused hazards
Priority (High, Moderate, Low):	High
Estimated Cost:	$30,000
Potential Funding Sources:	FEMA – Emergency Management Performance Grant
Lead Agency/Department Responsible:	City of New Castle, DEMA
Implementation Schedule:	12 months

New Castle Mitigation Action 4	Enhance building code to reduce number of flat roofs.
Category:	
Hazard(s) Addressed:	All hazards
Priority (High, Moderate, Low):	High
Estimated Cost:	Staff time
Potential Funding Sources:	No funding needed
Lead Agency/Department Responsible:	City of New Castle, New Castle County
Implementation Schedule:	12 months

Newark, City of

		HAZARD RISK		
		Low	Moderate	High
OVERALL CAPABILITY	High			X
	Moderate			
	Limited			

Newark Mitigation Action 1	Assess damages sustained to city property after a disaster.
Category:	Other (Emergency Services)
Hazard(s) Addressed:	All hazards
Priority (High, Moderate, Low):	High
Estimated Cost:	To be determined
Potential Funding Sources:	FEMA – Emergency Management Performance Grants, Hazard Mitigation Grant Program, Pre Disaster Mitigation
Lead Agency/Department Responsible:	Emergency Management
Implementation Schedule:	18 months

Newark Mitigation Action 2	Retrofit storm sewer system.
Category:	Property Protection
Hazard(s) Addressed:	Flood
Priority (High, Moderate, Low):	High
Estimated Cost:	To be determined
Potential Funding Sources:	FEMA –Hazard Mitigation Grant Program, Pre Disaster Mitigation
Lead Agency/Department Responsible:	Emergency Management
Implementation Schedule:	24 months

Newark Mitigation Action 3	Preserve riparian buffer along White Clay Creek.
Category:	Natural Resource Protection
Hazard(s) Addressed:	Flood
Priority (High, Moderate, Low):	High
Estimated Cost:	To be determined
Potential Funding Sources:	FEMA –Hazard Mitigation Grant Program, Pre Disaster Mitigation
Lead Agency/Department Responsible:	Emergency Management
Implementation Schedule:	24 months

Newark Mitigation Action 4	Inspect stormwater outfalls and facilities annually.
Category:	Property Protection
Hazard(s) Addressed:	Flood
Priority (High, Moderate, Low):	High
Estimated Cost:	$50,000
Potential Funding Sources:	FEMA –Hazard Mitigation Grant Program, Pre Disaster Mitigation
Lead Agency/Department Responsible:	City of Newark Public Works
Implementation Schedule:	24 months

Newark Mitigation Action 5	Conduct six inspections of creek annually.
Category:	Property Protection
Hazard(s) Addressed:	Flood
Priority (High, Moderate, Low):	High
Estimated Cost:	$50,000
Potential Funding Sources:	FEMA –Hazard Mitigation Grant Program, Pre Disaster Mitigation
Lead Agency/Department Responsible:	City of Newark Public Works
Implementation Schedule:	24 months

Newark Mitigation Action 6	Improve storm drain spill response.
Category:	Other (Emergency Services)
Hazard(s) Addressed:	Flood
Priority (High, Moderate, Low):	Moderate
Estimated Cost:	Staff time
Potential Funding Sources:	No funding needed.
Lead Agency/Department Responsible:	City of Newark, New Castle County Emergency Management
Implementation Schedule:	24 months

Newark Mitigation Action 7	Initiate a tree maintenance program.
Category:	Natural Resource Protection
Hazard(s) Addressed:	All hazards
Priority (High, Moderate, Low):	Moderate
Estimated Cost:	Staff time
Potential Funding Sources:	No funding needed.
Lead Agency/Department Responsible:	City of Newark
Implementation Schedule:	24 months

Newark Mitigation Action 8	Own generation back up power at varied voltages and place at critical loads and substations.
Category:	Other (Emergency Services)
Hazard(s) Addressed:	All hazards
Priority (High, Moderate, Low):	High
Estimated Cost:	To be determined
Potential Funding Sources:	FEMA – Emergency Management Performance Grant
Lead Agency/Department Responsible:	City of Newark
Implementation Schedule:	12 months

Newark Mitigation Action 9	Develop storage area at designated parkland for debris composting.
Category:	Other (Emergency Services)
Hazard(s) Addressed:	All hazards
Priority (High, Moderate, Low):	High
Estimated Cost:	To be determined
Potential Funding Sources:	FEMA – Emergency Management Performance Grant
Lead Agency/Department Responsible:	City of Newark
Implementation Schedule:	12 months

Newark Mitigation Action 10	Keep Christina Creek clear of obstruction, including 11 bridge culverts.
Hazard(s) Addressed:	Flood
Priority (High, Moderate, Low):	High
Estimated Cost:	To be determined
Potential Funding Sources:	To be determined
Lead Agency/Department Responsible:	City of Newark
Implementation Schedule:	24 months

Newark Mitigation Action 11	Clean catch basins and grates three times a year.
Hazard(s) Addressed:	Flood
Priority (High, Moderate, Low):	High
Estimated Cost:	To be determined
Potential Funding Sources:	To be determined
Lead Agency/Department Responsible:	City of Newark
Implementation Schedule:	24 months

Newark Mitigation Action 12	Routinely inspect all E&S measures.
Hazard(s) Addressed:	Flood
Priority (High, Moderate, Low):	High
Estimated Cost:	To be determined
Potential Funding Sources:	FEMA – Hazard Mitigation Grant Program
Lead Agency/Department Responsible:	City of Newark
Implementation Schedule:	24 months

Newark Mitigation Action 13	Study and recommend solutions to alleviate the periodic flooding threat on the Christina River at Nottingham Road (SR-273), Barksdale Road, near the Christina River at the Newark CSX rail line and Cashno Mill Road, on the Christina River at W Chesnut Hill Road/Rittenhouse Park, on the Christina River at Welsh Track Road, and on White Clay Creek at Paper Mill Road.
Hazard(s) Addressed:	Flood
Priority (High, Moderate, Low):	High
Estimated Cost:	To be determined
Potential Funding Sources:	FEMA – Pre-disaster Mitigation and Hazard Mitigation Grant Program
Lead Agency/Department Responsible:	City of Newark
Implementation Schedule:	48 months

Newark Mitigation Action 14	Support cost effective property acquisition through Federal grants.
Hazard(s) Addressed:	Flood
Priority (High, Moderate, Low):	High
Estimated Cost:	To be determined
Potential Funding Sources:	FEMA – Hazard Mitigation Grant Program
Lead Agency/Department Responsible:	City of Newark
Implementation Schedule:	48 months

Newark Mitigation Action 17	Routinely inspect all construction E & S measures.
Hazard(s) Addressed:	Flood
Priority (High, Moderate, Low):	High
Estimated Cost:	To be determined
Potential Funding Sources:	FEMA – Hazard Mitigation Grant Program
Lead Agency/Department Responsible:	City of Newark
Implementation Schedule:	24 months

Newark Mitigation Action 17	Study and recommend solutions to alleviate the periodic flooding threat on the Christina River at Nottingham Road (SR-273), Barksdale Road, near the Christina River at the Newark CSX rail line and Cashno Mill Road, on the Christina River at W Chestnut Hill Road/Rittenhouse Park, on the Christina River at Welsh Track Road, and on White Clay Creek at Paper Mill Road.
Hazard(s) Addressed:	Flood
Priority (High, Moderate, Low):	High
Estimated Cost:	To be determined
Potential Funding Sources:	FEMA – Hazard Mitigation Grant Program, PDM
Lead Agency/Department Responsible:	City of Newark
Implementation Schedule:	60 months

Newport, Town of

		HAZARD RISK		
		Low	Moderate	High
OVERALL CAPABILITY	High			
	Moderate	X		
	Limited			

Newport Mitigation Action 1	Initiate wetlands protective measures along the Christiana River.
Category:	Natural Resource Protection
Hazard(s) Addressed:	Flood
Priority (High, Moderate, Low):	Moderate
Estimated Cost:	Unknown
Potential Funding Sources:	Environmental Protection Agency – Watershed Initiative Grants, Environmental Protection Agency – Water Quality Cooperative Agreements, USDA Natural Resources Conservation Service – Watershed Protection and Flood Prevention Program
Lead Agency/Department Responsible:	Delaware Open Space Program
Implementation Schedule:	24 months

Newport Mitigation Action 2	Work with the County to conduct a detailed flood vulnerability study for the entire Town.
Category:	Property Protection
Hazard(s) Addressed:	Flood, Storm Surge
Priority (High, Moderate, Low):	High
Estimated Cost:	$20,000
Potential Funding Sources:	Hazard Mitigation Grant Program, Pre-Disaster Mitigation Grant Program, Flood Mitigation Assistance Program
Lead Agency/Department Responsible:	Town of Newport
Implementation Schedule:	24 months

Newport Mitigation Action 3	Study and recommend solutions to alleviate the periodic flooding threat on the Christina River at Interstate 95/US 202.
Hazard(s) Addressed:	Flood
Priority (High, Moderate, Low):	High
Estimated Cost:	To be determined
Potential Funding Sources:	FEMA – Hazard Mitigation Grant Program, PDM
Lead Agency/Department Responsible:	Town of Newport
Implementation Schedule:	36 months

Odessa, Town of

		HAZARD RISK		
		Low	Moderate	High
OVERALL CAPABILITY	High			
	Moderate			
	Limited		X	

Odessa Mitigation Action 1	Establish a comprehensive all-hazards warning system.
Category:	Other (Emergency Services)
Hazard(s) Addressed:	All Hazards
Priority (High, Moderate, Low):	High
Estimated Cost:	Unknown
Potential Funding Sources:	FEMA – All Hazards Emergency Operational Planning, FEMA – Hurricane Local Grant Program, Hazard Mitigation Grant Program, Review FEMA warning notification guidance, FEMA and Red Cross provide materials free of charge
Lead Agency/Department Responsible:	Town Emergency Management
Implementation Schedule:	12 months

Odessa Mitigation Action 2	Educate residents on hazards that can impact the community.
Category:	Outreach and Coordination
Hazard(s) Addressed:	All Hazards
Priority (High, Moderate, Low):	High
Estimated Cost:	Staff time and resources, $10,000
Potential Funding Sources:	FEMA – Hurricane Local Grant Program, FEMA – Hazardous Materials Program, FEMA – Emergency Management Performance Grants, FEMA and Red Cross educational materials available free of charge
Lead Agency/Department Responsible:	Town Emergency Management and Public Information Office
Implementation Schedule:	12 months

Odessa Mitigation Action 3	Develop an evacuation policy for the Town.
Category:	Other (Emergency Services)
Hazard(s) Addressed:	Hurricane, Flood
Priority (High, Moderate, Low):	High
Estimated Cost:	Staff time and resources
Potential Funding Sources:	FEMA provides evacuation guidance free of charge, FEMA – Emergency Management Performance Grants
Lead Agency/Department Responsible:	Town Emergency Management
Implementation Schedule:	12 months

Odessa Mitigation Action 4	Update the local Flood Damage Prevention Ordinance.
Category:	Prevention
Hazard(s) Addressed:	Flood
Priority (High, Moderate, Low):	High
Estimated Cost:	Staff time and resources, $5,000
Potential Funding Sources:	Flood Mitigation Assistance Program, Pre Disaster Mitigation Program
Lead Agency/Department Responsible:	Town Planning Department
Implementation Schedule:	12 months

Odessa Mitigation Action 5	Encourage citizens to purchase flood insurance.
Category:	Outreach and Coordination
Hazard(s) Addressed:	Flood
Priority (High, Moderate, Low):	High
Estimated Cost:	Staff time and resources, $5,000
Potential Funding Sources:	FEMA - Community Assistance Program-State Support Services Element (CAP-SSSE)
Lead Agency/Department Responsible:	Town Administration
Implementation Schedule:	Ongoing

Odessa Mitigation Action 6	Identify and evaluate shelters.
Category:	Other (Emergency Services)
Hazard(s) Addressed:	All Hazards
Priority (High, Moderate, Low):	Moderate
Estimated Cost:	Staff time and resources, Shelter assessment costs unknown
Potential Funding Sources:	Red Cross provides technical assistance and designation criteria, Hazard Mitigation Grant Program, Pre Disaster Mitigation Program
Lead Agency/Department Responsible:	Town of Odessa Emergency Management
Implementation Schedule:	12 months

Odessa Mitigation Action 7	Study and recommend solutions to alleviate the periodic flooding threat on Appoquinimink River at Main Street (SR-299).
Hazard(s) Addressed:	Flood
Priority (High, Moderate, Low):	High
Estimated Cost:	To be determined
Potential Funding Sources:	FEMA – Hazard Mitigation Grant Program, PDM
Lead Agency/Department Responsible:	Town of Odessa
Implementation Schedule:	36 months

Townsend, Town of

		HAZARD RISK		
		Low	Moderate	High
OVERALL CAPABILITY	High			
	Moderate		X	
	Limited			

Townsend Mitigation Action 1	Develop an educational and outreach program for residents, business owners and government employees to include specific actions that can be taken to reduce the impact of natural hazards.
Category:	Outreach and Coordination
Hazard(s) Addressed:	All Hazards
Priority (High, Moderate, Low):	High
Estimated Cost:	Staff time and resources, $5,000
Potential Funding Sources:	Hazard Mitigation Grant Program, Pre-Disaster Mitigation Program, materials available from FEMA and Red Cross free of charge
Lead Agency/Department Responsible:	Town of Townsend
Implementation Schedule:	12 months

Wilmington, City of

		HAZARD RISK		
		Low	Moderate	High
OVERALL CAPABILITY	High		X	
	Moderate			
	Limited			

Wilmington Mitigation Action 1	Educate and encourage citizens to purchase and install backflow preventers in flood-prone homes.
Category:	Property Protection
Hazard(s) Addressed:	Flood
Priority (High, Moderate, Low):	Low
Estimated Cost:	$500 per home x 5,000 homes = $2,500,000
Potential Funding Sources:	Taxes, Hazard Mitigation Grant Program, Housing and Urban Development - Disaster Recovery Initiative, Pre-Disaster Mitigation, Flood Mitigation Assistance Program
Lead Agency/Department Responsible:	Public Works
Implementation Schedule:	36 months

Wilmington Mitigation Action 2	Continue to increase public education so people are in a position to survive for three days without power.
Category:	Outreach and Coordination
Hazard(s) Addressed:	All Hazards
Priority (High, Moderate, Low):	High
Estimated Cost:	$20 per person X 70,000 = $1,400,000
Potential Funding Sources:	FEMA – Hurricane Local Grant Program, FEMA - Emergency Management Performance Grant, Pre-Disaster Mitigation Grant Program
Lead Agency/Department Responsible:	City of Wilmington, DEMA, FEMA
Implementation Schedule:	Ongoing

Wilmington Mitigation Action 3	Continue to increase public education for all hazards.
Category:	Outreach and Coordination
Hazard(s) Addressed:	All Hazards
Priority (High, Moderate, Low):	High
Estimated Cost:	$10,000
Potential Funding Sources:	FEMA – Hurricane Local Grant Program, FEMA -Emergency Management Performance Grant, Pre-Disaster Mitigation Grant Program
Lead Agency/Department Responsible:	Channel 22 and all departments
Implementation Schedule:	Ongoing

Wilmington Mitigation Action 4	Evaluate the adequacy of existing code to address potential wind-related damages—particularly damage caused by flying glass in downtown area.
Category:	Prevention
Hazard(s) Addressed:	Hurricane, Thunderstorm, Nor'easter
Priority (High, Moderate, Low):	High
Estimated Cost:	Study of code - $50,000; Retrofit could cost millions
Potential Funding Sources:	Hazard Mitigation Grant Program, Pre-Disaster Mitigation
Lead Agency/Department Responsible:	Planning, L&I, Council
Implementation Schedule:	12 months

Wilmington Mitigation Action 5	Reduce the likelihood of sewer overflow during flood events through real-time control (RTC).
Category:	Prevention
Hazard(s) Addressed:	Hazardous materials, Flood
Priority (High, Moderate, Low):	High
Estimated Cost:	$300,000,000
Potential Funding Sources:	Taxes/Grants, Hazard Mitigation Grant Program, Pre-Disaster Mitigation, Housing and Urban Development – Disaster Recovery Initiative
Lead Agency/Department Responsible:	Public Works has project started but will take 20 years
Implementation Schedule:	Ongoing

Wilmington Mitigation Action 6	Develop building construction code requiring shatterproof glass for new city buildings.
Category:	Prevention
Hazard(s) Addressed:	High Winds
Priority (High, Moderate, Low):	High
Estimated Cost:	Staff time and resources
Potential Funding Sources:	NA
Lead Agency/Department Responsible:	Labor and Inspection
Implementation Schedule:	12 months

Wilmington Mitigation Action 7	Establish a citywide disaster recovery/business continuity plan.
Category:	Prevention and Other (Emergency Services)
Hazard(s) Addressed:	All Hazards
Priority (High, Moderate, Low):	Moderate
Estimated Cost:	$50,000
Potential Funding Sources:	Pre-Disaster Mitigation, Economic Development Administration, Hazard Mitigation Grant Program, FEMA - Emergency Management Performance Grants, FEMA - All Hazards Emergency Operational Planning
Lead Agency/Department Responsible:	Personnel
Implementation Schedule:	Ongoing

Wilmington Mitigation Action 9	Coordinate with the Department of Public Works to apply traffic flow study to evacuation procedures.
Category:	Other (Emergency Services)
Hazard(s) Addressed:	All Hazards
Priority (High, Moderate, Low):	Moderate
Estimated Cost:	Unknown
Potential Funding Sources:	FEMA - Emergency Management Performance Grants, FEMA - All Hazards Emergency Operational Planning, Department of Justice - State and Local Domestic Preparedness Exercise Support, Department of Justice - State and Local Domestic Preparedness Technical Assistance, Department of Justice - State and Local Domestic Preparedness Training Program
Lead Agency/Department Responsible:	City Emergency Management Agency
Implementation Schedule:	9 months

Wilmington Mitigation Action 9	Evaluate Comprehensive Plan to check for hazard mitigation elements.
Category:	Prevention
Hazard(s) Addressed:	All Hazards
Priority (High, Moderate, Low):	Moderate
Estimated Cost:	Staff time and resources; $20,000
Potential Funding Sources:	Pre-Disaster Mitigation, Hazard Mitigation Grant Program, FEMA – All Hazards Emergency Operational Planning, FEMA – Emergency Management Performance Grant,
Lead Agency/Department Responsible:	Planning
Implementation Schedule:	Ongoing

Wilmington Mitigation Action 10	Ensure NIMS training for all appropriate City personnel and engage in tabletop exercises.
Category:	Prevention and Other (Emergency Services)
Hazard(s) Addressed:	All Hazards
Priority (High, Moderate, Low):	High
Estimated Cost:	Staff time
Potential Funding Sources:	FEMA – Emergency Management Performance Grant,
Lead Agency/Department Responsible:	Emergency Management
Implementation Schedule:	Ongoing

Wilmington Mitigation Action 11	On South Wilmington Wetland Park – Reestablish wetland to process storm water from South Wilmington Area east of Walnut Street, south of A street; Partial separation of storm water in Southbridge and from Garaches Lane.
Category:	Property Protection
Hazard(s) Addressed:	Flood
Priority (High, Moderate, Low):	High
Estimated Cost:	$12 million
Potential Funding Sources:	Pre-Disaster Mitigation, Hazard Mitigation Grant Program, Flood Mitigation Assistance Program
Lead Agency/Department Responsible:	Public Works
Implementation Schedule:	5 years

Wilmington Mitigation Action 12	Reestablish drainage along RR property between New Castle Avenue and Christiana Avenue to relieve street flooding on New Castle Avenue and to create a drainage path for the redevelopment of the Southbridge Extension area.
Category:	Property Protection
Hazard(s) Addressed:	Flood
Priority (High, Moderate, Low):	High
Estimated Cost:	$ 0.3 million
Potential Funding Sources:	Pre-Disaster Mitigation, Hazard Mitigation Grant Program, Flood Mitigation Assistance Program,
Lead Agency/Department Responsible:	Public Works
Implementation Schedule:	36 months

Wilmington Mitigation Action 13	Develop an Emergency Management GIS training program (including hardware and software).
Category:	Prevention
Hazard(s) Addressed:	All Hazards
Priority (High, Moderate, Low):	High
Estimated Cost:	$150,000-200,000
Potential Funding Sources:	FEMA RISKMAP
Lead Agency/Department Responsible:	Emergency Management, Public Works
Implementation Schedule:	Ongoing

Wilmington Mitigation Action 14	Study and recommend solutions to alleviate the periodic flooding threat on Brandywine Creek at E 12th Street/Wilmington Industrial Park and on Shellpot Creek at Governor Printz Blvd (US 13).
Category:	Other (Property Protection)
Hazard(s) Addressed:	Flood
Priority (High, Moderate, Low):	High
Estimated Cost:	To be determined
Potential Funding Sources:	FEMA Hazard Mitigation Grant Program, PDM
Lead Agency/Department Responsible:	Emergency Management, Public Works
Implementation Schedule:	48 months

University of Delaware – Newark and Wilmington Campuses

		HAZARD RISK		
		Low	Moderate	High
OVERALL CAPABILITY	High		X	
	Moderate			
	Limited			

University of Delaware Mitigation Action 1	Develop a strategy to abate asbestos campus-wide.
Category:	Other (Emergency Services)
Hazard(s) Addressed:	Other
Priority (High, Moderate, Low):	Medium
Estimated Cost:	$1,000,000
Potential Funding Sources:	University General Fund; University Capitol Fund
Lead Agency/Department Responsible:	Facilities, Environmental Health and Safety
Implementation Schedule:	36 months

University of Delaware Mitigation Action 2	Alleviate the water infiltration/flooding-taking place within four University buildings on the Newark campus: New Castle Hall, Kent Hall, Sussex Hall, and Robinson Hall.
Category:	Other (Emergency Services)
Hazard(s) Addressed:	Flooding
Priority (High, Moderate, Low):	High
Estimated Cost:	1,000,000
Potential Funding Sources:	University General Fund; University Capitol Fund; FEMA – Predisaster Mitigation Grant, Hazard Mitigation Grant Program
Lead Agency/Department Responsible:	Facilities, Environmental Health and Safety
Implementation Schedule:	12 months

University of Delaware Mitigation Action 3	Utilize university administrative and academic resources for emergency management related projects.
Category:	Other (Emergency Services)
Hazard(s) Addressed:	Other
Priority (High, Moderate, Low):	Medium
Estimated Cost:	Staff time
Potential Funding Sources:	No funding needed
Lead Agency/Department Responsible:	Emergency Management
Implementation Schedule:	18 months

Mitigation Action 4	Add utility meters at the building level for water, steam, chilled water, gas, and electricity on all buildings on the Newark campus.
Category:	Other (Emergency Services)
Hazard(s) Addressed:	All Hazards
Priority (High, Moderate, Low):	Medium
Estimated Cost:	$1,000,000
Potential Funding Sources:	University General Fund; University Capitol Fund
Lead Agency/Department Responsible:	Facilities
Implementation Schedule:	24 months

Mitigation Action 5	Increase the occurrence of joint trainings and exercises between the State of Delaware, New Castle County, the City of Newark and the University to strengthen the response partnership amongst all agencies.
Category:	Other (Emergency Services)
Hazard(s) Addressed:	All Hazards
Priority (High, Moderate, Low):	Medium
Estimated Cost:	$10,000
Potential Funding Sources:	University General Fund
Lead Agency/Department Responsible:	Emergency Management, Environmental Health and Safety, Communications and Public Affairs, Student Life, Campus and Public Safety
Implementation Schedule:	Ongoing

Mitigation Action 6	Increase the overall preparedness level of the University Community through outreach and training of both the student and the employee population.
Category:	Outreach and Coordination
Hazard(s) Addressed:	All hazards
Priority (High, Moderate, Low):	Medium
Estimated Cost:	$25,000
Potential Funding Sources:	University General Fund
Lead Agency/Department Responsible:	Emergency Management, Campus and Public Safety, Environmental Health and Safety, Communications and Public Affairs, Student Life
Implementation Schedule:	12 months

University of Delaware Mitigation Action 7	Develop an informational website which would be linked to the main site for Emergency Management. This site could be combined with the University and departmental social media tools (i.e. Facebook, Twitter, etc.).
Category:	Outreach and Coordination
Hazard(s) Addressed:	All hazards
Priority (High, Moderate, Low):	Medium
Estimated Cost:	$10,000
Potential Funding Sources:	University General Fund
Lead Agency/Department Responsible:	Emergency Management, Communications and Public Affairs
Implementation Schedule:	24 months

University of Delaware Mitigation Action 8	Update individual departments' disaster preparedness and emergency action plans. Focus on educating departments on the importance of keeping these plans current and rethink unit planning – scale and process and consider combining plans.
Category:	Prevention and Other (Emergency Services)
Hazard(s) Addressed:	All Hazards
Priority (High, Moderate, Low):	High
Estimated Cost:	$50,000
Potential Funding Sources:	FEMA - Emergency Management Performance Grants
Lead Agency/Department Responsible:	Emergency Management
Implementation Schedule:	24 months

University of Delaware Mitigation Action 9	Improve access to required annual safety trainings for faculty, staff and students as well as tracking laboratory activities such as lab inspections, chemical inventory, etc.
Category:	Outreach and Coordination
Hazard(s) Addressed:	All Hazards
Priority (High, Moderate, Low):	High
Estimated Cost:	Initially estimated at $140,000, annual subscription renewal estimate of $30,000
Potential Funding Sources:	University funds
Lead Agency/Department Responsible:	Environmental Health and Safety
Implementation Schedule:	24 months

University of Delaware Mitigation Action 10	Consider integrating effective mitigation practices and concepts into other relevant University (Examples include: the University Strategic Planning Initiative, Facilities Design Guidelines, Critical Incident Management Plan, etc.)
Category:	Prevention
Hazard(s) Addressed:	All Hazards
Priority (High, Moderate, Low):	High
Estimated Cost:	Staff time
Potential Funding Sources:	No funding required
Lead Agency/Department Responsible:	Emergency Management and all other departments
Implementation Schedule:	24 months

University of Delaware Mitigation Action 11	Continue to work closely with the State of Delaware, New Castle County and the City of Newark to ensure that the mitigation actions are coordinated effectively and are in harmony with that of the State, County and City. Collaborate with the local governments to improve the University's and the community's disaster resistance by conducting regular meetings with them to identify mitigation funds.
Category:	Outreach and Coordination
Hazard(s) Addressed:	All Hazards
Priority (High, Moderate, Low):	High
Estimated Cost:	Staff time
Potential Funding Sources:	No funding required
Lead Agency/Department Responsible:	Emergency Management
Implementation Schedule:	24 months

University of Delaware Mitigation Action 12	Develop procedures and documentation for the Information Technology recovery staff to ensure seamless operation of the Disaster Recover site thereby facilitating uninterrupted computer operations university-wide.
Category:	Outreach and Coordination
Hazard(s) Addressed:	All Hazards
Priority (High, Moderate, Low):	High
Estimated Cost:	Staff time
Potential Funding Sources:	University Funds
Lead Agency/Department Responsible:	Information Technology
Implementation Schedule:	12 months

University of Delaware Mitigation Action 13	Procure advanced emergency notification systems to include an exterior Public Address System; an in-classroom emergency notification system in academic buildings and a dedicated non-University redundant website for emergency notifications in the event the www.udel.edu site becomes overwhelmed during a disaster situation.
Category:	Other (Emergency Management)
Hazard(s) Addressed:	All Hazards
Priority (High, Moderate, Low):	High
Estimated Cost:	$500,000
Potential Funding Sources:	University funds
Lead Agency/Department Responsible:	Emergency Management; Information Technology
Implementation Schedule:	48 months

University of Delaware Mitigation Action 14	Update the University Continuity of Operations Plan.
Category:	Other (Emergency Management)
Hazard(s) Addressed:	All Hazards
Priority (High, Moderate, Low):	High
Estimated Cost:	$200,000
Potential Funding Sources:	University funds
Lead Agency/Department Responsible:	Emergency Management; Office of Risk Management
Implementation Schedule:	48 months

7. PLAN MAINTENANCE PROCEDURES

7.1 Introduction

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.

This section discusses how the Mitigation Strategy will be implemented by participating jurisdictions and how the overall All Hazard Mitigation Plan will be evaluated and enhanced over time. This section also identifies how the public can continue to be involved in the hazard mitigation planning process in the next five years.

The long-term success of the New Castle All Hazard Mitigation Plan Update depends in large part on routine monitoring, evaluating and updating of the Plan so that it will remain a valid and 'living' document for the community. The New Castle Office of Emergency Management and Steering Committee will spearhead the implementation of the Plan's actions.

The Steering Committee will continue to monitor the efficiency and effectiveness of various mitigation strategies and will make recommendation for additional improvements. The New Castle County Office of Emergency Management and Steering Committee will review local hazard events and impacts, community actions that may help or hinder mitigation capabilities, as well as the progress of mitigation activities on an annual basis. Any changes will be noted in the in the planning document accordingly, along with a summary of their findings and associated changes in a memorandum to the County's Critical incident Working Group (CIWG) and County Council Public Safety and Land Use Committee's, and the Delaware Emergency Management Agency.

Annual updates will be collected from the County and municipalities at the annual Mitigation Grant Workshop held in July/August, and updates will be included in the Plan's Appendix.

7.2 Implementation

Each jurisdiction participating in this Plan is responsible for implementing specific mitigation actions as prescribed in the County's Mitigation Action Plan (actions are listed by municipality). This enables individual jurisdictions to update their unique mitigation actions as needed without altering the County's Plan elements. The requirement of each municipality to adopt their unique actions also ensures that each jurisdiction is not held responsible for the actions of every other jurisdiction involved in the planning process.

In addition the specific local department or agency, an implementation time period or a specific implementation date has been assigned in order to assess whether actions are being implemented in a timely fashion. New Castle County and its jurisdictions will seek outside funding sources to implement mitigation projects in both the pre-disaster and post-disaster environments. Whenever possible, a funding source has been identified for proposed actions listed in the Mitigation Action Plan.

It will be left up to each participating jurisdiction to determine additional implementation procedures beyond those listed in the Mitigation Strategy section. This may include integrating the requirements of the Hazard Mitigation Plan into other planning documents, processes or mechanisms such as comprehensive plan, zoning ordinances, stormwater management plans, or capital improvement plans, where appropriate.

7.3 Evaluation and Enhancement

Periodic revisions and updates of the Hazard Mitigation Plan are required to ensure that the goals and objectives of the Plan are kept current, potential changes in hazard vulnerability and mitigation priorities, as well as any recent hazard events are taken into account. In addition, revisions may be necessary to ensure that the Plan is in full compliance with applicable Federal regulations or State statutes. Periodic evaluation of the Plan will also ensure that specific mitigation actions are being reviewed and carried out according to each jurisdiction's individual Mitigation Action Plan.

Five (5) Year Plan Review

The Plan will undergo a comprehensive review and evaluation process every five years by the New Castle Steering Committee under the authority of the New Castle County Council and Executive Office. The Update will serve as an opportunity to determine whether there have been any significant changes in the County, which may necessitate changes in the mitigation actions proposed. New development in identified hazard areas, an increased exposure to hazards, the increase or decrease in capability to address hazards, and changes to Federal or State legislation are factors that drive and affect the content of the Plan. The next Plan Update will be required to completed and submitted to the State and FEMA for review by February 2020. This update process will also provide community officials with an opportunity to evaluate those actions that have been successfully completed and to possibly document potential losses avoided due to the implementation of specific mitigation measures.

In addition to the FEMA-required 5-year review, the Steering Committee will continue to meet annually and after major events occur. This will ensure that the Plan is kept current and reflects changing conditions within the County and its jurisdictions.

Disaster Declaration

Following a disaster declaration, the Plan may need to be revised to reflect lessons learned, or to address specific circumstances arising from the event.

Reporting Procedures

The results of the five-year review will be summarized by the Steering Committee in a report that will include an evaluation of the effectiveness of the Plan and any required or recommended changes or amendments. The report will also identify progress for each of the proposed mitigation actions, identifying reasons for delays or obstacles to their completion along with recommended strategies to overcome them.

Revision of the Plan will be conducted by the New Castle County Office of Emergency Management, with full support and coordination of all NCC Departments and the municipalities covered by this Plan. If changes are required of individual Mitigation Action Plans, the appropriate local designee will assign responsibility for the completion of the task.[1]

[1] Local jurisdictions do have the authority to approve/adopt changes to their own Mitigation Action Plans without approval from the County; however, the County should be advised of all changes as a courtesy and for consideration for changes or modifications to the countywide Plan. Changes to either the multi-jurisdictional plan or local Mitigation Action Plans will necessitate the adoption of these changes by the appropriate governing body. Ultimately, the updated Plan or plan component(s) will be submitted to DEMA.

Plan Amendment Process

Upon the initiation of the amendment process, New Castle County and its municipalities will forward information on the proposed change(s) to all interested parties including, but not limited to, all affected county and municipal departments, residents, and businesses for a 45-day review and comment period. If no comments are received from the reviewing parties within the specified review period, such will be noted accordingly. Information will also be forwarded to DEMA.

At the end of the 45-day review and comment period, the proposed amendment and all comments will be forwarded to the Steering Committee for consideration. The Committee will review the proposed amendment along with the comments received from other parties, and submit a recommendation to the appropriate governing body within 60 days.

In determining whether to recommend approval or denial of a Plan amendment request, the following factors will be considered:

- There are errors or omissions made in the identification of issues or needs during the preparation of the Plan Update;
- New issues or needs have been identified which were not adequately addressed in the Plan Update;
- There has been a change in information, data, or assumptions from those on which the Plan Update was based.

Upon receiving the recommendation of the designee, the governing body will hold a public hearing. The governing body will review the recommendation (including the factors listed above) and any oral or written comments received at the public hearing. Following that review, the governing body will take one of the following actions:

- Adopt the proposed amendment as presented;
- Adopt the proposed amendment with modifications;
- Refer the amendments request back to the designee for further consideration; or
- Defer the amendment request for further consideration and/or hearing.

7.4 Continued Public Involvement

Public input was an integral part of the completion and the 2015 revision of this Plan and will continue to be essential as this Plan changes over time. As is the case with any officially adopted plan or ordinance, significant changes to this Plan shall require a public hearing.

Other efforts to involve the public in the maintenance, evaluation and revision process will be made as necessary. These efforts may include:

- Advertising meetings of the Steering Committee in the local newspaper, public bulletin boards and/or City and County office buildings;
- Utilizing local media to update the public of any maintenance and/or periodic review activities taking place;

- Utilizing municipal and County websites to advertise any maintenance and/or periodic review activities taking place; and
- Keeping copies of the Plan in public libraries.

APPENDIX A

Steering Committee Meeting December 3, 2014

New Castle County
ALL HAZARDS MITIGATION PLAN UPDATE
3 December 2014
AGENDA

Steering Committee Meeting #1
1pm-4pm

Introductions – Dave Carpenter, NCC Emergency Management

- County Staff
- Steering Committee Members
- Consultants
    - Deepa Srinivasan, President, Vision Planning and Consulting, LLC
    - Mike Scott, ESRGC, Salisbury University

PowerPoint Presentation – Deepa Srinivasan and Mike Scott

- Overview of the Hazard Mitigation Planning Process
- Schedule and Deliverables

Discussion of Hazards, Risks, and Vulnerability – Mike Scott

Summary of Capabilities – Deepa Srinivasan

Plan Integration - Relevant Plans, Ordinances, and Programs - Deepa Srinivasan

Discussion of 2009 Plan Goals and Objectives

Wrap-up

- Steering Committee Meeting 2 and Public Meeting February 2014
- Questions and Answers

Adjournment of Steering Committee Members

Municipal Workshop
4pm to 6pm

Review of Municipal Capabilities

Review of Municipal Problem Areas, Hazards, and Vulnerabilities

Review of Mitigation Actions

SIGN-IN SHEET
New Castle County HMP Update
3 December 2014

Name	Agency/ Municipality	Title	Phone No,	Email	Address
Janice Shute	DNREC Floodplain Management + dam safety	engineer		Janice.Shute@state.de.us	89 Kings Hwy Dover DE
DON KNOX	DEMA	NATURAL HAZARDS SUPERVISOR	302-222-6569	don.knox@state.de.us	
Ed Strouse	DEMA	Mitigation Project Officer	302-659-2214	edward.strouse@state.de.us	165 Brick store Landing Rd Smyrna DE 1997
Jeff Bergstrom	City of New Castle	BLDG OFFICIAL FIRE MARSHAL	302 322 9813	jeff@newcastlede.org	900 Wilmington New Castle DE 19
John Lloyd	"	Code Enforcement	"	JLLOYD@newcastlede.org	"
Tony Schiavi	NCC Dept. of Special Services	Asst. Const. Eng.	(302)395-5703	ajschiavi@nccde.org	187-A Old Churchm New Castle, DE 19720
George Giles	W.I.M	Director	302 576-3914	ggiles@ch.state.de.us	22 S. Heald St Wilm DE 1980
Anthony Facciolo	Town of Elsmere	Code Enforcement	302 998-2215	AFacciolo@Townofelsmere.com	11 Poplar Ave Wilm DE 19805
Diana Reed	Town of Elsmere	Admin Assist	302-998-2215	diana.reed@townofelsmere.com	11 Poplar Ave Wilmington DE 1980
MARK SEIFERT	UNIV. OF DELAWARE	EMERGENCY MGMT	3028317394	SEIFERT@UDEL.EDU	413 ACADEMY ST NEWARK, DE 19
David Brenner	Town of Bellefonte	Planning Commission	302-482-3104	Dkvebrenn@aol.com	901A Rosedale Av Bellefonte, DE 19
Dave Scott	NCC OEM	PLANNER	302 395 2704	DLSCOTT@NCCDE.ORG	3601 N DuPont Hw New Castle DE 197
Dick Cathcart	City of Delaware City	City Manager	302-834-4573	RCATHCART@CI.DELAWARE-CITY.DE.US	407 Clinton St. Delaware City, DE 19
Andrew Bereo	NCC DCS	Administrator	395-5890	asbero@nccde.org	77 Reads Way N.C. 19720
Dan Blevins	WILMAPCO	Planner/ GIS	737-6205	dblevins@wilmapco.org	850 Library Ave Newark, DE 19711
TJ Ferris	NCC OEM	EA	395-2700	TJFerris@nccde.org	
Melvin Gilbert Deldot	Planner CTS		760-2157	Bernie.Gilbert@state.de.us	800 Bay Rd Dover DE

DWAYNE DAY DELDOT HLS PLANNER 302-659-4604 dwayne.day@State.de.us

PAUL TIERNAN NEWARK PD 302-366-7104 PAUL.TIERNAN@CJ.STATE.DE.US

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KEVIN FEENEY NEWARK PD 302-366-7110 x128 KEVIN.FEENEY@CJ.STATE.DE

John Gysling NCCDLU (302) 395-5413 jgysling@nccde.org

Tim DeSchepper Middletown 302-378-1164 tdeschepper@middletownd

Silvana V Croope (302) 659-4606 Silvana.Croope@state.de

2014 All-Hazards Mitigation Plan Update
New Castle County, DE

Steering Committee Meeting #1 and Municipal Workshop
3 December 2014

Presented by:
Deepa Srinivasan, Vision Planning and Consulting, LLC

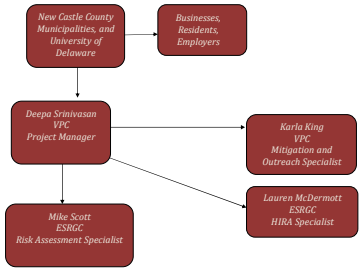
Project Purpose

To update the all-hazards mitigation plan to improve New Castle County's resistance to natural hazards by identifying actions to reduce the impact of various hazards to people and property.

Key Players

- New Castle County Staff – Emergency Management, Planning Department
- Hazard Mitigation Plan Steering Committee
- Municipalities
- University of Delaware
- Consultants
  - Deepa Srinivasan, President, Vision Planning & Consulting
  - Dr. Mike Scott, ESRGC- Salisbury University
- Public
- Delaware Emergency Management Agency (DEMA)
- Federal Emergency Management Agency (FEMA)

Project Organization



Steps in the Planning Process

1. Reconvene 2009 Steering Committee and develop planning process (meetings)
2. Assess hazards, risks, vulnerability
3. Assess municipal capabilities
   - Existing Plans, Programs, Policies
   - Plan Integration – Document Reviews
   - Local Codes and Zoning Ordinances
   - Current and Proposed Projects
4. Develop goals and objectives and mitigation actions
   - Preventative Measures
   - Projects
   - Natural Resource Protection
   - Outreach and Communication
   - Other Mitigation Actions

Steps in the Planning Process (cont'd)

5. Write mitigation plan and prioritize projects (using Evaluation Criteria)
   - Social
   - Technical
   - Administrative
   - Political
   - Legal
   - Economic
   - Environmental
6. Develop implementation plan
   - Priorities for Mitigation Actions
     - Short-, Medium-, or Long-Range
     - Potential Funding Sources
     - Responsible Entities
     - Target Completion Dates
   - Five-Year Plan Maintenance Cycle

Meetings

- 2 Steering Committee Meetings (Dec 2014 and Feb 2015)
  Meeting 1:
  - Planning process, schedule, deliverables, capability assessment
  - Hazard identification, risk assessment, goals and objectives

  Meeting 2:
  - Mitigation actions, prioritization
  - Implementation strategy
- Municipal Workshop (Dec 2014)
  - Planning process, hazard identification, risk assessment
  - Mitigation actions
- UDEL Workshop (Dec 2014)
  - Hazard identification, risk assessment
  - Goals and objectives, mitigation actions
- Public Meeting (Feb 2015)
  - Planning process
  - Present goals for mitigation of various hazards
  - Present options for mitigation actions and projects
  - Review proposed prioritization criteria for mitigation projects

Municipal Participation

Municipal Participation - New Castle County Hazard Mitigation Plan Update

Municipality	Capability Assessment Review	Mitigation Actions Review	Attendance at Municipal Workshop	Draft Plan Review
Arden, Village of				
Ardencroft, Village of				
Ardentown, Village of				
Bellefonte, Town of				
Delaware City, City of	1	1		
Elsmere, Town of	1	No changes		
Middletown, Town of				
New Castle, City of	1	1		
Newark, City of	1	1		
Newport, City of				
Odessa, Town of				
Townsend, Town of				
Wilmington, City of	No changes	1		
University of Delaware				

Municipal Capabilities

Relevant Plans and Programs in Place

Key to Table 5.1

HMP – Hazard Mitigation Plan
EOP – Emergency Operations Plan
CLUP – Comprehensive Land Use Plan
FMP – Floodplain Management Plan / Flood Mitigation Plan
SMP – Stormwater Management Plan
ECP – Emergency Operations Plan
COOP – Continuity of Operations Plan
REP – Radiological Emergency Plan
SARA – SARA Title III Emergency Response Plan
TRANS – Transportation Plan
CAFA – Critical Area Facets Plan (that regulates infrastructure in hazard areas)
RES/PL – Regional Planning
HPP – Historic Preservation Plan
ZO – Zoning Ordinance
SO – Subdivision Ordinance
FDPO – Flood Damage Prevention Ordinance
NFIP – National Flood Insurance Program
CRS – Community Rating System
BC – Building Codes

Municipal Capabilities

Local Comprehensive Plan Updates

Jurisdiction	Plan Status
Arden, Village of	Under County Jurisdiction
Ardencroft, Village of	Under County Jurisdiction
Ardentown, Village of	Under County Jurisdiction
Bellefonte, Town of	Under County Jurisdiction
Delaware City, City of	Certified (2008)
Elsmere, Town of	Completed 2010
Middletown, Town of	Complete (2001)
New Castle, City of	Certified (2009)
Newark, City of	Certified (2013)
Newport, City of	Certified (2003)
Odessa, Town of	Complete (2006)
Townsend, Town of	Certified (2003)
University of Delaware	
Wilmington, City of	

Source: Delaware Office of State Planning Coordination

Capability Assessment – Document Review

State Plans
- 5101 Sediment and Stormwater Regulations – Division of Watershed Stewardship, Department of Natural Resources and environmental Control
- Preparing for Tomorrow's High Tide 2014 Sea Level Rise – 2014 Sea Level Rise Workshop Proceedings and Interim Implementation Plan
- 2013 State of Delaware Hazard Mitigation Plan

County Plans
- Comprehensive Emergency Development Plan, New Castle County, Oct 2013
- New Castle County Continuity of Operations Plan
- 2012 New Castle County Comprehensive Plan
- Unified Development Code - Chapter 40
- New Castle County Capital Program and Budget – 2015 to 2020

Local Plans
- 2004 City of Newark, Delaware Comprehensive Development Plan
- 2012 Town of Middletown Comprehensive Plan
- City of New Castle, 2009 Comprehensive Plan Update
- A City-Wide Plan for Land Use - A Component of the Comprehensive Development Plan for Wilmington, Delaware

Capability Assessment

County Capabilities
- Emergency Management
- General Planning
- Floodplain Management
- Environmental Protection Measures

County and Municipal Self Assessment
- Technical capability
- Fiscal capability
- Administrative capability
- Political capability

Schedule

Next Steps

- University of Delaware Workshop (Dec 2015)
- Steering Committee Meeting #2 (February 2015)
- Public Meeting (February 2015)

Thank You!

Hazard Identification and Vulnerability Assessment of Environmental Hazards in New Castle County, DE

Michael S. Scott, PhD, GISP

Eastern Shore Regional GIS Cooperative
at Salisbury University

Outline

- Definitions
- Review of process
- Hazard Identification
- Vulnerability Assessment
- What happens next?

Definitions

- Asset – an object of value to a community
- Hazard – a threat to an asset
- Risk – probability that a hazard event may occur
- Vulnerability – potential for loss
- Mitigation – reducing the occurrence or the impact of a hazard event

Review of Planning Process

- Goal: Review the 2004 Hazard Mitigation Plan and recommend updates and corrections

- Organize work group and facilitate the process
- Hazard assessment and vulnerability analysis
- Assess local capabilities
- Develop goals and objectives and mitigation actions
- Write mitigation plan and prioritize projects
- Implement the plan

Hazard Identification & Profiling

- Data Sources
  - Federal Emergency Management Agency
  - National Climatic Data Center
  - US Army Corps of Engineers (Philadelphia)
  - US Geological Survey
  - US Department of Agriculture
  - Delaware DataMil

Hazards to be Updated

- Floods
  - Riverine and Coastal
- Coastal Storm Wind
  - Tropical or Nor'easter
- Tornadoes
- Thunderstorm Wind
- Hail
- Winter Storms
- Extreme Heat/Cold
- Earthquakes
- Droughts

Hazards Reviewed, Not Updated

- Low Level of Vulnerability
  - Wildfires
  - Erosion
  - Sinkholes
  - Landslides
  - Volcanoes
  - Tsunamis
- Not Required by FEMA
  - Dam/Levee Failures
  - Weapons of Mass Destruction
  - Pipelines
  - Hazardous materials

Assessment Method

- HAZUS-MH MR3
  - Flood
  - Earthquake
  - Hurricane Wind
- Area Averages
  - Tornado
  - Severe Thunderstorm
  - Hail
  - Winter Storm
  - Extreme Temperatures

Flood: Definition

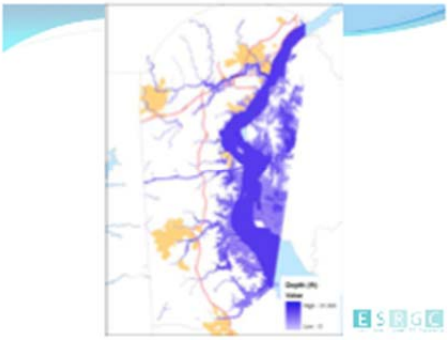
- Most frequent and costly natural hazard in the US
- Flood categories
  - General flood – excessive precipitation over a given river basin for a long period of time
  - Flash flood – excessive precipitation in a small area over a short period time
- Types of general flooding
  - Riverine – function of excessive precipitation within a river watershed
  - Coastal – result of storm surge, wind-driven waves, and heavy rainfall produced by coastal storms
  - Urban flooding – natural flow of water is obstructed by development

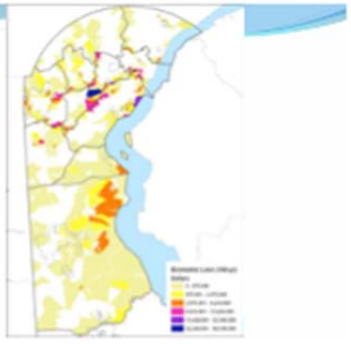
Flood: Definition

- Periodic flooding is a natural and inevitable occurrence
- Recurrence intervals is the average time expected between flood events of a similar magnitude
- Thus, a 100-year floodplain is the area covered by a flood magnitude that should occur, on average, once every hundred years.
  - Also means that flood magnitude has a 1% chance of happening in any given year

Vulnerability to Flooding

- Intersection of expected depth of 100-year flood with the value of the buildings in the floodplain
- HAZUS-MH MR3
  - Hazard loss estimation software
  - Generated flood depth map from predicted elevation of flood water and height of land surface
  - Overlays flood depth with building information
  - Generates maps of potential damage and reports





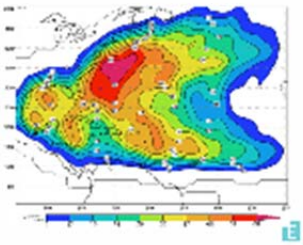
Coastal Storm Wind: Definition

- Hurricanes, tropical storms, & nor'easters
- Severe low-pressure center
- Generate high-level sustained winds, heavy precipitation, tornadoes, storm surge, wind-driven waves, & tidal flooding
- Hurricane season is from June 1 to Nov 30 and peaks in mid-September
- Saffir-Simpson Scale

Saffir-Simpson Scale

Category	Maximum Sustained Wind Speed (MPH)	Minimum Surface Pressure (Millibars)	Storm Surge (Feet)
1	74—95	Greater than 980	3—5
2	96—110	979—965	6—8
3	111—130	964—945	9—12
4	131—155	944—920	13—18
5	155+	Less than 920	19+

Probability of a named storm



Tornado: Definition

- A tornado is a violent windstorm characterized by a twisting, funnel-shaped cloud extending to the ground.
- Tornado wind speeds range from 40 to 300 miles per hour
- Most likely to occur in spring and early summer, or with a landfalling hurricane
- Fujita-Pearson Scale

Fujita-Pearson Scale

F Scale Number	Intensity Phrase	Wind Speed
F0	Gale tornado	40-72 MPH
F1	Moderate tornado	73-112 MPH
F2	Significant tornado	113-157 MPH
F3	Severe tornado	158-206 MPH
F4	Devastating tornado	207-260 MPH
F5	Incredible tornado	261-318 MPH
F6	Inconceivable tornado	319-379 MPH

Tornado Activity in the US

Tornado: Annualized Loss

County	Events	Loss	Years	Annual Events	Annual Loss	Death	Injuries
New Castle County, DE	22	$7,413,000	55	0.40	$134,781.82	0	8
Kent County, DE	18	$4,908,000	45	0.40	$109,066.67	2	54
Cecil County, MD	14	$3,355,000	42	0.33	$79,880.95	0	2
Kent County, MD	4	$503,000	59	0.07	$8,525.42	0	0
Chester County, PA	25	$13,008,000	56	0.45	$232,285.71	2	32
Delaware County, PA	3	$5,275,000	36	0.08	$146,527.78	0	0
Salem County, NJ	4	$750,000	49	0.08	$15,306.12	0	0
Gloucester, NJ	9	$675,000	49	0.18	$13,775.51	0	7
Average	11.4	$4,485,875	48.9	0.249	$92,518.75	0.5	12.9

Severe Thunderstorms: Definition

- More than 10,000 severe thunderstorms each year
- Caused when air masses of varying temperatures meet
- Rapid uplift of warm moist air causes thunder, lightning, hail, strong winds, and heavy precipitations
- Often to referred to as "straight-line winds"
- Lightning – discharge of electrical energy from a thunderstorm
  - Bolt of lightning can reach 50,000°F

Annual Average Number of Thunder Events

Severe Thunderstorms: Annualized Loss

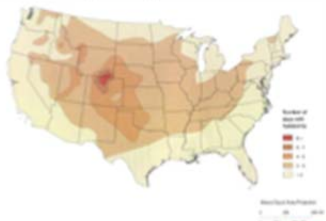
County	Events	Loss	Years	Annual Events	Annual Loss	Deaths	Injuries
New Castle County, DE	245	$11,116,000	49	5.00	$226,857.14	3	4
Kent County, DE	227	$3,850,000	51	4.45	$75,490.20	2	5
Cecil County, MD	189	$6,396,000	40	4.73	$159,900.00	2	5
Kent County, MD	173	$1,325,000	41	4.22	$32,317.07	0	1
Chester County, PA	307	$45,515,000	52	5.90	$875,288.46	18	29
Delaware County, PA	183	$41,354,000	52	3.52	$795,269.23	16	50
Salem County, NJ	144	$19,378,000	34	4.24	$569,941.18	8	36
Gloucester, NJ	180	$17,137,000	52	3.46	$329,557.69	10	38
Average	206.0	$18,258,875	46.4	4.44	$383,077.62	7.4	18.0

Hail: Definition

- Outgrowth of severe thunderstorms
- Rapid warming and cooling of ice crystals within a thunderstorm causes layers of ice to accumulate
- The accumulated ice balls fall as hail
- Size of the hailstone is correlated to the strength of the thunderstorm

ESRGC

Annual Frequency of Hailstorms



ESRGC

Hail: Annualized Loss

County	Events	Loss	Years	Annual Events	Annual Loss	Deaths	Injuries
New Castle County, DE	26	$5,000	39	0.67	$128.21	0	0
Kent County, DE	18	$105,000	41	0.44	$2,560.98	0	0
Cecil County, MD	15	$1,000	42	0.38	$25.00	0	0
Kent County, MD	11	$0	34	0.25	$0.00	0	0
Chester County, PA	48	$0	42	1.10	$0.00	0	0
Delaware County, PA	24	$0	52	0.46	$0.00	0	0
Salem County, NJ	15	$250,000	29	0.52	$8,620.69	0	0
Gloucester, NJ	32	$0	22	1.45	$0.00	0	0
Average	23.5	$45,125	37.4	0.671	$1,426.86	0.0	0.0

ESRGC

Winter Storms: Definition

- Combination hazard that includes snow, sleet, freezing rain, strong winds, and below normal temperatures
- Sleet – raindrops that freeze into ice pellets before reaching the ground
  - Usually accumulates like snow
- Freezing rain – rain that falls onto a surface that is below 32°F, forming a glaze of ice

ESRGC

Winter Storms – Annualized Loss

County	Events	Loss	Years	Annual Events	Annual Loss	Deaths	Injuries
New Castle County, DE	95	$4,500,000	16	5.94	$281,250.00	3	65
Kent County, DE	78	$5,500,000	16	4.875	$343,750.00	1	60
Cecil County, MD	91	$1,454,000	16	5.69	$90,875.00	0	0
Kent County, MD	73	$1,400,000	16	4.56	$87,500.00	0	0
Chester County, PA	130	$8,000,000	14	9.29	$571,428.57	5	65
Delaware County, PA	97	$5,000,000	14	6.93	$357,142.86	6	52
Salem County, NJ	93	$13,850,000	14	6.64	$989,285.71	0	2
Gloucester, NJ	97	$13,850,000	14	6.93	$989,285.71	0	3
Average	94.3	$6,693,750	15.0	6.257	$463,782.48	1.9	30.5

ESRGC

Extreme Temperatures: Definition

- Extreme cold or freeze – weather marked by temperatures below 32°F that are significantly below normal for the area and lasts an extended period of time
- Extreme heat – weather marked by temperatures are more than 10° higher than normal for an area, lasts an extended period of time, and is often accompanied by high humidity
- Both cause the most deaths of any natural hazard in the US

ESRGC

Extreme Temperatures: Annualized Loss

County	Events	Loss	Years	Annual Events	Annual Loss	Deaths	Injuries
New Castle County, DE	79	$0	14	5.64	$0.00	10	50
Kent County, DE	77	$0	14	5.50	$0.00	8	42
Cecil County, MD	80	$30,000	14	5.71	$2,142.86	14	66
Kent County, MD	77	$0	14	5.50	$0.00	3	35
Chester County, PA	96	$0	15	6.40	$0.00	400	321
Delaware County, PA	85	$0	15	5.67	$0.00	396	316
Salem County, NJ	87	$0	15	5.80	$0.00	23	131
Gloucester, NJ	87	$0	15	5.80	$0.00	24	132
Average	83.5	$3,750	14.5	5.753	$267.86	109.7	136.6

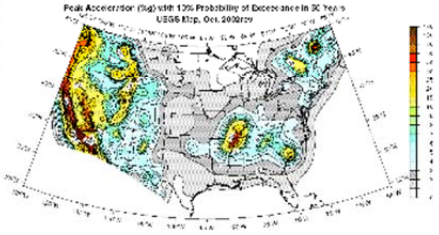
Earthquakes: Definition

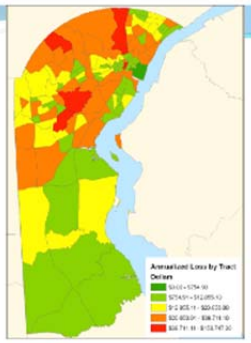
- Motion or trembling of the ground produced by sudden displacement of rock in the Earth's crust
- Caused by crustal strain, volcanism, landslides, and cavern collapse
- Most property damage is caused by failure and collapse of structures. Level of damage depends on amplitude and duration of shaking
- Earthquakes are most common along tectonic plate boundaries and intra-plate weak points
- Richter Scale

Richter Scale

Richter Magnitudes	Earthquake Effects
Less than 3.5	Generally not felt, but recorded.
3.5-5.4	Often felt, but rarely causes damage.
Under 6.0	At most slight damage to well-designed buildings. Can cause major damage to poorly constructed buildings over small regions.
6.1-6.9	Can be destructive in areas up to about 100 kilometers across where people live.
7.0-7.9	Major earthquake. Can cause serious damage over larger areas.
8 or greater	Great earthquake. Can cause serious damage in areas several hundred kilometers across.

Peak Acceleration with 10% probability of exceeding in 50 years





Ranking of Hazards for Vulnerability Assessment

- Not all hazards pose the same level of threat – there is a need focus efforts on those hazards that pose the greatest threat to the City
- Hazards are ranked (low, medium, high) according to:
  - Expected annualized loss
  - Expected frequency
  - Potential for loss of life

Annualized Expected Losses per Hazard

Hazard	Annualized Losses
Flood	$40,784,211
Hurricane Wind	$4,048,518
Earthquake	$2,371,659
Winter Storm	$261,251
Severe Thunderstorm	$226,857
Tornado	$134,781
Lightning	$122,857
Hail	$118
Extreme Temperatures	$0
Drought	Negligible

Overall Risk Ranking

Hazard	Rank
Coastal Flood	1
Riverine Flood	2
Hurricane Wind	3
Earthquake	4
Winter Storm	5
Severe Thunderstorm	6
Extreme Temperatures	7
Tornado	8
Lightning	9
Hail	10
Drought	11

What to do now?

- Please review the maps
- Point out areas that you think are vulnerable to hazards so that we can investigate them
- Ask lots of questions
- Stay involved
- On October 6th, there will be a public meeting regarding mitigation actions
- Contact me with any thoughts or concerns (msscott@salisbury.edu)

APPENDIX B

Steering Committee Meeting February 3, 2015

New Castle County
ALL HAZARDS MITIGATION PLAN UPDATE

Steering Committee Meeting #2
3 February 2015
2-4:30pm
AGENDA

County Mitigation Actions
- Discussion and finalization
- Review/comments by Committee

Municipal Mitigation Actions
- Summary (Deepa Srinivasan)

Prioritization of County Actions
- Review of prioritization criteria
- Project prioritization

Plan Maintenance

Overview of Draft Plan

Wrap-up
- Next steps
- Discussion of Public Meeting
- Questions

Adjournment

Prioritization Criteria

Social Considerations – Life/Safety Impact

- Will the project have minimal/direct/or significant impact on the safety of businesses, residents, and properties?
- Will the proposed action adversely affect one segment of the population?
- Will the project be a proactive measure to reducing flood risk?

Administrative Considerations – Administrative/Technical Assistance

- Is there sufficient staff currently to implement the project?
- Is training required for the staff to implement this project?

Economic Considerations – Project Cost

- What is the approximate cost of the project?

Evaluation Criteria for Project Prioritization

Criteria	Points	High	Points	Medium	Points	Low
Life/ Safety Impact	**10**	Significant impact on public safety for businesses, residents, properties	6	Direct impact on businesses, residents, properties	2	Minimal/negligible impact on businesses, residents, properties
Administrative/ Tech Assistance	**5**	No additional staff or technical support needed to implement action	3	Some administrative and technical support needed to implement action	1	Significant administrative and technical support needed to implement action
Project Cost	**5**	Low cost (<$25,000)	3	Moderate cost ($25,000-$100,000)	1	High cost to implement (>$100,000)

Timelines:

- Short range projects – implemented within first 2 years;
- Medium range projects - 3 to 5 years; and
- Long range projects – over 5 years.

SIGN-IN SHEET
New Castle County/University of Delaware HMP Update
3 February 2015
Steering Committee #2

Name	Department	Title	Phone No.	Email
Silvana V Croope	DelDOT	Resiliency, Climate Change, Sustainability Strategist	(302) 659-4606	Silvana.Croope@state.de.us
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Janice Shute	DNREC	Floodplain & Dam Safety Engineer	302 739 9921	Janice.Shute@state.de.us
Deepak	Univ.	Postdoc		
Michael	ESRGC	Postdoc		

APPENDIX C

University of Delaware Capability Assessment

This Appendix includes the capability assessment of the University to implement hazard mitigation activities. The capability assessment helps identify existing gaps, conflicts and/or shortcomings that may need to be addressed through future mitigation actions and helps to ensure that proposed mitigation actions are practical, while considering the University's capacity to implement these actions. The mitigation capability assessment includes an analysis of the municipalities' capacity from a planning, policy, staffing, and training standpoint.

Campus and Public Safety, Emergency Management

The responsibility of the Emergency Management Section is to ensure that the University is prepared to respond to, recover from, and mitigate against the effects of a wide variety of disasters that could adversely affect the health, safety and/or general welfare of its students, faculty, staff and visitors.

The Emergency Management Section is designed to provide the structure and guidance for the development of a hierarchy of programs for preparation, mitigation, planning and recovery from disasters. The Emergency Operations Plan (EOP) is the official emergency plan for the University. This Plan applies directly to all persons and entities associated with the University, including its students, faculty, staff, visitors, contractors and other support entities. The EOP defines the roles, responsibilities and relationships of external agencies and entities not normally associated with daily University operations but which may hold a role in disaster response. The Plan applies to all campuses, facilities and programs administered by the University regardless of location or purpose. Individual departments are highly encouraged to develop local emergency guidelines which are consistent with the contents of the University plan.

Emergency Management at the University is governed by University Policy 7-6; 7-51; 7-52 and 7-54 and the Robert T. Stafford Act/Disaster Relief and Emergency Assistance Act of 1974 (Public Law 93-288).

The Section has identified the following needs to be addressed:

1. Training: Upon adoption of the 2015 All-Hazards Mitigation Plan, the section would like to provide formal education, outreach and training on the Plan to the campus community.

University of Delaware Mitigation Action 6	Increase the overall preparedness level of the University Community through outreach and training of both the student and the employee population.
Category:	Outreach and Coordination
Hazard(s) Addressed:	All Hazards
Priority (High, Moderate, Low):	High
Estimated Cost:	$10,000
Potential Funding Sources:	University funds
Lead Agency/Department Responsible:	Environmental Health and Safety; Emergency Management
Implementation Schedule:	36 months

Redundant emergency notification systems: The section has identified certain technologies that were previously used for emergency notifications. Some of these systems have become obsolete i.e. classroom projection over-ride system. The section would like to procure equipment that will supplement the UD Alert system and provide redundant communications in the event of a disaster or emergency.

University of Delaware Mitigation Action 13	Procure advanced emergency notification systems to include an exterior Public Address System; an in-classroom emergency notification system in academic buildings and a dedicated non-University redundant website for emergency notifications in the event the www.udel.edu site becomes overwhelmed during a disaster situation.
Category:	Other (Emergency Management)
Hazard(s) Addressed:	All Hazards
Priority (High, Moderate, Low):	High
Estimated Cost:	$500,000
Potential Funding Sources:	University funds
Lead Agency/Department Responsible:	Emergency Management; Information Technology
Implementation Schedule:	48 months

2. Continuity of Operations Plan (COOP): The University has had significant turnover within some administrative units. As turnover is something that can be expected at a major university, the section would like to work with university stakeholders and units (i.e. the Office of Risk Management) in updating the existing COOP.

University of Delaware Mitigation Action 14	Update the University Continuity of Operations Plan.
Category:	Other (Emergency Management)
Hazard(s) Addressed:	All Hazards
Priority (High, Moderate, Low):	High
Estimated Cost:	$200,000
Potential Funding Sources:	University funds
Lead Agency/Department Responsible:	Emergency Management; Office of Risk Management
Implementation Schedule:	48 months

3. Staffing: The section seeks to hire a Federal work study or graduate research student to provide programmatic support; data management; social media management, research and planning and web services to increase awareness, outreach and training.

College of Earth, Ocean, and Environment

The mission of the University of Delaware College of Earth, Ocean, and Environment (CEOE) is to advance understanding of Earth's natural systems and the interactions of humans with the environment through engaged interdisciplinary research, teaching, and outreach. The College houses three very important components of Delaware's emergency management infrastructure--the Delaware Geological Survey (DGS), the Office of the State Climatologist, and the Delaware Environmental Observing System (DEOS). The CEOE also conducts significant research on hazards associated with the environment and is home to the Delaware Sea Grant (DESG) which features Federal and State funded research and community outreach programs devoted to hazard mitigation and resilience.

The Delaware Geological Survey, the Office of the State Climatologist, and the Delaware Environmental Observing System, all work with emergency management officials to decrease vulnerability to the University's top five hazards. The two primary ways DGS, DEOS, and the State Climate Office support the State's emergency operations and reduce potential losses is: 1) continued operation of our real-time monitoring platforms and subsequent derived data products that support emergency management and provide up-to-the-minute monitoring of our local environment; and 2) provide expert advice and support during emergencies caused by natural hazards.

DESG initiates and develops education and outreach programs that effectively communicate hazard-related information, strategies, and best practice guidance to citizens and local governments. Examples include natural disaster-related school programs and activities conducted as part of hazard awareness campaigns such as Hurricane Awareness Week, development of community natural hazard and climate adaptation action plans, and sponsorship of workshops and seminars focused on community resiliency. In addition, the Delaware Sea Grant College Program delivers products and publications related to hazard awareness and adaptation planning, including the *Delaware Homeowners Handbook to Prepare for Natural Hazards*, the *Natural Hazard and*

Climate Change Adaptation Tool Kit for Delaware Communities, and a flood-risk awareness webpage.

Delaware Sea Grant also provides funding for multiple research and monitoring projects that assist in establishing resilient communities that can adapt to the impacts of hazards and climate change. This includes research aimed at 1) improving the forecasting of coastal hazards (e.g. storm flooding and inundation, sea-level rise) for decision makers and the communities they serve; 2) programs that help decision makers adopt policies that will reduce risks, manage catastrophic events, and speed recovery; and 3) developing and/o9r making accessible state/regional databases that support hazard-related planning.

CEOE does have a disaster plan in place, and staffing and funding levels are adequate.

Delaware Geological Survey

The mission of the Delaware Geological Survey (DGS) is to conduct geologic and hydrologic research and exploration, and disseminate the results and information through publication and public service. Our research and service activities are focused on five areas: (1) geology; (2) hydrology; (3) natural hazards; (4) the state geospatial framework; and (5) information dissemination. DGS is involved in identification, investigation, and advisement regarding natural hazards including earthquakes, landslides, droughts, riverine and coastal flooding, erosion, sinkholes, unstable earth and subsidence, hurricanes, and winter storms. We are also involved in public education and outreach related to natural hazards.

The DGS has ongoing responsibilities for understanding natural hazards in Delaware and advising appropriate emergency management agencies on these hazards and related response and mitigation activities.

One of the Survey's primary roles is to provide hydrologic information relevant to Floods, Hurricanes and Coastal Storms, Severe Thunderstorms (flood), and Winter Storms (flood, etc.). DGS provides real-time analysis of hydrologic conditions (stream and river flooding, coastal flooding and erosion, etc.) as well as historical records, information and analysis to organizations such as the Delaware Emergency Management Agency, county emergency management agencies, municipalities, and the public, etc. The DGS, in cooperation with the United States Geologic Survey (USGS), manages and operates a statewide network of stream gages (flood), tide gages (coastal flood), and groundwater monitoring wells (drought). The DGS, in cooperation with the Delaware Environmental Observing System (DEOS), and the USGS has an early warning alert system in operation for stream flow and potential flooding conditions in northern New Castle County. DGS works closely with the Delaware Emergency Management Agency (DEMA), New Castle County, City of Wilmington, and City of Newark through provision of real time analysis and advisement prior to and during flooding events. DGS participates in DEMA's bridge calls and provide real time analyses of hydrologic conditions during major weather events. DGS staff serves in the DEMA Technical Assessment Center during major storm events. The real time stream and tide gage information is available online by those stakeholders involved in preparing for, responding to, and recovering from stream and tidal flooding, and droughts.

DGS's authority is statutory and has several active programs that are relevant to characterizing natural hazards. One such program is the operation and maintenance of the DGS Seismic Network. The DGS does not have statutory authority to protect people and property from losses due to natural, technological, and man-made disasters but provides interpretative reports, information, analysis, and advice to those who have such responsibilities.

DGS, in partnership with DEOS, also maintains the Delaware Coastal Flood Monitoring System (CFMS). CFMS is a web-based display tool and early warning system designed to provide emergency managers, planners, and others the information on the extent, timing, and severity of upcoming coastal flood conditions. It is comprised of hydrologic 48-hour forecasts along the Delaware Bay/River, a back-end system that determines predicted water levels for each coastal community and sends out any necessary alert notices, real-time water level observations from USGS and NOS tides gauges, and a website to display that information.

Current staffing levels are adequate for everyday research and departmental activities; however any additional research assignments would require short-term employees. Additional funding is always being sought to continue to maintain the same level of support for the state, and to accommodate and acquire new and better technologies for real-time earth observations.

Facilities Custodial and University Services

The mission of Facilities Custodial and University Services is to provide support service to the University for facilities maintenance as well as to identify hazards and report them immediately, when observed. To help decrease vulnerability to University hazards, Facilities Custodial and University Services maintains awareness of potential storm events and prepares staff and equipment accordingly. The Department works very closely with Campus & Public Safety in proactively preparing for and responding to the effects of severe weather (i.e. winter storms). Grounds Services is responsible for all grounds maintenance functions as they relate to the safety and appearance of the campus. The Department also serves as the central point for snow removal, solid waste and recycling services and pavement sweeping services.

The Grounds Unit maintains all university grounds, gardens and the athletic complex. Staff includes heavy equipment operators, refuse collectors, grounds equipment technicians, caretakers, grounds workers, arborists, horticulturists, grounds technicians, drivers and their supervisory staff who are dedicated to providing exceptional service to the University community. In providing this exceptional service they contribute to the greater mission of the University in providing quality educational, social, and athletic opportunities for the University community.

Custodial Services provides the University with quality custodial maintenance, ensuring a safe and healthy environment in all campus facilities and using products that meet Green Seal standards. Employing appropriate proper protective equipment, the department aids in mitigating future hazards.

The Department proactively plans and participates in functional and table-top exercises to assure a high-level of preparedness for all-hazards that could confront the University. In October, 2013, the Department's leadership participated in a University-wide Ebola preparedness tabletop exercise where best practices and sound procedures were reviewed. In 2013, a new state-of-the-art radio system was implemented further improving communications amongst the Grounds department. This system is linked to the UDPD 911 Center enhancing mission critical response and mitigation by key personnel.

It is important that existing staffing and funding levels be maintained in order to support mitigation efforts. These levels must be reviewed and adjusted accordingly as the campus buildings/systems continue to expand.

Facilities Maintenance and Operations

The mission of Facilities - Maintenance & Operations is to perform all of the corrective and preventive maintenance to ensure that buildings/systems are functional prior to any hazard event. Responsibilities include inspection of rain leaders, storm inlets and building sump pumps. This Department also assists in the development of design standards, which facilitates the mitigation of the effects from disasters. A Preventative Maintenance (PM) program is in place, which is designed to reduce potential losses. All PM's are performed via a set schedule, and implemented through a Computerized Maintenance Management System (CMMS). Existing staffing and funding levels are required to be maintained in order to support mitigation efforts. These levels must be reviewed and adjusted accordingly as the campus buildings/systems continue to expand.

Facilities Planning and Construction

The mission of Facilities Planning and Construction Office is to design, construct, and maintain safe and highly functional buildings and grounds for the University of Delaware students, faculty, staff, and guests. The Facilities Planning & Construction Office uses the applicable codes and standards enforced by the State of Delaware Department of Natural Resources and Environmental Control, and the City of Newark Building codes for all construction projects on campus as it relates to building, life safety, and environmental requirements. The responsibilities of the Department's mission impacts the overall costs of the project especially as it relates to maintaining storm water and erosion prevention during construction.

In the event of a predicted storm or high wind event, the Department ensures that contractors are securing the construction site to minimize damage from winds, snow or flooding. Securing scaffolding and construction material that may become windborne and clearing grates to ensure adequate drainage are a few examples their efforts. Hot work permitting and fire watch is required as part of the construction safety procedures to decrease vulnerability from fire.

Facilities ensure contractors follow the Federal, state, local, and University safety requirements and request assistance from the UD Environmental Health and Safety office when necessary. Furthermore inspectors are hired to conduct site inspections on active construction sites to ensure sediment and storm water requirements are being adhered to, by contractors.

Currently the Facilities Planning and Construction Office does have written policies about safety and environmental requirements; however, they are in the process of updating policies and procedures to include information on safety and environmental requirements. The department may not have adequate funds to address existing problems that could mitigate hazards and thus may be put on deferred maintenance to be addressed at a later date. The Facilities Planning and Construction Office relies on the Maintenance and Caps Operation and Environmental Health and Safety staff to provide existing data or information to decrease hazard vulnerability.

Facilities/Science, Technology, and Advanced Research (STAR) Campus

The University of Delaware's Science, Technology and Advanced Research (STAR) Campus is a 272-acre property currently being developed as a space that combines business, research, education and more. A former auto assembly plant, STAR Campus is currently home to UD's Health Sciences Complex, California-based Bloom Energy's East Coast fuel cell manufacturing center and UD's eV2g project.

Future development will establish it as a center of innovation, focused on leading research in areas such as health science, cyber security and alternative energy. Through partnerships with private businesses and government agencies, UD will provide educational and professional opportunities for students while igniting job and economic growth within the state.

The following needs have been identified to assist with future efforts focused upon all-hazards preparation, response, mitigation and recovery:

- Expanded training in ICS and NIMS methodologies (both functional and table-top exercises related to disaster management are suggested

University of Delaware Mitigation Action 6	Increase the overall preparedness level of the University Community through outreach and training of both the student and the employee population.
Category:	Outreach and Coordination
Hazard(s) Addressed:	All hazards
Priority (High, Moderate, Low):	Medium
Estimated Cost:	$25,000
Potential Funding Sources:	University General Fund
Lead Agency/Department Responsible:	Emergency Management, Campus and Public Safety, Environmental Health and Safety, Communications and Public Affairs, Student Life
Implementation Schedule:	12 months

A comprehensive plan to ensure business continuity of site operations - Work with the Office of Risk Management to update the University Continuity of Operations Plan.

University of Delaware Mitigation Action 14	Update the University Continuity of Operations Plan.
Category:	Other (Emergency Management)
Hazard(s) Addressed:	All Hazards
Priority (High, Moderate, Low):	High
Estimated Cost:	$200,000
Potential Funding Sources:	University funds
Lead Agency/Department Responsible:	Emergency Management; Office of Risk Management
Implementation Schedule:	48 months

Finance and Risk Management

The mission of the Office of Risk Management, within the Office of the Vice President of Finance, is to manage the protection of the University's human, physical, natural, and financial resources to minimize property and casualty losses and legal liabilities. The Office administers the University's risk management program by providing central coordination of the identification, evaluation, control, and financing of the risks faced by the University.

Through its risk control responsibilities, the Office of Risk Management provides services to reduce the frequency and severity of losses. In addition, through its risk financing responsibilities, it utilizes insurance and the transfer of risk to protect the University from the consequences of a financial loss.

Utilizing the expertise of the University's commercial property insurance engineers, Risk Management reviews building plans for new campus construction and major building renovations. The focus of these reviews is to prevent losses arising out of fire and high winds. Risk Management also conducts annual inspections of all major University facilities, and monthly inspections of new construction projects, with the goal to minimize building losses arising out of various perils including flood, high winds, and fire.

At this time, existing staffing and funding levels are adequate for the current level of hazard mitigation actions.

Human Resources

Human Resources (Includes: Payroll, Records Management and HRIS, Equity & Inclusion/Title IX, Employee Education and Well-being, Employee and Labor Relations, Compensation and Benefits, and Recruitment.) The mission of this unit primarily revolves around employees, their wellbeing, payment, and inclusion in the University community.

If there were a technological disaster it would definitely hinder the departments, but being a large user of technology has allowed the departments to be part of the technology disaster planning to help mitigate the effects of disaster. Human Resources plays a role in creating the University policies around how employees are impacted by these events and would be called upon after the fact to help employees and UD.

The Units authorities include the functioning of employees at the University and to the extent this would impact employees all of the personnel policies and procedures would be our authority. There are many statutes and UD policies that govern the operation of the units in Human Resources. These items cover much of what the unit does, but they believe there may be some room to better define polices and to create some policies that do not exist. The units currently have a disaster recovery plan that would help them recover from most of the disasters listed.

The biggest concern for Human Resources is the loss of technological records. As long as the physical records can be accessed, systems can continue, although payroll, benefits and other processes might take longer to complete.

The units do have procedures designed to reduce losses and have a disaster recovery plan. When considering Staffing levels, for minimal disasters, staffing could be reassigned while normal functions of the unit were put on hold; however for prolonged disasters, staffing would become an issue. Current funding is insufficient to cover disaster situations.

Information Technology

The mission of Information Technologies (IT) includes maintaining the communication infrastructure (Internet, telephone, cable television, radio, wired and wireless networking) as well as the emergency notification infrastructure (emails, text, voice mail, and in-class video), all 1-800 call center on-demand issues, maintaining network and data center redundancy and maintaining the 911 location data (ALI) for buildings and dormitories. The responsibilities of IT act to facilitate the mitigation of the effects of a disaster. Communications are essential in managing a response to a disaster. The UD community and the public need information to be able to communicate with others.

IT has fire suppression to mitigate fire issues in the main data center on Chapel St. IT has implemented a disaster recovery site to allow for switch over to an alternate computing site in the event the main site becomes unusable. The communication infrastructure support Internet access, digital telephone and other forms of communication are highly redundant with three diversely connected Internet Service Providers (ISPs). IT has campus-wide responsibility for administrative computing functions and a robust and diverse communications infrastructure. IT does not have direct authority over non-IT managed computing infrastructures found in many of the individual colleges.

The main data center has an Uninterruptible Power Supply (UPS) system that includes battery backup as a transitional power source and a diesel generator for extended outages to support IT operations. The capacity of the generator is two megawatts. The generator fuel tank capacity is 6,000 gallons. Generally between 3-4,000 gallons is kept in the tank. At current power usage levels, that amount of fuel will provide more than 24 hours of runtime. IT has contracted for diesel fuel delivery as necessary (not less than once per day) should the generator be operated for an extended period of time.

IT also has the ability to respond to emergencies on an as needed or ad-hoc basis as was illustrated during the H1N1 crisis in 2010. IT helped to establish a temporary infirmary in the Bob Carpenter Center for the H1N1 crisis. Additionally, IT has a disaster recovery site to ensure

continued operations of computing functions. IT is currently engaged in a project to develop procedures and documentation for the recovery staff of the disaster recovery site in an emergency. Projected completion is the end of 2015.

Office of Communications and Public Affairs

The University of Delaware Communications and Public Affairs Office is dedicated to developing strategies that will continue to elevate recognition of the University of Delaware as a premier research institution. Its aim is to help attract the brightest students and most distinguished faculty, and highlight that talent for potential donors and supporters.

The Office is led by the Vice President of Communications and Public Affairs who is the authorized Public Information Officer (PIO) for the University. All public information is coordinated and disseminated by this office with assistance from other University departments and personnel.

During critical incidents, the Communications and Public Affairs will work with each organizational unit to gather accurate information regarding the situation and details of the University response. The University PIO, working with other University Critical Incident Management Team (CIMT) members and City and County PIOs, as appropriate, will provide notification to faculty, staff and students, and the general public on progress toward recovery. The PIO will work with the CIMT at the Emergency Operations Center and provide timely briefings at a pre-designated media briefing location.

The office will participate in joint trainings and exercises to ensure that key staff members are following best practices and the procedures of the university. Should additional technological equipment related to the crisis management function and the emergency notification systems be acquired, the office would like to ensure that key staff members are trained in the use of these systems. The Office is also involved in a major overhaul of the university's main web pages and the need for emergency communications will be a key component of that effort.

Office of Residence Life

The Residence Life and Housing supports the missions of the University of Delaware and the Division of Student Life by partnering with our students to develop vibrant inclusive communities where students engage in living-learning environments, freely exchange ideas, and cultivate skills and knowledge to become citizens and leaders in our increasingly global society.

The Office serves to facilitate the response in terms of communication to students. Because a large percentage of UD students live in residence halls, the department has the ability and an obligation to communicate to them quickly should a disaster occur. Residence Life and Housing also provides support to those units on campus charged specifically with disaster management.

In conjunction with Facilities, Public Safety and Environmental Health and Safety, residence life and housing staff works to communicate fire safety expectations to students living in the residence halls. Staff members are trained on alarm response protocol, fire prevention strategies, and are expected to strictly enforce those policies in place to lessen fire risks in the buildings. Staff also works to educate students throughout the year about fire safety risks through educational programs and conversations; and by conducting safety room inspections several times a year.

In addition to enforcing those policies articulated in the Code of Conduct and referring students to the Office of Student Conduct as necessary, Residence Life and Housing also administers the Residence Hall Regulation System. Existing staffing and funding levels are adequate for hazard mitigation efforts.

Residence Life and Housing leadership identified the need to enhance communication during a disaster and request that their office be provided with Radiophones that work through radio communications. Since this office is central in communicating emergency plans to staff and students, in the event of loss of electricity, they will not be able to communicate through the provided VOIP service. Also, if cell towers are down or overloaded, this leaves no realistic way to communicate urgent emergency instructions or updates.

Department of Public Safety, University Police

The University of Delaware, Department of Public Safety works with members of the University community and other law enforcement agencies in providing a collaborative approach to crime prevention and the safeguarding of life and property.

The Department of Public Safety works to create an environment where people can feel safe to learn, work, live and visit and is committed to providing quality service and protection to the entire University community. While reported crime is relatively low at the University of Delaware, it is still important for the community to remember that the University is not immune from criminal activity. In partnership with the community and other local police agencies, UD's Department of Public Safety works to prevent crime and to prepare, respond and proactively mitigate both human and natural hazards that affect students, faculty, staff, and visitors. During a disaster, the Department works in partnership with the regional first responder community and implements the University Critical Incident Management Plan.

The Department has identified the following needs to assist with all-hazards preparation, response, mitigation and recovery:

- Expanded training on ICS and NIMS methodologies

University of Delaware Mitigation Action 6	Increase the overall preparedness level of the University Community through outreach and training of both the student and the employee population.
Category:	Outreach and Coordination
Hazard(s) Addressed:	All hazards
Priority (High, Moderate, Low):	Medium
Estimated Cost:	$25,000
Potential Funding Sources:	University General Fund
Lead Agency/Department Responsible:	Emergency Management, Campus and Public Safety, Environmental Health and Safety, Communications and Public Affairs, Student Life
Implementation Schedule:	12 months

- Expanded training on the EOC and 911 Center fold-down procedures in collaboration with NPD

- Study and potential procurement of a redundant phone system independent of the existing VOIP phone system. The system would be effective in the case of a catastrophic university-wide network/power outage

- Collaborate with Aetna Hose, Hook & Ladder & EHS on a real-time hazardous materials database. The database would be a secure central repository encompassing the transportation sector that utilizes the major roadways and railways in/around the City of Newark.

Office of the Provost

As the University's chief academic office, the Provost is responsible for administration of all programs of instruction, research and service, and for facilitating the success of the University's faculty and students.

With respect to hazard mitigation and safety, the Office of the Provost coordinates with the Office of the President, the Office of Campus and Public Safety, the Communications and Public Affairs office, the Office of Student Life, as well as university-wide academic and administrative units to disseminate information and promote activities that will help the University prepare for, respond to and recover from, emergency hazards and disasters.

The Provost serves on the Critical Incident Management Team (CIMT), which may be convened as a decision-making body for the University on issues related to an emergency or disaster. This Team is comprised of an Operations Group and a Policy Group. The Provost serves on the Policy Group with the University President, Executive Vice President and others. The priorities of the Policy Group include defining crisis policy; approving overall priorities and strategies; disseminating timely, accurate and appropriate information to the University faculty, staff and students, parents, media and other concerned community partners; determining class or campus closure and resumption; and planning long-term recovery actions.

As the University completes the 2015 All-Hazards Mitigation Plan, the Office of the Provost recommends a primary goal of ensuring the University's mission of teaching, research and public service is maintained in the event of a natural or man-made disaster. Additionally, the protection of university assets and critical infrastructure including utilities infrastructure, communication systems, information technology systems and research facilities is critically important.

In September, 2012, the Office procured new safety technology by installing two duress alarms, which are maintained in the Office for the personal protection of employees. The Office completed a needs assessment of security and technology needs within Hullihen Hall. This technology provides employees with a secondary means of contacting University 911 in the event of an emergency.

Office of Student Conduct

The Mission of the Office of Student Conduct (Student Conduct) is to promote a campus environment that supports the overall educational mission of the University; to protect the University community from disruption and harm; to encourage appropriate standards of individual and group behavior; and to foster ethical standards and engaged citizens. The Office fulfills this mission by providing programs and services that develop, disseminate, interpret and enforce campus regulations; teach students about appropriate behavior and community membership; provide programs and activities that foster student's intellectual, ethical and cultural development; intervene effectively when behavior violates the Code of Conduct; and offer educational and

leadership opportunities for students who participate in the operation of the Student Conduct System.

Student Conduct works very closely in partnership with Campus and Public Safety, to achieve the overall goal of decreasing student vulnerability to any natural or human-made hazards. An example of hazard mitigation is the Office's proactive efforts to ensure system redundancy by maintaining database backup on an off-campus server. In September, 2012, the Office procured new safety technology by installing nine duress alarms, which are maintained throughout the Office for the personal protection of employees, especially when hearings are being conducted. This technology provides employees with a secondary means of contacting University 911 in the event of an emergency.

Student Health Services

The mission of the University of Delaware's Student Health Service (SHS) is to provide students with quality primary health care and education about healthy lifestyles. SHS is a nationally accredited by the Accreditation Association for Ambulatory Health Care (AAAHC) every 3 years. The in-house clinical laboratory is also nationally accredited every 3 years by the Commission on Office Laboratory Accreditation (COLA). Both national accrediting agencies have Quality Improvement (QI) standards that measure patient care but also the infrastructure of the administration (Governance) and the physical plant. Health education is provided to individual patients and to the whole campus through the website as well as a Healthy HENS program encouraging healthy exercise, nutrition, and sleep. Importantly, because it can affect the whole campus, we emphasize infection control (hand washing, cough etiquette, etc.) in all encounters. Responsibilities stated above to help to facilitate the mitigation of disasters.

Health services provide medical support to the victims of UD's top five hazards. Student Health Service plays a significant role in decreasing vulnerability to "infectious Processes" that affect the campus. There are immunization requirements for all students for many communicable diseases (Measles, Mumps, and Rubella) and recommendations for vaccination for Tetanus, Diphtheria, Pertussis, Varicella (Chickenpox), Hepatitis A and B, Meningococcal Meningitis, and screening requirements for Tuberculosis. The Department is given the authority to address campus health concerns and also offers education classes designed to reduce potential hazards. The Department maintains internal written policies and procedures that focus on reducing loss during a disaster.

SHS has adequate staffing to meet "immediate" short-term mitigation activities. Providing ongoing cost projections would be difficult without a "delineation" of the specific hazard and total staff/time needed to address it. Additional funding support is requested of the UD administration for additional staffing/time coverage.

SHS has experienced some flooding issues during times of heavy rain. This tends to cause collection of water in the SHS basement.

SHS also has limited perimeter security from an access control perspective and currently has an "open" facility with multiple unsecured entrances. In the event of an active shooter, there is limited capability to be able to lock down the building. The installation of access control devices would allow for better perimeter security.

In 2012, a total of seven duress alarms were installed in certain areas within Laurel Hall. These are primarily assigned to the Center for Counseling and Student Development. This technology provides employees with a secondary means of contacting University 911 in the event of an emergency. SHS and Campus and Public Safety also collaborated in adding approximately 12 new I.P. surveillance cameras at Laurel Hall. These cameras provide additional perimeter and premise security and are monitored 24/7 by the UDPD 911 Cente

APPENDIX D

University of Delaware Meeting January 9, 2015

New Castle County/University of Delaware
ALL HAZARDS MITIGATION PLAN UPDATE

General Services Building, Room 130
9 January 2015

AGENDA

Committee Meeting
1pm-2pm

Introductions – Mark Seifert, Emergency Management Coordinator, University of Delaware

- Steering Committee Members
- Consultants
    - Deepa Srinivasan, President, Vision Planning and Consulting, LLC
    - Mike Scott, ESRGC, Salisbury University

PowerPoint Presentation – Deepa Srinivasan

- Overview of the Hazard Mitigation Planning Process
- Schedule and Deliverables

Discussion of Hazards, Risks, and Vulnerability – Mike Scott

Discussion of 2011 Plan Goals and Objectives

Discussion of 2011 Mitigation Actions

Wrap-up

- Questions and Answers

SIGN-IN SHEET
New Castle County/University of Delaware HMP Update
9 January 2015

Name	Department	Title	Phone No.	Email
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APPENDIX E

Municipal Workshop December 3, 2014

SIGN-IN SHEET
New Castle County HMP Update
3 December 2014

Name	Agency/ Municipality	Title	Phone No.	Email	Address
George Giles	Wilmington				
TJ Ferris	NCC OEM		395 2700	TJFerris@nccde.org	
Dave [illegible]	NCC OEM				
Silvana	Del DOT		302659 4606	Silvana.croope@state.de	
Mike [illegible]	E&RCC			[illegible]	
[illegible]	VPC				

* Presentations listed in Appendix A were presented at the Municipal Workshop

APPENDIX F

Public Meeting February 3, 2015

The ***DEPARTMENT OF LAND USE AND PLANNING BOARD*** of New Castle County will hold a public hearing on **Tuesday, February 3, 2015,** in the Multi-Purpose Room of the Gilliam Building, 67 Reads Way, New Castle, DE, beginning at 7 p.m. to consider the following plan.

2015 New Castle County Multi-Jurisdictional All Hazard Mitigation Plan –
Description – 44 CFR Section 201 sets the FEMA requirement for local governments to develop and implement an All Hazard Mitigation Plan. The Plan identifies the jurisdictional hazards, the potential for economic loss from those hazards, and incorporates any mitigation strategies and actions developed which would either reduce or eliminate damage from that risk. A presentation on the updated and recently developed Mitigation Actions identified by NCC and the incorporated municipalities will be conducted, along with an opportunity for public input and comment on the Plan. The public, elected officials, neighboring jurisdictions, and community leaders are encouraged to attend.

Considerations of rezonings may include zones other than those specified in the ordinances, and considerations for all other applications, including text amendments, may include changes other than those specified or requested in the proposals. Time limitations will be imposed on speakers. Information on all applications is available for public review in the **Land Use Department, New Castle County Government Center, 87 Reads Way, Corporate Commons, New Castle, DE, from 8:00 A.M. to 4:00 P.M., Monday through Friday.**

Individuals needing reasonable accommodations according to the *Americans with Disabilities Act,* call 395-5400 (TT/TRY/T.D.: D.S., 1-800-232-5460) at least five business days before the meeting/hearing.

Richard E. Killingsworth, Chairman
Planning Board
Manager

Eileen P. Fogarty
General

DELAWAREBUSINESS

USA TODAY MONEY DOW LIKELY TO GIVE SOME WHIPLASH PAGE 5B

New Castle County Department of Land Use - WWW.NCCDELU.ORG

Below you will find information on matters being considered by the New Castle County Land Use Department and its public boards. Plans are available for public review at the New Castle County Government Center; 87 Read's Way, New Castle, Monday - Friday from 8:00 a.m. to 4:00 p.m. Call 395-5400 or Email: landuse@nccde.org. Eileen P. Fogarty, General Manager

NEW PLANS RECEIVED

Council District 6

*North side of Reihm Drive, 219 feet west of Summit Bridge Road. Resubdivision Plan to reconfigure lot lines on parcels 14-006.43-019 and 14-00.43-020. Deep Branch Farm. NC21 Zoning. (App. 2015-0033-S)

Council District 8

*Southeasterly corner of Naamans and Peachtree Road intersection. Minor Land Development Plan for the redevelopment of parcel with a 4,335 s.f. commercial building and site improvements. 698 Naamans Road. CR. Zoning. (App. 2015-0007-S)

Council District 12

*Southeast corner of Wrangle Hill Road and Red Lion Road. Minor Rezoning Plan to construct a 4,685 s.f. convenience store with gas pumps and a 4,800 s.f. bank with drive thru, including associated parking and driveway facilities. 3601 Wrangle Hill Road. NC21 Zoning (App. 2015-0017-S)

BOARD OF ADJUSTMENT PUBLIC HEARING
THURSDAY, JANUARY 22, 2015 at 6:00 P.M.
Land Use Conference Room
87 Reads Way, New Castle

Council District 5

*10 Newland Court, Newark 19713. Area variances to maintain an above-ground pool 2.75 feet from the rear property line (6-foot pool setback) and to maintain a shed 1 foot from the rear property line (3-foot accessory structure setback). Lincoln Isaac. NC 6.5 Zoning. CD 5. (App. 2014-0773-A) TP 09-033.10-128.

Council District 6

*4028 DuPont Parkway, Townsend 19734. Area variances to facilitate the resubdivision of three parcels into two parcels: 1. to provide an .92-acre lot area for the Residual Lot (5-acre minimum lot area exclusive of protected resources); 2. to maintain an above-ground pool with decking 5 feet from the southerly side lot line (6-foot pool setback); and 3. to provide a 50-foot lot width for the Residual Parcel (300-foot minimum lot width). Pepper/Biddle/Minnich Engineering. SR Zoning. CD 6. (App. 2014-0776-A) TP 14-016.00-266.

Council District 7

*39 Roxeter Road, New Castle 19720. Area variances to maintain a dwelling with an attached garage 1.5 feet from the southerly side lot line (6-foot side year setback), and a covered porch 20 feet from the Roxeter Road right-of-way (25-foot street yard setback). Carlos Velez & Jennifer Santiago/Ward & Taylor. NC 6.5 Zoning. CD 7. (App. 2014-0785-A) TP 10-020.10-282.

*164 Cross Avenue, New Castle 19720. Area variances to maintain a front addition 15 feet from the Cross Avenue right-of-way (25-foot street yard setback) and to maintain a detached carport 0 feet from the northerly side lot line (6-foot side yard setback). Penn March Properties LLC. NC 6.5 Zoning. CD 7. (App. 2014-0786-A) TP 10-015.10-224.

*713 E. Basin Road (William Penn High School), New Castle 19720. Area variances to maintain existing and to construct new school signage: 1. to construct a 110 square foot ground sign, including a 40 square foot Electronic Variable Message Sign/EVMS, (20 square foot maximum sign area); 2. to maintain an 82 square foot wall sign; 3. to maintain a 10 square foot wall sign; 4. to maintain a 10 square foot wall sign; 5. to maintain a 6 square foot monument sign; and 6. to maintain a 6 square foot monument sign (20 square foot maximum sign area and a 20-foot sign setback). Colonial School District. S Zoning. CD 7. (App. 2014-0777-A) TP 10-025.00-002.

Council District 8

*506 Ivydale Road, Wilmington 19803. Area variance to enclose an existing carport 3.5 feet from the northwesterly side lot line (8-foot side yard setback). Facciolo, Amanda. NC 10 Zoning. CD 8 (App. 2014-0784-A) TP 06-104.00-133.

Individuals needing reasonable accommodations according to the Americans with Disabilities Act, please call 395-5400 (DRS, 1-800-232-5460) at least (5) business days before the meeting/hearing. Information is available in the Department of Land Use, New Castle County Government Center, 87 Reads Way, Corporate Commons, New Castle, DE from 8:00 a.m. to 4:00 p.m., or call 395-5400.

HISTORIC REVIEW BOARD PUBLIC HEARING REVISED
TUESDAY, JANUARY 20, 2015 at 5:00 P.M.
Land Use Conference Room
87 Reads Way, New Castle

Council District 11

*Northeast corner US 40 and SR 896. Exploratory Land Development Plan for Glasgow Park Farmer's Market proposes to construct a bathroom facility, maintenance building, and parking areas, and to demolish several buildings for the purpose of adapting the historic Hermitage farmstead for use as a farmers market. S zoning district. App. 2014-0741-S.

THIS APPLICATION WILL NOT BE HEARD. CONTINUED TO FUTURE HEARING: *Southwest corner Paxon Lane and Glasgow Avenue, Demolition Permit Application for Cann Farmhouse. BP zoning district. App. 2014-01833.

The next business meeting is tentatively scheduled for Tuesday, February 3, 2015.

Time limitations will be imposed on speakers. Information on all applications is available for public review in the Department of Land Use, New Castle County Government Center, 87 Reads Way, Corporate Commons, New Castle, DE, from 8:00 A.M. to 4:00 P.M., Monday through Friday.

Individuals needing reasonable accommodations according to the Americans with Disabilities Act, call 395-5400 (TT/TRY/T.D.: D.S., 1-800-232-5460) at least five business days before the meeting/hearing.

PLANNING BOARD PUBLIC HEARING
TUESDAY, FEBRUARY 3, 2015 at 7:00 P.M.
Multi-Purpose Room, Gilliam Bldg.
67 Reads Way, New Castle

The following presentation will be heard:

2015 New Castle County Multi-Jurisdictional All Hazard Mitigation Plan –
Description – 44 CFR Section 201 sets the FEMA requirement for local governments to develop and implement an All Hazard Mitigation Plan. The Plan identifies the jurisdictional hazards, the potential for economic loss from those hazards, and incorporates any mitigation strategies and actions developed which would either reduce or eliminate damage from that risk. A presentation on the updated and recently developed Mitigation Actions identified by NCC and the incorporated municipalities will be conducted, along with an opportunity for public input and comment on the Plan. The public, elected officials, neighboring jurisdictions, and community leaders are encouraged to attend.

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Information on all applications is available for public review in the Land Use Department, New Castle County Government Center, 87 Reads Way, Corporate Commons, New Castle, DE, from 8:00 A.M. to 4:00 P.M., Monday through Friday.

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SIGN-IN SHEET
New Castle County/University of Delaware HMP Update
3 February 2015
Public Meeting

Name	Department	Title	Phone No.	Email
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Valerie Castorano	NCC Land Use		395-5440	vcastorano@nccde.org
MONICA HORTON	NCC Dept of Law	ACA I	395-5147	mahorton@nccde.org
Sandra Anderson	NCC Plan. Bd.		302-652-1639	anderson904@comcast.net
R. McDowell	NCC PL. B.D.		302-373-[illegible]	Rob.McDowell@verizon.net
Robert Snowden	" "		302-383-[illegible]	[illegible]
DAVID SHEPPARD	" "		302 893-1580	dsheppard@desu.edu
Rich Killingsworth	NCC Planning Board	Chairperson	302-376-7070	Rich_Killingsworth@Hotmail.com
Tess Abegglen	American Red Cross Disaster Services Dept	Disaster Services Specialist	1-800-777-6650	tess.abegglen@redcross.org
Marianne Cinaglia	Red Clay Creek Watershed Assoc. of Deaths(?)		302-475-8037	mcinaglia@aol.com
MARK SEIFERT	UNIV. OF DELAWARE	EMERGENCY MGR	302 831-7205	seifert@udel.edu
Jeff Peters	Pike Creek Civic League		302-3664	jpeters[illegible]@comcast.net
Ruth Visvardis	NCC Planning Bd		302 836-8001	visvarr@msn.com
Louise L. Prine(?)	NCC Planning Board		302-229-0869	[illegible]
Bill McGlinchey	NCC Planning Board		302 778 5440	billmcglinchey@comcast.net
Adam Wilson	NCC Planning Board		302-540-4664	arwil10@comcast.net
Mike Sell	EBLGC	Director		