2011 Maryland State Hazard Mitigation Plan Update

Maryland Emergency Management Agency

August 2011

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2011 Maryland State Hazard Mitigation Plan Update

Maryland Emergency Management Agency

August 26, 2011

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August 25, 2011

MaryAnn Tierney
Regional Administrator
FEMA Region III
One Independence Mall, Sixth Floor
615 Chestnut Street
Philadelphia, PA 19106-4404

Dear Ms. Tierney:

In accordance with the authority vested in me by the *Annotated Code of Maryland*, Public Safety, Article 14 Sections 106(b)(2) and (b)(4), I hereby approve and declare adopted the *2011 Maryland State Hazard Mitigation Plan Update*. This plan update shall be effective as of August 26, 2011.

The *2011 Maryland State Hazard Mitigation Plan Update* has been developed in conformity with Section 322 of the Robert T. Stafford Disaster Relief and Emergency Assistance Act and 44 CFR, Part §201 Mitigation Planning.

The efforts of many State and local departments and agencies were coordinated for the development and update of this plan. In the interest of all citizens and businesses in Maryland, let this *2011 Maryland State Hazard Mitigation Plan Update* continue to serve as an impetus for improved mitigation and recovery from disasters in the State of Maryland.

Sincerely,

Governor

STATE OF MARYLAND
MILITARY DEPARTMENT

MARTIN O'MALLEY
GOVERNOR

ANTHONY G. BROWN
LIEUTENANT GOVERNOR

JAMES A. ADKINS
MAJOR GENERAL
THE ADJUTANT GENERAL

RICHARD MUTH
EXECUTIVE DIRECTOR

MARYLAND EMERGENCY MANAGEMENT AGENCY
State Emergency Operations Center, Camp Fretterd Military Reservation
5401 Rue Saint Lo Drive, Reisterstown, MD 21136
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August 26, 2011

Dear Friends,

On behalf of the Maryland Emergency Management Agency it is my pleasure to present the *2011 Maryland State Hazard Mitigation Plan Update*. The enclosed Plan Update has been developed in conformity with Section 322 of the Robert T. Stafford Disaster Relief and Emergency Assistance Act and 44 CFR, Part §201 Mitigation Planning.

The purpose of this plan update is to assist the State and its local governments in reducing the human and economic costs of disasters. This plan update will continue to provide a framework for linking pre and post-disaster mitigation planning efforts with mitigation projects and initiatives to ensure an integrated, comprehensive approach to disaster loss reduction throughout the State.

I would like to sincerely thank those agency members that serve on the Mitigation Advisory Committee and for those individuals from both local and state agencies that participated in the coordination and development of the plan update. Thank you for your consistent support of Maryland's Hazard Mitigation program.

Sincerely,

Richard Muth,
Executive Director, Maryland Emergency Management Agency

Executive Summary

Purpose of the Plan

The 2011 Maryland State Hazard Mitigation Plan Update serves as guidance for hazard mitigation for the State of Maryland. Its vision is supported by a central goal, objectives and strategies for Maryland state government, local governments and organizations that will reduce or prevent injury from natural hazards to people, property, infrastructure and critical state facilities. This plan complements the Maryland Core Plan for Emergency Operations – August 26, 2009.

The updated plan features a comprehensive natural hazard identification, risk assessment and vulnerability analysis, which ranks hazard risks across the state's counties. The risk analysis uses a comparative formula that includes total population, population density, damages, injury and deaths from past hazard events, geographic extent of the hazard, and each hazard's ranking in local hazard mitigation plans. The plan also includes mitigation strategies to address the identified vulnerabilities, a thorough capability assessment, and concludes with plan implementation and maintenance procedures. The plan has been approved by the Federal Emergency Management Agency (FEMA) Region III's Regional Administrator, and was adopted by Governor Martin O'Malley on August 25, 2011. The complete 2011 Maryland State Hazard Mitigation Plan Update can be accessed at:
http://www.mema.state.md.us/MEMA/MitigationPlan.html

Planning Process

The Maryland Emergency Management Agency (MEMA) led a fast-tracked mitigation planning process during spring and summer 2011. Funding assistance for the preparation and production of the update was provided by FEMA through the Hazard Mitigation Grant Program. The plan was completed with leadership from the hazard mitigation staff at MEMA, and its consultant team, Dewberry, S&S Planning and Design, LLC and VANTIX. The Maryland Mitigation Plan Stakeholders comprised of the Maryland Mitigation Advisory Committee (MAC), state agency program managers, and local emergency managers, attended two Stakeholder Meetings and guided plan development through document review sessions and comment periods. Additionally, FEMA Region III provided technical assistance and plan review. Public outreach was conducted through six regional stakeholder workshops, a mitigation plan update portal on the MEMA website Homepage, and a press release provided to Maryland media outlets.

Mitigation Advisory Committee

The MAC is a standing committee which advises the Maryland Hazard Mitigation Program on mitigation grant subapplication prioritization and mitigation planning policy issues. Nearly every member of the MAC attended the June 15 and July 20, 2011 Stakeholder Meetings and provided data, specific plan section reviews, and other technical support throughout the planning process.

The 2011 plan update process included:

- Convening the MAC on March 3, 2011;
- Development of a State profile and capability assessment;

- Review and integration of all local hazard mitigation plan hazard characterization into the hazard ranking formula;
- Gathering and analyzing information on past and future impacts of hazards on the state;
- Analysis of hazard risk to the state's critical facilities;
- Convening Stakeholders at the June 15, 2011 Hazard Analysis Meeting;
- Creating goals and mitigation strategies;
- Reviewing final hazard analysis and mitigation strategies at the July 20, 2011 Mitigation Plan Meeting;
- Program development; and
- Development of a plan maintenance schedule to guide plan strategy implementation during through 2014.

Figure ES-1. Regional Outreach Meeting.

Hazard Identification and Risk Assessment

Communities in Maryland are vulnerable to a wide range of hazards. These hazards vary by type, severity and probability of occurrence. Within Maryland there are portions of six distinct physiographic provinces: the Atlantic Continental Shelf, Coastal Plain, Piedmont Plateau, Blue Ridge, Ridge and Valley Province, and the Appalachian Plateaus Province. Natural hazards show some variability across the provinces.

Recent disasters have focused the attention of Maryland's citizens and government officials on the resultant human, economic and environmental impacts. During the past decade, Maryland has experienced nine events warranting Presidential Disaster declarations. Flood and Winter Storm represent the majority of Federally Declared Disasters in Maryland.

Table ES-1 is a summary of natural hazard event data collected from the National Climatic Data Center (NCDC) and the Maryland Department of Natural Resources Forest Service (MD FS). Each event in this table represents an event affecting a single county.

Table ES-1. Hazard event data from NCDC and MD FS (Inflated to 2011 dollars).

Hazard Type	Period of Record	# of Events	Property Damage (2011 $)	Crop Damage (2011 $)	Injuries	Deaths
Coastal Hazards (storm surge, tropical storms)	1993-2010	66	$109,050,194	$193,215	201	1
Drought	1995-2010	75	$0	$13,903,863	0	0
Flooding	1993-2010	1,179	$121,538,808	$1,400,983	64	16
Thunderstorm (Lightning & Hail)	1956-2010	1,216	$33,461,165	$821,890	73	13
Tornado	1950-2010	339	$463,257,911	$719,906	314	7
Wildfire (MD FS)	2001 - 2006 (1998 – 2010)	10 (7,052)	$0 ($320,326)	$0 (combined)	2 (33)	0 (1)
High Winds	1956-2010	3,462	$47,362,158	$306,871	122	8
Winter Weather	1993-2010	659	$4,307,752	$13,620	168	10

Based on input from the MAC, a standardized methodology was developed to compare different hazards' risk on a county basis. This method prioritizes hazard risk based on a blend of quantitative factors extracted from NCDC and other available data sources.

Table ES-2 summarizes the overall hazard ranking for Maryland. Flooding was given a 'high' ranking for the State.

Table ES-2. Summary Maryland Hazard Ranking

High	Medium-High	Medium	Medium-Low	Low	Negligible
Flooding	Coastal Hazards Drought High Winds Winter Storm	Tornado Wildfire	Landslide Thunderstorm (Lightning and Hail)	Karst/ Sinkholes Earthquake	Mining Hazards Dam and Levee Failure

Flood

Flooding can be categorized as flash, riverine and coastal in Maryland. Flooding is a persistent concern in Maryland, a coastal state with more than twelve percent of its surface area in floodplains and nearly 8,000 miles of tidal shoreline associated with the Chesapeake Bay and its tributaries. Between 1993 and 2010, 1,179 flooding events were recorded for Maryland in the NOAA National Weather Service NCDC storm database accounting for $121.5 Million in property damages, $1.4 Million in crop damages, 16 deaths and 64 injuries. To address the threat of flood damage, many communities and residents participate in the National Flood Insurance Program (NFIP). As of April 2011, 124 communities in Maryland currently participate in the NFIP. By June 30, 2011,

more than $56.4 Million has been paid in repetitive loss properties (non-mitigated and mitigated properties); nearly $985,192 of that amount is from severe repetitive loss properties.

Flood loss estimates and risk to critical facilities were examined using the FEMA HAZUS – MH MR5 (Level 2 analysis) software for riverine and coastal flood hazards. Based on HAZUS model results, Maryland could expect $8.7 Billion in flood losses for the 100-year scenario; $11.2 Billion from the 500-year scenario.

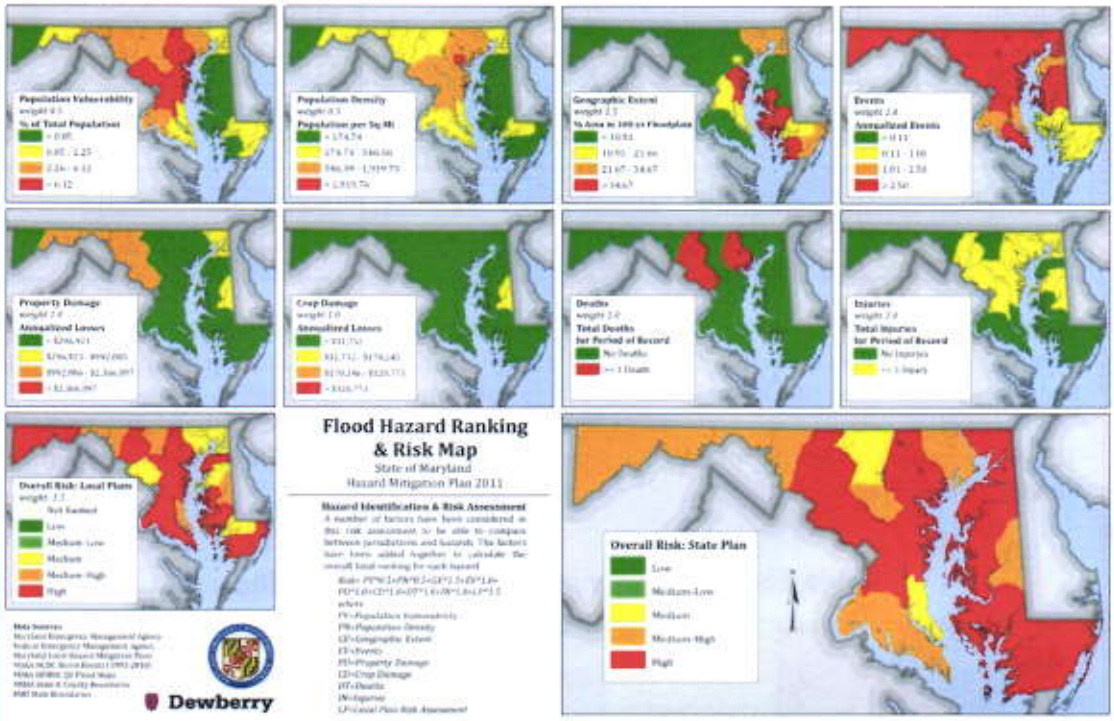

Figure ES-2. Flood Hazard Ranking Map.

Coastal Hazards

Coastal hazards take many forms ranging from storm systems like tropical storms, hurricanes and Nor'easters that can cause storm surge inundation, heavy precipitation that may lead to flash flooding, and exacerbation of shoreline erosion to longer-term hazards such as sea level rise. Between 1993 and 2010, 66 coastal hazard events were recorded for Maryland in the NOAA National Weather Service NCDC storm database accounting for $109 Million in property damages, $193,215 in crop damages, 1 death and 201 injuries.

Shoreline erosion is one of the most significant problems facing Maryland's diverse coastal environment. Approximately 69% of Maryland's 7,600 mile coastline is currently experiencing some degree of erosion. While the range and magnitude of erosion varies, the problem affects each of Maryland's sixteen coastal counties of the Chesapeake Bay and Coastal Bays watersheds. HAZUS-MH MR5 was also run for hurricane wind in order to determine potential losses due to winds associated with tropical storms and hurricanes. Annualized losses due to hurricane wind were

estimated at $32 Million, with the highest losses calculated for Worcester County at more than$9 Million.

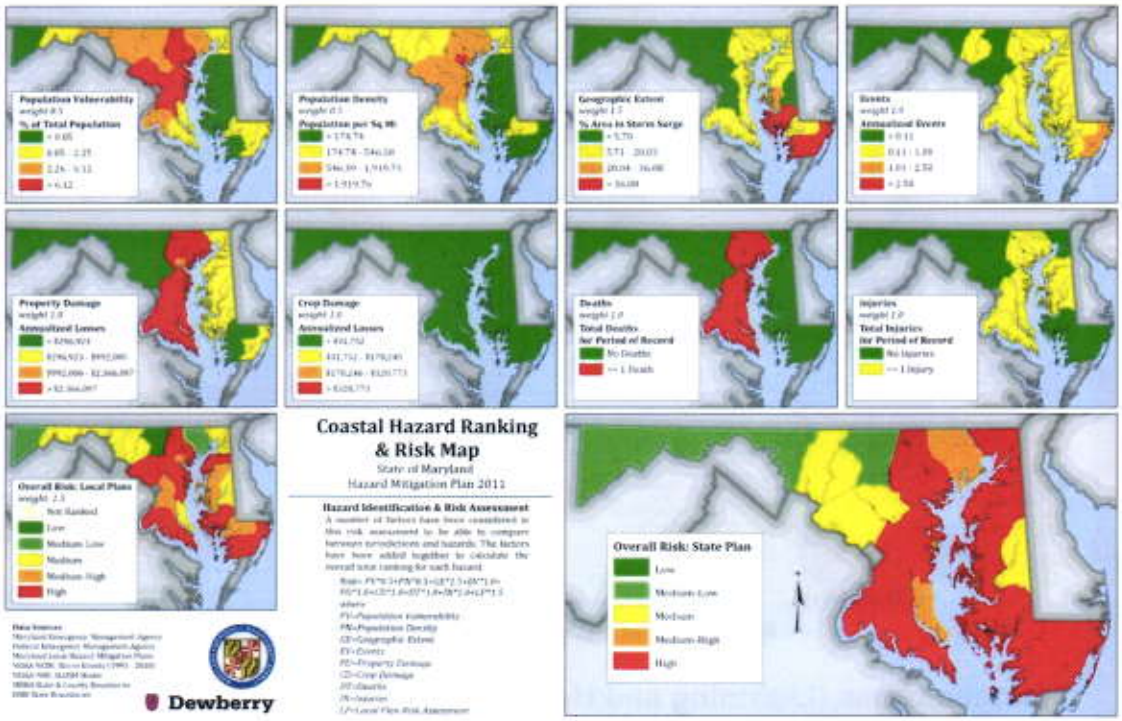

Figure ES-3. Coastal Hazards Ranking Map.

Wind

Wind is the motion of air past a given point caused by a difference in pressure from one place to another. Wind poses a threat to Maryland in many forms, including that produced by severe thunderstorms and tropical weather systems.

Between 1956 and 2010, 3,462 wind events were recorded for Maryland in the NOAA National Weather Service NCDC storm database accounting for $47.4 Million in property damages, $306,871 in crop damages, 8 deaths and 122 injuries.

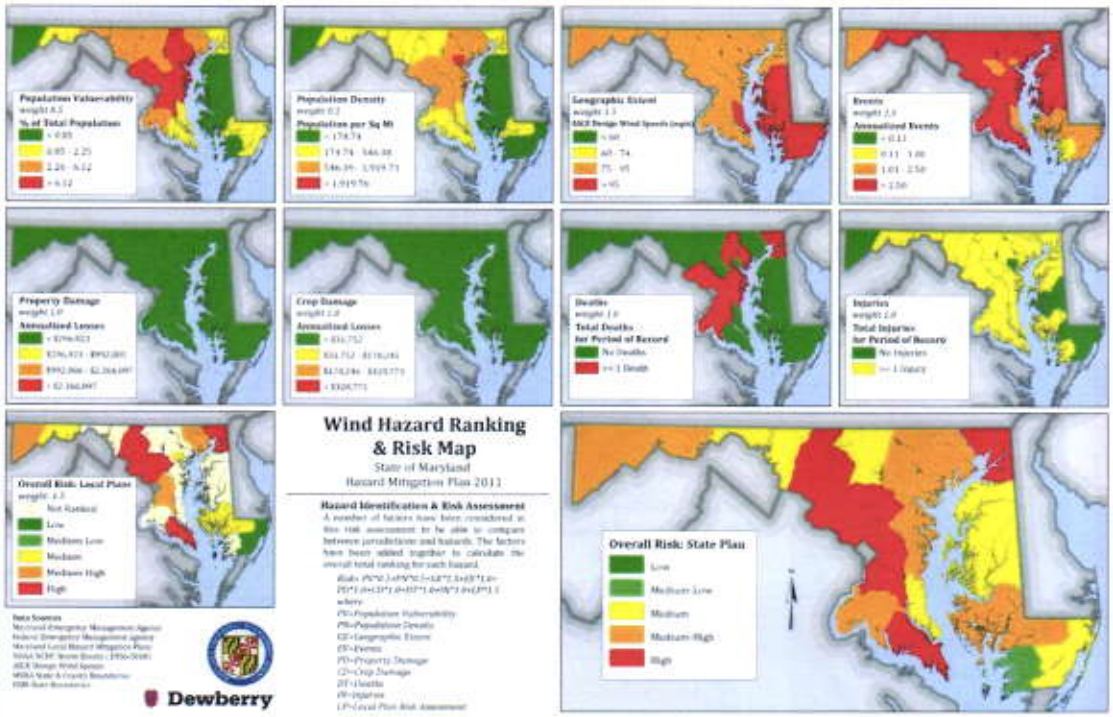

Figure ES-4. Wind Hazard Ranking Map.

Thunderstorms (Lightning and Hail)

Thunderstorms form when the right atmospheric conditions combine to provide moisture, lift, and warm unstable air that can rise rapidly. Thunderstorms occur any time of the day and in all months of the year, but are most common during summer afternoons and evenings and in conjunction with frontal boundaries. Maryland sees approximately 20-40 thunderstorm days per year. All thunderstorms produce lightning, and therefore all thunderstorms are dangerous. Lightning often strikes outside of areas where it is raining, and may occur as far as 10 miles away from rainfall.

Hail is formed in towering cumulonimbus clouds (thunderheads) when strong updrafts carry water droplets to a height at which they freeze. Between 1956 and 2010, 1,216 lightning and hail events that produced damage and/or injuries and fatalities were recorded for Maryland in the NOAA National Weather Service NCDC storm database accounting for $33.5 Million in property damages, $821,890 in crop damages, 13 deaths and 73 injuries. NCDC data shows that for any county, approximately 0 to 3 significant thunderstorm(s) (lightning and hail) events that cause injury, fatalities, and/or damage will occur each year. Montgomery County has the highest incidence rate for such thunderstorm events, with about 2.67 events occurring annually, or roughly one event every 4.5 months.

Tornadoes

A tornado is a violently rotating funnel-shaped column of air that extends from a thunderstorm cloud toward the ground. Tornadoes can touch the ground with winds exceeding 300 mph.

Although tornadoes normally travel on the ground for short distances, tornado tracks of 200 miles or more have been reported. Nationally, the tornado season lasts from March to August, with peak tornado activity normally occurring in April, May, and June. Tornadoes can and do occur in every month of the year.

There are numerous instances of damaging and in some cases deadly tornadoes having impacted Maryland. Of particular note, an F4 tornado struck La Plata in Charles County on Sunday, April 28, 2002, resulting in the most injuries and greatest reported damages of any tornado in Maryland history. The tornado was responsible for three deaths, 122 injuries, and more than $115 Million in damages.

Between 1950 and 2010, 339 tornado events that produced damage and/or injuries and fatalities were recorded for Maryland in the NOAA National Weather Service NCDC storm database accounting for $463.3 Million in property damages, $719,906 in crop damages, 7 deaths and 314 injuries. Based on NCDC data, on average, an individual Maryland county is impacted by a tornado roughly every 2 to 14 years. Tornadoes are considered to be low frequency, high-impact events.

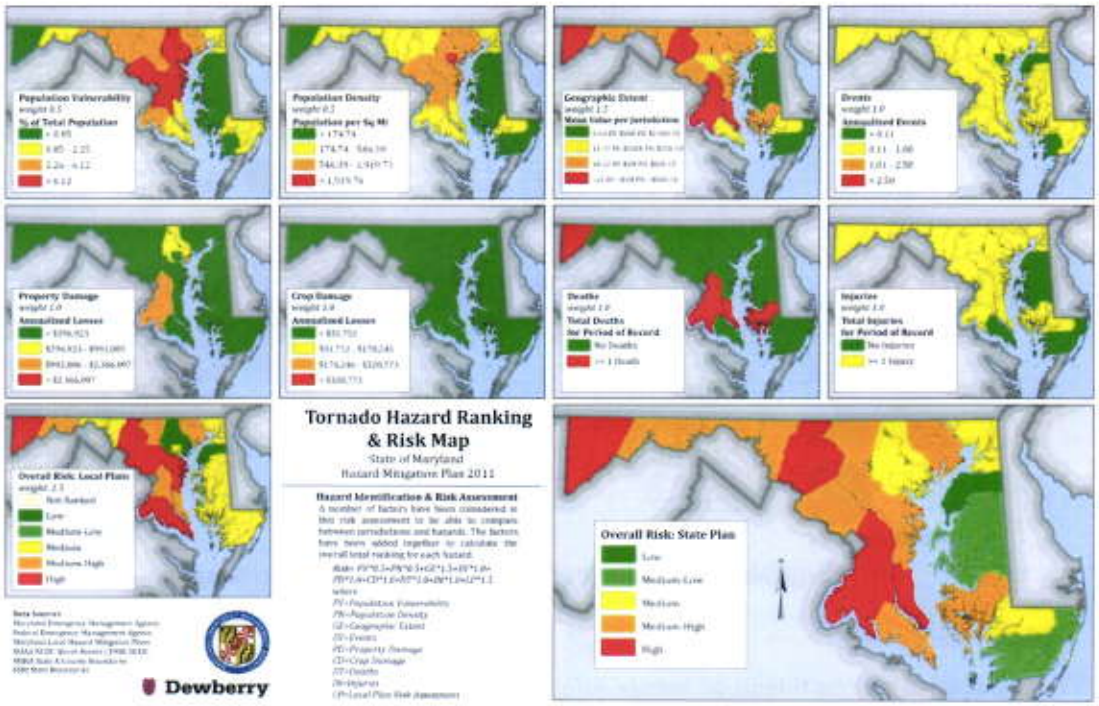

Figure ES-5. Tornado Hazard Ranking Map.

Winter Storms

Winter weather take many forms including snow, freezing rain, sleet and extreme cold that may occur singly or in combination. Maryland's three western counties, particularly Garrett County, can experience lake-effect snow originating from Lake Erie. Unlike Nor'easters and their associated Atlantic moisture, lake-effect snow is usually associated with Great Lakes moisture being uplifted

and deposited as snow. Western and central portions of Maryland generally see more snow annually and more frequent heavy snow events than the remainder of the State.

Ice is another winter hazard that can have significant impacts on Maryland. Freezing rain is rain that falls onto a surface with a temperature below freezing, causing it to form a coating or glaze of ice. Between 1993 and 2010, 659 winter storm events were recorded for Maryland in the NOAA National Weather Service NCDC storm database accounting for $4.3 Million in property damages, $13,620 in crop damages, 10 deaths and 168 injuries. An examination of NCDC data suggests that on an annual basis, approximately two to 12 winter weather events (snow and/or ice) of some significance occur in any particular Maryland county.

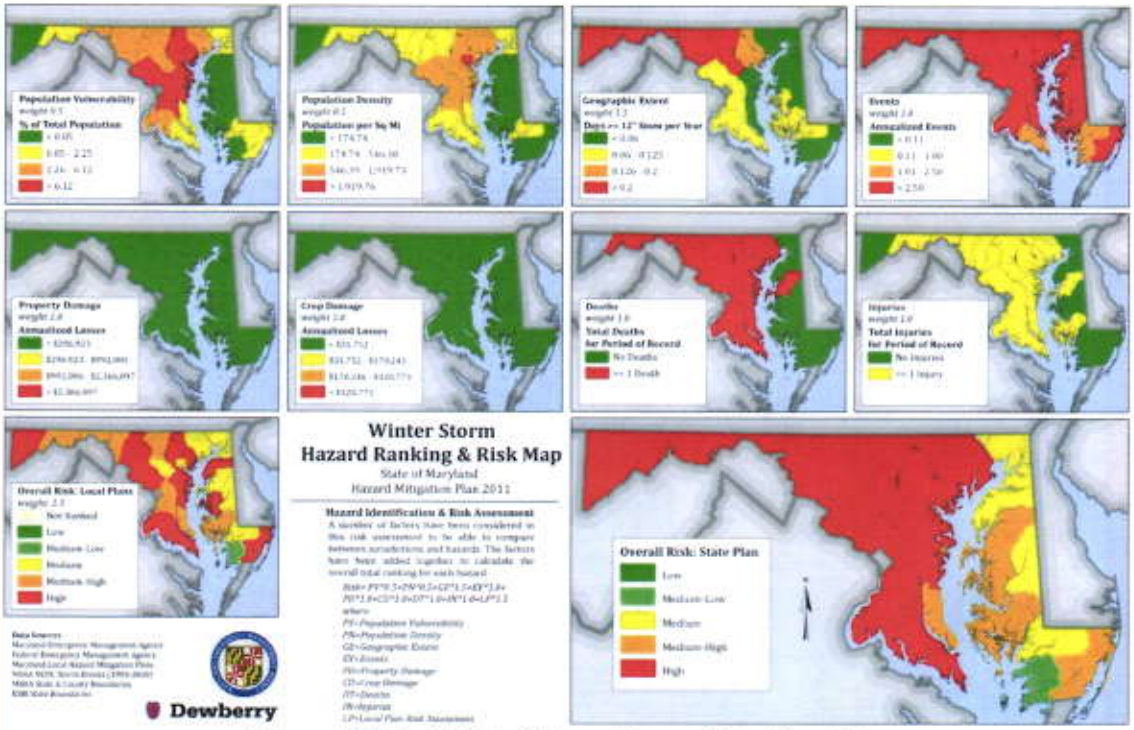

Figure ES-6. Winter Storm Hazard Ranking Map.

Wildfire

Wildfires pose serious threats to human safety and property in rural and suburban areas. They can destroy crops, timber resources, recreation areas, and habitat for wildlife. An examination of Maryland Forest Service data suggests that on an annual basis, approximately three to 78 wildfire events of some significance occur in any particular Maryland county in which the state responds to the fire. Between 1998 and 2010, 7,052 wildfire events were recorded for Maryland by the Maryland Forest Service accounting for $320,326 in damages, 1 death and 33 injuries.

Landslides

A landslide is the downhill movement of soil, rock, or other earth materials in response to the pull of gravity. The greatest landslide hazards are present in western Maryland. According to the USGS, the areas west of Frederick County have a moderate landslide incidence and high landslide susceptibility. This area is comprised of the Appalachian Plateaus Province, Ridge and Valley Province, and the Blue Ridge Province. The steep sided gorges, folds, and fractured rock in these provinces are prone to debris avalanches and debris slides.

Drought

The Maryland Department of the Environment has elected to use the U.S. Army Corps of Engineers' definition of drought, which states, droughts are periods of time when natural or managed water systems do not provide enough water to meet established human and environmental uses because of natural shortfalls in precipitation or stream flow. Short-term droughts can impact agricultural productivity, while longer term droughts are more likely to impact not only agriculture, but also water supply. Between 1995 and 2010, 75 drought events of varying length and severity were recorded for Maryland in the NOAA National Weather Service NCDC storm database accounting for $13.9 Million in crop damages.

Land Subsidence/Sinkholes

Land subsidence is a gradual settling or sudden sinking of the Earth's surface owing to subsurface movement of earth materials. Maryland is affected by a broad, regional subsidence phenomenon and more localized land collapsing due to sinkhole formation. Sinkholes have the potential to cause damage to infrastructure and buildings and may result in injuries or even fatalities. Based on historical data, the most-affected Maryland counties are Washington, Carroll, Frederick, Baltimore, and Allegany.

Earthquake

An earthquake, also known as a seismic event, is a shaking of the ground caused by the sudden breaking and movement of large sections (tectonic plates) of the earth's rocky outermost crust. Earthquakes are low probability, high-consequence events. Ground shaking can lead to the collapse of buildings and bridges; disrupt gas, life lines, electric, and phone service. Deaths, injuries, and extensive property damage are possible vulnerabilities from this hazard. Although Maryland has experienced numerous earthquakes from inside and outside the State, the quakes have been relatively small in magnitude and caused minimal economic damage.

HAZUS-MH MR5 was also run for earthquake to predict potential losses. Annualized losses due to seismic risk were estimated at $6.7 Million with the highest losses calculated in Baltimore and Montgomery counties. The 1998 earthquake in Pennsylvania, magnitude 5.2, was also modeled to show damages from a historic event that impacted the state.

Dam and Levee Failure

Dams are artificial barriers with the ability to impound water, wastewater, or liquid-borne materials. Dam failure refers to a collapse, overtopping, breaching, or other related conditions that cause an

uncontrolled release of water and downstream flooding. A levee is a structure, earthen or artificial, with the primary purpose of providing protection from flooding during seasonal high water, storm surges, precipitation and other weather events. Levees are often parallel to a river or along low-lying coastlines. Failure of a levee or dam can result in catastrophic flooding with little or no advanced warning.

Mining Hazards

There are roughly 30 active coal mines in Maryland, located in Garrett and Allegany Counties and all but two are strip mine operations. Non-coal mining is now far more prevalent than coal mining in Maryland. Today there are about 330 surface mines in the state, with at least one in each county. Materials that are mined include: dimension stone, limestone, hard rock aggregate, clay, fill dirt, topsoil, sand, and gravel. Subsurface mining hazards include workplace risks such as cave-ins and collapses, equipment-induced injury, flooding, fires, and toxic gas accumulations. Hazards to the environment caused by mining include land subsidence and acid mine drainage, both of which can negatively impact natural systems and communities.

Hazard Summary

Natural hazards have significant economic and human consequences in Maryland. Based on data from the NCDC and other sources, Maryland can expect approximately $70 million in annualized damages from Coastal, Drought, Flood, Thunderstorm, Tornado Wind, Winter Storm, and Wildfire hazards. This data does have limitations due to the availability of historic data and the possibility that some significant events may not have been reported and/or loss values under-reported.

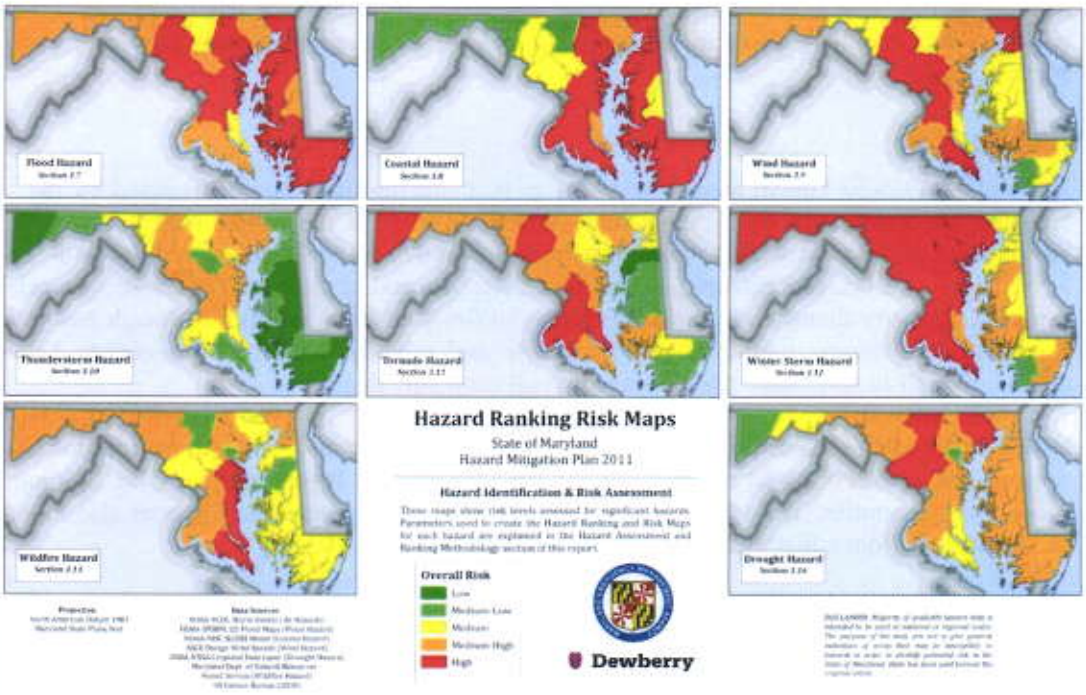

Figure ES-7. Summary Hazard Ranking Map.

A Hazard Mitigation Strategy for Maryland

2011 Mitigation Goal

To protect life, property, and the environment from hazard events through:

- Increased public awareness of hazard events, mitigation and preparedness;
- Enhanced coordination with jurisdictions to develop a relationship at the state and local level; and
- Efficient use of State resources.

2011 Mitigation Objectives

1. Provide state guidance and technical assistance to enhance mitigation planning and project efforts by public and private stakeholders;
2. Enable MEMA to encourage each Maryland county or municipality to secure funding and initiate critical facility mitigation by obtaining HMA subgrants;
3. Support Unified HMA grant programs that acquire and demolish hazard prone structures or elevate, retrofit and relocate existing structures and facilities (including non-residential structures) in vulnerable locations with a priority on repetitive loss and severe repetitive loss structures;
4. Develop a comprehensive mitigation and preparedness program to educate private and public stakeholders, academia, government employees and elected officials on the hazards pertinent to the State;
5. Identify both state and local statutory, regulatory or policy-based initiatives that support Maryland mitigation planning actions and leverage support for their inclusion in upcoming updates (i.e. building code regulations);
6. Promote, identify and undertake three infrastructure mitigation projects to improve the state's resiliency to potential hazards;
7. Integrate the mitigation planning process, including the hazard vulnerability assessment, into related local and state plans (i.e. environmental plans, land use plans, comprehensive plans, mitigation plans).

108 Mitigation Actions and strategies were developed through the work of five Subcommittees made up of MAC members and Stakeholders who attended the two Stakeholder Maryland Plan Update meetings:

- Policy, Planning, Programs and Funding
- Mitigation of High Hazard Structures
- 2014 Vulnerability Assessment
- Local Planning Interface
- Education & Outreach

High Priority Strategies

Table ES-3. Maryland Mitigation Action Plan High Ranked Strategies.

Programs, Planning, Policy and Funding
Ensure that local flood damage prevention regulations are up-to-date and consistently enforced.
Mitigation of Structures
Investigate increasing the minimum wind standard in the Statewide Building Code for critical facilities.
The Department of Housing and Community Development will provide continued support to ensure that local building codes are up to date and consistently enforced.
Incorporate climate change and coastal hazard considerations into building codes for coastal communities (e.g. freeboard, septic siting).
Incorporate hazard and risk analysis into databases of publicly-owned structures.
Identify flood protection techniques for flood prone wastewater treatment plants.
Install traffic maintenance and evacuation message signing along flood-prone highways in Cecil County. Investigate evacuation and detour messaging in other flood prone areas throughout the state.
Develop and implement a plan to improve pump stations susceptible to damage in flood-prone areas.
Identify flood prone roads and replace/mitigate undersized and clogged culverts.
Install trash racks upstream of critical bridges to preserve structures.
Re-profile and reconstruct roads in low-lying areas that are prone to flooding.
Support the construction of tornado safe rooms in critical facilities, public schools, or individual residences.
Assess all police and fire facilities, designated shelters, and other state structures statewide for current and potential use as safe rooms.
Develop shelter-in-place plans/provisions for public facilities.
Identify and mitigate sinkholes. Evaluate drainage in the area to prevent development of new sinkholes.
Improve stormwater management throughout the state.
Examine the FEMA-MEMA repetitive loss and severe repetitive loss data sets to seek candidate properties that could potentially be mitigated through the FEMA RFC, SRL or other HMA funding programs or any other available funding sources on an annual basis. Prioritize jurisdictions that will receive planning & project grants through HMA programs to those jurisdictions with SRL and RL properties.
2014 Maryland Vulnerability Assessment
Inventory hazard risks to state-owned facilities and identify their risks to hazards including climate change related (sea level rise, coastal and riverine stream erosion, and increased flooding) hazards.
In coordination with the MSGIC and local jurisdictions, organize and convene a 2014 Vulnerability Assessment working group to discuss the review/refinement of the 2011 HIRA.
Develop tools, data templates, etc., to assist the jurisdictions in developing rating systems for vulnerability assessments and to ensure consistency across the state.
Expand hazard profiles and mapping analysis for the 2011 hazards that are text-analysis only, in the 2014 vulnerability assessment.
Determine feasibility of adding human-caused hazards into the 2014 VA (i.e., nuclear, terrorism, utilities)
Determine feasibility of adding human-health and safety risks in conjunction with other hazard occurrences (i.e., vector-borne illnesses, pandemic outbreaks, water contamination) in the 2014 VA.
Maintain access to the Data Exchange System NFIP database of repetitive loss properties through continued relationships with DEP's State NFIP Coordinator's office
Continue to pursue and develop clean datasets. Improve existing geo-coding by researching matches for properties with incomplete addresses and out of date address based on rural road designations that have changed.
Align Maryland RL property data, and SRL property data with validated FEMA NFIP RL and SRL property data, annually;
Align Greatest Savings to the Fund (GSTF) data and the new 2011 methodology to inventory and further demonstrate the cost effectiveness of potential RL and SRL mitigation projects. Evaluate projects further for environmental soundness and technical feasibility to create successful HMA grant subapplications.

2014 Maryland Vulnerability Assessment (cont'd)
Update listing of completed SRL and RL mitigated properties and FEMA's RL database with Maryland's mitigated properties database annually. Update of the merged database can also occur at HMA grant close-out or whenever improved local data becomes available.
Complete FEMA Form AW-501s for each mitigated property. Provide to FEMA through current FEMA databases or submittal to the region upon project close out Archive at MEMA.
MEMA will provide state direction to ensure that local jurisdictional plans must address the mitigation of severe repetitive loss and repetitive loss structures in the mitigation strategies section of every local jurisdiction §322 plan with SRL or RL properties.
Local Planning Interface
Coordinate the distribution of mitigation related data produced by State agencies to local government entities and other State agencies. This data will include but not be limited to the State of Maryland Hazard Mitigation Plan, Maryland Hazard Analysis and Risk Assessment. These materials are important for both mitigation and other planning purposes. MEMA will also conduct training seminars for data recipients.
Ensure State HIRA data is provided to local government. Expand distribution to include Planning Departments, Public Works, and Emergency Services. Provide technical assistance as necessary.
Request that local governments advise MEMA when mitigation project locations are impacted by hazard events. Follow-up with regular contacts to ensure that information is consistently provided. Implement mechanisms and standards by which local mitigation related information may be shared with the State and stored.
Provide technical assistance to local government with the administration and enforcement of building codes.
Education and Outreach
Continue to sponsor and host the Annual Severe Storms Conference before the start of hurricane season.
Develop and execute Public Service Announcements.
Provide factsheets and informational brochures on personal preparedness and hazards to the public.
Prepare and provide an Emergency Preparedness course provided to state employees to ensure safety of socially vulnerable individuals in state care.
Develop Preparedness tips through twitter / face book / text messaging / email - work with state agencies to incorporate.
Provide list of hazard mitigation best practices to provide guidance and motivate local governments to reduce hazard impacts through mitigation.
Develop public presentations to government leaders and legislators on the importance of emergency preparedness and hazards that the state faces.
Maintain media advisory template based on risk.
Offer a variety of emergency management training opportunities for state and local employees.
Investigate emergency public broadcast protocol on telecommunication networks for notification of impending disaster
Continue Coast Smart Program and expand outside of Coastal Region - Reaching out to EM and planning personnel.
Reach out to civic organizations to become partners on emergency preparedness outreach programs.
Investigate establishing training for developing multi-lingual Emergency Management representatives.
Investigate improving communication between state agencies' mitigation programs and activities.
Enhance outreach to at risk neighborhoods and new populations at-risk due natural hazards including climate change.
Leverage relationships with universities/scientists to educate through Cooperative Extension on hazards and climate change.
Develop and conduct education efforts that are targeted to repetitive loss property owners increase knowledge and awareness of mitigation grants by conducting various outreach activities.
Promoting mitigation of RL and SRL properties at regional meetings hosted by MEMA Regional Administrators attended by county and municipal emergency managers. These meetings will provide potential HMA grant sponsors with mitigation options information through a presentation.

Plan Implementation and Maintenance

Responsibility for the overall implementation and maintenance of the *2011 Maryland State Hazard Mitigation Plan Update* rests with MEMA, the MAC and the Stakeholders who participated in the plan update and development of the Mitigation Plan Strategies. A full schedule for the next plan update in 2014 is provided in the full plan which may be accessed at: http://www.mema.state.md.us/MEMA/MitigationPlan.html.

Chapter 1. Introduction

1.1 Purpose of the Maryland State Hazard Mitigation Plan Update

The 2011 Maryland State Hazard Mitigation Plan Update serves as guidance for hazard mitigation for the State of Maryland. Its vision is supported by a central goal, objectives and strategies for Maryland state government, local governments and organizations that will reduce or prevent injury from natural hazards to people, property, infrastructure and critical state facilities. This plan complements the Maryland Core Plan for Emergency Operations – August 26, 2009.

This plan fulfills the standard state mitigation planning requirements (44 CFR §201.4) of the Disaster Mitigation Act of 2000 (DMA2000; Public Law 106-390, signed into law October 10, 2000). The DMA2000 amends the 1988 Robert T. Stafford Disaster Relief and Emergency Assistance Act, and reinforces the importance of mitigation planning, emphasizing planning for disasters before they occur. Section 322 of the act specifically addresses mitigation planning at state and local levels. New requirements are identified that allow Hazard Mitigation Grant Program (HMGP) funds to be used for mitigation activities and projects for states and localities with Hazard Mitigation Plans approved by November 1, 2004 and updated on a three year cycle. The *2011 Maryland State Hazard Mitigation Plan Update* is a standard plan meeting the requirements for A Standard State Plan detailed in Interim Rule 44 CRF 201.4, published by the Federal Emergency Management Agency February 28, 2004 and revised November 2, 2006. The Standard Plan was first approved by FEMA Region III during August, 2005. Maryland received approval for its first updated Plan on August 26, 2008. Maryland is seeking approval of a reduced cost share (90/10) for grants awarded under the FMA and SRL programs that address FEMA-listed severe repetitive loss properties.

Meeting the requirements and criteria of section 322 regulations and rules enables Maryland to remain qualified for all disaster-related assistance including categories C through G of the Public Assistance Program. This is an essential component of disaster recovery. In addition, the State will remain eligible for Hazard Mitigation Assistance program funds: HMGP, Flood Mitigation Assistance (FMA), Pre-disaster Mitigation Program (PDM), Repetitive Flood Claims (RFC) and Fire Management Grants. The state also participates in the CAP-SSSE program and may pursue use of the Severe Repetitive Loss (SRL) program to mitigate its severe repetitive loss properties.

The *2011 Maryland State Hazard Mitigation Plan Update* ("the Hazard Mitigation Plan") was developed under the authority of the Maryland Emergency Management Agency (MEMA), the Maryland Military Department, Adjunct General and the Governor, as established in the Maryland Code. Emergency Management Policy was updated in 1991 through EXECUTIVE ORDER 01.01.1991.02 State of Maryland Emergency Management Policy:

A. The Maryland Emergency Management Agency (MEMA) is the agency of State government with primary responsibility and authority for:

(1) The planning and execution of disaster and emergency preparedness, response, and recovery;
(2) The coordination of disaster and emergency response between State agencies and political subdivisions;
(3) The coordination and liaison with related agencies of the federal government and other states;
(4) The coordination with private agencies involved in emergency services;
(5) The coordination of all recovery operations subsequent to disasters and emergencies; and
(6) The coordination of hazard mitigation planning activities.

B. Emergency Operations Plan.

(1) MEMA shall coordinate the preparation of an Emergency Operations Plan (EOP) for the disaster and emergency response of the State of Maryland.

(2) The EOP shall:

(a) Be submitted to and subject to the approval of the Governor;

(b) Be integrated with the disaster and emergency response plans of the federal government, and to the fullest extent possible, those of other states; and

(c) Identify the specific requirements and responsibilities of the various State agencies in the event of disasters and emergency situations in this State.

(3) MEMA also shall coordinate the preparation of plans and programs for disaster and emergency response by the various jurisdictions of the State.

C. Operational Responsibilities.

(1) Except as provided in subparagraph (2), the Adjutant General, through the MEMA Director, is responsible for the operations of MEMA. The Adjutant General shall ensure that MEMA is organized and managed in a manner that ensures the protection and safety of Maryland's citizens.

(2) The Governor may, from time to time, require the MEMA Director to report directly to him. In such instances, the MEMA Director shall advise the Adjutant General of all actions taken or contemplated.

(3) If an emergency requires the services of more than two State agencies, each affected State agency shall:

(a) Report the emergency to the MEMA Director; and

(b) Assess its resources for assisting with the emergency.

D. Rapid Response Team.

(1) The MEMA Director may create, as needed, a Rapid Response Team capable of assisting local jurisdictions to respond to an emergency. The Rapid Response Team shall be prepared to deploy for on-site evaluation of emergencies and to provide State resources to local jurisdictions, as necessary.

(2) The Military Department, MEMA, the Maryland Institute for Emergency Medical Services System, the Department of the Environment, the Office of the State Fire Marshal, the Department of Human Resources, the Office of the Attorney General, the Department of Health and Mental Hygiene, the Department of Human Resources, the Department of Natural Resources, the Office of the Secretary of the State, the Maryland State Police, and the Department of Transportation shall each designate:

(a) Individuals to serve as its member and its alternate member of the Rapid Response Team; and

(b) Individuals to serve as its Emergency Services Coordinator (ESC) and an alternate ESC.

E. Each State agency shall:

(1) Be assigned primary or support responsibility by MEMA;

(2) Be prepared to execute tasks as specified in the State EOP;

(3) Assign a primary or alternate ESC to the EOC when notified by MEMA;

(4) Authorize its ESC or alternate to act on behalf of the agency in matters relating to the emergency; and

(5) Maintain procedures necessary to assure contact between the ESC and the State agency during the emergency;

(6) Develop and maintain relevant annexes of the State EOP, as requested by the MEMA Director;

(7) Participate in exercises of the State EOP;

(8) Conduct and participate in training essential to the implementation of its assigned emergency services;
(9) Ensure that its Statewide emergency notification data is current;
(10) Provide personnel to staff Disaster Application Centers and to assist in the processing of applications for emergency assistance, as necessary; and
(11) Each State agency shall review the EOP annually, identify those parts that need updating, and notify the MEMA Director of necessary changes.

F. All affected State agencies shall cooperate fully in carrying out the provisions of this Executive Order.

Effective date: January 10, 1991 (18:3 Md. R. 258)

In 2007, the Governor addressed the emerging issue of climate change through the following executive order establishing a Commission of Climate Change which included MEMA. The 2011 Plan Update Vulnerability Analysis considered climate change as an amplifier of the effects of natural hazards.

EXECUTIVE ORDER 01.01.2007.07 Commission on Climate Change
A. Established. A Climate Change Commission is hereby established to advise the Governor and General Assembly on matters related to climate change.
B. Tasks. The Commission shall develop a Plan of Action to address the drivers and causes of climate change, to prepare for the likely consequences and impacts of climate change to Maryland, and to establish firm benchmarks and timetables for implementing the Plan of Action.
C. Membership.
(1) The Commission shall consist of up to 21 members, including:
(a) The Secretary of Agriculture, or the Secretary's designee;
(b) The Secretary of Budget and Management, or the Secretary's designee;
(c) The Secretary of Business and Economic Development, or the Secretary's designee;
(d) The State Superintendent of Schools, or the Superintendent's designee;
(e) The Secretary of Natural Resources, or the Secretary's designee;
(f) The Secretary of the Environment, or the Secretary's designee;
(g) The Secretary of Planning, or the Secretary's designee;
(h) The Secretary of Transportation, or the Secretary's designee;
(i) The Director of the Governor's Office of Homeland Security, or the Director's designee;
(j) The Director of the Maryland Energy Administration, or the Director's designee;
(k) The Secretary of Housing and Community Development, or the Secretary's designee;
(l) The Maryland Insurance Commissioner, or the Commissioner's designee;
(m) The Director of the Maryland Emergency Management Agency, or the Director's designee;
(n) The Chairman of the Public Service Commission, or the Chairman's designee; and
(o) The Chancellor of the University System of Maryland, or the Chancellor's designee;
(2) The Speaker of the House of Delegates and the President of the Senate are invited to appoint 3 members, respectively, from the House of Delegates and Senate, to serve as members of the Commission.
D. Chair. The Chair of the Commission shall be designated by the Governor from among the members of the Commission.
E. Staff Coordination. The Department of Natural Resources and Department of the Environment shall jointly staff the Commission in coordination with other State agencies as directed by the Chair.
F. Working Groups. The Commission shall be supported by Working Groups, to be established by the Chair, as follows:
(1) Scientific and Technical Working Group.

(a) Tasks. The Working Group shall develop a Comprehensive Climate Change Impact Assessment. The Assessment should:

(i) Advise the Commission, as well as other Working Groups, on the scientific and technical aspects of climate change;

(ii) Inventory Maryland's greenhouse gas emission sources and sinks;

(iii) Calculate Maryland's "carbon footprint" to measure the impact of human activities on the environment based on the State's greenhouse gas production;

(iv) Investigate climate change dynamics, including current and future climate models and forecasts; and

(v) Evaluate the likely consequences of climate change to Maryland's agricultural industry, forestry resources, fisheries resources, fresh water supply, aquatic and terrestrial ecosystems, and human health.

(b) Chair. The Scientific and Technical Working Group will be chaired and staffed jointly by the University System of Maryland, the Maryland Department of the Environment and the Department of Natural Resources.

(2) Greenhouse Gas and Carbon Mitigation Working Group.

(a) Tasks. The Working Group shall develop a Comprehensive Greenhouse Gas and Carbon Footprint Reduction Strategy. The Strategy should:

(i) Evaluate and recommend goals that include but not be limited to the reduction of Maryland's greenhouse gas emissions to 1990 levels by 2020 and 80% of 2006 levels by 2050;

(ii) Recommend short and long-term goals and strategies that include both energy and non-energy related measures to mitigate greenhouse gases and offset carbon emissions; and

(iii) Provide a detailed implementation timetable, with benchmarks, for each recommendation and strategy.

(b) Chair. The Greenhouse Gas and Carbon Mitigation Working Group shall be chaired and staffed jointly by the Department of the Environment and the Maryland Energy Administration.

(3) Adaptation and Response Working Group.

(a) Tasks. The Working Group shall develop a Comprehensive Strategy for Reducing Maryland's Climate Change Vulnerability. The Strategy should:

(i) Recommend strategies for reducing the vulnerability of the State's coastal, natural and cultural resources and communities to the impacts of climate change, with an initial focus on sea level rise and coastal hazards (e.g., shore erosion, coastal flooding);

(ii) Establish strategies to address short and long-term adaptation measures, planning and policy integration, education and outreach, performance measurement, and as necessary, new legislation and/or modifications that will strengthen and enhance the ability of the State and its local jurisdictions to plan for and adapt to the impacts of climate change;

(iii) Work with local governments to identify their capacity to plan for and adapt to sea level rise;

(iv) Develop appropriate guidance to assist local governments with identifying specific measures (e.g., local land use regulations and ordinances) to adapt to sea level rise and increasing coastal hazards; and

(v) In consultation with the Scientific and Technical Working Group, propose a timetable for the development of adaptation strategies to reduce climate change vulnerability among affected sectors, such as agriculture, forestry, water resources, aquatic and terrestrial ecosystems, and human health.

(b) Chair. The Adaptation and Response Working Group shall be chaired and staffed jointly by the Department of Natural Resources and the Department of Planning.

(4) Additional Working Groups and/or Subcommittees to Working Groups may be created, as necessary, to accomplish the Commission mandate and Working Group Tasks.

(5) Appointments.

(a) The Chair of the Commission shall appoint Working Group and Subcommittee members who broadly represent both public and private interests in climate change, including but not limited to: Other levels of government, academic institutions, renewable and traditional energy providers, environmental organizations, labor organizations, and business interests, including the insurance industry.

(b) Working Group and Subcommittee members shall serve at the pleasure of the Commission.

(c) Working Group and Subcommittee members may not receive compensation for service.

G. Milestones.

(1) Within 60 days of the effective date of this Executive Order, the Commission shall be convened and Working Group members appointed.

(2) Within 90 days of the effective date of this Executive Order, Working Groups shall meet and establish individual work plans.

(3) Within one year of the effective date of this Executive Order, the Commission shall present to the Governor and General Assembly the Plan of Action, including the Comprehensive Climate Change Impact Assessment, the Comprehensive Greenhouse Gas and Carbon Footprint Reduction Strategy, and the Comprehensive Strategy for Reducing Maryland's Climate Change Vulnerability.

H. Reporting. The Commission shall report to the Governor and General Assembly on or before November 1 of each year including November 1, 2007, on the Plan of Action, including an update on development of the Plan of Action, implementation timetables and benchmarks, and preliminary recommendations, including draft legislation, if any, for consideration by the General Assembly.

Effective date: April 20, 2007 (34:10 Md. R. 867)

1.2 Disaster Mitigation Act of 2000 and Implementing Regulations

Section 322 of the Robert T. Stafford Disaster Relief and Emergency Assistance Act (Stafford Act or the Act), 42 U.S.C. 5165, was enacted under § 104 of the Disaster Mitigation Act of 2000, (DMA 2000) Public Law 106-390. DMA 2000 was intended to facilitate cooperation between state and local authorities. It encourages and rewards local and state disaster planning in advance of disasters in order to promote sustainability of communities and services as a strategy to improve disaster resistance. This pre-disaster plan is intended to support state and local governments' efforts to articulate accurate and prioritized needs for hazard mitigation that will reduce exposure to natural hazards. This planning effort will result in timely allocation of funding and more effective risk reduction strategies and projects.

FEMA prepared an Interim Final Rule, published in the Federal register on February 26, 2002 within 44 CFR Parts 201 and 206 that establishes planning and funding criteria for states. The Final Rule was published in October, 2009. The Guidance and Standard Plan Crosswalk were revised November 4, 2006 and was further updated to include requirements for 90-10 Federal funding for the Severe Repetitive Loss and Flood Mitigation Assistance grant programs in January, 2009. The completed Crosswalk for the *2011 Maryland Hazard Mitigation Plan Update* may be found in Appendix B.

44 Code of Federal Regulations Part 201

44 CFR § 201.1 et seq. was promulgated by the Federal Emergency Management Agency, (FEMA) on February 26, 2002 in order to implement DMA 2000. The interim final rule was amended several times to address standard and enhanced state plans during 2007. Revised guidance for local plans was released July 1, 2008 with a major revision slated for September 2011. In addition, guidance for the Severe Repetitive Loss and Flood Mitigation Assistance Programs (44 CFR § 201.4 et *seq.*) requires amendment of state plans per a new crosswalk for these programs issued on January 14, 2008. The rule addresses state mitigation planning, and specifically in 44 CFR § 201.3 (c) identifies the states' mitigation planning responsibilities, which include:

1. Prepare and submit to FEMA a Standard Hazard Mitigation Plan following criteria established in 44 CFR § 201.4 as a condition of receiving Stafford Act assistance (except emergency assistance).
2. For consideration for 20 percent HMGP funding, prepare and submit an Enhanced State Mitigation Plan in accordance with 44 CFR § 201.5, which must be reviewed and updated, if necessary, every three years from the date of the approval of the previous plan.
3. Review and if necessary, update the Standard State Mitigation Plan by November 1, 2004, and every three years from the date of approval of the previous plan in order to continue program eligibility.
4. Make available the use of up to the seven percent of HMGP funding for planning in accordance with 44 CFR § 206.434. *See* 44 CFR § 201.3 (c).

44 CFR § 201.4, Standard State Mitigation Plans, lists the required elements of state hazard mitigation plans. Under 44 CFR § 201.4 (a), by November 1, 2004 states must have an approved Standard State Hazard Mitigation Plan that meets the requirements of the regulation to receive Stafford Act assistance. The planning process, detailed by 44 CFR § 201.4 (b), must include coordination with other state agencies, appropriate Federal agencies and interested groups. Guidance for state standard and enhanced plans and local and multi-jurisdictional plans has been updated several times to incorporate changes from the Katrina Reform Act, new Unified Hazard Mitigation Assistance Grant Programs and "lessons learned" through the first cycle of state and local mitigation planning. Current state standard plan guidance and the state plan cross walk were used to inform the *2011 Maryland State Hazard Mitigation Plan Update.*

44 § 201.4 (c), Plan content, identifies the following elements that must be included in a state hazard mitigation plan:

1. A description of the planning process used to develop the plan;
2. Risk assessments that provide the factual basis for activities proposed in the strategy portion of the mitigation plan;
3. A Mitigation Strategy that provides the state's blueprint for reducing losses identified in the risk assessment;
4. A section describing Coordination of Local Mitigation Planning;
5. A Plan Maintenance Process, including a method and schedule for monitoring, evaluating and revising the plan; a system for monitoring implementation of mitigation strategies and projects; and a system for reviewing progress in achieving goals, objectives and strategies as well as project implementation;
6. A Plan Adoption Process for formal adoption by the State Prior to submittal to FEMA for final review and approval; and
7. Assurances that the State will comply with all applicable Federal statutes and regulations in effect with respect to grant funding periods, in compliance with 44 CFR 13.11(c). The state must amend its plan whenever needed to reflect changes in state or federal laws and statutes as required by 44 CFR 13.11 (d).
8. Revisions to plans per guidance issued January 14, 2008 must include a program strategy for state eligibility for 90 percent federal funding for the Severe Repetitive Loss Program for FY 2008 and

the Flood Mitigation Assistance Program for FY2009. Plan revisions must in compliance with 44CFR201.4.

44 CFR Part 206

On February 26, 2002, FEMA also changed 44 CFR Part 206 in order to implement DMA 2000 (*See* 67 *Federal Register 8844 [February 26, 2002]).* Changes to 44 CFR Part 206 authorize HMGP funds for planning activities and increase the amount of HMGP funds available to states that develop an Enhanced Mitigation Plan. FEMA amended Part 206 in 2006 following the passage of the Katrina Reform Act which restored HMGP funding to 15 percent of eligible disaster recovery costs for states with approved Standard Mitigation Plans.

44 CFR Part 400

(a) *As a condition of the receipt of any disaster assistance under the Stafford Act, the applicant shall carry out any repair or construction to be financed with the disaster assistance in accordance with applicable standards of safety, decency, and sanitation and in conformity with applicable codes, specifications and standards.*

(b) Applicable codes, specifications, and standards shall include any disaster resistant building code that meets the minimum requirements of the National Flood Insurance Program (NFIP) as well as being substantially equivalent to the recommended provisions of the National Earthquake Hazards Reduction Program (NEHRP). In addition, the applicant shall comply with any requirements necessary in regards to Executive Order 11988, Floodplain Management, Executive Order 12699, Seismic Safety of Federal and Federally Assisted or Regulated New Building Construction, and any other applicable Executive orders.

(c) In situations where there are no locally applicable standards of safety, decency and sanitation, or where there are no applicable local codes, specifications and standards governing repair or construction activities, or where the Regional Administrator determines that otherwise applicable codes, specifications, and standards are inadequate, then the Regional Administrator may, after consultation with appropriate State and local officials, require the use of nationally applicable codes, specifications, and standards, as well as safe land use and construction practices in the course of repair or construction activities.

(d) The mitigation planning process that is mandated by section 322 of the Stafford Act and 44 CFR part 201 can assist State and local governments in determining where codes, specifications, and standards are inadequate, and may need to be upgraded

1.3 Assurances and Adoption

STATE OF MARYLAND
MILITARY DEPARTMENT

MARTIN O'MALLEY
GOVERNOR

ANTHONY G. BROWN
LIEUTENANT GOVERNOR

JAMES A. ADKINS
MAJOR GENERAL
THE ADJUTANT GENERAL

RICHARD MUTH
EXECUTIVE DIRECTOR

MARYLAND EMERGENCY MANAGEMENT AGENCY
State Emergency Operations Center, Camp Fretterd Military Reservation
5401 Rue Saint Lo Drive, Reisterstown, MD 21136
(410) 517-3600 • Fax (410) 517-3610 • Toll Free 1 (877) 636-2873

As a condition of approval of a state hazard mitigation plan by the FEMA Regional Administrator, 44 CFR Part 201.4(c)(7) requires that the plan contain certain assurances. The state must assure that it will comply with federal statutes and regulations that pertain to grant funding, and will amend the plan to reflect changes in pertinent state or federal laws. Accordingly, under the authorities provided to the Maryland Emergency Management Agency through Executive Orders, the Maryland Emergency Management Agency pledges that it will continue to:

1. Comply with all applicable federal statutes and regulations in effect with respect to the periods for which it receives grant funding, in compliance with *44 CFR 13.11(c)*; and
2. Amend this plan whenever necessary to reflect changes in state or federal laws and statutes as required in *44 CFR 13.11(d)*.

Signed: Richard J Muth

Name: Richard Muth

Title: Director, Maryland Emergency Management Agency

Date: 8/10/11

STATE OF MARYLAND
OFFICE OF THE GOVERNOR

MARTIN O'MALLEY
GOVERNOR

STATE HOUSE
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ANNAPOLIS, MARYLAND 21401-1925
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TTY USERS CALL VIA MD RELAY

August 25, 2011

MaryAnn Tierney
Regional Administrator
FEMA Region III
One Independence Mall, Sixth Floor
615 Chestnut Street
Philadelphia, PA 19106-4404

Dear Ms. Tierney:

In accordance with the authority vested in me by the *Annotated Code of Maryland*, Public Safety, Article 14 Sections 106(b)(2) and (b)(4), I hereby approve and declare adopted the *2011 Maryland State Hazard Mitigation Plan Update*. This plan update shall be effective as of August 26, 2011.

The *2011 Maryland State Hazard Mitigation Plan Update* has been developed in conformity with Section 322 of the Robert T. Stafford Disaster Relief and Emergency Assistance Act and 44 CFR, Part §201 Mitigation Planning.

The efforts of many State and local departments and agencies were coordinated for the development and update of this plan. In the interest of all citizens and businesses in Maryland, let this *2011 Maryland State Hazard Mitigation Plan Update* continue to serve as an impetus for improved mitigation and recovery from disasters in the State of Maryland.

Sincerely,

Governor

1.4 Planning Team

Funding assistance for the preparation and printing of this plan was provided by the FEMA through a HMGP grant is prepared in accordance with appropriate regulations and guidance provided by that agency.

This plan was completed with planning assistance and support by the hazard mitigation staff at the Maryland Emergency Management Agency, and Dewberry, its consultant. The Maryland Mitigation Advisory Committee (MAC) and a group of stakeholders that include Maryland state agency state and local emergency managers and other local government staff attended two plan development meetings and provided comments on the plan draft. Staff from FEMA Region III offices provided additional technical assistance and plan review.

1.5 Overview of Plan

For the 2011 update, each chapter was reviewed and reinvigorated to highlight progress since the 2008 plan adoption. All of the chapters were re-formatted, new data integrated, and the overall plan was re-organized to better meet the needs of the state.

Each chapter begins with a brief introduction followed by relevant information, charts, tables, and maps, which fulfill regulation requirements. The main chapters of the plan follow primary requirements of the hazard mitigation planning law:

Chapter 2.0 ***Planning Process*** describes the activities and work of the Maryland Emergency Management Agency State Hazard Mitigation Officer and Hazard Mitigation Planner, the Maryland Mitigation Advisory Committee (MAC), Stakeholders invited to participate in the process, the primary consultant, Dewberry, and two certified Maryland small business sub-contractors S&S Planning and Design, LLC and VANTIX. The plan participants, planning process, planning products and relevance to other related plans or state functions is described.

Chapter 3.0 ***Hazard Identification, Risk Assessment and Vulnerability Analysis*** has three primary components. A description of Maryland is provided that includes: Identification, Risk Assessment and Vulnerability Analysis with the impacts of Social Vulnerability and Climate Change discussed where appropriate. Risk is characterized using these factors:

- Population distribution and characteristics
- Business and industry
- Agriculture and forestry
- Locations of state government facilities, including those deemed critical

Natural hazards affecting the state are identified, including:

- Descriptions and histories of hazards;
- Assessment of geographic extent and risk of hazards;
- Hazard specific loss estimation for state facilities;

Amplifiers include sea level rise and climate change. A summary assessment of the potential losses and risks is provided. The original 2005 plan profiled 40 natural and human-caused hazards. This analysis was condensed through technical support from Towson State during the 2008 plan update process to 12 groupings of natural and human-caused hazards. During the early formation of the 2011 plan update process it was decided to focus only on natural hazards. These were condensed into fewer categories to enable use of best available data.

A decision was made to better characterize flooding through the use of the FEMA HAZUS-MH tool to perform a Level II analysis using the state's critical facilities database overlaid with created depth grids generated from FEMA Map Modernization and Risk MAP products. Information from the analysis will be provided to local governments to be used during project analysis and when updating local plans; further analysis for several counties will be required during the 2014 plan update as some county flood maps are currently under revision. In addition, the state's critical facilities data set was under revision during 2011 and was not available for use for the 2011 vulnerability analysis or HAZUS-MH runs. Repetitive and Severe Repetitive loss properties are also analyzed and new tracking tables showing mitigated properties through HMA grants and ICC were created. These may be found in Appendix M.

The new vulnerability assessment was initiated in May 2011 with the objective of gathering and incorporating, where usable, data from local and regional plan HIRAs. The current county and municipal plans were analyzed and hazard rankings were captured. These were used in the state plan hazard ranking formula. Hazard information from the local plans was archived using a newly developed tracking spreadsheet. This tracker can be maintained as local plans are updated to facilitate the update of the 2014 Maryland State Plan.

The new plan HIRA and associated vulnerability analysis now provides a more comprehensive look at natural hazards challenging Maryland's people, property, critical facilities, and natural resources. Where data allowed, hazards were ranked comparatively on a county basis using algorithm-based evaluation methods using parameters such as population, population density, hazard occurrence and probability. Where data was insufficient to provide a formula-based analysis a detailed hazard description is provided, the hazard is characterized geographically to the extent practicable. Data gaps are listed along with strategies to continue to develop analytical data sets for the hazards which require a more analytical analysis.

Chapter 4.0 ***Hazard Mitigation Strategy*** presents the mitigation goals and objectives necessary to reduce the risk from hazards across the state to specific state facilities and citizens. The final section presents the program strategies and projects with complete rankings for importance to reduce exposure to hazards. A complete listing of evaluated 2008 projects and strategies are presented in Appendix I. This MS Excel Spreadsheet reflects progress to date on the 2008 state plan mitigation plan strategies and actions. It will be updated at least annually prior to the 2014 state plan update.

The 2011 Plan Update takes a very different approach to Mitigation Actions and Strategies than the 2008 Plan Update, which separated actions into either an all-hazard category or into categories for each of the twelve profiled hazards. Since many potential actions and strategies respond to several hazards, it was decided to develop actions and strategies through the work of five MAC and Stakeholder Subcommittees:

- Mitigation of High Hazard Structures
- Policy, Planning, Programs and Funding
- 2014 Vulnerability Assessment
- Local Planning Interface
- Education & Outreach

A plan to address Repetitive and Severe Repetitive Loss properties is included in Chapter 4.0 with related strategies included in Chapter 5.0.

Chapter 5.0 ***Coordination with Local Mitigation Planning Efforts*** describes a comprehensive three-year process to engage all Maryland communities in hazard mitigation planning. Initially, 23 plans were approved. These original local mitigation plans for Maryland Counties and several cities are undergoing update on a five-year cycle.

Chapter 6.0 ***Plan Maintenance, Implementation and Adoption***, outlines implementation of the plan and development of the anticipated 2014 plan revision. Processes used to maintain and update data and information contained in the hazard identification and vulnerability assessment databases are described. Plan adoption and revision are also described, augmented with a timeline. This chapter has been expanded to detail an annual progress review.

Appendices may be found immediately following the plan. These provide detailed listings and agendas from each plan update meeting that was held, new MS Excel tracking tools, results from the comprehensive regional outreach workshops and other relevant documents supporting the plan or its production.

Standard Plan Appendices:

Appendix A: Presents the August Governor's Adoption Resolution.
Appendix B: Archives the *2011 Maryland State Hazard Mitigation Plan Update* Crosswalk.
Appendix C: Glossary of Terms
Appendix D: Provides profiles of major state and federal agencies and private non-profit organizations that participated during the planning process.
Appendix E: Presents the Capability Assessment of programs and agency technical assistance available to support implementation of the objectives and strategies of this plan.
Appendix F: Contains documentation regarding the two meetings conducted during the 2011 plan update process.
Appendix G: Provides summary Riverine HAZUS-MH Analysis documents completed for Maryland Counties.
Appendix H: Provides the MS Excel Workbook of the local plan upload process.
Appendix I: Presents the comprehensive list of the 2008 mitigation actions as well as the Mitigation Actions Tracker of new 2011 mitigation actions.
Appendix J: Includes the Priority Project Scoping Profiles.
Appendix K: Provides the complete listing of those who contributed to this plan through participation in the planning process.
Appendix L REDACTED*: Hazard Mitigation Grant Program Administration Plan – March 2011*
Appendix M REDACTED*:* Repetitive and Severe Repetitive Loss MS Excel Trackers
Appendix N REDACTED*:* Hazard Mitigation Assistance Grant Workbook
Appendix O: Outreach and Education
Appendix P: Supplementary HIRA documents and Data
Appendix Q REDACTED: Social Vulnerability Index

Chapter 2. Planning Process

The update to the *2011 Maryland State Hazard Mitigation Plan Update* was conducted through a process which involved a review of the Plan by the staff of the State Hazard Mitigation Division, the Mitigation Advisory Committee and a Stakeholder group comprised of state and local agency staff and local emergency managers. Additionally, revisions to the Plan were made based upon the updated 2005 Maryland Hazard Analysis; however, the update to the Risk Assessment portion of the Plan was conducted based upon new data. The 2008 plan update was formally approved by the Governor on August 26, 2008.

2.1 Overview of the Planning Process

The planning process for the *2011 Maryland State Hazard Mitigation Plan Update* was initiated by the Maryland Emergency Management Agency (MEMA) supported by Dewberry and Davis, LLC, and two subcontractors, S&S Planning and Design, LLC and VANTIX, who provided capacity and technical support to the MEMA Mitigation staff. Based upon the expedited period of performance to complete the plan, a truncated plan update schedule was developed. The Contractor, Maryland State Hazard Mitigation Officer, Maryland Mitigation Planner and FEMA Region III concurred upon the following strategy to fast-track review of the plan:

1. At least two meetings of the Mitigation Advisory Committee and additional stakeholders including invited county and city emergency managers would be conducted at the MEMA to maximize committee time. Intermittent communication would be handled through the project's dedicated SharePoint website, conference calls, and WebEx to minimize travel costs and maximize efficiency;
2. Total overhaul of the Hazard Identification, Risk Assessment and Vulnerability Analysis was a priority. All available data sets, including the National Climatic Data Center would be used;
3. The local plan upload would include a MS Excel Tool to enable MEMA staff to maintain status as local plans are updated and mitigation actions are completed beyond this plan update;
4. During the first June HIRA and Mitigation Actions Meeting the draft Vulnerability Analysis would be presented, followed by goal verification and breakout subcommittee meetings to develop mitigation actions responsive to priority hazards. The Contractor would suggest an objective framework once mitigation actions were finalized so as to maximize stakeholder input at the July Final Plan Review meeting. The June HIRA and Mitigation Actions meeting would address mitigation actions in five subcommittees:
    a. Mitigation of High Hazard Structures
    b. Planning, Policy and Funding
    c. Education & Outreach
    d. 2014 Vulnerability Assessment
    e. Local Planning Interface
5. After posting the draft plan in early July and conducting six regional outreach meetings, a July Final Plan Review meeting would be hosted at MEMA's Reisterstown facility where outreach workshop outcomes and final HAZUS-MH flooding analysis results would be presented. In addition, stakeholders would be invited to share comments on the draft plan via the MEMA website.
6. Following final incorporation of MEMA, FEMA, MAC, stakeholders (state agency and local emergency managers) and public comments into the plan, MEMA, FEMA and the contractor would meet the week of August 8, 2011 to assure that the plan met all FEMA and MEMA requirements. This would also ensure that the final plan could be forwarded to the Governor for adoption two weeks prior to the present plan's expiration date of August 26, 2011.

Many of the planning activities were completed concurrently throughout the spring and summer of 2011. Datasets from Maryland and national open sources were gathered and databases to support GIS mapping were developed. Continued development of an inventory of state facilities, analysis of the recorded history of damage impacts due to natural hazards and synthesis of GIS layers for hazards led to the prediction of probability for incurred damages to state facilities from identified natural hazards. The planning process continued to evolve to ensure comprehensive agency responses, as data was being developed and analyzed.

2.2 Plan Coordination

The following individuals were involved in the actual update of the 2011 Maryland State Hazard Mitigation Plan:

Table 2-1. Plan Coordination Participants

MEMA State Hazard Mitigation Officer
Mark James, Acting Maryland State Hazard Mitigation Officer
Maryland Emergency Management Agency Mitigation Program Staff
William (Bill) Carroll, Mitigation Planner
Maryland State National Flood Insurance Program Coordinator
Dave Guinet, State NFIP Coordinator
Kevin Wagner, State NFIP Planner
FEMA Region III, Community Mitigation Division
Therese Grubb
Elizabeth Ranson
Matthew McCullough
Dewberry and Davis, LLC Team
Deborah Mills, CFM
Carrie Speranza, CFM, PEM
Jane Sibley Frantz, CFM, AICP
Rachael Heltz-Herman, CFM
Ryan Towell
Julia Moline, EIT, CFM
Janna Newman, CFM
Mark Matulik, CFM
James Mawby, CFM
Ray Miller
Marcus Martin
Jake Jarosz
S&S Planning Team
Virginia (Ginny) Smith
Michele King
VANTIX
Ken Pittman

2.3 Mitigation Advisory Committee

The Maryland Mitigation Advisory Committee is a standing committee which advises the Maryland Hazard Mitigation Program on mitigation grant subapplication prioritization and mitigation planning policy issues. They have served as the key technical advisors on mitigation program matters to MEMA for the past decade. The MAC is made up of representatives of key state agencies whose programs and interests are integral to implementation of the state's hazard mitigation program. The Committee met on several occasions to discuss the plan development process and guide the overall update of the 2008 plan document. Nearly every member of the MAC attended the June 15 and July 20, 2011 Stakeholder meetings and provided data, specific plan section reviews, and other technical support throughout the planning process. The members of the Mitigation Advisory Committee are:

Table 2-2. Mitigation Advisory Committee

Committee Member	Agency
Catherine McCall	Maryland Department of Natural Resources
Kevin Wagner	Maryland Department of the Environment
Ed Landon	Maryland Department of Housing and Community Development
Jesse Ash	Maryland Department of Planning
Joy Hatchette	Maryland Insurance Administration
Kevin Wagner	Maryland Department of the Environment/NFIP Program Planner
Margaret Fisher	Maryland Department of General Services
Mark Harris	Maryland Department of Transportation
Mia Liley	Maryland State Treasurer's Office
Pam Spring	Maryland Department of Human Resources
Tim LaValle	Maryland Business and Economic Development
Jeff Allenby	Maryland Department of Natural Resources

2.4 Stakeholder Involvement and Meetings

The involvement of a large array of stakeholders during the planning process was considered a vital element to the success in developing a FEMA-compliant plan. Traditional agency stakeholders were sought from state and federal agencies and local jurisdictions across the state. These stakeholders evolved into mitigation planning experts who provided critical input to each step in the plan update process. They shared inventories of state facilities, database layers identifying risk to structures from various hazards, and participated in the refinement of the 2008 mitigation goal and development of 2011 mitigation actions.

The 2011 Maryland State Hazard Mitigation Plan involved five meetings:

- A preliminary project management meeting with MEMA, FEMA, the MAC and Dewberry
- A project Kick-off meeting with MEMA, FEMA, and Dewberry
- The June 15, 2011 Stakeholder Vulnerability Analysis/Mitigation Actions meeting
- The July 20, 2011 Final Plan Review Meeting
- The August 8 -10, 2011 MEMA, FEMA and Contractor Final Plan Compliance Review Meeting

Stakeholders participated in two of these meetings at the MEMA facility during the two and a half month planning process. These meetings provided a forum for discussion on hazard identification and assessment methods for a variety of hazards, and the refinement and development of the plan goals and strategies. Please refer to Appendix E for documentation on all of the Committee Meetings. The following is a synopsis of the planning process meetings:

2.4.1. Preliminary Project Management Meeting

March 3, 2011

On March 3, 2011 MEMA, FEMA Region III and the Dewberry Project Manager met to outline the tentative project schedule. At this time, MEMA outlined project expectations and the schedule necessary to ensure seamless state eligibility for the FEMA post-disaster Public Assistance Program as well as FEMA Hazard Mitigation Assistance (HMA) grant programs.

On the afternoon of March 3, 2011 members of the MAC met with MEMA, FEMA and Dewberry for a briefing on the project. At this time, the first "data call" was issued and MAC member's "desired outcomes" for the 2011 plan update and plan outreach opportunities were solicited. It should be noted that several participants in this meeting provided data early in the process which allowed the contractor to begin the Vulnerability Analysis update.

2.4.2. Project Kick-off Meeting

May 12, 2011

The kick-off meeting was hosted by the Acting State Hazard Mitigation Officer, Mark James. The Maryland Mitigation Planner, Bill Carroll as well as the Recovery and Mitigation Manager, John Zeller attended this meeting. In addition, FEMA Region III's Tess Grubb, Betsy Ranson and Matt McCullough were in attendance. Dewberry was represented by Deborah Mills, Rachael Heltz-Herman, Ryan Towell and James Mawby.

At the kick-off meeting, the requirements of Section 322 of the 2000 Stafford Act were discussed among MEMA, FEMA and the Contractor, to assure that all requirements would be met during the compressed schedule. Dewberry presented the West Virginia 2010 Vulnerability Analysis results so that MEMA would have a sense of the possible data analyses that could be provided in this plan update. Additional tools and templates were also presented and ranking formulas were confirmed so that the weighting algorithm could be finalized to hasten the hazard ranking process.

Additional topics covered during the meeting included:

- Project Schedule
- FEMA state hazard mitigation plan update rule requirements
- Hazard Identification, Risk Assessment and Vulnerability Analysis Update
  - Data Needs
  - Confirmation of hazards to profile (modified from 2008 plan)
  - Ranking protocols
  - Map templates
  - Climate change and sea level rise
  - Social Vulnerability
- Organization of HMA Grant data, MS Excel Workbooks, Tools
- Outreach Methods – Website, Public Survey, Regional Outreach Open Houses
- Finalization of June 15, 2011 Vulnerability Analysis/Strategies Meeting Date

- Finalization of July 20, 2011 Final Plan Review Meeting Date
- Communication, Next Steps

2.4.3. Draft HIRA Presentation and Goals and Strategies Development Meeting

June 15, 2011

The Hazard Identification, Risk Assessment (HIRA) and resultant Vulnerability Analysis was the focus of the first Stakeholders Meeting, conducted just five weeks following the project kick-off meeting. The hazard identification and risk assessment was revised resulting in a critical facilities-specific Vulnerability Analysis. Discussion was lively as participants began to understand the relative scope of Maryland's natural hazards risks since the previous analysis ranked hazards without consideration of population data. The second half of the meeting focused on the refinement and development of the plan goal and initial development of mitigation actions in five subcommittees.

Figure 2-1. Draft HIRA Meeting.

2011 Maryland State Hazard Mitigation Plan Update Goal

To protect life, property, and the environment from hazard events through:
– Increased public awareness of hazard events, mitigation and preparedness.
– Enhance coordination with jurisdictions to develop a relationship at the state and local level.
– Efficient use of State resources.

It was evident that subcommittees organized by MEMA and Stakeholder interest and expertise could most effectively develop mitigation actions based on the newly defined hazard vulnerabilities. Subcommittee structure was configured to the following subcommittees:

- Mitigation of High Hazard Structures
- Policy, Planning, and Funding
- 2014 Vulnerability Assessment
- Local Planning Interface
- Education & Outreach

The subcommittees met following lunch and each was supported by a contractor facilitator and recorder who guided the group as they developed mitigation actions to address the natural hazard vulnerabilities presented at the meeting. These were refined during the next two weeks during conference calls and WebEx meetings; which included use of the STAPLEE analysis to rank each action. The groups worked on mitigation actions, strategies and projects which can be found in Chapter 4 and Appendix I.

Table 2-3. STAPLE/E Review and Selection Criteria for Alternatives

Social
• Is the proposed action socially acceptable to the community(ies)? • Are there equity issues involved that would mean that one segment of a community is treated unfairly? • Will the action cause social disruption?
Technical
• Will the proposed action work? • Will it create more problems than it solves? • Does it solve a problem or only a symptom? • Is it the most useful action in light of other community(s) goals?
Administrative
• Can the community(ies) implement the action? • Is there someone to coordinate and lead the effort? • Is there sufficient funding, staff, and technical support available? • Are there ongoing administrative requirements that need to be met?
Political
• Is the action politically acceptable? • Is there public support both to implement and to maintain the project?
Legal
• Is the community(ies) authorized to implement the proposed action? Is there a clear legal basis or precedent for this activity? • Are there legal side effects? Could the activity be construed as a taking? • Is the proposed action allowed by a comprehensive plan, or must a comprehensive plan be amended to allow the proposed action? • Will the community(ies) be liable for action or lack of action? • Will the activity be challenged?
Economic
• What are the costs and benefits of this action? • Do the benefits exceed the costs? • Are initial, maintenance, and administrative costs taken into account? • Has funding been secured for the proposed action? If not, what are the potential funding sources (public, non-profit, and private)? • How will this action affect the fiscal capability of the community(ies)? • What burden will this action place on the tax base or local economy? • What are the budget and revenue effects of this activity? • Does the action contribute to other community goals, such as capital improvements or economic development? • What benefits will the action provide?
Environmental
• How will the action affect the environment? • Will the action need environmental regulatory approvals? • Will it meet local and State regulatory requirements? • Are endangered or threatened species likely to be affected?

2.4.4. Final Plan Review Meeting

July 20, 2011

Richard Muth, MEMA Director, kicked off the Final Plan Review Meeting with a summary of how the new plan vulnerability analysis could be used for more robust emergency management and mitigation efforts throughout the state. During the meeting the regional public outreach workshop results were presented and the final flooding HAZUS-MH analysis results were presented to attendees who included the MAC and state and local agency stakeholders. After the Outreach and HAZUS presentations, meeting participants were randomly divided into subgroups and facilitated through a discussion of the draft plan contents. These breakout groups were designed to allow for a more intimate question/answer review session on the draft plan. Where suggested comments and changes were brought to the facilitator's attention, sections of the draft plan were altered appropriately.

2.4.5. Final Plan Compliance Review Meeting

August 8-10, 2010

For the final meeting, MEMA set up a "war room" for a three-day meeting between MEMA, FEMA and Dewberry to ensure that all MEMA and FEMA requirements and expectations were met during the planning process and in the final plan draft. Due to time constraints, the usual 45-day FEMA review period suggested by *44 Code of Federal Regulations* was not available so MEMA, FEMA and Contractor staff reviewed and edited the plan together to ensure that a fully compliant plan could be conditionally approved by FEMA, adopted by the Governor and formally approved by FEMA prior to plan expiration. The Contractor team project manager attended the meeting with other essential team members available via conference call and WebEx to make corrections so that a seamless revision was accomplished in digital format with full version control.

2.5. Hazard Mitigation Stakeholder Communication

The Hazard Mitigation Plan Update Stakeholders and MAC consisted of more than 100 individuals who were invited to participate in the planning process. They attended the planning meetings, participated in subcommittee web-ex conference calls, and provided comments throughout the plan update process. Communication was conducted through the use of email and a password secure SharePoint project site where documents and planning templates were posted for population and review by council members and MEMA mitigation staff. The Contractor established a dedicated SharePoint website and an FTP site. These sites were used to facilitate the transfer and archival of project documentation. These documents were not always intended to be public documents, so access was restricted via username and password for both sites. Stakeholders were each given the information necessary in order for them to access this information.

July 20 - Participants discuss the Plan Draft in a break-out group.

A screen capture of the SharePoint site follows:

Figure 2-2. SharePoint Site Screenshot.

In addition, agency profiles were developed through agency contacts and research. Profiles were completed by agency stakeholders and characterized their agency's role in mitigation planning. Agency profiles taken from each agency's website on the MAC can be found below in Table 2-3; complete agency profiles can be located in Appendix D and the full listing of the Maryland Hazard Mitigation Council and contributors may be found in Appendix K.

Table 2-4. Mitigation Advisory Committee Agency Descriptions

Agency	Agency Description
Maryland Emergency Management Agency (MEMA)	The Maryland Emergency Management Agency (MEMA) was created by the Maryland legislature to ensure that the state is prepared to deal with large-scale emergencies. MEMA is responsible for coordinating the state's response in any major emergency or disaster. This includes supporting local governments as needed or requested, and coordinating assistance with the Federal Emergency Management Agency (FEMA) and other federal partners. The MEMA staff of emergency management professionals, which numbers in excess of 70 people, is divided into two directorates – Operations and Administration. The Operations Directorate includes exercise and training, planning, regional programs, mitigation and recovery, the Maryland Joint Operations Center, and critical infrastructure protection. The Administration Directorate handles agency logistics, personnel, supplies, fiscal services, grants managements, technology support, interoperability, and communications. The Executive Director's office manages all public affairs, direct interaction with the National Capital Region, and legislative activities. Through their mitigation and recovery process, MEMA strives to reduce or eliminate the impact of future disasters. Close coordination with local jurisdictions and other state agencies may result in responsible land use, appropriate changes to building codes, and suitable routes for hazardous material transportation. Proper planning and preparedness are the keys to surviving a disaster. Therefore by working together with local emergency managers their action plans become pivotal in saving resources, funds, and most importantly, lives.
Maryland Department of Natural Resources	The Department of Natural Resources leads Maryland in securing a sustainable future for the environment, society, and economy by preserving, protecting, restoring, and enhancing the State's natural resources. Agency-wide Objectives include: Healthy Terrestrial & Aquatic Ecosystems; Efficient Use of Energy & Resources; Citizen Stewardship, Outdoor Recreation, & Opportunities to Take Action; Vibrant Communities & Neighborhoods; Long-Term Economic Prosperity; Professional Commitment.
Maryland Department of the Environment	The mission of the Maryland Department of the Environment (MDE) is to protect and restore the quality of Maryland's air, water, and land resources, while fostering smart growth, economic development, healthy and safe communities, and quality environmental education for the benefit of the environment, public health, and future generations. In 1987 the Maryland Department of the Environment was created to protect and preserve the state's natural resources. In addition to restoring Maryland environment and safeguarding the environmental health of Maryland citizens, MDE's duties encompass enforcement and regulation, long-term planning and research, and technical assistance to industry and communities for pollution, growth issues, and environmental emergencies. The office of the State NFIP Coordinator is located in the Department. The NFIP Coordinator and Floodplain Management Planner support local government enforcement of the National Flood Insurance Program, and support HMA grants as a repository of repetitive loss and severe repetitive loss data. In addition, Maryland is a Cooperative Technical Partner (CTP), bringing match resources to the FEMA Risk MAP program that provides updated flood and coastal hazard data such as DFIRMS and Flood Insurance Studies for participating NFIP jurisdictions.

Agency	Agency Description
Maryland Department of Housing and Community Development	The Maryland Department of Housing and Community Development is proud to be at the forefront in implementing housing policy that promotes and preserves homeownership and creating innovative community development initiatives to meet the challenges of a growing Maryland. Such initiatives include: the Maryland Mortgage Program, which has empowered thousands of Maryland families to realize the homeownership; rental housing programs that increase and preserve the supply of affordable housing; and other community development and revitalization programs like Neighborhood Business Works, Community Legacy, and Main Street Maryland support Smart Growth and help our cities and towns remain rich, vibrant communities. DHCD remains committed to building on our past successes to maintain our reputation as an innovator in community revitalization and a national leader in housing finance.
Maryland Department of Planning	The Maryland Department of Planning (MDP) promotes growth that fosters vibrant, livable communities, preserves and protects the environment, and makes efficient use of State resources. MDP works to discourage growth that results in "sprawl" development. MDP provides data, trend analysis, research assistance, and policy development and implementation support for local governments, communities, businesses, and organizations. The Department provides technical assistance, local program review and planning design services for Maryland's counties and municipalities. As MDP monitors and forecasts changes in development and land use throughout the state, we create and produce research tools and resources to assist in planning for Maryland's future. Information on demographic, socio-economic, political, cultural, geographic and land-use trends is collected, analyzed, and distributed in multiple formats. With computer mapping and geographic information systems, MDP supports map display and analysis of census data, satellite imagery, aerial photography, land-use and parcel data to enhance and assist growth management and land-use planning across the State.
Maryland Insurance Administration	The MIA's goal is to provide fast, friendly, efficient, and effective service to the citizens and businesses of Maryland, both the purchasers of insurance and the insurance industry. The MIA best serves its two core constituents - the consumers and the sellers of insurance - by assuring fair treatment of consumers. Consumer protection begins by having insurance coverage available at fair prices and extends to issues of solvency and fair sales, claims and settlement practices. The Administration is committed to fairness in licensing and to the expeditious review of proposed new products and other filings. A viable competitive insurance industry is essential to our mission of consumer protection. Their regulatory and enforcement efforts strengthen the environment in which the insurance industry operates in Maryland and, hopefully, encourages the insurance industry to find more and better ways to protect the citizens and businesses of Maryland. Rigorous enforcement of all applicable statutes and regulations fosters a positive economic environment by assuring that those who comply with the law are not disadvantaged by those who seek to escape compliance.
Maryland Department of General Services	The mission of the Maryland Department of General Services is to provide leading-edge professional and technical services to keep State and local government working today and in the future. This is accomplished by creating safe and secure work environments; designing, building, leasing, managing and maintaining facilities; leading energy conservation efforts; procuring goods and services; and providing essential functions such as fuel management, disposition of surplus property and records storage.

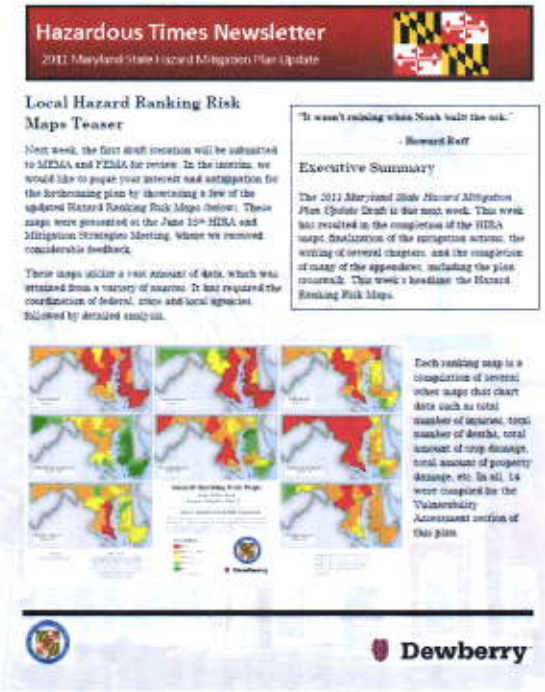
Agency	Agency Description
Maryland Department of Transportation	MDOT directs and oversees the planning, construction and operation of Maryland's highway, transit, maritime and aviation facilities, as well as the Maryland Motor Vehicle Administration. All five modes fall under the direction of the Transportation Secretary. They are funded by a common funding source, Maryland's Transportation Trust Fund. The Transportation Trust Fund is separate from the state's general fund with its revenues dedicated to operating Maryland's world-class transportation network. MDOT provides services such as the State Highway Administration, the Maryland Transit Administration, the Maryland Port Administration, the Maryland Aviation Administration and the Maryland Motor Vehicle Administration. You also will find a link to our sister agency, the Maryland Transportation Authority that operates the state's seven toll facilities.
Maryland State Treasurer's Office	The State Treasurer's Office organization includes an Executive Office and seven Divisions, Administration, Banking Services, Data Processing, Debt Management, Insurance, Investments, and the Legal Office. The Treasurer is the principal custodian of the State's cash deposits, monies from bond sales, and other securities and collateral and directs the investments of those assets. The Treasurer's duties include maintaining an ongoing relationship with the rating agencies, conducting outreach with State Agencies, keeping legislators informed of the operations of the State Treasurer's Office, and serving on numerous boards and commissions including the Board of Public Works, the State's highest administrative council. The Treasurer is elected by a joint ballot of both houses of the General Assembly.
Maryland Department of Human Resources	The mission of the Department of Human Resources supports a state where people independently support themselves and their families and where individuals are safe from abuse and neglect. The agency I aggressively pursues opportunities to assist people in economic need, provide prevention services, and protect vulnerable children and adults. Programs include: Foster Care/Adoption, Child Protective Services, Food Assistance, Energy Assistance, Child Support, Medical Assistance/Health Coverage, and Purchase of Care.
Maryland Business and Economic Development	Maryland's one-stop economic development shop strives to attract new businesses, stimulate private investment, encourage the expansion and retention of existing companies and provide Maryland business with workforce training and financial assistance. The Department markets local products and services at home and abroad. One of 20 agencies within Maryland's Executive Branch, the Department has 237 employees and an FY2010 budget of $85.6 million.

2.5 Public Outreach

Public outreach was led by the State Hazard Mitigation Division, the Chief Technological Officer, the Web Administrator, and the MEMA Public Information Officer, and the Contractor. Dewberry's sub-contractor, S&S Planning and Design, LLC coordinated regional outreach workshops. Another sub-contractor, VANTIX, supported development of web-based materials. These outreach efforts involved the publication of information in the form of a weekly e-newsletter, a public outreach website, an online survey, several regional open houses, and press releases. Appendix O presents the full catalogue of Outreach e-newsletters, results of the Outreach Workshops, the plan press release and screen shots of the MEMA website.

2.5.1. Hazardous Times Newsletter

Beginning on June 3, 2011, a weekly e-newsletter was distributed to all plan update Stakeholders. These newsletters included updates on the progress of the Hazard Identification and Risk Analysis process, follow-up on the 2008 mitigation actions, other outreach components including the website and Regional Workshops, updating to the current capabilities assessment, solicitation for project scoping, contact information for project managers and personnel, information on the FTP and SharePoint sites, and any other information pertaining to the 2011 Maryland All-Hazard Mitigation Plan Update process. These newsletters have been archived in Appendix O – Outreach and Education.



2.5.2. Project Website

The project website was designed and implemented through MEMA Web Administrators, as well as one of the project Subcontractors, VANTAX. It included a brief synopsis of what the State Hazard Mitigation Plan is, why it needs to be reviewed, and who is responsible for reviewing it, followed by several maps resulting from the Hazard Identification and Risk Analysis process, Hazard Ranking Maps, information on upcoming Open House meetings, and a link to the survey. Finally, it solicits comments and suggestions on the plan, and lists an email address for that purpose.

Additional information on the Outreach Website is contained in Appendix O – Outreach and Education.

2.5.3. Public Survey

This aspect of public outreach was conducted in both print and electronic formats. The two surveys were designed separately, each targeting a separate audience. The survey that linked to the project outreach website developed by VANTIX was intended for distribution to the general public. As such, it asked nontechnical questions intended for the average Maryland constituent.

The second survey was targeted towards emergency management professionals and planners. It was distributed via email to MEMA and Planning Associations. It was also distributed in print format at the regional open house outreach meetings. The online survey was created using the web survey facilitator, Survey Monkey. This website does all of the electronic tabulation and ensures accurate tracking of surveys taken.

2.5.4. Regional Outreach Workshops

As part of the process to update to the *2011 Maryland State Hazard Mitigation Plan Update*, outreach efforts targeted organizations outside of state government with an interest in hazard mitigation were conducted within the five MEMA designated regions. However, due to the number of jurisdictions within the Eastern Region, the region was divided into the Upper and Lower Eastern Regions as shown on the map below.

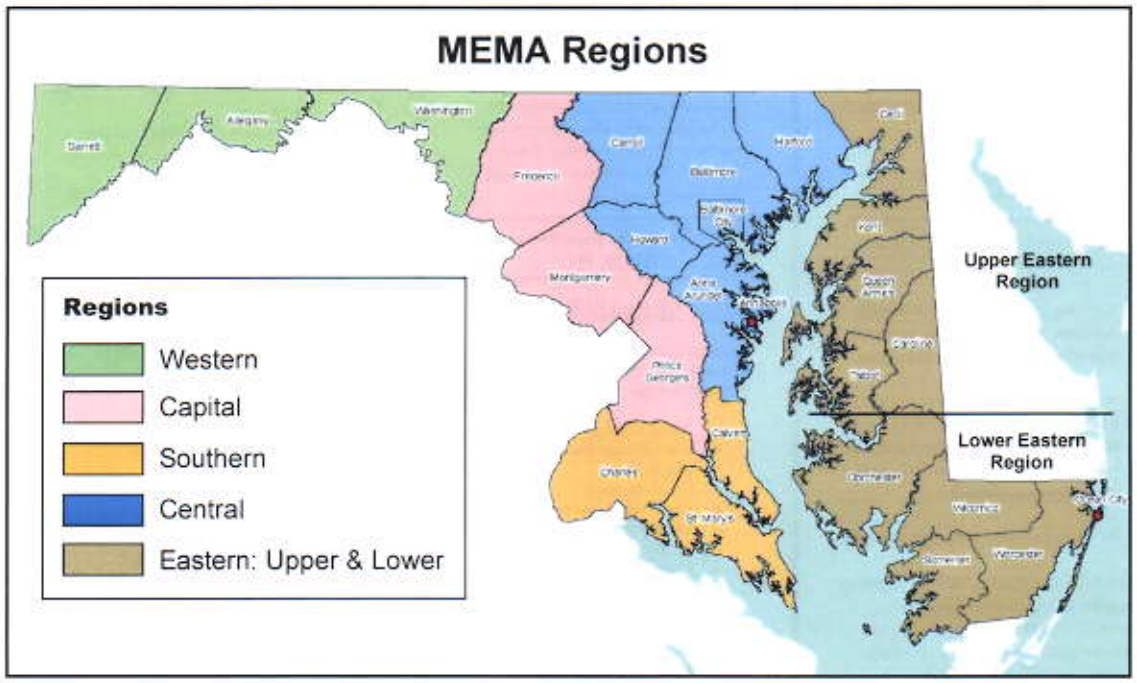
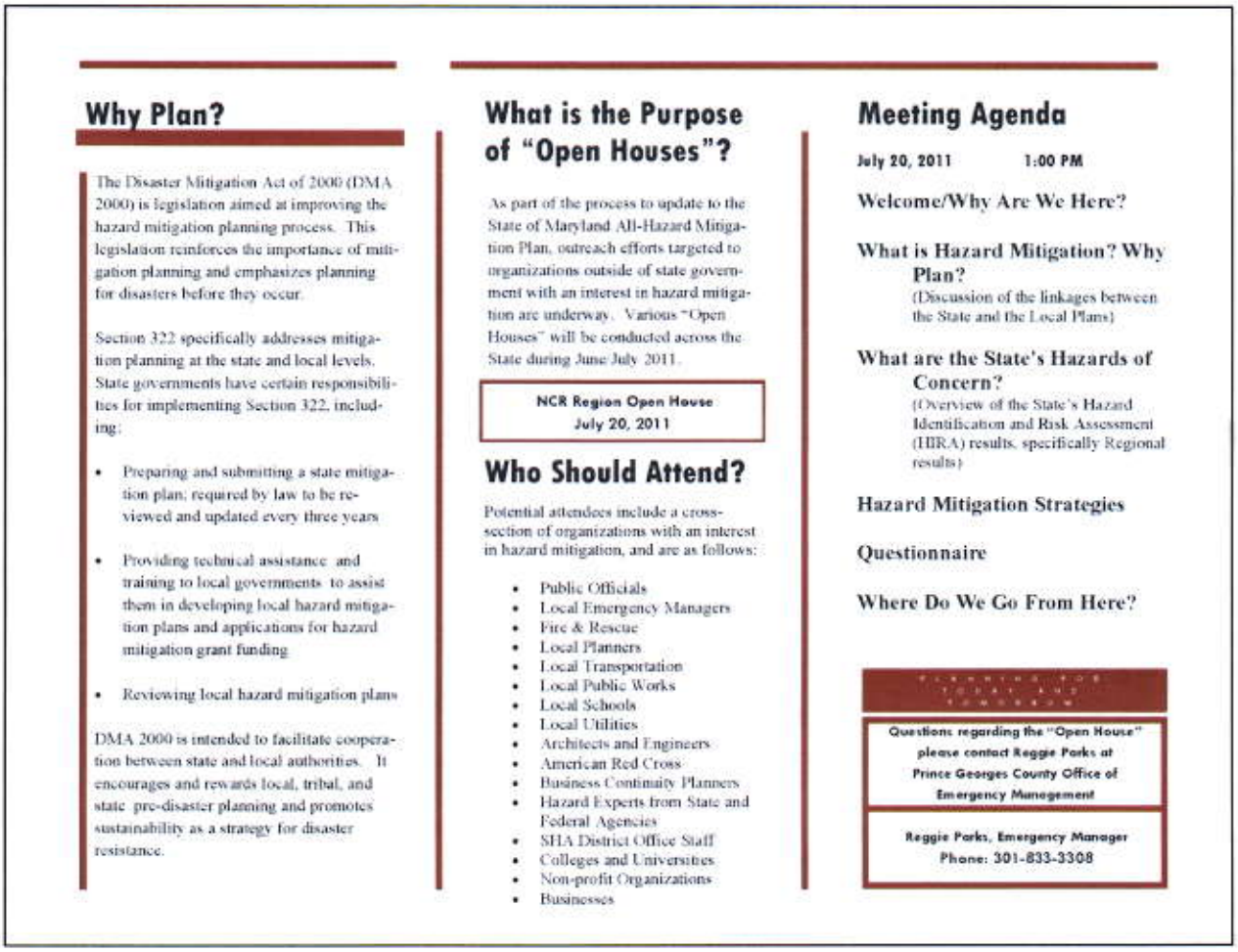


Figure 2-3. MEMA Regions

Open Houses were conducted throughout around the state were held in June and July of 2011. Invitees included a cross section of organizations with an interest in hazard mitigation, and were as follows:

- Public Officials
- Local Emergency Managers
- Fire & Rescue
- Local Planners
- Local Transportation
- Local Public Works
- Local Schools
- Local Utilities
- Architects and Engineers
- American Red Cross
- Business Continuity Planners
- Hazard Experts from State & Federal
- SHA District Office Staff
- Colleges and Universities
- Non-profit Organizations
- Businesses

To maximize participation and coordination, MEMA Regional Administrators worked with the counties within their Region to determine the date, time and meeting location for their Region's Open House. Following the establishment of the meeting logistics, each county was provided an email invitation and brochure for distribution. Each brochure contained a local point of contact, ensuring that invitees had the opportunity to obtain additional information from a designated contact within their own jurisdiction. This level of coordination conveyed the partnership and linkage between the State and Local hazard mitigation planning update process.



Why Plan?

The Disaster Mitigation Act of 2000 (DMA 2000) is legislation aimed at improving the hazard mitigation planning process. This legislation reinforces the importance of mitigation planning and emphasizes planning for disasters before they occur.

Section 322 specifically addresses mitigation planning at the state and local levels. State governments have certain responsibilities for implementing Section 322, including:

- Preparing and submitting a state mitigation plan; required by law to be reviewed and updated every three years
- Providing technical assistance and training to local governments to assist them in developing local hazard mitigation plans and applications for hazard mitigation grant funding
- Reviewing local hazard mitigation plans

DMA 2000 is intended to facilitate cooperation between state and local authorities. It encourages and rewards local, tribal, and state pre-disaster planning and promotes sustainability as a strategy for disaster resistance.

What is the Purpose of "Open Houses"?

As part of the process to update to the State of Maryland All-Hazard Mitigation Plan, outreach efforts targeted to organizations outside of state government with an interest in hazard mitigation are underway. Various "Open Houses" will be conducted across the State during June/July 2011.

NCR Region Open House
July 20, 2011

Who Should Attend?

Potential attendees include a cross-section of organizations with an interest in hazard mitigation, and are as follows:

- Public Officials
- Local Emergency Managers
- Fire & Rescue
- Local Planners
- Local Transportation
- Local Public Works
- Local Schools
- Local Utilities
- Architects and Engineers
- American Red Cross
- Business Continuity Planners
- Hazard Experts from State and Federal Agencies
- SHA District Office Staff
- Colleges and Universities
- Non-profit Organizations
- Businesses

Meeting Agenda

July 20, 2011 1:00 PM

Welcome/Why Are We Here?

What is Hazard Mitigation? Why Plan?
(Discussion of the linkages between the State and the Local Plans)

What are the State's Hazards of Concern?
(Overview of the State's Hazard Identification and Risk Assessment (HIRA) results, specifically Regional results)

Hazard Mitigation Strategies

Questionnaire

Where Do We Go From Here?

Questions regarding the "Open House" please contact Reggie Parks at Prince Georges County Office of Emergency Management

Reggie Parks, Emergency Manager
Phone: 301-833-3308

Figure 2-4. Regional Open House Brochure.

In order to adequately discuss the *2011 Maryland State Hazard Mitigation Plan Update* process, a presentation of background information specific to hazard mitigation was necessary and yielded audience comments. This information included examples of hazard mitigation from various agency perspectives, such as Public Works, Planning, and the Board of Education perspectives, just to name a few. The benefits of hazard mitigation and how mitigation has been implemented by their own jurisdictions were discussed at the Open Houses as well.

Western Region Open House
Date: 29 June 2011
Time: 9-10:30 AM
Location: Allegany County Public Safety Building; 11400 PPG Road SE; Cumberland, MD 21502
Western Region Jurisdictions: Garrett, Allegany, Washington

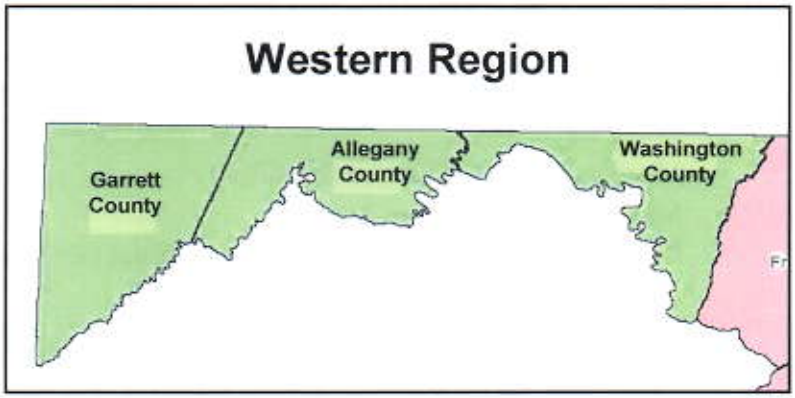


Figure 2-5. Western Region

The Regional Outreach Workshops were conducted in an "open house" manner featuring a PowerPoint presentation and a facilitated comment/response session.

The presentation's focus was the results of the Maryland Hazard Identification and Risk Assessment (HIRA), specifically the results for that specific region's counties. Each Region's participants were pleased to learn that their local HIRA results had been incorporated into the scoring system utilized in the State's HIRA. However, concerns were voiced by some of the rural Regions as to the use of population and population density in the HIRA scoring system ranking parameters. Participants questioned whether or not variables such as household income and the age of housing stock were considered in the planning process. In fact, social vulnerability has been considered and incorporated in the planning process using data from the American Communities Survey, 2005-2009 estimates data. Following the HIRA presentation participants were given a questionnaire and a comment/response session ensued. The questionnaires were discussed by the overall group; however each participant completed and submitted their forms prior to departure.

FOR IMMEDIATE RELEASE
MEDIA ADVISORY
July 21, 2011

Highlights of the 2011 Maryland State Hazard Mitigation Plan Update

2011 Maryland All-Hazard Mitigation Plan Update

Figure 2-6. Press Release

2.5.5. Media

The Maryland Emergency Management Agency's Public Information Office issued a press release on the MEMA website. This article targeted the Maryland constituency in order to attract attention and solicit input on the 2011 Maryland State Hazard Mitigation Plan Update.

2.6 State Planning Integration

The development of the *2011 Maryland State Hazard Mitigation Plan Update* incorporated other State-level planning initiatives into the planning process, hazard analysis and mitigation actions. The following documents were reviewed, and information integrated, where appropriate. Detailed information about these plans can be found in the Capability Assessment section of this plan:

- Maryland Energy Assurance Draft Plan
- Maryland Sheltering Gap Analysis
- Local Hazard Mitigation Plans and Plan Updates (see Chapter 5)

3.0 Hazard Identification, Risk Assessment (HIRA) and Vulnerability Analysis

3.1 Declared Disasters and National Climatic Data Center (NCDC) Events

An important source for identifying hazards that can affect a state is the record of federal disaster declarations. According to FEMA, since 1962 there have been 23 major disaster declarations for Maryland.

NCDC *Storm Data* is published by the National Oceanic and Atmospheric Administration (NOAA), U.S. Department of Commerce. The storm events database contains information on storms and weather phenomena that have caused loss of life, injuries, significant property damage, and/or disruption to commerce.

3.1.1 Federally Declared Disasters

Local and State governments share the responsibility for protecting their citizens and for helping them recover when a disaster strikes. In some cases, a disaster is beyond the capabilities of the state and local government to respond. In 1988, the Robert T. Stafford Disaster Relief and Emergency Assistance Act was enacted to support state and local governments and their citizens when disasters overwhelm them and exhaust their resources. This law, as amended, established a process for requesting and obtaining a Presidential disaster declaration, defines the type and scope of assistance available from the Federal government, and sets the conditions for obtaining that assistance.[1]

The steps to a Presidential Disaster Declaration are as follows:

1. Local governments respond, supplemented by neighboring communities through mutual aid agreements and volunteer agencies. If overwhelmed, the local government requests aid from the State;
2. The State responds with state resources, such as its response team, the National Guard and other state agencies;
3. A Rapid Needs Assessment (RNA) which focuses on lifesaving needs, immanent hazards, and critical lifelines is performed, usually within the first 24 hours of an event;
4. An Initial Damage Assessment (IDA) is performed by the local government, which evaluates damages to residences, businesses, and public infrastructure (i.e., roads, bridges, public utilities, etc.);
5. IDAs determine if there is sufficient damage to warrant a Joint Preliminary Damage Assessment (PDA) which consists of local, state, and federal staff verifying the IDAs to determine if enough damage exists to warrant federal recovery assistance;

[1] *A Guide to the Disaster Declaration Process and Federal Disaster Assistance*. FEMA March 4, 2008.

6. A Major Disaster Declaration is requested from the Governor to FEMA Region III which evaluates the request and provides recommendations to the President based on the RNA and PDAs and the type of federal assistance requested;
7. Depending on the nature of the disaster and the type of assistance being requested, a Presidential declaration could be approved within hours or may take weeks;
8. A Presidential Declaration can also be approved prior to an event (i.e. hurricane or significant winter storm) if it anticipated that the damage will be severe in order to pre-position resources; and
9. Federal funds for post disaster Hazard Mitigation Grant Program projects based on 15 percent of the Stafford Act disaster recovery assistance that is provided to the jurisdictions statewide.

Recent disasters have focused the attention of Maryland's citizens and government officials on the resultant human, economic and environmental impacts. During the past decade, Maryland has experienced eight events warranting Presidential Disaster declarations. Two have been declared in 2010; both were winter storms, the first one occurred in late in 2009 and the second in February 2010. Figure 3-1 shows the total declared disasters by county. Flood and Winter Storm represent the majority of Federally Declared Disasters in Maryland. Appendix P includes the methodology used to group the declared disasters into the hazard groupings used for analysis as well as full size maps of these events.

Table 3-1 summarizes the federally declared disasters and emergencies that have occurred from 1962 to February 2010. Historically, flooding has caused the most damage to the state and its citizens.

A brief summary of selected declared disasters is highlighted below:

- The entire state of Maryland felt the impact of a major winter storm system that hit during the first weeks of February 2010. This system, referred to as 'snowmageddon' dumped 1-3 feet of snow to the area and in some places over 3 feet. In many cases historic accumulations were recorded. The excessive snowfall totals were also aided by a very unstable atmosphere which led to the presence of thundersnow which usually signals intense snowfall rates. DR 1910 was declared for this event.
- Almost $25 million in grant money was provided to the 12 affected counties of the December 18-20, 2009 winter storms. At the highest peak, the storm snow was falling at a rate of two inches an hour. Some areas, particularly in Southern Maryland, experienced wind gusts up to 40 mph. DR 1875 was declared for this event.
- Caroline, Dorchester and Montgomery Counties were impacted by the severe storms, flooding and tornadoes remnants of a tropical system from the Atlantic. High rainfall accumulation and high winds speeds were present. $8.3 million was provided in public assistance to help with the recovery efforts.

Table 3-1. Federally declared disasters 1962 – 2010.

Disaster Number	Date Declared	Incident Period	Description	Number of Counties Declared
1910	05/06/2010	02/5/2010 - 02/11/2010	Severe Winter Storms and Snowstorms	IA=0 PA=22 HMGP=24
1875	02/19/2010	12/18/2009 - 12/20/2009	Severe Winter Storms and Snowstorms	IA=0 PA=12 HMGP=24
1652	07/02/2006	06/22/2006 - 07/12/2006	Severe Storms, Flooding and Tornadoes	IA=0 PA=3 HMGP=24
3251	09/13/2005	08/29/2005 - 10/1/2005	Maryland Hurricane Katrina Evacuation	IA=0 PA=24 HMGP=24
1492	09/19/2003	09/18/2003 - 09/29/2003	Hurricane Isabel	IA=24 PA=24 HMGP=24
3179	03/14/2003	02/14/2003 - 02/23/2003	Snowstorm	IA=0 PA=20 HMGP=0
1409	05/01/2002	04/28/2002 - 04/28/2002	Tornado	IA=3 PA=2 HMGP=24
1324	04/10/2000	01/25/2000 - 01/30/2000	Winter Storm	IA=0 PA=15 HMGP=0
1303	09/24/1999	09/16/1999 - 09/20/1999	Hurricane Floyd	IA=11 PA=11 HMGP=24
1139	09/17/1996	09/6/1996 - 09/9/1996	Hurricane Fran	IA=2 PA=2 HMGP=0
1094	01/23/1996	01/19/1996 - 01/31/1996	Flooding	IA=6 PA=5 HMGP=0
1081	01/11/1996	01/6/1996 - 01/12/1996	Blizzard	IA=0 PA=24 HMGP=0
1016	03/16/1994	02/8/1994 - 02/18/1994	Ice Storms, Severe Storm, Winter Storm	IA=0 PA=9 HMGP=0
3100	03/16/1993	03/13/1993 - 03/17/1993	Severe Snowfall and Winter Storm	IA=0 PA=24 HMGP=0
839	08/28/1989	06/14/1989 -	Severe Storms, High Winds	IA=0

Disaster Number	Date Declared	Incident Period	Description	Number of Counties Declared
		06/15/1989		PA=1 HMGP=0
773	09/10/1986	11/4/1985 - 11/6/1985	Severe Storms, Flooding	IA=0 PA=1 HMGP=0
601	09/14/1979	09/14/1979 - 09/14/1979	Severe Storms, Tornados, Flooding	IA=5 PA=5 HMGP=0
524	01/26/1977	01/26/1977 - 01/26/1977	Ice Conditions	IA=0 PA=0 HMGP=0
522	10/14/1976	10/14/1976 - 10/14/1976	Severe Storms, Flooding	IA=2 PA=2 HMGP=0
489	10/04/1975	10/04/1975 - 10/04/1975	Heavy Rains, Flooding	IA=13 PA=13 HMGP=0
341	06/23/1972	06/23/1972 - 06/23/1972	Tropical Storm Agnes	IA=21 PA=21 HMGP=0
309	08/17/1971	08/17/1971 - 08/17/1971	Severe Storms, Flooding	IA=9 PA=9 HMGP=0
127	03/09/1962	03/9/1962 - 03/9/1962	Severe Storms, High Tides, Flooding	IA=0 PA=0 HMGP=0

3.1.2 NCDC

The NCDC data provides information about events from 1950 to November 2010. Records for the majority of weather events were reported starting in 1993, with the exception of tornado (reports date to 1950), thunderstorm and hail (reports date to 1956). Figure 3-2 shows a graphical breakdown of the number of events reported in the database by year and Figure 3-3 shows a breakdown of the events by month.

NCDC is known to have spotty recording of geological hazards (i.e., earthquake, landslide, karst). In the absence of better data it was decided to proceed with the records available in NCDC for these events. In all cases NCDC records for these events are significant under-representations of what has happened in Maryland's past. Efforts were made to contact the correct state representative for these hazards to see if better data sources of historical accounts were available. Wildfire incidents have been used to supplement the ranking, as discussed later in this section.

Appendix P includes the methodology that was used to process the NCDC events to be able to use them for the ranking analysis (described in section 3.5). Processing included normalizing records to account for zonal events, inflating damages into 2011 dollars, annualizing the data to be able to compare hazards to each other and compiling the NCDC event types into the hazard types used in the analysis.

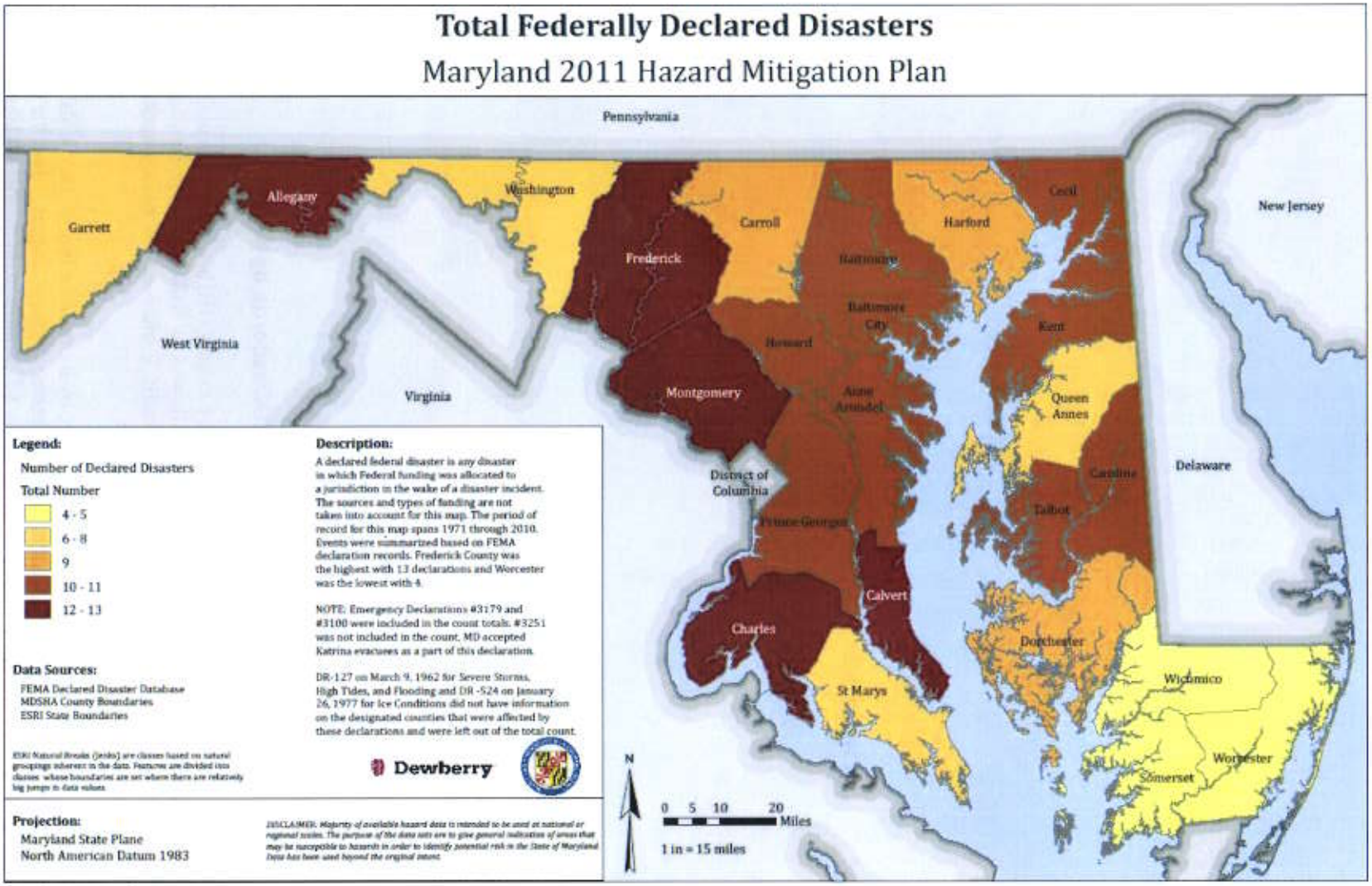


Figure 3-1. Total of all Federally Declared Disasters in Maryland (1962-2011).

Figure 3-2. Total number of NCDC records by year.

Figure 3-3. Total number of NCDC records by month.

Figure 3-4 shows the total number of NCDC events, by county. High wind events make up more than 47.5 percent of the events for the jurisdictions, followed by hail Thunderstorm (lightning and hail) (16.7 percent) and flooding (16.2 percent). Appendix P includes the hazard specific NCDC total maps for the hazards addressed in this plan update.

Table 3-2 shows the normalized sum of all the counties, by hazard, for the NCDC fields of interest. Each event in this table represents a storm event affecting a single county. For the hazards of interest, this database includes 7,006 events, close to $779 million in property damage, $17.3 million in crop damage, 944 injuries and 55 fatalities. The wildfire events have been supplemented

by MD Dept of Natural Resource Forest Service. Grand total values are not a direct sum of each of the county/city totals. The grand total events do not include zonal events as described in Section 3.3 and Section 3.5.

Table 3-3 and Table 3-4 show the total number of events and annualized events by county. These estimates are believed to be an underrepresentation of the actual losses experienced due to both hazards as losses from events that go unreported or that are difficult to quantify are not likely to appear in the NCDC database; this is especially true with crop damages.

Table 3-2. NCDC storm events normalized for zonal events and inflated.

Hazard Type	Period of Record	Number of Events	Property Damage (2011 $)	Crop Damage (2011 $)	Injuries	Deaths
Coastal Hazards	1993-2010	66	$109,050,194	$193,215	201	1
Drought	1995-2010	75	$0	$13,903,863	0	0
Flooding	1993-2010	1,179	$121,538,808	$1,400,983	64	16
Thunderstorm (Lightning & Hail)	1956-2010	1,216	$33,461,165	$821,890	73	13
Tornado	1950-2010	339	$463,257,911	$719,906	314	7
Wildfire (MD FS)	2001 - 2006 (1998 – 2010)	10 (7,052)	$0 ($320,326)	$0 (combined)	2 (33)	0 (1)
High Winds	1956-2010	3,462	$47,362,158	$306,871	122	8
Winter Weather	1993-2010	659	$4,307,752	$13,620	168	10

Table 3-3. NCDC storm total events and inflated (not normalized for zonal events).

County/City	Coastal Hazards	Drought	Flooding	Thunderstorm (Lightning & Hail)	Tornado	Wildfire (from MD FS)	High Winds	Winter Storm
Years of Record	**1993-2010**	**1995-2010**	**1993-2010**	**1956-2010**	**1950-2010**	**1998 - 2010**	**1956-2010**	**1993-2010**
Allegany County	1	10	50	28	7	407	144	185
Anne Arundel County	14	13	72	95	20	37	290	75
Baltimore County	12	20	95	91	21	119	267	209
Calvert County	11	12	33	43	16	374	132	47
Caroline County	6	42	51	17	7	421	144	76
Carroll County	1	8	59	59	14	53	196	123
Cecil County	2	38	81	30	16	403	198	105
Charles County	9	13	33	77	25	1016	199	61
Dorchester County	8	2	16	25	12	673	69	46
Frederick County	2	11	100	74	31	381	275	118
Garrett County	1	2	53	33	11	238	96	121
Harford County	5	9	57	69	24	271	163	103
Howard County	1	13	59	35	9	40	135	89

County/City	Coastal Hazards	Drought	Flooding	Thunderstorm (Lightning & Hail)	Tornado	Wildfire (from MD FS)	High Winds	Winter Storm
Years of Record	**1993-2010**	**1995-2010**	**1993-2010**	**1956-2010**	**1950-2010**	**1998 - 2010**	**1956-2010**	**1993-2010**
Kent County	7	42	44	26	5	116	180	84
Montgomery County	1	14	112	147	21	74	331	114
Prince George's County	2	12	75	87	23	131	284	81
Queen Anne's County	7	42	51	13	8	275	174	87
St. Mary's County	11	12	52	62	18	495	149	43
Somerset County	8	2	7	19	5	218	46	39
Talbot County	8	42	51	29	8	345	160	75
Washington County	1	13	59	72	13	351	189	114
Wicomico County	6	2	14	29	9	470	93	43
Worcester County	19	2	17	28	13	144	72	73
City of Baltimore	10	9	48	19	4	-	121	93
Grand Total*	**66**	**75**	**1,179**	**1,216**	**339**	**7,052**	**3,462**	**659**

** Grand total values are not a direct sum of each of the county/city totals. The grand total events do not include zonal events as described in Section 3.3 and Section 3.5.*

Table 3-4. NCDC storm annualized events and inflated (not normalized for zonal events).

County/City	Coastal Hazards	Drought	Flooding	Thunderstorm (Lightning & Hail)	Tornado	Wildfire (from MD FS)	High Winds	Winter Storm
Years of Record	**1993-2010**	**1995-2010**	**1993-2010**	**1956-2010**	**1950-2010**	**1998-2010**	**1956-2010**	**1993-2010**
Allegany County	0.06	0.63	2.78	0.51	0.11	31.31	2.62	10.28
Anne Arundel County	0.78	0.81	4.00	1.73	0.33	2.85	5.27	4.17
Baltimore County	0.67	1.25	5.28	1.65	0.34	9.15	4.85	11.61
Calvert County	0.61	0.75	1.83	0.78	0.26	28.77	2.40	2.61
Caroline County	0.33	2.63	2.83	0.31	0.11	32.38	2.62	4.22
Carroll County	0.06	0.50	3.28	1.07	0.23	4.08	3.56	6.83
Cecil County	0.11	2.38	4.50	0.55	0.26	31.00	3.60	5.83
Charles County	0.50	0.81	1.83	1.40	0.41	78.15	3.62	3.39
Dorchester County	0.44	0.13	0.89	0.45	0.20	51.77	1.25	2.56
Frederick County	0.11	0.69	5.56	1.35	0.51	29.31	5.00	6.56
Garrett County	0.06	0.13	2.94	0.60	0.18	18.31	1.75	6.72

County/City	Coastal Hazards	Drought	Flooding	Thunderstorm (Lightning & Hail)	Tornado	Wildfire (from MD FS)	High Winds	Winter Storm
Years of Record	1993-2010	1995-2010	1993-2010	1956-2010	1950-2010	1998-2010	1956-2010	1993-2010
Harford County	0.28	0.56	3.17	1.25	0.39	20.85	2.96	5.72
Howard County	0.06	0.81	3.28	0.64	0.15	3.08	2.45	4.94
Kent County	0.39	2.63	2.44	0.47	0.08	8.92	3.27	4.67
Montgomery County	0.06	0.88	6.22	2.67	0.34	5.69	6.02	6.33
Prince George's County	0.11	0.75	4.17	1.58	0.38	10.08	5.16	4.50
Queen Anne's County	0.39	2.63	2.83	0.24	0.13	21.15	3.16	4.83
St. Mary's County	0.61	0.75	2.89	1.13	0.30	38.08	2.71	2.39
Somerset County	0.44	0.13	0.39	0.35	0.08	16.77	0.84	2.17
Talbot County	0.44	2.63	2.83	0.53	0.13	26.54	2.91	4.17
Washington County	0.06	0.81	3.28	1.31	0.21	27.00	3.44	6.33
Wicomico County	0.33	0.13	0.78	0.53	0.15	36.15	1.69	2.39
Worcester County	1.06	0.13	0.94	0.51	0.21	11.08	1.31	4.06
City of Baltimore	0.56	0.56	2.67	0.35	0.07	-	2.20	5.17

3.1.3 Hazards Addressed in HIRA

Based on review of the Federally Declared Disasters, NCDC data, previous versions of this plan, and local plan rankings, the following hazards are discussed and analyzed in this Chapter:

- Flooding (Section 3.7)
- Coastal Hazards (Section 3.8)
  - Hurricane and Tropical Storms
  - Nor'easter
  - Sea Level Rise
  - Tsunami
  - Shoreline Erosion
- High Winds (Section 3.9)
- Thunderstorm (Lightning & Hail) (Section 3.10)
- Tornado (Section 3.11)
- Winter Storm (Section 3.12)
- Wildfire (Section 3.13)
- Landslide (Section 3.14)
- Land Subsidence/Karst/Sinkholes (Section 3.15)
- Drought (Section 3.16)
- Earthquake (Section 3.17)
- Dam Failure (Redacted - Section 3.18)
- Mining Hazards (Section 3.19)

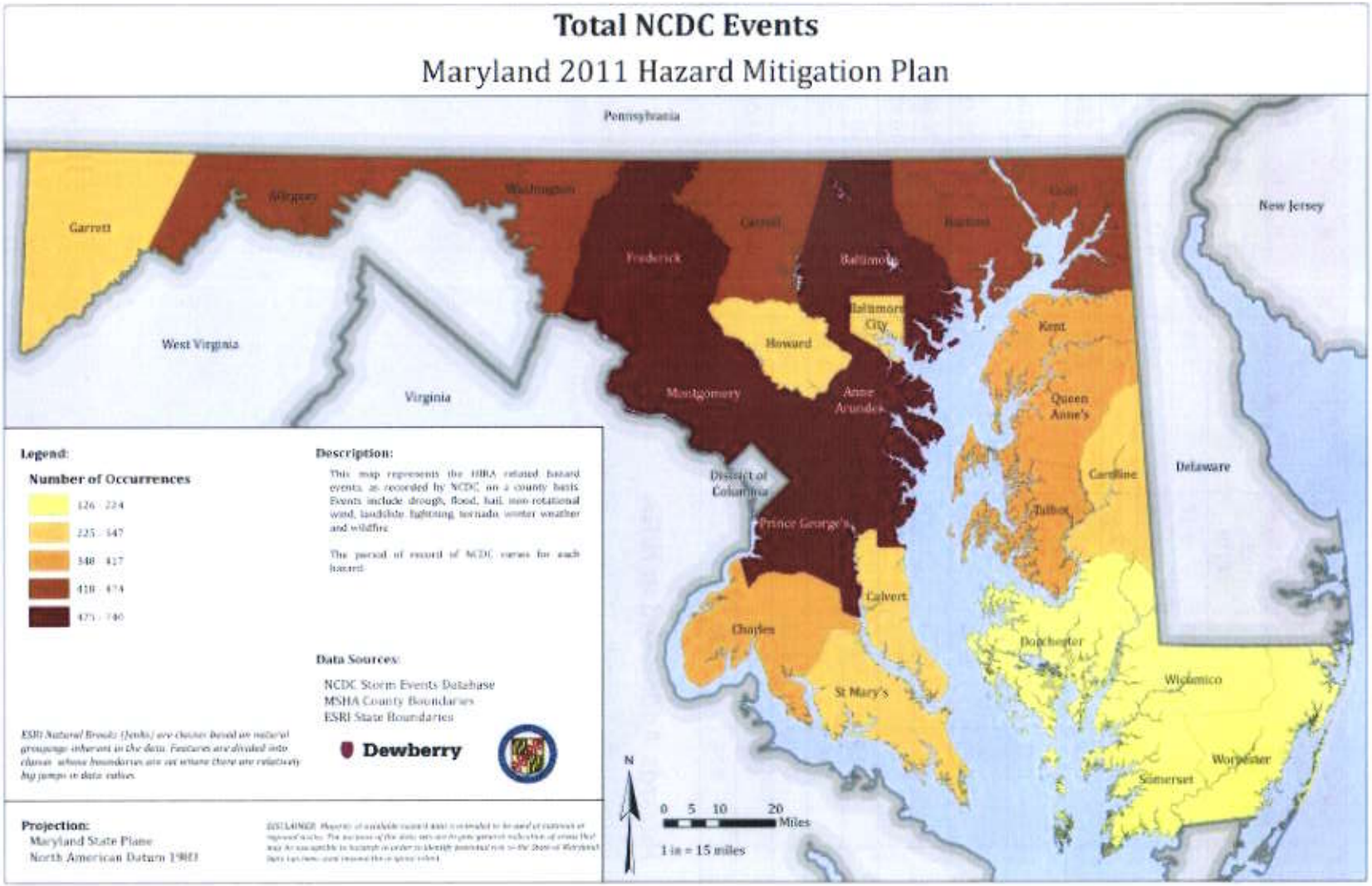


Figure 3-4. Total NCDC hazard events in Maryland.

It should be noted that the above hazards are not a complete listing of hazards that may impact Maryland. The MAC agreed that this listing accurately represents those hazards that impact Maryland annually and has the potential to cause fatalities, injuries, property damage, infrastructure damage, agricultural loss, damage to the environment, interruption of business, or other types of harm or loss.

Section 3.6.2 summarizes the hazards that have been included in the local plan risk assessments and Section 3.20 provides a comparison with the 2011 Maryland Hazard Ranking.

At the kick-off meeting for the 2011 Plan Update, the decision was made to curtail hazards analyzed to natural hazards along with dams and mining as the latter human activities that can impact natural resources and thus vulnerabilities result.

3.2 State and Critical Facility Analysis

Facility datasets that were created for the 2004 and 2008 plans were reviewed to determine data sets and facility types analyzed in previous plans.

The Maryland State Treasurers' Office was able to provide a February 2011 export of their state facility data for analysis. For many of the facilities in the dataset, 2010 building and content values had been designated by the Treasurer's Office. However, if a building value but no content value was included, a content value of 1/3 the building value was inserted. If a content value but no building value was included, the content value was multiplied by 3 to produce an estimated building value. This estimation process was also conducted in the 2008 Plan and is standard procedure for FEMA's Benefit-Cost Analysis for estimating contents. State facility types included in analysis:

- Administrative
- Airport,
- Correctional,
- Department of Natural Resources,
- Educational,
- Environmental,
- Fire and Police Departments,
- Health Related,
- Historic,
- Judicial/Legal,
- Military,
- Social Services,
- Transportation, and
- Utility/Infrastructure.

Critical facilities, which were outlined and used in the 2008 Plan, were the most up-to-date and available datasets; they were further supplemented with additional sources. Critical facility types included in analysis (2008 data):

- Above Ground Storage Tanks
- Underground Storage Tanks
- Bridges and Overpasses
- Emergency Operations Centers (EOC)
- Hospitals and Nursing Homes
- Nuclear Power Plants
- Consolidated Waste Management Information System
- Environmental Permit Service Center
- Department of Juvenile Services Facilities
- Gas Chlorine Plants
- Large System Water Sources
- 2007 Maryland Department of Planning's Property View Dataset:

- Police, Fire, and Educational Facilities
- Airports and Transportation/Terminal Facilities
- Fresh and Wastewater Pumping Facilities

Several layers from the HAZUS-MH MR5 essential facility, transportation systems and utility systems databases were used to supplement the critical facility data used in the 2008 plan. Listed below are the HAZUS datasets2 that were used to supplement the critical facility data gathered from the 2008 plan:

- Airports
- EOCs
- Ferry
- Fire Stations
- Hospitals and Health Facilities
- Police Stations
- Ports/Docks
- Potable Pumping Stations
- Public and Private Schools
- Waste Water Pumping Stations

Table 3-5, Figure 3-5, and Figure 3-6 provide a summary of the number of critical and state facilities included in the analysis and associated building and contents values. Appendix P provides detailed information on the state facility and critical facility datasets as well as the analysis methodology for determining hazard specific risk. The GIS files used for the analysis can be found in Appendix P.

As part of the plan update mitigation actions have been developed to standardize and maintain the spatial data for future state and local hazard identification and risk assessments.

3.3 Hazard Assessment and Ranking Methodology

The purpose of the hazard identification and risk assessment is to provide a factual basis for developing mitigation strategies; to prioritize those jurisdictions which are most threatened and vulnerable to natural hazards. For the 2011 plan update, MEMA and the MAC decided to change the hazard analysis that was used in the 2008/2005/2000 mitigation plans and to develop a new ranking method that would take into account multiple factors. These factors are explained below.

Table 3-6 includes the hazards that have been ranked with the new ranking formula and also the hazards that will be discussed in the plan narrative. The update only includes natural hazards impacting Maryland; technological and human caused hazards are covered under separate EOPs and will not be addressed in this plan.

[2] FEMA, Summary of Databases in HAZUS-MH, http://www.fema.gov/plan/prevent/hazus/hz_database.shtm (August 2010)

3.3.1 Development of Ranking

Many of the hazards assessed in this plan did not have quantifiable probability or impact data, so a semi-quantitative ranking system was used instead to compare all of the hazards of interest. This system allows for greater flexibility and more room for expert judgment.

Based on input from the MAC, a standardized methodology was developed to compare different hazards' risk on a county basis. This method prioritizes hazard risk based on a blend of quantitative factors extracted from National Climatic Data Center and other available data sources. These include:

- Historical occurrence;
- Vulnerability of population in the hazard area;
- Historical impact, in terms of human lives and property; and
- How the Local plans ranked the hazards.

3.3.2 Ranking Parameters

Nine ranking parameters were used to come up with jurisdiction based hazard rankings for the hazard outlined in Table 3-6.

Each parameter was rated on a scale of one (1) through four (4) with those rated one (1) considered low risk and those rated at four (4) considered high risk. Population vulnerability and density are each weighted at 0.5 relative to all of the other parameters. Geographic extent and local plan ranking were each weighted at 1.5 relative to all the other parameters. These scores were summed at a county level for each hazard separately, allowing for easy comparison between counties for each hazard type. A summation of all the scores for all hazards in each county provides an overall, "all-hazards" risk prioritization (Section 3.20).

Below is an overview of the parameters that were used in ranking the hazards; Appendix P includes the storm events data and ranking spreadsheet used for this analysis.

Population Vulnerability and Density. Population vulnerability and density are important factors in the risk assigned to a county. A hazard event that occurs in a highly populated area generally has a much higher impact as compared to an event that takes place in a very rural, unpopulated area. Two population parameters were used to account for counties with high populations and counties with densely populated areas. Each of these parameters was given a weight of 0.5 in an effort to avoid biasing the overall ranking with population data.

Population vulnerability was calculated as the percent of the total population of Maryland present in each county. The 2010 U.S. Census population for each county was divided by the total population for the state and multiplied by 100; a value between one and four was assigned based on a geometric interval. By ranking counties this way, those counties with significantly larger populations have effectively been given extra weight.

Population density was based on the population per square mile for each county. The 2010 U.S. Census population for each county was divided by the total area (sq. mi.) for the county; a value between one and four was assigned based on geometric intervals. By ranking jurisdictions this way, those counties with densely populated areas have effectively been given extra weight.

Table 3-5. State and Critical Facilities for the 2011 Maryland Hazard Mitigation Plan Update.

County/City	Police	Fire	Health	Educational	Total Number of Critical Facilities	Critical Facilities Building and Contents Values	Total Number of State Facilities	State Facilities Building and Contents Values
Allegany County	6	56	21	52	984	$382,118,400	287	$717,855,663
Anne Arundel County	7	44	179	209	5,033	$1,468,465,960	605	$3,458,410,555
Baltimore County	21	73	17	304	8,415	$1,873,803,613	695	$2,450,029,306
Calvert County	3	9	26	42	551	$415,662,333	123	$149,722,737
Caroline County	9	10	12	17	530	$94,451,160	421	$128,519,419
Carroll County	8	29	21	65	1,767	$773,619,613	228	$400,429,463
Cecil County	11	25	17	43	1,362	$310,623,133	287	$172,110,420
Charles County	3	21	7	60	1,146	$517,267,067	138	$46,599,098
Dorchester County	4	25	12	21	659	$93,601,080	108	$140,627,062
Frederick County	7	40	62	96	2,053	$646,917,427	189	$230,155,484
Garrett County	3	19	8	23	628	$109,658,267	293	$54,734,083
Harford County	9	27	8	85	2,342	$739,153,507	207	$115,126,325
Howard County	0	12	46	109	2,208	$851,168,040	363	$590,258,515
Kent County	3	11	6	14	472	$84,609,347	36	$20,015,708
Montgomery County	19	40	49	367	6,992	$2,764,069,667	181	$305,032,976
Prince George's County	31	58	19	355	7,381	$1,173,039,907	587	$4,226,006,209
Queen Anne's County	2	16	5	20	612	$149,137,613	94	$67,877,189
Somerset County	2	26	21	33	390	$51,809,600	256	$746,537,360
St. Mary's County	3	10	7	35	888	$309,846,013	317	$633,515,069
Talbot County	4	10	11	12	658	$125,100,853	66	$29,772,755
Washington County	7	32	95	72	2,084	$531,299,493	311	$336,788,350
Wicomico County	4	24	38	43	1,329	$458,389,427	183	$891,466,997
Worchester County	10	23	11	25	931	$192,044,587	126	$22,813,119
City of Baltimore	10	49	169	318	7,904	$3,179,149,973	765	$7,596,281,448
Grand Total	**186**	**689**	**867**	**2,420**	**57,319**	**$17,295,006,080**	**6,866**	**$23,530,685,311**

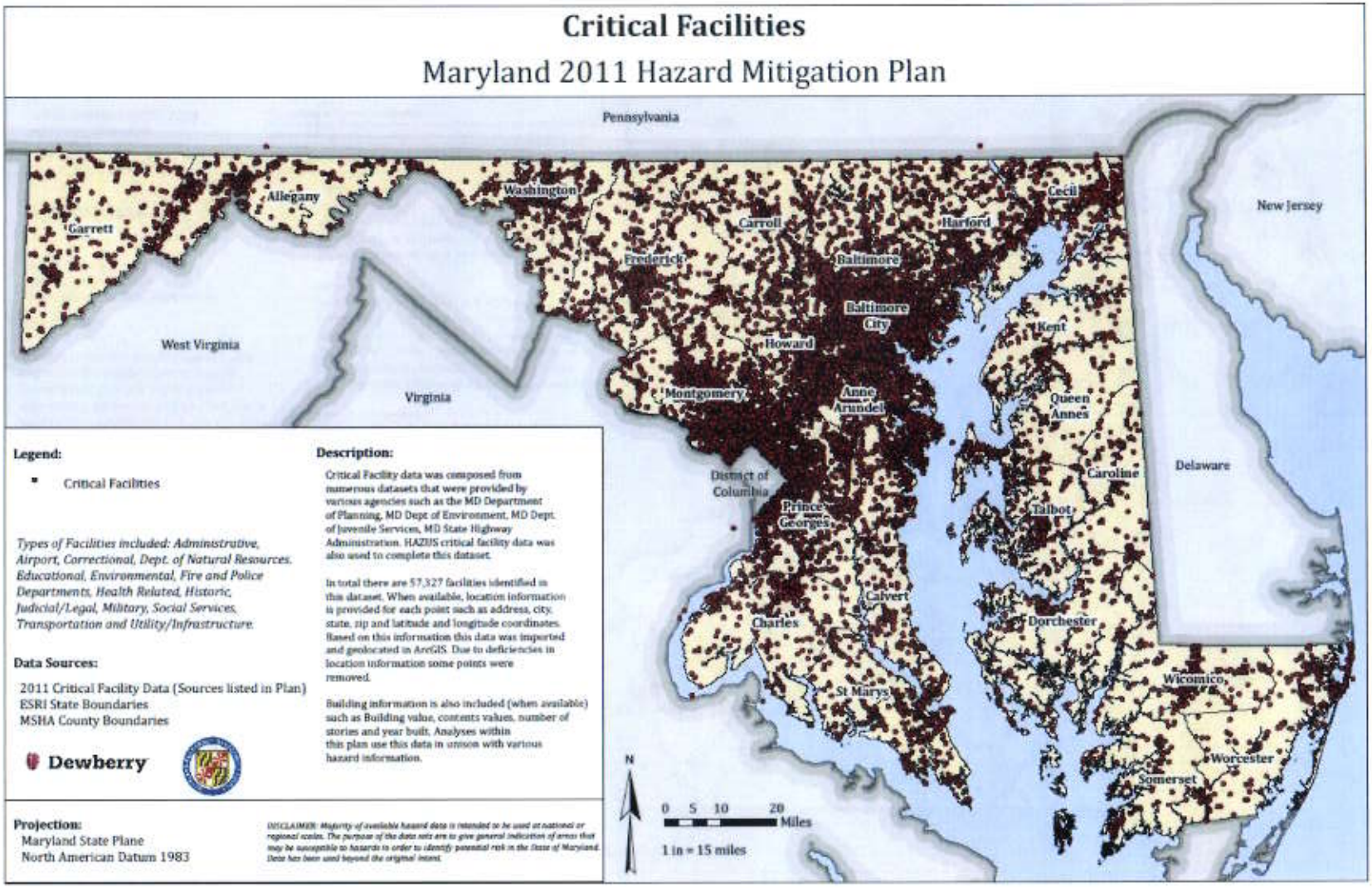


Figure 3-5. Critical facility locations.

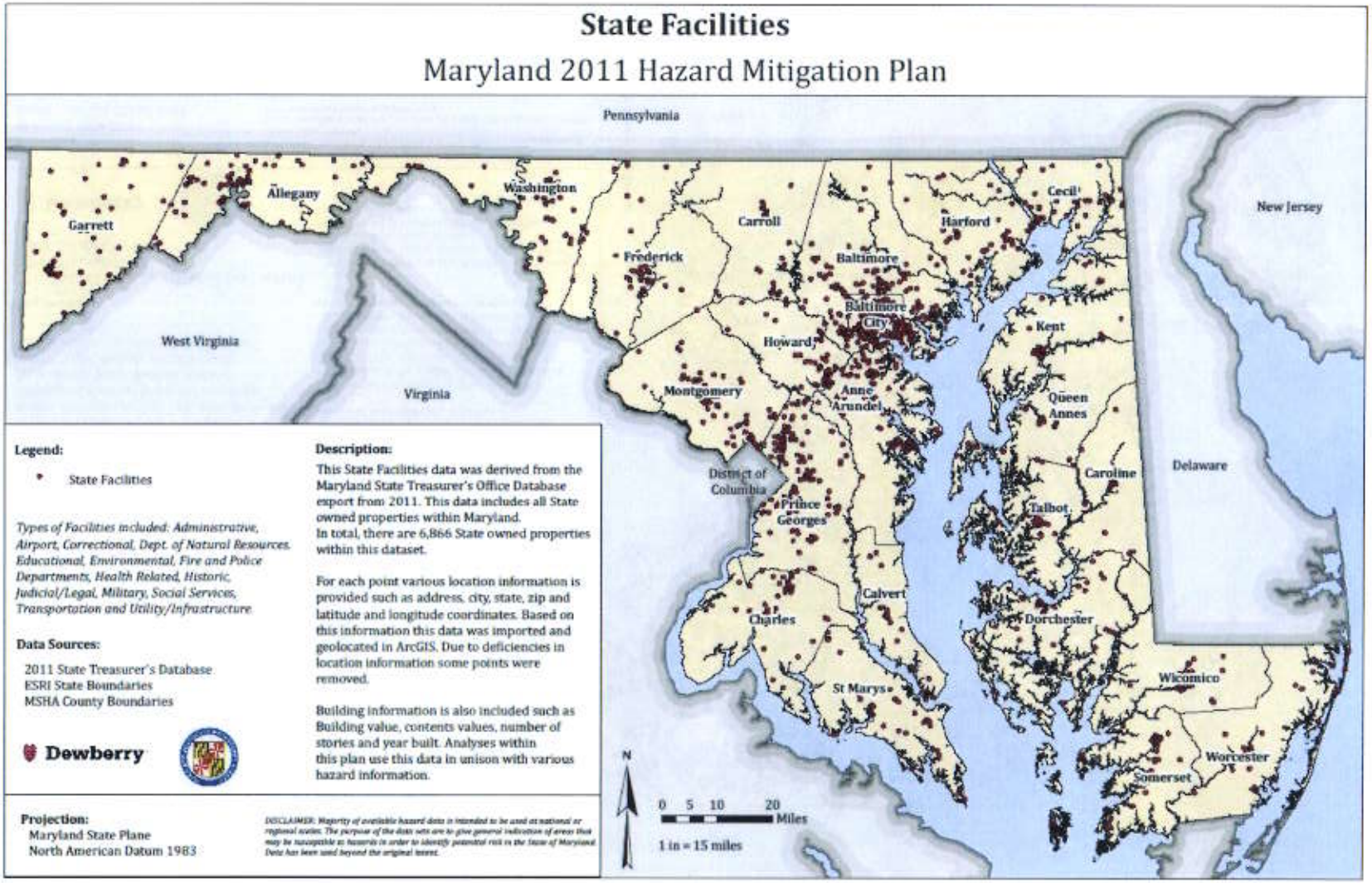


Figure 3-6. State facility locations.

Table 3-6. Hazards included in state-aide ranking.

Hazards Ranked	Not Ranked - Included in Plan
Coastal Hazards Drought Earthquake Flooding Land Subsidence/Karst/Sinkhole Landslide Thunderstorm (Lightning & Hail) Tornado Wildfire High Winds Winter Storm	Shoreline Erosion (section 3.8) Sea Level Rise(section 3.8) Extreme Heat(section 3.16) Extreme Cold(section 3.12) Dam Failure(section 3.18) Mining Hazards (section 3.19) Marcellus Shale(section 3.19) Tsunami(section 3.8)

Injuries and Deaths. Deaths and injuries are also important factors to evaluate when determining hazard ranking. Using NCDC and WFS data, past deaths and injuries were totaled for each hazard. If a county had at least one injury it was given a score of two and a score of four for at least one death. Hazards having no reported deaths or injuries were assigned a ranking of one.

Property and Crop Damage. Crop damage and property damage were also analyzed separately in order to give each jurisdiction a score of one (1) to four (4) based on natural breaks in the data. This data was obtained from the NCDC storm events database, inflated into 2011 dollars and annualized according to the period of record for each event category. The rating scales used for this parameter are provided in the ranking spreadsheet in Appendix P.

Geographic Extent. The majority of the hazards have defined geography where there is a greater likelihood of the hazard occurring in the future. To be able to include this in the ranking system, each hazard has been assigned individual scores based on the available hazard data. Geographic extent was given a 1.5 weighting relative to the other parameters, as geographic extent was deemed to be critically important. Data sources for geographic extent are shown in Table 3-7. The rating scales used for this parameter are provided in the ranking spreadsheet in Appendix P.

Table 3-7. Sources for Geographic Extent.

Hazard	Source
Coastal Hazards	NOAA NCDC Storm Events (1993-2010) NOAA-NHC SLOSH Model
Drought	NOAA NCDC Storm Events (1995-2010) USDA-NSSA Cropland Data Layer (2008)
Earthquake	FEMA HAZUS-MH MR5 Earthquake Model Peak Ground Acceleration Maryland Geological Survey Earthquakes in Maryland (1758-2010)
Flooding	NOAA NCDC Storm Events (1993-2010) FEMA DFIRM & Q3 Flood Maps
Land Subsidence/Karst/Sinkhole	Maryland Geological Survey karst mapping
Landslide	USGS: Landslide Incidence and Susceptibility in the Conterminous US
Lightning and Hail	NOAA NCDC Storm Events (1956-2010)
Tornado	NOAA NCDC Storm Events (1950-2010)
Wildfire	NOAA NCDC Storm Events (2001-2006) MD Dept of Natural Resources – Forest Service (1998-2010) MD Dept of Natural Resources – Forest Service Wildfire Risk Assessment
High Winds	NOAA NCDC Storm Events (1956-2010) ASCE Minimum Design Loads for Buildings and Other Structure (1998).
Winter Storm	NOAA NCDC Storm Events (1993-2010)

Events. While each hazard may not have a comprehensive database of past historical events, the record of historical occurrences is still an important factor in determining where hazards are likely to occur in the future. Annualizing the NCDC storm events data yields a rough estimate of the number of times a jurisdiction might experience a similar hazard event in any given year. To accomplish this, the total number of events in the NCDC database, for each specific hazard in each jurisdiction, was divided by the total years of record for that hazard to calculate an 'annualized events' value. Wildfire events were supplemented with MFS data, as described above.

It should be noted that there were no significant events reported for karst and landslide in NCDC or through other quality-controlled data sources; as a result, the events for these hazards all received a rank of one. The rating scales used for this parameter are provided in the ranking spreadsheet in Appendix P.

Local Plan Ranking. Local plans were reviewed for ranking methodology, loss estimates and risk to facilities. Based on feedback from the June 15, 2011, HIRA presentation, the results of the ranking methodology were used as parameter in the updated ranking methodology. Local Plan Ranking was given a 1.5 weighting relative to the other parameters, as local input was deemed to be critically important to the overall state ranking. Section 3.6 provides information on how the plans were reviewed and summarized for incorporation into the ranking formula.

Overall Ranking (Risk). To determine overall risk, the scores for population vulnerability, population density, annualized events, property damage, crop damage, injuries and deaths, and local plan ranking were added together (weighting applied as described previously) for each hazard to estimate the total county risk due to that hazard.

The overall or total hazard score for the state was determined by calculating the average hazard risk for each of the counties and using natural breaks to assign the ranking. Comparison of the overall or total hazards ranking with local plan rankings can be found in Sections 3.6 and 3.20. Appendix P includes the ranking spreadsheet and supporting data sources.

3.3.3 Limitations of Ranking

The NWS does not guarantee the accuracy or validity of the information used for weather-related hazards. Although the historical records in the database often vary widely in their level of detail, the NWS does have a set of guidelines for use in the preparation of event descriptions which were followed in preparation of this hazard analysis.[3]

As described in section 3.3, NCDC is not a complete data source. It was chosen for use in ranking because of its standardized collection of many of the hazards that impact Maryland. Unfortunately, the data set is somewhat lacking in terms of geological hazards. As a result, the ranking can only characterize the current form of the data with wildfire data for events, deaths, injuries and damages provided by Maryland Forest Service (MFS) and earthquake events supplemented by the Maryland Geological Survey. Future plan updates and mitigation actions should assess the availability of other data sources to be sure that the parameters are still valid for ranking of the hazards.

[3] National Water Service Instruction 10-1605. Operations and Services Performance: Storm Data Preparation Guide. August 17, 2007. Available at: http://www.nws.noaa.gov/directives/sym/pd01016005curr.pdf

3.4 Local Plan Incorporation

3.4.1 Summary of Planning Efforts

Maryland has 26 local (county and city) hazard mitigation plans that were approved by MEMA and FEMA Region III and adopted by Maryland local governments. The following section addresses local hazard identification, vulnerability and potential losses based on estimates provided in local plan risk assessments. For the 2011 plan update, the processed results from the local plan reviews were used in the statewide hazard ranking. Section 3.5 and Appendix P provides the ranking methodology used for the update.

3.4.2 Local Hazard Identification

The most significant hazards identified in the local hazard mitigation plans are floods, hurricanes, thunderstorms, tornadoes, and winter storms. Local plans identified 18 distinct hazards; Table 3-8 below classifies these hazards by assigning a ranking of high, medium-high, medium, medium-low, and low. These rankings are based on the ranking of distinct hazards by all the independent local plans and the frequency a disaster was mentioned in the plans. For example, the average ranking of a flood hazard from the local plans is a medium-high, but, because flooding was mentioned in every local Maryland plan it received a ranking of "high." In general, if more than half of local plans discussed a hazard then that hazard was ranked one degree higher (e.g., "medium-low" ranking was elevated to "medium").

Table 3-8. Summary of local plan hazard ranking.

High	Medium-High	Medium	Medium-Low	Low
Flood Hurricane Thunderstorm Tornado Winter Storm	Drought Erosion Extreme Heat Lightning Wildfire Wind	Hail Land Subsidence/Karst/Sinkholes Landslide Urban Fire	Epidemics Earthquake	None

Counties used a variety of approaches with a range of complexity to rank identified hazards. Some plans used a blend of techniques and discussions to determine their final hazard ranking. Several of the ranking/scoring techniques used in the local plans included:

- Extracting hazard rankings from MEMA's Hazard Analysis;
- Quantitative Scoring (historical frequency, potential losses, future probability);
- Assessments from county planning committees;
- Analyzing the severity of previous hazards; and
- Public polling.

FEMA guidance indicates that the jurisdictions at greatest risk to specific hazards should be identified, considering both the characteristics of the hazard and the jurisdictions' degree of vulnerability. A variety of analysis methods may be sufficient to meet these goals; FEMA does not mandate a specific analysis method. As a result, many local plans have developed their own ranking system.

None of the ranking techniques used in the local plans are incorrect as there is no standard way to rank hazards that impact specific jurisdictions. Lack of available data for each hazard is often a driving factor in the ranking method's degree of subjectivity. The numerical rankings are frequently performed by different contractors and different data processing methodologies are used. The variability in the ranking systems makes it difficult for a similar comparison of local hazard rankings to the state risk assessment. Table 3-9 summarizes the hazard rankings for each of the counties. Figure 3-7 compares the hazard

rankings for the significant hazards that have been ranked for this 2011 update. Section 3.5, Appendix P, and the individual hazard specific sections include information on the local hazard rankings.

One local plan discussed hazards but did not qualitatively rank them; as a result these hazards were assigned high and low rankings based on whether they were described in detail in the local plans. If they are discussed in detail, a high ranking was assigned. In some cases this may be misleading. Anne Arundel County is the only county that received high rankings for all hazards discussed because none are qualitatively ranked. In addition, several hazards were combined into a more generic hazard type to simplify the comparison between local plans. The majority of the rankings did not change when the hazard types were simplified, but in a few cases the average ranking between the hazards was used. In detail, coastal storms and storm surges were included with hurricanes, Nor'easters and extreme cold were included with winter storm, brush fires and conflagration were included with wildfire, and heavy rains were included with thunderstorms. Two hazards were not included in the hazard ranking table because each was only mentioned by one county. The hazards are tsunamis (Calvert County – ranking Low) and shoreline and sea level rise (Dorchester – ranking Low). Appendix P includes the summary tables created during the review of the local plans.

Table 3-9 also compares the average ranking of local plans to the average ranking based on the analysis completed for this revision. Several of the hazard categories that are addressed in the local plans are not considered in the state plan; these have been included as textual descriptions in the major hazard sections. Of the hazards considered in this revision, average rankings in local and state analysis are comparable.
To further align with the 2011 state hazard categories, several of the hazards addressed in the local plans were combined together for the statewide ranking. Plans that did not have a specific hazard category were reviewed and supplemented with information from related hazards to be able to include this information in the statewide ranking. The wind results were used to supplement coastal and tornado hazards and information on flood mitigation plans were used to determine flood rank in the City of Annapolis. Figure 3-8 shows the altered local hazard rankings that align with the 2011 state-wide hazard ranking.

Results from the 2011 analysis are further discussed in each of the hazard sections and in the overall results (Section 3.20).

3.4.3 Addressing Uncertainty in Hazard Identification

Future local plan updates will present an opportunity to address some of the ambiguity between hazard naming conventions if MEMA standardizes applicable hazard names. MEMA will encourage local plan revisions to approach classifying hazards in a similar fashion as done in this revised risk assessment. Table 3-10 provides an outline of what types of events could fall within the designated HIRA hazard categories. For this risk assessment the following hazards were evaluated: Coastal, Drought, Flood, Landslide, Thunderstorm, Tornado, Wildfire, Wind, Winter Storm, Karst/Sinkhole, and Earthquake.

3.4.4 Assessment of Local Vulnerability and Potential Losses

Local hazard rankings are highly variable across each local plan; as a result each local plan has its own set of criteria to develop monetary loss values; there is little consistency among the 26 local plans that were reviewed for the 2011 plan update. This variability does not lend itself to comparison of relative loss values for each hazard address by the 2011 state plan update. . Annualized loss values were pulled from local plans and analyzed. Flood and hurricane were the two dominate hazards that had loss estimate values; loss estimate values are plotted below in Table 3-11. Appendix P provides additional information on the local plan estimated losses and methodology.

Twenty of the 26 local plans provided flood loss-estimates. Values ranged from $6.8 million to $1.8 billion. The large variation can be partially attributed to the methods that the county used to determine a loss-estimate as well as what is being accounted for in the exposure and vulnerability. The majority of counties determined a flood loss-estimate value by determining the total exposure value of all structures within a 100 year floodplain. A combination of NFIP data, Maryland tax assessment values, and FEMA's HAZUS software were used to determine the extent of floodplains and value of structures within the floodplains. The flood loss estimates can be found in Table 3-11. Without proper documentation and data these values cannot be compared in their current form.

Fourteen of the 26 counties provided hurricane loss-estimates. These values ranged from $11.8 million to $7.7 billion. Similar to the flood estimates, the large variation is a result of different methods used to estimate the hurricane losses. Counties that provided hurricane loss-estimates either provided a number that reflected the total exposure of all structures to a hurricane or an estimate cost per event based on previous damage assessments. Without proper documentation and more uniform data, these values cannot be compared in their current form. One of the goals of this revision is to standardize the data analysis process in order for future versions of local plans to be consistent and comparable.

Table 3-9. Local plan upload summary of natural hazards addressed.

County/City	Plan Year	Dam	Epidemics	Drought	Earth-quake	Erosion	Extreme Heat	Flooding	Hail	Hurricane	Karst	Land-slide	Lightning	Thunder-storms	Tornado	Urban Fire	Wild-fire	Wind	Winter Storm
Allegany County	2006	M-H	M	M	N/A	N/A	L	H	N/A	M	N/A	M-H	N/A	M-H	M-H	N/A	M	M	M-H
Annapolis	2007	N/A	N/A	N/A	N/A	N/A	L	N/A	N/A	L	N/A	N/A	N/A	M	H	H	L	L	M
Anne Arundel County	2010	H	N/A	H	H	H	H	H	H	H	N/A	N/A	N/A	H	H	H	H	N/A	H
City of Baltimore	2005	N/A	N/A	L	L	N/A	M	H	N/A	N/A	N/A	L	N/A	N/A	N/A	N/A	N/A	M	M
Baltimore County	2006	L	L	M	L	N/A	L	H	N/A	H	N/A	N/A	N/A	M	L	N/A	M	N/A	H
Calvert County	2005	L	N/A	M-L	M	H	M	M-H	H	M	L	M-L	H	M	M-H	M-H	H	N/A	M-H
Caroline County	2011	L	M	M-H	N/A	L	M-H	M-H	M	M	N/A	N/A	N/A	M-H	M	N/A	M-L	N/A	M
Carroll County	2009	M	N/A	H	N/A	N/A	N/A	M-H	N/A	L	H	M-H	N/A	N/A	M-H	N/A	N/A	N/A	M-H
Cecil County	2009	M-H	M	H	N/A	N/A	M-H	M	N/A	M	N/A	M-H	N/A	M-H	M	N/A	M	N/A	M
Charles County	2006	N/A	N/A	H	L	N/A	H	H	H	H	N/A	L	M	H	H	N/A	M	N/A	H
Dorchester County	2011	L	L	M	N/A	N/A	M	H	N/A	H	N/A	N/A	N/A	M	M	N/A	M	M	M-H
Frederick County	2009	L*	N/A	M	L	N/A	L	H	M	M	H	L	M	H	H	M	M	H	H
Garrett County	2004	M-H	M	M	N/A	N/A	L	H	N/A	M-L	N/A	H	N/A	H	H	N/A	M	M-H	H
Harford County	2004	N/A	N/A	H	N/A	N/A	N/A	M	N/A	M-L	N/A	N/A	N/A	M-H	M-H	N/A	L	M-H	M
Howard County	2004	M-L	N/A	H	M	N/A	H	H	N/A	H	N/A	N/A	M	N/A	N/A	L	L	H	M
Kent County	2004	N/A	N/A	M	N/A	N/A	L	H	M-L	H	N/A	M	M	M	L	N/A	M	N/A	H

County/City	Plan Year	Dam	Epidemics	Drought	Earth-quake	Erosion	Extreme Heat	Flooding	Hail	Hurricane	Karst	Land-slide	Lightning	Thunder-storms	Tornado	Urban Fire	Wild-fire	Wind	Winter Storm
Montgomery County	2007	L	L	H	M	N/A	L	M	N/A	H	N/A	L	N/A	H	H	M	L	H	H
Ocean City	2006	M-L	L	L	L	N/A	M-L	M	N/A	H	N/A	N/A	N/A	L	M	N/A	L	N/A	M-L
Prince George's County	2010	M	N/A	M-H	L	M-H	M	H	N/A	N/A	N/A	M-H	N/A	M-H	N/A	N/A	M	M-H	M-H
Queen Anne's County	2005	M	M	M	N/A	N/A	M-L	M	N/A	M-H	N/A	M-L	N/A	M-L	M	N/A	M-L	N/A	M
St. Mary's County	2006	N/A	N/A	M	L	H	M	H	M	H	N/A	L	H	H	H	N/A	H	H	H
Somerset County	2005	L	M-H	M	N/A	N/A	M-L	H	N/A	H	N/A	M-L	N/A	M-H	M	N/A	M	N/A	M-L
Talbot County	2010	N/A	N/A	M	L	M	N/A	H	M-H	M-H	N/A	L	M-H	M-H	M	N/A	M	N/A	H
Washington County	2005	M	M	M-H	N/A	N/A	M	M-H	N/A	M	M-L	M-L	N/A	M	M	N/A	M-L	N/A	M-H
Wicomico County	2011	M	M	M	M-L	M	M	M	M	M-H	M-L	M-L	M	M	M	M	M	M	M
Worcester County	2006	N/A	N/A	M	N/A	N/A	L	H	L	H	N/A	N/A	M	M	M	N/A	N/A	L	H
Total # Plans that Ranked Hazard		**17**	**12**	**25**	**13**	**7**	**23**	**25**	**10**	**24**	**5**	**17**	**9**	**23**	**23**	**7**	**23**	**13**	**26**
Average Hazard Ranking		**M**	**M-L**	**M-H**	**M-L**	**M-H**	**M-H**	**H**	**M**	**H**	**M**	**M**	**M-H**	**H**	**H**	**M**	**M-H**	**M-H**	**H**

*Man-made hazard annex ranked Dam Failure as limited/low.

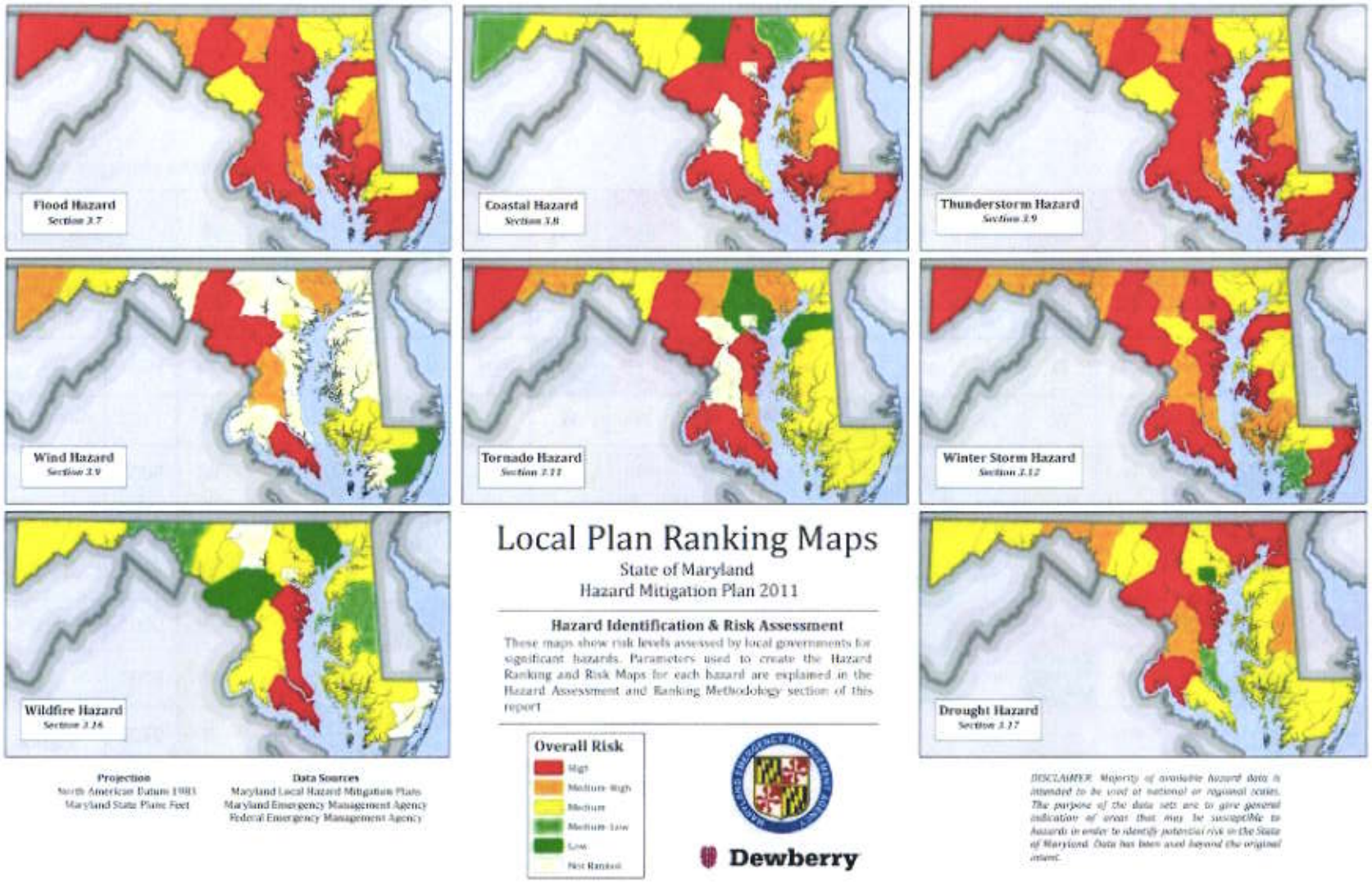


Figure 3-7. Local plan hazard ranking maps without alterations for 2011 statewide hazard ranking.

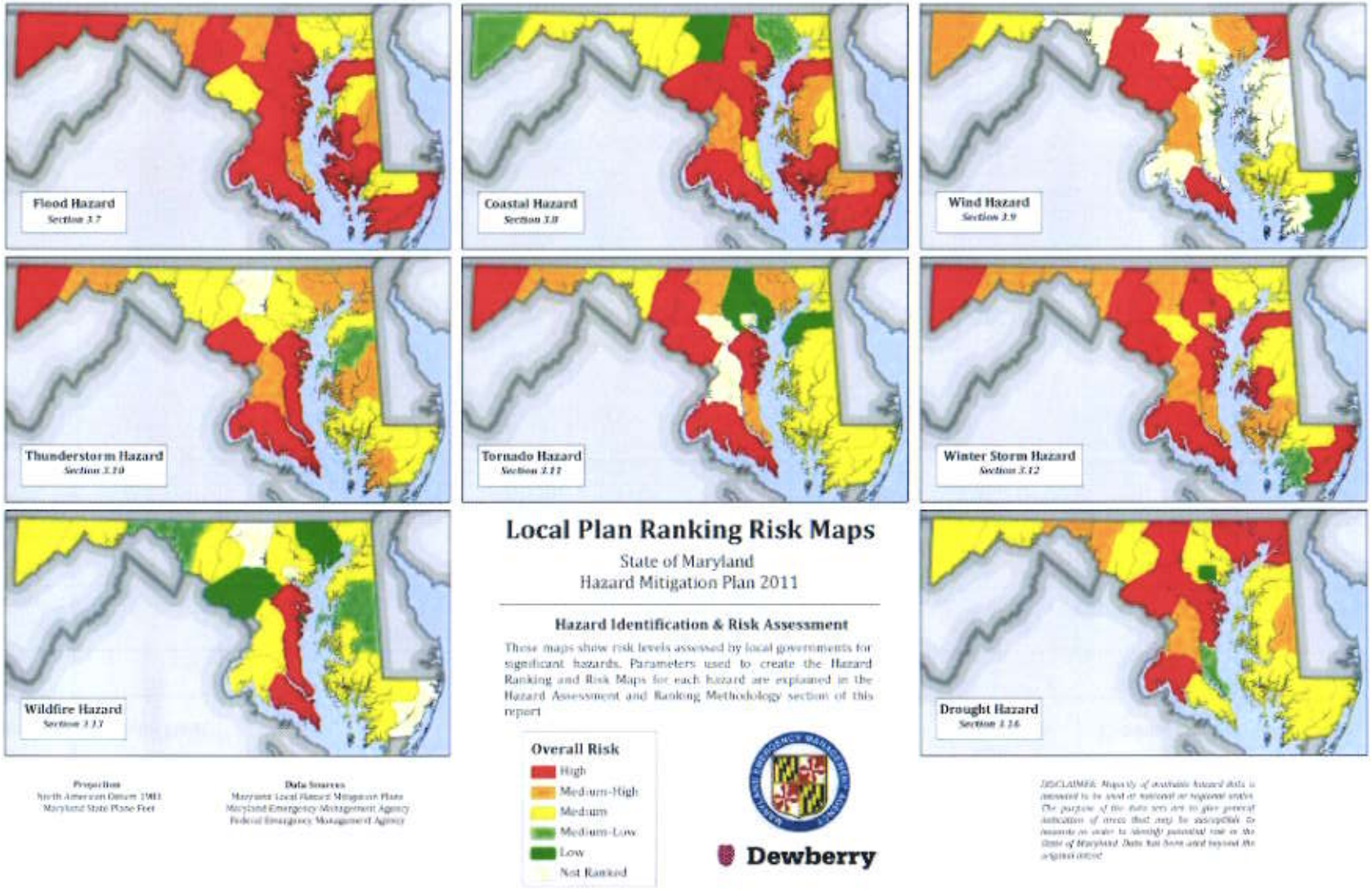


Figure 3-8. Local plan hazard ranking maps with alterations for 2011 statewide hazard ranking.

Table 3-10. Summary of hazard events by MEMA category hazards.

Coastal Hazards	Drought	Flooding	Landslide	Thunder-storm (Lightning & Hail)	Tornado	Wildfire	High Winds	Winter Storm	Land Subsidence/ Karst/ Sinkhole	Earthquake
Coastal Flooding	Drought	Flood	Landslide	Thunder-storm	Tornado	Wildfire	Thunderstorm winds	Winter Storm	Karst	Earthquake
Coastal Storms	Extreme Heat			Lightning		Brush Fire	Non-thunderstorm wind	Extreme Cold	Sinkholes	
Storm Surge				Hail		Conflagration		Nor'easter (Snowfall)		
Hurricane/ Tropical Storm										
Nor'easter Sea Level Rise										
Shoreline Erosion Tsunami										

Table 3-11. Local hazard mitigation plan loss estimates.

County/City	Type	Flood Loss Total	Type	Hurricane Loss Total
Allegany County	N/A	N/A	N/A	N/A
City of Annapolis	[1]*TE (100)*	$250,000,000	[5] *TEH*	$500,000,000
Anne Arundel County	[2]*AL*	$6,863,537	[6] *E*	$29,067,925
City of Baltimore	[1]*TE (100)*	$733,722,800	N/A	N/A
Baltimore County	[3] *TE*	$670,594,570	N/A	N/A
Calvert County	[3] *TE*	$243,587,055	[5] *TEH*	$4,222,000,000
Caroline County	[4]*TE (100 + 500)*	$93,120,890	[6] *E*	$213,497,290
Carroll County	[1]*TE (100)*	$188,785,181	[5] *TEH*	$3,772,650,000
Cecil County	[1]*TE (100)*	$210,863,690	N/A	N/A
Charles County	[1]*TE (100)*	$167,013,950	[5] *TEH*	$7,655,697,830
Dorchester County	[7] *SS*	$134,450,200	N/A	N/A
Frederick County	[1]*TE (100)*	$216,380,000	N/A	N/A
Garrett County	[3] *TE*	$151,000,000	[6] *E*	$11,815,000
Harford County	[3] *TE*	$188,000,000	N/A	N/A
Howard County	[2]*AL*	$22,303,830	[6] *E*	$20,000,000
Kent County	N/A	N/A	N/A	N/A
Montgomery County	N/A	N/A	N/A	N/A
Ocean City, Town of	N/A	N/A	[5] *TEH*	$3,861,432,196
Prince George's County	[1]*TE (100)*	$641,600,000	[5] *TEH*	$568,000,000
Queen Anne's County	[2]*AL*	$10,000,000	[6] *E*	$27,000,000
St. Mary's County	[1]*TE (100)*	$453,813,120	[6] *E*	$50,950,000
Somerset County	N/A	N/A	[6] *E*	$11,815,000
Talbot County	[4]*TE (100 + 500)*	$97,854,900	[6] *E*	$79,950,070
Washington County	N/A	N/A	N/A	N/A
Wicomico County	[4]*TE (100 + 500)*	$204,509,460	N/A	N/A
Worcester County	[1]*TE (100)*	$1,825,064,610	N/A	N/A
	Grand Total	**$6,509,527,793**		**$21,023,875,311**

[1] *TE (100) – Total exposure within 100 yr. floodplain*

[2] *AL – Annualized loss*

[3] *TE – Total exposure to flood (unknown extent)*

[4] *TE (100 + 500) – Total exposure within 100 and 500 yr. floodplain*

[5] *TEH – Total exposure to hurricane*

[6] *E – Event based estimate*

[7] *SS – Storm Surge Inundation*

3.4.5 Critical Facility Data Collection

Maryland lacks a standardized hazard and critical facility dataset. The local plans used different datasets to compile critical facilities within their jurisdiction and did not present the data in a uniform or consistent manner. Pertinent critical facility information was extracted from each local plan and the quality and completeness of these data varied greatly. Some local plans presented critical facility data in a table form, others plotted critical facility locations on maps, and others only discussed critical facilities in text. Local plans used numerous sources to determine critical facilities within their jurisdiction including the HAZUS-MH Database, MEMA Data Spreadsheets, and MEMA and counties GIS databases. The results of the compilation of critical facilities within the local plans can be found in Table 3-12. However, because the data are incomplete and inconsistent, further analysis was not performed.

3.4.6 Land Use and Growth Trends

Maryland continues to see growth, especially in areas close to Washington D.C., U.S. Army Bases, and the I-95 transportation corridor. Counties with growth plans are attempting to focus growth in incorporated areas and already existing communities to preserve rural and forested areas. Encouraging growth in incorporated areas also allows existing water, sewer services, and other public facilities to be utilized. Large cities like Annapolis and Ocean City are mostly developed and, therefore, for growth to occur these areas would need to be rebuilt/redeveloped. In contrast, the City of Baltimore has seen a reduction in its population by approximately a third. Many counties mentioned that they have developed comprehensive plans that redirect growth away from flood prone areas and ensure new growth complies with floodplain ordinances.

3.4.7 Local Plan Updates

The Disaster Mitigation Act of 2000 (DMA 2000) requires local governments to update their plans every five years. The majority of the local plans were completed during 2004 through 2007 and the local governments are currently updating these plans (see Chapter 5 and Appendix H). .

Several mitigation actions have been developed by MEMA that will standardize some of the HIRA ambiguities outlined in this section. Section 4 summarizes these actions.

Table 3-12. List of critical facilities from local plan uploads[1]

County/City	Total # of Facilities	Fire Stations	Schools	Hospitals/ Nursing homes	Police	Government	Transportation Infrastructure	Utilities	Emergency Services	Commercial and Industrial	Post Office	Library	Historic	Other
Allegany County	695	30	37	12	13	32	274	190		9	20	7		71
City of Annapolis	40	3	7	0	5	0	5	2	0	3	0	0	0	15
Anne Arundel County	68			2	7	11	17	16	3					12
City of Baltimore	13	2	3		2			6						
Baltimore County	3,017	8	94	18	2	244	106	56						2,489
Calvert County	2,128	9	49	26	2	740	28			935				339
Caroline County														
Carroll County														
Cecil County	182	17	52	28	8	0	0	3	3	0	0	0	0	71
Charles County	94	9	53	3	4			9	9					7
Dorchester County	264	16	11	6	4	91	86	34	5			2		9
Frederick County	451	32	64	28	8	50	5	67			24	8		165
Garrett County	347	15	26	4	6	23	153	56		3	10	5		46
Harford County														
Howard County	230	12	84	101	3								30	
Kent County	12	0	2	0	0	0	0	1	0	0	0	0	0	9
Montgomery County	~500													
Ocean City, Town of	22	4				3	2	11						2
Prince George's County	35	1	5			1		6					5	17
Queen Anne's County	451	12	21	28	9	37	117	64		3	12	3		145
St. Mary's County	82	17	40	20	2	2			1					

County/City	Total # of Facilities	Fire Stations	Schools	Hospitals/ Nursing homes	Police	Government	Transportation Infrastructure	Utilities	Emergency Services	Commercial and Industrial	Post Office	Library	Historic	Other
Somerset County	266	9	18	4	7	14	85	75		1	11	3		39
Talbot County	279	0	26	100	0	63	0	57	11	0	0	0	0	22
Washington County	583	29	65	26	9	26	190	56		20	19	6		137
Wicomico County	431		55	89		83	3	48	20					133
Worcester County	132	17	14	1	8	6	2	26			12	4		42
Grand Total	**10,322**	**242**	**726**	**496**	**99**	**1,426**	**1,073**	**783**	**52**	**974**	**108**	**38**	**35**	**3,770**

[1]The majority of values within this table were extracted from tables, maps, and text within local plans and therefore may not accurately reflect the number of critical facilities within a county or city.

3.5 Flood

3.5.1 Description

Flooding can be categorized as flash, riverine and coastal in Maryland. Flash and riverine flooding have been profiled and assessed in this section. Coastal flooding is addressed in Section 3.8 Coastal Hazards.

Flash Flooding. Flash flooding results from a combination of rainfall intensity and duration, and is further influenced by local topography and the ground's capacity to hold water. Flash floods also can result from the sudden release of water from the breakup of an ice jam or a dam failure. More than half of all flash flood deaths occur when motorists are trapped in their cars by rapidly rising water.

Riverine Flooding. In contrast to the intense rainfalls that typify flash flooding events, riverine flooding is caused by persistent moderate or heavy rain over one or more days, sometimes combined with snowmelt, causing a river to slowly rise and overflow its banks. Rivers may take several days or even weeks to rise over their banks, providing enough warning for people to move to higher ground. River floods can last for weeks and can inundate very large areas or entire regions. An example of the potential impact of these events is the 1993 Upper Mississippi River Basin flood, which affected nine states, caused 47 deaths, and cost about $14 billion in damages.

3.5.2 Historical Occurrences

Flooding is a persistent concern in Maryland, a coastal state with more than twelve percent of its surface area in floodplains and nearly 8,000 miles of tidal shoreline associated with the Chesapeake Bay and its tributaries. Between 1993 and 2010, 1,179 flooding events were recorded for Maryland in the NOAA National Weather Service National Climatic Data Center (NCDC) storm database accounting for $121.5 Million in property damages, $1.4 Million in crop damages, 16 deaths and 64 injuries.

Baltimore, Frederick, Anne Arundel, and Montgomery counties have experienced more than 30 flash flood events from 1993 through 2010 based on NCDC data. Fifteen injuries have been reported in Harford County as a result of flash floods.

According to the NCDC storm database, flooding caused by Hurricane Floyd on September 16, 1999 caused more than $20 million (1999 dollars) in property damage throughout Maryland. Flooding associated with Hurricane Floyd exceeded the 100-year-flood for most of the Eastern Shore. Flooding recurrence intervals for several streams (Morgan Creek near Kennedyville, Little Elk Creek at Childs, and Northeast Creek at Leslie) were estimated in the magnitude of the 500-year-flood.

Two flood events during 1996 resulted in Presidential Disaster Declarations for Maryland. In January, rapid snowmelt from a blizzard earlier in the month led to widespread flooding in Allegany, Garrett, Frederick, Washington, and Cecil Counties. Additionally, extensive flooding induced by a dislodged ice jam occurred at Port Deposit on the Susquehanna River in Cecil County. In September, a second declaration was granted for parts of Maryland due to heavy rainfall from the remnants of Hurricane Fran.

In terms of geographic extent and duration, the greatest recorded riverine and stream flooding for Maryland occurred in 1972, when the remnants of Hurricane Agnes became nearly stationary over Pennsylvania and New York. Heavy rainfall from June 20 through 25 caused floods to exceed the 100-year floodplains in tributaries along the north side of the Potomac River from Conococheague Creek at Fairview, Maryland, to Rock Creek, near Washington, D.C. The Monocacy River crested 16 feet above flood stage in Frederick, and the Potomac crested 21 feet above flood stage at Point of Rocks. Peak flow

through the Conowingo Dam on the Susquehanna River was more than 30 times the average June flow. The storm resulted in 19 deaths in Maryland. Hundreds of bridges were damaged or destroyed.

One of the deadliest flash flooding events in Maryland occurred August 1-2, 1971. Fourteen people were killed in eastern Baltimore County near White Marsh, when 11 inches of rain fell from thunderstorms within a 10-hour time span (5.5 inches of rain fell within three hours).

The flood of record for many of the upper-Potomac gauging stations occurred in March 1936. Prior to the event, snow depths in the basin averaged 15 inches, and a cold spell caused thick ice to form on many Potomac River tributaries. Rain and warmer temperatures in the days before the storm caused moderate rises in stream flow. On March 17, heavy rainfall triggered severe flooding along the Potomac, washing out or damaging miles of roads and railroad track and many bridges.

Table 3-13 lists some of the more significant flood events, depicted by riverine and flash flooding, that have impacted Maryland over the years.

Table 3-13. Significant flooding events.

Date	Event	Comments
March 17,1936	River Flood	Snowmelt and intense rainfall runoff led to the greatest flooding of the Potomac River basin since 1889. Damages reached $2 million.
June 21,1972	River Flood	Hurricane Agnes brought widespread flooding of the Potomac River. In the tributaries on the north side of the Potomac River, from the Conococheague Creek at Fairview, Maryland down to Rock Creek at Washington, DC, floods in excess of the 100 year frequency level were observed.
November 28, 1993	River Flood	After nearly 12 hours of rain across most of the state, the Potomac and Monocacy Rivers and their tributaries rose out of their banks. Many homes and businesses along the rivers were inundated and suffered significant damage. Farmlands were also flooded, leaving livestock lost. Several families had to be temporarily evacuated until the water receded. Washington, Frederick, and Montgomery were the counties worst affected, suffering $5 million in property damages.
June 27, 1995	Flash Flood	A stationary front, combined with an upper-level disturbance, allowed deep tropical moisture to be lifted along and east of the Allegheny Plateau, causing extremely heavy rains on soils already saturated from the previous week's thunderstorms. Six inches of rain caused severe flooding and flash flooding in Westernport (Allegany Co). Damage to roads alone was estimated at $600,000. At least 200 homes sustained moderate to major damage; several businesses and an elementary school were also heavily damaged. Total property damages reached $1.3 million, with crop damages of $50,000.
January 19, 1996	River Flood	Snowmelt combined with 1 to 3 inches of rain (some locations received 5 inches) to produce, in some cases, catastrophic river flooding. The flooding was the worst in the region since 1985. Crests ranged from 3 to 21 feet above flood stage. The National Park Service's C&O Canal and towpath was severely damaged, with damages estimated at $20 million. There were several water and sewage plant failures. Total damages were estimated at $60 million, and counties affected include Allegany, Washington, Frederick, and Montgomery.
September 6, 1996	River Flood	Torrential rains associated with Tropical Storm Fran caused the rapid onset of river flooding along the headwaters of the Potomac River late on the 6th, spreading gradually southeast throughout the entire basin by early on the 10th. The damage was concentrated along the Potomac and the Georges Creek in the towns of Lonaconing and Westernport. As the near record flows moved downstream towards higher population areas of Frederick and Montgomery Counties, damages continued to pile up. Substantial agricultural damage was limited to Montgomery County, where 450 acres of corn and soybean crops were destroyed. The flooding caused 10.75 million in property damages and $230 thousand in crop damages.

Date	Event	Comments
September 16, 1999	Flash Flood	Hurricane Floyd caused widespread flash flooding as storm totals averaged around ten inches, most of which fell in a twelve hour period from the early morning through the afternoon on the 16th. The highest verifiable storm total was 14.00 inches in Chestertown (Kent County). The torrential downpours associated with Hurricane Floyd exceeded the 100-year-flood return period for most of the Eastern Shore. Hundreds of roads and bridges were closed. At one point there were 225 roads closed throughout the state. About 450 people were evacuated from low lying areas, 300 in Cecil County. Five people were seriously injured, and one was killed. President Clinton declared all of the Maryland Eastern Shore a disaster area. Damages were estimated at $3.5 million.
September 11, 2000	Flash Flood	Numerous roads, creeks, and structures were flooded when a thunderstorm with torrential rainfall became stationary over the western portion of Allegany County during the evening of the 11th. Serious flash flooding developed in less than an hour. Nearly $2 million in damages occurred.
November 19, 2003	Flash Flood	Creeks and roads were flooded in Baltimore City, and four people were killed by the flash floods.
June 25, 2006	Flash Flood	Repeated thunderstorms with torrential downpours dropped up to one foot of rain across southern parts of Caroline County. This caused extensive roadway, field and stream flooding. Hardest hit was Federalsburg where 11.5 inches of rain fell. About 40 people were evacuated along the Marshyhope Creek where the worst flooding occurred. Flooding along the Marshyhope Creek destroyed Railroad Avenue and badly damaged the tracks of the Maryland and Delaware Railroad Line. Over a dozen roads were closed in the county including the Central Avenue Bridge in Federalsburg. Schools were closed throughout the week mainly because of closed roads. The heavy rain caused agricultural damage which ranged from fifteen to forty-five percent losses. President George W. Bush declared Caroline and Dorchester Counties a disaster area. The flooding caused $4 million in property damages and $1 million in crop damages.
June 27, 2006	Flash Flood	A mudslide closed a section of Harp Mill Road in Wolfsville (Frederick County). Numerous road closures and water rescues were reported countywide. The Monacacy River overflowed, flooding a parking lot and field along Monocacy Boulevard. Basement flooding occurred in Emmitsburg, Myersville and Middletown. Shank Road was closed indefinitely to repair a washed-out pipe. Flooding in underground tunnels caused much of the Washington Metro to close. Five people died when they were washed away by strong currents, and one person was injured in a rescue effort. Property damages were estimated at $500,000.

3.5.3 Flood Hazard Mapping Efforts

During the past 30 years, the federal government has made a shift in focus from flood "control" to "flood "management". The primary impetus for this shift is due to continuing flood losses, especially those experienced during the latter half of the 20th century. The goal of flood management is to prevent loss of life and damage to public and private property by reducing the effects of flood damage and formulating effective plans for recovery and rehabilitation. This change from flood control to flood management resulted in revisions and improvements to federal policies. One of the major undertakings was to produce flood maps for the entire United States. The development of Special Flood Hazard Area (SFHA) maps was the federal government's first comprehensive attempt to identify flood hazard risk in the nation's floodplains.

The beginnings of this effort occurred in 1968, with the passage of the National Flood Insurance Program (NFIP) Act by the U.S. Congress. The program's intent is to reduce future damage and to provide protection for property owners from potential losses. Flood insurance is made available in communities

participating in the NFIP. Policyholders pay premiums that are based on the level of flood risk at an identified location in the community. To accurately identify the risk, FEMA produces Flood Insurance Rate Maps (FIRMs) that show areas subject to flooding. The flood risk information presented on the FIRMs is based on historic, hydrologic, and hydraulic data, as well as open-space conditions, flood-control works, and development.

Table 3-14 and Figure 3-9 show the status of flood maps available for analysis. The majority of the counties in Maryland have preliminary Digital FIRMs (DFIRMs) with seven effective DFIRMs and six Q3 counties. Q3 data only contains certain features from the existing hard-copy FIRMS and have only been used for communities that did not have better digital data.

Table 3-14. Digital flood map status.

Flood Map Type	Number of Counties
Digital FIRM (DFIRM)	7
Preliminary DFIRM	11
Q3	6

3.5.4 National Flood Insurance Program (NFIP)

Floodplain management begins at the community level with operation of a community program of corrective and preventative measures for reducing flood damage. These measures take a variety of forms; for inclusion in the NFIP, communities adopt their flood hazards maps and the community Flood Insurance Study (FIS). In addition, a FEMA-compliant floodplain management ordinance that regulates activity in the floodplain is adopted and enforced.

A community's agreement to adopt and enforce floodplain management ordinances, including regulation of new construction in the SFHA, is a requirement for making flood insurance available to home and business owners. Currently more than 20,100 communities, nationwide, voluntarily adopt and enforce local floodplain management ordinances that provide flood loss reduction building standards for new and existing development. To address the threat of flood damage, many communities and residents participate in the NFIP. As of April 2011, 124 communities in Maryland currently participate in the NFIP. These policy and claim information for these communities have been summarized by their respective County and City. Data on active policies was gathered in April 2011 from FEMA's BureauNet database.

Table 3-15 shows NFIP flood policy and claim information by jurisdiction. There are 69,250 policies in-force for communities participating in the NFIP. Maryland residents are paying nearly $38.3 million annually for premiums for $14.7 billion in coverage. For active policies, there have been 14,746 claims, paying $239.8 million. The average claim payment on active policies has been $16,263. Annapolis (Anne Arundel County) and the City of Baltimore have the highest average claims at $32,481 and $26,054, respectively. Worchester County accounts for over 40 percent of the policies in-force and coverage value, the majority of these polices (27,352) are in Ocean City. Figure 3-10 illustrates the total NFIP payments per county.

Counties with more than 2,500 flood insurance policies:

- Worcester County (33,721 with 27,352 in the Town of Ocean City)
- Anne Arundel County (6,281 with 464 in Annapolis)
- Baltimore County (4,401)
- Prince George's County (3,006)

- Queen Anne's County (2,655)
- City of Baltimore (2,576)

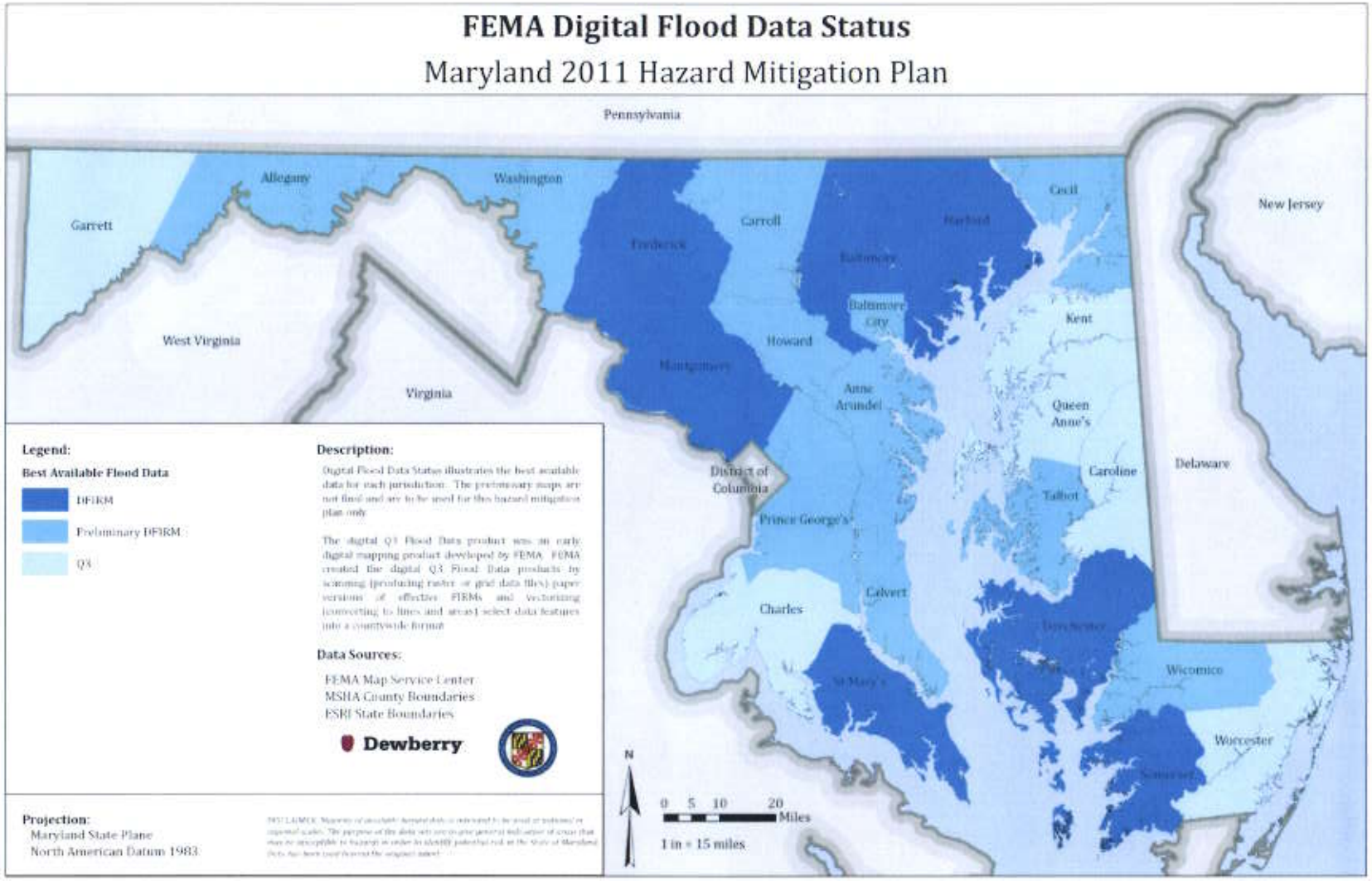


Figure 3-9. FEMA Digital Flood Data Status by County.

Counties with more than $10 million in total claims paid:

- Baltimore County ($60,490,433)
- Anne Arundel County ($45,858,417 with $4,352,459 in Annapolis)
- City of Baltimore ($19,253,974)
- Dorchester County ($16,505,720)
- Queen Anne's County ($13,347,266)
- Worcester County ($11,190,682 with $7,087,223in the Town of Ocean City)
- Talbot County ($10,866,087)

A study conducted by The Rand Corporation[4] found the number of homes with flood insurance is significantly lower in rural communities with 500 or fewer homes in the SFHA, communities where less than 50 percent of homes are in SFHA and communities that do not experience coastal flooding. Results of the study also appear to suggest that the decision of whether or not to buy flood insurance is not particularly sensitive to the price of flood insurance. However, large changes in prices may have proportional impacts on market penetration rates than the study results find. There does not appear to be a strong relationship between market penetration rates and the enforcement of floodplain management requirements.

3.5.5 FEMA Repetitive Flood Claims Program

The Bunning-Bereuter-Blumenauer Flood Insurance Reform Act of 2004 (Public Law 108-264) revised the existing Flood Mitigation Assistance (FMA) Program by creating a Pilot Program at $40 million per year to mitigate Repetitive Loss properties. The act was signed into law by President George W. Bush on June 30, 2004.

The FEMA HMA Repetitive Loss (RL) and Severe Repetitive Loss (SRL) Program provides funds for local governments to address the most egregious flood-prone properties with the most flood insurance claims. The program features a reduced non-federal match (from 25 percent to 10 percent) with an approved mitigation plan that specifies the state's strategy to reduce the number of Repetitive Loss and Severe Repetitive Loss properties. The amendment authorizes scheduled increases in flood insurance premium rates to actuarial rates for SRL property owners who refuse a formal and complete mitigation grant offer through the SRL grant program to mitigate an SRL structure. Appendix M contains a supporting Excel Spreadsheet that features SRL and RL property files which have been merged with the State's Mitigated Properties file so that mitigated repetitive loss properties are properly characterized. As of June 30, 2011, Maryland had approximately 756 residential and 145 non-residential mitigated and non-mitigated RL properties for a total of 901 properties, of which eleven are validated SRL properties. FEMA's Bureau Net database shows claims paid that reflect either repetitive loss or severe repetitive loss properties. Additionally, 155 RL properties have been mitigated.

Repetitive Loss and Severe Repetitive Loss Properties. Many flood insured properties have had more than one claim. A property that is currently insured for which two or more NFIP losses (occurring more than 10 days apart) of at least $1,000 each have been paid within any 10-year period since 1978 is defined as a "repetitive loss property" by the NFIP program.

Residential SRL properties are single family structures consisting of one to four residences that have flood insurance which have incurred flood related damages on four or more separate occasions with the amount of each claim exceeding $5,000 and the cumulative amount of the total claims paid exceeding $20,000; or cumulative amount of the claims exceeds the value of the property, when at least two separate

[4] The National Flood Insurance Program's Market Penetration Rate Estimates and Policy Implications, 2006; Lloyd Dixon, Noreen Clancy, Seth A. Seabury, Adrian Overton.

claim payments have been made. In either case, at least two losses must have occurred within a 10-year time span; claims must be more than ten days apart.

As of June 30, 2011, more than $56.4 Million has been paid in repetitive loss properties (non-mitigated and mitigated properties); nearly $985,192 of that amount is from severe repetitive loss properties. Anne Arundel and Carroll counties have the most losses on SRL properties. Figure 3-12 show the approximate locations of the repetitive and severe repetitive loss properties and total amount paid in insurance claims. Table 3-17 shows the total of repetitive and severe repetitive loss total claim amounts paid.

Table 3-15. NFIP policy and claim information. (as of 4/30/2011)

County/City *	Number of Policies In-Force	Coverage Total Value $	Annual Premium $	Number of Claims	Claim Total Value $	Average Claim Value $
Allegany County	416	$65,739,500	$373,434	308	$3,160,975	$10,263
Anne Arundel County	6,281	$1,589,011,100	$4,753,652	2,238	$45,858,417	$20,491
Annapolis (included in County)	464	$110,160,400	$370,855	134	$4,352,459	$32,481
Baltimore County	4,401	$1,014,270,700	$4,205,743	2,785	$60,490,433	$21,720
Calvert County	861	$226,912,300	$654,990	451	$8,577,400	$19,019
Caroline County	222	$46,166,800	$186,657	45	$482,871	$10,730
Carroll County	197	$46,727,500	$146,024	109	$747,329	$6,856
Cecil County	1,076	$229,381,500	$817,305	521	$9,440,295	$18,120
Charles County	650	$174,362,400	$439,667	209	$4,839,782	$23,157
Dorchester County	1,660	$349,433,100	$1,280,424	885	$16,505,720	$18,651
Frederick County	518	$131,076,900	$460,171	184	$1,447,276	$7,866
Garrett County	168	$26,305,300	$118,971	112	$954,363	$8,521
Harford County	938	$201,389,300	$810,870	272	$2,549,991	$9,375
Howard County	675	$182,025,500	$395,257	113	$577,443	$5,110
Kent County	702	$167,032,800	$654,853	316	$7,723,629	$24,442
Montgomery County	2,019	$522,941,700	$937,038	408	$1,929,185	$4,728
Prince George's County	3,006	$658,771,400	$1,800,123	388	$2,397,141	$6,178
Queen Anne's County	2,655	$668,969,500	$1,711,046	911	$13,347,266	$14,651
Somerset County	2,024	$323,743,700	$1,246,144	395	$2,117,629	$5,361
St. Mary's County	1,348	$353,103,800	$972,265	490	$9,814,275	$20,029
Talbot County	2,127	$607,728,900	$1,588,653	572	$10,866,087	$18,997
Washington County	348	$70,288,300	$337,246	383	$4,071,537	$10,631
Wicomico County	665	$164,567,700	$430,644	102	$1,528,367	$14,984
Worcester County	33,721	$6,239,457,000	$12,271,283	1,816	$11,190,682	$6,162
Ocean City (included in County)	27,352	$4,539,317,800	$8,719,968	1,196	$7,087,223	$5,926
City of Baltimore	2,576	$644,022,800	$1,685,231	739	$19,253,974	$26,054
Grand Total	**69,250**	**$14,703,175,500**	**$38,276,114**	**14,746**	**$239,809,263**	**$16,263**

*Town of Millington totals have been included in both Kent and Queen Anne's Counties. Value has only been counted once in grand totals.
Source: http://bsa.nfipstat.com

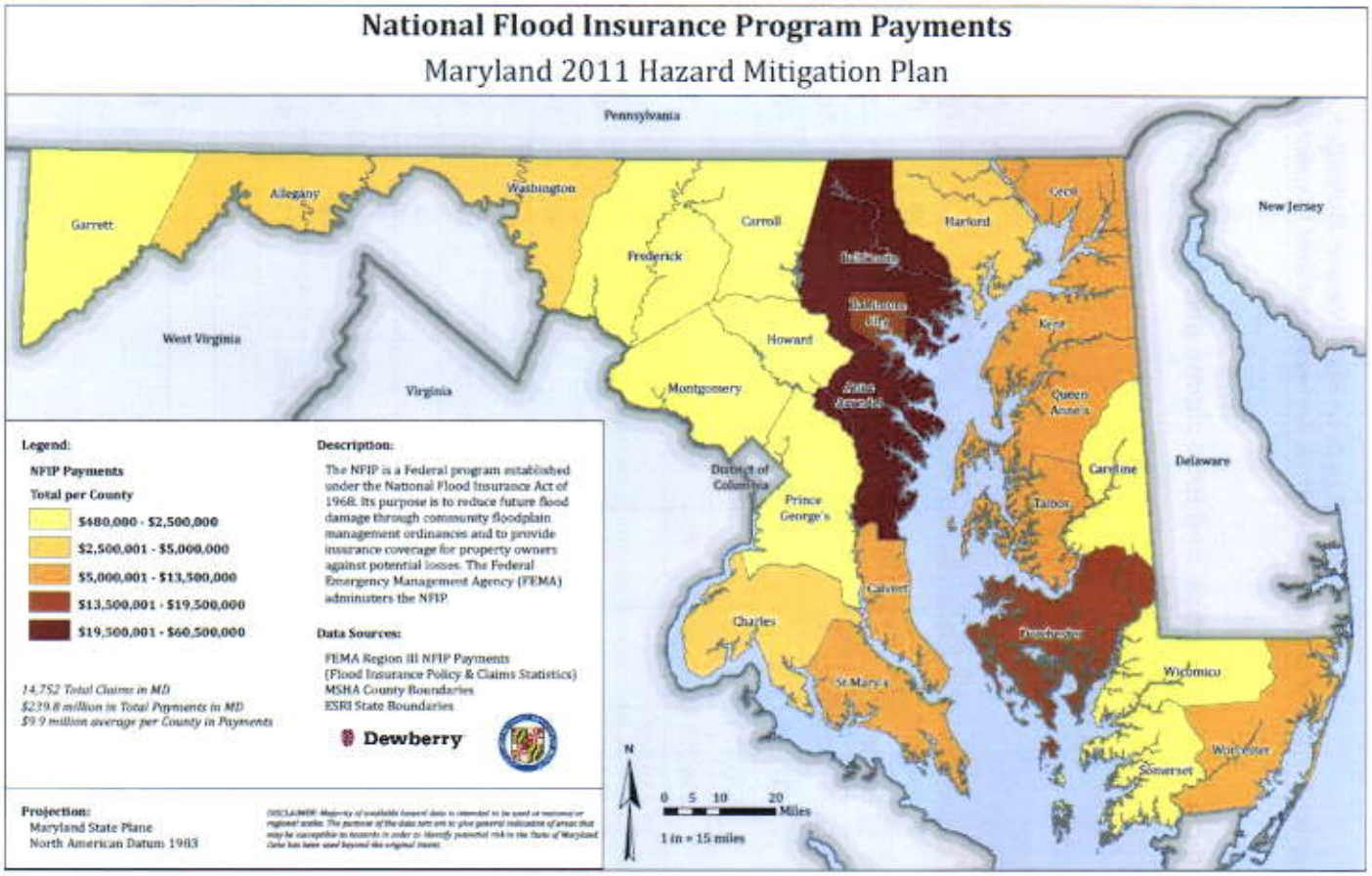


Figure 3-10. National Flood Insurance Program (NFIP) payments.

3.5.6 Mitigated Repetitive Loss Properties

As part of this plan update, a system has been developed to help maintain accurate datasets for RL and SRL Properties. These datasets facilitate program planning, HMA grant targeting and outreach efforts to potential project-sponsoring communities, as well as the property owners. The maintenance system includes utilizing a MS Excel workbook that compares known mitigation project locations to repetitive loss locations as identified by FEMA. This will provide an update as to which RL and SRL properties have been mitigated, and provide a tool for targeting mitigation projects to those properties requiring mitigation (Appendix P).

Residential SRL properties receive priority for mitigation under the *Bunning-Bereuter-Blumenauer Reform Act (Public Law 108-264)*. The primary goal of the Severe Repetitive Loss Program is to reduce excessive flood claim payments and reliance on the National Flood Insurance Fund for flood relief when mitigation is an option.

Table 3-16. Repetitive Loss and Validated Severe Repetitive Loss properties, and total claims paid for mitigated and non-mitigated properties. (6/30/2011)

County/City	# Mitigated Properties	# RL Residential Properties	# of RL Properties	# of Total RL Events	RL Total Paid	# of SRL Properties (All Residential)	# of SRL Events	SRL Total Paid	RL + SRL # of Properties	RL + SRL # of Events	RL + SRL Total Paid
Allegany County	8	24	28	60	$1,368,997				28	60	$1,368,997
Anne Arundel County	11	83	89	209	$7,551,361	3	14	$429,809	92	223	$7,981,170
Baltimore County	26	110	134	336	$9,367,661	1	6	$142,276	135	342	$9,509,937
Calvert County	13	48	53	129	$3,092,088				53	129	$3,092,088
Caroline County		1	1	2	$50,150				1	2	$50,150
Carroll County	4	10	10	24	$234,356	2	10	$170,189	12	34	$404,545
Cecil County		34	41	118	$1,832,907				41	118	$1,832,907
Charles County		16	21	48	$2,138,132				21	48	$2,138,132
Dorchester County	4	42	44	94	$1,821,657				44	94	$1,821,657
Frederick County	4	22	26	69	$1,025,622				26	69	$1,025,622
Garrett County	1	14	16	42	$551,432	1	3	$61,795	17	45	$613,227
Harford County	7	11	14	39	$415,464				14	39	$415,464
Howard County	2	5	6	14	$298,890				6	14	$298,890
Kent County	1	7	8	16	$516,329				8	16	$516,329
Montgomery County	3	40	41	98	$1,011,824	2	4	$33,455	43	102	$1,045,279
Prince George's County		8	9	22	$550,980				9	22	$550,980
Queen Anne's County		24	24	60	$1,084,213				24	60	$1,084,213
Somerset County	2	13	17	39	$457,230				17	39	$457,230
St. Mary's County	6	53	57	118	$3,395,379				57	118	$3,395,379

County/City	# Mitigated Properties	# RL Residential Properties	# of RL Properties	# of Total RL Events	RL Total Paid	# of SRL Properties (All Residential)	# of SRL Events	SRL Total Paid	RL + SRL # of Properties	RL + SRL # of Events	RL + SRL Total Paid
Talbot County	3	15	18	40	$1,212,789				18	40	$1,212,789
Washington County	11	55	60	146	$2,411,493	1	4	$58,236	61	150	$2,469,729
Wicomico County		0	2	5	$31,255				2	5	$31,255
Worcester County	45	98	121	281	$5,211,707	1	2	$89,432	122	283	$5,301,139
City of Baltimore	4	23	50	125	$9,796,882				50	125	$9,796,882
Grand Total	**155**	**756**	**890**	**2,134**	**$55,428,798**	**11**	**43**	**$985,192**	**901**	**2,177**	**$56,413,990**

Table 3-17. Repetitive Loss and Validated Severe Repetitive Loss properties, and total claims paid for non-mitigated properties. (4/30/2011)

County/City	# of RL Properties	# Residential Properties	# of RL Events	RL Total Paid	# of SRL Properties	# of SRL Events	SRL Total Paid	RL + SRL # of Properties	RL + SRL # of Events	RL + SRL Total Paid
Allegany County	20	16	41	$1,086,105	-	-	-	20	41	$1,086,105
Anne Arundel County	80	72	190	$6,110,514	1	4	$85,221	81	194	$6,195,735
Baltimore County	99	76	252	$6,805,758	1	5	$136,974	100	257	$6,942,732
Calvert County	40	36	90	$1,867,424	-	-	-	40	90	$1,867,424
Caroline County	1	1	2	$50,150	-	-	-	1	2	$50,150
Carroll County	6	7	12	$102,452	2	8	$124,906	8	20	$227,358
Cecil County	41	34	118	$1,832,907	-	-	-	41	118	$1,832,907
Charles County	21	16	48	$2,138,132	-	-	-	21	48	$2,138,132
Dorchester County	35	33	72	$1,387,988	-	-	-	35	72	$1,387,988
Frederick County	22	18	57	$818,437	-	-	-	22	57	$818,437
Garrett County	15	13	40	$531,929	1	3	$61,795	16	43	$593,724
Harford County	7	5	17	$162,068	-	-	-	7	17	$162,068
Howard County	4	3	10	$254,625	-	-	-	4	10	$254,625

County/City	# of RL Properties	# Residential Properties	# of RL Events	RL Total Paid	# of SRL Properties	# of SRL Events	SRL Total Paid	RL + SRL # of Properties	RL + SRL # of Events	RL + SRL Total Paid
Kent County	7	7	14	$238,725	-	-	-	7	14	$238,725
Montgomery County	38	37	88	$877,842	2	4	$33,455	40	92	$911,297
Prince George's County	9	8	22	$550,980	-	-	-	9	22	$550,980
Queen Anne's County	24	24	60	$1,084,213	-	-	-	24	60	$1,084,213
Somerset County	15	13	31	$277,450	-	-	-	15	31	$277,450
St. Mary's County	51	47	106	$2,702,479	-	-	-	51	106	$2,702,479
Talbot County	14	11	30	$928,524	-	-	-	14	30	$928,524
Washington County	49	44	122	$1,982,282	1	4	$58,236	50	126	$2,040,518
Wicomico County	2	0	5	$31,255	-	-	-	2	5	$31,255
Worcester County	77	67	182	$3,093,497	2	7	$163,963	79	189	$3,257,460
City of Baltimore	46	19	116	$9,683,093	-	-	-	46	116	$9,683,093
Grand Total	**723**	**607**	**1,725**	**$44,598,829**	**10**	**35**	**$664,550**	**733**	**1,760**	**$45,263,379**

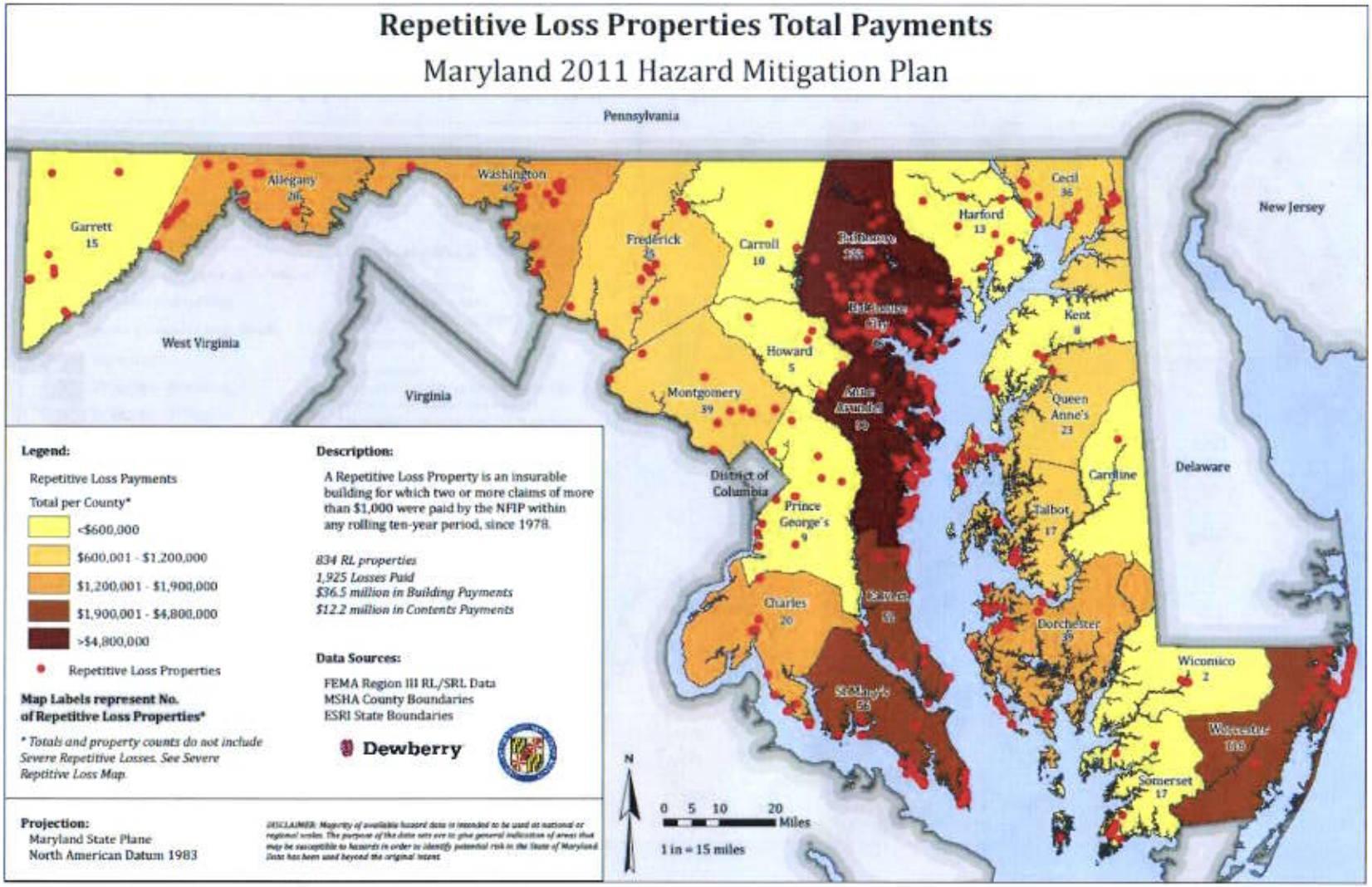


Figure 3-11. Total payments on Repetitive Loss Property claims.

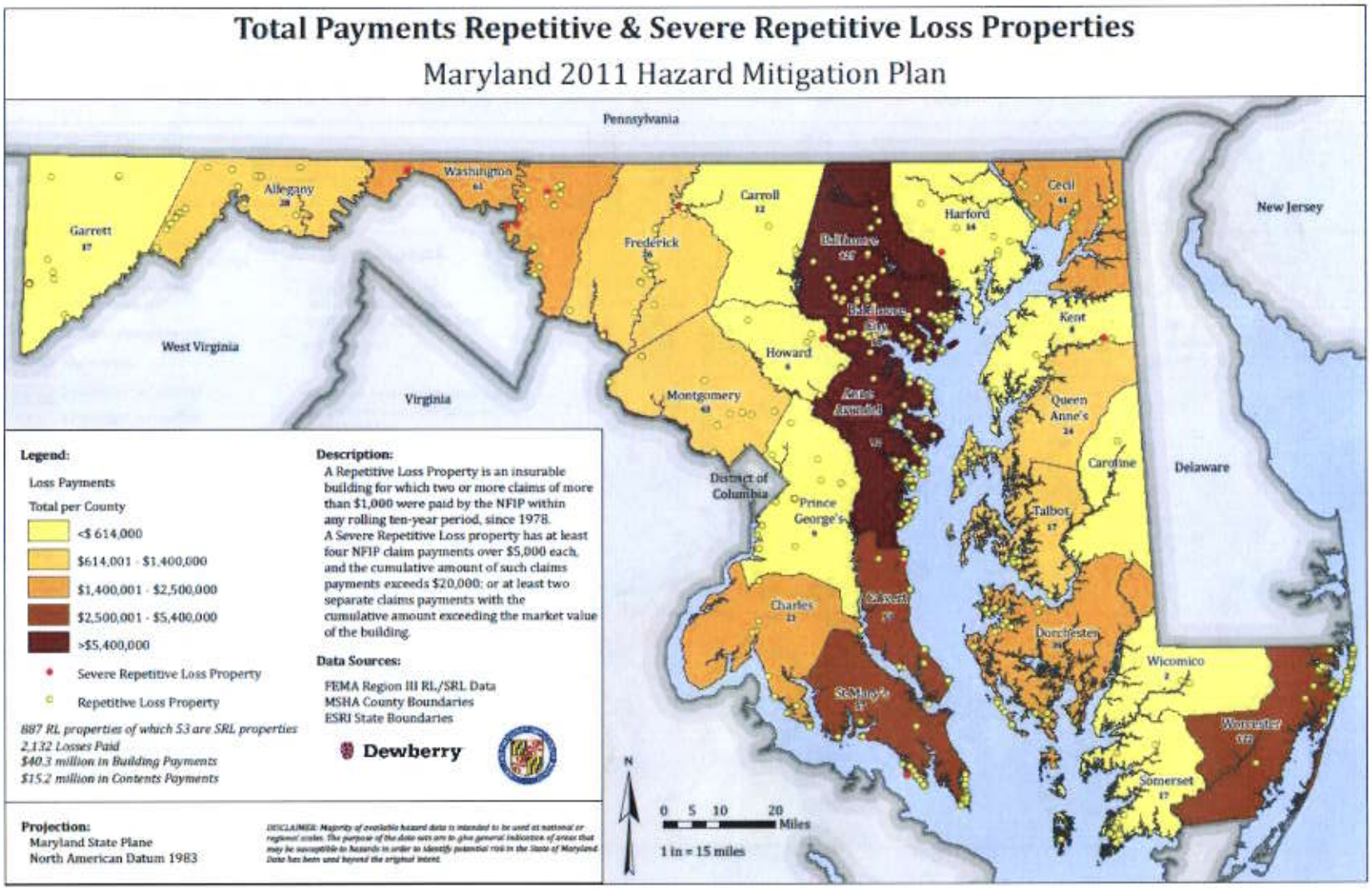


Figure 3-12. Total payments on Repetitive and Severe Repetitive Loss Property claims.

Increased Cost of Compliance (ICC). The Standard Flood Insurance Policy has a provision that will pay the policy holder to comply with a State or local floodplain management law or ordinance to repair or reconstruct a structure that has suffered cumulative (50 percent or greater) flood damage. Mitigation activities eligible for payment are: elevation, flood proofing, relocation, or demolition (or any combination of these activities) of the structure.

Policyholders may receive up to $30,000 under this coverage. The structure must meet certain eligibility criteria, including a substantial damage or repetitive loss determination by a local official. A building is eligible for an ICC claim payment if it is in a SFHA and the community floodplain manager determines that the building has been damaged by flood whereby the cost of restoring the building to before damaged conditions would equal or exceed 50 percent of the market value of the building (before the damage occurred) as determined by the community.
If it is a repetitive loss structure and is subject to community floodplain management laws or ordinances there are two conditions that must be met in order for an ICC claim to be paid for a repetitive loss structure: (a) the State or community must have adopted and be currently enforcing a repetitive loss provision or a cumulative substantial damage provision requiring action by the property owner to comply with the State or community floodplain management laws/ordinances; and (b) the building must have a history of NFIP claim payments that satisfy the definition of repetitive loss structure.

Under ICC coverage, the building must be elevated, flood proofed, demolished, or relocated as soon as reasonably possible after the loss, not to exceed two years. Table 3-18 shows the total number of properties mitigated in each of the activity types. The majority of ICC projects in Maryland have been elevations. Coverage for ICC is now automatically eligible for HMA grant match.

Table 3-18. ICC Mitigated Properties.

County/City	Demolition	Elevation	Other	Relocation	Total
Allegany County					
Anne Arundel County	16	76	9	3	104
Baltimore County	27	176	25		228
Calvert County	7	26	3	1	37
Caroline County					
Carroll County	1				1
Cecil County	2	12	4		18
Charles County	1	3			4
Dorchester County	2	52	6		60
Frederick County					
Garrett County					
Harford County	1		1		2
Howard County					
Kent County	1	22	4		27
Montgomery County					
Prince George's County					

County/City	Demolition	Elevation	Other	Relocation	Total
Queen Anne's County	3	13	1		17
Somerset County		1			1
St. Mary's County	2	20	1		23
Talbot County		12	2		14
Washington County					
Wicomico County		2			2
Worcester County			2		2
City of Baltimore	2	10	6		18
Grand Total	**65**	**425**	**64**	**4**	**558**

Mitigation Programs. Mitigation funding has been used to mitigate structures by acquiring and converting the land into open-space; elevating above the base flood elevation level; or building infrastructure that improved local drainage problems. Theoretically, these structures will no longer require payments for flood loss claims from the National Flood Insurance Fund (NFIF).

Table 3-19 shows the distribution of mitigation projects completed or approved in Maryland for all HMA Grants awarded to the State of Maryland under the HMGP, FMA, PDM, PDM-C, RFC, SRL programs from 1988 to the present. Two hundred and seventy-three (273) mitigated structures were included in the export from FEMAs Enterprise Data Warehouse (Business Objects), only 140 are actively approved, 72 closed, 22 obligated and one pending; totaling 235 mitigation projects. Most of these projects were funded through the FEMA post-disaster Hazard Mitigation Grant Program (HMGP). Most of these buildings were acquired and demolished flood-prone residences. Appendix P includes the mitigation project data that was verified and revised for this plan update.

Table 3-19. Mitigation funding sources that have been approved, obligated, pending, and closed.

County/City	99/00 Supplemental	Floyd Supplemental	FMA	HMGP	LPDM	PDM	Grand Total
Allegany County			19	52			71
Anne Arundel County			5	16			21
Baltimore County				35			35
Calvert County				6			6
Caroline County		3		5			8
Carroll County							
Cecil County			1	14		3	18
Charles County				1			1
Dorchester County				2			2
Frederick County				6			6
Garrett County			3	7			10
Harford County		2	1				3
Howard County				2			2

County/City	99/00 Supplemental	Floyd Supplemental	FMA	HMGP	LPDM	PDM	Grand Total
Kent County		3		1			4
Montgomery County				3	1		4
Prince George's County			1	9		7	17
Queen Anne's County	1	1		2		1	5
Somerset County							
St. Mary's County				4	3	3	10
Talbot County				2		1	3
Washington County			2				2
Wicomico County				1			1
Worcester County						6	6
City of Baltimore							
Grand Total	**1**	**9**	**32**	**168**	**4**	**21**	**235**

3.5.7 Risk Assessment

Flood risk was determined by examining historical records found in the NCDC database and FEMA designated 100-year floodplains and then, by applying the hazard ranking methodology described in the Hazard Assessment and Ranking Methodology section of the HIRA. Risk due to storm surge is discussed in the Coastal Storm Surge Hazard Assessment (section 3.8).

Flood loss estimates and risk to critical facilities have been derived using the FEMA HAZUS – MH MR5 software for riverine and coastal flood hazards. Flood hazard is defined by a relationship between depth of flooding and the annual chance of inundation to that depth. This assessment has been completed for Level 2 analysis with user-provided depth grids that were generated from provided terrain data, and FEMA Digital Flood Insurance Rate Maps (DFIRMs).

The flood model was used to run scenarios for both the 1-percent (i.e. 100 year) and 0.2-percent (i.e., 500 year) annual chance frequencies where the flood hazard is based on FIRM data. All but four Counties have some level of NFIP floodplain data and these data were used in the HAZUS analyses. Certain updates to stock HAZUS MR-5 databases (essential facilities, transportation and utilities) were performed given geospatial databases provided by various State departments and/or agencies.

See Appendix P for county specific flood loss maps, tables, and supporting data from the HAZUS-MH MR5 runs.

Probability of Future Occurrence. SFHAs on FEMA DFIRMs are subject to inundation by a flood that has a 1-percent or greater chance of being equaled or exceeded in any given year. Commonly referred to as the 100-year flood, 1% chance flood or base flood; 100-year flood is not a flood that occurs every 100 years. The 100-year flood has a 26 percent chance of occurring during a 30 year period, the typical length of many mortgages. It is also important to note that once a flood occurs, its chance of recurring remains the same.

The 100-year flood is a regulatory standard used by Federal agencies, states and NFIP-participating communities to administer and enforce floodplain management programs. The 100-year flood is also used by the NFIP as the basis for insurance requirements nationwide[5]. The main recurrence intervals used on the FIRMS are shown in Table 3-20.

Table 3-20. Flood recurrence intervals.

Annual Chance of Occurrence	Recurrence Interval
10-year	0.1
50-year	0.02
100-year	0.01
500-year	.002

Based on historical frequency of occurrence using NCDC data, a reasonable determination of probability of future flood events can be made. Flooding has had significant impacts on Maryland in the past and is likely to impact the State in the future. An examination of NCDC data suggests that on an annual basis, approximately one to seven events of some significance occur in any particular county in Maryland. Montgomery County has had the highest number of reported flood events, followed by Frederick, Baltimore and Cecil Counties. Table 3-21 shows the total and annualized number of flood events by county based on the NCDC historical record. Table 3-2, Table 3-3 and Table 3-4 (section 3.3.2) shows total and annualized events for each county by hazard type for comparison. Based on NCDC data, flash flood events of some significance occur in any one particularly Maryland county one to three times annually, depending on the county. Montgomery and Baltimore counties have had the most flash flood events in the state.

More intense rainfall, the result of climate change, is likely to increase peak flooding, particularly in urban environments in the future. The magnitude of this increase is dependent on the level and rate of greenhouse gas emissions through the end of the century. It is projected that there will be a 20 percent increase in the magnitude of the 100-year flood under a higher greenhouse gas emissions scenario (A26) and a 10 percent increase in magnitude under a lower greenhouse gas emissions (B17) scenario.8 For the 10-year flood recurrence interval, the increase in magnitudes is expected to be approximately 29 percent and 16 percent respectively.

Table 3-21. NCDC total and annualized flood events (1993-2010).

County/City	Flood Total Events	Flood Annualized Events	Flash Flood Total Events	Flash Flood Annualized Events
Allegany County	50	2.78	27	1.50
Anne Arundel County	72	4.00	37	2.06
Baltimore County	95	5.28	54	3.00
Calvert County	33	1.83	14	0.78
Caroline County	51	2.83	10	0.56

[5] National Flood Insurance Program (www.fema.gov)
[6] Intergovernmental Panel on Climate Change, IPCC Special Report, Emissions Scenarios, 2000.
[7] Intergovernmental Panel on Climate Change, IPCC Special Report, Emissions Scenarios, 2000.
[8] Maryland Commission on Climate Change, Climate Action Report; 2008. Pages 2; 25; 31-32.

County/City	Flood Total Events	Flood Annualized Events	Flash Flood Total Events	Flash Flood Annualized Events
Carroll County	59	3.28	36	2.00
Cecil County	81	4.50	29	1.61
Charles County	33	1.83	8	0.44
Dorchester County	16	0.89	6	0.33
Frederick County	100	5.56	42	2.33
Garrett County	53	2.94	33	1.83
Harford County	57	3.17	36	2.00
Howard County	59	3.28	28	1.56
Kent County	44	2.44	8	0.44
Montgomery County	112	6.22	57	3.17
Prince George's County	75	4.17	30	1.67
Queen Anne's County	51	2.83	12	0.67
St. Mary's County	52	2.89	21	1.17
Somerset County	7	0.39	1	0.06
Talbot County	51	2.83	9	0.50
Washington County	59	3.28	21	1.17
Wicomico County	14	0.78	7	0.39
Worcester County	17	0.94	8	0.44
City of Baltimore	48	2.67	22	1.22
Grand Total*	**1,179**	**65.5**		

** Grand total values are not a direct sum of each of the county/city totals. The grand total events do not include zonal events as described in Section 3.3 and Section 3.5.*

Impact and Vulnerability. Populations and property are extremely vulnerable to flooding. Homes and business may suffer damage and be susceptible to collapse due to heavy flooding. Floodwaters can carry chemicals, sewage, and toxins from roads, factories, and farms; therefore any property affected by the flood may be contaminated with hazardous materials. Debris from vegetation and man-made structures may also be hazardous following the occurrence of a flood. In addition, floods may threaten water supplies and water quality, as well as initiate power outages.

In regard to continuity of operations, those state and critical facilities within the FEMA 100-year flood zone, especially Baltimore City, would be at greater risk from flood-related impacts. Jurisdictions within Maryland are required to have Continuity of Operation Plans to ensure the continuation of services during an event. In some instances, services may be temporarily delayed due to an extreme hazard event. Public utilities representation staff both the state and local emergency operation centers.

Table 3-22 provides a breakdown of injuries and fatalities by county that are the result of flood events between 1993 and November 2010. Eight deaths in Frederick County have been attributed to flooding. Baltimore County has experienced the most injuries (36) due to flooding, followed by Harford County (17).

Table 3-22. Flood Hazard - Injuries and Deaths.

County/City	Total Injuries	Total Deaths
Allegany County	0	0
Anne Arundel County	2	0
Baltimore County	36	2
Calvert County	0	0
Caroline County	1	0
Carroll County	0	0
Cecil County	5	0
Charles County	0	0
Dorchester County	0	0
Frederick County	1	8
Garrett County	0	0
Harford County	17	0
Howard County	2	0
Kent County	0	0
Montgomery County	5	1
Prince George's County	3	0
Queen Anne's County	2	0
St. Mary's County	0	0
Somerset County	0	0
Talbot County	0	0
Washington County	0	0
Wicomico County	0	0
Worcester County	0	0
City of Baltimore	4	5
Grand Total	**64**	**16**

** Grand total values are not a direct sum of each of the county/city totals. The grand total events do not include zonal events as described in Section 3.3 and Section 3.5.*

Risk. As evidence in property and crop loss figures (

Table 3-23) obtained from NCDC, floods have the potential to be destructive. Total damages (adjusted for inflation) on an annualized basis range from more than $5,000 to more than $41.8 Million in Allegany County. Flood events were not recorded by the NCDC in Dorchester, Somerset, and Wicomico counties; additional sources should be investigated for future plan updates. These estimates are believed to be an underrepresentation of the actual losses experienced

due to hazards as losses from events that go unreported or that are difficult to quantify are not likely to appear in the NCDC database; this is especially true with crop damages.

Table 3-23. Flood Hazard - Crop and Property Damage 1993 - 2010.

County/City	Property Damage (Total)	Property Damage (Annualized)	Crop Damage (Total)	Crop Damage (Annualized)	Total Damage	Total Damage (Annualized)
Allegany County	$41,662,705	$2,314,595	$218,699	$12,150	$41,881,404	$2,326,745
Anne Arundel County	$3,858,423	$214,357	$0	$0	$3,858,423	$214,357
Baltimore County	$4,624,949	$256,942	$0	$0	$4,624,949	$256,942
Calvert County	$715,911	$39,773	$0	$0	$715,911	$39,773
Caroline County	$8,851,508	$491,750	$1,111,538	$61,752	$9,963,046	$553,503
Carroll County	$3,157,659	$175,426	$0	$0	$3,157,659	$175,426
Cecil County	$7,872,610	$437,367	$0	$0	$7,872,610	$437,367
Charles County	$356,134	$19,785	$0	$0	$356,134	$19,785
Dorchester County	$0	$0	$0	$0	$0	$0
Frederick County	$34,733,165	$1,929,620	$95,507	$5,306	$34,828,672	$1,934,926
Garrett County	$4,628,299	$257,128	$0	$0	$4,628,299	$257,128
Harford County	$4,940,692	$274,483	$0	$0	$4,940,692	$274,483
Howard County	$353,815	$19,656	$0	$0	$353,815	$19,656
Kent County	$1,332,533	$74,030	$0	$0	$1,332,533	$74,030
Montgomery County	$27,528,079	$1,529,338	$88,432	$4,913	$27,616,511	$1,534,251
Prince George's County	$2,954,743	$164,152	$0	$0	$2,954,743	$164,152
Queen Anne's County	$5,337,814	$296545	$0	$0	$5,337,814	$296,545
St. Mary's County	$991,420	$55,079	$0	$0	$991,420	$55,079
Somerset County	$0	$0	$0	$0	$0	$0
Talbot County	$4,663,866	$259,104	$0	$0	$4,663,866	$259,104
Washington County	$36,076,797	$2,004,267	$130,880	$7,271	$36,207,677	$2,011,538
Wicomico County	$0	$0	$0	$0	$0	$0
Worcester County	$5,684	$316	$0	$0	$5,684	$316
City of Baltimore	$2,325,146	$129,175	$0	$0	$2,325,147	$129,175
Grand Total*	**$121,538,808**	**$6,752,156**	**$1,400,983**	**$77,832.39**	**$122,939,791**	**$6,829,988**

** Grand total values are not a direct sum of each of the county/city totals. The grand total events do not include zonal events as described in Section 3.3 and Section 3.5.*

State and Critical Facility Risk. For some activities and facilities, even a slight chance of flooding is too great a threat. These facilities should be given special consideration when forming

regulatory alternatives and floodplain management plans. A critical facility should not be located in a floodplain if at all possible. If a critical facility must be located in a floodplain it should be given a higher level of protection (at least 0.002 percent frequency design) so that it can continue to function and provide services during and after a flood. Communities should develop emergency plans that detail Continuity of Operations for critical facilities and the services they provide to a community.

Through Executive Order 11988, Floodplain Management, Federal agencies funding and/or permitting critical facilities are required to avoid the 0.2 percent (500-year) floodplain or protect the facilities to the 0.2 percent chance flood level. In order to assess risks due to flooding, this plan used the FEMA flood zones to intersect state and critical facility locations to determine what flood zone the structure is in.

Facility points were intersected with the FEMA 100-year flood zone to determine each facility's flood zone location. This simplified approach was used due to limited spatial and attribute data for facilities. Loss estimations were not calculated; with better attribute information this could be completed for state and critical facilities. Mitigation actions should address these data limitations. Based on the available data, more than half of the counties in Maryland have been determined to have a high flood ranking (Figure 3-15).

Table 3-24 shows a breakdown of the number of facilities and building and contents values for those jurisdictions with a high flood ranking. The City of Baltimore has the largest number of critical facilities located near or within the SFHA. Caroline County has the largest number of state-owned facilities located within or near the SFHA. Based on the available building values, the state-owned and critical facilities located within FEMA-designated 100-year floodplains have a total value of $2.4 Billion.

A MS Excel Worksheet that categorizes critical facilities per county for each hazard may be found in Appendix P.

Jurisdictional Risk. Based on available data, more than half of the counties have been determined to have a high flood ranking (Figure 3-15). This ranking was accomplished using the methodology described in the Hazard Analysis and Ranking Methodology section of the HIRA.

As described above, the flood model was used to determine risk to both the 1-percent and 0.2-percent annual chance frequencies. Based on these runs, Maryland could expect $8.7 Billion in flood losses for the 100-year scenario; $11.2 Billion from the 500-year scenario. Worcester County has the highest 100-year estimated loss ($1.7 Billion) and Anne Arundel County has the highest 500-year loss estimate ($1.4 Billion). Building and contents damage make up the majority of the loss

Loss estimation for this HAZUS module is based on specific input data. The type of data shown below includes information on the local economy that is used in estimating losses. Table 3-25 displays the economic loss categories used to calculate annualized losses by HAZUS. See Appendix P for county specific flood loss maps, tables, and supporting data from the HAZUS-MH MR5 runs.

Table 3-24. State and Critical Facilities within FEMA 100-year flood zone.

County/City	Total Number of Critical Facilities	Critical Facilities Building and Contents Values	Total Number of State Facilities	State Facilities Building and Contents Values
Allegany County	181	$21,800,133	7	$3,749,353
Anne Arundel County	443	$1,103,200	16	$25,137,983
Baltimore County	717	$9,734,000	63	$184,312,142
Baltimore City	1,049	$149,117,733	106	$1,127,435,779
Calvert County	55	$2,445,813	5	$1,935,284
Caroline County	458	$4,581,227	333	$106,551,157
Carroll County	147	$40,471,440	0	$0
Cecil County	265	$1,308,667	4	$149,816
Charles County	75	$0	4	$496,269
Dorchester County	203	$7,335,333	19	$1,990,181
Frederick County	331	$1,732,173	5	$48,150,415
Garrett County	128	$5,339,867	5	$21,920
Harford County	319	$29,786,800	3	$117,089
Howard County	255	$2,481,307	4	$346,734
Kent County	86	$2,544,400	1	$974,500
Montgomery County	313	$0	1	$63,308
Prince George's County	749	$7,488,840	6	$13,340,297
Queen Anne's County	136	$5,587,480	1	$0
Somerset County	184	$588,267	62	$15,540,817
St. Mary's County	330	$10,209,200	227	$531,629,696
Talbot County	149	$1,521,653	20	$6,573,363
Washington County	239	$6,626,533	6	$1,324,378
Wicomico County	274	$2,311,067	22	$86,973,263
Worcester County	398	$7,045,373	46	$10,669,632
Grand Total	**7,484**	**$321,160,506**	**966**	**$2,156,813,744**

Local Plan Risk Assessment. All of the local plans addressed and ranked flood in their hazard mitigation plans. Sixteen local plans considered flood a high hazard, four medium-high and six medium. Section 3.6 includes a summary of how each of the local plans ranked flood and outlines the assumptions that were made in an effort to compare the local hazard rankings to each other.

Table 3-25. HAZUS direct economic loss categories and descriptions.

Category Name	Description of Data Input into Model	HAZUS Output
Building	Cost per sq ft to repair damage by structural type and occupancy for each level of damage	Cost of building repair or replacement of damaged and destroyed buildings
Contents	Replacement value by occupancy	Cost of damage to building contents
Inventory	Annual gross sales in $ per sq ft	Loss of building inventory as contents related to business activities
Relocation	Rental costs per month per sq ft by occupancy	Relocation expenses (for businesses and institutions)
Income	Income in $ per sq ft per month by occupancy	Capital-related incomes losses as a measure of the loss of productivity, services, or sales
Rental	Rental costs per month per sq ft by occupancy	Loss of rental income to building owners
Wage	Wages in $ per sq ft per month by occupancy	Employee wage loss as described in income loss

Table 3-26. 100-year flood loss estimates by building type.

County/City	Building	Contents	Inventory	Relocation	Income	Rental	Wage	Direct Loss	Grand Total
Allegany County	$65,678,000	$102,031,000	$5,390,000	$171,000	$288,000	$54,000	$1,169,000	$1,866,000	**$176,647,000**
Anne Arundel County	$489,456,000	$490,213,000	$9,984,000	$681,000	$993,000	$284,000	$3,697,000	$4,529,000	**$999,837,000**
Baltimore County	$360,963,000	$384,768,000	$13,086,000	$629,000	$893,000	$178,000	$2,985,000	$4,305,000	**$767,807,000**
Calvert County	$62,856,000	$52,515,000	$881,000	$74,000	$74,000	$4,000	$221,000	$409,000	**$117,034,000**
Caroline County	$9,804,000	$11,695,000	$500,000	$5,000	$24,000	$2,000	$101,000	$138,000	**$22,269,000**
Carroll County	$60,136,000	$56,273,000	$2,160,000	$26,000	$45,000	$5,000	$127,000	$412,000	**$119,184,000**
Cecil County	$126,517,000	$133,813,000	$3,227,000	$181,000	$418,000	$99,000	$1,414,000	$1,538,000	**$267,207,000**
Charles County	$98,858,000	$85,670,000	$1,704,000	$145,000	$160,000	$27,000	$1,047,000	$1,763,000	**$189,374,000**
Dorchester County	$49,146,000	$46,695,000	$3,136,000	$133,000	$147,000	$15,000	$571,000	$1,566,000	**$101,409,000**
Frederick County	$142,202,000	$144,351,000	$4,859,000	$177,000	$324,000	$57,000	$1,403,000	$1,741,000	**$295,114,000**
Garrett County	$25,352,000	$35,913,000	$1,346,000	$24,000	$97,000	$7,000	$749,000	$1,135,000	**$64,623,000**
Harford County	$182,464,000	$167,510,000	$3,753,000	$270,000	$235,000	$63,000	$793,000	$1,365,000	**$356,453,000**
Howard County	$330,783,000	$344,224,000	$11,765,000	$470,000	$749,000	$163,000	$2,483,000	$3,218,000	**$693,855,000**
Kent County	$40,796,000	$31,060,000	$1,061,000	$56,000	$25,000	$6,000	$164,000	$206,000	**$73,374,000**
Montgomery County	$292,618,000	$261,948,000	$6,899,000	$404,000	$401,000	$100,000	$2,336,000	$3,076,000	**$567,782,000**
Prince George's County	$264,065,000	$334,430,000	$16,067,000	$876,000	$1,528,000	$383,000	$8,827,000	$7,980,000	**$634,156,000**
Queen Anne's County	$74,956,000	$74,610,000	$2,201,000	$173,000	$275,000	$43,000	$640,000	$1,211,000	**$154,109,000**
St. Mary's County	$60,234,000	$52,516,000	$716,000	$48,000	$65,000	$5,000	$1,206,000	$783,000	**$115,573,000**
Somerset County	$79,564,000	$73,977,000	$2,451,000	$216,000	$172,000	$40,000	$1,688,000	$1,770,000	**$159,878,000**
Talbot County	$49,933,000	$44,865,000	$958,000	$85,000	$173,000	$36,000	$480,000	$735,000	**$97,265,000**
Washington County	$72,981,000	$79,352,000	$3,675,000	$31,000	$133,000	$12,000	$667,000	$1,259,000	**$158,110,000**
Wicomico County	$72,089,000	$111,680,000	$3,461,000	$129,000	$503,000	$75,000	$1,621,000	$2,328,000	**$191,886,000**
Worcester County	$932,553,000	$808,222,000	$12,244,000	$1,593,000	$3,660,000	$1,394,000	$7,049,000	$9,803,000	**$1,776,518,000**
City of Baltimore	$200,365,000	$387,009,000	$19,877,000	$663,000	$2,436,000	$567,000	$8,320,000	$7,737,000	**$626,974,000**
Grand Total	**$4,144,369,000**	**$4,315,340,000**	**$131,401,000**	**$7,260,000**	**$13,818,000**	**$3,619,000**	**$49,758,000**	**$60,873,000**	**$8,726,438,000**

Table 3-27. 500-year flood loss estimates by building type.

County/City	Building	Contents	Inventory	Relocation	Income	Rental	Wage	Direct Loss	Grand Total
Allegany County	$146,762,000	$211,248,000	$8,180,000	$317,000	$799,000	$150,000	$3,589,000	$4,103,000	**$375,148,000**
Anne Arundel County	$696,926,000	$708,244,000	$12,830,000	$1,102,000	$1,504,000	$455,000	$5,003,000	$6,118,000	**$1,432,182,000**
Baltimore County	$604,938,000	$635,366,000	$25,462,000	$1,130,000	$1,554,000	$374,000	$5,369,000	$7,068,000	**$1,281,261,000**
Calvert County	$78,799,000	$65,655,000	$1,083,000	$84,000	$96,000	$9,000	$299,000	$480,000	**$146,505,000**
Caroline County	$15,437,000	$18,613,000	$942,000	$14,000	$42,000	$5,000	$358,000	$287,000	**$35,698,000**
Carroll County	$84,134,000	$76,569,000	$2,713,000	$37,000	$64,000	$6,000	$251,000	$517,000	**$164,291,000**
Cecil County	$177,142,000	$183,084,000	$3,889,000	$263,000	$541,000	$123,000	$1,686,000	$1,941,000	**$368,669,000**
Charles County	$124,218,000	$105,718,000	$1,959,000	$161,000	$174,000	$28,000	$1,171,000	$1,902,000	**$235,331,000**
Dorchester County	$78,330,000	$73,675,000	$4,135,000	$153,000	$226,000	$44,000	$1,063,000	$2,104,000	**$159,730,000**
Frederick County	$194,282,000	$205,634,000	$7,883,000	$249,000	$459,000	$95,000	$1,908,000	$2,296,000	**$412,806,000**
Garrett County	$32,139,000	$44,059,000	$1,569,000	$32,000	$117,000	$9,000	$910,000	$1,278,000	**$80,113,000**
Harford County	$191,547,000	$176,317,000	$4,049,000	$287,000	$274,000	$66,000	$891,000	$1,543,000	**$374,974,000**
Howard County	$339,605,000	$354,937,000	$12,033,000	$481,000	$785,000	$167,000	$2,706,000	$3,341,000	**$714,055,000**
Kent County	$52,006,000	$40,213,000	$1,380,000	$71,000	$39,000	$11,000	$238,000	$351,000	**$94,309,000**
Montgomery County	$427,584,000	$378,370,000	$8,554,000	$657,000	$683,000	$173,000	$3,978,000	$4,954,000	**$824,953,000**
Prince George's County	$260,460,000	$331,150,000	$16,111,000	$882,000	$1,519,000	$387,000	$8,930,000	$7,950,000	**$627,389,000**
Queen Anne's County	$113,458,000	$109,901,000	$3,395,000	$265,000	$359,000	$66,000	$936,000	$1,656,000	**$230,036,000**
St. Mary's County	$164,750,000	$134,002,000	$1,887,000	$159,000	$149,000	$27,000	$3,959,000	$1,751,000	**$306,684,000**
Somerset County	$110,991,000	$103,807,000	$3,477,000	$261,000	$214,000	$46,000	$2,064,000	$2,089,000	**$222,949,000**
Talbot County	$87,823,000	$81,300,000	$1,921,000	$211,000	$326,000	$87,000	$876,000	$1,576,000	**$174,120,000**
Washington County	$87,006,000	$95,538,000	$4,541,000	$48,000	$174,000	$19,000	$880,000	$1,558,000	**$189,764,000**
Wicomico County	$78,950,000	$119,822,000	$3,713,000	$139,000	$566,000	$84,000	$1,754,000	$2,575,000	**$207,603,000**
Worcester County	$717,780,000	$625,850,000	$9,019,000	$1,587,000	$2,938,000	$1,207,000	$6,740,000	$8,390,000	**$1,373,511,000**
City of Baltimore	$395,211,000	$718,477,000	$36,480,000	$1,152,000	$4,317,000	$1,269,000	$17,869,000	$14,257,000	**$1,189,032,000**
Grand Total	**$5,260,278,000**	**$5,597,549,000**	**$177,205,000**	**$9,742,000**	**$17,919,000**	**$4,907,000**	**$73,428,000**	**$80,085,000**	**$11,221,113,000**

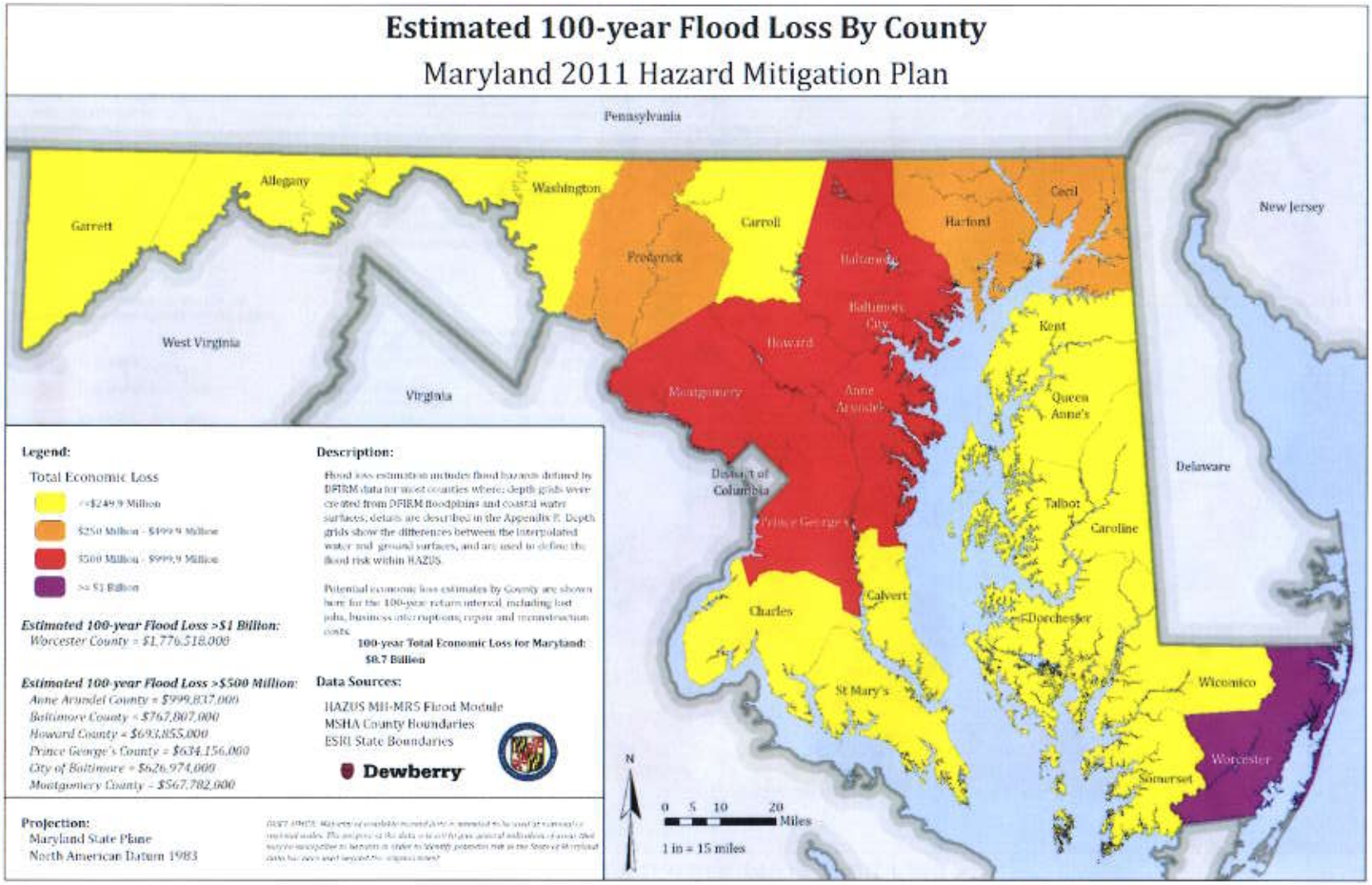


Figure 3-13. Estimated 100-year Flood Loss by County.

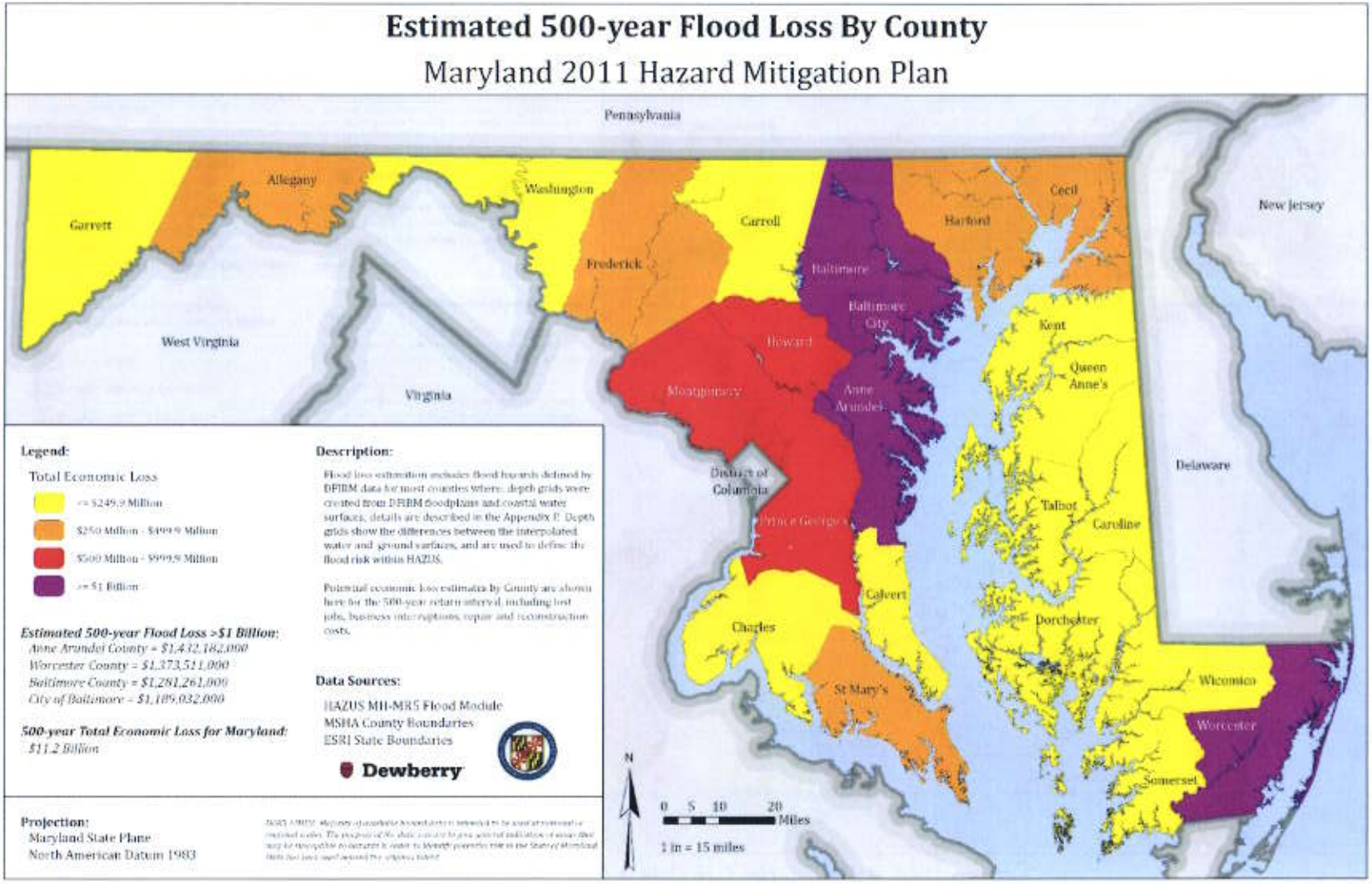


Figure 3-14. Estimated 500-year Flood Loss by County.

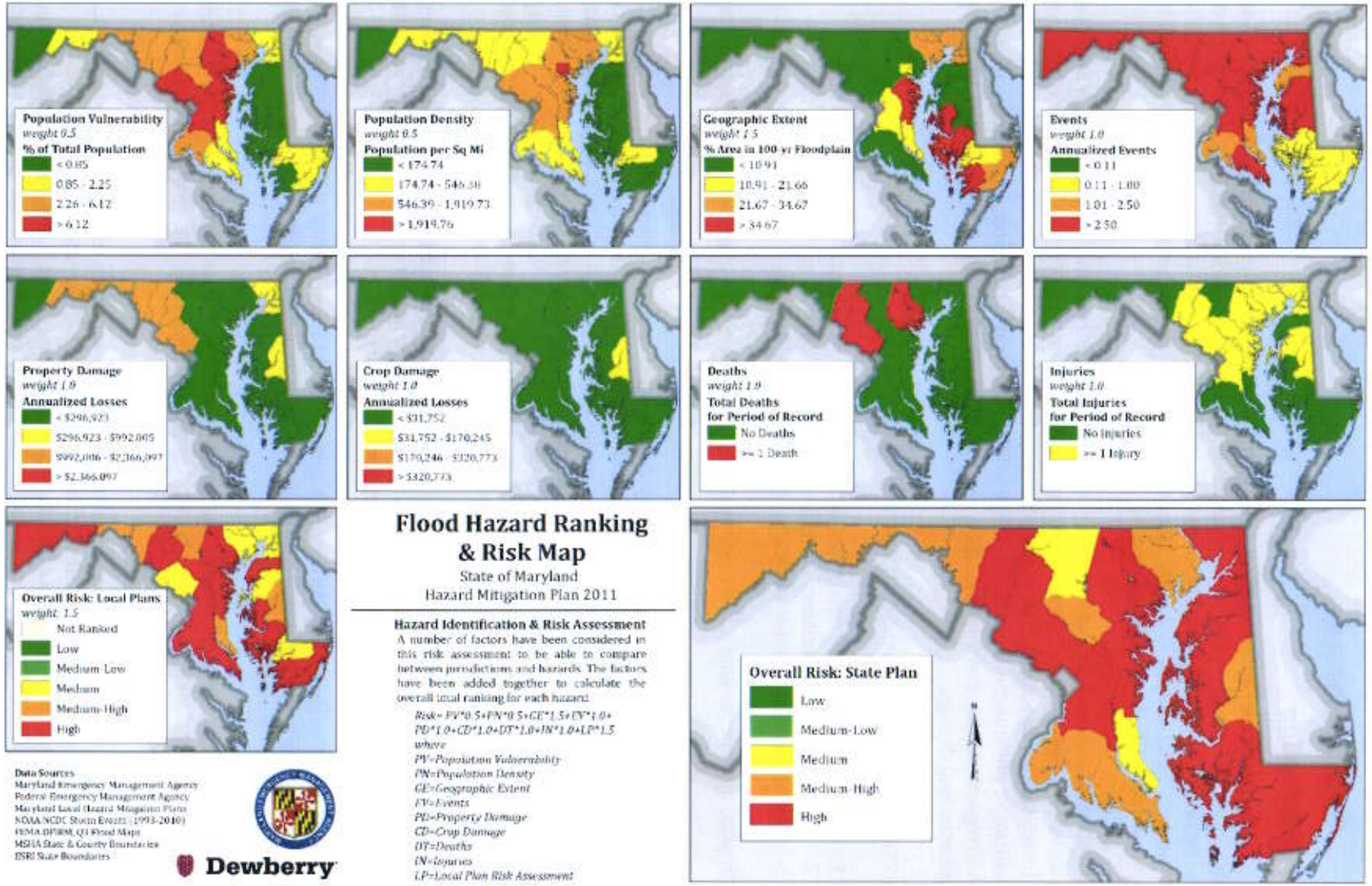


Figure 3-15. Flood Hazard Ranking and Risk.

3.6 Coastal Hazards

3.6.1 Description

Coastal hazards take many forms ranging from storm systems like tropical storms, hurricanes and Nor'easters that can cause storm surge inundation, heavy precipitation that may lead to flash flooding, and exacerbation of shoreline erosion to longer term hazards such as sea level rise. The focus for much of this section is coastal storms with discussion and limited analysis for shoreline erosion, sea level rise and tsunami included.

Tropical cyclones, a general term for tropical storms and hurricanes, are low pressure systems that usually form over the tropics. These storms are referred to as "cyclones" due to their rotation. Tropical cyclones are among the most powerful and destructive meteorological systems on earth. Their destructive phenomena include very high winds, heavy rain, lightning, tornadoes, and storm surge. As tropical storms move inland, they can cause severe flooding, downed trees and power lines, and structural damage.

There are three categories of tropical cyclones:

1. Tropical Depression: maximum sustained surface wind speed is less than 39 mph.
2. Tropical Storm: maximum sustained surface wind speed from 39-73 mph.
3. Hurricane: maximum sustained surface wind speed exceeds 73 mph.

Once a tropical cyclone no longer has tropical characteristics it is then classified as an extratropical system.

Most Atlantic tropical cyclones begin as atmospheric "easterly waves" that propagate off the coast of Africa and cross the tropical North Atlantic and Caribbean Sea. When a storm starts to move toward the north, it begins to leave the area where the easterly trade winds prevail, and enters the temperate latitudes where the westerly winds dominate. This produces the eastward curving pattern of most tropical storms that pass through the Mid-Atlantic region. When the westerly steering winds are strong, it is easier to predict where a hurricane will go. When the steering winds become weak, the storm follows an erratic path that makes forecasting very difficult.

Hurricanes are categorized according to the Saffir/Simpson scale with ratings determined by wind speed and central barometric pressure. Hurricane categories range from One through Five, with Category Five being the strongest (winds greater than 155 mph).

A hurricane watch is issued when hurricane conditions could occur within the next 36 hours. A hurricane warning indicates that sustained winds of at least 74 mph are expected within 24 hours or less.

The National Weather Service (NWS) National Hurricane Center defines June 1 through November 30 as the Atlantic hurricane season. September is typically the most active month for tropical cyclones in Maryland.

Tropical storms and hurricanes are accompanied by a storm surge, an abnormal local rise in sea level. The storm surge is caused by the difference in wind and barometric pressure between a tropical system and the environment outside the system. The end result is that water is pushed onto a coastline. The height of the surge is measured as the deviation from mean sea level and can reach

over 25 feet in extreme circumstances. The most devastating storm surges occur just to the right of the eye of a land falling hurricane. For coastal areas, the storm surge is typically the most dangerous and damaging aspect of the storm.

Howling winds associated with Nor'easters also have the potential to produce significant storm surge, similar to that of a Category One hurricane. In addition, these types of storms can also produce wind gusts to near hurricane force as well as flooding rain and crippling snowfall. The wintry impacts of Nor'easters are discussed in greater detail in Section 3.12.

The Sea, Lake, and Overland Surges from Hurricanes (SLOSH) model is used to evaluate the potential impact of storm surge. Emergency managers use data from SLOSH to identify at-risk populations and determine evacuation areas. Storm surges also affect tidal rivers and creeks, potentially increasing evacuation areas. Figure 3-16 indicates the potential inland extent of storm surge as a function of hurricane category. It is readily apparent from this figure that Maryland has significant vulnerability to storm surge. This is particularly true of portions of the Eastern Shore.

The Saffir/Simpson scale (Table 3-28) was developed in 1971 by Herbert Saffir and Dr. Robert Simpson as a way to classify hurricanes. The scale rates the intensity of hurricanes based on wind speed and barometric pressure measurements. The scale gives an indication of the potential flooding and wind damages associated with each hurricane category.

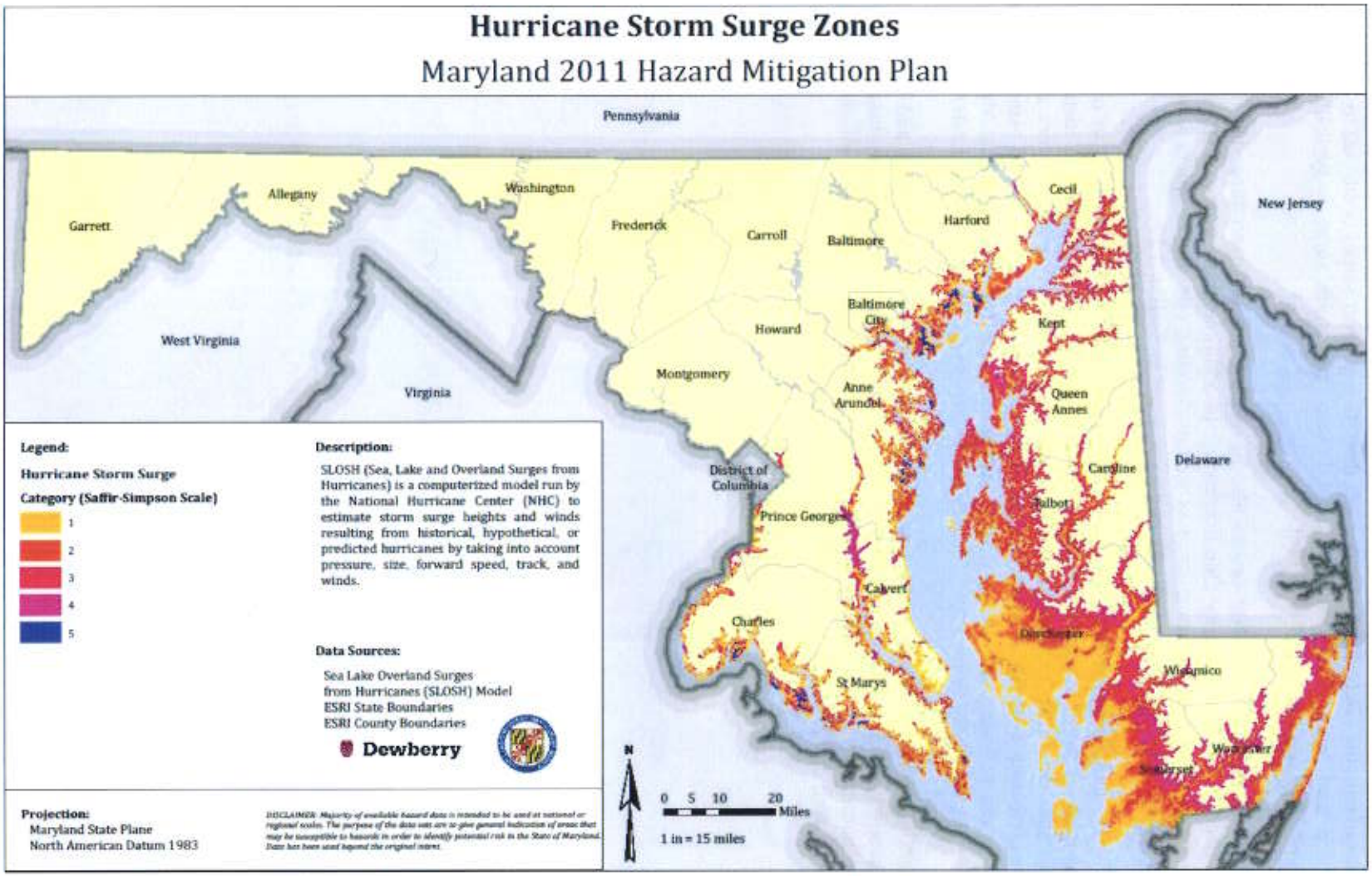


Figure 3-16. Potential Storm Surge Inundation by Hurricane Category.

Table 3-28. Saffir/Simpson Hurricane Intensity Categories.

Wind Speed	Typical Effects
Category One Hurricane – Weak	
74-95 mph (64-82kt)	Minimal Damage: Damage is primarily to shrubbery, trees, foliage, and unanchored mobile homes. No real damage occurs in building structures. Some damage is done to poorly constructed signs.
Category Two Hurricane – Moderate	
96-110 mph (83-95kt)	Moderate Damage: Considerable damage is done to shrubbery and tree foliage, some trees are blown down. Major structural damage occurs to exposed mobile homes. Extensive damage occurs to poorly constructed signs. Some damage is done to roofing materials, windows, and doors; no major damage occurs to the building integrity of structures.
Category Three Hurricane – Strong	
111-130 mph (96-113kt)	Extensive damage: Foliage torn from trees and shrubbery; large trees blown down. Practically all poorly constructed signs are blown down. Some damage to roofing materials of buildings occurs, with some window and door damage. Some structural damage occurs to small buildings, residences and utility buildings. Mobile homes are destroyed. There is a minor amount of failure of curtain walls (in framed buildings).
Category Four Hurricane - Very Strong	
131-155 mph (114-135kt)	Extreme Damage: Shrubs and trees are blown down; all signs are down. Extensive roofing material and window and door damage occurs. Complete failure of roofs on many small residences occurs, and there is complete destruction of mobile homes. Some curtain walls experience failure.
Category Five Hurricane – Devastating	
Greater than 155 mph (135kt)	Catastrophic Damage: Shrubs and trees are blown down; all signs are down. Considerable damage to roofs of buildings. Very severe and extensive window and door damage occurs. Complete failure of roof structures occurs on many residences and industrial buildings, and extensive shattering of glass in windows and doors occurs. Some complete buildings fail. Small buildings are overturned or blown away. Complete destruction of mobile homes occurs.

Source: National Climatic Data Center, 2001. The Saffir/Simpson Hurricane Scale. Accessed 11/03, http://www.ncdc.noaa.gov/oa/satellite/satelliteseye/educational/saffir.html.

3.6.2 Historical Occurrence

Generally, Maryland is spared from frequent land falling hurricanes because of the orientation of the Mid-Atlantic coastline, as well as the state's latitude. Because the coast of North Carolina juts out into the Atlantic, storms trending up the coast tend to make landfall there or pass offshore. Most hurricanes approaching Maryland make landfall to the south and are soon thereafter downgraded to tropical storm or depression status.

The intensity of tropical cyclones is generally measured by wind velocity, although the greatest devastation is usually associated with storm surge and flooding. For example, Hurricanes Agnes (1972) and Fran (1996) produced some of the worst flooding ever recorded for western and central

Maryland due to heavy rains. In terms of storm surge, the August 1933 storm was particularly destructive, generating a 7-foot surge and waves over 20 feet high that created the inlet now separating Ocean City from Assateague Island.

On September 18, 2003, Hurricane Isabel arrived in Maryland after making landfall earlier that day at Topsail, North Carolina. Hurricane Isabel was downgraded to Tropical Storm Isabel by the time it reached Maryland. Regardless, the storm brought widespread flooding to low-lying areas adjacent to the Chesapeake Bay and its tributaries, significant wind damage, and power outages for over 1 million Maryland residents. Isabel prompted the closing of the Chesapeake Bay Bridge and cancellation of all flights at Baltimore-Washington International Airport.

In the Baltimore area, Tropical Storm Isabel (Figure 3-17) delivered the worst flooding in decades to area residents and businesses. Aided by a high tide, the storm surge measured ten feet and pushed water several blocks into the downtown area, stranding hotel guests, inundating hundreds of cars, and forcing much of the central business district to close. More than 400 people were rescued from the floodwaters in downtown Baltimore. The low-lying Bowley's Quarters area of southeastern Baltimore County was particularly hard hit, with over 300 homes destroyed and thousands more damaged by floodwaters resulting from the storm surge.

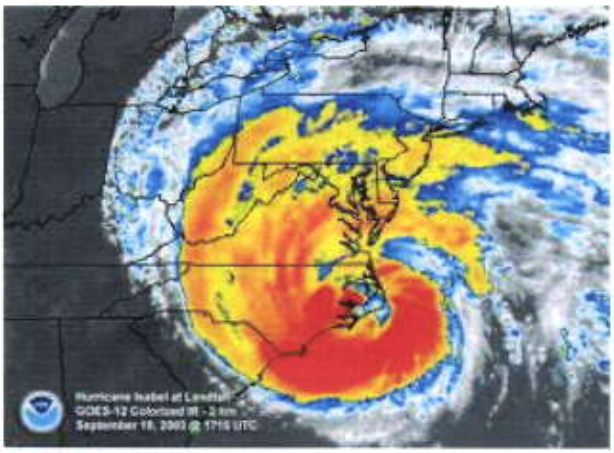


Figure 3-17. Infrared satellite image of Hurricane Isabel at the time of landfall on September 18, 2003. (NOAA)

Annapolis also experienced record flooding as Tropical Storm Isabel swamped the city's downtown waterfront and marinas. The U.S. Naval Academy closed after floodwaters inundated several basements of academic buildings and dormitories. Annapolis public works officials reported a high-water mark from Isabel of 7.58 feet, eclipsing the previous mark of 6.35 feet from the hurricane of 1933.

Hurricane Floyd is another recent tropical cyclone to cause widespread damage in Maryland. Making landfall just east of Cape Fear, North Carolina on September 16, 1999, Floyd moved north-northeast, downing hundreds of trees and utility lines across Virginia and Maryland. More than 500,000 Marylanders lost electricity during the storm. By the time Floyd hit Maryland it was downgraded to a tropical storm, but still generating sustained winds of 69 mph, Floyd skirted over the length of Maryland's barrier islands before heading out to sea. Strong southerly winds ahead of the hurricane pushed tides 2-3 feet above normal, causing extensive tidal flooding along the length of the Chesapeake Bay. Storm surges of 5-7 feet occurred over central portions of the Bay, inundating sections of Dorchester and Somerset Counties. Rainfall amounts generally ranged from 3-6 inches across much of the lower Eastern Shore, causing significant crop damage and inland flooding. Anne Arundel, Calvert, Caroline, Cecil, Charles, Harford, Kent, Queen Anne's, St. Mary's, Somerset, and Talbot Counties qualified for FEMA disaster assistance.

Hurricane Agnes, which occurred in June 1972, remains the most devastating tropical cyclone in Maryland's history, and serves to illustrate the unpredictable nature of hurricanes. Instead of high winds and storm surge causing most of the damage, meteorological events conspired to produce

devastating flooding, particularly in northern and central Maryland. While the storm approached Maryland from the south, a separate large low-pressure system was causing flooding in New York and Pennsylvania. After Agnes had crossed southeastern Virginia and headed out to sea, the influence of the second storm system caused Agnes to return inland, joining the other storm over north central Pennsylvania. As a result, Maryland experienced extremely heavy rains combined with torrential floodwaters from the north. Twenty-four hour rainfall totals across northern and central counties exceeded 10 inches, with over 14 inches recorded in Westminster. Peak flow through the Conowingo Dam was over 30 times the average June flow. The Monocacy River crested 16 feet above flood stage in Frederick, and the Potomac crested at 21 feet above flood stage in Point of Rocks. Hundreds of bridges in the state were damaged or destroyed. Of the 122 deaths attributed to the storm, 19 occurred in Maryland. In all, Agnes caused $354 million in damages in Maryland (August 2003 dollars).

A number of factors point to the potential for increased danger from severe tropical cyclones in Maryland. Steady population growth and continuing near-shore development is increasing the risk of human injury and property loss. There is also widespread agreement among climatologists that a gradual global warming is occurring. Potential effects include the melting of polar ice, expansion of the oceans, and an overall rise in sea levels. The slow sinking of land in the Chesapeake region, due to the combined effects of ground water withdrawal and post-glacial rebound, effectively doubles the global rate of sea level rise in Maryland's coastal areas. These factors increase the vulnerability of coastal areas to surge.

Additionally, meteorologists are predicting busier hurricane seasons for the next 10 to 40 years. Higher sea surface temperatures and wind patterns more than doubled the number of Atlantic tropical cyclones over a 10-year period beginning in 1995. Tropical cyclones in the Caribbean have quintupled, and previously infrequent storms that occur after September have increased tenfold.

This same combination of weather conditions resulted in an increase in powerful tropical cyclones in the 1950s and 1960s. Hazel in 1954, Connie and Diane in 1955, and Donna in 1960 were particularly damaging in Maryland. There is evidence that these hurricane cycles, lasting for up to 40 years from peak to peak, extend back at least to the 1600s. Table 3-29 lists several significant tropical storm and hurricane events that have impacted Maryland over the years.
Figure 3-18 depicts the tracks of tropical storms and hurricanes between 1851 and 2009.

Table 3-29. Previous Significant Hurricane/Tropical Storm Events.

Date	Event	Comments
August 27, 1667	Unnamed Hurricane	A strong hurricane ripped through the Mid-Atlantic region, causing 1667 to be known as "the Year of the Hurricane". A government report noted, "A mighty wind...destroyed four-fifths of (our) tobacco and corn and blew down in two hours fifteen thousand houses in Virginia and Maryland." Several separate accounts of the storm describe the great devastation. This was known as a benchmark storm for many generations.

Date	Event	Comments
October 15, 1954	Hurricane Hazel	Hurricane Hazel made landfall as a Category 4 hurricane near the North Carolina-South Carolina border on October 15. Hurricane-force gusts swept the eastern half of Maryland, while heavy rains pounded the west. Washington National Airport reported a record sustained wind of 78 mph with gusts up to 98 mph. Gusts near 100 mph were commonplace throughout the Chesapeake Bay region and on the Eastern Shore. Severe flooding occurred along the bay and its tidal tributaries, and flash flooding plagued western Maryland, where 3-6 inches of rain fell. Generally, less than 2 inches of rain fell in the eastern half of the state.
August 12 and 18, 1955	Hurricanes Connie and Diane	Hurricanes Connie and Diane both passed over Maryland as tropical storms within several days of each other, on Aug. 12 and 18, respectively. The rains from Connie set the stage for the devastating floods caused by Diane, which poured 10-20 inches of rain on the already-soaked region. Major flooding occurred in central Maryland, particularly along the Potomac River. Strong gales from Connie sunk the tour schooner Levin J. Marvel, about 20 miles south of its home port of Annapolis. Fourteen passengers drowned.
June 21-23, 1972	Hurricane Agnes	Hurricane Agnes moved through the Atlantic past Maryland as a tropical storm on June 21-23. Widespread and in some places record flooding wrought one of the state's most destructive natural disasters. In the tributaries on the north side of the Potomac River, from the Conococheague Creek at Fairview, Maryland down to Rock Creek at Washington, DC, floods in excess of the 100 year frequency level were observed. Many roads were closed, particularly in central Maryland, and thousands of evacuations occurred. The event proved to be an ecological calamity for the Chesapeake Bay. The damage in Maryland was in excess of $1.1 million, and there were 19 deaths.
July 13, 1996	Hurricane Bertha	Hurricane Bertha moved across the Lower Maryland Eastern Shore on July 13th. The highest sustained wind speed recorded was 23 mph at Salisbury, with gusts up to 63 mph at Ocean City. One confirmed tornado was spawned by the hurricane near Madison in Dorchester county. Numerous trees and power lines were blown down and resulted in scattered property damage and power outages. Rainfall amounts generally ranged from 3.0 to 5.0 inches and caused some street flooding. Property damages of $100,000 and crop damages of $15,000 occurred.
September 6, 1996	Tropical Storm Fran	Spiral bands associated with Hurricane Fran affected the Lower Maryland Eastern Shore during Friday, September 6th. The highest sustained wind speed recorded was 22 mph at Salisbury with gusts of 35 mph. A storm surge of 4 to 6 feet inundated portions of the communities of Taylors Island, Hoopers Island, and Madison in Dorchester county along the Chesapeake Bay. Many roads were flooded with some homes receiving water damage at the time of high tide. Dorchester, Wicomico, Somerset, and Worcester counties were affected, and property damages reached $1 million. Storm winds channeled water up the Chesapeake Bay and its main tributaries, which became a small-scale storm surge, causing $1.6 million in property damages and $5,000 in crop damages in central Maryland.

Date	Event	Comments
October 8, 1996	Tropical Storm Josephine	Remnants of Tropical Storm Josephine moved quickly up the East Coast during Tuesday, October 8th, affecting the Lower Maryland Eastern Shore. The storm produced 1.5 to 3.5 inches of rain resulting in flooding of several roads. The storm caused $100,000 in damages.
September 16, 1999	Hurricane Floyd	Hurricane Floyd moved north-northeast across extreme southeast Virginia and reached Maryland near Ocean City by evening on the 16th. Hurricane Floyd was a Category 1 hurricane as it crossed the Wakefield WFO county warning area. The storm surge caused tides two to three feet above normal throughout central Maryland. Tropical storm force wind gusts occurred in the northwest quadrant of the storm over portions of the Lower Maryland Eastern Shore. Property damages of over $1 million and crop damages of $575,000 occurred.
September 18, 2003	Hurricane Isabel	Hurricane Isabel had been downgraded to a tropical storm by the time it reached Maryland, but it still caused significant damage in the state. Isabel's eye tracked well west of the bay, but the storm's 40 to 50 mph sustained winds pushed a bulge of water northward up the bay and its tributaries producing a record storm surge. The Maryland western shore counties of the Chesapeake Bay and along the tidal tributaries of the Potomac, Patuxent, Patapsco and other smaller rivers experienced a storm surge that reached 5 to 9 feet above normal tides. Over 2000 people were evacuated from their homes. Many buildings were destroyed and the Lower Maryland East Shore suffered the worst power outages in history. The storm caused one fatality, 200 injuries, $530 million in property damages, and $190,000 in crop damages. Counties affected include Anne Arundel, Calvert, Charles, Harford, Baltimore, Prince George's, and St. Mary's.
September 1, 2006	Tropical Storm Ernesto	Moderate coastal flooding occurred due to the storm surge from the remnants of Tropical Storm Ernesto. The tide crest at Annapolis was 3.56 MLLW late Friday. In Charles County, mandatory evacuations were ordered due to the flooding, with many roads flooded. Property damage reached $50,000.
September 6, 2008	Tropical Storm Hanna	Tropical Storm Hanna brought heavy rain, strong winds and some tidal flooding to the Eastern Shore during the day and into the evening of the 6th. Maximum sustained winds reached 50 mph. Tree damage was sustained throughout much of the state, and many roads were closed due to trees down.

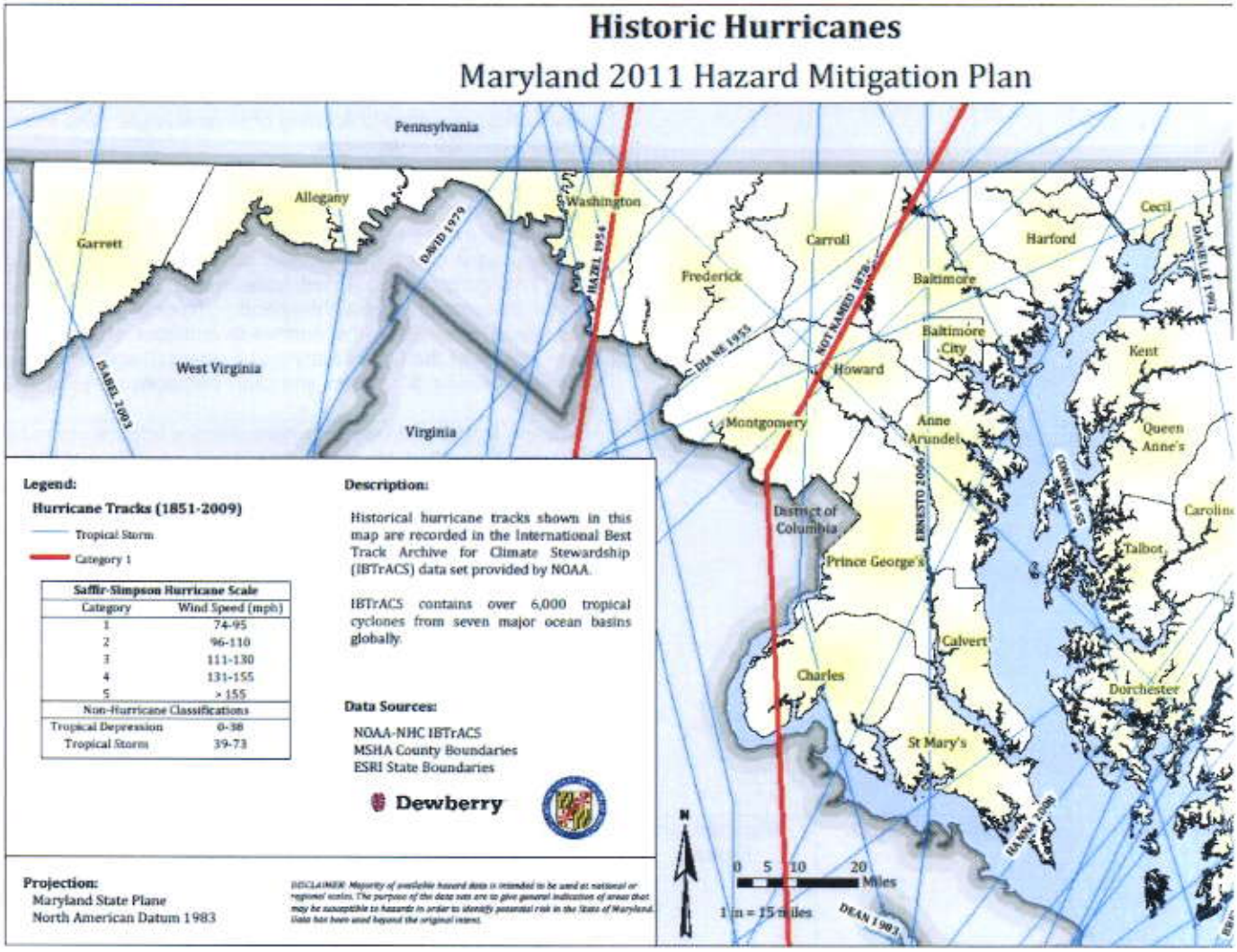


Figure 3-18. Historic Tropical Storm and Hurricanes.

3.6.3 Risk Assessment

Coastal hazard risk was determined by examining historical records found in the NCDC database and other sources and then, by applying the hazard ranking methodology described in the Hazard Assessment and Ranking Methodology section (Section 3.5) of the HIRA.

Probability of Future Occurrence. Based on historical frequency of occurrence using NCDC data, a reasonable determination of probability of future coastal hazard events can be made. Coastal hazards have had significant impacts on Maryland in the past and are likely to impact the State in the future. An examination of NCDC data suggests that on an annual basis, approximately 0.06 to 1.06 coastal hazard events occur in any particular Maryland county. In other words, on average, an individual Maryland county is impacted by a significant coastal hazard event roughly every 1 to 17 years. Obviously, the impacts of coastal events are most frequent nearest the coast and less so further inland. This is not to say that coastal storms do not have any impacts inland, as strong winds from coastal storms can sometimes extend hundreds of miles outward from the storm's center. Worcester County has had the highest number of significant coastal events annually, experiencing roughly one per year. Table 3-30 shows the annualized number of coastal hazard events by county based on the NCDC historical record. Table 3-3 and Table 3-4 (section 3.3.2) show total and annualized events for each county by hazard type for comparison.

Based on a range of long-term global climate models under Intergovernmental Panel on Climate Change (IPCC) warming scenarios, it is possible that hurricanes will become more intense, with stronger winds and heavier precipitation through the 21st century. Using an ensemble-mean of 18 climate models, IPCC A1B emissions scenario[9], and operational hurricane forecast models, one study[10] showed a decrease in the total number of tropical storms and hurricanes, but an increase in the number of intense hurricanes, particularly Category 4 or 5 hurricanes. Future plan updates should consider a review of the latest climate science to determine what impact, if any, climate change might have on the future frequency or intensity of hurricanes and tropical storms and how this might apply to Maryland.

Impact and Vulnerability. The impact of significant coastal events is greatest for those areas along and immediately near the coast. Electrical utilities and communications as well as transportation infrastructure are vulnerable to significant coastal events. Damage to power lines or communication towers has the potential to cause power and communication outages for residents, businesses and critical facilities. In the event of a temporary loss of power or communications for state and/or critical facilities, alternative means of communication and delivery of services are pre-established as per the jurisdictional COOP and/or Standard Operating Procedures (SOP). In addition to lost revenues, downed power lines present a threat to personal safety. Further, downed wires and lightning strikes have been known to spark fires.

A structure's vulnerability to significant coastal event hazards is based in large part on building construction and standards and its location in relation to potential storm surge inundation zones. In general, mobile homes and wood-framed structures are more vulnerable to damage from wind during significant coastal events than steel framed structures. Other factors, such as location, condition and maintenance of trees also plays a significant role in determining vulnerability.

[9] IPCC Special Report on Emissions Scenarios, 2000.
[10] Modeled Impact of Anthropogenic Warming on the Frequency of intense Atlantic Hurricanes, Morris A. Bender, Thomas R. Knutson, Robert E. Tuleya, Joseph J. Sirutis, Gabriel A. Vecchi, Stephen T. Garner, Isaac M. Held.

Table 3-30. NCDC total and annualized coastal hazards (1993-2010).

County/City	Total Events	Annualized Events
Allegany County	1	0.06
Anne Arundel County	14	0.78
Baltimore County	12	0.67
Calvert County	11	0.61
Caroline County	6	0.33
Carroll County	1	0.06
Cecil County	2	0.11
Charles County	9	0.50
Dorchester County	8	0.44
Frederick County	2	0.11
Garrett County	1	0.06
Harford County	5	0.28
Howard County	1	0.06
Kent County	7	0.39
Montgomery County	1	0.06
Prince George's County	2	0.11
Queen Anne's County	7	0.39
St. Mary's County	11	0.61
Somerset County	8	0.44
Talbot County	8	0.44
Washington County	1	0.06
Wicomico County	6	0.33
Worcester County	19	1.06
City of Baltimore	10	0.56
Grand Total*	**66**	**3.67**

** Grand total values are not a direct sum of each of the county/city totals. The grand total events do not include zonal events as described in Section 3.3 and Section 3.5.*

Human vulnerability is based on the availability, reception and understanding of early warnings of coastal hazard events (i.e., Hurricane Watches and Warnings issued by the NWS) as well as access to substantial shelter and a means and desire to evacuate if so ordered. In some cases, despite having access to technology (computer, radio, television, outdoor sirens, etc.) that allows for the reception of a warning, language differences are sometimes a barrier to individuals understanding them. Once warned of an impending significant coastal hazard event, seeking shelter in a substantial indoor structure, that is wind resistant and outside of storm surge zones, is recommended as the best protection against bodily harm. Table 3-31 gives a breakdown of injuries and fatalities by county that are the result of coastal hazard events between 1950 and November 2010. The NCDC storm events database often reports injuries and deaths related to coastal hazard events for groupings of counties without assignment of specific values to specific counties or jurisdictions. Lacking better, more specific data, these values have been 'normalized' by evenly spreading the reported values evenly over each county in the event grouping. Based on this data, Baltimore County has experienced a higher number of reported injuries and fatalities related to coastal hazard events than other jurisdictions.

Table 3-31. Coastal Hazards - Injuries and Deaths.

County/City	Total Injuries	Total Deaths
Allegany County	0	0
Anne Arundel County	200	1
Baltimore County	400	2
Calvert County	200	1
Caroline County	1	0
Carroll County	0	0
Cecil County	0	0
Charles County	200	1
Dorchester County	0	0
Frederick County	0	0
Garrett County	0	0
Harford County	200	1
Howard County	0	0
Kent County	1	0
Montgomery County	0	0
Prince George's County	200	1
Queen Anne's County	1	0
St. Mary's County	200	1
Somerset County	0	0
Talbot County	1	0
Washington County	0	0
Wicomico County	0	0
Worcester County	0	0
City of Baltimore	200	1
Grand Total*	**200**	**1**

** Grand total values are not a direct sum of each of the county/city totals. The grand total events do not include zonal events as described in Section 3.3 and Section 3.5.*

Risk. As evidence in property and crop loss figures (Table 3-32) obtained from NCDC, coastal hazard events have the potential to be very destructive. Total damages (adjusted for inflation) on an annualized basis exceeds $4 million in Anne Arundel, Calvert, Charles, Harford, Prince George's and St. Mary's Counties and over $6 million in Baltimore County. These estimates are believed to be an underrepresentation of the actual losses experienced due to hazards as losses from events that go unreported or that are difficult to quantify are not likely to appear in the NCDC database; this is especially true with crop damages.

HAZUS-MH MR5 was also run for hurricane wind in order to determine potential losses due to winds associated with tropical storm and hurricanes (depicted in Figure 3-19). Appendix P provides background information regarding HAZUS-MH MR and also includes potential loss estimates for two hurricane scenarios, including a look at potential losses today should a hurricane similar to Hurricane Hazel (1954) occur. Annualized losses estimates based on this analysis are

shown (in thousands of dollars) in Table 3-33. Annualized losses due to hurricane wind were estimated at $32 million for Maryland, with the highest losses calculated for Worcester County at just over $9 million. Table 3-34 shows that residential losses are over $27 million for the State, and make up the majority of the total annualized losses. Governmental loss due to hurricane wind is estimated at $192,000 annually. Wood-framed structures appear to be particularly vulnerable to hurricane wind as is apparent in Table 3-35.

Table 3-32. Coastal Hazard - Crop and Property Damage.

County/City	Property Damage (Total)	Property Damage (Annualized)	Crop Damage (Total)	Crop Damage (Annualized)	Total Damage	Total Damage (Annualized)
Allegany County	$1,280	$71	$0	$0	$1,280	$71
Anne Arundel County	$82,425,109	$4,579,173	$28,655	$1,592	$82,453,764	$4,580,765
Baltimore County	$120,465,785	$6,692,544	$28,667	$1,593	$120,494,452	$6,694,137
Calvert County	$81,478,386	$4,526,577	$28,655	$1,592	$81,507,041	$4,528,169
Caroline County	$12,065,217	$670,290	$0	$0	$12,065,217	$670,290
Carroll County	$1,280	$71	$0	$0	$1,280	$71
Cecil County	$12,065,217	$670,290	$0	$0	$12,065,217	$670,290
Charles County	$82,724,776	$4,595,821	$35,729	$1,985	$82,760,505	$4,597,806
Dorchester County	$8,549,926	$474,996	$157,486	$8,749	$8,707,412	$483,745
Frederick County	$1,280	$71	$0	$0	$1,280	$71
Garrett County	$1,280	$71	$0	$0	$1,280	$71
Harford County	$80,174,274	$4,454,126	$28,655	$1,592	$80,202,929	$4,455,718
Howard County	$0	$0	$0	$0	$0	$0
Kent County	$12,065,217	$670,290	$0	$0	$12,065,217	$670,290
Montgomery County	$0	$0	$0	$0	$0	$0
Prince George's County	$80,174,274	$4,454,126	$28,655	$1,592	$80,202,929	$4,455,718
Queen Anne's County	$12,065,217	$670,290	$0	$0	$12,065,217	$670,290
St. Mary's County	$80,609,479	$4,478,304	$28,655	$1,592	$80,638,134	$4,479,896
Somerset County	$1,072,936	$59,608	$157,486	$8,749	$1,230,422	$68,357
Talbot County	$12,065,217	$670,290	$0	$0	$12,065,217	$670,290
Washington County	$1,280	$71	$0	$0	$1,280	$71
Wicomico County	$1,008,308	$56,017	$157,486	$8,749	$1,165,794	$64,766
Worcester County	$6,123,652	$340,203	$314,972	$17,498	$6,438,624	$357,701
City of Baltimore	$40,107,828	$2,228,213	$13	$1	$40,107,841	$2,228,214
Grand Total*	**$109,050,194**	**$6,058,344**	**$193,215**	**$10,734**	**$109,243,409**	**$6,069,078**

**Grand total values are not a direct sum of each of the county/city totals. The grand total events do not include zonal events as described in Section 3.3 and Section 3.5*

Table 3-33. HAZUS-MH MR5 Hurricane Wind Annualized Loss Estimates.

County/City	Annualized Losses
Allegany County	$20,000
Anne Arundel County	$2,759,000
Baltimore County	$3,140,000
Calvert County	$505,000
Caroline County	$322,000
Carroll County	$262,000
Cecil County	$415,000
Charles County	$404,000
Dorchester County	$519,000
Frederick County	$239,000
Garrett County	$10,000
Harford County	$932,000
Howard County	$742,000
Kent County	$146,000
Montgomery County	$2,219,000
Prince George's County	$2,727,000
Queen Anne's County	$359,000
Somerset County	$564,000
St Mary's County	$1,015,000
Talbot County	$461,000
Washington County	$91,000
Wicomico County	$2,683,000
Worcester County	$9,081,000
City of Baltimore	$2,619,000
Grand Total*	**$32,234,000**

** Grand total values are not a direct sum of each of the county/city totals. The grand total events do not include zonal events as described in Section 3.3 and Section 3.5.*

Table 3-34. HAZUS-MH MR5 Hurricane Wind Annualized Loss Estimates by Occupancy.

County/City	Agricultural	Commercial	Educational	Government	Industrial	Religion/Non-Profit	Residential
Allegany County	$0	$1,000	$0	$0	$0	$0	$18,000
Anne Arundel County	$5,000	$254,000	$14	$14,000	$106,000	$17,000	$2,349,000
Baltimore County	$6,000	$304,000	$18	$13,000	$85,000	$24,000	$2,690,000
Calvert County	$1,000	$29,000	$2	$2,000	$7,000	$4,000	$460,000
Caroline County	$4,000	$34,000	$2	$4,000	$15,000	$4,000	$259,000
Carroll County	$1,000	$16,000	$1	$1,000	$5,000	$1,000	$237,000
Cecil County	$3,000	$30,000	$2	$4,000	$10,000	$3,000	$363,000
Charles County	$1,000	$29,000	$1	$3,000	$5,000	$3,000	$362,000
Dorchester County	$4,000	$72,000	$3	$13,000	$24,000	$8,000	$395,000
Frederick County	$1,000	$14,000	$1	$1,000	$6,000	$2,000	$214,000
Garrett County	$0,000	$0	$0	$0	$0	$0	$9,000
Harford County	$2,000	$76,000	$3	$4,000	$18,000	$6,000	$822,000
Howard County	$2,000	$74,000	$4	$2,000	$18,000	$5,000	$637,000
Kent County	$2,000	$16,000	$1	$1,000	$4,000	$2,000	$120,000
Montgomery County	$4,000	$181,000	$8	$10,000	$24,000	$16,000	$1,977,000
Prince George's County	$3,000	$227,000	$13	$13,000	$44,000	$28,000	$2,399,000
Queen Anne's County	$3,000	$36,000	$2	$3,000	$9,000	$2,000	$304,000
Somerset County	$1,000	$41,000	$2	$11,000	$8,000	$3,000	$497,000
St Mary's County	$11,000	$114,000	$9	$13,000	$24,000	$14,000	$830,000
Talbot County	$4,000	$69,000	$4	$3,000	$14,000	$5,000	$362,000
Washington County	$0,000	$7,000	$0	$1,000	$3,000	$1,000	$79,000
Wicomico County	$14,000	$450,000	$27	$19,000	$84,000	$40,000	$2,049,000
Worcester County	$22,000	$1,309,000	$18	$41,000	$109,000	$96,000	$7,488,000
City of Baltimore	$2,000	$351,000	$21	$18,000	$71,000	$35,000	$2,121,000
Grand Total	**$97,000**	**$3,733,000**	**$155,000**	**$192,000**	**$694,000**	**$322,000**	**$27,041,000**

Table 3-35. HAZUS-MH MR5 Hurricane Wind Annualized Loss Estimates by Building Type.

County/City	Wood	Masonry	Concrete	Steel	Manufactured Homes
Allegany County	$11,000	$7,000	$0	$1,000	$0
Anne Arundel County	$1,678,000	$804,000	$50,000	$201,000	$14,000
Baltimore County	$1,876,000	$983,000	$53,000	$202,000	$13,000
Calvert County	$332,000	$143,000	$5,000	$18,000	$3,000
Caroline County	$181,000	$93,000	$6,000	$28,000	$14,000
Carroll County	$166,000	$79,000	$3,000	$10,000	$1,000
Cecil County	$250,000	$124,000	$6,000	$23,000	$10,000
Charles County	$258,000	$118,000	$4,000	$18,000	$2,000
Dorchester County	$277,000	$144,000	$14,000	$59,000	$25,000
Frederick County	$148,000	$74,000	$3,000	$11,000	$1,000
Garrett County	$6,000	$3,000	$0	$0	$1,000
Harford County	$578,000	$276,000	$12,000	$49,000	$12,000
Howard County	$447,000	$228,000	$10,000	$47,000	$5,000
Kent County	$83,000	$44,000	$3,000	$12,000	$2,000
Montgomery County	$1,358,000	$715,000	$28,000	$103,000	$1,000
Prince George's County	$1,646,000	$878,000	$39,000	$147,000	$4,000
Queen Anne's County	$220,000	$101,000	$5,000	$25,000	$6,000
Somerset County	$337,000	$165,000	$9,000	$33,000	$16,000
St Mary's County	$541,000	$271,000	$27,000	$94,000	$81,000
Talbot County	$263,000	$135,000	$11,000	$45,000	$6,000
Washington County	$52,000	$30,000	$1,000	$5,000	$1,000
Wicomico County	$1,490,000	$761,000	$68,000	$293,000	$72,000
Worcester County	$5,295,000	$2,330,000	$225,000	$811,000	$422,000
City of Baltimore	$1,435,000	$882,000	$63,000	$230,000	$1,000
Grand Total	**$18,929,000**	**$9,390,000**	**$650,000**	**$2,467,000**	**$714,000**

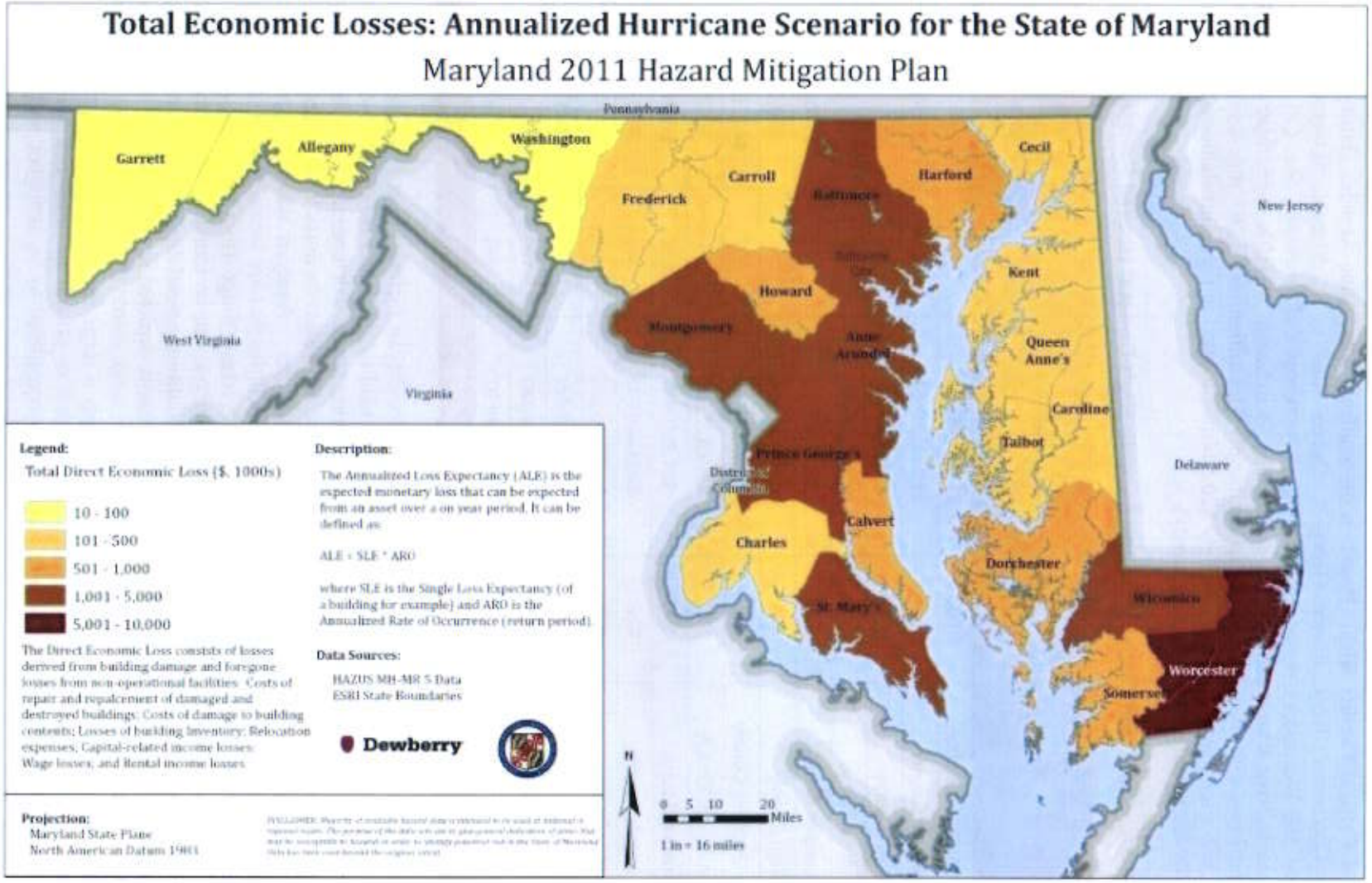


Figure 3-19. HAZUS MH-MR5 Annualized Hurricane Wind Loss Estimates.

State and Critical Facility Risk. Based on the available data, Anne Arundel, Baltimore, Cecil, Charles, Dorchester, Kent, Prince George's, Queen Anne's, St. Mary's, Somerset, Talbot, Wicomico, and Worcester Counties and the City of Baltimore and Town of Ocean City have been determined to have a high coastal hazards ranking. As indicated in Table 3-36, there are 37,180 critical facilities with a total worth of approximately $10 billion and 4,263 state facilities (non-critical) with a total worth of approximately $20.5 billion located in these jurisdictions. (values for Ocean City are included in Worcester County).

Table 3-36. State and Critical Facilities within High Coastal Hazard Ranking Areas.

County/City	Total Number of Critical Facilities	Critical Facilities Building and Contents Values	Total Number of State Facilities	State Facilities Building and Contents Values
Anne Arundel County	5,033	$1,468,465,960	605	$3,458,410,555
Baltimore County	8,415	$1,873,803,613	695	$2,450,029,306
Cecil County	1,362	$310,623,133	287	$172,110,420
Charles County	1,146	$517,267,067	138	$46,599,098
Dorchester County	659	$93,601,080	108	$140,627,062
Kent County	472	$84,609,347	36	$20,015,708
Prince George's County	7,381	$1,173,039,907	587	$4,226,006,209
Queen Anne's County	612	$149,137,613	94	$67,877,189
Somerset County	390	$51,809,600	256	$746,537,360
St. Mary's County	888	$309,846,013	317	$633,515,069
Talbot County	658	$125,100,853	66	$29,772,755
Wicomico County	1,329	$458,389,427	183	$891,466,997
Worcester County	931	$192,044,587	126	$22,813,119
City of Baltimore	7,904	$3,179,149,973	765	$7,596,281,448
Grand Total	**37,180**	**$9,986,888,173**	**4,263**	**$20,502,062,295**

The type and age of construction plays a role in vulnerability of facilities to coastal hazard winds. In general, concrete, brick and steel-framed structures tend to fare better than older, wood-framed structures or manufactured homes. Vulnerability to storm surge is determined by facility location in relation to storm surge inundation zones. Finally, not all critical facilities have redundant power sources and may not even be wired to accept a generator. Analysis was also performed to determine the number and values of state and critical facilities that are located within storm surge inundation zones as determined by Sea, Lake and Overland Surge from Hurricanes (SLOSH) model. Tables showing the complete results of this analysis can be found in Appendix P. Table 3-37 summarizes the number of state and critical facilities potentially at risk of storm surge inundation in various categories of hurricanes. The results depicted in this table are cumulative. For instance, a facility inundated in a Category 1 storm surge would also be included in the counts for the other hurricane category surges, since they imply a surge that reaches even further inland. Future plan updates should consider closer examination of critical facilities risk by looking at construction type of critical facilities in jurisdictions considered to be at higher risk of coastal hazard events.

Table 3-37. Number of State and Critical Facilities Potentially Impacted by Storm Surge (Cumulative).

Facility Type	Cat. 1 Surge	Cat. 2 Surge	Cat. 3 Surge	Cat. 4 Surge	Cat. 5 Surge
Critical Facilities	550	1,634	2,725	4,476	4,821
State Facilities	98	295	787	1,186	1,202

Jurisdictional Risk. Based on the available data, Anne Arundel, Baltimore, Cecil, Charles, Dorchester, Kent, Prince George's, Queen Anne's, St. Mary's, Somerset, Talbot, Wicomico, and Worcester Counties and the City of Baltimore and Town of Ocean City have been determined to have a high coastal hazards ranking. (Figure 3-20) This ranking was accomplished using the methodology described in Hazard Assessment and Ranking Methodology.

Local Plan Risk Assessment. All of the local plans addressed and ranked coastal related hazards in their hazard mitigation plans; as discussed in Section 3.6, hazard naming conventions vary from locality so hazards were assessed to determine which ones could be considered coastal hazards for the state ranking. Two local plans included the coastal category in their assessments; seven included and ranked erosion; one included tsunami and nor'easter. Eleven local plans considered hurricane a high hazard, three medium-high and six medium, two medium-low and two low. Section 3.6 includes a summary of how each of the local plans ranked the various coastal hazards and outlines the assumptions that were made in an effort to compare the local hazard rankings to each other.

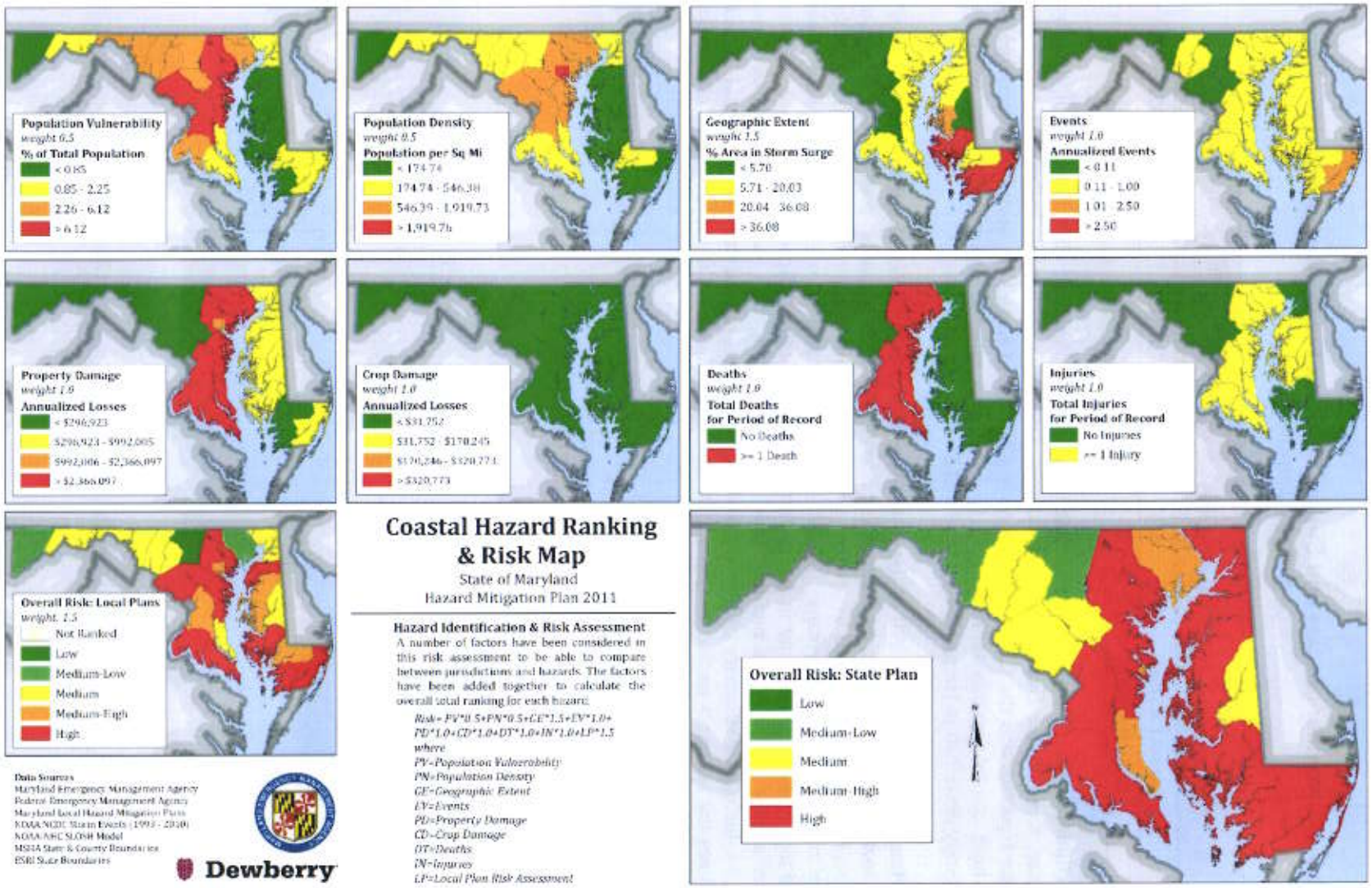


Figure 3-20. Coastal Hazard Ranking and Risk Map.

3.6.4 Relative Sea Level Rise

3.6.4.1 Description

Relative sea level rise (RSLR) presents a hazard that should be considered in long-term land use, development, and critical infrastructure planning. Maryland has large exposure to the potential impacts of RSLR, with over 3,100 miles of tidal shoreline and significant areas of low elevation. Climate change, including the continued increase in global temperature, is projected to result in an acceleration of observed rates of RSLR. Projections in global increases in sea level by 2100 due to climate change range from 1-2 feet[11] up to 6.5 feet[12]. Although RSLR is a gradual process, impacts may be experience in the near term. Some examples include increased frequency of low-level inundation, exacerbated flood elevations during storm events, increased rates of coastal erosion, and increased saltwater intrusion into groundwater.

Much of the material for this section is derived from The Maryland Commission on Climate Change Comprehensive Strategy for Reducing Maryland's Vulnerability to Climate Change. Readers are referred to the state's Climate Change portal for reports and detailed information on actions to date.[13]

3.6.4.2 Historical Occurrence and Anticipated Increases

The magnitude of RSLR is a function of thermal expansion of the oceans, high latitude and altitude ice melt, and land subsidence. Historically, RSLR rates in the state of Maryland have been about 1 foot/century (Figure 3-21). Notable impacts of RSLR over the last century have included the loss of thirteen Chesapeake Bay islands, a process which is exemplified by James Island (Figure 3-22).

The Maryland Commission on Climate Change Scientific and Technical Working Group provided estimates of RSLR by the end of the century. Projections were derived from the 2007 Intergovernmental Panel on Climate Change (IPCC) global SLR projections and combined with regional land subsidence magnitudes. The values, presented as "conservative", include estimates from 1-1.3 feet by 2050 to 2.7-3.4 feet by 2100 (Figure 3-23). Numerous projections have subsequently appeared in the scientific literature by various independent researchers that note increased rates of ice melt and produced estimates of eustatic SLR by 2100 up to just under 6 feet (above 1990 levels)[14]. The next IPCC synthesis report, which should provide an updated consensus prediction, is expected in fall 2014.

11 IPCC, 2007: Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E.Hanson, Eds., Cambridge University Press, Cambridge, UK, 976pp.

12 Pfeffer, W.T. et al, 2008: Kinematic Constraints on Glacier Contributions to 21st-Century Sea-Level Rise. Science 321, 1340.

13 http://www.mde.state.md.us/programs/Air/ClimateChange/Pages/Air/climatechange/index.aspx

14 Vermeer M & Rahmstorf S, 2009: Global sea level linked to global temperature. Proceedings of the National Academy of Science. December 2009.

Figure 3-21. Historically observed rates of RSLR in Maryland[15].

[15] Maryland Department of Natural Resources, 2008: Comprehensive Strategy for Reducing Maryland's Vulnerability to Climate Change. Phase I: Sea-level rise and coastal storms. Report of the Maryland Commission on Climate Change Adaptation and Response Working Group.

Figure 3-22. Shoreline positions of James Island in 1847, 1942, and 1994 exemplify shoreline retreat due to RSLR in the Chesapeake Bay[25].

Figure 3-23. RSLR projections for Maryland for 2050 and 2100 for lower and higher emission scenarios.

3.6.4.3 Risk Assessment

The MDDNR provides RSLR hazard layers that represent inundation extents for generalized RSLR scenarios of 0-2, 2-5, and 5-10 ft, relative to mean sea level. These coverages were developed for MDDNR by Towson University using a high-resolution base map consisting of LiDAR topography to support the Maryland Commission on Climate Change. The inundation coverages consist of ERDAS Imagine raster layers with a 2 m (6.56 ft) horizontal resolution that identify land areas as inundated or non-inundated by the RSLR scenario. The dataset provides coverage for all Maryland coastal jurisdictions, with the exception of Baltimore City, Harford County and Prince George's County (LiDAR data was unavailable at the time of layer production).

Probability and Risk Assignment. Due to the uncertainty of climate, and thus RSLR projections, it is difficult to assign quantitative probabilities to projections of sea level increases. Probabilities can be couched in the qualitative sense, whereas lower levels of RSLR are more probable than higher levels. As such, we assign the following levels (Table 3-38) of probability, and in turn risk, to the RSLR hazard layers developed by MDDNR. Likelihoods are based on historical observations, MDDNR scenarios for future RSLR, in addition to the current state of RSLR predictions. These classifications reflect probability of occurrence within the 2050-2100 time horizons.

Table 3-38. RSLR inundation probability and risk.

MDDNR RSLR Coverage	Probability	Risk
0-2 ft inundation	Near Certain to Highly Likely	High Risk
2-5 ft inundation	Highly Likely to Unlikely	Moderate Risk
5-10 ft inundation	Unlikely to Remote	Low Risk

Impact and Vulnerability. Coastal regions within Maryland are the most vulnerable to RSLR and will experience the greatest impacts within the next 50 to 100 years. Impacts include inundation of coastal areas, an increased rate of shoreline erosion, increased severity of storm surge, damage to existing infrastructure, displacement of homeowners, and potential negative economic impacts related to a decline in coastal tourism.

Exposure and Risk Assessment. Exposure and risk to the three risk classes of RSLR were evaluated by intersecting the MDDNR RSLR hazard layers with the Maryland critical and state-owned facility geospatial database. The MDDNR RSLR layers were resampled from 2 m (6.56 feet) to 5 m (16.4 feet) and converted to ESRI polygon coverages to facilitate the analysis. Baltimore City, Harford County and Prince George's County were excluded from all exposure and risk analyses due to lack of coverage in the RSLR hazard layers produced by MDDNR.

Exposure to each risk class is presented discreetly by MDDNR inundation scenario. Reported values represent exposed assets in the inundation range of the hazard layer. Occurrence of a higher range scenario would accumulate risk in a step-wise fashion on top of a lower range scenario. Cumulative risk is summarized in the bottom rows of each table, where applicable.

State and Critical Facility Risk. Risk to state-owned and critical facilities was evaluated for each RSLR risk class by facility category. State-owned facilities showed considerable exposure to the High Risk scenario of 0-2 feet RSLR (
Table 3-39). Of the facility types, educational facilities were the most at risk across the range of scenarios, followed by administrative and transportation facilities.

Although analysis of the critical facilities data against the RSLR scenarios showed lower overall exposure to the High and Moderate Risk scenarios (Table 3-40), this is due in large part to a lack of building and content value data for a significant portion of the critical facilities. Review of exposure by category to the High Risk scenario showed that, for State-Owned facilities, Educational assets have by far the greatest exposure at just over $500 million. St. Mary's College

of Maryland assets account for $428 million of the educational facilities at risk.[16] The second largest contributor to the educational exposure is the Maryland Department of Education, University of Maryland Center for Environmental Science, followed by University of Maryland Eastern Shore. Transportation Facilities have the second-highest exposure at $28 million. Critical Facility exposure by category to the High Risk scenario is topped by Transportation assets at $9 million, followed by Fire Department and Educational facilities at $1.8 million and $1.2 million, respectively.

Table 3-39. State-Owned Facility risk by facility type to RSLR.

State-Owned Facility Type	High Risk (0-2 ft RSLR)	Moderate Risk (2-5 ft RSLR)	Low Risk (5-10 ft RSLR)
Administrative Facility	--	$87,658,295	$34,440,604
Correctional Facility	--	$535,008	$267,504
Department of Natural Resources Facility	$2,989,496	$26,384,445	$13,329,838
Educational Facility	$507,142,828	$44,835,576	$203,175,694
Environmental Related Facility	--	$80,000	--
Fire Department Facility	--	$126,000	$126,000
Health Related Facility	--	--	$30,132
Judicial/Legal Facility	$2,505,472	$2,155,780	$16,136
Military Facility	--	$5,164,080	$6,730,080
Police Department Facility	--		$10,500,000
Social Services	--	$304,052	$9,778,700
Transportation Facility	$28,535,636	$1,533,513	$66,459,226
Utility/Infrastructure Facility	--	$3,033,765	$1,733,580
Historic Facility	$19,366,408	--	--
Grand Total by Risk Class	**$560,539,840**	**$171,810,515**	**$346,587,495**
	Cumulative Risk	$732,350,355	$1,078,937,850

Table 3-40. Critical Facility risk by facility type to RSLR.

Critical Facility Type	High Risk (0-2 ft RSLR)	Moderate Risk (2-5 ft RSLR)	Low Risk (5-10 ft RSLR)
Airport Facility	$341,867	--	$2,525,333
Correctional Facility	$654,133	--	--
Educational Facility	$1,240,360	$20,895,200	$62,992,267
Fire Department Facility	$1,890,267	$4,814,667	$9,573,600
Health Related Facility	--	$9,188,800	$1,185,693
Police Department Facility	--	$3,836,667	$296,147
Transportation Facility	$9,037,227	$64,133	$1,816,133

[16] NOTE: Latitude/longitude information for each building on the campus was not available in the State Treasurer's database. Instead, the database assigned one latitude/longitude to the campus. This point location was located within the 0-2 ft RSLR inundation zone.

Critical Facility Type	High Risk (0-2 ft RSLR)	Moderate Risk (2-5 ft RSLR)	Low Risk (5-10 ft RSLR)
Utility/Infrastructure Related Facility	$33,560	$52,800	$87,320
Grand Total by Risk Class	**$13,197,413**	**$38,852,267**	**$78,476,493**
	Cumulative Risk	$52,049,680	$130,526,173

Exposed state-owned and critical facilities and exposed asset value were tabulated by county. Counties with no exposure were excluded from reporting. Baltimore City, Harford County and Prince George's County were excluded due to lack of coverage in the RSLR hazard layers produced by MDDNR. Counts of State Owned and Critical facilities are reported in Table 3-41, combined structure and content value is reported in Table 3-42.

Exposure of state owned facilities to the High Risk RSLR scenario is relatively low, as compared to critical facilities; however, risk in terms of dollar value is much greater. This discrepancy, as noted previously, is due in part to building and content value data not being available for a significant number of critical facilities. St. Mary's County has a very large number of state owned facilities (150) exposed to the High Risk RSLR, with a total estimated value of $527 million (Table 3-42). In comparison, Somerset has the next highest number of state owned facilities exposed to the High Risk RSLR scenario at eight (8); although these facilities have an estimated value of only $384,000. In term of risk, Baltimore and Anne Arundel Counties have the second and third most exposure, with $16 and $14 million of state-owned facilities vulnerable to the High Risk RSLR scenario. Overall, Caroline (333), Worcester (101), and Somerset (84) have the greatest exposure across the range of RSLR scenarios behind St. Mary's County.

A greater number of critical facilities are exposed to the RSLR hazard. Anne Arundel (151) and Dorchester Counties (123) both have significant exposure at to the High Risk RSLR scenario (Table 3-41). Queen Anne's (75), Worcester (71), Baltimore (70), and Somerset (69) also have a relatively high level of exposure to the High Risk RSLR scenario. Across the range of scenarios, Worchester has the greatest exposure, followed by Anne Arundel and Dorchester Counties. Dorchester ($2.9 million), Queen Anne's ($2.5 million) and Somerset Counties ($1.9 million) have the highest values of facilities exposed to the High Risk RSLR scenario. Across the range of RSLR scenarios, Dorchester has the highest value of exposed facilities ($32 million), followed by Baltimore ($28 million) and Somerset Counties ($23 million). A ranking of combined exposure of state owned and critical infrastructure to the High Risk RSLR scenario is provided in Table 3-43.

Table 3-41. State Owned and Critical Facility Exposure to RSLR Scenario by County.

County/City	State Owned Facilities			Critical Facilities		
	High Risk (0-2 ft RSLR)	Moderate Risk (2-5 ft RSLR)	Low Risk (5-10 ft RSLR)	High Risk (0-2 ft RSLR)	Moderate Risk (2-5 ft RSLR)	Low Risk (5-10 ft RSLR)
Anne Arundel County	7	4	6	151	92	95
Baltimore County	6	1	4	70	55	122
Calvert County	1	0	20	24	22	13
Caroline County	0	0	333	47	8	48
Cecil County	0	0	2	57	21	22
Charles County	0	0	0	28	6	6
Dorchester County	5	14	45	123	56	39
Harford* County	--	--	--	--	--	--
Kent County	0	1	1	44	33	24
Prince George's County*	--	--	--	--	--	--
Queen Anne's County	0	1	9	75	54	49
Somerset County	8	55	21	69	66	36
St. Mary's County	150	76	3	40	27	42
Talbot County	1	0	23	61	33	40
Wicomico County	0	19	3	49	42	56
Worcester County	2	98	1	71	180	148
City of Baltimore *	--	--	--	--	--	--

*Vulnerability data not available from MDDNR

Table 3-42. County-by-County Value and Percent of Risk by RSLR Scenario of Exposed State Owned and Critical Facilities.

County	State Owned Facilities			Critical Facilities		
	High Risk (0-2 ft RSLR)	Moderate Risk (2-5 ft RSLR)	Low Risk (5-10 ft RSLR)	High Risk (0-2 ft RSLR)	Moderate Risk (2-5 ft RSLR)	Low Risk (5-10 ft RSLR)
Anne Arundel	$14,698,605 (75%)	$3,194,094 (16%)	$1,733,580 (9%)	$48,267 (3%)	$244,400 (13%)	$1,544,747 (84%)
Baltimore	$16,296,471 (60%)	$13,333 (0%)	$10,901,464 (40%)	$0	$7,857,200 (27%)	$20,721,467 (73%)
Calvert	$1,188,909 (3%)	$0	$42,912,568 (97%)	$1,304,480 (53%)	$1,141,333 (47%)	$0
Caroline	$0	$0	$106,551,157 (100%)	$627,227 (15%)	$3,570,800 (85%)	$0
Cecil	$0	$0	$149,816 (100%)	$0	$0	$1,308,667 (100%)
Charles	$0	$0	$0	$528,133 (53%)	$0	$476,400 (47%)
Dorchester	$310,424 (0%)	$1,679,757 (2%)	$76,848,400 (97%)	$2,905,067 (9%)	$4,266,400 (13%)	$25,206,000 (78%)
Harford*	--	--	--	--	--	--
Kent	$0	$974,500 (13%)	$6,730,080 (87%)	$471,467 (81%)	$0	$114,147 (19%)
Prince George's*	--	--	--	--	--	--
Queen Anne's	$0	$0	$8,610,717 (100%)	$2,517,213 (18%)	$0	$11,311,867 (82%)
Somerset	$384,160 (0%)	$15,156,657 (15%)	$84,299,481 (84%)	$1,987,200 (8%)	$14,965,467 (64%)	$6,487,200 (28%)
St. Mary's	$527,615,239 (99%)	$3,606,161 (1%)	$106,975 (0%)	$588,267 (9%)	$0	$5,729,333 (91%)
Talbot	$37,632 (1%)	$0	$7,407,078 (99%)	$1,275,520 (28%)	$13,333 (0%)	$3,258,800 (72%)
Wicomico	$0	$86,637,083 (100%)	$336,180 (0%)	$10,533 (1%)	$1,767,200 (87%)	$262,267 (13%)
Worcester	$8,400 (0%)	$60,548,929 (100%)	$0	$934,040 (12%)	$5,026,133 (63%)	$2,055,600 (26%)
City of Baltimore *	--	--	--	--	--	--

*Vulnerability data not available from MDDNR

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Table 3-43. Ranking of Counties by Exposed Value of Combined State-Owned and Critical Facilities to the High Risk RSLR Scenario (0-2 ft).

County/City	Value of Facilities in High Risk Exposure
St. Mary's County	$528,203,506
Baltimore County	$16,296,471
Anne Arundel County	$14,746,872
Dorchester County	$3,215,491
Queen Anne's County	$2,517,213
Calvert County	$2,493,389
Somerset County	$2,371,360
Talbot County	$1,313,152
Worcester County	$942,440
Caroline County	$627,227
Charles County	$528,133
Kent County	$471,467
Wicomico County	$10,533
Cecil County	$0

Jurisdictional Risk. Jurisdictional Risk was assessed by evaluating the areal loss of land for each RSLR scenario. The potential area subject to inundation by each RSLR scenario is reported in square miles and by percent area of county in Table 3-445. Dorchester and Somerset Counties have the greatest potential for land inundation to the High Risk RSLR scenario with land areas of 195.5 square miles (36 percent of the county) and 91.5 square miles (29 percent of the county) subject to inundation by a RSLR of 0-2 feet, respectively. Worchester and Wicomico Counties follow, with potential inundation areas of 39 (8 percent) and 25.6 square miles (6.8 percent), to the High Risk RSLR scenario, respectively.

Consequence Analysis. A consequence analysis, derived from the Emergency Management Accreditation Program (EMAP) has been performed to better understand and outline the impacts that sea level rise may have on the public; responders; continuity of operations including delivery of services; property, facilities and infrastructure; the environment; the economic condition of the state, and public confidence in the states governance. The results of the consequence analysis are shown in Table 3-44.

Table 3-44 EMAP Consequence Analysis for Sea Level Rise

Subject	Impacts
Healthy and Safety of the Public	Home and land owners along the coastline are most at risk to impacts from sea level rise. Impacts to the public include destruction and/or loss of land and property, displacement of populations, and negative economic impacts to coastal tourism. Significant sea level rise is expected to occur over a period of 50-100 years, which means it is unlikely that sea level rise will result in injury or loss of life.
Health and Safety of Responders	Similarly to the public, first responders would likely face minimal adverse impacts due to long term sea level rise. The potential exception would be in the

	case of a temporary rise in sea level as caused by a severe tropical cyclone event. In this case, first responders would be exposed to the standard occupational hazards involved in dealing with a coastal flooding event.
Continuity of Operations (incl. delivery of services)	The impacts on continuity of operations will be limited, unless a facility is within the incident area. In this case, state and critical facilities within the high risk area (defined as "near certain to highly likely of 0-2 feet of inundation) will face economic impacts related to costs of mitigation measures, relocation, and potential damages.
Property, facilities, and infrastructure	Home and land owners within coastal regions may experience damage to or loss of property depending upon the severity of water inundation in the area. Infrastructure may experience impacts in the form of damages to roads/bridges and/or the complete loss of transportation routes.
Environment	Sea level rise will alter the landscape. Changes in the shoreline will occur, with some areas of shore becoming completely inundated, while others are damaged from erosion. Vegetation and wildlife habitat along the coast may be damaged or destroyed within inundation areas.
Economic condition of the state	Sea level rise and major changes to the coastline will drain state, county, and local resources. The economic costs related to mitigation and relocation measures will be high, in addition to the economic burden caused by loss of land.
Public confidence in state governance	Public confidence will largely depend upon how effectively the State of Maryland, and county and local governments prepare for and respond to sea level rise.

Table 3-44 Potential County Areal Loss by RSLR Risk Class. Values are explicit to each RSLR Scenario and are not cumulative (each scenario, as defined by MDDNR, represents an explicit range of affected land elevation).

County/City	Area Subject to High Risk (0-2 ft RSLR), sq mi	% of County Area	Area Subject to Moderate Risk (2-5 ft RSLR), sq mi	% of County Area	Area Subject to Low Risk (5-10 ft RSLR), sq mi	% of County Area	Total Area Covered by all RSLR Risk Scenarios, sq mi	Total Percentage	Land Area of County, sq mi
Anne Arundel County	5	1.2%	7.5	1.8%	18	4.3%	30.5	7.4%	413.9
Baltimore County	4	0.7%	5.5	0.9%	9.8	1.6%	19.3	3.2%	599.5
City of Baltimore *	--	--	--	--	--	--	--	--	--
Calvert County	5.6	2.6%	3.3	1.5%	4.5	2.1%	13.4	6.3%	214.3
Caroline County	5.8	1.8%	2.4	0.7%	4.3	1.3%	12.5	3.9%	320.1
Cecil County	3.5	1.0%	3.8	1.1%	4.6	1.3%	11.9	3.4%	348.8
Charles County	10.6	2.3%	5.6	1.2%	10.4	2.3%	26.6	5.8%	460.1
Dorchester County	195.5	36.1%	96.4	17.8%	62.3	11.5%	354.2	65.3%	542.3
Harford County *	--	--	--	--	--	--	--	--	--
Kent County	6.9	2.5%	9.1	3.2%	12.2	4.4%	28.2	10.1%	280.2
Prince George's County *	--	--	--	--	--	--	--	--	--
Queen Anne's County	6.9	1.9%	9.3	2.5%	17.7	4.8%	33.9	9.1%	371.9
Somerset County	91.5	28.5%	46.8	14.6%	51	15.9%	189.3	59.0%	320.8
St. Mary's County	7.4	2.1%	9.8	2.7%	19	5.3%	36.2	10.1%	359.7
Talbot County	10.7	4.0%	12.9	4.8%	49.5	18.4%	73.1	27.1%	269.5
Wicomico County	25.6	6.8%	15.3	4.1%	25.7	6.8%	66.6	17.7%	375.7
Worcester County	39	8.3%	31.1	6.6%	50.5	10.7%	120.6	25.6%	471.5

*Vulnerability data not available from MDDNR

3.6.4.4 Mitigation Actions to Date

In recognition of the state's exposure to climate change impacts, including RSLR, Maryland Executive Order 01.01.2007.07 established the Maryland Commission on Climate Change to reduce the state's long-term vulnerability to climate change. The commission has produced several reports documenting anticipated changes and suggesting and promoting risk mitigation strategies. To date, the commission has issued two climate change risk management strategies to provide a road map and priorities for state-level planning efforts (RSLR addressed in 2008 report). Implementation has been underway and key activities, as of January 2010[17] include:

- Passage of the Living Shoreline Protection Act;
- key administrative provisions to the Chesapeake and Atlantic Coastal Bays Critical Area Act;
- Launch of the Coast-Smart Communities Initiative;
- Issuance of a policy by DNR to direct its land and infrastructure investments in areas vulnerable to sea level rise;
- Incorporation of policies for "lands subject to climate change" into the Draft State Development Plan;
- Completion of sea level rise vulnerability assessments by the State Highway Administration, the Maryland Historic Trust, the Maryland Port Administration, and Dorchester County; and
- Completion of sea level rise strategic plans by Anne Arundel and Worchester Counties.

The Maryland Commission on Climate Change has promoted freeboard as a risk mitigation strategy. Most communities in Maryland have established a 1-foot freeboard over FEMA NFIP requirements. In early 2011, several communities in Somerset and Dorchester Counties adopted increased freeboard standards. The communities of Princess Anne and Crisfield adopted a 2-foot freeboard, for example. In Dorchester County, Cambridge adopted a 1.5-foot freeboard whereas the county and all other municipalities elected to adopt a 2-foot freeboard. Recent activity suggests that other Maryland communities are beginning to follow suit, as Cecil County also recently adopted a 2-foot freeboard[18]

3.6.5 Shoreline Erosion

3.6.5.1 Description

The characteristics of the shoreline erosion hazard in Maryland reflect a unique combination of natural and man-made conditions affecting the State's shoreline region. Natural conditions influencing erosion rates in Maryland include soil composition, weather, topography, water depth, fetch and surface water and groundwater conditions. Shores consisting of very fine or unconsolidated silts and clays, or lighter organic materials, such as marshes, are particularly at-risk. This is especially true when these conditions are exacerbated by severe weather, wave energy and soil drainage conditions.

[17] Maryland Department of the Environment, 2010: Maryland Commission on Climate Change January 2010 Update to Governor and General Assembly.
[18] Per Comm., Zoe Johnson, Maryland Department of Natural Resources, July 1, 2011.

According to the Maryland Department of Natural Resources, the Chesapeake Bay shoreline including the Coastal Bays and Atlantic Coast in Maryland is about 7,600 miles long. At the time of the study, manmade structures were incorporated into nearly 1,000 miles of shoreline.

Of the manmade structures incorporated into 1,000 miles of the shoreline, the preferred method of erosion control in Maryland is the Living Shoreline as this method provides habitat while offering shoreline protection. It is at times appropriate to utilize other manmade erosion control measures such as the wooden bulkhead, stone revetment, beach replenishment, and segmented breakwaters (to encourage beach and wetland creation). For instance, wooden bulkheads may be appropriate where boats must access the shore and stone revetments may be appropriate in high wave energy environments. In addition stone revetments may be used in conjunction with a living shoreline to create salt marsh habitat.

3.6.5.2 Historical Occurrence

According to the May 2005 report prepared by the Tidal Sediment Task Force under the Chesapeake Bay Program, the Maryland Geological Survey (MGS) conducted the first comprehensive survey of coastal erosion in Maryland in 1949 and "concluded that over 90 years the State suffered a net loss of 24,712 acres from islands in the Chesapeake Bay." Another MGS study, completed in 1975, "calculated erosion along approximately 1,600 miles of Chesapeake Bay (and tributary) shoreline and found that approximately 84 percent of the shoreline measured was eroding."

One particular segment of coastline that has historically shown significant erosion is located on the Atlantic coastline in Worcester County approximately 1.25 miles south of the inlet at Ocean City. This area has been eroding at a long-term rate of -21 to -12 ft/yr, although the very northern portion of this segment of shoreline has shown short-term accretion, historically this shoreline has been eroding at a significant rate.

3.6.5.3 Risk Assessment

Probability of Future Occurrence. Man-made factors affecting shore erosion include land use, shoreline reinforcement activities and surface water and ground water usage. Buildings, roads and other infrastructure are often constructed in erosion areas without regard to erosion control objectives. According to Maryland Department of Natural Resources 2010 Chesapeake Bay Shoreline Erosion Management Guide[19], nearly 40 percent of all Bay beaches are projected to experience increased erosion induced by adjacent shoreline stabilization work. About 11 miles of beach (2.5 percent) are expected to experience moderate to high erosion (6 or 11 feet/year on average). Over the next 50 years, it is projected that more than 3,000 acres of wetlands will be lost to erosion, with about 10 percent of the loss directly related to erosion control structures or land use.

In addition, poorly designed, located, or constructed shore erosion control projects may increase erosion problems by removing the local source of sand that supplies adjacent beaches, reducing the shore's natural ability to dampen wave action or otherwise disturbing natural avenues for sediment distribution.

Tidal erosion is caused by many factors that produce varying rates and types of erosion throughout the Chesapeake. These factors include anthropogenic actions, shoreline type, shoreline sediment composition, wave energy, shoreline slope and orientation and upland runoff. Tidal erosion tends

to be worse where sediments are unconsolidated and barren of vegetation, fetch is greater than one mile and upland areas are developed or generate significant runoff. Anthropogenic factors such as shoreline development, which removes the natural protective riparian buffer, shoreline reinforcement activities and surface water and ground water usage are also important factors that contribute to tidal erosion.

Sea level rise is one of the long term causes of shoreline erosion. (see sea level rise section for a full description of that hazard) Over shorter periods of time, waves and storm events are the primary cause of changes in shoreline conditions.[19] Sea level in the Chesapeake Bay has risen approximately 1.3 feet over the past 100 years, and is expected to continue to rise in the next century. Recent estimates suggest that this rate may increase to as much as 2-3 feet in the next 100 years.[20]

Sea level rise contributes to erosion by influencing and worsening on-going coastal processes, making coastal areas ever more vulnerable to extreme events. As sea level rises, storm surges and waves will extend further inland, flooding homes, businesses and roadways. Measurements in the Chesapeake Bay and Mid-Atlantic region show rates of sea level rise that are nearly double the global average. In Maryland, this is likely due in large part due to substantial land subsidence as a result postglacial rebound. The potentially large effect of sea level rise on erosion rates must therefore be considered.

Impact and Vulnerability. Shoreline erosion is one of the most significant problems facing Maryland's diverse coastal environment. Approximately 69 percent of Maryland's over 7,600 mile coastline is currently experiencing some degree of erosion. While the range and magnitude of erosion varies, the problem affects all sixteen of the State's coastal counties of the Chesapeake Bay and the Coastal Bays watersheds. Consequently, shore erosion poses a significant threat to property owners, the public, and the State's natural resources.

Risk. Maryland Department of Natural Resources reports that approximately 37 miles of shoreline are stabilized annually within the Chesapeake Bay. The remaining shoreline that erodes each year is a serious economic and ecological problem because the costs of shore erosion control and reclaiming lost property are beyond the means of some waterfront property owners.

- Valuable structures such as homes and businesses are at risk to storm damage.
- Sediments from the eroded shoreline smother important aquatic resources, contributing to the degradation of water quality, and fill navigation channels vital to commerce and recreation.

It is estimated that 57 percent of the total sediment load into the Chesapeake Bay is from tidal erosion. In addition, according to the draft 2004 Maryland Hazard Analysis that the State of Maryland loses approximately 260 acres of tidal shoreline to erosion each year, resulting in a loss

[19] Maryland Department of Natural Resources. 2010. *Chesapeake Bay Shoreline Erosion in Maryland: A Management Guide.*

[20] Leatherman, S. P., R. Chalfont, E. C. Pendleton, T. L. McCandless and S. Funderburk. 1995. *Vanishing Lands: Sea Level, Society and Chesapeake Bay.* University of Maryland, Laboratory for Coastal Research, and the U.S. Fish and Wildlife Service, Chesapeake Bay Field Office, Annapolis, MD

of public and private property, historic and cultural sites, recreational beaches, productive farmland and forested areas. Additionally, erosion carries approximately 5.7 million pounds of nitrogen and 4.2 million pounds of phosphorus into the Chesapeake Bay, significantly degrading water quality. Erosion also contributes approximately eleven million cubic yards of sediment into the Chesapeake Bay, intensifying the need for navigational dredging and diminishing water quality due to increased turbidity. Accelerating rates of sea level rise combined with increased development along the State's coastline has tended to prolong or exacerbate these erosion problems.

The MGS has calculated erosion rates for these shorelines based on historic change. The 100-foot risk zone was chosen to identify facilities potentially at risk within ten years based on the highest MGS erosion rate category of greater than eight feet per year.

State and Critical Facility Risk. This shoreline erosion risk assessment examines Maryland's critical and state-owned facilities along tidal shorelines that are located within the 100-foot risk zone. Separate analysis was completed for the state-owned facilities and the critical facilities. State facility data was compiled based on available data from the Maryland State Treasurer's Office dataset. Unknown building values were estimated for facilities that have a content value. Critical facility data was compiled from several sources, including the Maryland Department of Planning Maryland Property View (MD Property View) dataset, that are outlined in Section 3.6 and Appendix P.

A total of 242 state-owned facilities and 1,018 critical facilities are identified within the 100-foot risk zone (Table 3-45). There are zero critical facilities within the high risk zone (>-8 ft/yr) directly. The majority of the critical facilities fall in the categories for above ground and underground storage facilities for oil. The current assessment focuses on the 242 facilities that are state-owned within the 100-ft erosion zone with known building and content values.

St. Mary's County contains the most state owned facilities in the 100-foot risk zone at 153 that include a total value (building + content) of $527.7 million and a building value of $422.2 million. These facilities are associated with a shoreline that is eroding at a slight rate of -0.01 to -2 feet per year (Table 3-46).

Portions of Anne Arundel County are also within the 100-foot erosion zone and experiencing slight rates of erosion on the order of -0.01 to -2 feet per year. Anne Arundel has six state owned facilities within this zone with a total building value of $ 6.6 million. Of these six facilities two are categorized as judicial/legal facilities with a building value of $1.8 million one is a utility/infrastructure facility with a building value of $1.3 million, one is health related (medical services) with an unknown building value, two are categorized as transportation facilities with a total building value of $3.4 million, and one is an environmental related facility with an unknown value (Table 3-46).

Table 3-45. Summary of state owned and critical facilities within the 100-ft erosion zone by county.

County/City	Critical Facilities in the Erosion Zone	State Facilities in the Erosion Zone
Allegany County	0	0
Anne Arundel County	152	6
Baltimore County	68	6
City of Baltimore	248	54
Calvert County	30	1
Caroline County	35	0
Carroll County	0	0
Cecil County	52	0
Charles County	14	0
Dorchester County	78	8
Frederick County	0	0
Garrett County	0	0
Harford County	23	0
Howard County	0	0
Kent County	22	1
Montgomery County	0	0
Prince George's County	15	0
Queen Anne's County	55	0
Somerset County	30	8
St. Mary's County	26	153
Talbot County	57	0
Washington County	0	0
Wicomico County	40	0
Worcester County	73	5

Table 3-46. Summary of state owned facilities within the 100-ft erosion zone with available building values, category, and risk value.

County Name	Category	Building Value	Erosion Risk	Erosion Rate (ft/yr)
Anne Arundel County	Judicial/Legal Facility	$1,736,106.00	2	-0.01 TO -2.00
Anne Arundel County	Judicial/Legal Facility	$142,998.00	2	-0.01 TO -2.00
Anne Arundel County	Utility/Infrastructure Facility	$1,300,185.00	2	-0.01 TO -2.00
Dorchester County	Health Related Facility	Unknown	2	-0.01 TO -2.00

County Name	Category	Building Value	Erosion Risk	Erosion Rate (ft/yr)
Anne Arundel County	Transportation Facility	$1,343,868.00	2	-0.01 TO -2.00
Anne Arundel County	Transportation Facility	$2,096,510.40	2	-0.01 TO -2.00
St. Mary's County	Environmental Related Facility	Unknown	2	-0.01 TO -2.00

The Madison Fire Company in Dorchester County is also within the 100-foot erosion zone. The total building value is $242,300. The Madison city boat ramp and Ragged Point Marina are also included in this area with values of $68,100 and $357,800 respectively. These facilities are both located in an area with a shoreline eroding at a slight rate of -0.01 to -2 feet per year.

While there are 1,018 critical facilities and 242 state facilities located within the 100-foot erosion zone, only very few are associated with shorelines that are experiencing some degree of erosion greater than -0.01 to 2.00 feet/year Dorchester and Queen Anne's Counties each have a critical facility located in a low and moderate erosion risk zone. While other shoreline counties have facilities at risk, these three were the only with complete data sets available to fully characterize the building value at risk.

Additional information on state facility and critical facility data is available in the State and Critical Facility Analysis Section 3.6 and Appendix P.

Jurisdictional Risk. Maryland's shoreline measures 7,660 miles. Dorchester County has the most shoreline located in the moderate and high erosion categories (70.6 miles), accounting for approximately 30.3 percent of the 233 miles of Maryland's total shoreline located in these two categories (Figure 3-24). By comparison, the next highest total amount of shoreline within the moderate and high erosion categories is Somerset County, with approximately 46.5 miles, accounting for approximately 20 percent of Maryland's total shoreline eroding at moderate and high rates. Table 3-47 shows the erosion rate in miles of shoreline subject to different rates of erosion in each of Maryland's sixteen coastal counties.
Table 3-48 lists the erosion risk codes with their associated erosion levels, and rates measured in feet per year. Table 3-49 summarizes shoreline erosion statistics for the state by erosion risk category and percentage of shoreline located within each category.

Table 3-47. Summary of Erosion Rate by County.

Summary of Erosion Rate by County* (miles of shoreline)						
County	Erosion Rate 0-2 ft/yr	Erosion Rate 2-4 ft/yr	Erosion Rate 4-8ft/yr	Erosion Rate >8 ft/yr	Total Eroding Shoreline	Total County Shoreline
Anne Arundel County	246	46	10	1	303 (60%)	508
Baltimore County and City of Baltimore	114	31	7	2	154 (66%)	232
Calvert County	152	14	4	0	170 (74%)	230.5
Caroline County	24	4	2	0.5	30.5 (25%)	121
Cecil County	67	37	8	0.5	112.5 (52%)	217.5

Summary of Erosion Rate by County* (miles of shoreline)						
County	Erosion Rate 0-2 ft/yr	Erosion Rate 2-4 ft/yr	Erosion Rate 4-8ft/yr	Erosion Rate >8 ft/yr	Total Eroding Shoreline	Total County Shoreline
Charles County	202	32	5	1	240 (79%)	305
Dorchester County	606	113	42	22	783 (51%)	1,539
Harford County	95	41	13	1	150 (60%)	249
Kent County	142	48	14	1	205 (60%)	343
Prince George's County	64	5	1	0	70 (59%)	119
Queen Anne's County	180	27	8	2	217 (52%)	414
St. Mary's County	371	24	10	2	407 (76%)	536
Somerset County	625	105	29	8	767 (69%)	1,106
Talbot County	381	27	6	2	416 (69%)	605
Wicomico County	91	11	4	0	106 (29%)	361
Worcester County	314	51	12	15	392 (51%)	774
Grand Total	**3,674**	**616**	**175**	**58**	**4,523 (59%)**	**7,660**

*From the State of Maryland Department of Natural Resources Coastal Atlas: Historical Shorelines from 1841-1998.

Table 3-48. Erosion Risk Categories, Levels, and Rates.

Erosion Risk Code	Erosion Level	Erosion Rate (Ft/Yr)
0	No Change	-0.01 to 0.01
1	Accretion	>0.01
2	Slight	-0.01 to – 2.00
3	Low	-2.00 to – 4.00
4	Moderate	-4.00 to – 8.00
5	High	>-8.00
6	Protected	Protected Area
7	Unknown	Unknown
8	No Data	No Data

Table 3-49. Maryland Shoreline Erosion Statistics.

Erosion Level	Miles of Shoreline	Percentage of Maryland's Total Shoreline
No Change	1.6	0.02%
Accretion	428.8	5.60%
Slight Erosion	1369.3	17.88%
Low Erosion	247.6	3.23%
Moderate Erosion	87.6	1.14%
High Erosion	27.8	0.36%
Protected Shoreline	274.2	3.58%
Unknown Erosion Rate	4213.3	55.00%
No Data	1068.5	13.95%

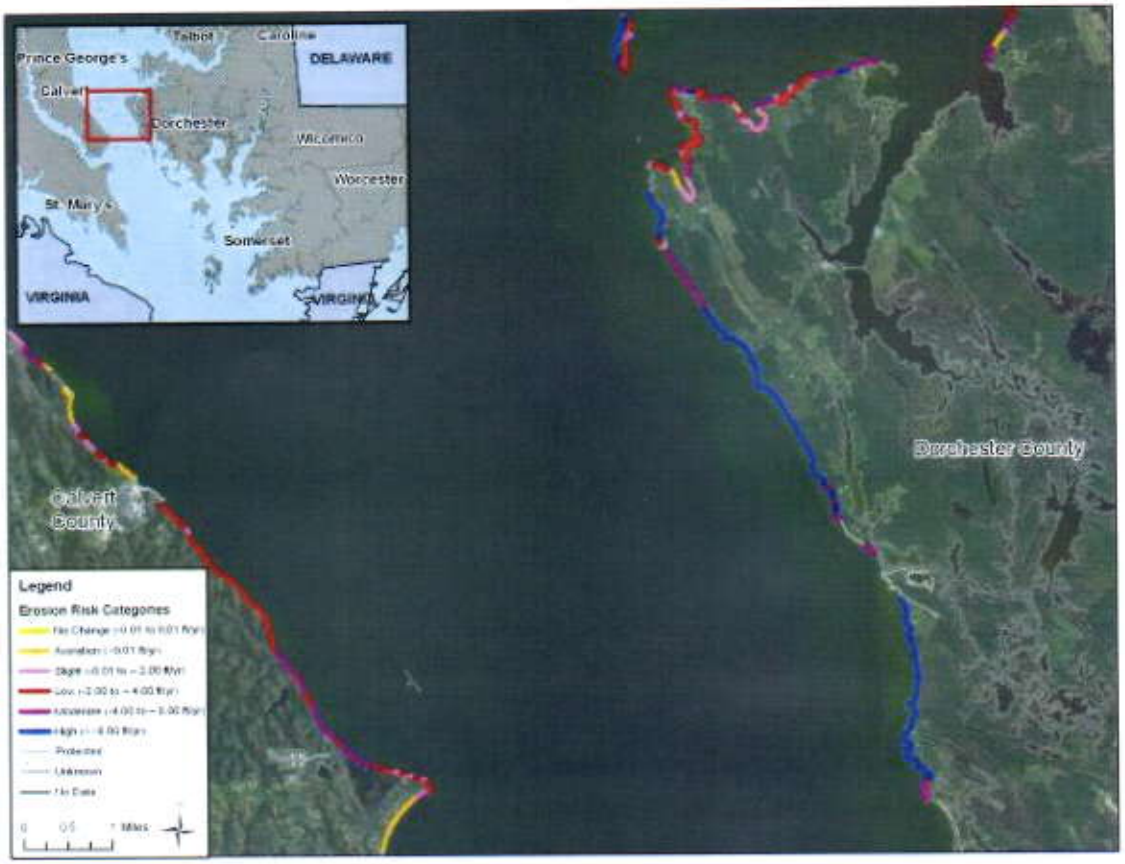

Figure 3-24. Dorchester County Erosion Risk Categories: zones of moderate and high erosion.

Protected Shoreline Summary. Slightly more than 274 miles of Maryland's shoreline is protected from erosion. Of all of the counties in Maryland, Worcester County has the most miles of protected shoreline at approximately 28.9, which is 3.7 percent of that county's total shoreline. Worcester County is part of the Assateague Island National Seashore on the Atlantic facing coastline in Maryland. Assateague Island is a 37-mile long barrier island and is comprised of various marshes,

embayments, and coves. The City of Baltimore has the second highest number of miles of protected shoreline at approximately 22.6, which is 9.7 percent of the city's total shoreline.

Though Worcester County contains the largest amount of protected shoreline, it also has the third highest total amount of shoreline within the moderate and high erosion categories, with approximately 27 miles, accounting for approximately 11.6 percent of Maryland's total shoreline eroding at moderate and high rates calculated using long-term regression rates (Figure 3-25). In comparison, the short-term end point rates of change show an area in the northern portion of Worcester County with accretion of the shoreline on the order of 3-44 feet per year according to the USGS shoreline change (end-point rate) data from the 2010 open-file report for the mid-Atlantic coasts (Figure 3-26).

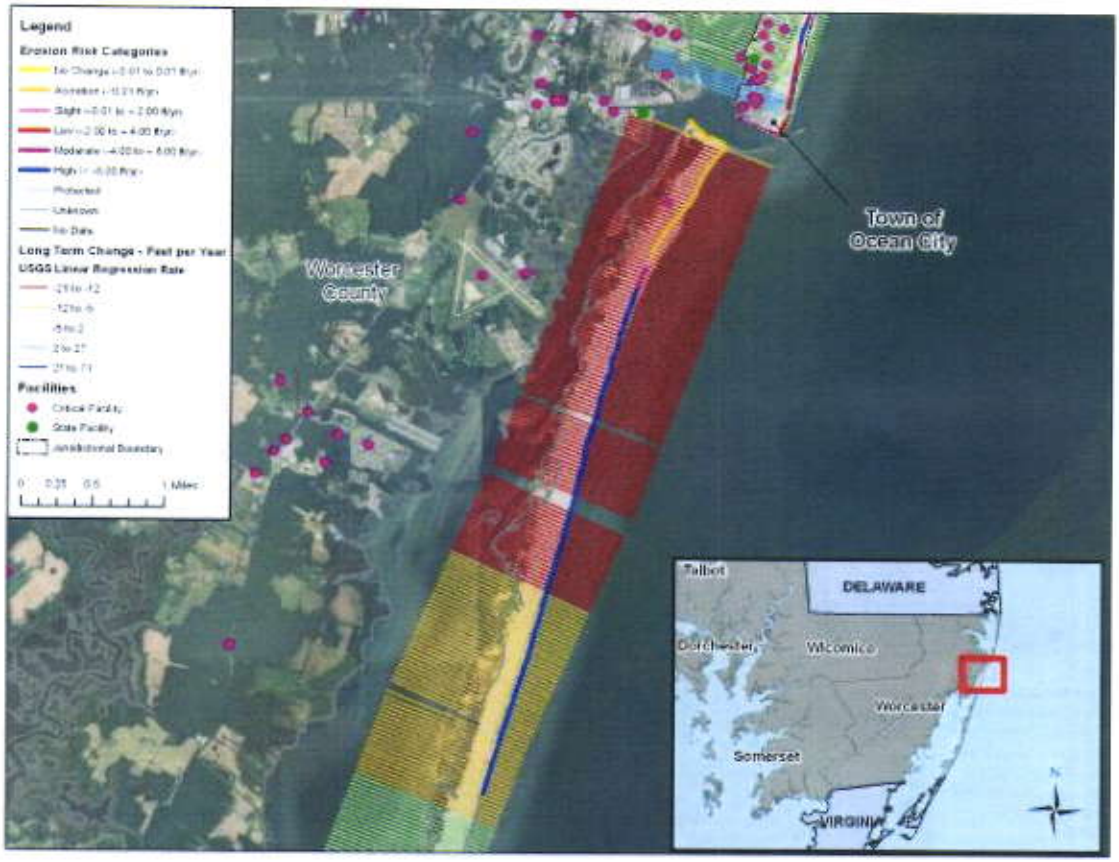

Figure 3-25. Worcester County erosion risk categories and long-term rates of shoreline change: zones of moderate and high erosion. Long-Term linear regression rates are from the USGS National Assessment of Shoreline Change, 2010.

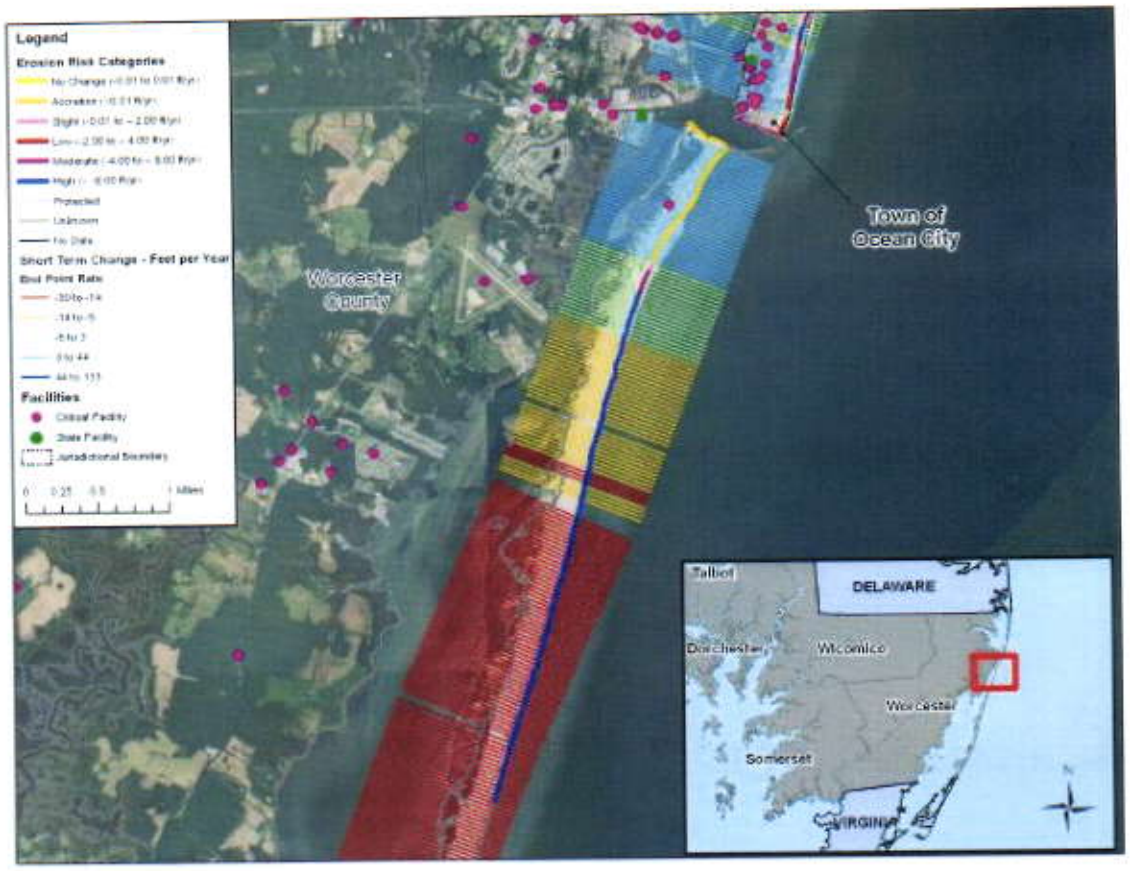

Figure 3-26. Worcester County erosion risk categories and short-term (end-point) rates of shoreline change: zones of moderate and high erosion and accretion. Short-Term end-point rates are from the USGS National Assessment of Shoreline Change, 2010.

Local Plan Risk Assessment. Seven local plans addressed and ranked erosion in their hazard mitigation plans. Anne Arundel, Calvert, and St .Mary's counties ranked erosion high, Prince George's County ranked as Medium-High, Tabot and Wicomico counties and Medium and Caroline County as Low. Section 3.6 outlines the assumptions that were made in an effort to compare the local hazard rankings to each other.

The 2011 Maryland hazard ranking did not rank erosion as a stand-alone hazard. The impacts of erosion have been incorporated into the Coastal Hazards ranking. Section 3.6 includes the ranking for all the hazards addressed in the local plans.

NOTE: The preceding analysis for Shoreline Erosion was drafted based upon information contained in the *Chesapeake Bay Shoreline Erosion in Maryland: A Management Guide (2010)* and *State of Maryland Shore Erosion Task Force Final Report* prepared by the Maryland Department of Natural Resources (DNR), and completed in January 2000. For the Atlantic facing shorelines, *The National Assessment of Shoreline Change: A GIS compilation of vector Shorelines and Associated Shoreline Change Data for the New England and Mid-Atlantic Coasts, 2010,* was used to evaluate long-term and short-term erosion rates.

Consequence Analysis. A consequence analysis, derived from the Emergency Management Accreditation Program (EMAP) has been performed to better understand and outline the impacts that shoreline erosion may have on the public; responders; continuity of operations including delivery of services; property, facilities and infrastructure; the environment; the economic condition of the state, and public confidence in the states governance. The results of the consequence analysis are shown in Table 3-50.

Table 3-50 EMAP Consequence Analysis for Shoreline Erosion

Subject	Impacts
Healthy and Safety of the Public	Home and land owners along the coastline are most at risk to impacts from shoreline erosion. Impacts to the public include destruction and/or loss of land and property. Shoreline erosion can occur suddenly during a tropical cyclone event, such as a hurricane. In this case, people in coastal areas at the time of the event are at an increased risk of injury due to erosion, in addition to the distinct hazards a hurricane brings.
Health and Safety of Responders	First responders would likely face minimal adverse impacts due to long term shoreline erosion caused by sea level rise. However, an exception would be in the case of sudden erosion which can be caused by a severe tropical cyclone event. In this case, first responders would be exposed to the standard occupational hazards involved in dealing with a coastal erosion/flooding event.
Continuity of Operations (incl. delivery of services)	The impacts on continuity of operations will be limited, unless a facility is within a coastal area during a severe tropical cyclone event that causes shoreline erosion. In this event, delivery of services may be slowed or halted in coastal areas if key roadways become impassable due to erosion.
Property, facilities, and infrastructure	Home and land owners within coastal regions may experience damage to or loss of property depending upon the severity of shoreline erosion in the area. Infrastructure may experience impacts in the form of damages to roads/bridges and/or the complete loss of transportation routes.
Environment	Shoreline erosion will negatively impacts beaches, wetlands, marshes, and coastal habitats. With the loss of environments, coastal areas may experience more frequent and destructive flooding.
Economic condition of the state	At present, it is estimated that nearly 70% of shoreline in the state is being eroded to some degree. Erosion of the shoreline at this level will drain state, county, and local resources. The economic costs related to mitigation projects, relocation, loss of land, and more severe flooding will be high.
Public confidence in state governance	Public confidence will largely depend upon how effectively the State of Maryland, and county and local governments prepare for and respond to shoreline erosion.

3.6.6 Tsunamis

3.6.6.1 Tsunami Description

A tsunami is a series of sea waves caused by the displacement of a large volume or body of water. Tsunamis may result from local or distant large-scale seafloor displacement, including seismic activity, volcanic activity or landslides that generate an uplift or drop in the ocean floor. Waves travel in all directions from the originating tsunami sources, building in height as the wave approaches the shore. The topography and geometry of the coastline, wave direction or path, and offshore topography influence the run-up (or terminal height) of the wave and therefore potential for damage[21]. Coastal areas with the greatest tsunami risk are generally less than 25 feet above sea level and within one mile of the shoreline[22]. There are three primary sources of damage from tsunamis: inundation (the extent the water goes over the land), wave impact (from incoming and receding currents) and coastal erosion.

Most tsunamis occur in the Pacific Ocean, which consists of subduction zones where vertical plate movement results in earthquakes. Conversely, the U.S. East Coast has been considered an area with reduced threat from tsunamis. In the Atlantic Ocean, the Mid-Atlantic Ridge is a spreading center (a divergent plate boundary). The U.S. East Coast is a passive margin, characterized by minimal tectonic activity and a low sloping continental shelf. The majority of the Atlantic Ocean's tectonically active areas (seismic and volcanic) are concentrated near the Caribbean Islands and at the Scotia island arc chain[23].

3.6.6.2 East Coast Tsunami Sources

The hazard posed by tsunamis along the upper east coast of the United States is difficult to assess due to the lack of tsunami observations in the geological and historical records and the uncertainty of return periods for tsunami events that have been reported in the literature[24]. Although few records exist for the U.S. East Coast, it is believed that only about 10 percent of tsunami events that have affected the U.S. originated in the Atlantic basin (i.e., Atlantic, Gulf of Mexico, Puerto Rico, the lesser Antilles, and Virgin Islands)[25].

Since subduction zones are absent around most of the Atlantic basin, tsunamis and tsunami-like waves along the U.S. East Coast are generally the result of slumping or landsliding associated with local earthquakes or with wave action associated with strong storms[26]. Other eastern seaboard tsunami sources include volcanic debris falls or catastrophic failure of volcanic slopes, explosive decompression of underwater methane deposits or oceanic meteor splashdowns. Although few historical landslide tsunamis have been identified along the entire U.S. East Coast, several studies

[21] George Pararas-Carayannis, The Tsunami Page of Dr. George P.C., http://www.drgeorgepc.com/TsunamiFAQ.html (June 2011).
[22] Federal Emergency Management Agency, Fact Sheet: Tsunamis, http://www.fema.gov/hazard/tsunami/index.shtm (June 2011).
[23] Maine Geological Survey, Tsunamis in the Atlantic Ocean, http://www.maine.gov/doc/nrimc/mgs/explore/hazards/tsunami/jan05.htm (June 2011).
[24] S. Maretzki, S. Grilli and C.D.P. Baxter, "Probabilistic SMF Tsunami Hazard Assessment for the Upper East Coast of the U.S.," *Advances in Natural and Technological Hazards Research* **27:7** (2007): 377-385.
[25] P.K. Dunbar and C.S. Weaver, "U.S. States and Territories National Tsunami Hazard Assessment: Historical Record and Sources for Waves," Prepared for the National Tsunami Hazard Mitigation Program by *NOAA* and *USGS* (2008).
[26] P.A. Lockridge, L.S. Whiteside, and J.F. Lander, "Tsunamis and tsunami-like waves of the Eastern Unites States," *Science of Tsunami Hazards* **20:3** (2002): 120-157.

suggest that one third of the New England continental slope and rise is covered with landslide scars and deposits[27,28].

Tsunami events in the Atlantic Ocean basin that can affect the U.S. East coast include[29] (Figure 3-27):

- Earthquakes in the Azores-Gibraltar convergence zone (e.g., Lisbon earthquake in 1755);
- Earthquakes along the Hispaniola-Puerto Rico-Lesser Antilles (Caribbean) subduction zone, in and around the Puerto Rico Trench or near the Leeward Islands;
- Large mass failure event, including the potential flank collapse of the Cumbre Vieja Volcano in the Canary Islands;
- Landslide tsunamis caused by Submarine Mass Failures (SMF) triggered along the East coast continental slope by moderate seismic activity. Significant geological and historical evidence (e.g., the 1929 Grand Bank landslide tsunami and the Currituck Slide off North Carolina and Virginia) suggests that SMF tsunamis pose the most significant tsunami hazard to the upper east coast, triggered on the continental slope by moderate seismic activity (magnitude 6.0 to 7.5). Although such near-field landslide tsunami sources are less energetic than co-seismic (e.g. earthquake induced) tsunamis, SMFs can occur at a shorter distance from shore and therefore cause significant run-up on small sections of the coast while offering little warning time, thus posing significant hazard to local, low-lying, coastal communities, such as Ocean City, MD and Worcester County. For example, SMFs with volumes of above 100 km^3 can generate vertical extent of wave uprush on a beach or structure (run-up) of more than two meters.

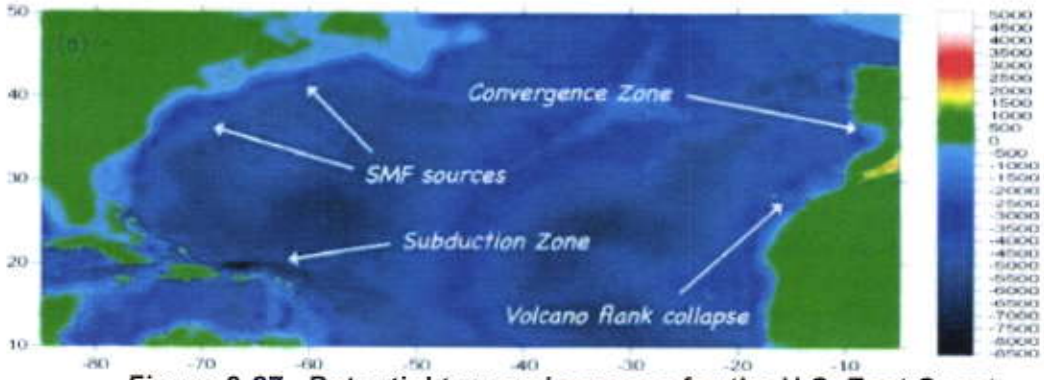

Figure 3-27. Potential tsunami sources for the U.S. East Coast.

[27] U.S. ten Brink, D. Twichell, E. Geist, J. Chaytor, J. Locat, H. Lee, B. Buczkowski, and M. Sansoucy, "The Current State of Knowledge Regarding Potential Tsunami Sources Affecting U.S. Atlantic and Gulf Coasts," Report to the Nuclear Regulatory Commission, *USGS* (2008): 166 pages.
[28] D.C. Twichell, J.D. Chaytor, U.S. ten Brink, and B. Buczkowski, "Morphology of Late Quaternary Submarine Landslides along the U.S. Atlantic Continental Margin," *Marine Geology* **264** (2009): 4-15.
[29] J.T. Kirby, *Literature review of tsunami sources affecting tsunami hazard along the US East Coast*, https://chinacat.coastal.udel.edu/~kirby/papers/draft_lit_review.pdf (June 2011)

3.6.6.3 Relevant Studies

The National Tsunami Hazard Mitigation Program performs exercises that are designed to improve the effectiveness of the tsunami warning system along the U.S./ Canadian Atlantic and Caribbean coasts. Two such simulations are described below that address two of the potential tsunami sources (listed above) that may affect segments of the Maryland coast, and may be used to support tsunami mitigation planning. Studies covering the remaining two source region threats will be completed by early 2012, followed by inundation mapping for Ocean City and the remainder of the East Coast[30]. The current science indicates that there would be very little impact to the coastal stretches of the Bay. At present the only Maryland coastline segments identified at risk are Ocean City and Worcester County; however, this may change after the completion of ongoing study efforts[30].

3.6.6.4 National Tsunami Hazard Mitigation Exercises

LANTEX 09- Northwest-Atlantic tsunami warning exercise. The 2009 exercise scenario demonstrates the effects of a major earthquake (magnitude 8.6) off the northern coast of Puerto Rico[31]. The earthquake generated a moderate, though damaging, tsunami (amplitudes 0.1 to 2.0m) along the U.S. and Canadian Atlantic coast (Figure 3-28). The maximum modeled tsunami amplitude for Ocean City, MD is 1.32 meters. The hypothetical earthquake occurred at 1300UTC on April 2, 2009, and the resulting simulated tsunami was observed at Ocean City, MD, at 2010UTC with an amplitude of 1.28m.

LANTEX 10- Atlantic tsunami warning exercise. The Alaska tsunami forecast model was used to simulate the tsunami generated by a hypothetical magnitude 7.5 earthquake located 90 miles

[30] J.T. Kirby, *Project Narrative: Modeling Tsunami Inundation and Assessing Tsunami Hazards for the U.S. East Coast*, https://chinacat.coastal.udel.edu/~kirby/papers/NTHMP-Project-Narrative-East-Coast-Modeling-final.pdf (June 2011).

[31] National Tsunami Hazard Mitigation Program, "A northwest-Atlantic tsunami warning exercise," *LANTEX09 Participant Handbook* (April 2, 2009).

south of Nantucket, MA[32]. The earthquake occurred at 1300UTC on March 24, 2010, and immediately triggered a 100 cubic km underwater slide of sediment off the continental slope at a rate of 50 meters per second. The tsunami generated by the slide was more than thirty times larger than the tsunami generated by the earthquake uplift. The simulated tsunami amplitudes along the U.S. Atlantic coast ranged from 0.04 m (Annapolis, MD) to 3.3 m (Atlantic City, NJ). For this event the maximum modeled amplitude for Ocean City, MD, was 2.19 meters, which occurred at a travel time of 2.25 hours (Figure 3-29). Note that these amplitudes are what would be recorded by a tide gage and do not necessarily reflect the expected vertical run-up along the shore; vertical run-ups can exceed or double the height of the tide gage observation.

3.6.6.5 Modeling Tsunami Inundation and Assessing Tsunami Hazards for the U.S. East Coast

An ongoing reanalysis is being conducted by the Universities of Delaware and Rhode Island. The project focuses on the four major tsunami source regions posing a threat to the East coast (described above). This project will assess ocean scale simulations of transoceanic tsunami sources, such as the Lisbon 1755 earthquake or Puerto Rico Trench co-seismic events, and Cumbre Vieja Volcano collapse, with regional scale simulations of these events and other regional SMF events, in order to establish the hazards for U.S. East Coast communities. Detailed inundation studies will be conducted for the highest-risk East Coast communities, and results will be used to generate inundation maps.

[32] National Tsunami Hazard Mitigation Program, "An Atlantic tsunami warning exercise," *LANTEX10 Participant Handbook* (March 24, 2010).

3.6.6.6 North Carolina/ Virginia Continental Shelf

Two East Coast off-shore areas are currently being investigated for potential future large-scale submarine slope failure. These sites include

- Large cracks discovered northeast of Cape Hatteras (off the coast of North Carolina and Virginia). The cracks are located on the outer shelf edge and exist as a series of "en echelon cracks" (Figure 3-30).
- Submarine canyons located approximately 150 kilometers east of Atlantic City, New Jersey.

The North Carolina-Virginia site also contains evidence of a large submarine landslide, the Albemarle-Currituck Slide, which has been dated to approximately 18,000 years ago, with over 33 mi^3 of material moved seaward from the continental shelf, most likely causing a tsunami[33] . These cracks may indicate a progression in slope failure and the potential for another submarine landslide to occur that could trigger a tsunami on the order of a few to several meters in height, similar to a storm surge resulting from a Category 3 or 4 hurricane. Further, investigations suggest that the cracks are in areas of large deposits of methane hydrate and pressurized water, wherein sudden release of the water or methane may have produced the cracks and slope failure.

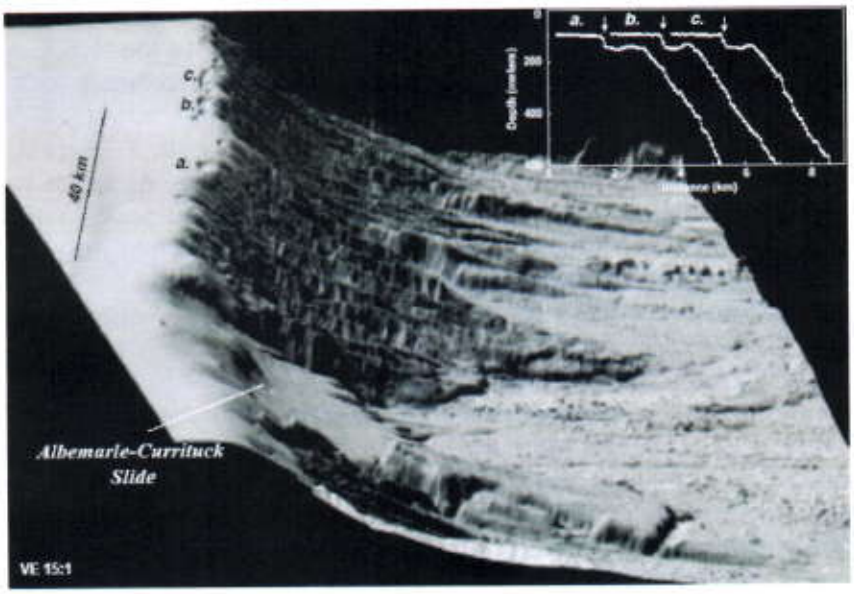

Figure 3-30. Side-scan sonar imagery of the Albemarle-Carrituck slide site and submarine canyons to the north. The faults (cracks) in the upper slope are marked a, b, and c.

4.6.6.7 Risk Assessment

Probability of Future Occurrence. According to the National Geophysical Data Center (NGDC), which records information regarding reported and observed tsunamis all over the world, eighteen tsunami events have impacted the east coast of the U.S. since 1900. Ten of these events resulted from a meteorological event, four via landslide, one via earthquake, and three were of

[33] N.W. Dricoll, J.K. Weissel, and J.A. Goff, "Potential for large-scale submarine slope failure and tsunami generation along the U.S. mid-Atlantic coast," *Geology* **28(5)**:407-410.

unknown origin. The most recent tsunami event, and the only one to have affected coastal regions within Maryland, occurred in June of 2013 and was the result of a meteorological event. Coastal areas affected included Annapolis, Baltimore, Bishops Head, Ocean City, and Tolchester Beach in Kent County. There were no reported injuries, deaths, or property damages associated with this event. Based on the historical occurrences of tsunami events that have impacted Maryland in the last 100 years, it can be gathered that the probability of future occurrence of a tsunami event affecting the State of Maryland is very low.

Impact and Vulnerability. Similarly to other coastal hazards, impacts from tsunamis primarily consist of inundation, wave action, and shoreline erosion. Coastal areas in Maryland along the Atlantic (Worchester County and Ocean City) as well as areas along the Chesapeake Bay, are most vulnerable to a tsunami event. Populations most vulnerable to a tsunami include those within Maryland's coastal communities. According to the NGDC, within the last 100 years, no injuries or deaths have been recorded as a result of a tsunami event impacting the State.

Risk. Coastal areas within Maryland, including areas along the Chesapeake Bay and the Atlantic Ocean, are at greater risk for a tsunami event than other regions of the state. Counties and areas at high risk include: Anne Arundel, Baltimore, Calvert, Cecil, Dorchester, Harford, Kent, Queen Anne's, Somerset, St. Mary's, Talbot, Wicomico, and Worcester Counties, and the City of Annapolis, City of Baltimore, and Ocean City. These areas have a greater risk of flooding, wave action, and shoreline erosion caused by a tsunami event. According to the NGDC, within the last 100 years, no property damage as a result of a tsunami event has been recorded.

State and Critical Facility Risk. State and critical facilities along the Chesapeake Bay and the Atlantic Ocean are at greatest risk to tsunami compared to other regions in the state. Given the unpredictable nature of tsunamis, state and critical facilities within all coastal counties and areas have been considered as shown in Table 3-52.

Local Plan Risk Assessment. One local plan, Calvert County, addressed and ranked tsunami in its hazard mitigation plan as a separate hazard. In this plan, Calvert County ranked tsunami as low.

Consequence Analysis. A consequence analysis, derived from the Emergency Management Accreditation Program (EMAP) has been performed to better understand and outline the impacts that a tsunami would have on the public; responders; continuity of operations including delivery of services; property, facilities and infrastructure; the environment; the economic condition of the state, and public confidence in the states governance. The results of the consequence analysis are shown in Table 3-51.

Table 3-51 EMAP Consequence Analysis for Tsunami

Subject	Impacts
Healthy and Safety of the Public	Home and land owners along the coastline are most at risk to impacts from a tsunami event. Impacts to the public include potential for injury or loss of life, and destruction and/or loss of land and property due flooding and wave action
Health and Safety of Responders	First responders, such as fire and police, would be called to the incident area(s) to evacuate people, close roads, and attend to any injured. For a tsunami event, as with all disaster events, responders face the risk of personal injury while performing necessary job functions.

Continuity of Operations (incl. delivery of services)	The impacts on continuity of operations will be limited to state and critical facilities within a coastal area during a tsunami event. Delivery of services may be slowed or halted in coastal areas if key roadways become impassable due to damage or flooding.
Property, facilities, and infrastructure	Home and land owners within coastal regions may experience damage to or loss of property depending upon the terminal height (run-up) of the tsunami wave(s). Infrastructure may experience impacts in the form of damages to roads and bridges, temporary closure of transportation routes, and the potential inability of the stormwater system to handle flood waters in a severe event.
Environment	Flooding, wave action, and shoreline erosion will be the major impacts to the coastal environment during a tsunami.
Economic condition of the state	While there is no historical record of a major tsunami event impacting Maryland's shores within the last 100 years, a major tsunami event would be very costly for state and local governments due to the potential for damages to property associated with flooding, wave action, and shoreline erosion. Some of the costs could be recouped through federal grant reimbursements, but local governments would still feel the fiscal impact of a major tsunami.
Public confidence in state governance	Public confidence will largely depend upon how effectively the State of Maryland, and county and local governments, prepare for and respond to a tsunami event.

Table 3-52 State and Critical facility exposure in counties with high tsunami risk.

County/City	Police	Fire	Health	Educational	Total Number of Critical Facilities	Critical Facilities Building and Contents Values*	Total Number of State Facilities	State Facilities Building and Contents Values
Caroline County	9	10	12	17	530	$99,545,768	421	$135,451,637
Carroll County	8	29	21	65	1,767	$815,347,934	228	$422,028,255
Dorchester County	4	25	12	21	659	$98,649,835	108	$148,212,355
Harford County	9	27	8	85	2,342	$779,022,758	207	$121,336,132
Kent County	3	11	6	14	472	$89,173,096	36	$21,095,337
Queen Anne's County	2	16	5	20	612	$157,181,957	94	$71,538,421

** Adjusted for inflation (2014)*

Somerset County	2	26	21	33	390	$54,604,162	256	$786,804,889
St. Mary's County	3	10	7	35	888	$326,558,818	317	$667,686,281
Talbot County	4	10	11	12	658	$131,848,676	66	$31,378,670
Wicomico County	4	24	38	43	1,329	$483,114,525	183	$939,551,896
Worchester County	10	23	11	25	931	$202,403,29	126	$24,043,637
City of Baltimore	10	49	169	318	7,904	$3,350,630,360	765	$8,006,017,790
Grand Total	**68**	**260**	**321**	**688**	**18,482**	**$6,588,081,182**	**2,807**	**$11,375,145,300**

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3.6.7 Nor'easter

4.6.7.1 Description

In addition to tropical cyclone events, Maryland's coasts have the potential to be impacted by Nor'easter events. Nor'easters, named for the strong northeast winds they produce, are a type of tropical storm which occur during the late fall to early spring period and affect the East Coast. In order for Maryland to experience a Nor'easter, an arctic air mass – a high pressure system that builds over New England and flows south – has to occur. This dense cold air is unable to move west over the Appalachian Mountains, therefore it is funneled southward through the valleys and along the Coastal Plain. The intense winds around the center of the Nor'easter can create large waves that thrash against the State's coastlines and force water inland, which contributes to coastal flooding and shoreline erosion. A Nor'easter differs from a hurricane in that hurricanes typically come and go within one tide cycle. The Nor'easter can linger through several tide cycles, with each tide cycle delivering more water onto the shore and dragging sand away from the beaches and depositing it into the Chesapeake Bay.

4.6.7.2 Historical Occurrences

The NCDC database does not include "nor'easter" as one of its subcategories for storm events. As such, the events listed in the table below were identified by searching for the keyword "nor'easter" in the remarks portion of the database. Events described as nor'easters were found to be included under the following event types: coastal flooding, flood, freezing rain, gusty wind, heavy rain, high wind, strong wind, thunderstorm, and tidal flooding. Between 1995 and 2012, there were 18 unique events described as a nor'easter within the database. Table 3-53 shows the most significant nor'easter events in Maryland from 1996 through 2009.

Table 3-53. Historical Significant Nor'easter Events, 1996-2009.

Date	Event	Comments
October 8, 1996	Nor'easter	The remnants of Tropical Storm Josephine evolved into a nor'easter which raced from South Carolina to just off the southern New Jersey coast in a 12 hour period. Wind gusts in excess of 50 knots from the Bay through the western shore of central and southern Maryland were recorded. The highest gust, 77 MPH, was recorded in St Mary's County. Numerous trees were knocked down in Calvert and St Mary's Counties; power outages were widespread, numbering 7,000 in the predominantly rural eastern portions of the counties. Trees fell onto homes in Great Mills and North Town Creek in St Mary's Co; dozens more fell onto power lines and across roads. Lesser damage was noted in Anne Arundel Co; however, the high winds knocked down a few trees and several power lines, cutting service to 7,000 customers. The winds diminished rapidly with the passage of the storm.
January 27, 1998	Nor'easter	A Nor'easter battered the Lower Maryland Eastern Shore on Tuesday, January 27th and Wednesday, January 28th. The slow movement of the storm combined with the highest astronomical tides of the month resulted in an extended period of gale to storm force onshore winds which drove tides to an estimated 8.0-8.5 feet above MLLW at Ocean City. These tide levels resulted in moderate coastal flooding throughout the Lower Maryland Eastern Shore. The rainfall combined with the gale and storm force winds resulted in scattered tree limbs downed across much of the area. Numerous homes, several buildings and one hotel sustained damage in the Ocean City area. Assateague State Park also received significant damage. In addition, there were widely scattered power outages.

Date	Event	Comments
February 4, 1998	Nor'easter	A Nor'easter battered the Lower Maryland Eastern Shore from Tuesday, February 3rd through Thursday, February 5th. The slow movement of the storm resulted in an extended period of gale to storm force onshore winds which drove tides to an estimated 8.5 feet above MLLW at Ocean City. These tide levels resulted in moderate to severe coastal flooding throughout the Lower Maryland Eastern Shore. The south end of Ocean City, from 15th street to the inlet, received significant street flooding and flooding of homes. Significant beach erosion occurred in Ocean City, with major dune and beach damage experienced in Assateague Island. In addition, there were widely scattered power outages.
March 21, 2001	Nor'easter	A Nor'easter moved from the North Carolina coast to New England from the 20th to the 22nd. As it passed by the Mid-Atlantic region, it dropped heavy precipitation between midnight and mid-afternoon on the 21st. From Washington County eastward, the precipitation fell in the form of rain and totaled between 1 and 2.5 inches. After the precipitation ended on the 21st, northwest winds gusted between 35 and 50 MPH. Recorded gusts included 52 MPH at Parkton in Baltimore County, 51 MPH at Smithsburg in Washington County, and 43 MPH at Tall Timbers in St. Mary's County.
April 15, 2007	Nor'easter	An intense nor'easter brought heavy rain and flooding to the Maryland Eastern Shore on the 15th and strong winds to the region on the 16th. Rain began falling during the evening on the 14th, but fell at its heaviest from about Midnight EDT through about 3 p.m. EDT on the 15th. The rain ended before sunrise during the early morning of the 16th. Event precipitation totals averaged between 3 and 6 inches. The strongest winds occurred as the nor'easter pulled northeast of the region on the 16th from the early morning into the afternoon. Peak wind gusts averaged around 50 mph. Peak wind gusts included 54 mph in Salisbury (Dorchester County), 53 mph at the Baltimore-Washington International Airport, 48 mph in Easton (Talbot County), 47 mph in Annapolis (Anne Arundel County) and 46 mph in Chesapeake City (Cecil County) and Tolchester Beach (Kent County).
November 12, 2009	Nor'easter	An intense Nor'easter produced moderate to severe coastal flooding across portions of the Lower Eastern Shore. The peak high tide at Cambridge was 3.69 feet above MLLW, which was 1.67 feet above the astronomical tide. Several streets, homes, and businesses were flooded in low lying areas close or adjacent to the Chesapeake Bay in Dorchester County. Property damage was estimated to be around $100,000.

3.6.7.3 Risk Assessment

Coastal nor'easter risk was assessed using historical data acquired from the NCDC's U.S. Storm Events Database. Event data ranges from December 19, 1995 through April 16, 2010.

Probability of Future Occurrence. As with most weather phenomenon, it is difficult to predict the probability of future occurrence for nor'easter events. While it may be possible to predict a nor'easter event based on observation of specific conditions that make nor'easters more likely, such as those outlined in section 4.6.7.1, there is little way of predicting the severity of these events.

Table 3-54 provides the annualized number of nor'easter events by county based on the NCDC historical record. This record only extends back to 1995, which makes it difficult to provide any long-term forecast based on the data. However, it is reasonable to assume that all coastal counties and areas in Maryland will remain especially prone to nor'easter events in the future.

Table 3-54 NCDC total and annualized nor'easter events (1995-2012).

County/City	Total Events	Annualized Events
Allegany County	2	0.11
Anne Arundel County	10	0.56
Baltimore County	7	0.39
Calvert County	8	0.44
Caroline County	8	0.44
Carroll County	5	0.28
Cecil County	3	0.17
Charles County	6	0.33
Dorchester County	4	0.22
Frederick County	5	0.28
Garrett County	0	0.00
Harford County	5	0.28
Howard County	5	0.28
Kent County	3	0.17
Montgomery County	7	0.39
Prince George's County	8	0.44
Queen Anne's County	4	0.22
St. Mary's County	10	0.56
Somerset County	3	0.17
Talbot County	8	0.44
Washington County	4	0.22
Wicomico County	2	0.11
Worcester County	6	0.33
City of Baltimore	2	0.11
Grand Total*	**53**	**2.94**

** Grand total values are not a direct sum of each of the county/city totals. The grand total events do not include zonal events as described in Section 3.3 and Section 3.5.*

Impact and Vulnerability. Generally, each area in Maryland is potentially vulnerable to nor'easters, especially those areas in the Chesapeake Bay region that are within the coastal floodplain. Since 1995, Maryland has only suffered 2 injuries and zero deaths as a result of nor'easter related accidents as shown in Table 3-55 Critical facilities, legacy structures, and infrastructure in central and coastal Maryland may be vulnerable to nor'easters due to flooding and high winds. In particular, structures that are not properly flood mitigated and/or built prior to building codes (the use of construction design wind speeds and corresponding zones shown in Figure 3-32) may be vulnerable to nor'easter damage.

Table 3-55 Nor'easter related injuries and deaths per county, 1995-2012.

Jurisdiction	Total Injuries	Total Deaths
Allegany County	0	0
Anne Arundel County	1	0
Baltimore County	0	0
Calvert County	0	0
Caroline County	0	0
Carroll County	0	0
Cecil County	0	0
Charles County	0	0
Dorchester County	0	0
Frederick County	0	0
Garrett County	0	0
Harford County	0	0
Howard County	0	0
Kent County	0	0
Montgomery County	1	0
Prince George's County	0	0
Queen Anne's County	0	0
St. Mary's County	0	0
Somerset County	0	0
Talbot County	0	0
Washington County	0	0
Wicomico County	0	0
Worcester County	0	0
City of Baltimore	0	0
Grand Total	**2**	**0**

Risk. Coastal areas in Maryland are at greater risk for a nor'easter event than the rest of the state, with Worcester, St. Mary's, Calvert, Anne Arundel, and Dorchester Counties especially at risk. In terms of property damages associated with nor'easters, these counties rank the highest, with over $5 million in combined statewide damages between 1995 and 2012 as shown in Table 3-57. Of this amount, just over $4.3 million in damages is associated with Worcester County. These estimates are believed to be an underrepresentation of the actual losses experienced due to hazards

as losses from events that go unreported or that are difficult to quantify are not likely to appear in the NCDC database; this is especially true with crop damages.

State and Critical Facility Risk. In terms of historical damage estimates, state and critical facilities in coastal regions are at greatest risk to nor'easters compared to other areas in the state. Critical facilities are especially at risk within Worcester, St. Mary's, Calvert, Anne Arundel, and Dorchester Counties as shown in Table 3-58. Regarding state owned facilities, more than 1,150 buildings are within these five counties with a total value of more than $5 billion. State facility exposure is shown in Table 3-59.

Local Plan Risk Assessment. Two local plans, Anne Arundel and Worcester Counties, addressed and ranked nor'easter in their hazard mitigation plans as a separate hazard; several local plans addressed nor'easter within the hurricane or coastal hazard categories. Of the two counties that ranked nor'easter as a separate hazard, Anne Arundel ranked it as a medium-hazard and Worcester ranked it as a medium-high hazard.

Consequence Analysis. A consequence analysis, derived from the Emergency Management Accreditation Program (EMAP) has been performed to better understand and outline the impacts that a nor'easter event would have on the public; responders; continuity of operations including delivery of services; property, facilities and infrastructure; the environment; the economic condition of the state, and public confidence in the states governance. The results of the consequence analysis are shown in Table 3-56.

Table 3-56 EMAP Consequence Analysis for Nor'easter

Subject	Impacts
Healthy and Safety of the Public	Home and land owners along the coastline are most at risk to impacts from a nor'easter event. Impacts to the public include potential for injury or loss of life, and destruction and/or loss of land and property due to flood and high winds.
Health and Safety of Responders	First responders, such as fire and police, would be called to the incident area(s) to evacuate people, close roads, and attend to any injured. For a nor'easter event, as with all disaster events, responders face the risk of personal injury while performing necessary job functions.
Continuity of Operations (incl. delivery of services)	The impacts on continuity of operations will be limited, unless a facility is within a coastal area during a severe nor'easter event. Delivery of services may be slowed or halted in coastal areas if key roadways become impassable due to flooding.
Property, facilities, and infrastructure	Home and land owners within coastal regions may experience damage to or loss of property depending upon the severity of flooding and winds in the area. Infrastructure may experience impacts in the form of damages to roads and bridges, temporary closure of transportation routes, and the potential inability of the stormwater system to handle flood waters in a severe event.
Environment	Shoreline erosion will be the major impact to the coastal environment during a nor'easter.
Economic condition of the state	A major nor'easter event would be costly for state and local governments due to the potential for damages from flooding and high winds. Some of the costs could

	be recouped through federal grant reimbursements, but local governments would still feel the fiscal impact of a major event.
Public confidence in state governance	Public confidence will largely depend upon how effectively the State of Maryland, and county and local governments prepare for and respond to a nor'easter event.

Table 3-57 Nor'easter crop and property damages per county, 1995-2012.

City/County	Property Damage (Total)	Property Damage (Annualized)	Crop Damage (Total)	Crop Damage (Annualized)	Total Damage**	Total Damage (Annualized)**
Allegany County	$11,362	$631	$0	$0	$11,362	$631
Anne Arundel County	$140,253	$7,792	$26,444	$1,469	$166,697	$9,261
Baltimore County	$61,254	$3,403	$26,444	$1,469	$87,698	$4,872
Calvert County	$146,177	$8,121	$26,444	$1,469	$172,621	$9,590
Caroline County	$1,727	$96	$0	$0	$1,727	$96
Carroll County	$31,804	$1,767	$26,444	$1,469	$58,248	$3,236
Cecil County	$1,727	$96	$0	$0	$1,727	$96
Charles County	$69,754	$3,875	$26,444	$1,469	$96,198	$5,344
Dorchester County	$110,504	$6,139	$0	$0	$110,504	$6,139
Frederick County	$40,665	$2,259	$26,444	$1,469	$67,109	$3,728
Garrett County	$0	$0	$0	$0	$0	$0
Harford County	$31,804	$1,767	$26,444	$1,469	$58,248	$3,236
Howard County	$30,534	$1,696	$26,444	$1,469	$56,978	$3,165
Kent County	$1,727	$96	$0	$0	$1,727	$96
Montgomery County	$62,843	$3,491	$26,444	$1,469	$89,287	$4,960
Prince George's County	$67,346	$3,741	$26,444	$1,469	$93,790	$5,210
Queen Anne's County	$1,727	$96	$0	$0	$1,727	$96
St. Mary's County	$219,260	$12,181	$26,444	$1,469	$245,704	$13,650
Somerset County	$0	$0	$0	$0	$0	$0
Talbot County	$1,727	$96	$0	$0	$1,727	$96
Washington County	$48,084	$2,671	$0	$0	$48,084	$2,671
Wicomico County	$0	$0	$0	$0	$0	$0
Worcester County	$4,372,307	$242,906	$0	$0	$4,372,307	$242,906
City of Baltimore	$0	$0	$0	$0	$0	$0
Grand Total*	**$210,892**	**$11,716**	**$0**	**$0**	**$210,892**	**$11,716**

** Grand total values are not a direct sum of each of the county/city totals. The grand total events do not include zonal events as described in Section 3.3 and Section 3*
***Adjusted for inflation (2014)*

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Table 3-58 Critical facility exposure in counties with high nor'easter risk.

County/City	Police	Fire	Health	Educational	Total Number of Facilities in High Risk	Building and Content Values in High Risk (2014 dollars)
Anne Arundel County	7	44	179	209	5,033	$1,679,023,845
Calvert County	3	9	26	42	551	$475,262,612
Dorchester County	4	25	12	21	659	$107,022,192
St. Mary's County	3	10	7	35	888	$354,273,683
Worcester County	10	23	11	25	931	$219,581,148
Grand Total						

Table 3-59 State facility exposure in counties with high nor'easter risk.

County/City	Total Number of Facilities in High Risk	Building Values in High Risk (2014 dollars)	Content Values in High Risk (2014 dollars)	Building and Content Values in High Risk
Anne Arundel County	462	$3,667,681,594	$290,750,290	$3,958,431,884
Calvert County	114	$147,173,686	$15,550,247	$162,723,933
Dorchester County	126	$170,006,258	$22,573,454	$192,579,712
St. Mary's County	308	$571,926,774	$134,148,681	$706,075,455
Worcester County	144	$22,291,958	$3,640,580	$25,932,538
Grand Total	1154	$4,579,080,270	$466,663,252	$5,045,743,522

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3.7 Wind

3.7.1 Description

Wind is the motion of air past a given point caused by a difference in pressure from one place to another. Wind poses a threat to Maryland in many forms, including that produced by severe thunderstorms and tropical weather systems. The effects can include blowing debris, interruptions in elevated power and communications utilities and intensified effects of winter weather. Harm to people and animals as well as damage to property and infrastructure may be the result.

Two basic types of damaging wind events other than tropical systems affect Maryland: synoptic-scale winds and thunderstorm winds. Synoptic-scale winds are high winds that occur typically with cold frontal passages or Nor'easters. When thunderstorm winds exceed 58 mph, the thunderstorm is considered severe and a warning is issued. "Downbursts" cause the high winds in a thunderstorm. Downburst winds result from the sudden descent of cool or cold air toward the ground. As the air hits the ground, it spreads outward, creating high winds. Unlike tornadoes, downburst winds move in a straight line, without rotation. The term "microburst" refers to a small downburst with damaging winds up to 168 mph and less than 2.5 miles in length. The term "macroburst" refers to a large downburst that can extend greater than 2.5 miles with winds up to 134 mph and can last 5 to 30 minutes.

3.7.2 Historical Occurrences

Between 1956 and 2010, there were 4,107 wind events recorded in the NCDC database for Maryland, an average of 76.1 events per year. Table 3- shows significant wind events in Maryland from 1984 through 2009.

Table 3-60. Historical Significant Wind Events, 1984-2009.

Date	Event	Comments
May 8, 1984	Thunderstorm Winds	Strong thunderstorm winds in Baltimore City injured 18 people.
October 1, 1986	Thunderstorm Winds	One person was killed and one injured during strong thunderstorm winds in Baltimore County.
March 17, 1990	Thunderstorm Winds	Severe thunderstorm winds caused two fatalities and one injury in Anne Arundel county.
November 1, 1994	Thunderstorm Winds	A microburst felled hundreds of trees in Carroll County, causing substantial damage. A large tree crushed a home in the Tannery Road area. A swath of trees was blown down in a band 50 to 75 feet wide. In Anne Arundel County, a microburst surged through Riviera Beach, causing extensive damage to a 30-block area in the town. A total of 12 homes were damaged, and one home was nearly destroyed when a 5 foot diameter oak tree fell. The microburst caused more than $100,000 in damage to a private airfield in northwest Calvert Co. One hangar was destroyed, and the roof of another hangar was thrown 1,000 feet, destroying an antique single-engine piper cub. There was $500,000 in total property damages as well as $50,000 in crop damages.

Date	Event	Comments
March 19, 1996	Strong Winds	Deep low pressure moving up the Ohio Valley produced gusty east winds which blew down trees and limbs, some onto power lines. Undoubtedly, moist ground contributed to the damage. Most of the damage occurred in Baltimore City, where larger buildings likely induced localized severe (greater than 58 mph) gusts. One of these gusts blew down a plywood walkway in downtown Baltimore, injuring 6 persons. Baltimore Gas and Electric (BG&E) reported over 22,000 customers were without power at the height of the storm. $75,000 in property damages was reported.
June 18, 1997	Thunderstorm Winds	A wet microburst, associated with a heavy-precipitation supercell moving out of northern Virginia, produced a 13-mile swath of scattered tree and power line damage across extreme southern Montgomery Co. Sustained wind speeds averaged 55 MPH. One person was killed by a tree falling on their vehicle, and property damages of $300,000 occurred, mainly from trees falling on buildings.
June 15, 2000	Thunderstorm Winds	A boater drowned on the Potomac River after his craft was overturned by high winds and waves. A line of thunderstorms which produced winds in excess of 55 MPH, large hail, heavy rain, and frequent lighting moved across Charles County during the afternoon, causing $5,000 in property damages.
August 24, 2003	Thunderstorm Winds	A line of thunderstorms with winds up to 78 MPH, hail, and frequent lightning moved from northwest to southeast across Maryland during the afternoon and evening of the 26th. Numerous trees and power lines were downed. Damages reached $500,000 in Prince George's County.
November 13, 2003	Strong Winds	There was one fatality and $70,000 in damages after strong winds moved through the area in Prince George's County.
September 18, 2004	Thunderstorm Winds	Severe thunderstorms caused wind damage in Charlestown and Colora in Cecil County. Two people were killed in Colora after a large tree fell onto the house they were sleeping in. About six large trees were uprooted in Colora. Two other homes were damaged by fallen trees.
July 31, 2009	Thunderstorm Winds	A severe thunderstorm knocked down numerous trees in Perryville (Cecil Co.) as well as overturning five storage trailers and two vehicles. One vehicle was pushed into a ditch on Ikea Way off of U.S. Route 7 and resulted in two injuries. Total property damages reached $250,000.

3.7.3 Risk Assessment

Wind risk was assessed using historical data acquired from the NCDC's U.S. Storm Events Database. Event data ranges from May 30, 1956 through November 17, 2010. Specific event types queried from the database are listed in Table 3-.

Table 3-61. Events queried from NCDC U.S. Storm Events Database.

Event Type	
Wind	Thunderstorm Wind
Dry Microburst	Thunderstorm Winds
Gusty Wind	Thunderstorm Winds/Hail
Gusty Wind/Heavy Rain	Thunderstorm Winds/Heavy Rain
Gusty Wind/Rain	TSTM Wind
Gusty Winds	TSTM Wind/Hail

Event Type	
High Wind	Wet Microburst
High Wind and Seas	Wind
High Winds	Winds
Strong Wind	Thunderstorm winds
Strong Winds	

Probability of Future Occurrence. Since strong winds occur during a variety of meteorological events such as thunderstorms, it is difficult to determine the probability of future occurrences with any degree of accuracy. Historically, wind events have occurred throughout the state as shown in Figure 3-31, with central Maryland experiencing the greatest number of events. Table 3- provides the annualized number of wind events by county based on the NCDC historical record. Based on this, it is reasonable to assume that Maryland will continue to experience strong winds, especially in the Chesapeake Bay region. Table 3-3 and Table 3-4 (section 3.3.2) show total and annualized events for each county by hazard type for comparison.

Table 3-62. NCDC total and annualized high wind events (1956-2010).

County/City	Total Events	Annualized Events
Allegany County	144	2.62
Anne Arundel County	290	5.27
Baltimore County	267	4.85
Calvert County	132	2.40
Caroline County	144	2.62
Carroll County	196	3.56
Cecil County	198	3.60
Charles County	199	3.62
Dorchester County	69	1.25
Frederick County	275	5.00
Garrett County	96	1.75
Harford County	163	2.96
Howard County	135	2.45
Kent County	180	3.27
Montgomery County	331	6.02
Prince George's County	284	5.16
Queen Anne's County	174	3.16
St. Mary's County	149	2.71
Somerset County	46	0.84
Talbot County	160	2.91
Washington County	189	3.44
Wicomico County	93	1.69
Worcester County	72	1.31
City of Baltimore	121	2.20
Grand Total*	**3,462**	**62.95**

** Grand total values are not a direct sum of each of the county/city totals. The grand total events do not include zonal events as described in Section 3.3 and Section 3.5.*

Figure 3-31. Historic wind events, Maryland and adjacent States.

Impact and Vulnerability. Generally, each area in Maryland is vulnerable to severe winds, especially those in central Maryland and the Chesapeake Bay region. Since 1950, Maryland has suffered 211 injuries and eight deaths as a result of wind related accidents as shown in Table 3-. Critical facilities, legacy structures and infrastructure in central and coastal Maryland may be vulnerable to strong winds. In particular, structures that were built before building codes and use of construction design wind speeds and corresponding zones shown in Figure 3-32 may be vulnerable to wind damage. Worcester and Somerset Counties are located within the 111-120 mph wind zone and structures in these counties are potentially at greater risk, particularly from hurricane events.

State and critical facilities within high risk areas as described above may be impacted by high winds due to power outages and/or communication failure. In some instances, communications systems utilize backup generators to ensure continuation of services for first responders. These backup generators not only ensure the continued safety of the public during an event, but also the safety of emergency response personnel.

Table 3-63. Wind related injuries and deaths per county, 1956-2010.

Jurisdiction	Total Injuries	Total Deaths
Allegany County	5	0
Anne Arundel County	27	2
Baltimore County	26	1
Calvert County	5	0
Caroline County	0	0
Carroll County	23	0
Cecil County	7	2
Charles County	4	1
Dorchester County	2	0
Frederick County	13	0
Garrett County	0	0
Harford County	10	0
Howard County	15	0
Kent County	2	0
Montgomery County	8	1
Prince George's County	9	1
Queen Anne's County	1	0
St. Mary's County	12	0
Somerset County	4	0
Talbot County	0	0
Washington County	8	0
Wicomico County	0	0
Worcester County	0	0
City of Baltimore	30	0
Grand Total*	**122**	**8**

**Grand total values are not a direct sum of each of the county/city totals. The grand total events do not include zonal events as described in Section 3.3 and Section 3.5.*

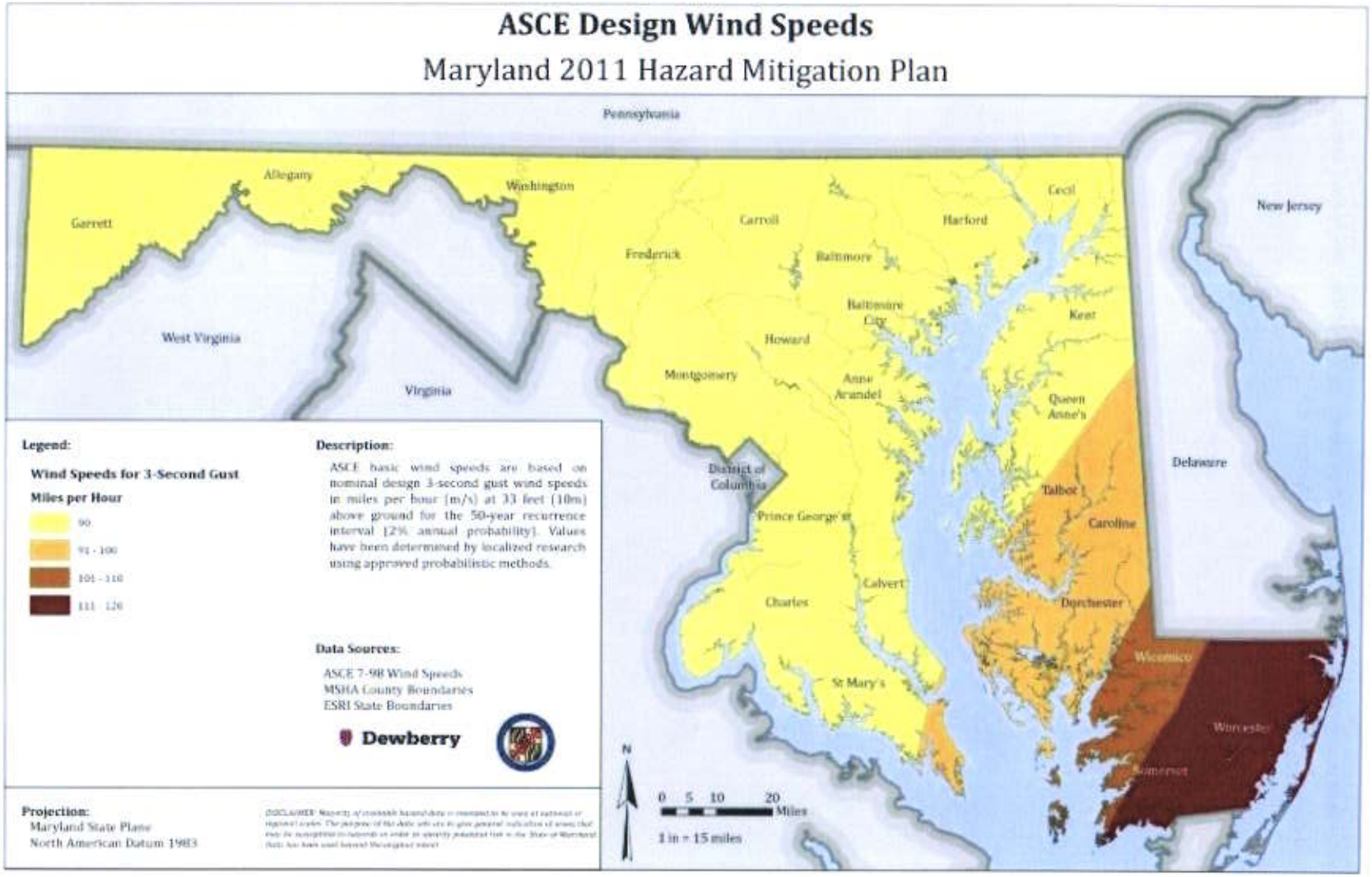

Figure 3-32. ASCE Design Wind Speed Zones.

Risk. Central Maryland is at greater risk for a wind event than the rest of the state, with Frederick, Montgomery, Prince George's, Anne Arundel, and Baltimore Counties all at high risk of wind events. Each of these counties has experienced more than 200 events, with average damages per event ranging from $13,195 to $33,070. Since 1956, Maryland has suffered more than $47 million in damages statewide as shown in Table 3-. These estimates are believed to be an underrepresentation of the actual losses experienced due to hazards as losses from events that go unreported or that are difficult to quantify are not likely to appear in the NCDC database; this is especially true with crop damages.

State and Critical Facility Risk. State and critical facilities in the Chesapeake Bay region and central Maryland are at greatest risk to severe winds compared to other regions in the state. Critical facilities in Cecil, Frederick, Howard, Montgomery, Prince George's, and St. Mary's Counties are at greatest risk as shown in Table 3-. Regarding state owned facilities, more than 1,900 buildings are in these six counties with a total value of more than $6 billion. State facility exposure is shown in Table 3-66.

Jurisdictional Risk. Based on the available data, Cecil, Frederick, Howard, Montgomery, Prince George's, and St. Mary's Counties have a high wind ranking as shown in Figure 3-33. This ranking was accomplished using the methodology described in the Hazard Analysis and Ranking Methodology section of this Chapter.

Local Plan Risk Assessment. Thirteen local plans addressed and ranked wind in their hazard mitigation plans as a separate hazard; several local plans addressed wind within the hurricane or coastal hazard categories. Four plans ranked wind as a high hazard, three as medium-high, four as medium and two as low.

Local hazard rankings were used as a parameter in the statewide hazard ranking (Section 3.5). Section 3.6 outlines the assumptions that were made in an effort to compare the local hazard rankings to each other.

Table 3-64. Wind crop and property damages per county, 1956-2010.

City/County	Property Damage (Total)	Property Damage (Annualized)	Crop Damage (Total)	Crop Damage (Annualized)	Total Damage	Total Damage (Annualized)
Allegany County	$1,830,233	$33,277	$59,246	$1,077	$1,889,479	$34,354
Anne Arundel County	$6,186,690	$112,485	$27,652	$503	$6,214,342	$112,988
Baltimore County	$3,943,846	$71,706	$27,652	$503	$3,971,498	$72,209
Calvert County	$3,736,844	$67,943	$22,699	$413	$3,759,543	$68,356
Caroline County	$620,620	$11,284	$0	$0	$620,620	$11,284
Carroll County	$4,069,494	$73,991	$156,844	$2,852	$4,226,338	$76,843
Cecil County	$2,426,514	$44,118	$0	$0	$2,426,514	$44,118
Charles County	$1,358,075	$24,692	$22,699	$413	$1,380,774	$25,105
Dorchester County	$1,666,207	$30,295	$0	$0	$1,666,207	$30,295
Frederick County	$3,468,485	$63,063	$160,250	$2,914	$3,628,735	$65,977
Garrett County	$1,298,518	$23,609	$0	$0	$1,298,518	$23,609
Harford County	$2,620,671	$47,649	$22,699	$413	$2,643,370	$48,062
Howard County	$1,804,354	$32,806	$84,775	$1,541	$1,889,129	$34,347
Kent County	$452,892	$8,234	$0	$0	$452,892	$8,234
Montgomery County	$10,843,175	$197,149	$102,904	$1,871	$10,946,079	$199,020
Prince George's County	$6,085,717	$110,649	$27,652	$503	$6,113,369	$111,152
Queen Anne's County	$400,062	$7,274	$0	$0	$400,062	$7,274
St. Mary's County	$3,527,291	$64,133	$29,509	$537	$3,556,800	$64,670
Somerset County	$1,510,750	$27,468	$0	$0	$1,510,750	$27,468
Talbot County	$364,172	$6,621	$0	$0	$364,172	$6,621
Washington County	$4,571,870	$83,125	$100,369	$1,825	$4,672,239	$84,950
Wicomico County	$1,415,988	$25,745	$0	$0	$1,415,988	$25,745
Worcester County	$4,432,246	$80,586	$0	$0	$4,432,246	$80,586
City of Baltimore	$858,078	$15,601	$1	$0	$858,079	$15,601
Grand Total	**$47,362,158**	**$861,130**	**$306,871**	**$5,579**	**$47,669,029**	**$866,710**

** Grand total values are not a direct sum of each of the county/city totals. The grand total events do not include zonal events as described in Section 3.3 and Section 3.5.*

Table 3-65. Critical facility exposure in counties with high wind risk.

County/City	Police	Fire	Health	Educational	Total Number of Facilities in High Risk	Building Values in High Risk	Content Values in High Risk	Building and Content Values in High Risk
Cecil County	11	25	17	43	1,362	$232,967,350	$77,655,783	$310,623,133
Frederick County	7	40	62	96	2,053	$485,188,070	$161,729,357	$646,917,427
Howard County	0	12	46	109	2,208	$638,376,030	$212,792,010	$851,168,040
Montgomery County	19	40	49	367	6,992	$2,073,052,250	$691,017,417	$2,764,069,667
Prince George's County	31	58	19	355	7,381	$879,779,930	$293,259,977	$1,173,039,907
St. Mary's County	3	10	7	35	888	$232,384,510	$77,461,503	$309,846,013
Grand Total	**71**	**185**	**200**	**1005**	**20,884**	**$4,541,748,140.00**	**$1,513,916,047.00**	**$6,055,664,187.00**

Table 3-66. State facility exposure in counties with high wind risk.

County/City	Total Number of Facilities in High Risk	Building Values in High Risk	Content Values in High Risk	Building and Content Values in High Risk
Cecil County	287	$157,635,773	$14,474,647	$172,110,420
Frederick County	189	$208,358,501	$21,796,983	$230,155,484
Howard County	363	$552,692,301	$37,566,215	$590,258,515
Montgomery County	181	$261,145,098	$43,887,878	$305,032,976
Prince George's County	587	$3,811,680,828	$414,325,380	$4,226,006,209
St. Mary's County	317	$519,518,796	$113,996,273	$633,515,069
Grand Total	**1924**	**$5,511,031,297.00**	**$646,047,376.00**	**$6,157,078,673.00**

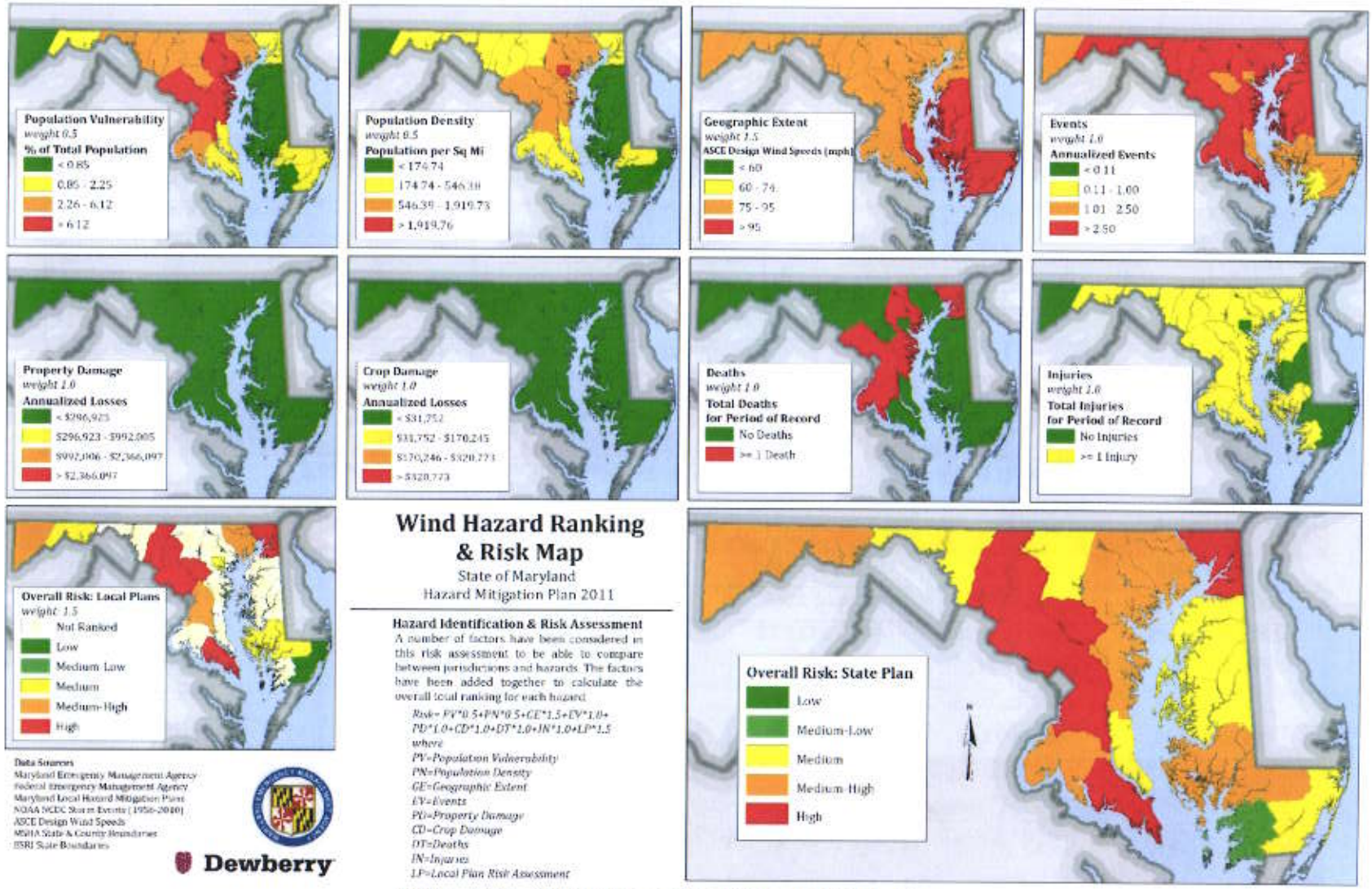

Figure 3-33. Wind Hazard Ranking and Risk Map.

3.8 Thunderstorms (Lightning and Hail)

3.8.1 Description

Thunderstorms are formed when the right atmospheric conditions combine to provide moisture, lift, and warm unstable air that can rise rapidly. Thunderstorms occur any time of the day and in all months of the year, but are most common during summer afternoons and evenings and in conjunction with frontal boundaries. Maryland sees approximately 20-40 thunderstorm days per year. The National Weather Service classifies a thunderstorm as severe if it produces hail at least one inch in diameter, winds of 58 mph or greater, or a tornado. About 10 percent of the estimated 100,000 annual thunderstorms that occur nationwide are considered severe.[34] Thunderstorms affect a smaller area compared with winter storms or hurricanes, but they can be dangerous and destructive for a number of reasons. Storms can form in less than 30 minutes, giving very little warning; they have the potential to produce lightning, hail, tornadoes, powerful straight-line winds, and heavy rains that produce flash flooding. The focus of this section will be on lightning and hail, as thunderstorm winds, flooding, and tornadoes hazards are included in other Chapter 3 sections.

All thunderstorms produce lightning, and therefore all thunderstorms are dangerous. Lightning often strikes outside of areas where it is raining, and may occur as far as 10 miles away from rainfall. It can strike from any part of the storm, and may even strike after the storm has seemed to pass. Hundreds of people across the nation are injured annually by lightning, most commonly when they are moving to a safe place but have waited too long to seek shelter. Lightning strike victims often suffer long-term effects such as memory loss, sleep disorders, weakness and fatigue, chronic pain, depression and muscle spasms. Lightning has the potential to start both house fires and wildfires, although in Maryland it was estimated that lightning was the cause of only 2 percent of wildfires between 2000 and 2006.[35] Lightning causes an average of 55-60 fatalities, 400 injuries, and over $1 billion in insured losses annually nationwide.

Hail is formed in towering cumulonimbus clouds (thunderheads) when strong updrafts carry water droplets to a height at which they freeze. Eventually, these ice particles become too heavy for the updraft to hold up, and they fall to the ground at speeds of up to 120 mph. Hail falls along paths called swaths, which can vary from a few square acres to up to 10 miles wide and 100 miles long.[36] Hail larger than ¾ inch in diameter can do great damage to both property and crops, and some storms produce hail over 2 inches in diameter. Hail causes about $1 billion in damages annually in the U.S.

3.8.2 Historical Occurrence

Maryland is not known for experiencing the same frequency of severe thunderstorms as the Midwest and Southeast, but the state has observed a number of very destructive hail and lightning events over the years. The NCDC has recorded 1,216 significant (those causing injury, fatalities, and/or damage) lightning and hail events throughout Maryland between 1956 and 2010; and these events have caused more than $34 million in total damages. Some of the most significant hail and lightning events in the state's history are listed in 3-67.

According to the NOAA, lightning has struck and killed 13 people and injured 73 people in Maryland between 1956 and 2010. The deadliest lightning-related disaster occurred in 1963, when lightning struck a passenger plane over Cecil County and caused it to crash, killing all 81 passengers. This crash still represents one of the worst lightning strike death tolls in the world.

[34] National Oceanic and Atmospheric Administration, http://www.nws.noaa.gov/om/severeweather/resources/ttl6-10.pdf.
[35] Maryland Department of Natural Resources, http://www.dnr.state.md.us/forests/fire/index.asp.
[36] University Corporation for Atmospheric Research, http://www.ucar.edu/communications/factsheets/Hail.html.

Hail with a diameter of over 4.5 inches (softball-sized) has been recorded several times; hail events have caused significant damages to vehicles, roofing, siding, windows, and crops. Between 1956 and 2010, hailstorms in Maryland have caused more than $34 million in total damages. Hail rarely injures or kills people. Hail events from 1955 through 2010 are shown in Figure 3-34.

Table 3-67. Previous Significant Lightning and Hail Events.

Date	Event	Comments
July 14, 1900	Lightning	Kent, Dorchester, Wicomico, and Somerset counties suffered great damage when a series of wind and electrical storms moved through the area. Numerous livestock were killed by lightning, a store was set on fire, and a sailor was killed when his vessel was struck. The lightning hit a house, where it knocked two people inside unconscious, paralyzed a small boy, and killed a pet dog.
December 8, 1963	Lightning	A Boeing 707 passenger plane crashed near Elkton (Cecil County) after being hit by lightning. All 81 people on board were killed. This crash represents one of the worst lightning strike death tolls in the world.
June 18, 1970	Hail	Hail with an average diameter of 4.5 inches was reported in Baltimore City.
August 2, 1993	Lightning	Lightning struck a house in Crofton (Anne Arundel Co.) causing a fire. Damage was estimated at $235,000. Lightning also caused scattered power outages throughout the county. The storm caused total property damages of $500,000.
May 25, 1994	Lightning	Lightning struck and set ablaze four homes in the Potomac-Rockville area in Montgomery County, causing nearly $600,000 in damage.
July 30, 1999	Hail	A thunderstorm moved south through Baltimore County, producing wind gusts in excess of 55 MPH, heavy downpours, and grapefruit sized hail with an average diameter of 4.0 inches. As the storm moved into the southern half of the county it produced golf ball sized hail at Cockeysville and in the city of Baltimore.
August 7, 2000	Lightning	Scattered thunderstorms moved across central Maryland during the afternoon and early evening hours of the 7th. These storms produced winds in excess of 55 MPH, frequent lightning, and hail. Lightning started a fire in the attic of an apartment complex in Frederick County. Damages amounted to $750,000.
April 28, 2002	Hail	A massive tornadic storm tore through Central Charles and Calvert Counties between 7 and 8 PM EDT on the 28th. Golf ball to CD sized hail was observed, reaching a diameter of 4.5 inches. The tornadoes it produced left a 64 mile path of destruction ranging from F1 to F4 damage.

Date	Event	Comments
June 1, 2006	Lightning	Newspaper reports indicated that at least 3 house fires occurred due to intense lightning associated with the strong to severe thunderstorms which moved through the county. The house fires occurred in the northwest portion of Montgomery County, causing $500,000 in damages.
May 14, 2010	Hail	Hail up to the size of golf balls, with an average diameter of 1.75 inches, was reported near Waldorf in Charles County. Hundreds of cars around the Waldorf area were significantly damaged due to the large hail, including broken wind shields and dented bodies. There were also reports of damage to hundreds of homes, with total property damages reaching $750,000.

Sources: *Storms in Maryland*, NY Times Archive, http://query.nytimes.com/mem/archive-free/pdf (July 1900).

3.8.3 Risk Assessment

Hail and lightning risks were evaluated by examining historical records found in the NCDC database and other sources, followed by applying the hazard ranking methodology described in the Hazard Assessment and Ranking Methodology section of this chapter.

Probability of Future Occurrence. Significant thunderstorms are very difficult to predict, but based on past NCDC records of thunderstorm occurrence, a reasonable determination of the probability of future significant hail or lightning events can be made. Table 3-68 shows the annualized number of thunderstorm events by county based on the NCDC historical record. NCDC data shows that for any county, approximately 0 to 3 significant thunderstorm (lightning and hail) events that cause injury, fatalities, and/or damage will occur each year. Montgomery County has the highest incidence rate for such thunderstorm events, with about 2.67 events occurring annually, or roughly one event every 4.5 months. Anne Arundel, Baltimore, and Prince George's counties have the next highest event rates in the state, with an average of 1.65 hail or lightning incidents occurring annually. Table 3-3 and Table 3-4 (section 3.3.2) show total and annualized events for each county by hazard type for comparison.

Impact and Vulnerability. It is impossible to predict with certainty where lightning or hail will strike, and all counties in Maryland can be considered susceptible to these dangers.

Building construction, location, and nearby trees or other tall structures will have a large impact on how vulnerable an individual facility is to a lightning strike. A rough estimate of a structure's likelihood of being struck by lightning can be calculated using the structure's ground surface area, height, and striking distance between the downward-moving tip of the stepped leader (negatively charged channel jumping from cloud to earth) and the object.[37] In general, buildings are more likely to be struck by lightning if they are located on high ground or if they have tall protrusions such as steeples or poles which the stepped leader can jump to. Electrical and communications utilities are also vulnerable to direct lightning strikes. Damage to these lines has the potential to cause power and communications outages for businesses, residencies, and critical facilities. Continuity of Operation Plans ensure that state and critical facilities are able to continue to provide services during a hail or lightning event.

[37] Hasbrouck, P.E. *Determining the Probability of Lightning Striking a Facility*, National Lightning Safety Institute, http://lightningsafety.com/nlsi_lhm/prbshort.html (April 2004).

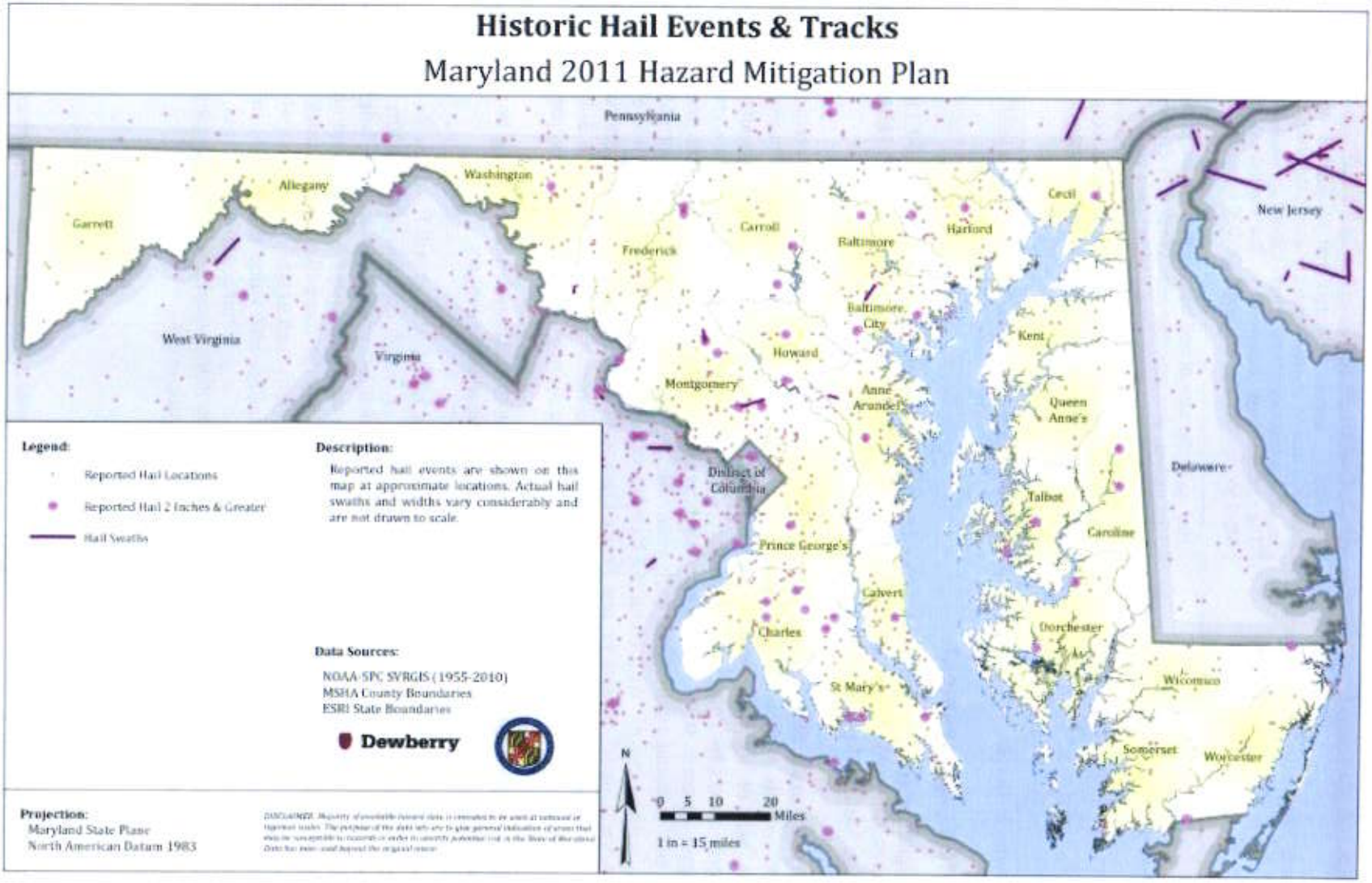

Figure 3-34. Historic Hail Events and Tracks.

Table 3-68. NCDC total and annualized thunderstorm (lightning & hail) events (1956-2010).

County/City	Total Events	Annualized Events
Allegany County	28	0.51
Anne Arundel County	95	1.73
Baltimore County	91	1.65
Calvert County	43	0.78
Caroline County	17	0.31
Carroll County	59	1.07
Cecil County	30	0.55
Charles County	77	1.40
Dorchester County	25	0.45
Frederick County	74	1.35
Garrett County	33	0.60
Harford County	69	1.25
Howard County	35	0.64
Kent County	26	0.47
Montgomery County	147	2.67
Prince George's County	87	1.58
Queen Anne's County	13	0.24
St. Mary's County	62	1.13
Somerset County	19	0.35
Talbot County	29	0.53
Washington County	72	1.31
Wicomico County	29	0.53
Worcester County	28	0.51
City of Baltimore	19	0.35
Grand Total*	**1,216**	**22.11**

** Grand total values are not a direct sum of each of the county/city totals. The grand total events do not include zonal events as described in Section 3.3 and Section 3.5.*

Structure vulnerability to hail is determined mainly by construction and exposure. Metal siding and roofing is better able to stand up to the damages of a hailstorm than many other materials, although it may also be damaged by denting. Exposed windows and vehicles are also susceptible to damage. Crops are extremely susceptible to hailstorm damage, as even the smallest hail stones can rip apart unsheltered vegetation.

Human vulnerability is largely determined by the availability and reception of early warnings for the approach of severe storms, and by the availability of nearby shelter. Individuals who immediately seek shelter in a sturdy building or metal-roofed vehicle are much safer than those who remain outdoors. Early warnings of severe storms are also vital for aircraft flying through the area. Table. 3- gives a breakdown of injuries and deaths attributed to thunderstorms in Maryland between 1956 and 2010. Anne Arundel County tops the list with 15 injuries and 2 fatalities (both due to lightning).

Table. 3-69. Thunderstorm Injuries and Deaths 1956-2010.

County/City	Total Injuries	Total Deaths
Allegany County	1	0
Anne Arundel County	15	2
Baltimore County	3	1
Calvert County	1	1
Caroline County	1	0
Carroll County	12	0
Cecil County	2	0
Charles County	0	1
Dorchester County	0	0
Frederick County	5	2
Garrett County	4	0
Harford County	2	1
Howard County	0	0
Kent County	8	0
Montgomery County	4	1
Prince George's County	5	1
Queen Anne's County	0	0
St. Mary's County	0	0
Somerset County	0	0
Talbot County	6	0
Washington County	1	0
Wicomico County	1	1
Worcester County	1	0
City of Baltimore	1	2
Grand Total	**73**	**13**

** Grand total values are not a direct sum of each of the county/city totals. The grand total events do not include zonal events as described in Section 3.3 and Section 3.5.*

Risk. As seen in Table 3-, which gives crop and property damages between 1956 and 2010, lightning and hail events can be very costly. Total damages range from $3,054 in Somerset County to $16.4 million in Montgomery County. Montgomery County has the highest annualized losses at $297,294, with Anne Arundel County following with an average of $63,454 in annual damages. These estimates are believed to be an underrepresentation of the actual losses experienced due to hazards as losses from events that go unreported or that are difficult to quantify are not likely to appear in the NCDC database; this is especially true with crop damages.

State and Critical Facility Risk. The location and construction of a facility plays a role in how it will be affected by lightning and hail incidents. If a structure is located on a hilltop, is tall or has other tall structures around it, or has large exposed windows, it may be damaged during a storm. Communications and power supplies may be compromised during thunderstorms, and some critical facilities might not be equipped with a backup power source.

Table 3-70. Thunderstorm Crop and Property Damage 1956-2010.

County/City	Property Damage (Total)	Property Damage (Annualized)	Crop Damage (Total)	Crop Damage (Annualized)	Total Damage	Total Damage (Annualized)
Allegany County	$94,648	$1,721	$13,620	$248	$108,268	$1,969
Anne Arundel County	$3,489,954	$63,454	$0	$0	$3,489,954	$63,454
Baltimore County	$1,598,821	$29,069	$13,620	$248	$1,612,441	$29,317
Calvert County	$335,213	$6,095	$75	$1	$335,288	$6,096
Caroline County	$144,909	$2,635	$0	$0	$144,909	$2,635
Carroll County	$868,222	$15,786	$21,178	$385	$889,400	$16,171
Cecil County	$401,659	$7,303	$0	$0	$401,659	$7,303
Charles County	$876,177	$15,930	$76,817	$1,397	$952,994	$17,327
Dorchester County	$103,111	$1,875	$0	$0	$103,111	$1,875
Frederick County	$2,477,310	$45,042	$18,048	$328	$2,495,358	$45,370
Garrett County	$8,489	$154	$0	$0	$8,489	$154
Harford County	$1,061,573	$19,301	$644,599	$11,720	$1,706,172	$31,021
Howard County	$1,174,703	$21,358	$749	$14	$1,175,452	$21,372
Kent County	$26,090	$474	$6,268	$114	$32,358	$588
Montgomery County	$16,330,792	$296,923	$20,429	$371	$16,351,221	$297,294
Prince George's County	$942,740	$17,141	$0	$0	$942,740	$17,141
Queen Anne's County	$72,391	$1,316	$0	$0	$72,391	$1,316
St. Mary's County	$795,631	$14,466	$0	$0	$795,631	$14,466
Somerset County	$3,054	$56	$0	$0	$3,054	$56
Talbot County	$2,357,405	$42,862	$0	$0	$2,357,405	$42,862
Washington County	$206,136	$3,748	$6,488	$118	$212,624	$3,866
Wicomico County	$39,775	$723	$0	$0	$39,775	$723
Worcester County	$3,104	$56	$0	$0	$3,104	$56
City of Baltimore	$49,257	$896	$0	$0	$49,257	$896
Grand Total	**$33,461,165**	**$608,385**	**$821,890**	**$14,943**	**$34,283,055**	**$623,328**

** Grand total values are not a direct sum of each of the county/city totals. The grand total events do not include zonal events as described in Section 3.3 and Section 3.5.*

Table 3- shows the numbers and estimated values of critical and state facilities in the six jurisdictions that were determined to have a medium-high risk of thunderstorm events. No jurisdictions were determined to have a high risk. There are approximately 32,216 critical facilities valued at a total of $8.7 billion and 2,464 state facilities (non-critical) valued at a total of $10.8 billion within these jurisdictions.

Table 3-71. State and Critical Facilities within Medium-High Thunderstorm Ranking Areas.

County/City	Total Number of Critical Facilities	Critical Facilities Building and Contents Values	Total Number of State Facilities	State Facilities Building and Contents Values
Anne Arundel County	5,033	$1,468,465,960	605	$3,458,410,555
Baltimore County	8,415	$1,873,803,613	695	$2,450,029,306
Frederick County	2,053	$646,917,427	189	$230,155,484
Harford County	2,342	$739,153,507	207	$115,126,325
Montgomery County	6,992	$2,764,069,667	181	$305,032,976
Prince George's County	7,381	$1,173,039,907	587	$4,226,006,209
Grand Total	**32,216**	**$8,665,450,081**	**2,464**	**$10,784,760,855**

Jurisdictional Risk. A medium-high thunderstorm ranking has been determined for the counties of Anne Arundel, Baltimore, Frederick, Harford, Montgomery, and Prince George's based on the methodology described in Section 3.5 Hazard Assessment and Ranking Methodology. No Maryland jurisdiction was determined to have an overall high thunderstorm ranking. Figure 3-35 graphically demonstrates how each jurisdiction was ranked on various hazard factors, and how the final overall thunderstorm risk for each jurisdiction was determined.

Local Plan Risk Assessment. The majority of the local plans addressed and ranked thunderstorm, or hail and lightning, in their hazard mitigation plans. Ten local plans ranked hail as a separate hazard, nine included lightning, and 23 included thunderstorms. Six of the local plans considered thunderstorm as a high hazard, seven as medium-high, eight as medium, one as medium low, and one as low. Section 3.6 includes a summary of how each of the local plans ranked thunderstorm, hail and lightning and outlines the assumptions that were made in an effort to compare the local hazard rankings to each other.

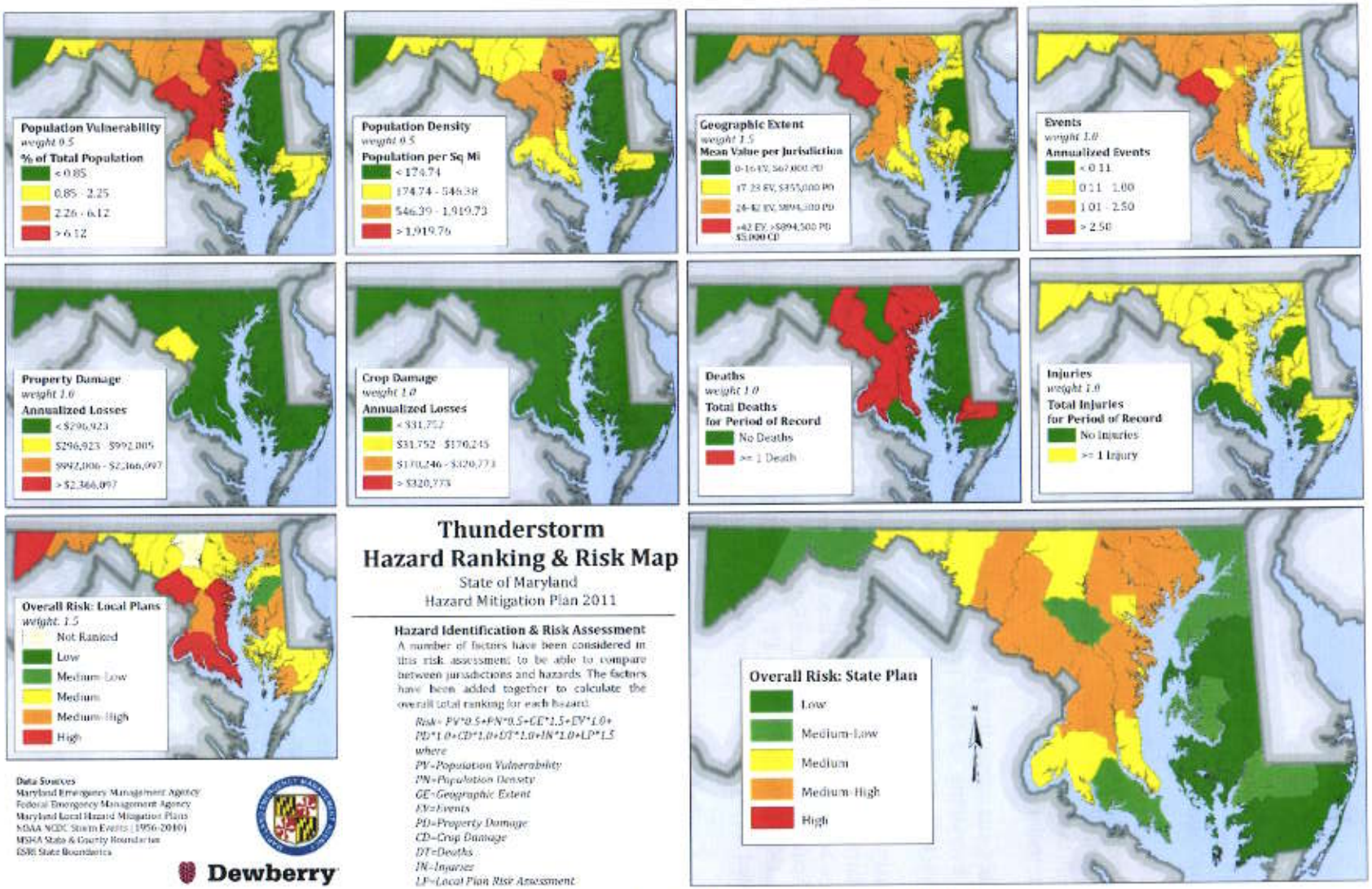

Figure 3-35. Thunderstorm Hazard Ranking and Risk.

3.9 Tornadoes

3.9.1 Description

A tornado is a violently rotating funnel-shaped column of air that extends from a thunderstorm cloud toward the ground. Tornadoes can touch the ground with winds of over 300 mph. While relatively short-lived, tornadoes are intensely focused and are one of nature's most violent storms.

Tornadoes usually form from one of three types of thunderstorms: 1) squall-lines; 2) multicells; and 3) supercells. Supercell thunderstorms are rotating storms containing what is known as a mesocyclone, or a rotating updraft (column of air) from which tornadoes sometimes form. Supercell thunderstorms have a greater potential than other thunderstorms for producing severe weather, including tornadoes.

Tornadoes can range from just several yards to over two miles in width. Tornadoes can destroy almost everything in their path. Although tornadoes normally travel on the ground for short distances, tornado tracks of 200 miles or more have been reported.

Previously, tornado damage was measured on the Fujita Scale, also called the F-Scale, named for Dr. Tetsuya Theodore Fujita. The operational Fujita scale ranges from an F0 to an F5. The strongest tornadoes observed to date have been F5 (winds between 261-318 mph). An Enhanced Fujita Scale (EF Scale) was developed and implemented operationally by the National Weather Service (NWS) in 2007. The EF Scale was developed to better align tornado wind speeds with associated damages. Table 3- provides a side-by-side comparison of the F Scale and the EF Scale.

Table 3-72. Fujita Scale Vs. Enhanced Fujita Damage Scale.

Fujita Scale			Enhanced Fujita Scale	
F Number	Fastest 1/4-mile (mph)	3 Second Gust (mph)	EF Number	3 Second Gust (mph)
0	40-72	45-78	0	65-85
1	73-112	79-117	1	86-110
2	113-157	118-161	2	111-135
3	158-207	162-209	3	136-165
4	208-260	210-261	4	166-200
5	261-318	262-317	5	Over 200

The Storm Prediction Center issues tornado and severe thunderstorm watches. A tornado watch defines an area shaped like a parallelogram, where tornadoes and other kinds of severe weather are possible in the next several hours. A tornado watch does not indicate an imminent tornado; rather, a tornado watch is an advisory for citizens to be alert and prepared to go to safe shelter if tornadoes do develop or if a tornado warning is issued.

Local NWS offices are responsible for issuing tornado warnings. Tornado warnings indicate that a tornado has been spotted, or that Doppler radar detects a thunderstorm circulation capable of spawning a tornado.

Nationally, the tornado season lasts from March to August, with peak tornado activity normally occurring in April, May, and June. The highest concentrations of tornadoes have been in the Central U.S. and portions of the Gulf Coast states.

3.9.2 Historical Occurrence

There are numerous instances of damaging and in some cases deadly tornadoes having impacted Maryland. Of particular note, an F4 tornado struck La Plata in Charles County on Sunday, April 28, 2002, resulting in the most injuries and greatest reported damages of any tornado in Maryland history. The storm crossed the Potomac River into Maryland near the mouth of Mattawoman Creek, south of Indian Head, as an F1 tornado. The tornado gained strength as it traveled east across Charles County, reaching F4 status by the time it passed directly through the center of La Plata (Figure 3-36). The tornado continued to track to the southeast, across the Patuxent River and into Calvert County, and then across the Chesapeake Bay into Dorchester County. The tornado was responsible for three deaths, 122 injuries, and more than $115 million in damages. The tornado occurred on a Sunday afternoon, when fewer people were away from their homes; otherwise, the human toll could have been much greater.

On September 24, 2001, an F3 tornado touched down near Hyattsville and traveled to College Park, where it killed two University of Maryland students. The tornado then followed the Route 1 corridor toward Laurel and crossed into Howard County, finally dissipating outside of Columbia. Fifty-five people were injured, and property damage was estimated at $100 million.

A tornado that impacted Frostburg in Allegany County in 1998 was the first F4 recorded in Maryland after the F-Scale was implemented. Five injuries and estimated damages of $5 million were reported.

The deadliest tornado to impact Maryland touched down on November 9, 1926 at 2:30 pm about five miles southwest of La Plata. Traveling 18 miles in 20 to 25 minutes, the tornado moved northeast through La Plata and continued on the ground to Cedarville in Prince George's County. A schoolhouse containing 60 children and two teachers was lifted from its foundation and thrown against a grove of trees 50 feet away. Some of the wreckage of the schoolhouse was found deposited 25 miles away near Upper Marlboro. Seventeen people were known to have died, including 14 of the children who had been in the schoolhouse. Table 3- lists some of the more significant tornado events that have impacted Maryland over the years. Figure 3-37 shows tornado touchdowns and tracks in Maryland from 1950 to 2010.

Figure 3-36. Path of the 2002 La Plata Tornado as observed from above.

Table 3-73. Previous Significant Tornado Events.

Date	Comments
May 19, 1967	A tornado hit Garrett County, killing one person and causing $25,000 in damages
June 29, 1980	An F2 tornado in Harford County caused 10 injuries and $250,000 in property damages.
May 15, 1981	A tornado, rated as an F2 on the Fujita scale, hit Cecil County, causing two injuries and $2.5 million in property damages.
May 8, 1984	Multiple F1 tornados touched down in Dorchester and St. Mary's counties, causing 18 injuries, one fatality and over $2.5 million in damages.
October 18, 1990	A strong F2 tornado moved through Baltimore County, causing 59 injuries and more than $25 million in property damages.
November 1, 1994	Two devastating F1 tornadoes ripped through working-class neighborhoods in central Baltimore City, causing upwards of $3 million in damages to 150 buildings. Up to 200 families were displaced by the storms. The same squall line which produced the central Maryland storms continued to eastern Harford County, where two F0 tornadoes caused minor roof, siding, and gutter damage as well as tree damage. There was a total of $5 million in damages done.
October 5, 1995	A mesocyclone produced several tornados in Prince George's, Anne Arundel, Charles, and St. Mary's counties. The strongest tornado, containing estimated winds of 150 mph, caused substantial damage and several injuries at a Temple Hills neighborhood in Prince George's County. Three people sustained minor injuries requiring a short hospital stay; 17 others reported cuts and abrasions. The storms caused $5 million in property damages.
July 19, 1996	One of the most potent tornadoes in recorded history in the state of Maryland tracked for 2 and 1/4 miles through the Mystic Kane and Four Seasons subdivisions just off state route 32 northwest of Gamber in Carroll County. The tornado was a strong F3 (180 mph estimated winds), and caused 3 injuries, $5 million in property damages, and $20,000 in crop damages. The same supercell thunderstorm produced slightly less destructive tornadoes over much of the central part of the state, including in Washington, Frederick, Baltimore, and Montgomery counties.
June 2, 1998	The combination of an upper-level disturbance, increasing atmospheric shear, and ample instability set the stage for a major severe weather episode across the northern half of Maryland during the late afternoon and evening. A destructive F-4 tornado hit Allegany County, causing $5 million in property damages, $250,000 in crop damages, and 5 injuries. The tornado passed southeast through southern Fayette County PA, the northeast tip of Preston County WV, and into northwest Garrett County MD. The total length of the tornado as it passed across these three counties was 12 miles. Several buildings were destroyed, amounting to $1 million in damages.
September 24, 2001	A large F3 multi-vortex tornado touched down near Hyattsville in Prince George's County, tracked along the Route 1 corridor from College Park to Laurel, and then crossed into Howard County. The tornado killed two students at the University of Maryland, injured 54 others countywide, and caused $100 million in property damages. A second tornado crossed into Howard County from Laurel and remained on the ground until it dissipated about 1 mile east of Columbia. Several townhomes in North Laurel were damaged and trees were downed along the remainder of its path. The area suffered $1 million in damages.
April 28, 2002	A strong tornado (F4 on the Fujita scale) crossed the Patuxent River from Charles County and moved east through central Calvert County. It tracked between Patuxent View and Western Shore Estates before moving onto the Chesapeake Bay. Two people were killed and $10 million in property damages was caused.

Date	Comments
April 28, 2002	A massive tornadic storm tore through Central Charles and Calvert Counties between 7 and 8 PM EDT on the 28th. An F4 tornado crossed the county from just north of Rison, through La Plata, to Benedict before moving into Calvert County. The tornado caused three fatalities, 122 injuries, and $114 million in property damages. A second tornado, rated as an F2, briefly touched down at the same time just north of downtown La Plata, causing $1 million in property damages.
November 5, 2003	An F1 tornado touched down 2 miles west of downtown Poolesville in Montgomery County. The tornado destroyed a horse barn on Whites Ferry Road on the western edge of Poolesville. The storm then tracked east and produced more concentrated damage in the Rickman Horse Farm Complex. Total damages amounted to $1.2 million.
September 28, 2006	A tornado touched down in the area of Severna Park in Anne Arundel County about 6:34 pm, and caused about $6 million in damages. The National Weather Service conducted a storm survey in Severna Park and Pasadena Maryland, rating the tornado an F1 on the Fujita scale of tornado intensity.
November 17, 2010	An F1 tornado hit Baltimore City, causing three minor injuries and $200,000 in property damages. Three of the units in the Dutch Village Apartment complex had their roofs blown off. There was also extensive tree damage across the area and several cars were shifted by the force of the wind. Additional damage was centered on the Perring Parkway Shopping Center in Parkville. $50,000 in damages was done in Baltimore County.

3.9.3 Risk Assessment

Tornado risk was determined by examining historical records found in the NCDC database and other sources and then, by applying the hazard ranking methodology described in the Hazard Assessment and Ranking Methodology section (Section 3.5).

Probability of Future Occurrence. Based on historical frequency of occurrence using NCDC data, a reasonable determination of probability of future tornado events can be made. Although relatively infrequent, tornadoes have had significant impacts on Maryland in the past and are likely to impact Maryland in the future. An examination of NCDC data suggests that on an annual basis, approximately 0.07 to 0.51 tornadoes occur in any particular Maryland county. In other words, on average, an individual Maryland county is impacted by a tornado roughly every 2 to 14 years. Frederick County has had the highest number of annualized tornadoes (0.51 annually or roughly a tornado every two years), followed closely by Charles County (0.41 annually or roughly a tornado every two and a half years). Table 3-74 shows the annualized number of tornado events by county based on the NCDC historical record. Table 3-3 and Table 3-4 (section 3.3.2) show total and annualized events for each county by hazard type for comparison.

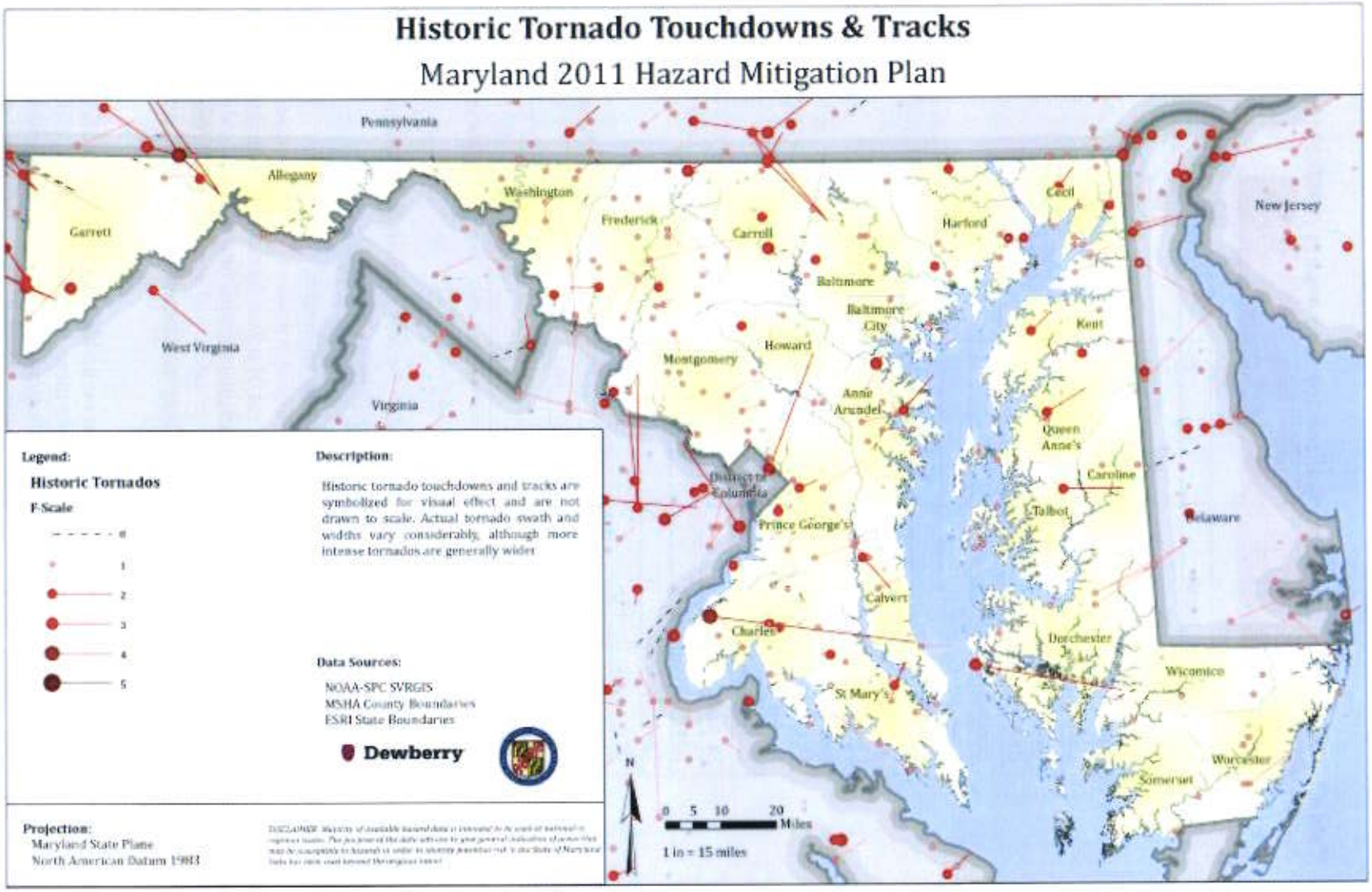

Figure 3-37. Historic Tornadoes 1950 – 2010.

Table 3-74. NCDC total and annualized tornado events (1950-2010).

County/City	Total Events	Annualized Events
Allegany County	7	0.11
Anne Arundel County	20	0.33
Baltimore County	21	0.34
Calvert County	16	0.26
Caroline County	7	0.11
Carroll County	14	0.23
Cecil County	16	0.26
Charles County	25	0.41
Dorchester County	12	0.20
Frederick County	31	0.51
Garrett County	11	0.18
Harford County	24	0.39
Howard County	9	0.15
Kent County	5	0.08
Montgomery County	21	0.34
Prince George's County	23	0.38
Queen Anne's County	8	0.13
St. Mary's County	18	0.30
Somerset County	5	0.08
Talbot County	8	0.13
Washington County	13	0.21
Wicomico County	9	0.15
Worcester County	13	0.21
City of Baltimore	4	0.07
Grand Total*	**61**	**5.56**

** Grand total values are not a direct sum of each of the county/city totals. The grand total events do not include zonal events as described in Section 3.3 and Section 3.5.*

Impact and Vulnerability. Tornadoes are considered to be low frequency, high-impact events. All areas of Maryland face nearly uniform susceptibility to tornadoes.

Electrical utilities and communications infrastructure are vulnerable to tornadoes. Damage to power lines or communication towers has the potential to cause power and communication outages for residents, businesses and critical facilities. In the event of power loss due to a tornado, state and critical facilities utilize COOP to continue performance of essential functions. In addition to lost revenues, downed power lines present a threat to public safety and emergency responders. Fire, police, and EMT responders are called upon to perform evacuations, close roads, attend to the injured, and direct traffic away from the impacted area.

A structure's tornado vulnerability is based in large part on building construction and standards. In general, mobile homes and wood-framed structures are more vulnerable to damage in a tornado than steel framed structures. Other factors, such as location, condition and maintenance of trees also plays a significant role in determining vulnerability. Human vulnerability is based on the

availability, reception and understanding of early warnings of tornadoes (i.e. Tornado Warning issued by the NWS) and access to substantial shelter. In some cases, despite having access to technology (computer, radio, television, outdoor sirens, etc.) that allows for the reception of a warning, language differences are sometimes a barrier to full understanding of the risk. Once warned of an impending tornado hazard, seeking shelter indoors on the lowest floor of a substantial building away from windows is recommended as the best protection against bodily harm. Table 3- gives a breakdown of injuries and fatalities by county that are the result of tornadoes between 1950 and June 2011. Charles, Baltimore, and Prince George's Counties top the list in number of tornado injuries, while Calvert and Prince George's Counties have had at least two tornado-related deaths.

Table 3-75. Tornado Hazard - Injuries and Deaths.

County/City	Total Injuries	Total Deaths
Allegany County	6	0
Anne Arundel County	1	0
Baltimore County	66	0
Calvert County	2	2
Caroline County	0	0
Carroll County	3	0
Cecil County	2	0
Charles County	122	1
Dorchester County	16	1
Frederick County	1	0
Garrett County	12	1
Harford County	10	0
Howard County	2	0
Kent County	0	0
Montgomery County	1	0
Prince George's County	60	2
Queen Anne's County	0	0
St. Mary's County	4	0
Somerset County	0	0
Talbot County	0	0
Washington County	1	0
Wicomico County	2	0
Worcester County	0	0
City of Baltimore	3	0
Grand Total*	**314**	**7**

** Grand total values are not a direct sum of each of the county/city totals. The grand total events do not include zonal events as described in Section 3.3 and Section 3.5.*

Risk. As evidence in property and crop loss figures (Table 3-77) obtained from NCDC, tornadoes have the potential to be very destructive. Total damages (adjusted for inflation) on an annualized basis range from more than $1,864 in Somerset County to over $2.3 million in Charles and Prince George's Counties. The higher annualized damages in both of the latter counties mentioned are the result of the particularly destructive tornadoes described earlier in this hazard section.

The NCDC estimates are believed to be an underrepresentation of the actual losses experienced due to hazards as losses from events that go unreported or that are difficult to quantify are not likely to appear in the NCDC database; this is especially true with crop damages.

State and Critical Facility Risk. A high tornado ranking has been determined for Calvert, Charles, Frederick, and Garrett Counties based on the methodology described in HIRA Section 3.5 Hazard Assessment and Ranking Methodology. (see Figure 3-38) There are approximately 4,378 critical facilities valued at a total of $1.7 billion and 743 state facilities (non-critical) valued at a total of $481 million located within these jurisdictions. Table 3- shows a breakdown of the number of facilities and building and contents values for those jurisdictions with a high tornado ranking.

Not all critical facilities have redundant power sources and may not even be wired to accept a generator. Future state mitigation plan updates should consider closer examination of critical facilities risk by looking at construction type of critical facilities in jurisdictions considered to be at higher risk of tornadoes.

Jurisdictional Risk. Based on the available data, Calvert, Charles, Frederick and Garrett Counties have been determined to have a high tornado ranking. This ranking was accomplished using the methodology described in Hazard Assessment and Ranking Methodology. Figure 3-38 depicts the tornado hazard ranking for Maryland.

Local Plan Risk Assessment. Twenty-three of the local plans addressed and ranked tornado in their hazard mitigation plans and three plans addressed tornado with winds or thunderstorms. Seven local plans considered tornado a high hazard, four medium-high, ten medium, and two low. Section 3.6 includes a summary of how each of the local plans ranked tornado and outlines the assumptions that were made in an effort to compare the local hazard rankings to each other.

Table 3-76. State and Critical Facilities Within High Tornado Ranking Areas.

County/City	Total Number of Critical Facilities	Critical Facilities Building and Contents Values	Total Number of State Facilities	State Facilities Building and Contents Values
Calvert County	551	$415,662,333	123	$149,722,737
Charles County	1,146	$517,267,067	138	$46,599,098
Frederick County	2,053	$646,917,427	189	$230,155,484
Garrett County	628	$109,658,267	293	$54,734,083
Grand Total	**4,378**	**$1,689,505,094**	**743**	**$481,211,402**

Table 3-77. Tornado Hazard - Crop and Property Damage.

County/City	Property Damage (Total)	Property Damage (Annualized)	Crop Damage (Total)	Crop Damage (Annualized)	Total Damage	Total Damage (Annualized)
Allegany County	$8,322,078	$136,428	$401,779	$6,587	$8,723,857	$143,015
Anne Arundel County	$10,459,959	$171,475	$0	$0	$10,459,959	$171,475
Baltimore County	$60,512,404	$992,007	$7,075	$116	$60,519,479	$992,123
Calvert County	$14,997,694	$245,864	$0	$0	$14,997,694	$245,864
Caroline County	$478,570	$7,845	$0	$0	$478,570	$7,845
Carroll County	$16,162,126	$264,953	$28,298	$464	$16,190,424	$265,417
Cecil County	$7,373,779	$120,882	$0	$0	$7,373,779	$120,882
Charles County	$144,331,929	$2,366,097	$14,149	$232	$144,346,078	$2,366,329
Dorchester County	$11,572,741	$189,717	$0	$0	$11,572,741	$189,717
Frederick County	$4,652,068	$76,263	$70,746	$1,160	$4,722,814	$77,423
Garrett County	$5,158,085	$84,559	$0	$0	$5,158,085	$84,559
Harford County	$9,096,655	$149,125	$14,980	$246	$9,111,635	$149,371
Howard County	$6,259,456	$102,614	$0	$0	$6,259,456	$102,614
Kent County	$895,246	$14,676	$0	$0	$895,246	$14,676
Montgomery County	$7,277,477	$119,303	$49,522	$812	$7,326,999	$120,115
Prince George's County	$142,657,642	$2,338,650	$0	$0	$142,657,642	$2,338,650
Queen Anne's County	$1,521,308	$24,939	$0	$0	$1,521,308	$24,939
St. Mary's County	$7,481,724	$122,651	$0	$0	$7,481,724	$122,651
Somerset County	$113,720	$1,864	$0	$0	$113,720	$1,864
Talbot County	$355,739	$5,832	$0	$0	$355,739	$5,832
Washington County	$1,896,590	$31,092	$133,358	$2,186	$2,029,948	$33,278
Wicomico County	$418,510	$6,861	$0	$0	$418,510	$6,861
Worcester County	$1,058,792	$17,357	$0	$0	$1,058,792	$17,357
City of Baltimore	$203,617	$3,338	$0	$0	$203,617	$3,338
Grand Total*	**$463,257,911**	**$7,594,392**	**$719,906**	**$11,802**	**$463,977,817**	**$7,606,194**

** Grand total values are not a direct sum of each of the county/city totals. The grand total events do not include zonal events as described in Section 3.3 and Section 3.*

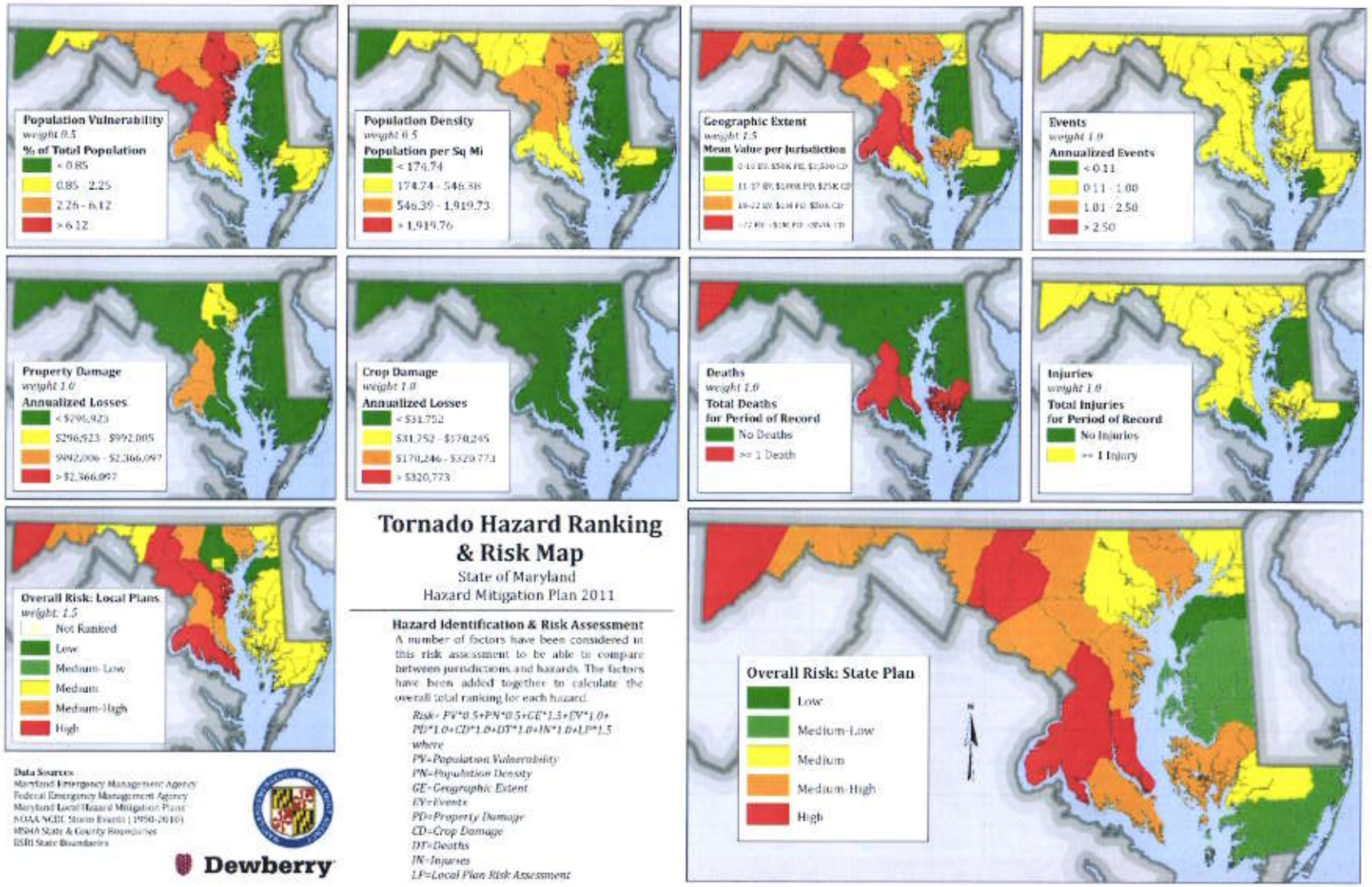

Figure 3-38. Tornado Hazard Ranking & Risk Map.

3.10 Winter Storms

3.10.1 Description

Winter weather can take many forms including snow, freezing rain, sleet and extreme cold that may occur singly or in combination. Some of the most significant winter storms that affect Maryland are known as "Nor'easters" because they are accompanied by strong northeast winds. The storms often form in the Gulf of Mexico, intensify, and then move up the East Coast. High pressure systems over the Maritime Provinces of Canada deliver the cold air to Nor'easters that result in winter precipitation. The cold air flowing from the north forms what actually looks like a wedge, bounded by the mountains of Washington and Allegany Counties on the west and warmer winds coming off the Atlantic Ocean on the east. Meteorologists call this the "cold air dam" or "the damming effect." Moist air coming from the south flows up over this dam, producing heavy winter precipitation.

Often, the heaviest snow with a Nor'easter occurs in a band 50 to 100 miles wide, usually setting up over central or eastern areas of Maryland. Precipitation along this band typically changes from snow in the west, to a transition area of freezing rain and sleet, then finally to rain in the east. Areas receiving mostly snowfall can experience totals of greater than a foot and in the most intense Nor'easters also observe thunder and lightning. Counties west of the Chesapeake Bay are more likely to experience snow or mixed precipitation. Eastern Shore counties are more likely to experience rain, as warmer easterly winds off the ocean erode the cold air dam. The distribution, intensity and type of precipitation associated with Nor'easters are highly dependent on the track of the center of the storm system. (See Coastal Hazards section 3.8 for additional discussion of Nor'easter events including storm surge) A system that tracks nearest the coast is more likely to produce rain along the coast and snowfall further inland. A system that tracks a bit further out to sea is more likely to produce mostly snowfall even along the coast.

Maryland's three western counties, particularly Garrett County, can experience lake-effect snow originating from Lake Erie. Unlike Nor'easters and their associated Atlantic moisture, lake-effect snow is usually associated with Great Lakes moisture being uplifted and deposited as snow. This lake-effect snow is generally a drier, fluffier snow (lower water content) than that associated with Nor'easters. As a result, this type of snowfall is less likely to lead to the collapse of buildings. On average, more snowfall accumulates annually in the higher elevations of western Maryland, particularly the western-facing slopes, as compared to the rest of the state. Annual snowfall based on extrapolation of weather station snow climatology data is shown in Figure 3-39 . The average number of days per year of 12 inches or more of snowfall is depicted in Figure 3-40. Although somewhat more variable in terms of distribution, western and central portions of Maryland see these heavy snowfall events with greater frequency (roughly every 3 years) than other areas of the state.

Ice Storms. A "pure ice" storm is rare in Maryland, where near-freezing temperatures are more likely to produce a mix of rain, freezing rain, sleet, and snow. Freezing rain is rain that falls onto a surface with a temperature below freezing, causing it to form a coating or glaze of ice. Sleet is defined as rain drops that freeze into ice pellets before reaching the ground. Sleet usually bounces when hitting a surface and does not stick to objects. Sleet can accumulate like snow and become a hazard to motorists.

The term "ice storm" is used by the NWS to describe a storm that produces a significant accumulation of ice during freezing rain. An accumulation of ¼ inch or more of ice is termed "glaze", and can trigger an NWS winter storm warning or ice storm warning.
Even small accumulations of ice can be hazardous, making walking and driving extremely dangerous. Significant accumulations of ice can fell trees and utility lines, resulting in loss of power and communication. To produce this amount of ice, freezing rain usually has to fall for several hours.

A winter storm warning is issued when snowfall is expected to accumulate more than 4 inches in 12 hours and/or a quarter inch or more of freezing rain accumulation. Severe winter storms can significantly slow traffic and commerce, cause power outages, disrupt communications, and cause buildings to collapse.

Extreme Cold. Exposure to extreme cold temperatures, even for a short period of time, can result in hypothermia, frostbite, or even death. Wind greatly increases the dangers of frostbite and hypothermia by drawing heat from the body, which decreases skin temperature and eventually body temperature. The wind chill index attempts to quantify the cooling effect of wind with the actual outside air temperature to determine a wind chill temperature that represents how cold people and animals feel, based on the rate of heat loss from exposed skin. A wind chill index of -5 indicates that the effects of wind and temperature on exposed flesh are the same as if the air temperature alone were 5 degrees below zero, even though the actual temperature could be much higher.

The NWS issues a wind chill advisory when wind chill temperatures are potentially hazardous, and a wind chill warning when the situation can be life-threatening.

3.10.2 Historical Occurrence

There are numerous instances of damaging and in some cases deadly winter weather having impacted the state over the years.

The most significant snowstorms in Maryland history have had accumulations ranging from 12 to 30 inches and tend to occur in January or February. The hyperactive winter weather season of 2009 and 2010 brought four crippling winter storms to Maryland and led to single-event, daily and annual snowfall records for many locations. Snowfall totals for the season topped 60 inches through much of the central and western areas of Maryland. . A storm in 2003 hit the Baltimore region between February 14 and 18, and produced a total of 28.2 inches of snow at Baltimore-Washington International Airport. The storm had a significant impact on residents, transportation, emergency responders, businesses, structures, and livestock. The cost to the state for snow removal totaled approximately $55 million.

The winter of 1993-1994 was one of the iciest on record. Repeated storms from January into early March produced between 19 and 23 days of icy precipitation over the greater Baltimore-Washington metropolitan area. The worst storm occurred on February 10-11, 1994, extending from Fredericksburg, Virginia, into Southern Maryland. Freezing rain caused a thick glaze of ice over trees, power and phone lines, and roads. Trees and utility lines fell under the weight of the ice, causing some residents to lose power for up to two weeks.

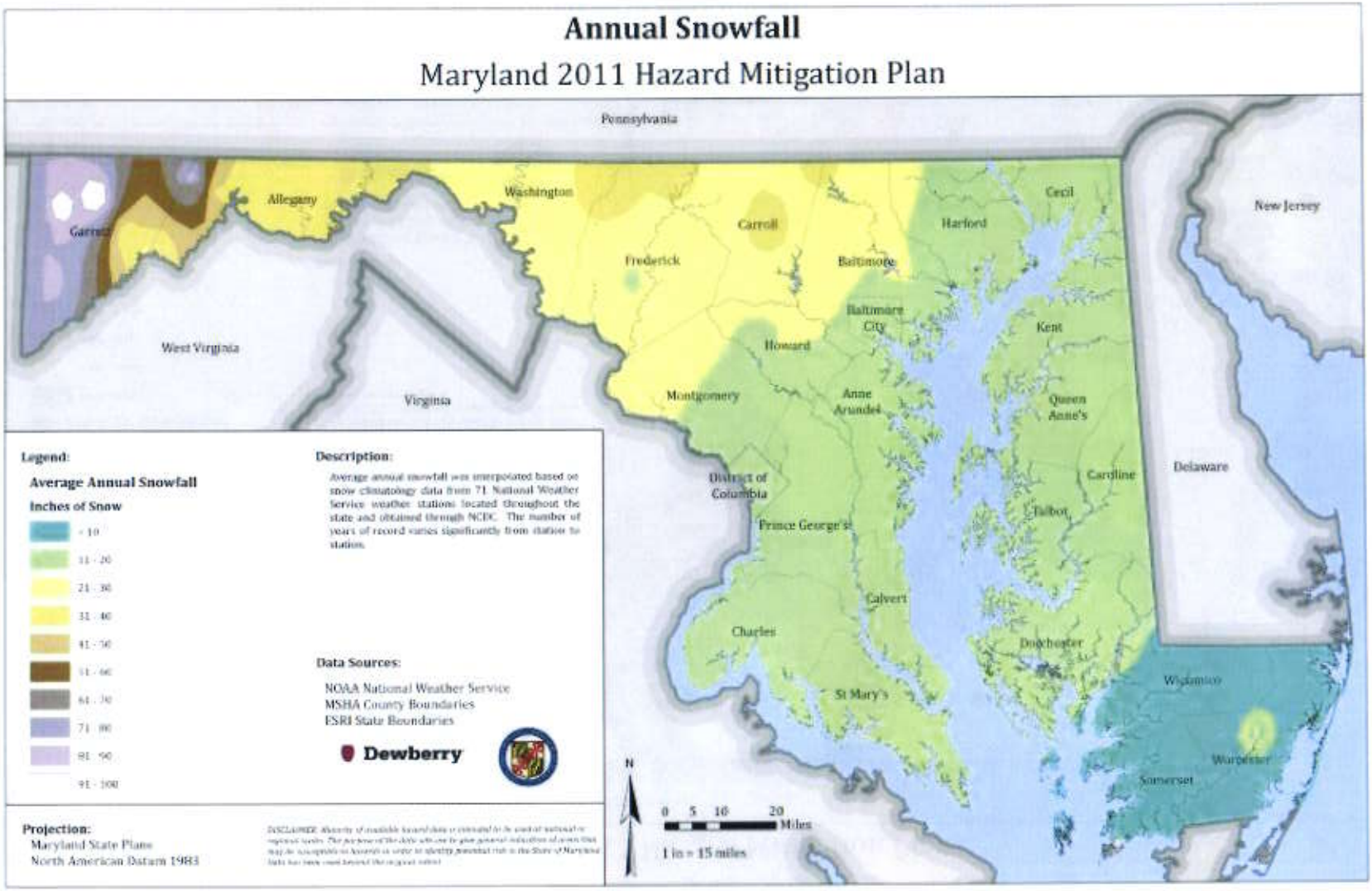

Figure 3-39. Average Annual Snowfall.

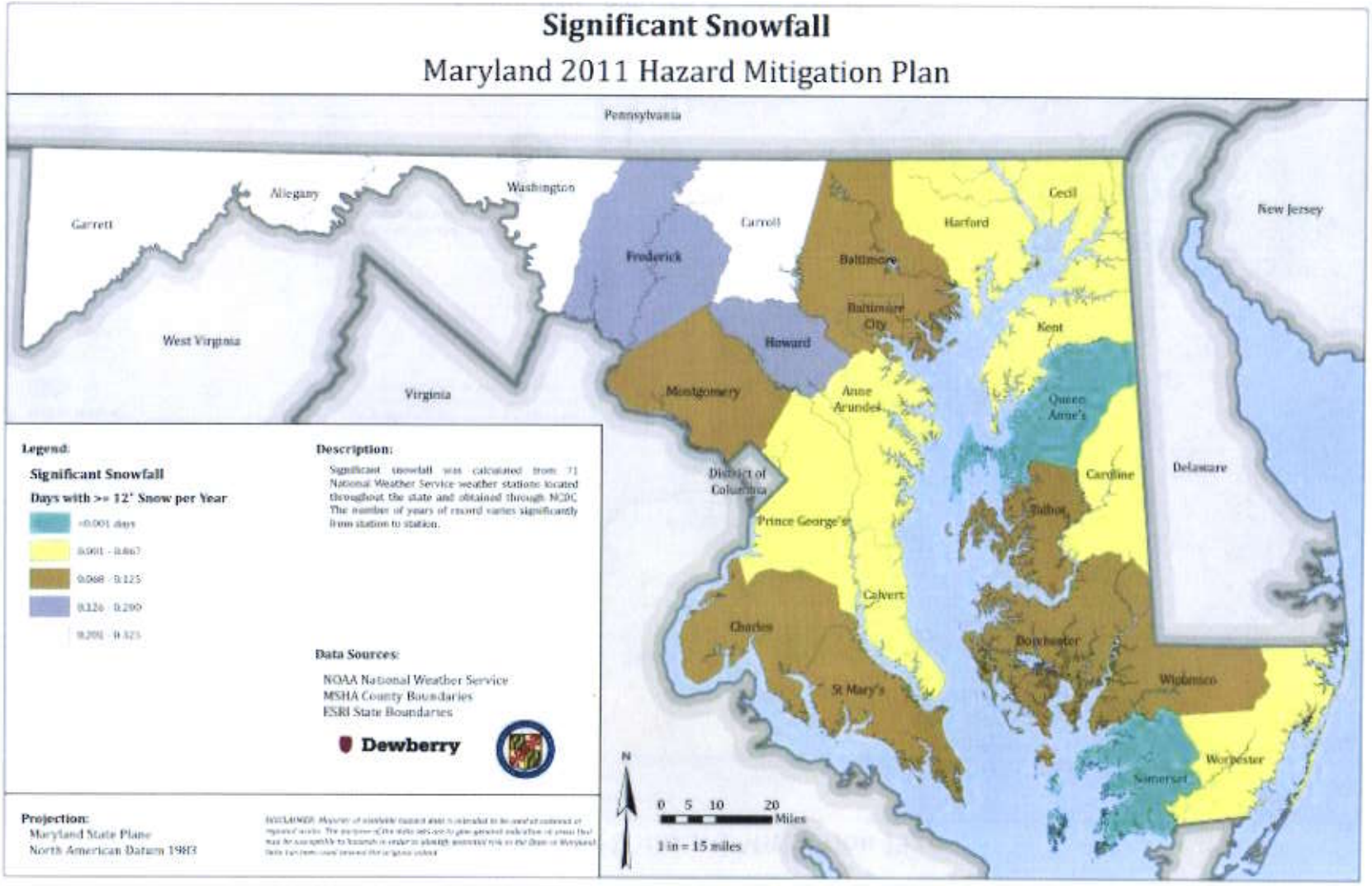

Figure 3-40. Average Number of Days Annually with >= 12" Snowfall.

In January 1994, a cold wave across Maryland produced persistent temperatures near or below 0°F. The great cold wave of January 1912 set records in Maryland, including the state's all-time record low temperature of -40°F recorded in Garrett County. Temperatures dropped to a low of -26°F in Prince George's County and -19°F in St. Mary's County.

Table 3- lists some of the more significant winter weather events that have impacted Maryland over the years.

Table 3-78. Previous Significant Winter Storm Events.

Date	Event	Comments
Winter of 1779-1780	Extreme Cold	This winter was so cold that the upper portion of the Chesapeake Bay froze solid down to the mouth of the Potomac River. There are records of people being able walk and drive loaded vehicles across from Annapolis to Kent Island. Ice was piled up 20 feet high along the Delmarva Coast and remained there until spring. Jefferson noted that such an extensive freeze of the tidal waters had never been recorded before.
January 18, 1857	Blizzard	On the morning of January 18, temperatures fell to 0 throughout central Maryland. A nor'easter then descended upon the state and began dumping snow which reached two feet deep in Baltimore, with drifts of 6-10 feet. Strong winds caused structural damage to buildings and wrecked ships at sea. Great drifts on the roads blocked transportation for several days.
January 13-14, 1912	Extreme Cold	A severe cold wave brought some of the lowest recorded temperatures for the state. Large amounts of ice formed on the rivers and bay, interfering with shipping. Oakland (Garrett County) recorded the state's all-time record low temperature of -40 degrees F. Westernport in Allegany County recorded -17 degrees, Hagerstown in Washington County recorded -27, and Emmitsburg in Frederick County recorded -23 degrees.
January 27-29, 1922	Winter Storm	A powerful storm brought the deepest snow of the century to Maryland and Virginia. Snow reached up to 30-32 inches in Baltimore, eastern Howard, northern Prince George's, and northern Anne Arundel counties. Strong winds gusting up to 50 mph created blizzard conditions. The roof of the Knickerbocker Theater in Northwest D.C. collapsed under the weight of snow, trapping 900 people inside for several hours. Ninety eight were killed and 158 were injured in the collapse.

Date	Event	Comments
January 1977	Extreme Cold	The average temperature in Baltimore was 22.9 degrees F, which is about 10 degrees below normal. The prolonged cold wave caused oil and natural gas shortages, and people were asked to turn down their thermostats to conserve energy. The Tidal Potomac, which is salt water, froze solid enough that people could skate across it. Snow storms hit every few days, coating streets that had just been cleared from the last storm.
February, 1993	Heavy Snow	Three separate snow storms hit Maryland over the course of ten days, each bringing about 4-8 inches of snow and wintery mix. These conditions closed schools and made roads treacherous, leading to numerous accidents.
March 14, 1993	Blizzard	A major winter storm that had developed in the Gulf of Mexico moved northeast across the mid-Atlantic region, producing blizzard conditions over a large part of Virginia, Maryland, and D.C. West-central and western Maryland recorded 16-35 inches of snow with snow drifts up to 12 feet in some places. One woman died of exposure in Baltimore. Hundreds of motorists abandoned their vehicles in western Maryland, and all roads and interstates closed. There was extensive damage to power lines and building roofs, with damages reaching $50,000. Cleanup efforts were estimated at $22 million.
February 5, 1995	Extreme Cold	Wind chill temperatures reached as low as -20 degrees. An elderly woman with Alzheimer's disease was found frozen to death outside the Maryland Odd Fellow's Home in Frederick (Frederick County). She had apparently wandered outside unchecked.
January 7, 1996	Blizzard	A historic winter storm, known as the "Blizzard of '96", crippled all of Maryland west of the Chesapeake Bay during the first full weekend of January. In general, snow totals were as follows: 20 inches in lower southern Maryland, 20 to 26 inches in central Maryland, and 26 to 36 inches to over the northern tier. Winds gusting in excess of 35 mph produced drifts of 4 to 7 feet and over 10 feet in the mountains. The storm effectively closed all major highways on the 7th, and the Metro system was severely crippled. Two people died of hypothermia, and over 150 injuries were reported, mostly from shoveling snow and slipping on ice. Snow removal/damage costs exceeded $70 million (state and county combined), a state record for an individual winter storm. Property damages were estimated at $160 thousand.

Date	Event	Comments
December 23-25, 1998	Ice Storm	A major ice storm affected the Lower Maryland Eastern Shore for two days. A prolonged period of freezing rain and sleet resulted in ice accumulations of 0.25-0.75 inches in many locations. The heavy ice accumulations on trees and power lines caused numerous power outages across the region. Many accidents occurred due to slippery road conditions, especially on bridges and overpasses. Many secondary roads were impassable due to fallen limbs and trees. Property damages were estimated at $5 million.
January 13-15, 1999	Ice Storm	An ice storm brought ice accumulations of one quarter to one half inch north and west of a line from Montgomery County to Harford County through early afternoon on the 14th. By 9 AM on the 15th, ice accumulations from one quarter to nearly one inch occurred across all of Western and Central Maryland, except Charles, Calvert, and St. Mary's county where a trace to one quarter inch accumulated. Hundreds of car accidents, slipping injuries, downed trees, and power outages were reported. On the morning of the 14th, 30 Montgomery County school buses slipped off the road. Interstate 68 in Allegany County was closed from midnight to 3 AM on the 15th because of several accidents. A 21 year old man was killed in a car crash on Interstate 70 in Western Maryland. Over 230,000 households lost power. Damages were estimated at $3.15 million.
February 14-18, 2003	Winter Storm	A complex storm system produced copious amounts of wintery precipitation across Maryland west of the Chesapeake Bay between the evening of the 14th and midday on the 18th. After the precipitation came to an end, record breaking snow and sleet accumulations were reported. Across western and north central Maryland, and the Baltimore metropolitan area, accumulations of mainly snow ranged from 20 to 32 inches. The highest amounts occurred across the north and west suburbs of Baltimore where a period of thunder snow produced snowfall rates up to 4 inches per hour on the 16th. Nicknamed the President's Weekend Snowstorm of 2003, this storm will go down in history as the heaviest snowstorm in the Baltimore region since records began in 1870. 9 people died of carbon monoxide poisoning while stranded in their cars, and there were many injuries due to slipping on ice and shoveling snow. Total property damages were estimated at $5.4 million.

Date	Event	Comments
February 11, 2006	Heavy Snow	A historic snowstorm occurred February 11-12 across the Mid-Atlantic. Storm total snowfall across much of Maryland ranged generally between 8-14 inches. A period of snow occurred overnight and early in the morning of the 12th across portions of the northern Washington DC suburbs and the Baltimore suburbs of Maryland, where localized snowfall ranged between 14 to 22 inches. The highest snowfall total occurred at Columbia Hills, MD, in Howard County, where snowfall was 22.5 inches. There were also numerous reports of downed trees and power lines, which caused significant power outages. Particularly hard hit were sections of Anne Arundel County, which had over 100 roads closed due to the combination of heavy snow and downed trees and power lines. The storm caused about $230,000 in property damages.
December 19, 2009	Winter Storm	A major winter storm affected the Eastern Shore on the 19th and 20th. Heavy snow fell across Cecil, Kent and Queen Anne's Counties and heavy snow and sleet fell across Caroline and Talbot Counties. Snowfall averaged 15 to 22 inches. Many municipalities declared states of emergency. Many school districts either closed schools or had two hour delayed openings on the 21st. Representative snowfall included 22.0 inches in Millington (Kent County), 17.0 inches in Elkton (Cecil County) and Denton (Caroline County), 13.0 inches in Centreville (Queen Anne's County) and 12.0 inches in Easton (Talbot County).
January 30, 2010	Winter Storm	Low pressure moving off the coastal Carolinas produced between six and thirteen inches of snow across the Lower Maryland Eastern Shore from Saturday morning into Saturday night January 30th. Representative snowfall included 11.0 inches at Crisfield (Somerset County), 13.0 inches at Toddville (Dorchester County), 12.0 inches at Ocean City (Worcester County), and 6.0 inches at Frostburg (Allegany County).

Date	Event	Comments
February 5-6, 2010	Heavy Snow	A large area of low pressure moving north from the Gulf of Mexico on February 5th combined with low pressure across the Ohio Valley and intensified over the Mid-Atlantic states. This produced a historic snow storm across western Pennsylvania, northern West Virginia, Garrett county Maryland, and eastern Ohio. Over 2 feet of snow fell across portions of Garrett county Maryland, with a total of 37 inches in Friendsville. Representative snowfall included 30.0 inches in Galena and Millington (Kent County), 29.5 inches in Royal Oak (Talbot County), 28.0 inches in Chester and Stevensville (Queen Anne's County), 24.0 inches in Saint Michaels (Talbot County), 23.5 in Easton (Talbot County), 23.0 inches in Denton (Caroline County), 21.0 inches in Elkton (Cecil County) and 18.0 inches in Fair Hills (Cecil County).

3.10.3 Risk Assessment

Winter storm risk was determined by examining historical records found in the NCDC database and other sources and then, by applying the hazard ranking methodology described in the Hazard Assessment and Ranking Methodology section of the HIRA.

Probability of Future Occurrence. Based on historical frequency of occurrence using NCDC data, a reasonable determination of probability of future winter storm events can be made. Winter storms have had significant impacts on Maryland in the past and are likely to impact the State in the future. An examination of NCDC data suggests that on an annual basis, approximately two to 12 winter weather events (snow and/or ice) of some significance occur in any particular Maryland county. Baltimore County has had the highest number of reported winter storms, followed by Allegany, Carroll and Garrett Counties. Table 3-79 shows the annualized number of winter weather events by county based on the NCDC historical record. Ice storms and significant freezing rain events can be particularly disruptive events. Based on NCDC data, ice events of some significance occur in any one particularly Maryland county roughly every one to 17 years, depending on the county. Garrett County leads the pack in terms of ice event occurrence, experiencing roughly one event annually. Table 3-3 and Table 3-4 (section 3.3.2) show total and annualized events for each county by hazard type for comparison.

Table 3-79. NCDC total and annualized winter storm events (1993-2010).

County/City	Total Winter Storm Events	Annualized Winter Storm Events	Total Ice Events	Annualized Ice Events
Allegany County	185	10.28	8	0.44
Anne Arundel County	75	4.17	2	0.11
Baltimore County	209	11.61	11	0.61
Calvert County	47	2.61	1	0.06
Caroline County	76	4.22	1	0.06
Carroll County	123	6.83	10	0.56
Cecil County	105	5.83	2	0.11

County/City	Total Winter Storm Events	Annualized Winter Storm Events	Total Ice Events	Annualized Ice Events
Charles County	61	3.39	1	0.06
Dorchester County	46	2.56	2	0.11
Frederick County	118	6.56	9	0.50
Garrett County	121	6.72	19	1.06
Harford County	103	5.72	5	0.28
Howard County	89	4.94	5	0.28
Kent County	84	4.67	2	0.11
Montgomery County	114	6.33	5	0.28
Prince George's County	81	4.50	2	0.11
Queen Anne's County	87	4.83	2	0.11
St. Mary's County	43	2.39	1	0.06
Somerset County	39	2.17	1	0.06
Talbot County	75	4.17	1	0.06
Washington County	114	6.33	10	0.56
Wicomico County	43	2.39	1	0.06
Worcester County	73	4.06	2	0.11
City of Baltimore	93	5.17	4	0.22
Grand Total*	**659**	**36.61**		

** Grand total values are not a direct sum of each of the county/city totals. The grand total events do not include zonal events as described in Section 3.3 and Section 3.5.*

Climate change is expected to bring an increase in precipitation to Maryland during the winter, however, the precipitation is expected to be increasingly in the form of liquid rather than frozen. A 25 percent decrease in snow volume is projected by 2025 and a 40 percent decrease by the end of the century. The Chesapeake Bay currently freezes over from shore to shore at the Chesapeake Bay Bridge roughly once every ten years. This is projected to occur less frequently in the future as temperatures warm; occurring once every 25 years for a low emissions scenario and roughly every 40 years in the case of a higher emissions scenario.[38]

Impact and Vulnerability. In general, the northern and western areas of Maryland experience winter weather of significance with greater frequency than the rest of the state. Electrical utilities and communications as well as transportation infrastructure are vulnerable to damages from winter storms. Damage to power lines or communication towers has the potential to cause power and communication outages for residents, businesses and critical facilities. In the event of damage to power and/or communication lines, Continuity of Operation Plans provide a means to continue services for state and critical facilities. Additionally, Emergency Operation Centers (EOCs) are activated to further ensure the continuation of services during a severe winter storm event. Public utilities representation staff both the state and local emergency operation centers. In addition to lost revenues, downed power lines present a threat to personal safety. Further, downed wires have been known to spark fires.

Vulnerability to these damages varies in large part due to specific factors; for example, proactive measures such as regular tree maintenance and utility system winterization can minimize property

38 Maryland Commission on Climate Change, Climate Action Plan, 2008, Page 19-20

vulnerability. Localities accustomed to winter weather events are typically more prepared to deal with them and therefore less vulnerable than localities that rarely experience winter weather.

Human vulnerability is based on the availability, reception and understanding of advanced warnings of impending significant winter weather events (i.e., Winter Storm Watches and Warnings issued by the NWS) and heeding the advice of local officials. In some cases, despite having access to technology (computer, radio, television, etc.) that allows for the reception of a watch or warning, language differences are sometimes a barrier to individuals understanding and responding to them. Table 3- gives a breakdown of injuries and fatalities by county that are the result of winter weather events between 1993 and November 2010. Baltimore County tops the list in the number of winter weather event related injuries and fatalities.

Table 3-80. Winter Storm Hazard - Injuries and Deaths.

County/City	Total Injuries	Total Deaths
Allegany County	167	6
Anne Arundel County	166	6
Baltimore County	332	15
Calvert County	161	5
Caroline County	0	0
Carroll County	166	8
Cecil County	0	0
Charles County	165	4
Dorchester County	0	0
Frederick County	166	7
Garrett County	0	0
Harford County	166	8
Howard County	166	8
Kent County	0	0
Montgomery County	166	8
Prince George's County	166	6
Queen Anne's County	1	1
St. Mary's County	161	4
Somerset County	0	0
Talbot County	0	0
Washington County	166	7
Wicomico County	0	0
Worcester County	0	0
City of Baltimore	166	8
Grand Total*	**168**	**10**

** Grand total values are not a direct sum of each of the county/city totals. The grand total events do not include zonal events as described in Section 3.3 and Section 3.5.*

Risk. As evidenced in property and crop loss figures (Table 3- and Table 3-) obtained from NCDC, winter storms have the potential to be destructive. Total damages (adjusted for inflation) on an annualized basis range from just over $18,000 to more than $152,762 in Worchester County. A particularly damaging ice storm on December 23, 1998 (See Table 3-), is skewing the annualized loss value for Worchester County.

The NCDC estimates are believed to be an underrepresentation of the actual losses experienced due to hazards as losses from events that go unreported or that are difficult to quantify are not likely to appear in the NCDC database; this is especially true with crop damages.

State and Critical Facility Risk. Based on the available data, Allegany, Anne Arundel, Baltimore, Carroll, Charles, Frederick, Garrett Harford, Howard, Montgomery, Prince George's, St. Mary's, and Washington Counties, and Baltimore City have been determined to have a high winter storm ranking. (Figure 3-41) There are less than 50,000 critical facilities with a total worth of $15.3 billion and over 5,000 state facilities (non-critical) with a total worth of roughly $21 billion located within these jurisdictions. Table 3- shows a breakdown of the number of facilities and building and contents values for those jurisdictions with a high winter storm ranking.

The type and age of construction plays a role in vulnerability of facilities to winter storms. It is apparent that transportation and communication structures are at great risk from winter storms. In addition, building construction type – particularly roof span and construction method, are factors that determine the ability of a building to perform under severe stress weights from snow. Finally, not all critical facilities have redundant power sources and may not even be wired to accept a generator. Future plan updates should consider closer examination of critical facilities risk by looking at construction type of critical facilities in jurisdictions considered to be at higher risk of winter storms.

Jurisdictional Risk. Based on the available data, Allegany, Anne Arundel, Baltimore, Carroll, Charles, Frederick, Garrett Harford, Howard, Montgomery, Prince George's, St. Mary's, and Washington Counties, and Baltimore City have been determined to have a high winter storm ranking. (Figure 3-41) This ranking was accomplished using the methodology described in the Hazard Analysis and Ranking Methodology section.

Local Plan Risk Assessment. All of the local plans addressed and ranked winter storms in their hazard mitigation plans. Ten local plans considered winter storm a high hazard, six medium-high, eight medium, and two medium-low. Section 3.6 includes a summary of how each of the local plans ranked winter storm and outlines the assumptions that were made in an effort to compare the local hazard rankings to each other.

Table 3-81. Winter Storm Hazard - Crop and Property Damage 1993 - 2010. (includes both snow and ice events)

County/City	Property Damage (Total)	Property Damage (Annualized)	Crop Damage (Total)	Crop Damage (Annualized)	Total Damage	Total Damage (Annualized)
Allegany County	$1,637,799	$90,989	$0	$0	$1,637,799	$90,989
Anne Arundel County	$878,529	$48,807	$0	$0	$878,529	$48,807
Baltimore County	$1,615,534	$89,752	$6	$0	$1,615,540	$89,752
Calvert County	$496,940	$27,608	$0	$0	$496,940	$27,608
Caroline County	$337,826	$18,768	$0	$0	$337,826	$18,768
Carroll County	$1,165,865	$64,770	$0	$0	$1,165,865	$64,770
Cecil County	$549,072	$30,504	$0	$0	$549,072	$30,504
Charles County	$496,940	$27,608	$0	$0	$496,940	$27,608
Dorchester County	$1,361,963	$75,665	$0	$0	$1,361,963	$75,665
Frederick County	$1,007,440	$55,969	$13,620	$757	$1,021,060	$56,726
Garrett County	$333,593	$18,533	$0	$0	$333,593	$18,533
Harford County	$1,110,584	$61,699	$0	$0	$1,110,584	$61,699
Howard County	$900,701	$50,039	$0	$0	$900,701	$50,039
Kent County	$337,826	$18,768	$0	$0	$337,826	$18,768
Montgomery County	$957,567	$53,198	$0	$0	$957,567	$53,198
Prince George's County	$878,529	$48,807	$0	$0	$878,529	$48,807
Queen Anne's County	$337,826	$18,768	$0	$0	$337,826	$18,768
St. Mary's County	$496,940	$27,608	$0	$0	$496,940	$27,608
Somerset County	$1,361,963	$75,665	$0	$0	$1,361,963	$75,665
Talbot County	$337,826	$18,768	$0	$0	$337,826	$18,768
Washington County	$1,243,842	$69,102	$13,620	$757	$1,257,462	$69,859
Wicomico County	$1,361,963	$75,665	$0	$0	$1,361,963	$75,665
Worcester County	$2,749,710	$152,762	$0	$0	$2,749,710	$152,762
City of Baltimore	$449,669	$24,982	$6	$0	$449,675	$24,982
Grand Total*	**$4,307,752**	**$239,320**	**$13,620**	**$757**	**$4,321,372**	**$240,076**

** Grand total values are not a direct sum of each of the county/city totals. The grand total events do not include zonal events as described in Section 3.3 and Section 3.5.*

Table 3-82. Ice-Related Property and Crop Damages 1993 - 2010. (only includes ice events; a sub-set of Table 3- damages)

County/City	Property Damage (Total)	Property Damage (Annualized)	Crop Damage (Total)	Crop Damage (Annualized)	Total Damage	Total Damage (Annualized)
Allegany County	$773,542	$42,975	$0	$0	$773,542	$42,975
Anne Arundel County	$381,589	$21,199	$0	$0	$381,589	$21,199
Baltimore County	$657,517	$36,529	$0	$0	$657,517	$36,529
Calvert County	$0	$0	$0	$0	$0	$0
Caroline County	$0	$0	$0	$0	$0	$0
Carroll County	$456,317	$25,351	$0	$0	$456,317	$25,351
Cecil County	$0	$0	$0	$0	$0	$0
Charles County	$0	$0	$0	$0	$0	$0
Dorchester County	$1,361,963	$75,665	$0	$0	$1,361,963	$75,665
Frederick County	$466,532	$25,918	$13,620	$757	$480,152	$26,675
Garrett County	$142,689	$7,927	$0	$0	$142,689	$7,927
Harford County	$402,399	$22,355	$0	$0	$402,399	$22,355
Howard County	$402,399	$22,355	$0	$0	$402,399	$22,355
Kent County	$0	$0	$0	$0	$0	$0
Montgomery County	$382,448	$21,247	$0	$0	$382,448	$21,247
Prince George's County	$381,589	$21,199	$0	$0	$381,589	$21,199
Queen Anne's County	$0	$0	$0	$0	$0	$0
St. Mary's County	$1,361,963	$75,665	$0	$0	$1,361,963	$75,665
Somerset County	$0	$0	$0	$0	$0	$0
Talbot County	$0	$0	$0	$0	$0	$0
Washington County	$466,532	$25,918	$13,620	$757	$480,152	$26,675
Wicomico County	$1,361,963	$75,665	$0	$0	$1,361,963	$75,665
Worcester County	$2,723,926	$151,329	$0	$0	$2,723,926	$151,329
City of Baltimore	$201,199	$11,178	$0	$0	$201,199	$11,178

Table 3-83. State and Critical Facilities within High Winter Storm Ranking Areas.

County/City	Total Number of Critical Facilities	Critical Facilities Building and Contents Values	Total Number of State Facilities	State Facilities Building and Contents Values
Allegany County	984	$382,118,400	287	$717,855,663
Anne Arundel County	5,033	$1,468,465,960	605	$3,458,410,555
Baltimore County	8,415	$1,873,803,613	695	$2,450,029,306
Carroll County	1,767	$773,619,613	228	$400,429,463
Charles County	1,146	$517,267,067	138	$46,599,098
Frederick County	2,053	$646,917,427	189	$230,155,484
Garrett County	628	$109,658,267	293	$54,734,083
Harford County	2,342	$739,153,507	207	$115,126,325
Howard County	2,208	$851,168,040	363	$590,258,515
Montgomery County	6,992	$2,764,069,667	181	$305,032,976
Prince George's County	7,381	$1,173,039,907	587	$4,226,006,209
St. Mary's County	888	$309,846,013	317	$633,515,069
Washington County	2,084	$531,299,493	311	$336,788,350
City of Baltimore	7,904	$3,179,149,973	765	$7,596,281,448
Grand Total	**49,825**	**$15,319,576,947**	**5,166**	**$21,161,222,544**

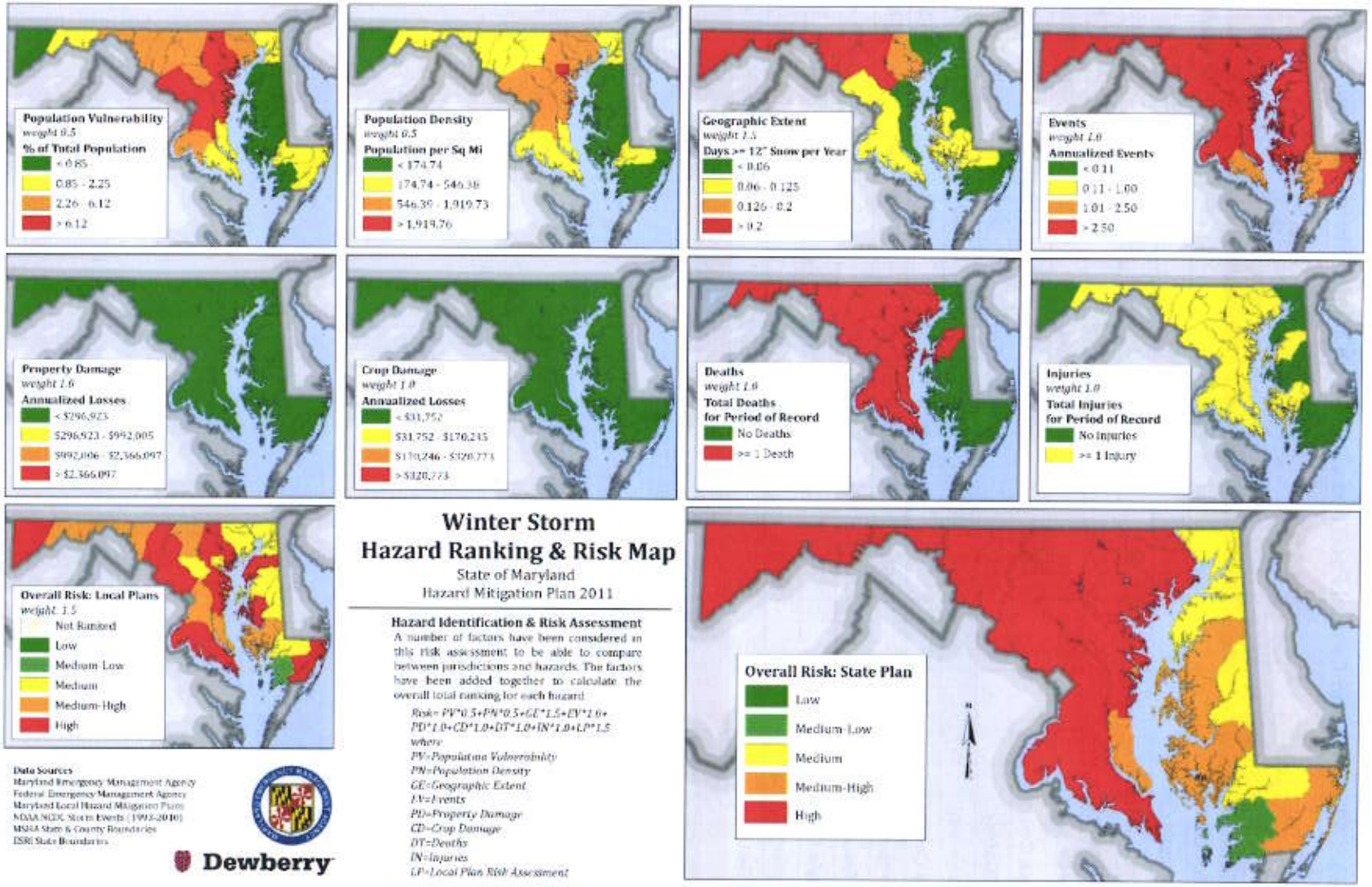

Figure 3-41. Winter Storm Hazard Ranking and Risk.

3.11 Wildfire

3.11.1 Description

Wildfires are fueled by natural cover, including native and non-native species of trees, brush and grasses, and crops along with weather conditions and topography. While available fuel, topography, and weather provide the conditions that allow wildfires to spread, most wildfires are caused by people through criminal or accidental misuse of fire.

Wildfires pose serious threats to human safety and property in rural and suburban areas. They can destroy crops, timber resources, recreation areas, and habitat for wildlife. Wildfires are commonly perceived as hazards in the western part of the country; however, wildfires are a growing problem in the wild land/urban interface of the eastern United States, including Maryland.

Wildfires are dependent upon the quantity and quality of available fuels. Fuel quantity is the mass per unit area. Fuel quality is determined by a number of factors, including fuel density, chemistry, and arrangement. Arrangement influences the availability of oxygen. Another important aspect of fuel quality is the total surface exposed to heat and air. Fuels with large area-to-volume ratios, such as grasses, leaves, bark and twigs, are easily ignited when dry.

Climatic and meteorological conditions that influence wildfires include solar insulation, atmospheric humidity, and precipitation, all of which determine the moisture content of wood and leaf litter. Dry spells, heat, low humidity, and wind increase the susceptibility of vegetation to fire.

Various natural and human agents can be responsible for igniting wildfires. Natural agents include lightning, sparks generated by rocks rolling down a slope, friction produced by branches rubbing together in the wind, and spontaneous combustion. However, arson and accidents cause most wildfires in Maryland.

Human-caused wildfires are typically worse than those caused by natural agents. Arson and accidental fires usually start along roads, trails, streams, or at dwellings that are generally on lower slopes or bottoms of hills and valleys. Nurtured by updrafts, these fires can spread quickly uphill. Arson fires are often set deliberately at times when factors such as wind, temperature, and dryness contribute to the fires' spread.

3.11.2 Historical Occurrences

The Maryland Forest Service (MFS) is the primary fire control authority for fires affecting natural cover within the state. The Maryland Forest Service also assists local and rural fire companies that lack the resources needed to fight large wildfires. Table 3- summarizes the total number of events and annualized events for each of the counties in Maryland. This data has been provided from the MFS, Department of Natural Resources (DNR) and includes events from 1998 to 2010. These totals (7,052 events in database) only show fires that the MFS personnel responded to, which, based on estimates from MFS, is approximately 10 percent of all wildfires (Figure 3-42). Volunteer fire companies respond to the remaining wildfires and do not report information to MFS.

Carelessness and accidents, including debris burning, campfires, smoking, equipment malfunction, and children playing with matches make up the majority of Maryland's wildfires. Debris burning accounts for 29 percent of all wildfire in the state followed closely by arson at 26 percent.

Approximately 83 percent of the fires burned were located in the eastern portion of the state with land classification of marsh. Recently it appears that there have been fewer but larger wildfires. Larger fires are linked to drought conditions that existed in 2001 and 2002; 917 events were recorded in 2001 and 736 in 2002. Record precipitation over much of the state in 2003 helped to significantly reduce the wildfire problem for the year with 128 events.

Multiple fires burning simultaneously throughout the state can greatly tax local and state resources. For example, on April 8, 1947, 3,500 firefighters, along with 1,000 soldiers from Fort Meade, fought wildfires that burned approximately 5,000 acres in several counties.

Wildfires and brush fires in Maryland from 1988 to 2002 have forced school closings, disrupted telephone services by burning fiber optic cables, damaged railroads and other infrastructure, and adversely affected tourism, outdoor recreation, and hunting

3.11.3 Risk Assessment

Wildfire risk was determined by examining historical records found in the MFS database and then, by applying the hazard ranking methodology described in the Hazard Assessment and Ranking Methodology section.

Wildfire hazard potential has been determined by the Wildland Urban Interface Project conducted in 2001 by the MFS; although dated, this data still represents current wildfire risk in the state. The Wildland Urban Interface Project rated wildfire hazard potential throughout Maryland based on terrain aspect, slope, available fuels, potential property loss, and availability of fire response resources (Figure 3-43).

Probability of Future Occurrence. Based on historical frequency of occurrence using MFS data, a reasonable determination of probability of future wildfire events can be made. Wildfires have had significant impacts on Maryland in the past and are likely to impact the State in the future. An examination of MFS data suggests that on an annual basis, approximately three to 78 wildfire events of some significance occur in any particular Maryland county in which the state responds to the fire.

Charles County accounts for over 14 percent of the total recorded MFS wildfires, followed by Dorchester County with almost 10 percent. Dorchester County has the highest number of acres (33,098) burned by wildfire. Table 3- shows the total and annualized wildfire events by county based on the MFS historical record. The more developed counties averaged less than ten wildfires per year that required state intervention. Table 3-3 and Table 3-4 (section 3.3.2) show total and annualized events for each county by hazard type for comparison.

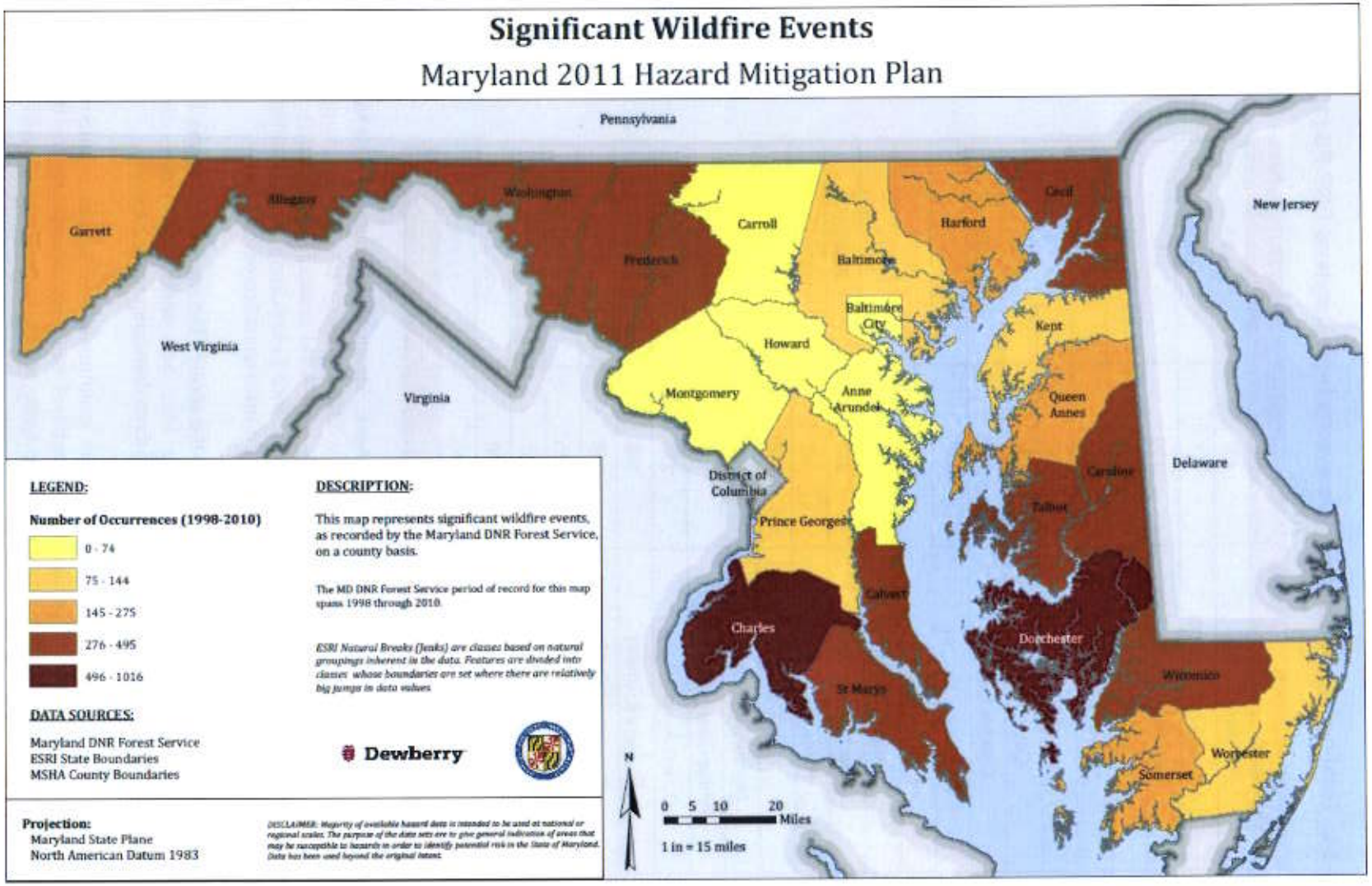

Figure 3-42. Significant wildfire events from Maryland Forestry Service, Department of Natural Resources (1998-2010).

Table 3-84. Total and annualized wildfire events from Maryland DNR FS (1998-2010).

County Name	Total Events	Annualized Events
Allegany County	407	31.31
Anne Arundel County	37	2.85
Baltimore County	119	9.15
Calvert County	374	28.77
Caroline County	421	32.38
Carroll County	53	4.08
Cecil County	403	31.00
Charles County	1,016	78.15
Dorchester County	673	51.77
Frederick County	381	29.31
Garrett County	238	18.31
Harford County	271	20.85
Howard County	40	3.08
Kent County	116	8.92
Montgomery County	74	5.69
Prince George's County	131	10.08
Queen Anne's County	275	21.15
St. Mary's County	495	38.08
Somerset County	218	16.77
Talbot County	345	26.54
Washington County	351	27.00
Wicomico County	470	36.15
Worcester County	144	11.08
Grand Total	**7,052**	**542.46**

The peak months for wildfire activity in Maryland are April, March, and November. The Maryland Forest Service anticipates and plans for increasing wildfire activity during the spring, when increasing daytime temperature, low relative humidity, and wind combine to dry surface litter, which promotes the ignition and spread of fires. However, once forest canopies are established, the forest floors become shaded, moisture levels increase, and fire hazard decreases.

The largest fires in Maryland historically occur during the spring. The majority of spring fires are surface fires, which generally burn off the surface litter and understory. Unless the litter accumulation is extensive, surface fires move rapidly without damaging mature trees.

Autumn is typically a time of depleted soil moisture conditions, low stream conditions, and increased insulation of the forest floor due to reduced leaf canopies, accounting for the high wildfire totals for November. Wildfire hazard can be quite severe in the fall, especially when following a dry summer.

Ground fires may burn during the fall and summer, or anytime during droughts. Ground fires are restricted to the thick layers of organic materials and may smolder underground for months, spreading very slowly. Often, ground fires are difficult to extinguish. Wildfires that occur in the summer are generally associated with droughts.

Gypsy Moth larvae and southern Pine Bark Beetle infestation in forests have increased the potential for wildfires, especially in the forests of Southern Maryland. Trees killed by the pests subsequently dry out and provide fuel for wildfires. Fire hazard may dramatically increase following periods of heavy infestations and tree mortality, particularly if weather conditions conducive to fires prevail.

In the future, the possibility of more frequent short-term drought[39] associated with a changing climate could result in more frequent occurrence of wildfire.

Impact and Vulnerability. Thirty-three injuries in different counties have resulted from MFS wildfire events and one death in Anne Arundel County. Allegany County has the most wildfire related injuries. Table 3- gives a breakdown of injuries and fatalities by county that are the result of wildfire events between 1998 and 2010.

State and critical facilities in high wildfire potential areas, Allegany, Charles, and St. Mary's Counties, are most vulnerable to impacts from a wildfire event. It is essential for these counties to ensure their Continuity of Operation Plans are up to date and utilized during such an event. Emergency responders, such as fire and police, are responsible for the evacuation of persons from the fire area, closing roads, creating fire breaks, and attending to the injured. As such, emergency responders are at risk for personal injury due to the nature of their job responsibilities. However, public confidence is ensured by the immediate and effective response of state, county, and/or local personnel.

Risk. As evidence in the MFS loss figures (Table 3-) wildfires have the potential to be destructive. Total damages, on an annualized basis, range from just over $91 in Howard County to over $8,965 in Somerset County.

State and Critical Facility Risk. Based on the available data for the hazard ranking, Anne Arundel, Calvert, and St. Mary's Counties have been determined to have a high wildfire ranking (Figure 3-44). There are 1,721 critical facilities with a total worth over $956 million and over 450 state facilities (non-critical) with a total worth of roughly $985 million located within these jurisdictions. Table 3- shows a breakdown of the number of facilities and building and contents values for all jurisdictions with facilities in the high and extreme wildfire potential zones.

[39] Maryland Commission on Climate Change, Climate Action Plan, 2008; Page 21.

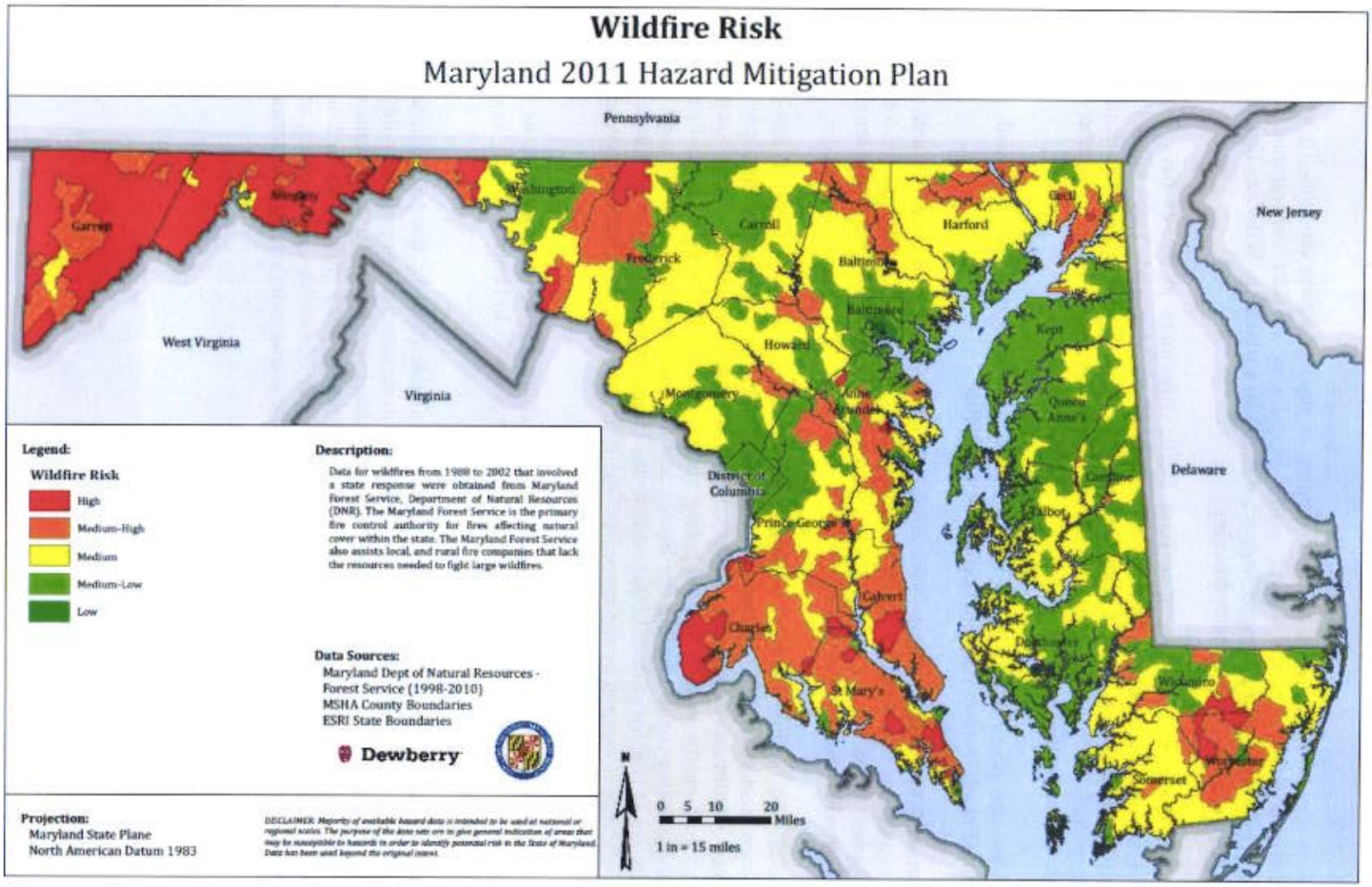

Figure 3-43. Wildfire hazard potential.

Table 3-85. Wildfire Hazard – Injuries and Deaths.

County/City	Total Injuries	Total Deaths
Allegany County	7	
Anne Arundel County	1	1
Baltimore County	1	
Calvert County	1	
Caroline County	1	
Carroll County		
Cecil County	3	
Charles County	3	
Dorchester County	2	
Frederick County	2	
Garrett County	3	
Harford County	2	
Howard County	1	
Kent County		
Montgomery County		
Prince George's County	1	
Queen Anne's County		
Somerset County		
St. Mary's County	2	
Talbot County		
Washington County	3	
Wicomico County		
Worcester County		

Table 3-86. Wildfire Hazard – Damages 1998-2010 from MD FS.

County/City	Total Damage	Total Damage (Annualized)
Allegany County	$29,295	$2,253
Anne Arundel County	$0	$0
Baltimore County	$1,495	$115
Calvert County	$4,419	$340
Caroline County	$9,115	$701
Carroll County	$2,450	$188
Cecil County	$19,191	$1,476
Charles County	$44,638	$3,434
Dorchester County	$20,591	$1,584

County/City	Total Damage	Total Damage (Annualized)
Frederick County	$18,882	$1,452
Garrett County	$3,853	$296
Harford County	$5,589	$430
Howard County	$1,177	$91
Kent County	$2,337	$180
Montgomery County	$3,689	$284
Prince George's County	$7,694	$592
Queen Anne's County	$4,154	$320
St. Mary's County	$9,310	$716
Somerset County	$116,544	$8,965
Talbot County	$4,813	$370
Washington County	$2,493	$192
Wicomico County	$8,597	$661
Worcester County	$5,329	$410
Grand Total	**$320,326**	**$24,640**

Jurisdictional Risk. Portions of 18 Maryland counties are within areas of extreme or high wildfire risk. An estimated 750,852 acres are within areas of extreme wildfire risk, and 1,259,329 acres are within high wildfire risk. Table 3.13- 1 lists the acreage totals for counties at risk of wildfire and the percent of total county area at risk.

Allegany and Garrett Counties are at greatest risk for wildfire potential based on geographic extent. Garrett County has an estimated 404,633 acres (96.4 percent of its total area) characterized as being at high or extreme risk of wildfire. Allegany follows with 263,951 (95.9 percent of its total area) at high or extreme risk of wildfire. Garrett and Allegany Counties combined account for over 70 percent of Maryland's land at extreme risk of wildfire.

Based on the available data for hazard ranking, Anne Arundel, Calvert, and St. Mary's Counties have been determined to have a high wildfire ranking (Figure 3-44). This ranking was accomplished using the methodology described in the Hazard Analysis and Ranking Methodology section.

Table 3-87. Critical and State Facilities located within high wildfire potential.

County/City	Total Number of Critical Facilities	Critical Facilities Building and Contents Values	Total Number of State Facilities	State Facilities Building and Contents Values
Allegany County	727	$267,705,853	217	$346,183,712
Anne Arundel County	545	$348,750,320	114	$210,865,890
Baltimore County	269	$45,440,667	17	$64,233,697
City of Baltimore	0	$0		$0
Calvert County	422	$355,442,773	106	$146,951,805
Caroline County	3	$0		$0
Carroll County	23	$6,388,800	44	$54,025,518
Cecil County	325	$35,400,800	98	$21,028,031
Charles County	771	$341,836,800	106	$30,350,726
Dorchester County	0	$0		$0
Frederick County	353	$118,770,933	114	$94,615,126
Garrett County	500	$52,818,400	255	$39,402,884
Harford County	141	$13,983,253	24	$1,203,789
Howard County	96	$20,077,480	2	$0
Kent County	2	$0		$0
Montgomery County	76	$4,359,053		$0
Prince George's County	521	$81,157,107	36	$322,200,550
Queen Anne's County	0	$0		$0
Somerset County	3	$0	1	$0
St. Mary's County	754	$252,602,547	230	$627,475,021
Talbot County	0	$0		$0
Washington County	271	$31,104,240	143	$20,228,765
Wicomico County	63	$1,875,333	8	$453,741
Worcester County	114	$16,917,987	61	$9,280,191
Grand Total	**5,979**	**$1,994,632,346**	**1,576**	**$1,988,499,445**

Table 3.13- 1. Estimated area of counties within High or Extreme wildfire potential zones.

County	Area of Extreme Wildfire Risk (Acres)	% of County within Extreme Wildfire Risk	Area of High Wildfire Risk (Acres)	% of County High Wildfire Risk	Total Area of High or Extreme risk (Acres)	Total percent of area of High or Extreme risk
Allegany County	238,893	86.8%	25,059	9.1%	263,952	**95.9%**
Anne Arundel County	6,119	2.3%	71,239	26.7%	77,358	**29.0%**
Baltimore County	0	0.0%	72,410	18.6%	72,410	**18.6%**
Calvert County	19,448	12.7%	87,282	56.8%	106,730	**69.5%**
Caroline County	0	0.0%	2,062	1.0%	2,062	**1.0%**
Carroll County	0	0.0%	9,673	3.3%	9,673	**3.3%**
Cecil County	3,201	1.4%	51,615	22.4%	54,816	**23.8%**
Charles County	55,058	13.4%	199,291	48.4%	254,349	**61.7%**
Dorchester County	0	0.0%	410	0.1%	410	**0.1%**
Frederick County	25,193	5.9%	92,597	21.7%	117,790	**27.6%**
Garrett County	299,403	71.3%	105,230	25.1%	404,633	**96.4%**
Harford County	0	0.0%	43,481	15.2%	43,481	**15.2%**
Howard County	26	0.0%	17,986	11.1%	18,012	**11.1%**
Montgomery County	0	0.0%	9,966	3.1%	9,966	**3.1%**
Prince George's County	2,984	0.9%	87,768	27.5%	90,751	**28.4%**
Queen Anne's County	0	0.0%	43	0.0%	43	**0.0%**
Somerset County	0	0.0%	9,808	4.6%	9,808	**4.6%**
St. Mary's County	28,352	7.2%	140,369	35.4%	168,721	**42.6%**
Washington County	42,655	14.2%	81,061	27.1%	123,716	**41.3%**
Wicomico County	10,936	4.5%	43,516	17.8%	54,452	**22.3%**
Worcester County	18584	6.1%	108,464	35.7%	127,049	**41.9%**

Local Plan Risk Assessment. Twenty-three of the local plans addressed and ranked wildfire in their hazard mitigation plans. Three local plans considered wildfire a high hazard, twelve medium, three medium-low, and five low. Seven local plans addressed risk to urban fire. Only natural hazards were included in the 2011 state plan update vulnerability analysis. Section 3.6 includes a summary of how each of the local plans ranked wildfire and urban fire and outlines the assumptions that were made in an effort to compare the local hazard rankings to each other.

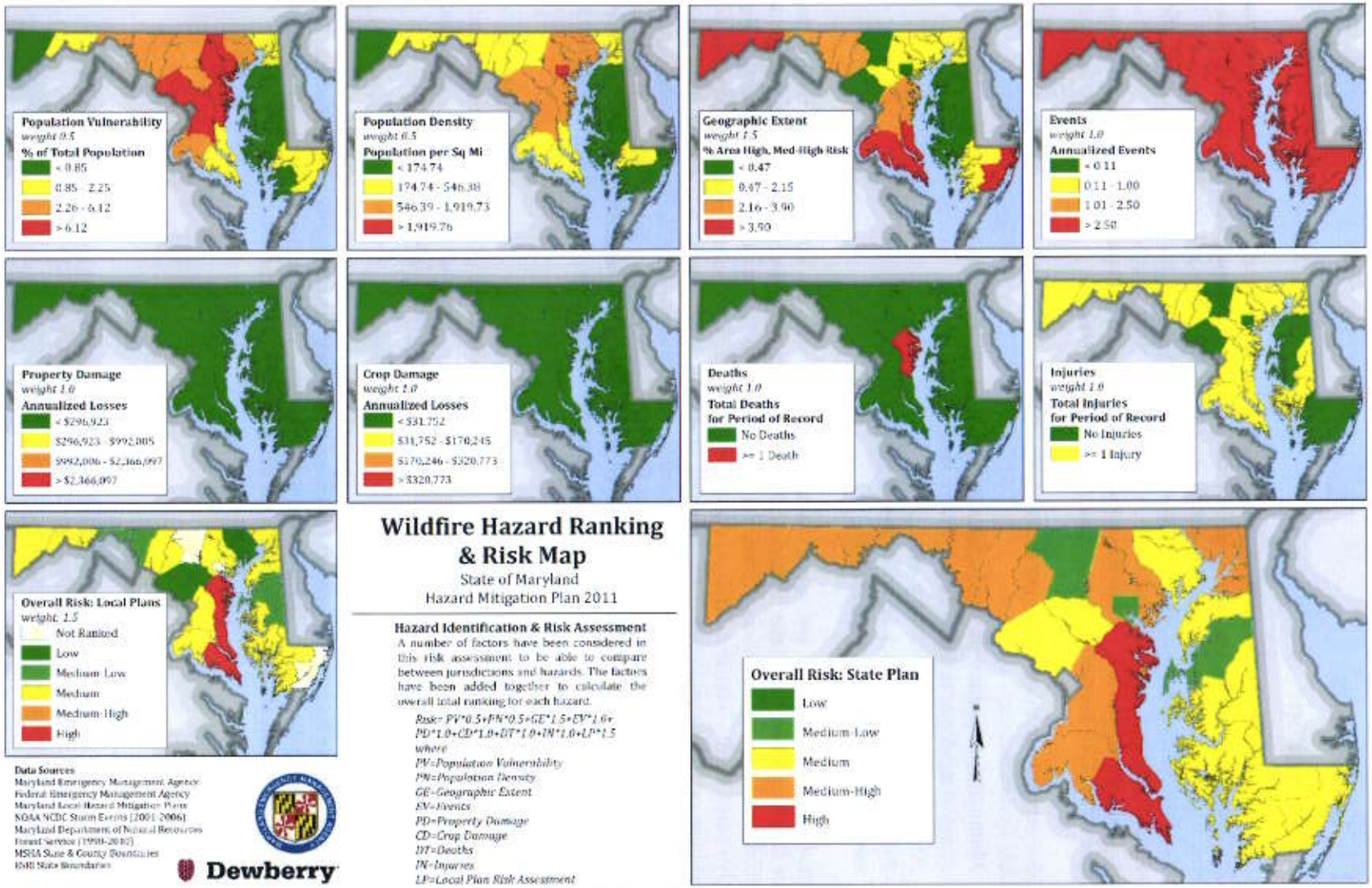

Figure 3-44. Wildfire Hazard Ranking and Risk.

3.12 Landslides

3.12.1 Description

A landslide is the downhill movement of soil, rock, or other earth materials in response to the pull of gravity. More specifically, the term landslide encompasses mudflows, mudslides, debris flows, rocks falls, rockslides, debris avalanches, debris slides, and earth flows. Landslides often occur in areas where the soil is over-saturated from heavy rain or snow-melt. Landslides can also occur after earthquakes, changes in groundwater levels, or changes in slope due to man-made construction activities. In detail, a landslide occurs when the force (gravity) that is pulling the slope downward exceeds the strength of the earth materials that compose the slope[40].

Landslides generally require a combination of steep slopes and water-saturated earth materials and susceptible terrain include:

- Mountainous terrain with very steep slopes;
- Areas of moderate relief suffering severe land degradation;
- Areas of heavy precipitation events;
- Areas covered with thick layers of finely grained soil deposits; and
- Areas subject to earthquake shaking.

Some landslides move slowly and cause damage gradually, whereas others move so rapidly that they can destroy property and take lives suddenly and unexpectedly. Debris flows (also referred to as mudslides, mudflows, or debris avalanches) are a common type of fast-moving landslide that generally occurs during intense rainfall on water-saturated soil. They usually start on steep hillsides as soil slumps or slides that liquefy and accelerate to speeds as great as 35 miles per hour or more. They continue flowing down hills and into channels, depositing sand, mud, boulders, and organic material onto more gently sloping ground. The flow consistency ranges from water mud to thick, rocky mud (like wet cement), which is dense enough to carry boulders, trees, and cars. Debris flows from different sources can combine in channels, where their destructive power may be greatly increased[41]

Geologic, physiographic, and climatic factors affect the nature and occurrence of landslides in Maryland. Geology and physiographic factors affecting the incidence of landslides includes folds, fractures and pre-existing faults in the underlying geologic formations. Steep areas with poor surface and/or subsurface drainage are particularly susceptible to landslides.

3.12.2 Historical Occurrences

The greatest landslide hazards are present in western Maryland. The majority of eastern Maryland is not susceptible to landslides. There is no comprehensive database documenting all landslide occurrences in the state. Historic information for dates that landslides have occurred is minimal.

[40] National Atlas Articles Geology: http://www.nationalatlas.gov/articles/geology/a_geohazards.html
[41] USGS Fact Sheet, *FS-159-96: Debris-Flow Hazards in the Blue Ridge of Virginia*, http://landslides.usgs.gov/docs/faq/fs159-96.pdf

3.12.3 Risk Assessment

According to the USGS Landslide overview map, the areas west of Frederick County have a moderate landslide incidence and high landslide susceptibility[42] (Figure 3-45). This area is comprised of the Appalachian Plateaus Province, Ridge and Valley Province, and the Blue Ridge Province[43]. The steep sided gorges, folds, and fractured rock in these provinces are prone to debris avalanches and debris slides. The debris slides are slow moving and therefore pose relatively little risk to humans but can cause millions of dollars in damage every year. However, the risk associated with these landslides is much greater in other states where the elevation of the Appalachian Mountains is higher than in Maryland. There is also a thin band of high landslide incidence and high landslide susceptibility just south of Baltimore City that trends south-west. Within this band, there is lower Cretaceous clay from the deeply weathered metamorphic rocks that is subject to slumps and earth flows. Due to the low topography in this area, these slumps are not large in area and pose relatively low risk to humans.

Probability of Future Occurrence. Presently the "probability" of a landslide occurrence cannot be estimated based on statistical data, nor can the "safety factor" for any given slope based on geotechnical laboratory tests and mathematical computations be calculated. As mentioned, according to the United States Geological Survey, the western half of Maryland resides in a zone of moderate incidence of landslides. In addition, a thin band south of Baltimore City that trends south-west has a high incidence of landslides.

Conditions in Maryland that contribute to the frequency of landslides include the mountainous terrain and the high average annual precipitation. Winter precipitation seeps into cracks and fissures in rock slopes and expands upon freezing, which frequently results in sliding and toppling failures. Precipitation throughout the year can raise the groundwater table which tends to reduce slope stability; seep into soil rock boundary layers and reduce friction between layers resulting in translational or block slides, or increase the moisture content and weaken loose or unconsolidated soils causing rotational failures or earth flows. Other factors that may also contribute to the occurrence of landslides include seismic activity, construction activities that increase surface runoff (e.g., wildfires) or construction of paved surfaces thereby causing increased localized erosion.

Climate change impacts, including the possibility of more frequent, intense precipitation events and more frequent short-term drought creating conditions more favorable for wildfires, could result in greater surface runoff and an increased probability of landslide in the future.

Impact and Vulnerability. Landslides can cause serious damage to highways, buildings, homes, and other structures that support a wide range of economics and activities. Landslides commonly coincide with other natural disasters. Expansion of urban development contributes to a greater risk of damage by landslides to both persons and property.

[42] Radbruch-Hall, D.H., Colton, R. B., Davis, W. E., Lucchitta, I., Skipp, B. A., Varnes, D. J., 1978, Landslide Overview Map of the Conterminous United States, United States Geological Survey
[43] Reger, J. P. and Cleaves, E. T., 2008, Physiographic Map of Maryland, Maryland Geological Survey

Figure 3-45. Landslide risk based from USGS landslide overview map.

The USGS recognizes six major impacts caused by landslides:[44]

1. Causes damage in all 50 States, Puerto Rico, and the U.S. Virgin Islands
2. Costs $3.5 billion per year, in 2005 dollars, in damage repair
3. Causes between 25 and 50 deaths in the United States annually
4. Reduces real estate values and tourist revenue
5. Leads to lost human, industrial, agricultural, and forest productivity
6. Causes damage to the natural environment

Risk. Risk, strictly defined as probability multiplied by impact, cannot be fully estimated for landslides due to the lack of historical data and detailed mapping. To assess risk, mapping by the USGS of landslide susceptibility and incidence was used as the probability of future occurrence. More than half of Maryland has a medium incidence or more, but this does not correlate with risk. Annualized losses of property damage and crop damage are low in all counties. Property damage from landslides is less than $296,923 and crop damage is less than $31,752. There have been no reported deaths or injuries in any county as a result of landslides. There are vulnerable populations in the center of Maryland where the population density increases. Overall risk of landslides is greater in the western counties of Maryland.

State and Critical Facility Risk. In order to determine which facilities are at risk for landslides, the state facilities were intersected with the USGS landslide layer. *It should be noted that the data is at a state scale and is not intended for site-specific research.* The total number of critical and state facilities that intersect with the USGS landslide layer are summed and the total building and content value of those facilities are summarized in Table 3-88.

Table 3-88. Critical Facilities Located Within Landslide Hazard Areas.

County/City	Total Number of Critical Facilities	Critical Facilities Building and Contents Values	Total Number of State Facilities	State Facilities Building and Contents Values
Allegany County	976	$ 382,118,400	287	$ 762,473,700
Anne Arundel County	2505	$ 551,473,587	132	$ 1,989,649,523
Baltimore County	373	$ 48,812,933	2	$ 347, 733
City of Baltimore	1055	$ 77,471,867	43	$ 149,471,406
Calvert County	2	-	-	-
Carroll County	1	-	-	-
Frederick County	1156	$ 446,714,307	108	$ 142,939,977
Garrett County	525	$ 105,701,733	252	85,726,901
Howard County	70	$ 3,051,867	-	-
Montgomery County	29	-	-	-
Prince George's County	4221	$ 718,626,787	386	$ 4,071,461,860
Washington County	210	$ 36,672,613	78	$ 11,168,444
Wicomico County	1	-	-	-

[44] USGS Fact Sheet: FS-2005-3156: Landslide Hazards – A National Threat

In addition, the total exposure value of critical and state facilities that overlap with the high incidence layer and high-susceptibility, moderate-incidence layer are summarized in Table 3-.

Table 3-89. Critical and State facilities that intersect with high landslide hazard layers.

County/City	Critical Facility Total Exposure in High Incidence	State Facility Total Exposure in High Incidence
Anne Arundel County	$ 551,473,586.67	$ 1,989,649,523.02
Baltimore County	$ 48,812,933.33	$ 347,733.33
City of Baltimore	$ 77,471,866.67	$ 149,471,406.49
Howard County	$ 3,051,866.67	$ -
Prince George's County	$ 717,589,880.00	$ 4,037,998,332.68
Allegany County	$ 382,118,400.00	$ 762,473,700.06
Frederick County	$ 446,714,306.67	$ 131,785,467.81
Garrett County	$ 105,701,733.33	$ 74,572,392.28
Washington County	$ 36,672,613.33	$ 11,168,444.00

Jurisdictional Risk. No counties were ranked as having a high landslide hazard. Garrett, Allegany, and Carroll counties were ranked as having a medium-high hazard ranking. This ranking was accomplished using the methodology described in the Hazard Analysis and Ranking Methodology Section 3.5 of the HIRA. Figure 3-46 shows the hazard ranking map for landslides.

Local Plan Risk Assessment. Seventeen of the local plans addressed and ranked landslide in their hazard mitigation plans. One of the local plans considered landslide as a high hazard, four as medium-high, one as medium, five as medium-low, and six as low. Section 3.6 includes a summary of how each of the local plans ranked landslide and outlines the assumptions that were made in an effort to compare the local hazard rankings to each other.

Consequence Analysis. A consequence analysis, derived from the Emergency Management Accreditation Program (EMAP) has been performed to better understand and outline the impacts that a landslide event would have on the public; responders; continuity of operations including delivery of services; property, facilities and infrastructure; the environment; the economic condition of the state, and public confidence in the states governance. The results of the consequence analysis are shown in Table 3-90.

Table 3-90. EMAP Consequence Analysis for Landslides

Subject	Impacts
Healthy and Safety of the Public	People living in Western Maryland are at greatest risk for impacts from landslide events. Impacts would be localized; only those in and around the incident area would be impacted. Potential impacts to the public include damage to roadways, homes, injuries, and loss of life in severe instances.
Health and Safety of Responders	First responders, such as fire and police, would be called to the incident area to evacuate people, close roads, and attend to any injured. For a landslide

	event, as with all disaster events, responders face the risk of personal injury while performing necessary job functions.
Continuity of Operations (incl. delivery of services)	The impacts on continuity of operations will be limited, unless a facility is within the incident area. Road closures and damages to transportation infrastructure as a result of a landslide may delay the delivery of some services.
Property, facilities, and infrastructure	Home and land owners within the incident area may experience property damage depending upon the severity of the event. Infrastructure may experience impacts in the form of road closures, damages to roads/bridges, and damages to the sewer network.
Environment	A landslide event will alter the landscape. Changes in topography will occur to varying degrees, and vegetation and wildlife habitat may be damaged or destroyed. Additionally, soil and sediment runoff accumulating downslope could block waterways and roadways.
Economic condition of the state	A major landslide event would drain state, county, and local resources. Some of the costs could be recouped through federal grant reimbursements, but local governments would still feel the fiscal impact of a major event.
Public confidence in state governance	Public confidence will largely depend upon how effectively the state, county, or local government responds to the landslide event.

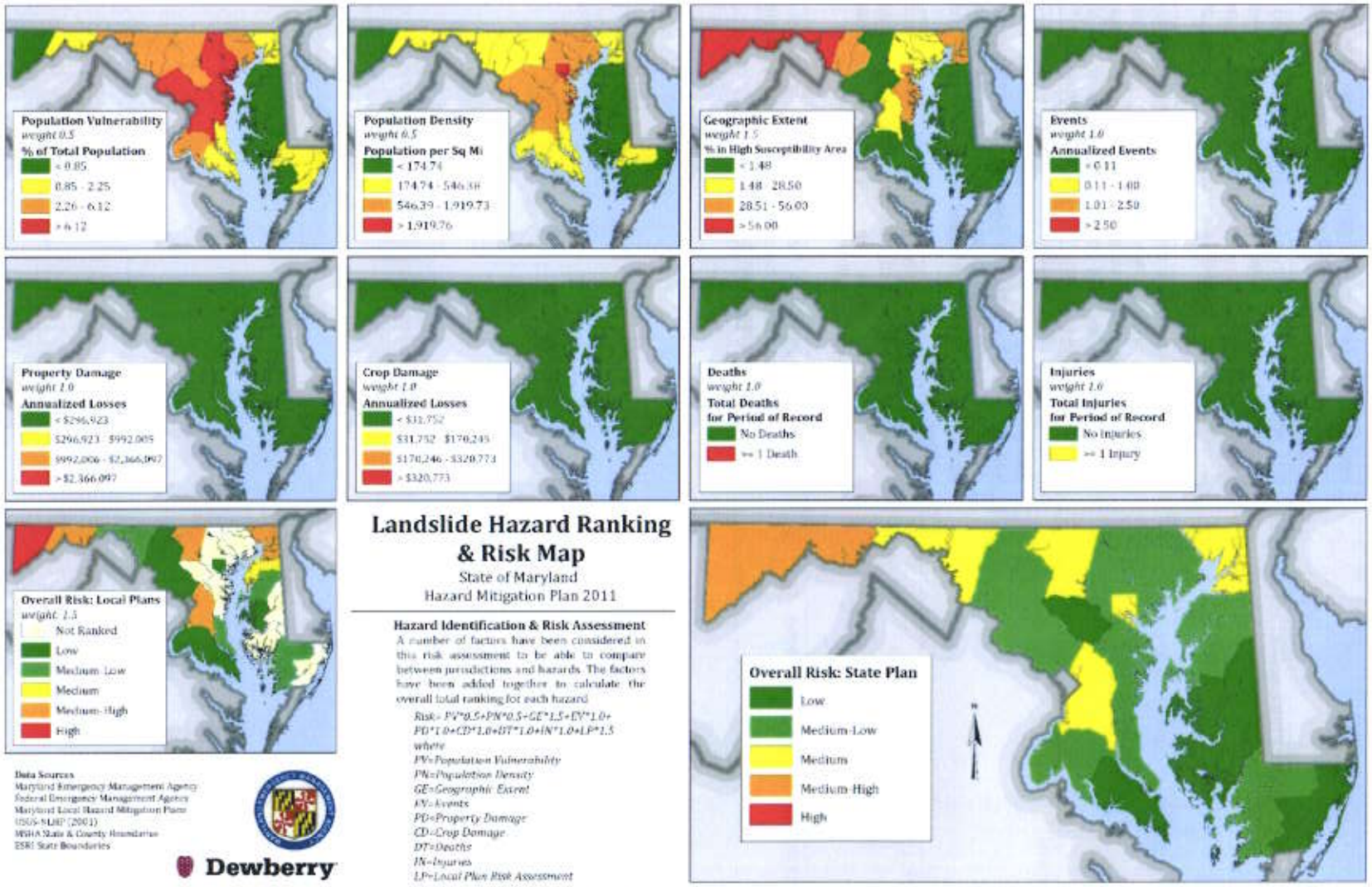

Figure 3-46. Landslide hazard ranking and risk map.

3.13 Land Subsidence/Karst/Sinkholes

3.13.1 Description

Land subsidence is a gradual settling or sudden sinking of the Earth's surface owing to subsurface movement of earth materials. Subsidence may be gradual or sudden and can range in extent from broad, regional reductions in elevation to localized areas of collapses. Subsidence is a global problem, and in the United States, more than 17,000 square miles in 45 States, an area roughly the size of New Hampshire and Vermont combined, have been directly affected by subsidence. The principal causes are aquifer-system compaction, drainage of organic soils, underground mining, hydrocompaction, natural compaction, sinkholes, and thawing permafrost. Three distinct processes account for most of the water-related subsidence--compaction of aquifer systems, drainage and subsequent oxidation of organic soils, and dissolution and collapse of susceptible rocks.[45]

Figure 3-47. Sinkholes in parking area, Frederick, Maryland.

Source: Brezinski et al., 2003, Geologic Mapping as a Basis for Sinkhole Susceptibility Prediction, Frederick Valley, Maryland.

"Karst" is the term commonly used to describe areas containing distinctive surficial and subterranean features, such as fissures, tubes, and caves, developed by solution of carbonate and other rocks. Karst areas are characterized by closed depressions, sinking streams, and cavern openings (Figure 3-47). When used in its broadest sense, the term karst encompasses many surface and subsurface conditions that give rise to problems in engineering geology. In Maryland, most karst lands are underlain by soluble limestone and dolomite, collectively referred to as "carbonate rock. The limestone and dolomite valleys west of the Blue Ridge Mountains are separated by narrow ridges largely composed of sandstone and shale. Lower ridges are often composed of sandy dolomites and limestones. Both of these terrains can exhibit extreme karst topography, with first and second order streams that abruptly or gradually lose drainage to the caves and closed depressions[46]

3.13.2 Historical Occurrences

Data on subsidence in Maryland was obtained from a number of sources: Maryland Geological Survey (MGS), Maryland Bureau of Mines, USGS, and the Maryland Department of Natural Resources. Maryland is affected by a broad, regional subsidence phenomenon and more localized land collapsing due to sinkhole formation.

[45] Land Subsidence in the United States. USGS Fact Sheet 165-00. December 2000.
[46] Reger, J., Foundation Engineering Problems and Hazards in Karst Terranes, http://www.mgs.md.gov/esic/fs/fs11.html

The regional subsidence is believed to be the result of post-glacial rebound from the last glacial maximum. The mass of the ice sheet displaced land, thus pushing the surrounding land up at the extent of the ice sheet's coverage (Chesapeake Bay region in Maryland). After the ice sheets retreated, the area that was pushed up has been subsiding. At a regional scale, Maryland land is subsiding at a rate of approximately 1.5 mm/yr[47].

To date there have been no Federal Declared Disasters or NCDC recorded events for karst related events in Maryland. Land subsidence is very site-specific and there are numerous news articles on sinkholes forming in several counties within Maryland. The formation of sinkholes is often reported due to the disruption of transportation avenues. For example, a sinkhole 20 feet across and ~35 feet deep was excavated on Interstate 70 in Frederick County in April, 2008[48]. There is currently no comprehensive long-term record of past events in Maryland. For future revisions of this section, it is recommended that the Maryland Department of Transportation be involved to determine areas where roads experience sinkholes to improve on the incidence reporting.

3.13.3 Risk Assessment

At the regional scale, there is little risk of the actual land subsidence. However, the direct consequences of this regional subsidence do pose a risk to Maryland and are discussed in the sea-level rise section of this report.

The most-affected counties are Washington, Carroll, Frederick, Baltimore, and Allegany (Figure 3-48). The MGS estimates that karst topography covers 35 square miles of Frederick County and 70 to 105 square miles of Washington County[49]. Through geologic mapping, the MGS has identified more than 1,000 karst features including 125 sinkholes in a small portion of Frederick County. The two geologic formations most associated with sinkholes are the Frederick Formation and the Grove Formation. This assessment focuses on areas that are vulnerable to collapse due to the underlying geologic formation dissolution; it does not focus on areas underlain by coal which are subject to abandoned mine collapse (See Section 3.19 for additional information regarding mining hazards) or failed urban underground infrastructure that leads to sinkholes. The land subsidence risk as determined from the U.S. Office of Surface Mining, Maryland Bureau of Mines, Maryland State Highway Administration, and MGS can be found in Figure 3-48. The land subsidence risk is likely greater than shown currently, but the risk can only be determined from available geologic mapping. As the bedrock geology and geomorphology of additional areas in Maryland are mapped, the land subsidence will need updating. In general, sinkholes pose a greater threat to infrastructure and property than to human life. However, in 1994 a man was killed in Carroll County when he drove his car into a recently formed sinkhole[50].

[47] Douglas, Bruce, Variations in Sea Level, http://www.ngs.noaa.gov/GRD/GPS/Projects/CB/SEALEVEL/sealevel.html
[48] Morse, Dan, Discovery of Sinkhole on I-70 Forces Repairs, Disrupts Traffic, April 25, 2008, http://www.washingtonpost.com/wp-dyn/content/article/2008/04/24/AR2008042401708.html
[49] Sherwood, T., 2004, Karst and Sinkholes in Western Maryland, http://users.erols.com/wmarylandrcd/14374_lores_screen.pdf
[50] Carroll County man dies after van falls into 2-story deep hole on Route 31, 1994, http://articles.baltimoresun.com/1994-03-31/news/1994090172_1_sinkhole-knight-carroll-county

Figure 3-48. Land subsidence risk.

Probability of Future Occurrence. Karst formations develop in specific ways that are influenced by unique local conditions. Sinkholes can be induced through natural or human causes. Sinkholes that occur naturally usually form by the slow downward dissolution of carbonate rock though bedrock collapse in areas that overlie caverns.51 Human induced sinkholes can be triggered by simple alteration in the local hydrology. Inadequate drainage along highways and increased runoff from pavements can also be sources of sinkhole development.

The probability of land subsidence cannot be expressed in terms of specific return periods or recurrence intervals as easily as it can be for other hazards. As a result, the probability analysis consists of delineating those regions that experience relatively more sinkholes.

Impact and Vulnerability. The most important environmental issue with respect to karst is the sensitivity of karst aquifers to groundwater contamination. This problem is universal among all karst regions in the United States that underlie populated areas.

The USGS recognizes four major impacts caused by land subsidence:

- Changes in elevation and slope of streams, canals, and drains
- Damage to bridges, roads, railroads, storm drains, sanitary sewers, canals and levees
- Damage to private and public buildings
- Failure of well casings from forces generated by compaction of fine-grained materials in aquifer systems

State and critical facilities within Washington, Frederick, and Baltimore Counties are most vulnerable to land subsidence caused by karst topography. Therefore, these counties should ensure their Continuity of Operation Plans (COOP) are up-to-date and utilized during a land subsidence event. First responders help guarantee continuity of services by evacuating structurally damaged buildings, closing damaged roadways and bridges, and limiting access to the land subsidence hazard area.

Risk. Risk, strictly defined as probability multiplied by impact, cannot be fully estimated for subsidence due to the lack of historical data and detailed mapping. To assess risk, mapping by the MGS of karst features was used as the probability of future occurrence. Mapping of karst topography is on-going.

State and Critical Facility Risk. To determine which facilities are at risk for land subsidence, the state facilities were intersected with the USGS land subsidence risk map. *It should be noted that the data is at a national scale and is not intended for site-specific research.* The total number of critical and state facilities that intersect with the USGS land subsidence layer are summed and the total building and content value of those facilities are summarized in Table 3-91.

Jurisdictional Risk. No counties were ranked as having a high land subsidence hazard. Carroll and Frederick County were ranked as having a medium-high hazard ranking while Washington County was ranked as having a medium hazard for land subsidence. This ranking was

[51] Langer, W. H. "Potential environmental impacts of quarrying stone in karst—a literature review." U.S. Geological Survey Open-File Report 0F-01-0484, (2001).

accomplished using the methodology described in Hazard Assessment and Ranking Methodology. Figure 3-49 shows the hazard ranking map for land subsidence.

Local Plan Risk Assessment. Five local plans addressed and ranked karst in their hazard mitigation plans. Carroll and Frederick counties both ranked karst as a high hazard, Washington and Wicomico counties as medium-low and Calvert County as low. Section 3.6 includes a summary of how each of the local plans ranked karst and outlines the assumptions that were made in an effort to compare the local hazard rankings to each other.

Table 3-91. Critical Facilities Located Within Land Subsidence Hazard Areas.

County/City	Total Number of Critical Facilities	Critical Facilities Building and Contents Values	Total Number of State Facilities	State Facilities Building and Contents Values
Allegany County	125	$19,650,800.00	21	$14,314,875
Baltimore County	959	$90,447,600.00	9	$65,254,788
Carroll County	68	$11,846,133.00	-	
Cecil County	1	$-	-	
Frederick County	1,118	$383,265,000.00	58	$131,499,228
Garrett County	22	$-	85	$ 6,134,279
Harford County	2	$-	-	
Howard County	15	$-	10	$1,778,553
Washington County	1,756	$503,291,600.00	169	$362,260,297
Grand Total	**4,066**	**$1,008,501,133**	**352**	**$581,242,020**

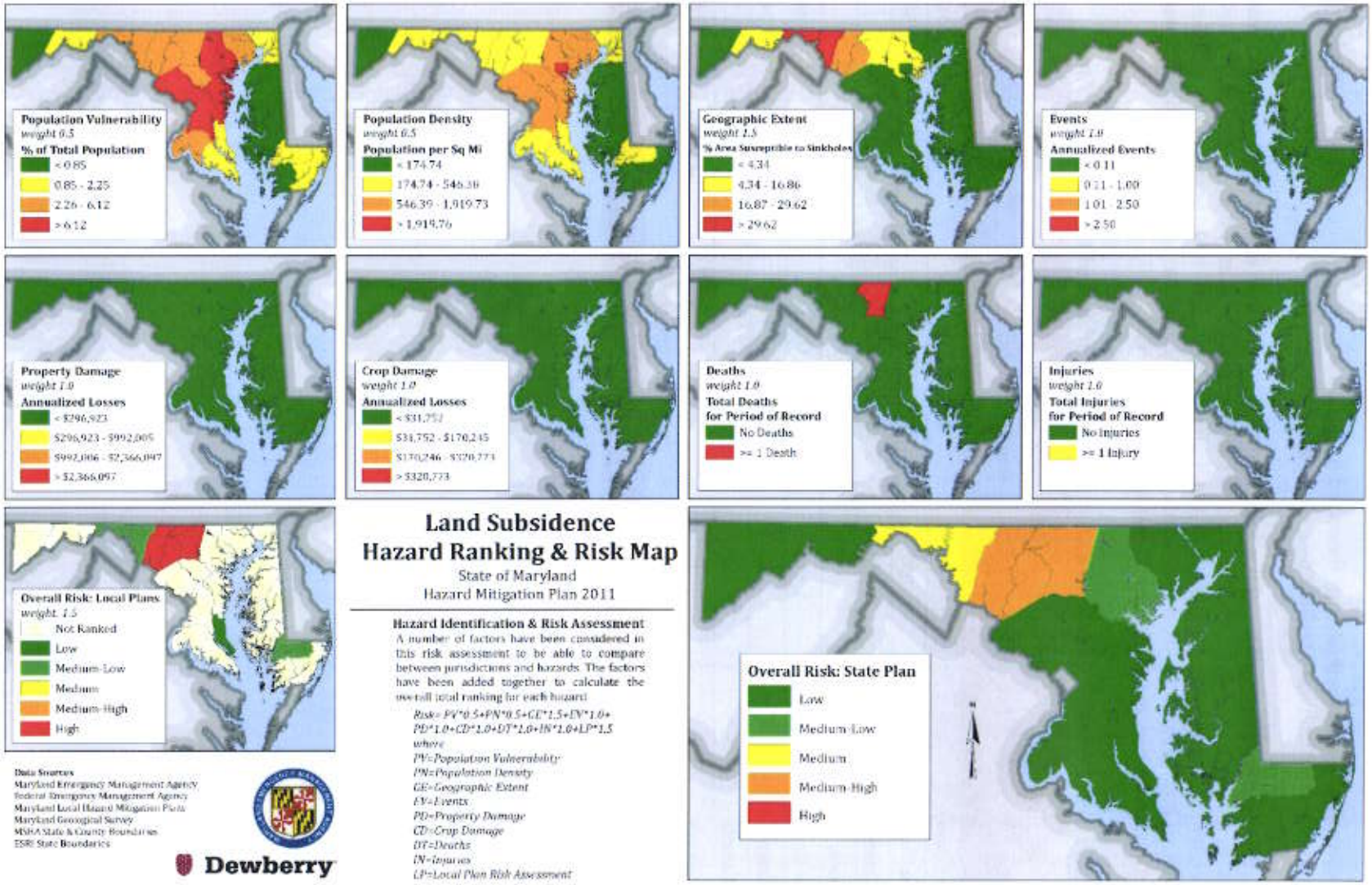

Figure 3-49. Land subsidence (karst/sinkhole) hazard ranking and risk map.

3.14 Drought

3.14.1 Description

Although the simplest definition of drought may be "an extended period of dry weather;" there are actually four different types of drought.

1. *Meteorological drought*: A measure of departure of precipitation from normal. Due to climatic differences, what is considered a drought in one location may not be a drought in another location.
2. *Agricultural drought:* The amount of moisture in the soil no longer meets the needs of a particular crop.
3. *Hydrological drought:* Surface and subsurface water supplies that are below normal.
4. *Socioeconomic drought:* The situation that occurs when physical water shortage begins to affect people.

With these different types of drought come differences in extent, severity, and duration. An entire region may experience drought for years, whereas a few counties may suffer catastrophic losses from a severe event that lasts only three months. Droughts can cause damage not only to crops, but also to livestock and wildlife. During a prolonged drought, land values can decrease, and unemployment can increase. Water restrictions implemented during a drought can have a negative economic impact on water-dependent businesses. Also, short and long-term drought may lead to an increase in the incidence of wildfires which might in turn lead to increased potential for landslides or mudflows once rain does fall.

The Maryland Department of the Environment has elected to use the U.S. Army Corps of Engineers' definition of drought, which states, "droughts are periods of time when natural or managed water systems do not provide enough water to meet established human and environmental uses because of natural shortfalls in precipitation or stream flow"[52]. Based on this definition, the State closely monitors precipitation levels, stream flows, ground water levels, and reservoir storage to manage water supplies for not only humans, but also for the needs of the environment and wildlife.

3.14.2 Historical Occurrences

Because the characteristics and impacts of drought differ in so many ways, it is difficult to quantify drought. A standard measure of drought severity is the Palmer Drought Severity Index[53] (PDSI), shown in Table 3-92. It uses temperature and precipitation levels to determine dryness. The advantage of the Palmer Index is that it is standardized to local climate, so it can be applied to any part of the country to demonstrate relative drought or rainfall conditions. A monthly PDSI value below -2.0 indicates moderate drought, and a value below -3.0 indicates severe drought.

[52] Maryland Department of the Environment. http://www.mde.state.md.us/programs/Water/DroughtInformation/DroughtInfoandIndicators/Pages/index.aspx (June 2011).
[53] NOAA Drought Information Center, http://www.drought.noaa.gov/palmer.html (June 2011)

Table 3-92. Palmer Drought Severity Index.

Value	Condition
3.0 and above	Extreme moist spell
3.0 to 3.99	Very moist spell
2.0 to 2.99	Unusual moist spell
1.0 to 1.99	Moist spell
0.50 to 0.99	Incipient moist spell
0.49 to -0.49	Near normal
-0.50 to -0.99	Incipient drought
-1.0 to -1.99	Mild drought
-2.0 to -2.99	Moderate drought
-3.0 to -3.99	Severe drought
-4.0 & below	Extreme drought

Annual average PDSI values have been recorded for Maryland's since 1895[54]. PDSI values from 1895-2010 can be found in Appendix P Historically, Maryland has experienced near normal moisture conditions. Table 3-93 shows each county's average PDSI value from 1895-2010. However, since 1990 several mild and moderate droughts have occurred in the State, including severe droughts in 1999, 2002 and 2006 as shown in Table 3-94.

Table 3-93. Average Annual PDSI Values per County, 1895-2010.

Jurisdiction	Average Annual PDSI Value
Allegany County	-0.25
Anne Arundel County	-0.11
Baltimore County	-0.32
Calvert County	-0.02
Caroline County	-0.10
Carroll County	-0.32
Cecil County	-0.32
Charles County	-0.02
Dorchester County	-0.10
Frederick County	-0.32
Garrett County	-0.20
Harford County	-0.32
Howard County	-0.32
Kent County	-0.12
Montgomery County	-0.32

[54] NOAA National Climatic Data Center, http://www.ncdc.noaa.gov/temp-and-precip/time-series/index.php?parameter=pdsi&month=5&year=2011&filter=ytd&state=18&div=0 (June 2011)

Jurisdiction	Average Annual PDSI Value
Prince George's County	-0.11
Queen Anne's County	-0.12
Somerset County	-0.03
St. Mary's County	-0.02
Talbot County	-0.10
Washington County	-0.25
Wicomico County	-0.03
Worcester County	-0.03
City of Baltimore	-0.32
Ocean City	-0.03

Table 3-94. Average Annual PDSI Values, State of Maryland, 1990-2010.

Year	PDSI Value
2010	-1.18
2009	1.05
2008	1.64
2007	-1.10
2006	-2.28
2005	0.46
2004	3.00
2003	3.18
2002	-3.20
2001	0.23
2000	0.60
1999	-3.38
1998	2.42
1997	-0.77
1996	2.19
1995	-1.94
1994	-0.59
1993	-0.49
1992	-2.76
1991	-1.88
1990	1.20

Maryland generally experiences average to higher-than-average values for stream flow. However, it is normal for Maryland to experience drought cycles. In 2002, 72 average monthly stream flow records were set across Maryland. In 2000, more wells broke monthly record lows than during any

other recorded period. In 1966, the worst year of the 1958-1971 droughts, 32 monthly stream flow records were set. Stream flow into the Chesapeake Bay for 1999 was the fourth lowest annual flow for the period 1951-1999. Lower flows were experienced only in years 1963, 1965, and 1966.

Since 1930, droughts have occurred about once every 10 years but differed in severity and duration. Annual average rainfall departure generally was most severe at the end of the 1958-1971 drought. Greater than average stream flow in Maryland and the District of Columbia has alternated with short periods of less than average stream flow.

The worst drought in Maryland appears to have occurred from December 1929 to February 1931, with 1930 being the driest year since 186955. During the 15-month agricultural drought, rainfall was 21.5 inches below normal. Crop losses in 1930 dollars were estimated at $40 million. Other significant drought events are presented in Table 3-95.

Table 3-95. Previous Significant Drought Events.

Date	Event	Comments
1930-1932	Drought	Probably the most severe agricultural drought ever recorded in Maryland and the District of Colombia. Rainfall was about 40 percent less than average, and crop losses for 1930 alone were estimated at $40 million.
July 10, 1936	Excessive Heat	The highest temperature ever recorded for the state was recorded in the cities of Cumberland (Allegany County) and Frederick (Frederick County) in western Maryland. Temperatures reached 109 degrees on the July day in 1936.
1953-1956	Drought	Affected almost all of Maryland and the District of Columbia. Drought recurrence intervals exceeded 25 years for those areas of Maryland west of Baltimore. For the remaining parts of Maryland and the District of Columbia, the drought had recurrence intervals of 10-25 years, except for the area north and east of Baltimore where recurrence intervals were less than 10 years.
1958-1971	Drought	This drought lasted the longest of any drought since 1930 and was the most severe in terms of annual departure from average stream flow. Rainfall was sufficient to prevent major agricultural losses. Stream flow in the Potomac declined to record lows, with withdrawals accounting for 80 percent of the available water flow.
1980-1983	Drought	Affected all but the westernmost part of Maryland. Recurrence interval of the drought was about 10 to 25 years throughout the affected area. The extent to which stream flow decreased during this drought is similar to that during the 1958-71 drought. No major agricultural drought developed, and water supplies were adequate for public supply use.
Fall 1984-Summer 1988	Drought	This drought affected Maryland east and south of Frederick and Washington D.C. Many counties were declared disaster areas because of large agricultural losses. These losses for 1986-1988 were estimated at $302 million. Water supplies for municipalities did not become critically low, although water use was restricted in several areas during summers.

[55] U.S Weather Bureau 1930

Date	Event	Comments
July 14-16, 1995	Excessive Heat	A 38-hour period of extremely hot and humid weather in mid-July took its toll on humans and animals alike. The most life-threatening period of the heat wave occurred during the afternoon of the 15th, when temperatures ranged from 98 to 103 but heat indices were between 115 and 129. For the entire period, heat indices were at or above 90 at most locations. In the Baltimore area, there were a reported six deaths from the excessive heat. The Medical Examiner's office reported two other deaths in the state during the same period. Thirty-one people were injured on the 17th when an elevated portion of Baltimore's subway bowed outward, causing a train to derail. Property damages were estimated at $30,000. In Worcester County, the intense heat was responsible for the loss of 3.7 million chickens on the Delmarva Peninsula. These losses amounted to $4.7 million.
August-September, 1995	Drought/Excessive Heat	Dry weather, combined with periods of excessive heat, caused substantial damage to several crops, and limited the production of healthy livestock, during a month-long period that extended through mid-September.
July 1, 1997	Drought	A very dry month, containing one 7-day heat wave, exacerbated drought-like conditions across much of the fertile farmland of Maryland. The weather in July proved to be the death knell for much of the crop yield, including corn, hay, alfalfa, and soybeans. Agricultural states of emergency were declared in many areas west of the Chesapeake Bay. Hardest-hit counties included Carroll, Frederick, Howard, Montgomery, and Washington. Total crop damages were estimated at $43.7 million.
March 27-31, 1998	Unseasonably Warm Temperatures	A strong atmospheric high brought very warm, dry weather to the area. One record high temperature was set at Baltimore Washington International airport with 86 degrees. Four long-standing records were shattered in Hagerstown. Notably, the all-time March high temperature (formerly 88 degrees) was broken on March 30th when the mercury topped out at 89. The record had stood since 1907. The dry and breezy conditions aided several small brush fires, including three in eastern Anne Arundel Co on the 28th through the 30th. One fire consumed 4 acres; the others burned less than 2 acres each. Crop damages reached $10,000.
August, 1999	Drought	High pressure was the dominant weather feature across Maryland through the 24th of August. Most rain producing storm systems steered north of the region through the period. This resulted in the continuation of the climatological, meteorological, and hydrological drought which plagued the area. By the third week of August the Palmer Drought Index, a measure of long term drought conditions, indicated Maryland was in an extreme drought. Washington County reported the lowest groundwater levels in history on the 4th. Nineteen Maryland counties were declared federal drought disaster areas on the 11th. The agricultural drought in Maryland continued to devastate farmers, who suffered crop damages of $30 million.

Date	Event	Comments
September 2001-September 2002	Drought	These months were the driest on record since record keeping began in 1871. Groundwater levels, reservoirs, and stream levels fell below record lows. Much of the state was under mandatory water-use restrictions, and wildfires were abundant. Precipitation amounts during this time were only about 57 percent of normal levels.
August 22, 2007	Drought	The U.S. Department of Agriculture Secretary declared a drought disaster for the entire State of Maryland. Carroll County rainfall totals are unknown. However, Frederick County experienced 9.52 inches below normal precipitation totals and Washington County experienced 7.54 inches below normal precipitation totals. As of February 2007, the monetary impact of these low precipitation totals is unknown.
November, 2008	Drought	This was the fifth month in a row that drought conditions were seen across Central and Northern Maryland. Persistent high pressure over the Southeast U.S. forced most rain producing low pressure systems to steer north of the region. The 5 month rainfall total at BWI Airport was only 5.79 inches, compared to the normal of over 17 inches. In Allegany County, the Georges Creek which feeds into the Potomac River dried up, causing 2,000 households and businesses to run out of water. The drought also contributed to a six-fold increase in the amount of brush fires seen across Maryland this November. The agricultural community continued to be hard hit by the persistent drought. By November 20th, 80 percent of topsoil moisture across the state was rated short or very short. The persistent drought contributed $40 million in damage to the fall harvest.

3.14.3 Risk Assessment

Drought risk was assessed using historical data acquired from the National Climatic Data Center's U.S. Storm Events Database. Event data ranges from August 7, 1995 through November 1, 2010. Specific event types queried from the database are listed in Table 3-. The extent of drought risk was assessed using the Cropland Data Layer 2010 GIS dataset produced by the U.S. Department of Agriculture's National Agricultural Statistics Service.

Probability of Future Occurrence. Due to the relatively short period of record of NCDC data, it is difficult to accurately forecast future incidence of drought. However, upon examining the available data it is reasonable to assume that drought will continue to impact Maryland the future. Based on past events from NCDC data, Caroline, Cecil, Kent, Queen Anne's, and Talbot counties may experience at least two significant short-term droughts annually. Table 3-96 shows the annualized number of drought events by county based on the NCDC historical record. Table 3-3 and Table 3-4 (section 3.3.2) shows total and annualized events for each county by hazard type for comparison.

The NCDC estimates are believed to be an underrepresentation of the actual losses experienced due to hazards as losses from events that go unreported or that are difficult to quantify are not likely to appear in the NCDC database; this is especially true with crop damages.

Future droughts can also be expected due to more frequent extreme heat events as a result of a warming climate. Long-term climate forecast models suggest that a warming planet will lead to changes in precipitation distribution and more frequent and severe drought in some parts of the country. In spite of projections of moderate increases in annual precipitation in Maryland, increases in temperatures in climate models lead to decreases in soil moisture throughout the year.[56] The Intergovernmental Panel on Climate Change (IPCC) Fourth Assessment Report indicates that it is very likely that hot extremes and heat waves will become more frequent as the Earth warms. In Maryland, the number of days above 90F is projected to more than double under a lower greenhouse gas emissions scenario and roughly triple under a higher emissions scenario by the end of the century. Extended heat waves (temperatures above 90F for at least three consecutive days) are expected to be much more frequent and longer lasting, particularly under higher emissions scenarios. The predictions for increasing heat waves and temperature extremes are likely, with moderate confidence.[57]

Table 3-96. Drought events and crop damages per County, 1995-2010.

County/City	Total Events	Annualized Events	Crop Damages	Crop Damage (Annualized)	Average Damage per Event
Allegany County	10	0.63	$11,171,626	$698,227	$1,117,163
Anne Arundel County	13	0.81	$11,172,719	$698,295	$859,440.
Baltimore County	20	1.25	$11,171,626	$698,227	$558,581.
Calvert County	12	0.75	$5,132,383	$320,774	$427,699
Caroline County	42	2.63	$0	$0	$0.
Carroll County	8	0.50	$8,897,148	$556,072	$1,112,144
Cecil County	38	2.38	$0	$0	$0.
Charles County	13	0.81	$5,130,926	$320,683	$394,687
Dorchester County	2	0.13	$2,723,926	$170,245	$1,361,963
Frederick County	11	0.69	$11,171,735	$698,233	$1,015,612
Garrett County	2	0.13	$0	$0	$0
Harford County	9	0.56	$8,897,402	$556,088	$988,600
Howard County	13	0.81	$11,171,626	$698,227	$859,356
Kent County	42	2.63	$0	$0	$0
Montgomery County	14	0.88	$11,171,772	$698,236	$797,984
Prince George's County	12	0.75	$11,174,102	$698,381	$931,175
Queen Anne's County	42	2.63	$0	$0	$0.00
St. Mary's County	12	0.75	$5,130,343	$320,646	$427,528.58
Somerset County	2	0.13	$2,723,926	$170,245	$1,361,963.00
Talbot County	42	2.63	$0	$0	$0.00
Washington County	13	0.81	$11,172,034	$698,252	$859,387.23
Wicomico County	2	0.13	$2,723,926	$170,245	$1,361,963.00
Worcester County	2	0.13	$0	$0	$0.00
City of Baltimore	9	0.56	$0	$0	$0.00
Grand Total*	**75**	**4.69**	**$13,903,863**	**$868,991**	**$185,385**

[56] Sheffield, J. and E.F. Wood, 2008, Global trends and variability in soil moisture and drought characteristics, 1950–2000, from observation-driven simulations of the terrestrial hydrologic cycle. Journal of Climate 21:432–458.

[57] Maryland Commission on Climate Change, Climate Action Plan, 2008; Pages 72-73.

** Grand total values are not a direct sum of each of the county/city totals. The grand total events do not include zonal events as described in Section 3.3 and Section 3.5.*

Impact and Vulnerability. Short-term droughts can impact agricultural productivity, while longer term droughts are more likely to impact not only agriculture, but also water supply. Maryland's diverse geology and water resources affect its vulnerability to drought. Ground water is the most commonly used source of water supply and is obtained from both confined and unconfined aquifers[58]. In fact, some regions of the State like Southern Maryland and the Eastern Shore rely exclusively on ground water for their water needs. Also, many individual home owners in rural areas pump ground water from their own wells. Public water suppliers like the Washington Suburban Sanitary Commission rely on surface waters for their water supply. About two-thirds of Maryland's citizens regularly consume water that originates from a surface water source[59]. In general, counties that have invested in water supply and distribution infrastructure are generally less vulnerable to drought. However, communities relying on the Potomac and Susquehanna Rivers and their tributaries for water are more vulnerable during a drought than those using the Chesapeake Bay. This is due to the lack of recharge from surrounding watersheds that flow into the rivers.

Currently, a standardized methodology for estimating drought vulnerability does not exist. As opposed to posing a direct threat to life and property, drought impact is primarily measured by its potential and actual economic effect on the agricultural sector as well as municipal and industrial water supplies. This economic effect can also be expected to affect related sectors such as wholesale and retail trade. Property and infrastructure is not directly affected by extreme heat associated with drought, however property and infrastructure is affected by secondary hazards caused by extreme heat, such as wildfires.

As the largest industry in Maryland, agriculture plays a very important role in Maryland's economy. Between 2002 and 2007, the State's agriculture was valued at almost $2 billion as shown in Table 3-97. Approximately one-third of Maryland's total land area is in agricultural use. In many areas of Maryland, agriculture is the dominant economic sector. The majority of farms are located in the north central portion of the State and the upper Eastern Shore as shown in Figure 3-50.

Drought is a significant, recurring problem for Maryland's agricultural industry. While many factors can influence agricultural productivity, declines in crop yields are most closely linked to insufficient precipitation. Depleted soil moisture has a direct effect on agricultural productivity and can continue to have an impact on yields even after precipitation levels return to normal.

As significant a threat as agricultural drought is to Maryland's economy, the impact drought can have on its water supply, environment, and people cannot be understated, even in urbanized counties. As the climate warms, a phenomenon known as urban heat island effect where metropolitan areas are significantly warmer than surrounding rural areas, will be of greater significance to Maryland's cities, especially the Baltimore-Washington D.C. corridor. This effect will be exacerbated if the frequency of extreme heat events increases as a result of climate change.

[58] Maryland Department of the Environment, http://www.mde.state.md.us/programs/Water/Water_Supply/Source_Water_Assessment_Program/Pages/Programs/WaterPrograms/Water_Supply/sourcewaterassessment/factsheet.aspx (June 2011).

[59] Maryland Department of the Environment, http://www.mde.state.md.us/programs/Water/DroughtInformation/DroughtSusceptibility/Pages/Water/Drought/susceptibility/index.aspx (June 2011).

State and critical facilities that are exposed to high drought risk are listed in Tables 3-98 and 3-99. These counties should ensure their Continuity of Operation Plan (COOP) is able to continue providing essential services; however, it is unlikely that a drought event would disrupt essential functions.

An example of urban heat island effect is presented in the following satellite imagery of the City of Baltimore during 2001. Figure 3-51 shows impervious surfaces of the Baltimore metropolitan area, where the darker red areas represent dense, highly developed land. When compared to the land surface temperature image in Figure 3-52, these same areas correspond with the hottest surface temperatures. Cooler areas correspond with open spaces, and low density development. According to the NASA Goddard Space Flight Center, the City of Baltimore's land surface temperature changes by as much as 10 degrees Celsius going out from the city center. More densely developed areas typically contain more materials (asphalt for example) likely to absorb and retain heat than rural areas.

Table 3-97. Agricultural Exposure 2002-2007.

Jurisdiction	Land in farms - 2007 acreage (% change from 2002)	Market Value of Agricultural Products Sold ($1,000)		
		Total value of agricultural products sold ($)	Value of crops including nursery and greenhouse ($)	Value of livestock, poultry, and their products ($)
Allegany County	36,643 (-7%)	3,159	1,842	1,317
Anne Arundel County	29,244 (-17%)	19,090	16,187	2,903
Baltimore County	78,282 (+10%)	68,423	56,291	12,132
Calvert County	26,443 (-12%)	4,052	3,345	707
Caroline County	131,277 (+14%)	186,039	48,941	137,098
Carroll County	141,934 (-4%)	87,406	46,717	40,689
Cecil County	85,026 (+10%)	95,789	44,129	51,660
Charles County	52,147 (+0.1%)	8,898	6,602	2,296
Dorchester County	133,188 (+6%)	166,732	43,344	123,387
Frederick County	202,087 (+3%)	127,034	35,903	91,130
Garrett County	95,514 (-6%)	25,726	6,465	19,261
Harford County	75,166 (-8%)	42,865	26,206	16,659
Howard County	29,371 (-22%)	22,685	17,892	4,793
Kent County	128,220 (+9%)	85,711	46,364	39,347
Montgomery County	67,613 (-10%)	33,193	25,344	7,850
Prince George's County	37,005 (-19%)	18,620	17,138	1,481
Queen Anne's County	146,927 (-6%)	113,328	48,216	65,112
St. Mary's County	68,648 (+1%)	15,947	11,696	4,252
Somerset County	60,255 (+6%)	192,563	14,929	177,634
Talbot County	109,002 (+3%)	50,541	25,388	25,153
Washington County	114,065 (-9%)	83,691	20,434	63,257
Wicomico County	92,852 (+5%)	197,828	40,448	157,381
Worcester County	110,847 (-16%)	185,771	25,484	160,287

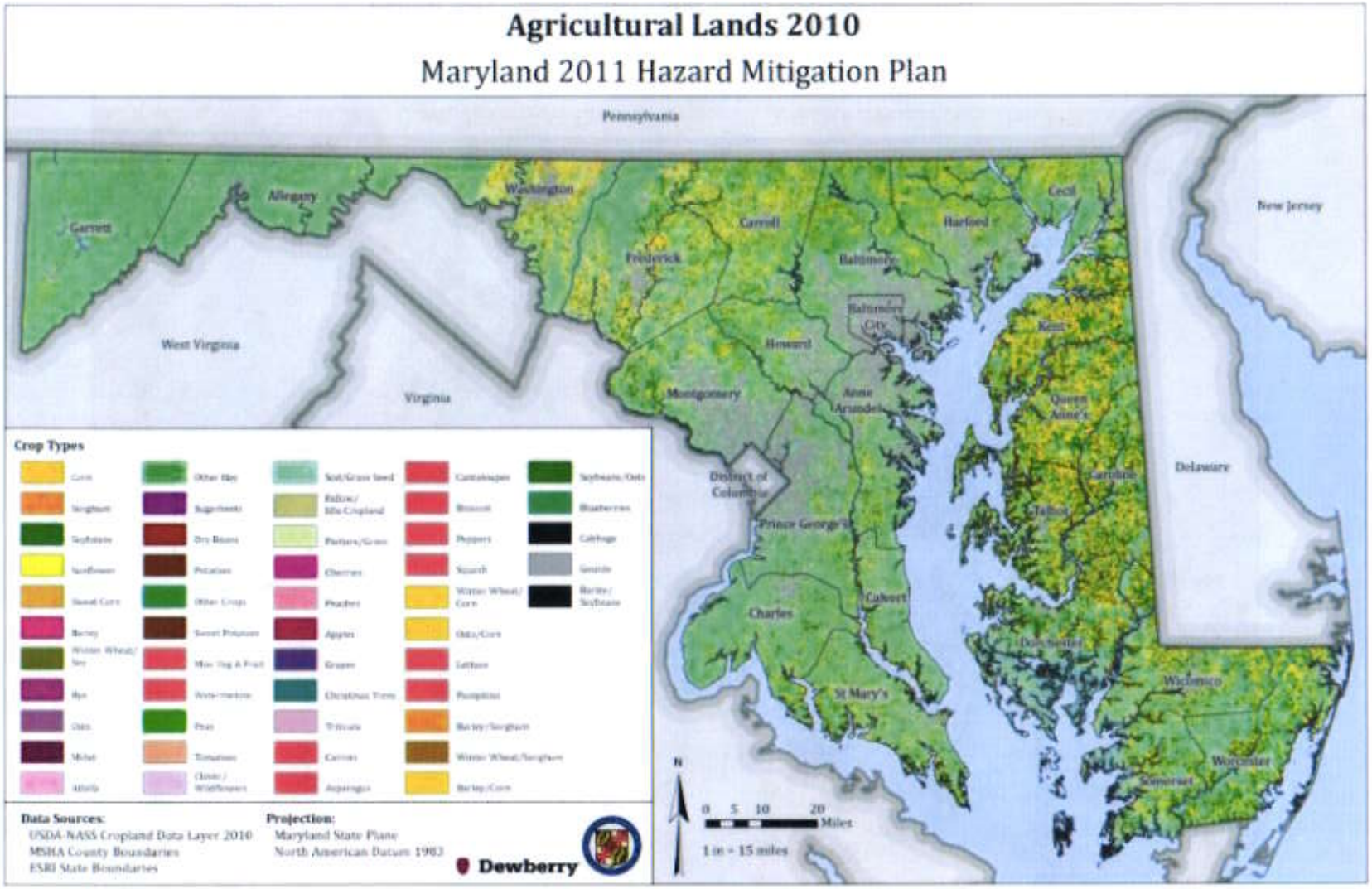

Figure 3-50. Agricultural Lands by Crop Type, 2010.

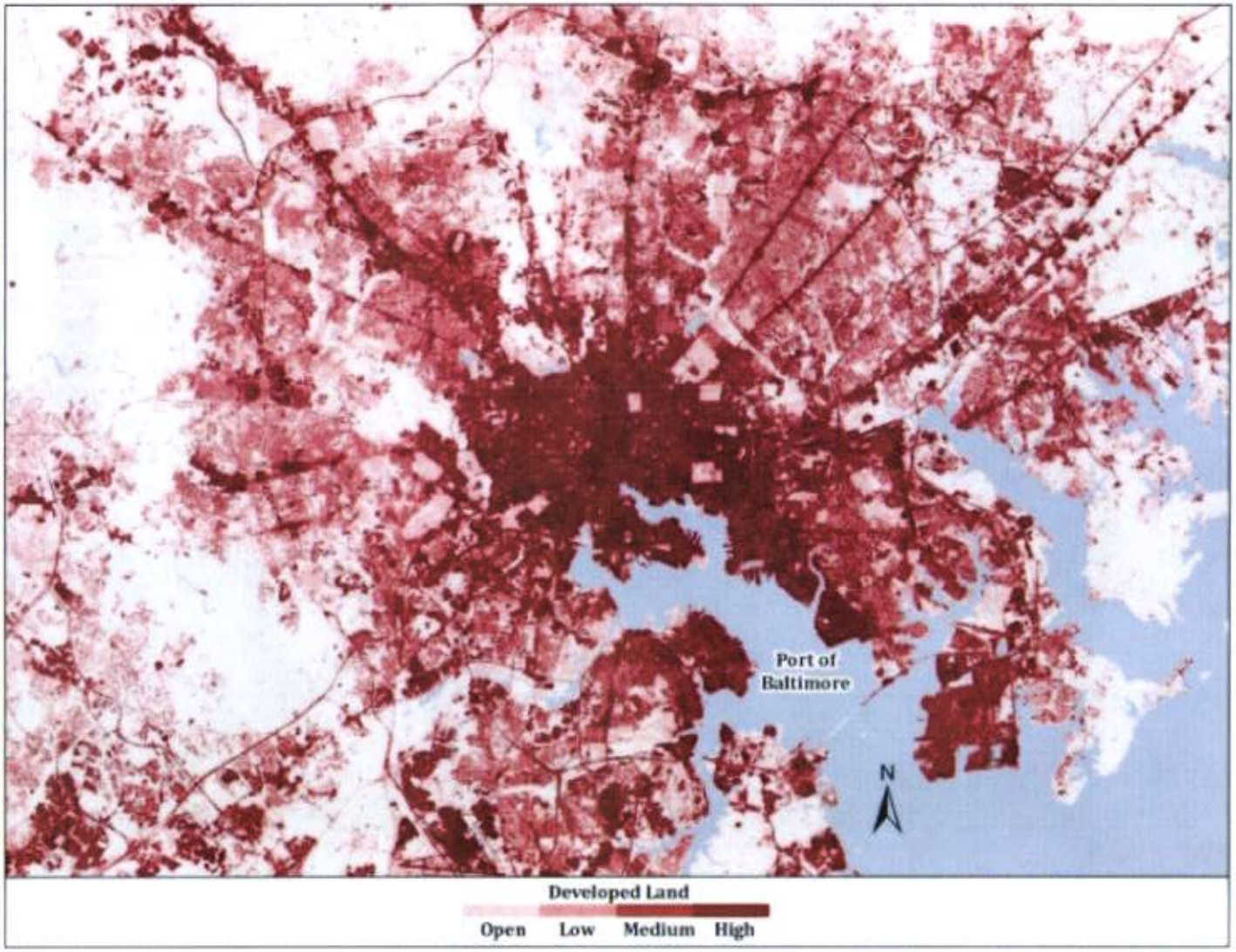

Figure 3-51. Developed Land, City of Baltimore, 2001.

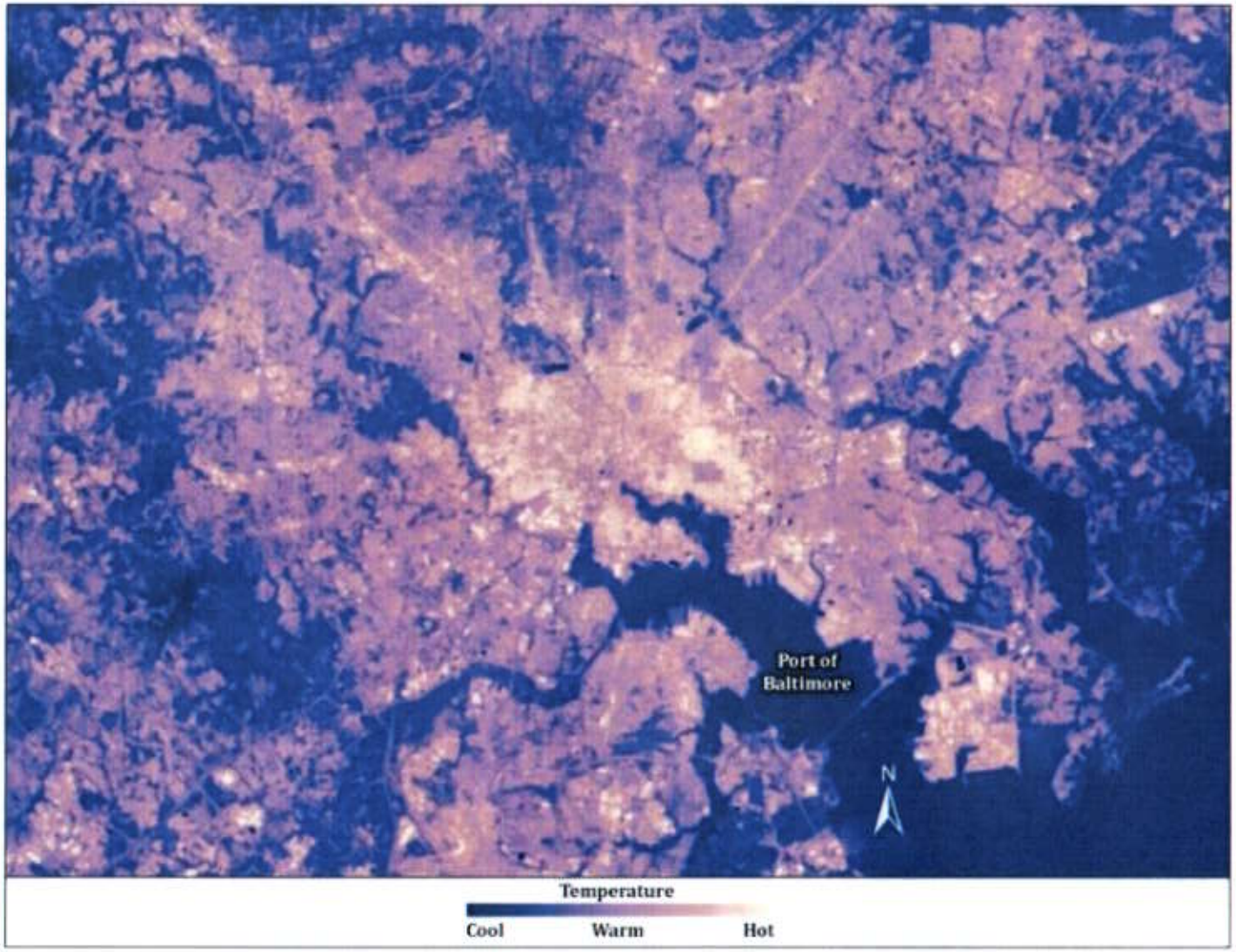

Figure 3-52. Earth Surface Temperature, City of Baltimore, 2001.

Risk. Due to the difficulty in assessing the rate of incidence, and the lack of complete data on drought impacts, long-term risk for drought hazard is difficult to quantify. Considering the importance of agriculture to Maryland's economy, counties that are predominantly agricultural are at greatest risk of drought. Figure 3-53 shows the number of drought events per county since 1995. In terms of economic impact, significant crop losses have been recorded in the NCDC U.S. Storm Events database since 1995, totaling over $13 million as shown in Table 3-96.

Future updates to this plan should consider methods for quantifying annual drought losses in sectors outside of agriculture. This might include defining losses related to maintaining water supply, hydropower, tourism and recreation and would require data sources outside of NCDC storm events data.

State and Critical Facility Risk. The majority of drought related damages do not impact buildings or infrastructure. However, water supplies for critical and state facilities may be impacted during severe drought. Table 3-98 shows the critical facility exposure in counties determined to have the highest drought risk. In regards to State facilities, 979 buildings are at risk of being impacted by drought. State facility exposure is shown in Table 3-99.

Jurisdictional Risk. Based on the available data, Montgomery, Howard, Carroll, and Harford Counties have been determined to have a high drought ranking as shown in Figure 3-54. This ranking was accomplished using the methodology described in the Hazard Analysis and Ranking Methodology Section 3.5 of the HIRA.

Local Plan Risk Assessment. Twenty-five of the local plans addressed and ranked drought in their hazard mitigation plans. Seven local plans considered drought a high hazard, three medium-high, twelve medium, one medium-low and two low. Section 3.6 includes a summary of how each of the local plans ranked drought and outlines the assumptions that were made in an effort to compare the local hazard rankings to each other.

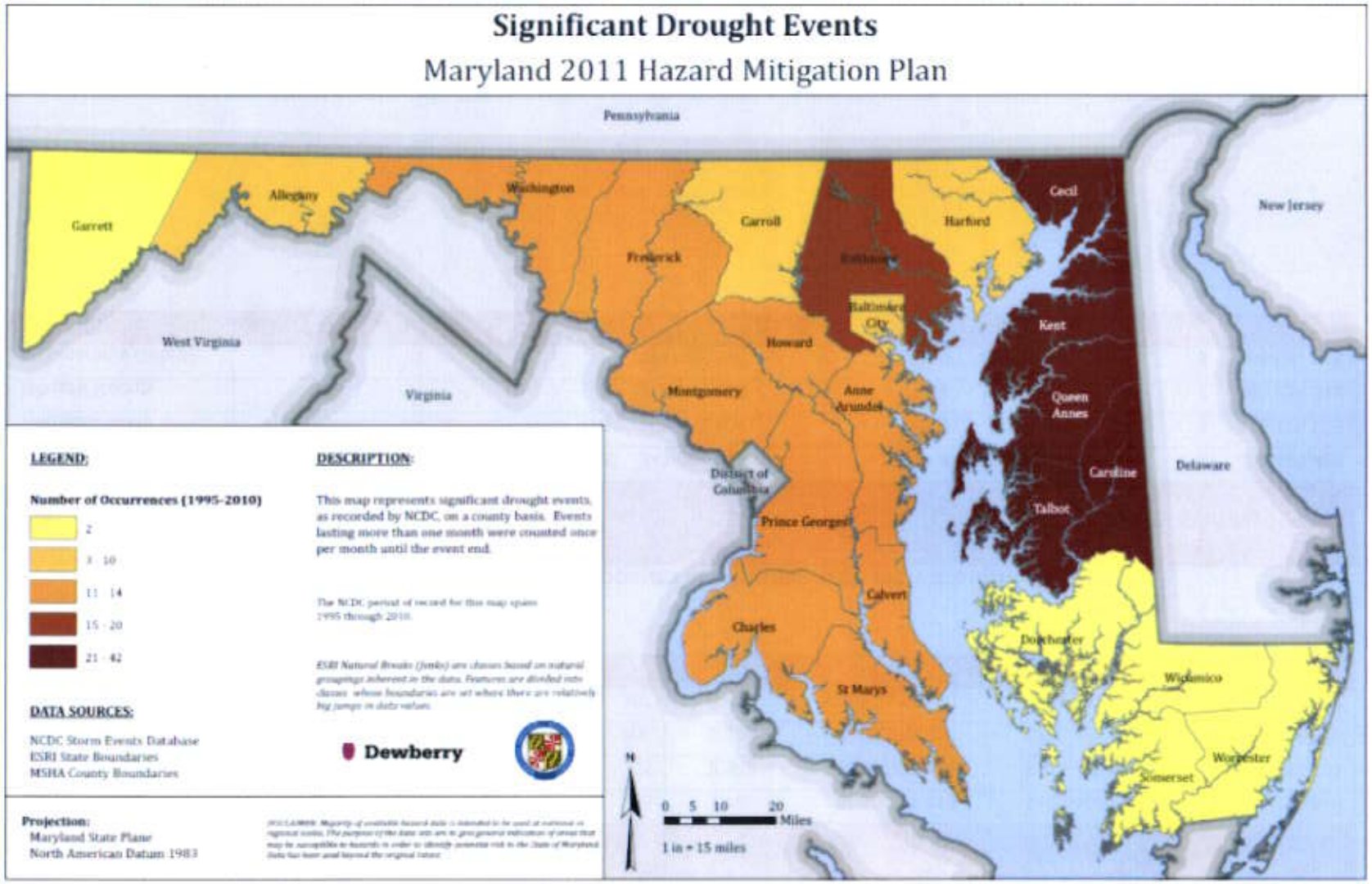

Figure 3-53. Significant Drought Events.

Table 3-98. Critical facility exposure in counties with high drought risk.

Jurisdiction	Police	Fire	Health	Educational	Total Number of All Types	Building Values of All Types	Content Values of All Types	Building and Content Values of all Types
Carroll County	8	29	21	65	1,767	$580,214,710	$193,404,903	$773,619,613
Harford County	9	27	8	85	2,342	$554,365,130	$184,788,377	$739,153,507
Howard County	0	12	46	109	2,208	$638,376,030	$212,792,010	$851,168,040
Montgomery County	19	40	49	367	6,992	$2,073,052,250	$691,017,417	$2,764,069,667
Grand Total	**36**	**108**	**124**	**626**	**13,309**	**$3,846,008,120.00**	**$1,282,002,707.00**	**$5,128,010,827.00**

Table 3-99. State facility exposure in counties with high drought risk.

Jurisdiction	Total Number of All Types	Building Values of All Types	Content Values of All Types	Building and Content Values of all Types
Carroll County	228	$ 347,961,627	$ 52,467,837	$ 400,429,463
Harford County	207	$ 105,847,401	$ 9,278,923	$ 115,126,325
Howard County	363	$ 552,692,301	$ 37,566,215	$ 590,258,515
Montgomery County	181	$ 261,145,098	$ 43,887,878	$ 305,032,976
Grand Total	**979**	**$1,267,646,427.00**	**$143,200,853.00**	**$1,410,847,279.00**

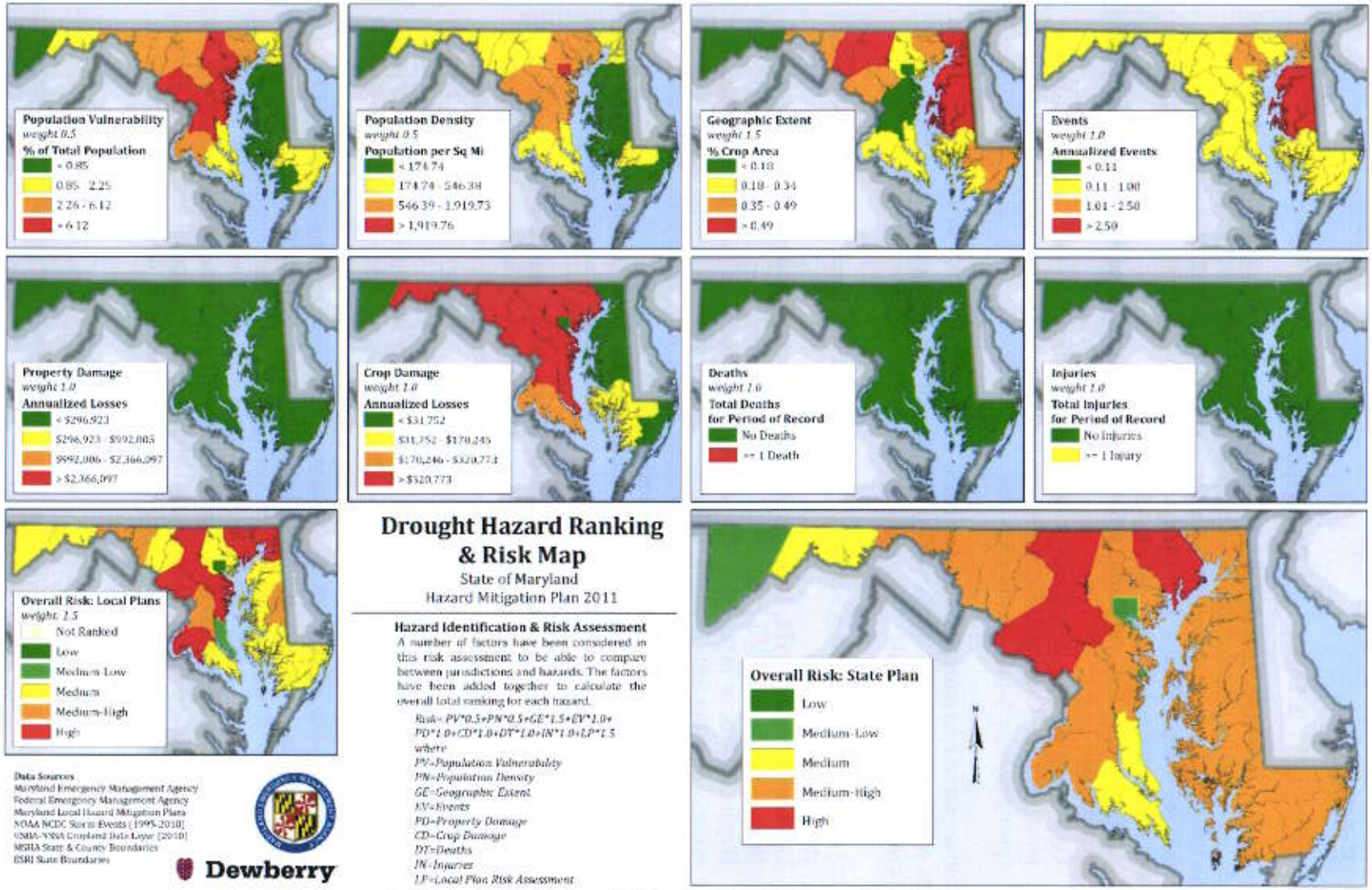

Figure 3-54. Drought Hazard Ranking and Risk Map.

3.15 Earthquake

3.15.1 Description

An earthquake, also known as a seismic event, is a shaking of the ground caused by the sudden breaking and movement of large sections (tectonic plates) of the earth's rocky outermost crust. The edges of the tectonic plates are marked by faults (or fractures). Most earthquakes occur along the fault lines when the plates slide past each other or collide against each other. The shifting masses send out shock waves that may be powerful enough to:

- Alter the surface of the Earth, thrusting up cliffs and opening great cracks in the ground and
- Cause great damage ... collapse of buildings and other man-made structures, broken power and gas lines (and the consequent fire), landslides, snow avalanches, tsunamis (giant sea waves) and volcanic eruptions.

Although other natural hazards account for much greater annual loss in the United States earthquakes pose the largest risk in terms of sudden loss of life and property. Risk factors that impact the extent of damage include:

- Amount of seismic energy released: The greater the vibrational energy, the greater the chance for destruction.
- Duration of shaking: This is one of the most important parameters of ground motion for causing damage.
- Depth of focus, or hypocenter: The shallower the focus (the point of an earthquake's origin within the earth), usually the greater the potential for destructive shock waves reaching the earth's surface. Even stronger events of much greater depth typically produce only moderate shaking at ground level.
- Distance from epicenter: The potential for damage tends to be greatest near the epicenter (the point on the ground directly above the focus), and decreases away from it.
- Geologic setting: A wide range of foundation materials exhibits a similarly wide range of responses to seismic vibrations. For example, in soft unconsolidated material, earthquake vibrations last longer and develop greater amplitudes, which produce more ground shaking, than in areas underlain by hard bedrock. Likewise, areas having active faults are at greater risk.
- Geographic and topographic setting: This characteristic relates more to secondary effects of earthquakes than to primary effects such as ground shaking, ground rupture, and local uplift and subsidence. Secondary effects include landslides (generally in hilly or mountainous areas), seismic sea waves, or tsunamis (pretty much restricted to oceans and coastal areas), and fires (from ruptured gas lines and downed utility lines).
- Population and building density: In general, risk increases as population and building density increase. Types of buildings: Wooden frame structures tend to respond to earthquakes better than do more rigid brick or masonry buildings. Taller buildings are more vulnerable than one- or two-story buildings when located on soft, unconsolidated sediments, but taller buildings tend to be the more stable when on a hard bedrock foundation.

- Time of day: Experience shows there are fewer casualties if an earthquake occurs in late evening or early morning because most people are at home and awake and thus in a good position to respond properly[60].

Measuring Earthquakes.[61] 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. On the Richter Scale, magnitude is expressed in whole numbers and decimal fractions. For example, a magnitude 5.3 might be computed for a moderate earthquake, and a strong earthquake might be rated as magnitude 6.3. Because of the logarithmic basis of the scale, each whole number increase in magnitude represents a tenfold increase in measured amplitude; as an estimate of energy, each whole number step in the magnitude scale corresponds to the release of about 31 times more energy than the amount associated with the preceding whole number value.

Earthquakes with magnitude of about 2.0 or less are usually called micro earthquakes; they are not commonly felt by people and are generally recorded only on local seismographs. Events with magnitudes of about 4.5 or greater - there are several thousand such shocks annually - are strong enough to be recorded by sensitive seismographs all over the world. Great earthquakes, such as the 1964 Good Friday earthquake in Alaska, have magnitudes of 8.0 or higher. On the average, one earthquake of such size occurs somewhere in the world each year. The Richter Scale has no upper limit.

The Richter Scale is not used to express damage. An earthquake in a densely populated area which results in many deaths and considerable damage may have the same magnitude as a shock in a remote area that has no direct impact. Large-magnitude earthquakes that occur beneath the oceans may not even be felt by humans.

The effect of an earthquake on the Earth's surface is called the intensity. The intensity scale consists of a series of certain key responses such as people awakening, movement of furniture, damage to chimneys, and, finally, total destruction. Although numerous intensity scales have been developed over the last several hundred years to evaluate the effects of earthquakes, the one currently used in the United States is the Modified Mercalli Intensity (MMI) Scale. It was developed in 1931 by the American seismologists Harry Wood and Frank Neumann. This scale, composed of 12 increasing levels of intensity that range from imperceptible shaking to catastrophic destruction, is designated by Roman numerals. It does not have a mathematical basis; instead, it is an arbitrary ranking based on observed effects.

The MMI value assigned to a specific site after an earthquake has a more meaningful measure of severity to the nonscientist than the magnitude because intensity refers to the effects actually experienced at a particular place.

The lower numbers of the intensity scale deal with the manner in which people feel the earthquake. The higher numbers of the scale are based on observed structural damage. Structural engineers usually contribute information for assigning intensity values of VIII or above. A detailed description of the MMI Scale of earthquake intensity and its correspondence to the Richter Scale is given in Table 3-100100.

[60] Maryland Geological Survey www.mgs.md.gov
[61] United States Geological Survey www.usgs.gov

Table 3-100. Richter Magnitude Scale and Modified Mercalli Intensity Scale.

Richter Magnitude Scale	Modified Mercalli Intensity Scale
1.0 to 3.0	I
3.0 to 3.9	II to III
4.0 to 4.9	IV to V
5.0 to 5.9	VI to VII
6.0 to 6.9	VII to IX
7.0 or Higher	VIII or Higher
Defined Modified Mercalli Intensity Rating Scale	
I	Not felt except by a very few under especially favorable conditions
II	Felt only be a few persons at rest, especially on upper floors of buildings.
III	Felt quite noticeably by persons indoors, especially on upper floors of buildings. Many people do not recognize it as an earthquake. Standing motor cars may rock slightly. Vibrations similar to the passing of a truck.
IV	Felt indoors by many, outdoors by few during the day. At night, some awakened. Dishes, windows, doors, disturbed; walls make cracking sound. Sensation like heavy truck striking building. Standing motor cars rocked noticeably.
V	Felt by nearly everyone; many awakened. Some dishes, windows broken. Unstable objects overturned. Pendulum clocks may stop.
VI	Felt by all, many frightened. Some heavy furniture moved; a few instances of fallen plaster. Damage slight.
VII	Damage negligible in buildings of good design and construction; slight to moderate in well-built ordinary structures; considerable damage in poorly built or badly designed structures; some chimneys broken.
VIII	Damage slight in specially designed structures; considerable damage in ordinary substantial buildings with partial collapse. Damage great in poorly built structures. Fall of chimneys, factor stacks, columns, monuments, walls. Heavy furniture overturned.
IX	Damage considerable in specially designed structures; well-designed frame structures thrown out of plumb. Damage great in substantial buildings, with partial collapse. Buildings shifted off foundations.
X	Some well-built wooden structures destroyed; most masonry and frame structures destroyed with foundations. Rails bent.
XI	Few, if any (masonry) structures remain standing. Bridges destroyed. Rails bent greatly.
XII	Damage total. Lines of sight and level are distorted. Objects thrown in the air.

3.15.2 Historical Occurrences

The USGS National Earthquake Information Center maintains a national database of significant earthquake epicenters from 1568-2010. USGS defines significant earthquakes as those that caused deaths, property damage, or geological effects, or that were experienced by populations in the epicentral area.[62] Significant earthquakes in Maryland and neighboring states are shown in Figure 3-55. The Maryland Geological Survey maintains the history of earthquakes in Maryland. Table 3-101 lists the historical earthquake data for Maryland.

[62] United States Geological Survey, http://www.nationalatlas.gov/mld/quksigx.html (June 2011).

The earliest recorded earthquake in Maryland occurred in Annapolis, on April 25, 1758. The shock lasted 30 seconds and was preceded by subterranean noises. Additional felt reports were received from a few points in Pennsylvania. The most recent significant event was on July 16, 2010 when a 3.6 magnitude earthquake occurred near Germantown. Ground shaking was felt as far away as Annapolis and Northern Virginia.

Between 1758 and 1987 Maryland experienced 22 minor earthquakes. However, from January 1990 through December 1996, Maryland experienced 35 small tremors—1 in Harford County, 2 in Cecil County, 3 in Baltimore County, and 29 in Howard County. In only seven years, the number of known earthquakes in Maryland more than doubled. [63]

Harford County, Maryland, was shaken by two or three earthquakes the night of March 11 and the morning of March 12, 1883. The intensity was in the IV - V range, (clocks stopped at Fallston) with felt points also noted in Baltimore County.

Another moderate shock occurred less than two years later, on January 2, 1885, in an area near the Frederick County, Maryland - Loudon County, Virginia, border (not believed to have originated in Maryland). Maximum intensity reached V, with the total felt area covering more than 3,500 square miles. Clarke, Fairfax, Fauquier, and Shenandoah Counties, Virginia, also reported this earthquake. Since 1885, ground shaking felt in Maryland have been associated with sources for adjacent states and points as far away as the St. Lawrence Valley and Timiskaming, Canada. A single felt report was received from West Hyattsville, associated with a November 19, 1969, earthquake (magnitude 4.3) near Elgood, West Virginia. The February 10, 1972, tremor at Wilmington, Delaware, was felt at Elkton, Maryland. On February 28, 1973, residents throughout a broad area of the middle-Atlantic region of the United States were jolted out of their sleep by shock waves from a minor earthquake near the Delaware - New Jersey - Pennsylvania border. Numerous points in northeastern Maryland reported this earthquake.

[63] Maryland Geological Survey http://www.mgs.md.gov/esic/publications/es9es.html (June 2011).

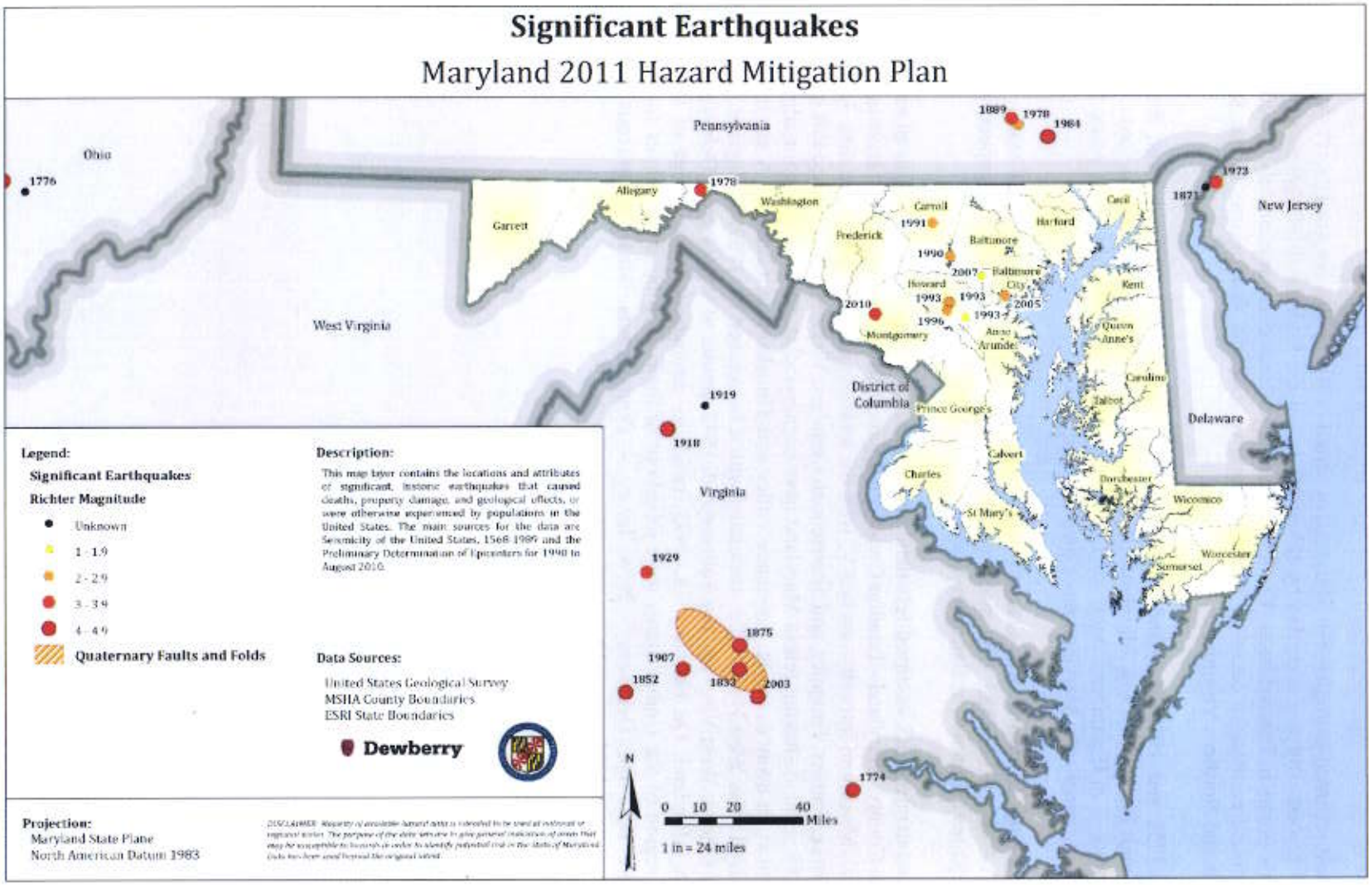

Figure 3-55. Significant Earthquakes, 1568-2010.

Table 3-101. Historical earthquakes in Maryland.

Date	General Location	Depth (km)	Intensity (Modified Mercali Scale)	Magnitude (parenthesis = pre-instrumentation)
4/25/1758	Annapolis	...	V	(3.5, 3.7)
2/24/1828	Bowie	...	...	...
1/30/1876	Annapolis	...	...	...
4/10/1876	Prince Frederick	...	III	-2.7
9/1/1877	Brandywine	...	III	-2.7
1/4/1881	Westminster	...	IV-V	-3.1
3/11/1883	Fallston	...	IV	(3.1, 3.3)
3/12/1883	Fallston	...	III	(2.7, 2.9)
03/10/02	Union Bridge	...	III	-2.7
03/11/02	Union Bridge	...	III	-2.7
01/01/03	Union Bridge	...	III	-2.7
01/01/03	Union Bridge	...	II	-2.4
10/13/06	Catonsville	...	III	-2.7
01/24/10	Westminster	...	II	-2.4
04/24/10	Catonsville	...	III	-2.7
10/15/28	Ocean City	...	IV	(2.7, 3.3)
11/01/30	Round Bay - Severna Park	...	IV	(3.1, 3.3)
11/01/30	Round Bay - Severna Park	...	III	-2.7
06/22/39	Phoenix	...	III	-2.7
11/18/39	Phoenix	...	IV	-3.1
11/26/39	Phoenix	...	V	(3.5, 3.7)
09/07/62	Hancock	38	IV	-3.3
04/26/78	Hancock	15	...	3.1
05/23/86	Accoceek - Piscataway	0.2	...	2.5
01/13/90	Randallstown (V), Eldersburg (IV), Ellicott City (IV), Granite (IV), Owings Mills (III)	5-Mar	V	2.6 2.5
04/04/90	Granite - Randallstown - Baltimore	7.0 10.0	II	1.7
09/28/91	Granite - Randallstown	5	III	2.4
03/10/93	Columbia (IV) - Ellicott City (II) - Fulton (II)	5	II-IV	2.5
03/12/93	Columbia - Allview Estates	5	II-III	2
03/15/93	Columbia - Allview Estates - Laurel	0.9	III-V	2.7
03/16/93	Columbia - Allview Estates	5	II-III	1.8

Date	General Location	Depth (km)	Intensity (Modified Mercali Scale)	Magnitude (parenthesis = pre-instrumentation)
03/16/93	Columbia - Allview Estates	5	II-III	1.8
03/17/93	Columbia - Allview Estates	0.5	I-II	equal to or less than 1.0
03/19/93	Columbia - Allview Estates	0.5	I-II	1
03/19/93	Columbia - Allview Estates	0.5	I	<1.0
03/21/93	Aberdeen - Bel Air	...	I-II	1.5
03/22/93	Columbia - Allview Estates	0.5	not felt	about 0.0
03/26/93	Ellicott City near jct US40 & 29	...	I-II	<1.5 (est.)
04/04/93	Columbia - Allview Estates	0.5	I-III	1.5
04/04/93	Columbia - Allview Estates	0.5	I-II	1.5
04/08/93	Columbia - Allview Estates	0.5	I-II	1-1.5
07/09/93	Columbia - Allview Estates	0.5 (est.)	II-III	1.9
07/12/93	Columbia - Allview Estates	0.5 (est.)	III-IV	2.1
10/28/93	Ilchester - Ellicott City	...	IV	2.1
10/28/93	Ilchester - Ellicott City	...	IV	1.8
11/17/93	Columbia - Allview Estates	0.5 (est.)	III	1.7 (est.)
11/27/93	Columbia - Allview Estates	...	I-II	<1.5 (est.)
11/27/93	Columbia - Allview Estates	...	I-II	about 1.5 (est.)
10/28/94	Glen Burnie - Pasadena - Gambrills -Millersville	...	IV	2.7
08/02/96	Perryville	...	II-III	2.2
10/17/96	Rising Sun (epicenter may be in Pennsylvania)	5.4	IV	2.2, 2.3
12/06/96	Columbia - Allview Estates	...	II	<1.5 (est.)
12/14/96	Columbia - Allview Estates	...	II	<1.5 (est.)
12/16/96	Ilchester - Ellicott City	...	I	about 1 (est.)
12/22/96	Columbia - Allview Estates	5	III	2.0, 2.3
12/18/01	Columbia nr US29-Md32	...	II	1.5-2.0 (est)
03/22/02	Columbia nr US29-Md32	...	I	1-2 (est.)
02/23/05	SE Baltimore nr. Fort McHenry, Dundalk, Glen Burnie, Pasadena, Gambrills	...	II-III (IV?)	2.0-2.1
09/27/09	Lochearn, Baltimore, Arbutus, Catonsville	...	II-III	1.5
10/08/07	12 km NE of Fallston, MD	...	I	1.6
07/16/10	Germantown	5		3.6

3.15.3 Risk Assessment

An earthquake risk assessment is difficult because it is challenging to monetize the potential damages accurately. FEMA has developed a software suite, Hazards US Multi-Hazard (HAZUS-MH), for estimating potential losses to natural disasters. The HAZUS-MH earthquake model was utilized to estimate damages and losses to buildings, lifelines, and essential facilities from deterministic (scenario-based) and probabilistic earthquakes. Estimates for the annualized losses as well as estimates based on the historical scenario of the 1998 5.2 magnitude earthquake in Pennsylvania have been developed and will be discussed in the sections that follow.

In April 2008 FEMA released *FEMA 366 HAZUS® MH Estimated Annualized Earthquake Losses for the United States*. This report presents the results of a HAZUS study estimating seismic risk in all regions of the United States by using two interrelated risk factors:

- The Annualized Earthquake Loss (AEL), which is the estimated long-term value of earthquake losses to the general building stock in any single year in a specified geographic area (e.g., state, county, metropolitan area); and
- The Annualized Earthquake Loss Ratio (AELR), which expresses estimated annualized loss as a fraction of the building inventory replacement value.

Although Maryland has experienced numerous earthquakes from inside and outside the State, the small magnitude and minimal economic damage has not warranted the need for considerable earthquake retrofit or similar mitigation programs. Nevertheless, a high-level risk assessment based on HAZUS data for: Annualized losses and the losses due to the 1998 seismic event in Pennsylvania have been completed for this 2011 plan update.

Probability of Future Occurrence. Earthquake events can and occasionally do occur in the state, though of much less intensity than those that occur elsewhere in the region or on the west coast. Additionally earthquake events are more likely to be felt as a result of an earthquake that occurs in the surrounding region rather than originating within Maryland.

Probabilistic ground motion maps are typically used to assess the magnitude and frequency of seismic events. These maps measure the probability of exceeding a certain ground motion, expressed as percent peak ground acceleration (%PGA), over a specified period of years. The severity of earthquakes is site specific, and is influenced by proximity to the earthquake epicenter and soil type, among other factors. Average PGA, for the 100-year return period, has been used in the hazard ranking as the geographic extent parameter (The average PGA values for the state would result in no felt shaking or potential damage.

Impact and Vulnerability. Earthquakes are low probability, high-consequence events. Although earthquakes may occur infrequently they can have devastating impacts. Ground shaking can lead to the collapse of buildings and bridges; disrupt gas, life lines, electric, and phone service. Deaths, injuries, and extensive property damage are possible vulnerabilities from this hazard. Some secondary hazards caused by earthquakes may include fire, hazardous material release, landslides, flash flooding, avalanches, tsunamis, and dam failure. Moderate and even very large earthquakes are inevitable, although very infrequent, in areas of normally low seismic activity. Consequently, buildings in these regions are seldom designed to deal with an earthquake threat; therefore, they are extremely vulnerable.

Most property damage and earthquake-related injuries and 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 shear strength and the ability to support foundation loads. In the case of liquefaction, anything relying on the substrata for support can shift, tilt, rupture, or collapse.

Within Maryland, Cecil County is ranked as medium risk for earthquakes, while Baltimore County, Baltimore City, and Prince George's County are rated as medium-low. It is essential that these counties maintain and update their Continuity of Operation Plans (COOP) so performance of essential functions can be continued under a broad range of scenarios caused by an earthquake event. Emergency responders will be responsible for coordinating evacuations, road and bridge closures, and caring for the injured. For an earthquake event, as with all disaster events, responders face the risk of personal injury while performing necessary job functions.

In the 2008 HAZUS Study, FEMA assessed several categories including; economic loss, debris generation, casualties, and displaced households. Maryland's rankings were consistent in the low to mid thirties indicating that although earthquakes are a threat, in comparison with the rest of the United States, it is not the most susceptible for significant impacts from an earthquake event.

- Maryland was ranked 33 with an estimated annualized loss of 7.218 million.
- With an annualized estimate of 5,000 tons of debris Maryland ranked 32nd.
- Maryland ranked 34 with an annualized estimate of 8 displaced households. In comparison, Pennsylvania ranked 18 with 35 displaced households, Virginia ranked 27 with 16 displaced household, and ranked Delaware 45th with 2 displaced households.
- Regarding annualized casualty estimates Maryland ranked 37 with 4 minor, 0 life threatening and 0 fatalities during both the daytime and nighttime. In comparison Pennsylvania ranked 25 with 14/18 day/night minor injuries, no fatalities, Virginia ranked 28th with 9 minor day/night injuries, and Delaware ranked 43 with 1 day/night minor injury and no fatalities.

Risk. As evidenced in the HAZUS-MH MR5 annualized direct economic losses Figure 3-56, damage from earthquakes will vary widely across the state (Table 3-102). Potential losses in Baltimore and Montgomery counties exceed 1.1 million dollars each. Losses in the remainder of the state range from $10,000 in Somerset County to $993,000 in Baltimore City. Total annualized losses for the state are estimated at $67,790,000.

The total annualized losses for each jurisdiction is further analyzed by building type. Table 3-103 demonstrates the breakdown of annualized losses by wood, masonry, concrete, steel, and mobile home construction.

Table 3-104 demonstrates the breakdown of annualized losses by occupancy type: agricultural, commercial, educational, government, industrial, religion/no-profit, and residential. Residential and commercial occupancy types are the highest accounting for 3,659,000 and 2,382,000 of the structures respectively. Montgomery and Baltimore County have the highest total of commercial and residential occupancies resulting in the largest total annualized losses in the state.

The 5.2 magnitude event in Northwest Pennsylvania historical event that took place in 1998 was chosen because it was considered a significant earthquake that occurred near Maryland in recent history. Direct economic losses based on this event are highest in Harford and Baltimore Counties

(Figure 3-57). The losses exceed $2.5 million in Harford County and $1.6 million in Baltimore County. Cecil County would experience $694,000 in losses followed by Baltimore City with $588,000 in losses. Economic losses in the state from an earthquake of this magnitude would total $6.2 million.

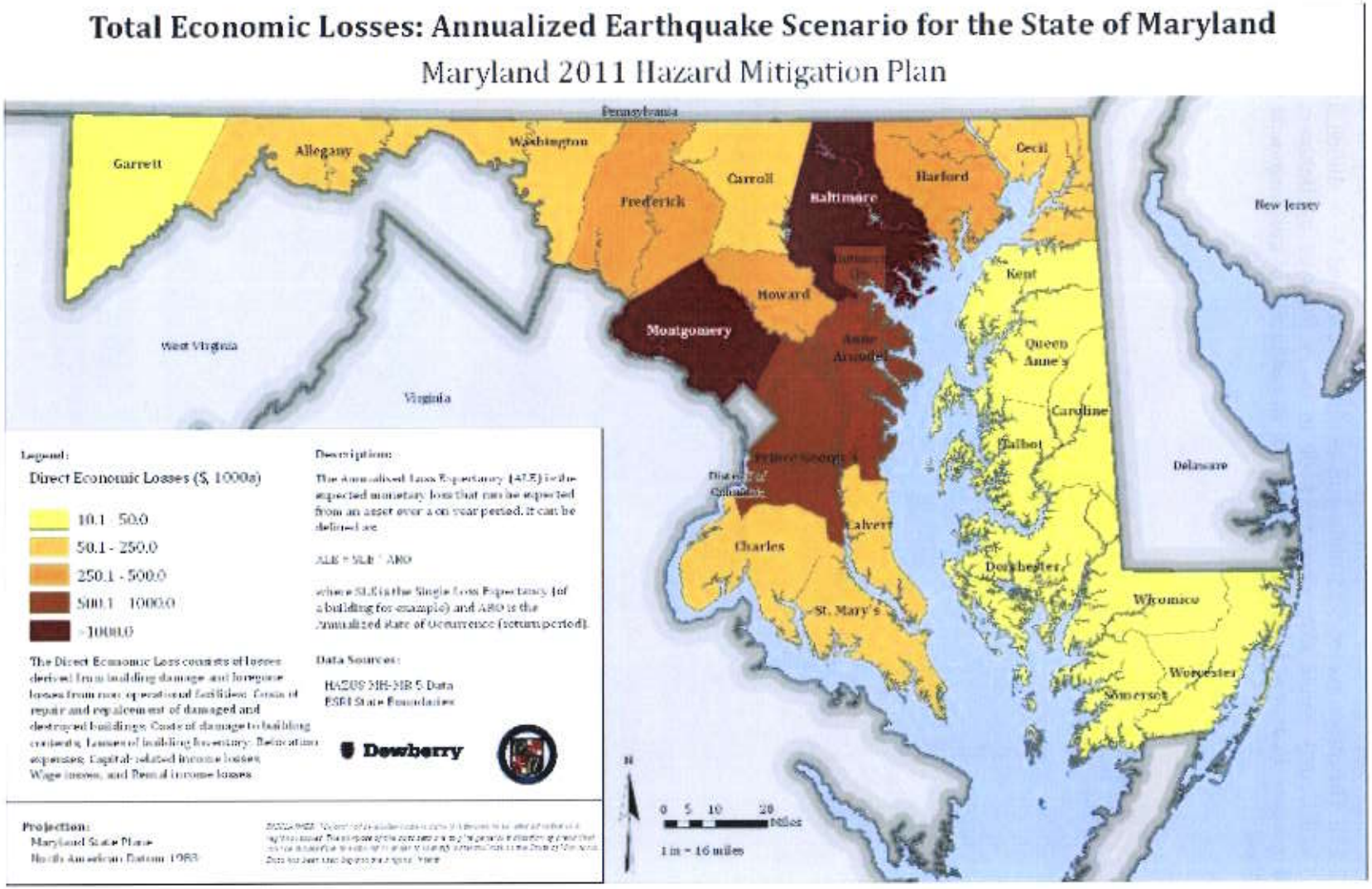

Figure 3-56. HAZUS-MH MR5 Total annualized loss.

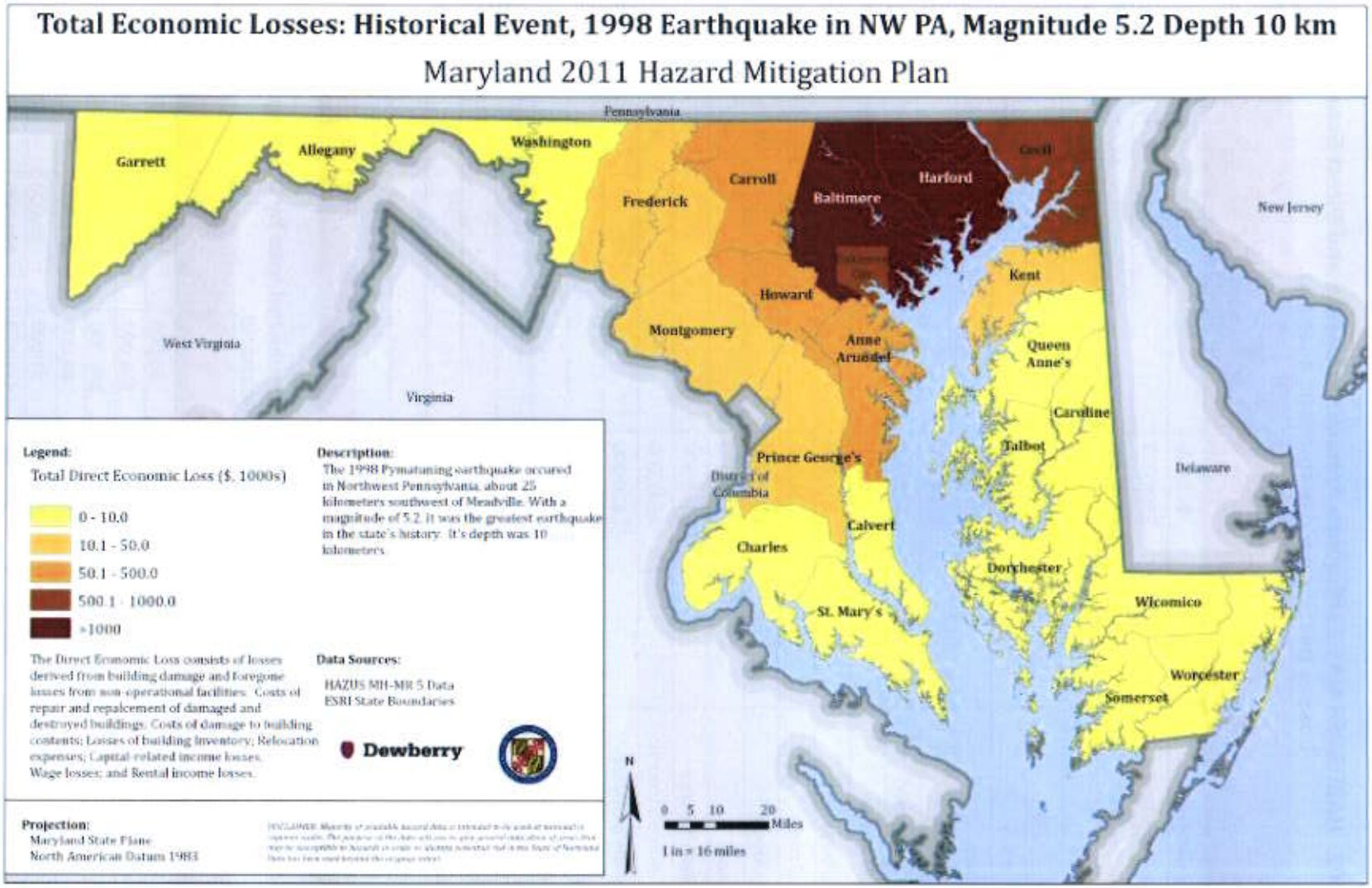

Figure 3-57. HAZUS-MH MR5 Total economic losses from 1998 historical earthquake epicenter in NW Pennsylvania.

Table 3-102. HAZUS-MH MR5 Earthquake Annualized Losses and Direct Economic Losses based on a deterministic scenario.

County/City	Annualized Direct Economic Losses	Direct Economic Losses for 1998 Event in PA with a Mag. 5.2 and Depth 10km
Allegany County	$77,000	$-
Anne Arundel County	$656,000	$245,000
Baltimore County	$1,103,000	$1,637,000
Calvert County	$61,000	$-
Caroline County	$21,000	$-
Carroll County	$189,000	$250,000
Cecil County	$176,000	$694,000
Charles County	$124,000	$-
Dorchester County	$24,000	$-
Frederick County	$264,000	$49,000
Garrett County	$37,000	$-
Harford County	$334,000	$2,529,000
Howard County	$353,000	$174,000
Kent County	$27,000	$14,000
Montgomery County	$1,151,000	$27,000
Prince George's County	$831,000	$17,000
Queen Anne's County	$39,000	$7,000
St. Mary's County	$72,000	$-
Somerset County	$10,000	$-
Talbot County	$36,000	$-
Washington County	$172,000	$1,000
Wicomico County	$49,000	$-
Worcester County	$40,000	$-
City of Baltimore	$933,000	$588,000
Grand Total	**$6,779,000**	**$6,232,000**

Table 3-103. HAZUS MH-MR5 Earthquake Total Annualized loss by building type based on a deterministic scenario.

County/City	Wood	Masonry	Concrete	Steel	Mobile Home
Allegany County	$13,000	$34,000	$8,000	$21,000	$2,000
Anne Arundel County	$124,000	$293,000	$54,000	$180,000	$4,000
Baltimore County	$223,000	$520,000	$90,000	$267,000	$3,000
Calvert County	$14,000	$32,000	$4,000	$11,000	$1,000
Caroline County	$4,000	$10,000	$1,000	$5,000	$1,000
Carroll County	$41,000	$93,000	$13,000	$41,000	$1,000

County/City	Wood	Masonry	Concrete	Steel	Mobile Home
Cecil County	$41,000	$77,000	$14,000	$39,000	$5,000
Charles County	$27,000	$62,000	$8,000	$27,000	$1,000
Dorchester County	$4,000	$11,000	$2,000	$6,000	$1,000
Frederick County	$52,000	$126,000	$20,000	$65,000	$1,000
Garrett County	$6,000	$18,000	$3,000	$9,000	$2,000
Harford County	$79,000	$157,000	$22,000	$71,000	$5,000
Howard County	$71,000	$169,000	$25,000	$87,000	$2,000
Kent County	$5,000	$12,000	$3,000	$7,000	$0
Montgomery County	$239,000	$571,000	$81,000	$260,000	$1,000
Prince George's County	$172,000	$408,000	$61,000	$189,000	$1,000
Queen Anne's County	$8,000	$18,000	$2,000	$9,000	$1,000
St. Mary's County	$14,000	$34,000	$5,000	$16,000	$2,000
Somerset County	$2,000	$5,000	$1,000	$2,000	$1,000
Talbot County	$6,000	$16,000	$3,000	$10,000	$0
Washington County	$29,000	$76,000	$16,000	$47,000	$3,000
Wicomico County	$8,000	$24,000	$3,000	$12,000	$1,000
Worcester County	$7,000	$21,000	$3,000	$8,000	$2,000
City of Baltimore	$162,000	$421,000	$93,000	$256,000	$0
Grand Total	**$1,349,000**	**$3,206,000**	**$535,000**	**$1,646,000**	**$42,000**

State and Critical Facility Risk. Based on the available data, relative to Maryland, Cecil County is ranked as a medium risk for earthquakes as a result of the slightly elevated PGA value compared to the rest of the state. With a total of 1,362 critical facilities valued at $310,623,133 and 287 state facilities (non-critical) valued at $172,110,420. Frederick, Montgomery, Prince George's, Charles, Calvert, Anne Arundel, Baltimore and Wicomico counties and Baltimore City all ranked medium-low. They have a total of 49,671 critical facilities with an estimated value of $15,210,695,800. There are 4,843 state facilities worth a total of $20.6 billion. Table 3-105 shows a breakdown of the number of facilities and building and contents values for those jurisdictions with a medium, medium-low earthquake ranking.

Table 3-104. HAZUS MH-MR5 Earthquake Total Annualized loss by occupancy type.

County/City	Agricultural	Commercial	Educational	Government	Industrial	Religion/ Non-Profit	Residential
Allegany County	$0	$27,000	$1,000	$3,000	$4,000	$2,000	$40,000
Anne Arundel County	$2,000	$211,000	$10,000	$8,000	$83,000	$9,000	$333,000
Baltimore County	$3,000	$395,000	$19,000	$12,000	$48,000	$21,000	$604,000
Calvert County	$0	$17,000	$1,000	$1,000	$2,000	$1,000	$39,000
Caroline County	$0	$6,000	0	$0	$2,000	$1,000	$11,000
Carroll County	$2,000	$61,000	$2,000	$2,000	$10,000	$3,000	$110,000
Cecil County	$2,000	$51,000	$3,000	$3,000	$11,000	$4,000	$102,000
Charles County	$1,000	$40,000	$2,000	$3,000	$4,000	$2,000	$73,000
Dorchester County	$0	$8,000	0	$1,000	$2,000	$1,000	$12,000
Frederick County	$2,000	$82,000	$6,000	$5,000	$20,000	$7,000	$142,000
Garrett County	$0	$11,000	$1,000	$1,000	$2,000	$1,000	$21,000
Harford County	$2,000	$106,000	$4,000	$3,000	$14,000	$6,000	$199,000
Howard County	$2,000	$131,000	$7,000	$4,000	$19,000	$6,000	$185,000
Kent County	$0	$9,000	$0	$0	$2,000	$1,000	$15,000
Montgomery County	$4,000	$414,000	$16,000	$18,000	$36,000	$23,000	$640,000
Prince George's County	$1,000	$279,000	$14,000	$12,000	$31,000	$23,000	$471,000
Queen Anne's County	$0	$13,000	$1,000	$1,000	$2,000	$1,000	$21,000
St. Mary's County	$0	$21,000	$1,000	$3,000	$3,000	$1,000	$44,000
Somerset County	$0	$2,000	$0	$0	$0	$0	$6,000
Talbot County	$0	$15,000	$1,000	$1,000	$2,000	$1,000	$17,000

County/City	Agricultural	Commercial	Educational	Government	Industrial	Religion/ Non-Profit	Residential
Washington County	$1,000	$65,000	$3,000	$3,000	$12,000	$4,000	$84,000
Wicomico County	$0	$18,000	$1,000	$1,000	$2,000	$1,000	$25,000
Worcester County	$0	$12,000	$0	$1,000	$1,000	$1,000	$25,000
City of Baltimore	$1,000	$386,000	$21,000	$16,000	$39,000	$29,000	$442,000
Grand Total	**$24,000**	**$2,381,000**	**$115,000**	**$101,000**	**$351,000**	**$149,000**	**$3,659,000**

Table 3-105. State and Critical Facilities within Medium, Medium-Low Earthquake Ranking Areas.

County/City	Critical Facilities		State Facilities	
	Total Number	Building and Contents Values	Total Number	Building and Contents Values
Allegany County	984	$382,118,400	287	$717,855,663
Anne Arundel County	5,033	$1,468,465,960	605	$3,458,410,555
Baltimore County	8,415	$1,873,803,613	695	$2,450,029,306
Carroll County	1,767	$773,619,613	228	$400,429,463
Cecil County	1,362	$310,623,133	287	$172,110,420
Charles County	1,146	$517,267,067	138	$46,599,098
Frederick County	2,053	$646,917,427	189	$230,155,484
Harford County	2,342	$739,153,507	207	$115,126,325
Howard County	2,208	$851,168,040	363	$590,258,515
Montgomery County	6,992	$2,764,069,667	181	$305,032,976
Prince George's County	7,381	$1,173,039,907	587	$4,226,006,209
Washington County	2,084	$531,299,493	311	$336,788,350
City of Baltimore	7,904	$3,179,149,973	765	$7,596,281,448
Grand Total	**49,671**	**$15,210,695,800**	**4,843**	**$20,645,083,812**

Jurisdictional Risk. Based on available data, the overall earthquake risk to all jurisdictions, with the exception of Cecil County, is low to medium-low, relative to Maryland. Cecil County is ranked as medium primarily driven by population vulnerability, density and geographic extent. Frederick, Montgomery, Prince George's, Charles, Calvert, Anne Arundel, Baltimore and Wicomico counties and Baltimore City are ranked medium-low based primarily on population density and population vulnerability. The earthquake hazard ranking is depicted in Figure 3-58. This ranking was accomplished using the methodology described in the Hazard Analysis and Ranking Methodology section of the HIRA.

Local Plan Risk Assessment. Thirteen of the local plans addressed and ranked earthquake in their hazard mitigation plans. Three local plans considered earthquake a medium hazard, one medium-low, eight low, and one plan described earthquake but did not rank their hazards. Section 3.6 includes a summary of how each of the local plans ranked earthquake and outlines the assumptions that were made in an effort to compare the local hazard rankings to each other.

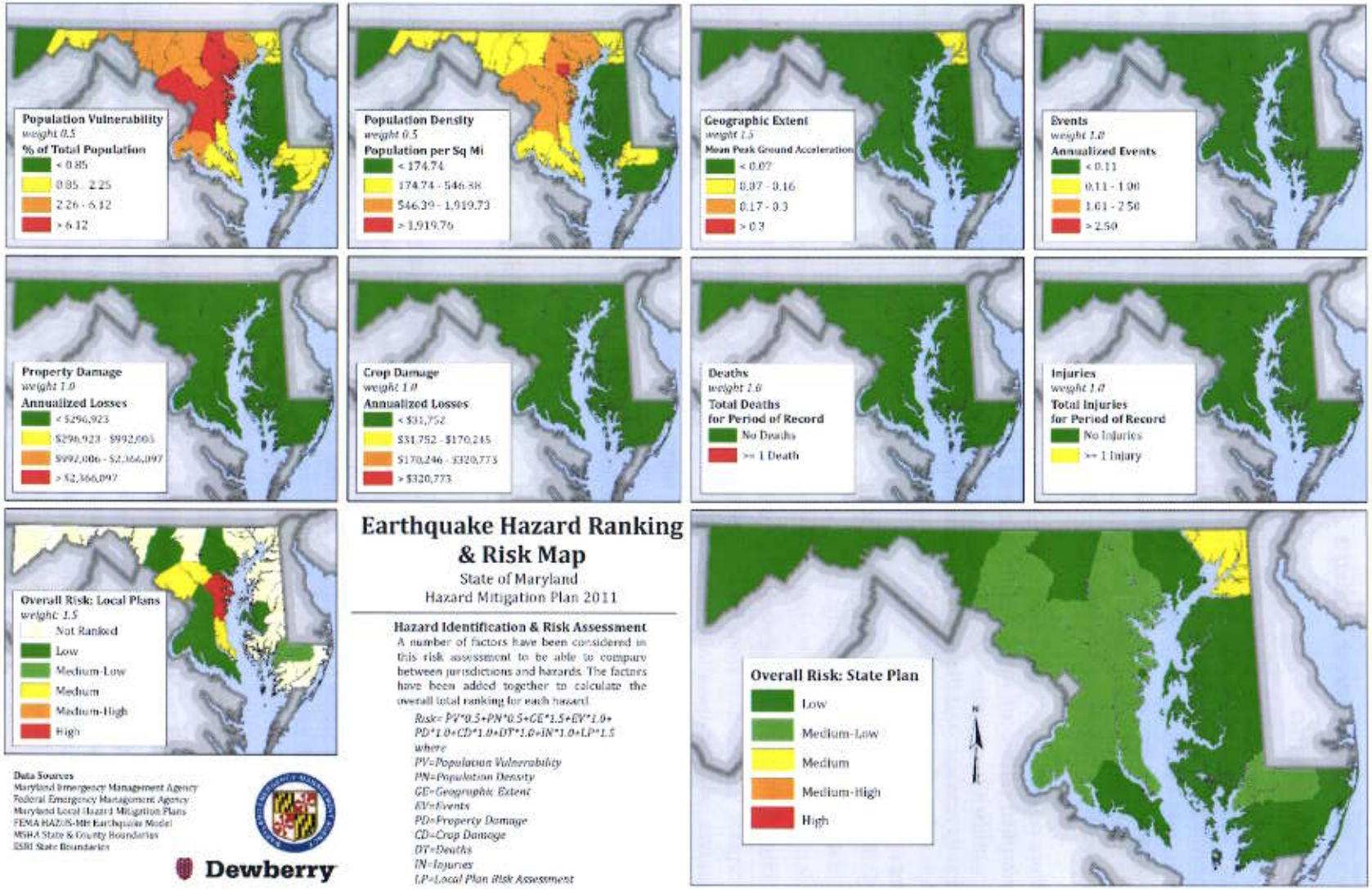

Figure 3-58. Earthquake Hazard Ranking and Risk.

3.22 Dam and Levee Failure

3.22.1 Description

Dams are artificial barriers with the ability to impound water, wastewater, or liquid-borne materials. Dams are constructed across watercourses to retain and control runoff for water supply, flood control, and power generation. Most dams in Maryland consist of an earthen embankment to retain water and a combination of spillways designed to convey water safely around or through the facility. Dams are sources of concentrated vulnerability and can be serious disaster agents when they fail. There is often very little or no advance warning prior to a dam failure. Hydrologic, geologic, seismic, and structural problems are leading potential causes of dam failure.

Dam failure refers to a collapse, overtopping, breaching, or any other related condition that causes an uncontrolled release of water and downstream flooding. Approximately one-third of all dam failures worldwide are caused by overtopping due to inadequate spillway capacity, another third are caused by seepage, and the rest result from improper design or construction, or hazards such as landslides and earthquakes. Dam failures may occur due to any one or a combination of the following causes:

- Prolonged periods of rainfall and flooding;
- Inadequate spillway capacity;
- Internal erosion caused by embankment or foundation leakage or piping;
- Improper maintenance, including failure to remove trees, repair internal seepage problems, replace lost material from the cross section of the dam and abutments, or maintain gates, valves, or other operational components;
- Improper design, including the use of improper construction materials and construction practices;
- Negligent operation, including failure to remove or open spillway gates or valves during high flow periods;
- Failure of upstream dams on the same waterway;
- High winds, which can cause significant wave action and result in substantial erosion; and
- Intentional criminal acts/sabotage.

The severity of a dam failure depends on its storage capacity and the types of land uses downstream. The hazard potential is the possible adverse consequences resulting from the release of water and other stored contents due to failure or improper operation of the dam. Once a dam is constructed, the downstream hydrologic regime may change, altering the frequency and severity of flood events. The change in hydrologic regime can encourage encroachment upon a reduced 100-year floodplain that otherwise would not have been developed if the dam were not constructed. Therefore the flood control benefits provided by a dam can sometimes encourage downstream development thus increasing the dam's overall hazard potential.

3.22.2 Historical Occurrence and Regional Perspective

Dams are prevalent throughout the U.S. but are more heavily concentrated in the central and eastern regions of the country. Maryland has never experienced a dam failure disaster, unlike nearby Pennsylvania and West Virginia. In Johnstown, Pennsylvania in 1889, a combination of heavy rains, design flaws, and substandard repairs resulted in a dam failure that caused the Johnstown Flood, resulting in 2,209 deaths. In 1972, an improperly designed and maintained coal

slagheap dam in Buffalo Creek, West Virginia failed, leaving 125 people dead and 3,000 homeless. Dams can be especially vulnerable during tropical storms. Approximately 230 dams in Georgia were damaged in 1994 by flooding caused by Tropical Storm Alberto. In September 1999, Hurricane Floyd caused failure of nine dams in Kent, Caroline, Queen Anne's and Cecil Counties. Most of the dams were classified as low hazard structures, although two were classed as "significant" hazard. There was no loss of life. The failures were caused by overtopping of their earthen embankments due to enormous runoff from the storm. The National Weather Service reported 11" of rain in Caroline County and 14" of rain in Chestertown, and up to 20" of rain was unofficially reported in some areas. The western portion of the state was spared the brunt of the rainfall though several isolated areas of Calvert and Anne Arundel Counties received 12."

Data used in this analysis were obtained from the Maryland Inventory of Dams, maintained by the Maryland Department of the Environment. This inventory excludes small impoundments such as farm ponds. As of spring 2011, the Maryland inventory included approximately 410 dams, of which 74 are high hazard, 108 area significant hazard, and 228 are low hazard.

Dams are rated according to their potential to cause damage in the event of failure. A hazard rating of "high" indicates that six or more persons are at risk if the dam fails; "significant" indicates that one to five persons are at risk; and "low" indicates that zero persons are at risk. Dams are also rated according to their condition, based on subjective field inspections: excellent, good, fair, poor, very poor, unsafe, or breached. Condition ratings can change and should be considered relative rather than absolute. Approximately 16 percent of Maryland dams rank in the high hazard category, and 22 percent are significant hazards.

Dams are located in every Maryland County. At least one high or significant hazard dam is located in every jurisdiction except Dorchester, Somerset, Talbot, and Worcester Counties. Montgomery County has the highest number of high-hazard dams, with 16 of its 50 dams in this category. Garrett County follows with 12 of its 30 dams rated as high-hazard. A map showing the locations of Maryland's dams is provided in Figure 3-59.

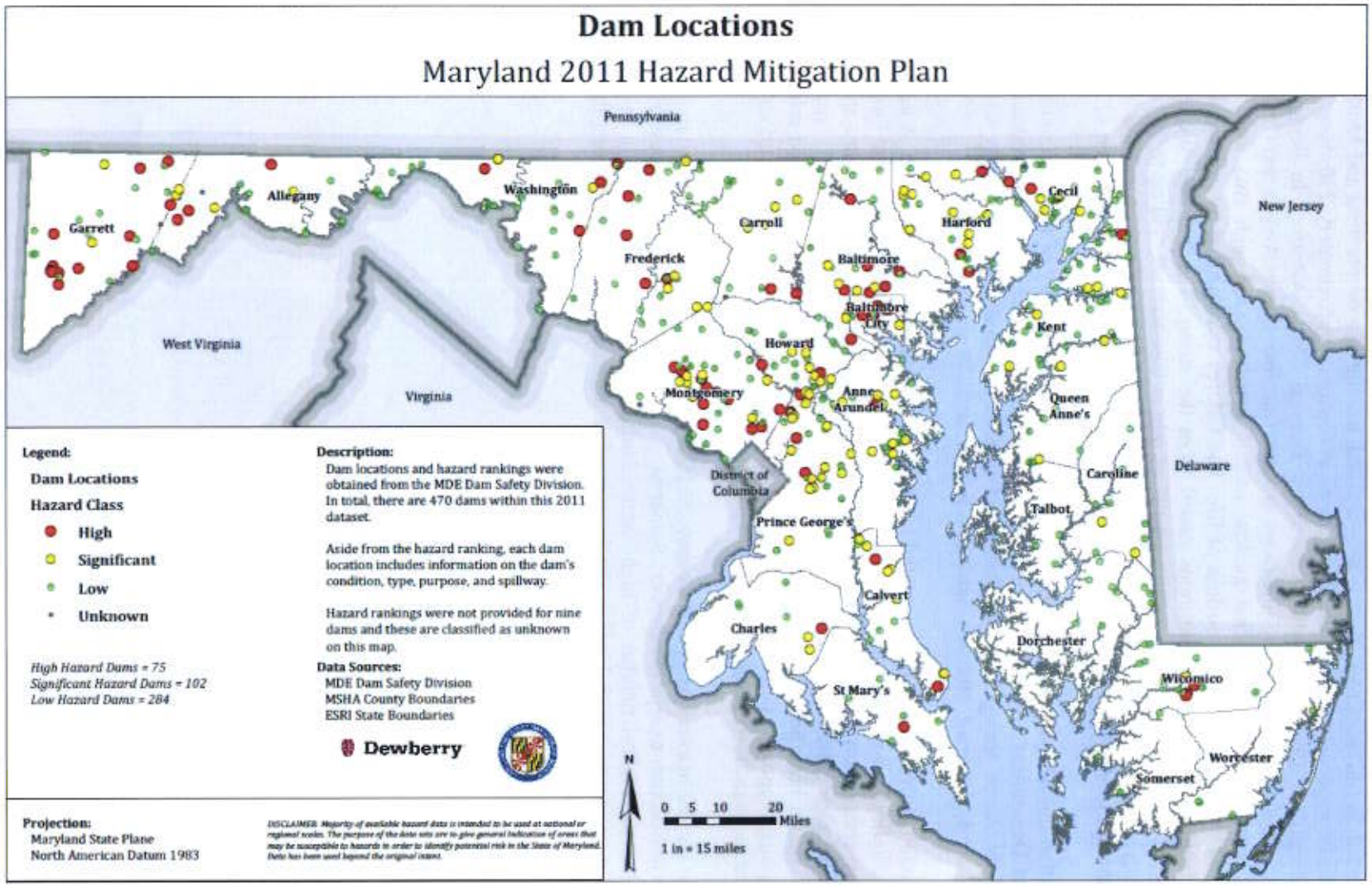

Figure 3-59. Dam locations and hazard rankings.

3.16.1 Risk Assessment

This assessment examines critical and state-owned facilities at risk of high hazard dam failure in the State of Maryland. The Maryland Department of the Environment (MDE) defines high hazard dams as those dams that would result in probable loss of life in the event of a dam failure, resulting in major increases in flood levels at houses, buildings, and major roadways with more than six lives in jeopardy. In Maryland, 75 dams are classified as high hazard. An assessment was conducted for 47 high hazard dams, based on the availability of dam failure inundation zone data. The area downstream from a failed dam that is expected to be inundated is known as the *danger reach* or *inundation zone*. The inundation zones examined in this assessment are defined as *rainy day* or *worst-case scenario* dam failures which means the dam failure inundation zone was determined assuming the dam fails during a large storm event such as the probable maximum flood (PMF).

Failure at a number of Maryland's dams could affect a large number of facilities and contribute to high losses, due either to the large extent of the inundation zones, or a dam's proximity to developed areas. Dams with especially large inundation zones include the Jennings Randolph, Liberty, and Savage River dams on the Savage River. Building values for critical facilities total $67,343,000 within Jennings Randolph Dam's danger reach, $4,232,900 within Liberty Dam's danger reach, and $16,344,800 within Savage River Dam's danger reach. The inundation zones for Druid Hill Lake Dam and Lake Roland Dam in Baltimore extend into highly developed urban areas, where numerous, valuable critical and state-owned facilities are located. The building value of critical facilities within the inundation zone of Druid Hill Lake Dam totals $82,778,600 and $152,894,100 for Lake Roland Dam. Piney Run Dam's high building value for critical facilities of $30,072,400 is unique due to its relatively small inundation zone and relatively low proximity to developed areas.

Value estimations for critical and state-owned facilities within inundation zones are based on building values and content values. Building values are extracted from the Maryland Department of Planning (MDP) Maryland Property View (MDProperty View) dataset and the Maryland State Treasurer's Office dataset (Section 3.4 and Appendix P). Building values for critical facilities located within the danger reach of the 47 high hazard dams examined total over $426,267,820. Although more than 3,733 critical facilities are at risk throughout Maryland, the $426,267,820 amount is based on 3,564 facilities with known building values.

Probability of Future Occurrence. The probability of a dam failure varies greatly from dam to dam and depends on numerous factors including the type of dam construction, the dam's condition, available spillway capacity, degree of maintenance performed, degree and frequency of monitoring, and vulnerability to potential damage from outside sources such as upstream dam failure or sabotage. In general the risk of failure of a well maintained dam meeting current design criteria is very low. However, the potential consequences of a dam failure in terms of loss of life and damage to critical infrastructure could be disastrous which warrants a rigorous state dam safety program to insure dams are designed and maintained to acceptable standards.

Impact and Vulnerability. In general, the western areas of the State of Maryland are home to some of the largest dams which typically have some of the largest dam breach inundation zones. However, some of the most vulnerable areas are located in the eastern portion of the state where a higher population and greater amounts of infrastructure exist below several high hazard dams. In particular, many of the water supply dams owned by the Baltimore City Department of Public Works are located upstream of highly populated areas containing significant infrastructure,

included numerous state and critical facilities. In addition to the potential disastrous downstream impacts that would result from failure of one of these dams, possible loss of the water supply reservoir is an additional piece of critical infrastructure that would be at risk.

Transportation facilities and water/waste water treatment infrastructure are typically vulnerable to damages from dam failure as these facilities are often located within or near floodplains downstream of dams. Other infrastructure such as power lines and telecommunication facilities may also be at risk. Dam failure could lead not only to inundation, but also have serious consequences in terms of power generation. Hydro-electric power from the Conowingo dam accounts for 4.5% of Maryland's electrical output (550 MW of power)[64]. A failure of the Conowingo dam, for instance, could have serious implications for the state.

In addition to impacts on the public and infrastructure, dam or levee failure could have several impacts on the environment. Such an event could spread pollution, overload water and wastewater treatment plants, carry silt and debris downstream, and disturb or destroy wildlife and natural habitat.

One of the most important tools available to emergency managers for mitigating the potential risks due to dam failure is an effective Emergency Action Plan (EAP). Maryland has a Dam Safety Program administered by Maryland Dept. of the Environment (MDE) requires EAPs for all significant and high hazard dams. In addition, the EAPs must meet certain minimum standards to insure their effectiveness including periodic updates to account for changes in development and property ownership, and drills/exercises to make sure the EAP is functional. MDE tracks the status of EAPs for high and significant hazard dams and works with dam owners to make sure their EAPs meet current standards. In June 2006 heavy rains caused a 23-foot rise in the water level behind Lake Needwood Dam resulting in uncontrolled seepage and elevated water levels along the downstream slope. The dam developed a leak and was on the verge of failure which resulted in activation of the dam's EAP while efforts were undertaken to control the seepage. Within a matter of hours, 2,400 people were evacuated from the downstream communities, including part of the City of Rockville. This emergency event was highly publicized and underscores the value of an effective EAP. Fortunately, complete dam failure was averted.

State and critical facilities within high hazard dam inundation areas are especially vulnerable to flooding caused by a dam failure event. Dam failures result in localized impacts, therefore it is unlikely that continuity of operations will be disrupted. However, relocation would be necessary if a facility is within an impacted portion of the dam inundation area; activating the Continuity of Operation Plan (COOP). In the event of a dam failure, responders face the risk of personal injury while performing necessary job functions.

State and Critical Facility Risk. The location of state and critical facilities within the dam breach inundation zone will determine the degree of damage likely to be experienced in the event of a dam failure. For example, those facilities located on the fringe of the inundation zone where lower flow depths and velocities would likely occur would be less susceptible to damage than those facilities located well within the inundation zone where higher flow depths and velocities would likely exists. A rule of thumb sometimes used to estimate building damage potential due to a flood event states that if the product of flood depth (in feet) and flow velocity (in feet per second) at a

[64] Correspondence with *David B. St. Jean, Energy Assurance Planning Manager for Maryland Energy Administration.8/1/2011.*

particular building structure is greater than seven or if the total flood depth is greater than 2 feet, then significant flood damage to the building structure may occur. Of course many other factors come into play in predicting the amount of potential flood damage such as the type of building construction, location of finished floors, location of critical contents, installation of flood proofing measures, etc.

Table 3-106 and Table 3-107 show the number of state and critical facilities at risk downstream of Maryland's high hazard dams along with estimated building and contents exposure values.

Table 3-106. State Facilities at Risk Due to Failure of High Hazard Dams.

High Hazard Dam Inundation Zone	Number of State Facilities	Total Building Value Exposure	Total Contents Value Exposure	Total Exposure
001-Prettyboy Dam	2	$3,402,966	$1,134,322	$4,537,288
002-Lochraven	61	$121,362,964	$38,083,591	$159,446,555
003-Liberty	23	$68,116,768	$20,066,116	$88,182,884
004-Deep Creek	4	$186,520	$9,326	$195,846
005-Brighton	3	$223,906	$35,923	$259,829
014-Savage River	82	$297,933,566	$17,287,546	$315,221,113
020-Rocky Gorge (Duckett)	4	$223,906	$35,923	$259,829
033-Little Youghiogheny Site #2 (Rt. 219)	9	$806,916	$268,972	$1,075,888
036-Broadford Lake	14	$1,551,614	$306,518	$1,858,132
045-Little Youghiogheny Site #3 (Winters)	6	$806,916	$268,972	$1,075,888
046 and 050-Needwood and Frank Dams	1	$31,072	$10,357	$41,429
055-Little Younghiogheny Site 5	13	$1,551,614	$306,518	$1,858,132
058-Hunting Creek	6	$1,570,960	$78,548	$1,649,508
069-Jennings Randolph	88	$299,200,233	$17,360,135	$316,560,369
097-Conowingo	1	$0	$0	$0
104-Lake Roland	56	$710,649,438	$22,563,058	$733,212,497
109-Druid Hill Lake	95	$1,317,662,486	$69,715,316	$1,387,377,802
241-Koontz	1	$0	$0	$0

Table 3-107. Critical Facilities at Risk Due to Failure of High Hazard Dams.

High Hazard Dam Inundation Zone	Number of Critical Facilities	Total Building Value Exposure	Total Contents Value Exposure	Total Exposure
001-Prettyboy Dam	190	$6,284,100	$2,094,700	$8,378,800
002-Lochraven	48	$0	$0	$0
003-Liberty	742	$4,232,900	$1,410,967	$5,643,867
004-Deep Creek	20	$2,287,100	$762,367	$3,049,467
005-Brighton	339	$7,575,840	$2,525,280	$10,101,120
006-Edgemont (Warner Gap) Reservoir	4	$0	$0	$0
009- Big Piney Run	3	$0	$0	$0
014-Savage River	263	$16,344,800	$5,448,267	$21,793,067
016-Fishing Creek	4	$0	$0	$0
017-Broad Creek	1	$0	$0	$0
018 - Emmitsburg Reservoir	2	$0	$0	$0
020-Rocky Gorge (Duckett)	348	$17,197,280	$5,732,427	$22,929,707
021-Linganore Lake	6	$0	$0	$0

High Hazard Dam Inundation Zone	Number of Critical Facilities	Total Building Value Exposure	Total Contents Value Exposure	Total Exposure
028-St. Mary's Watershed Site 1	5	$0	$0	$0
032-Little Youghiogheny #7 (Deer Park)	3	$0	$0	$0
033-Little Youghiogheny #2 (Rt. 219)	41	$1,636,400	$545,467	$2,181,867
036-Broadford Lake	78	$7,381,300	$2,460,433	$9,841,733
038-Jameson Dam	5	$0	$0	$0
042-Greenbrier State Park Dam and Dike	6	$0	$0	$0
045-Little Youghiogheny Site 3 (Winters)	40	$1,636,400	$545,467	$2,181,867
046 and 050-Needwood and Frank Dams	134	$6,853,600	$2,284,533	$9,138,133
055-Little Younghiogheny Site 5 (Wonderly)	81	$7,381,300	$2,460,433	$9,841,733
058-Hunting Creek	27	$0	$0	$0
061-Blair's Valley	6	$0	$0	$0
067-Atkisson	18	$0	$0	$0
069-Jennings Randolph	400	$67,343,000	$22,447,667	$89,790,667
070-Lower Lake Royer	1	$0	$0	$0
071 - Rocky Gap	1	$0	$0	$0
079 - Columbia Gateway	1	$0	$0	$0
081 - Laurel Sand and Gravel (Contee)	2	$0	$0	$0
083 - Edgewater Village	1	$0	$0	$0
097-Conowingo	70	$6,705,000	$2,235,000	$8,940,000
104-Lake Roland	295	$152,894,100	$50,964,700	$203,858,800
106 - Guilford Reservoir	2	$0	$0	$0
107-Lake Montebello	46	$388,700	$129,567	$518,267
108-Lake Ashburton	7	$5,959,500	$1,986,500	$7,946,000
109-Druid Hill Lake	444	$82,778,600	$27,592,867	$110,371,467
127-Wheaton Branch SWM	1	$0	$0	$0
139-Piney Run	5	$30,072,400	$10,024,133	$40,096,533
193-Inspiration Lake	5	$0	$0	$0
241 Koontz	2	$0	$0	$0
284-Centennial Park	13	$132,100	$44,033	$176,133
297-Little Seneca	8	$1,183,400	$394,467	$1,577,867
325-Lake Helene	5	$0	$0	$0
350 - Summit Hall Park	7	$0	$0	$0
358 Railroad Branch SWM	2	$0	$0	$0
371-Fedex Field SWM Pond 1	1	$0	$0	$0

Jurisdictional Risk. Based on the available data, Allegany, Anne Arundel, Baltimore, Garrett, Montgomery, Prince George's, and Washington Counties and Baltimore City have the most critical

and state facilities at risk due to a potential dam failure. Of all the Maryland jurisdictions, Baltimore City has the most facilities at risk including 935 critical facilities and 128 state facilities. The tables below show the number of state and critical facilities by county that are at risk downstream of Maryland's high hazard dams by jurisdiction along with estimated building and contents exposure values.

Table 3-108. State Facilities at Risk Due to Failure of High Hazard Dams.

County/City	Number of State Facilities	Total Building Value Exposure	Total Contents Value Exposure	Total Exposure
Allegany County	86	$297,966,233	$17,298,435	$315,264,669
Anne Arundel County	0	$0	$0	$0
Baltimore County	64	$124,956,730	$39,281,513	$164,238,243
Calvert County	0	$0	$0	$0
Caroline County	0	$0	$0	$0
Carroll County	0	$0	$0	$0
Cecil County	1	$0	$0	$0
Charles County	0	$0	$0	$0
Dorchester County	0	$0	$0	$0
Fredrick County	6	$1,570,960	$78,548	$1,649,508
Garrett County	20	$1,738,134	$315,844	$2,053,978
Harford County	0	$0	$0	$0
Howard County	0	$0	$0	$0
Kent County	0	$0	$0	$0
Montgomery County	1	$31,072	$10,357	$41,429
Prince George's County	4	$223,906	$35,923	$259,829
Queen Anne's County	0	$0	$0	$0
Somerset County	0	$0	$0	$0
St Mary's County	0	$0	$0	$0
Talbot County	0	$0	$0	$0
Washington County	4	$1,234,000	$61,700	$1,295,700
Wicomico County	0	$0	$0	$0
Worcester County	0	$0	$0	$0
City of Baltimore	128	$1,443,862,337	$94,000,353	$1,537,862,690

Table 3-109. Critical Facilities at Risk Due to Failure of High Hazard Dams

County/City	Number of Critical Facilities	Total Building Value Exposure	Total Contents Value Exposure	Total Exposure
Allegany County	339	$65,797,400	$21,932,467	$87,730,206
Anne Arundel County	213	$12,328,100	$4,109,367	$16,437,680
Baltimore County	502	$6,284,100	$2,094,700	$8,379,302
Calvert County	6	$33,060	$11,020	$44,086
Caroline County	3	$0	$0	$3
Carroll County	14	$30,072,400	$10,024,133	$40,096,547
Cecil County	42	$232,200	$77,400	$309,642
Charles County	5	$0	$0	$5
Dorchester County	0	$0	$0	$0
Fredrick County	43	$0	$0	$43
Garrett County	132	$10,994,500	$3,664,833	$14,659,465
Harford County	59	$6,472,800	$2,157,600	$8,630,459
Howard County	84	$132,100	$44,033	$176,217
Kent County	2	$0	$0	$2
Montgomery County	180	$8,037,000	$2,679,000	$10,716,180
Prince George's County	278	$7,541,780	$2,513,927	$10,055,985
Queen Anne's County	6	$0	$0	$6
Somerset County	0	$0	$0	$0
St Mary's County	5	$0	$0	$5
Talbot County	1	$0	$0	$1
Washington County	92	$478,360	$159,453	$637,905
Wicomico County	0	$0	$0	$0
Worcester County	0	$0	$0	$0
City of Baltimore	935	$195,554,500	$65,184,833	$260,740,268

Local Plan Risk Assessment. Seventeen of the local plans addressed and ranked dams in their hazard mitigation plans. One local plans considered dams a high hazard, three medium-high, five medium, two medium-low and six low. Section 3.6 includes a summary of how each of the local plans ranked dams.

3.16.2 Levees in Maryland (Limited Analysis)

3.16.2.1 Description

A levee is a structure, earthen or artificial, with a primary purpose of providing protection from flooding during seasonal high water, storm surges, precipitation and other weather events. Levees are often parallel to a river or along low-lying coastlines. Although their primary function is that of flood protection, levees may also confine the flow of water, resulting in higher and faster flows. Similar to a dam failure, failure of a levee can result in catastrophic flooding as was seen in New Orleans on August 29, 2005, during Hurricane Katrina when the failure of levees and flood walls flooded over 80% of the city.

3.16.2.2 Historical Occurrence and Regional Perspective

Levee failures have impacted Maryland in the past. Of note, in September 1996, George's Creek, in Westernport, MD, overflowed its blocked channel, flooding Front Street with floodwaters eventually reaching Main Street. Approximately 27 structures were substantially damage during the event. Homes in the area were eventually acquired and removed with a park replacing them.

3.16.2.3 Risk Assessment

There are a total of 18 levees located in six Maryland counties as inventoried by FEMA[65]. This inventory captures all levee data (USACE and non-USACE) with a focus on those levees that provide protection from the 1 percent annual chance flood. Levees inventoried are found in Allegany, Baltimore, Cecil, Frederick, Garrett, and Prince George's Counties as shown in Table 3-110. Figure 3-60 plots the levee centerlines for each levee contained within the inventory. Failure of any one of these levees has the potential to inundate the surrounding areas, particularly those that are low-lying. Levee failure can occur with little or no advanced warning.

Table 3-110. Inventoried Levees/Dikes in Maryland.

County	Number of Levees	Levee Names
Allegany County	4	1. Barton – Georges Creek levee 2. Cumberland – North Branch Potomac River Levee 3. Neff Run Levee 4. Cumberland City - Sewage Treatment Plan Dike
Baltimore County	2	1. Roland Run Levee 2. Painters Mill Flood Dike

[65] FEMA Midterm Levee Inventory Geodatabase file 05/17/2010

County	Number of Levees	Levee Names
Cecil County	6	1. Back Creek Levee 2. Hog Creek Levee 3. Chesapeake & Delaware Canal Levee 4. Sassafras River Levee 5. Elk River Levee 6. Pearce Creek Levee
Frederick County	1	1. Carroll Parkway Levee
Garrett County	1	1. Kitzmiller Levee
Prince George's County	4	1. Northwest Branch Anacostia River Levee 2. Northeast Branch Anacostia River Levee 3. Anacostia River Levee 4. Oxon Run Levee

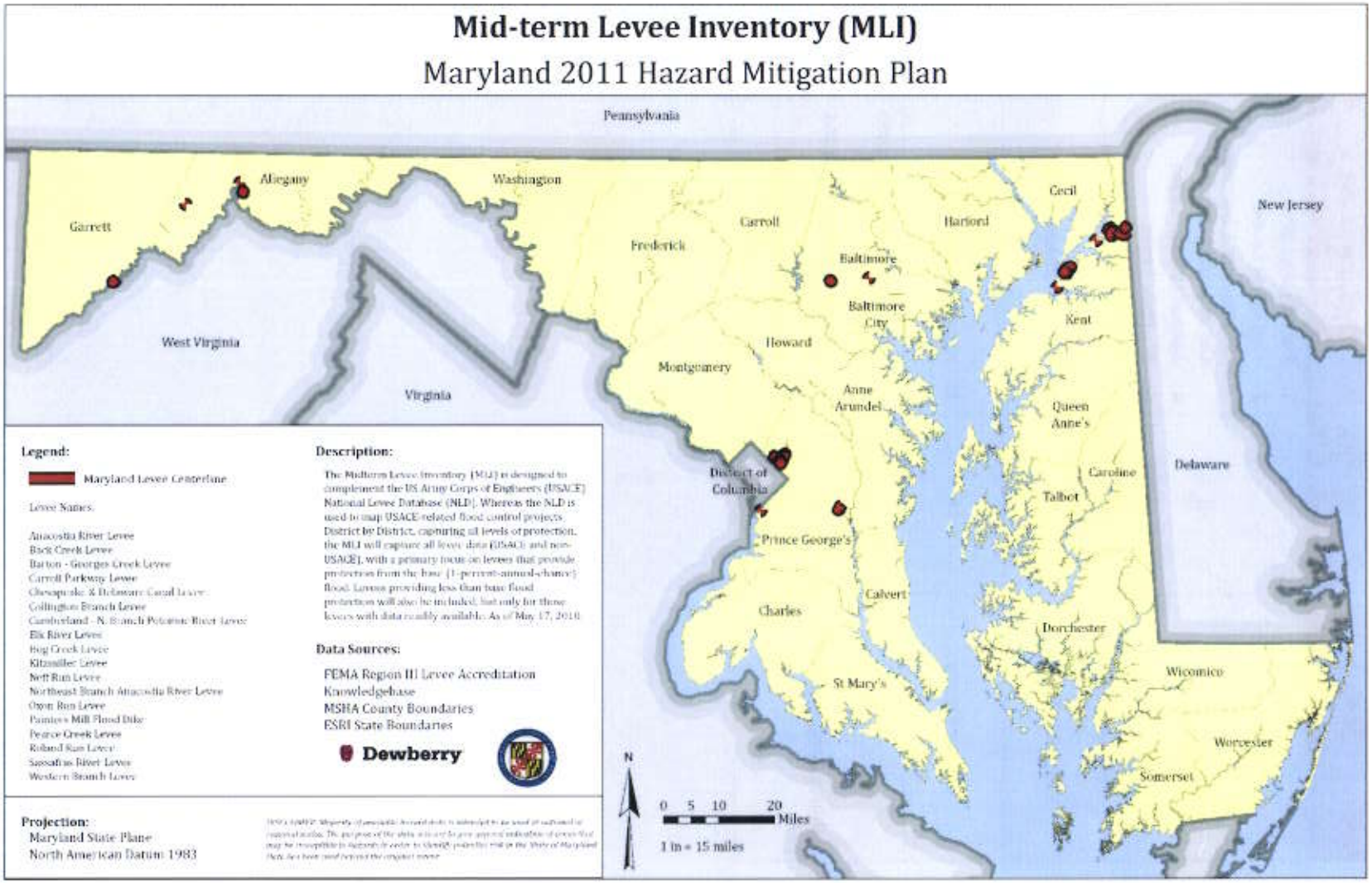

Figure 3-60. Inventoried Levees in Maryland.

3.17 Mining Hazards (Limited Analysis)

NOTE: Hazards associated with mining are described briefly in the section that follows. In-depth risk analysis including probability of future occurrences was not performed for this update to the 2011 Maryland State Hazard Mitigation Plan Update.

3.17.1 Description

Coal mining in Maryland began in the early 1700s in Garrett and Allegany Counties, and was some of the earliest coal to be mined in the eastern U.S. Maryland once had hundreds of active mines, but after World War I, the region's primary coal seam, the Pittsburgh Vein, ran out. Most of the subsurface mines were abandoned, and surface mining became the most prominent method of extraction.[66] Today, there are about 30 active coal mines in Maryland, located in Garrett and Allegany Counties and all but two are strip mine operations. The mines employ approximately 400 workers, and produced about 2.8 million tons of bituminous coal in 2008.[67] The coal basin locations in western Maryland can be seen in Figure 3-61

Non-coal mining is now far more prevalent than coal mining in Maryland. The first statewide comprehensive mining law for non-coal mining became effective in 1977 and permitted the formation of 18 surface mines in the first year. Today there are about 330 surface mines in the state, with at least one in each county. Materials that are mined include: dimension stone, limestone, hard rock aggregate, clay, fill dirt, topsoil, sand, and gravel.[68]

There are several state and federal agencies that regulate mining activities in Maryland. The Maryland Department of the Environment was created in 1987, and regulates all surface and subsurface mining within the state. The department's mission is: "to protect the public and the environment from the potential impacts of active mining; and to promote the restoration and enhancement of active and abandoned mine land and water resources."[69] They handle the reclamation of many of the abandoned mine sites within the state, as well as managing the effects of acid mine drainage on waterways that are near abandoned coal mines.

The Surface Mining Control and Reclamation Act was passed in 1977, and established the Office of Surface Mining Reclamation and Enforcement (OSMRE) within the U.S. Department of the Interior. This office regulates surface mining activities and the reclamation of coal-mined areas, and sets forth minimum impact requirements for all surface mines and any surface effects of underground mines. Mine operators are required to minimize disturbances and adverse impacts on natural systems. The restoration of land and water resources is a main priority of reclamation activities.[70]

[66] Maryland Coal Mine Mapping Project, http://www.frostburg.edu/minemapping/history.htm (2006).
[67] Calvert, Scott. *Md. Miners say accidents just part of the job.* The Baltimore Sun. http://articles.baltimoresun.com/2010-04-08/news/bal-mining-0408_1_mine-explosion-coal-west-virginia (April 2010).
[68] Maryland Department of the Environment, http://www.mde.state.md.us/programs/Land/mining/Non%20Coal%20Mining/Pages/Programs/LandPrograms/Mining/MOG/index.aspx.
[69] Maryland Department of the Environment, http://www.mde.maryland.gov/programs/Land/mining.
[70] U.S. Fish and Wildlife Service, http://www.fws.gov/laws/lawsdigest/SURFMIN.HTML.

Figure 3-61. Maryland Coal Basins.

Figure source: Frostburg State University, http://www.frostburg.edu/minemapping/gis.htm.

3.17.2 Hazards

Subsurface mining hazards include workplace risks such as cave-ins and collapses, equipment-induced injury, flooding, fires, and toxic gas accumulations. Surface mining hazards include those facing miners working in active operations and with heavy machinery, as well as the risk of collapse, such as the tragedy that occurred in 2007 at the Tri-State surface mine in Allegany County, where a 150-foot-tall wall section collapsed and buried two miners. Requirements for the control of workplace hazards and response to workplace emergencies are the responsibility of state and federal agencies including the Mine Safety and Health Administration (MSHA) and the Occupational Health and Safety Administration (OSHA), and are only touched on briefly in this plan. Hazards to the environment caused by mining include land subsidence and acid mine drainage, both of which can negatively impact natural systems and communities.

3.17.2.1 Cave-in and Collapse

A mine collapse has the potential to crush workers or to trap them in an airtight space where their oxygen may run out before rescuers can reach them. The incident of this type with the most fatalities in the State occurred in Garrett County in 1948, when a mine collapse trapped five men, who died of asphyxiation.

3.17.2.2 Methane

When a coal bed is mined, fissures and pores are exposed which contain the colorless, odorless, and highly flammable gas methane. Methane presents a two-fold danger; not only is it extremely explosive, but it will act as an asphyxiate which will drive oxygen out of the lungs and cause death by suffocation. Tools and equipment used by miners today are capable of generating sparks and open flame, which can be extremely dangerous if there is methane present in a tunnel or shaft. A methane explosion may cause a violent chain reaction as coal dust ignites in a series of secondary explosions throughout the mine. It is difficult to predict how much methane is likely to be present in a particular coal bed; factors such as coal type, the age of the coal strata, and the depth of the mine will help determine this.[71] In 1916, 16 men were killed in a mine explosion in Garret County. It was believed the explosion had likely occurred when the miners hit a methane pocket.

3.17.2.3 Flooding

Mine flooding can occur after heavy rains cause flash flooding or leaking into the mine, or if workers accidentally drill into a flooded underground chamber. These floods can trap or kill miners. No large flooding events (three or more fatalities) have been recorded in Maryland.

3.17.2.4 Acid Mine Drainage

Abandoned mine sites can have a lasting negative impact on the land. Allegany County has 867 abandoned mines and Garrett County has 647. The locations of these abandoned mines can be seen in Figure 3-62. The state has approximately 450 abandoned mines that predate the Surface Mine and Control Reclamation act of 1977 which may pose a threat to local waterways. As water leaches through the tailings and overburden left over at an abandoned mine site, it may pick up heavy metals and sulfide minerals in the rock. This water becomes highly acidic, with high concentrations of heavy metals, and will severely impair the waterways it drains into. Acid mine drainage from abandoned mines is western Maryland's most serious water pollution problem, with some of the streams and rivers in Garrett and Allegany counties now so badly polluted that they are unable to support any life.[72] These waterways eventually run into the Chesapeake Bay, where they have a severe impact on fisheries and wildlife. The

[71] *Coal Mining and the Risk of Methane Gas Explosions*, http://www.methanegasdetectors.com/info/category/coalbed-mining/.
[72] Office of Surface Mining Reclamation and Enforcement, http://www.osmre.gov/aml/AML.shtm (2009).

Maryland Bureau of Mines created the Acid Mine Drainage Program in 1982, which has since received about $8.2 million in federal grants. This program is helping to treat and clean up polluted waterways, but is predicted to run out of operating funds by 2014.[73]

3.17.2.5 Land subsidence

Land subsidence can occur when mine shafts and tunnels collapse, leading to a lowering of the ground surface due to the loss of subsurface support. This may occur gradually or suddenly, and can damage building foundations, roads, or underground facilities as well as being a risk to public safety. In terms of overall mining hazards, land subsidence poses the greatest risk to the operations of state and critical facilities. Facilities in regions such as Allegany and Garrett Counties, which have a rich mining history and are known to have experienced land subsidence caused by mining, are particularly at risk (see Section 4.13 for a more complete analysis of Karst/Subsidence). It is highly unlikely for a state and /or critical facility to be affected by an active mine disaster event; typically, abandoned mines pose the greatest risk for collapse. Continuity of Operations would be impacted only for those facilities within close proximity to an abandoned mine. The Continuity of Operation Plan would be activated for such an event, ensuring services to continue. Emergency personnel would respond under the guidance of MSHA. Risks to first responders exist considering secondary impacts may occur during a mining hazard event. Secondary impacts include flooding, additional collapses, and exposure to methane gas.

[73] Piazza, Elisabeth M. *Cleanup of mine runoff renewing state waterways*, The Baltimore Sun (October 2008).

Figure 3-62. Abandoned Mines in Maryland.

3.17.3 Historic Occurrence

The public is more often exposed to the hazards associated with abandoned mines, but most available data concerns disasters (classified as an event claiming three or more lives) at active mining operations. These events have become rare as safety standards and technology improve. All recorded events that have had three or more fatalities (save for one event, which involved two deaths but was recent and significant in the community) are listed below in Table 3-5011. It should be noted that there have been other accidents throughout Maryland's mining history that have claimed one or two lives.

Table 3-5011. Previous Significant Mining Disaster Events.

Date	Event	Comments
January 25, 1909	Machinery Accident	Five men were killed at the Washington No. 5 Mine in Franklin (Allegany County) when mine cars malfunctioned.
February 29, 1916	Mine Explosion	16 men were killed in an explosion at the Davis No. 42 Mine in Kempton (Garrett County).
November 4, 1948	Mine Collapse	Five miners died of asphyxiation after their tunnel collapsed at the Nethken Mine in Kitzmiller (Garrett County).
April 17,2007	Mine Collapse	A 150-foot wall section collapsed in an open pit mine, burying two miners instantly under 93,000 tons of debris. The bodies were found three days later. It was suspected that heavy rains and repeated freezing and thawing of the ground may have played a role in the collapse. The collapse occurred at the Tri-State Mine near Barton, in Allegany County.

Table Sources:
Bieniek, Matthew. Judge examines mine case claims. Cumberland Times. http://times-news.com/local/x1930917403/Judge-examines-mine-case-claims (November 2010).
Lebowitz & Mzhen, Maryland Accident Law Blog, http://www.marylandaccidentlawblog.com/2007/04/investigators_look_at_fatal_mi.html (April 2007).
U.S. Department of Labor- Mine Safety and Health Administration, http://www.msha.gov.
United States Mine Rescue Association, http://www.usmra.com/Mine_Disasters/search_all_state.asp (2011).

3.17.4 Marcellus Shale

Since mid-2006, energy companies have expressed interest in western Maryland because it overlies a geologic formation known as Marcellus Shale. The Marcellus Shale is an organic-rich shale in the Appalachians which occurs at the surface and in the subsurface from New York to eastern Tennessee. In Western Maryland, the Marcellus Shale underlies all of Garret County and much of Allegany County, and ranges from around 200 feet thick in western Garrett County to over 250 feet thick in eastern Allegany County.[74] Areas underlain by the shale can be seen in Figure 3-63. This sedimentary rock formation was deposited over 350 million years ago. The decomposition of organic materials under high pressure and temperature has produced reserves of natural gas, which is mainly held in pore spaces and fractures in the

[74] Brezinski, David K. *Geology of the Marcellus Shale in Maryland,* Maryland Geological Survey, http://www.mgs.md.gov/geo/pub/MarcellusShaleGeology.pdf.

shale. Newly developed drilling techniques now make it profitable for energy companies to target this shale for gas exploration.

A procedure called hydraulic fracturing (often called "hydrofracking" or "fracking") is used to retrieve the natural gas deposits. This process involves the hydraulic fracturing of the shale by pumping water at high pressures into the rock to create vertical fractures in the shale layer, while at the same time introducing sand into the rock to keep the fractures open once the water is removed. Then the gas company drills horizontally through the layer of shale to intersect the vertical fractures in the rock which contain the natural gas. [75]

Hydraulic fracturing has been shown to have negative impacts on the environment and for property owners and communities near the wells. The water that is pumped at high pressures into the well is mixed with a series of chemicals, a few of which include acids, diesel fuels, gelling agents, antibacterial agents, and corrosion inhibitors.[76] A portion of these chemicals may remain trapped in the ground and may leach into groundwater or surface water, and some of them qualify as hazardous materials and known carcinogens. There are cases in the U.S. where hydraulic fracturing is the primary suspect in cases of polluted drinking water. An additional environmental concern is the amount of water that this extraction method requires. According to Chesapeake Energy, drilling and fracking a typical deep shale gas well requires about 5 million gallons of water. Some of this liquid is recovered by the drilling company to either be injected in another well or stored in holding ponds on the surface, where it creates an additional risk of contamination. About 60-80 percent of the water solution remains in the ground.

In consideration of these potential environmental and public health risks, Maryland has established a commission to study hydraulic fracturing in the state. The Maryland Shale Safe Drilling Initiative was established in June 2011, and the commission will study the use of shale gas development and hydraulic fracturing including its risks. This study is scheduled to present recommendations for best gas exploration and extraction practices in the Marcellus Shale by August 12, and a final report by August 2014.[77]

[75] Maryland Geological Survey, http://www.mgs.md.gov/geo/marcellus.html (December 2010).
[76] Chesapeake Energy, http://www.hydraulicfracturing.com/Fracturing-Ingredients/Pages/information.aspx.
[77] Maryland Dept of the Environment, *Governor O'Malley Announces Study of Marcellus Shale Drilling*, http://www.mde.state.md.us/programs/PressRoom/Pages/060611.aspx (June 2011).

Figure 3-63. Marcellus Shale in Western Maryland.

Figure Source: Maryland Geological Survey, http://www.mgs.md.gov/geo/marcellus.html.

3.18 Overall Hazard Results

3.18.1 Summary of HIRA

Sections 3.7 through 3.19 discussed the various risks, probabilities and impacts associated with each natural hazard that has been determined to have a significant impact on Maryland's infrastructure and population. This final sub-section provides an overall assessment and summary of the individual hazard analyses. GIS data for critical and state faculties was used when possible to determine risk for the infrastructure in Maryland. Section 3.4 fully describes the data that was used to create the critical facility and state facility datasets.

3.18.2 State and Critical Facility Risk

Summary of Risk Assessment. The vulnerability of state and critical facilities to individual hazards is discussed in each of the hazard subsections (Sections 3.7-3.19). Refer to the tables in these sections to determine which facilities are at the greatest risk from each hazard type. These subsections highlight the results of the analysis completed for this plan; analysis is based on GIS intersections of the facility data with the available hazard extent data. The data used for this analysis is available through MEMA for localities to use to update their plans. This information is ideal for determining structural mitigation strategies.

Critical Facility Risk. The tables in each of the hazard specific analysis sections can be used as a starting point for determining types of mitigation actions that might be helpful to lower the vulnerability of critical facilities in the state. For example, there are 7,485 critical facilities determined to be within the FEMA 100-year flood zone.

Section 3.4 and Appendix P describe the critical facility types and sources that were used for the vulnerability analysis in each hazard specific section. Critical facility locations will be made available to localities through MEMA and can be used at the local level to determine if the spatial locations are correct. If acceptable, this analysis could be used to identify and recommend mitigation projects.

State Facility Risk. State facilities were analyzed in a method similar to the critical facilities. They were intersected with the available hazard extent data to determine if each building fell within any risk zones. A summary of this analysis is available in each of the hazard sections in this report. Appendix P summarizes, by agency name, the number of buildings and total known exposure for each hazard category. This information would be ideal to use in planning future mitigation actions.

3.18.3 Overall Hazard Ranking

The local plan ranking is described in Section 3.6. As discussed, the local plan ranking compares agreeably to the new ranking that was developed for this report. Analysis was not completed on human caused, hazardous materials, and technological hazards in this section since MEMA has separate plans that address these hazards in detail.

To determine the overall hazard ranking, the total ranking values were separately averaged for each hazard to determine which hazards should be considered the most significant in Maryland. Section 3.5 and Appendix P describe the ranking parameters and methodology that were used for this analysis. As can be seen in Table 3-512, flooding was the only hazard given a "high" ranking for the state of Maryland. Coastal hazards, drought, high winds, and winter storms were each given a

"medium-high" ranking. Hazards that are considered negligible or for which data is more limited were included as textual descriptions in the major hazard sections. Overall hazard ratings are broken down by jurisdiction in Table 3-523.

Table 3-51. Overall NCDC hazard ranking for Maryland.

High	Medium-High	Medium	Medium-Low	Low	Negligible
Flooding	Coastal Hazards	Tornado	Landslide	Karst/Sinkholes	Mining Hazards
	Drought	Wildfire	Thunderstorm (Lightning and Hail)	Earthquake	Dam Failure
	High Winds				
	Winter Storm				

The individual hazard sections provide information and analysis tables for jurisdictions that are considered high risk areas. Figure 3-64 provides a summary of each of the individual hazard ranking maps. Figure 3-65 gives a summary of local plan rankings for comparison.

Table 3-5213. Summary Hazard Ranking for Maryland.

County/City	Coastal Hazards	Drought	Flooding	Landslide	Thunderstorm (Lightning and Hail)	Tornado	Wildfire	High Winds	Winter Storm	Karst/ Sinkholes	Earth-quake
Allegany County	Medium-Low	Medium	Medium-High	Medium-High	Medium-Low	Medium-High	Medium-High	Medium-High	High	Low	Low
Anne Arundel County	High	Medium-High	High	Medium-Low	Medium-High	Medium-High	High	Medium-High	High	Low	Medium-Low
Baltimore County	High	Medium-High	High	Medium-Low	Medium-High	Medium	Medium-High	Medium-High	High	Medium-Low	Medium-Low
Calvert County	Medium-High	Medium	Medium	Medium-Low	Medium	High	High	Medium	Medium-High	Low	Medium-Low
Caroline County	Medium	Medium-High	Medium-High	Low	Low	Medium-Low	Medium	Medium	Medium	Low	Low
Carroll County	Medium-Low	High	Medium	Medium	Medium	Medium-High	Medium-Low	Medium	High	Medium	Low
Cecil County	High	Medium-High	High	Medium	Medium-Low	Medium	Medium-High	High	Medium	Low	Medium
Charles County	High	Medium-High	Medium-High	Medium-Low	Medium	High	Medium-High	Medium-High	High	Low	Medium-Low
Dorchester County	High	Medium-High	High	Low	Low	Medium-High	Medium	Medium-High	Medium-High	Low	Low
Frederick County	Medium	Medium-High	High	Medium-Low	Medium-High	High	Medium-High	High	High	Medium-High	Medium-Low
Garrett County	Medium-Low	Medium-Low	Medium High	Medium-High	Low	High	Medium-High	Medium-High	High	Low	Low
Harford County	Medium-High	High	Medium-High	Medium-Low	Medium-High	Medium-High	Medium	Medium-High	High	Low	Low
Howard County	Medium	High	Medium-High	Low	Medium-Low	Medium-Low	Medium	High	High	Low	Medium-Low

County/City	Coastal Hazards	Drought	Flooding	Landslide	Thunderstorm (Lightning and Hail)	Tornado	Wildfire	High Winds	Winter Storm	Karst/ Sinkholes	Earth-quake
Kent County	High	Medium-High	High	Medium-Low	Medium-Low	Low	Medium	Medium	Medium	Low	Medium-Low
Montgomery County	Medium	High	High	Medium-Low	Medium-High	Medium-High	Medium	High	High	Low	Medium-Low
Prince George's County	High	Medium-High	High	Medium	Medium-High	Medium-High	Medium-High	High	High	Low	Medium-Low
Queen Anne's County	High	Medium-High	High	Medium-Low	Low	Medium-Low	Medium-Low	Medium	Medium-High	Low	Low
St. Mary's County	High	Medium	Medium-High	Low	Medium-Low	Medium-High	High	High	High	Low	Low
Somerset County	High	Medium-High	High	Medium-Low	Low	Medium-Low	Medium	Medium-Low	Medium-Low	Low	Low
Talbot County	High	Medium-High	High	Low	Medium-Low	Medium-Low	Medium	Medium	Medium-High	Low	Low
Washington County	Medium-Low	Medium-High	Medium-High	Medium	Medium	Medium-High	Medium-High	Medium	High	Medium	Low
Wicomico County	High	Medium-High	High	Medium-Low	Medium-Low	Medium	Medium	Medium-High	Medium	Medium-Low	Medium-Low
Worcester County	High	Medium-High	High	Low	Low	Medium-Low	Medium	Medium	Medium-High	Low	Low
City of Baltimore	High	Medium-Low	High	Medium	Medium	Medium-Low	Medium-Low	Medium-High	High	Medium-Low	Medium-Low
Annapolis	Medium-High	Medium-Low	High	Medium-Low	Medium	Medium-High	Medium-High	Medium-High	Medium-High	Low	Low
Town of Ocean City	High	Medium-Low	High	Low	Medium-Low	Medium-Low	Medium	Medium	Medium	Low	Low

County/City	Coastal Hazards	Drought	Flooding	Landslide	Thunderstorm (Lightning and Hail)	Tornado	Wildfire	High Winds	Winter Storm	Karst/ Sinkholes	Earth-quake
Local Plan Ranking	High	Medium-High	High	Medium	High	High	Medium-High	Medium-High	High	Medium	Medium-Low
Statewide Ranking	Medium	Medium-Low	Medium	Low	Medium-High	Medium	Medium-High	High	High	Low	Low

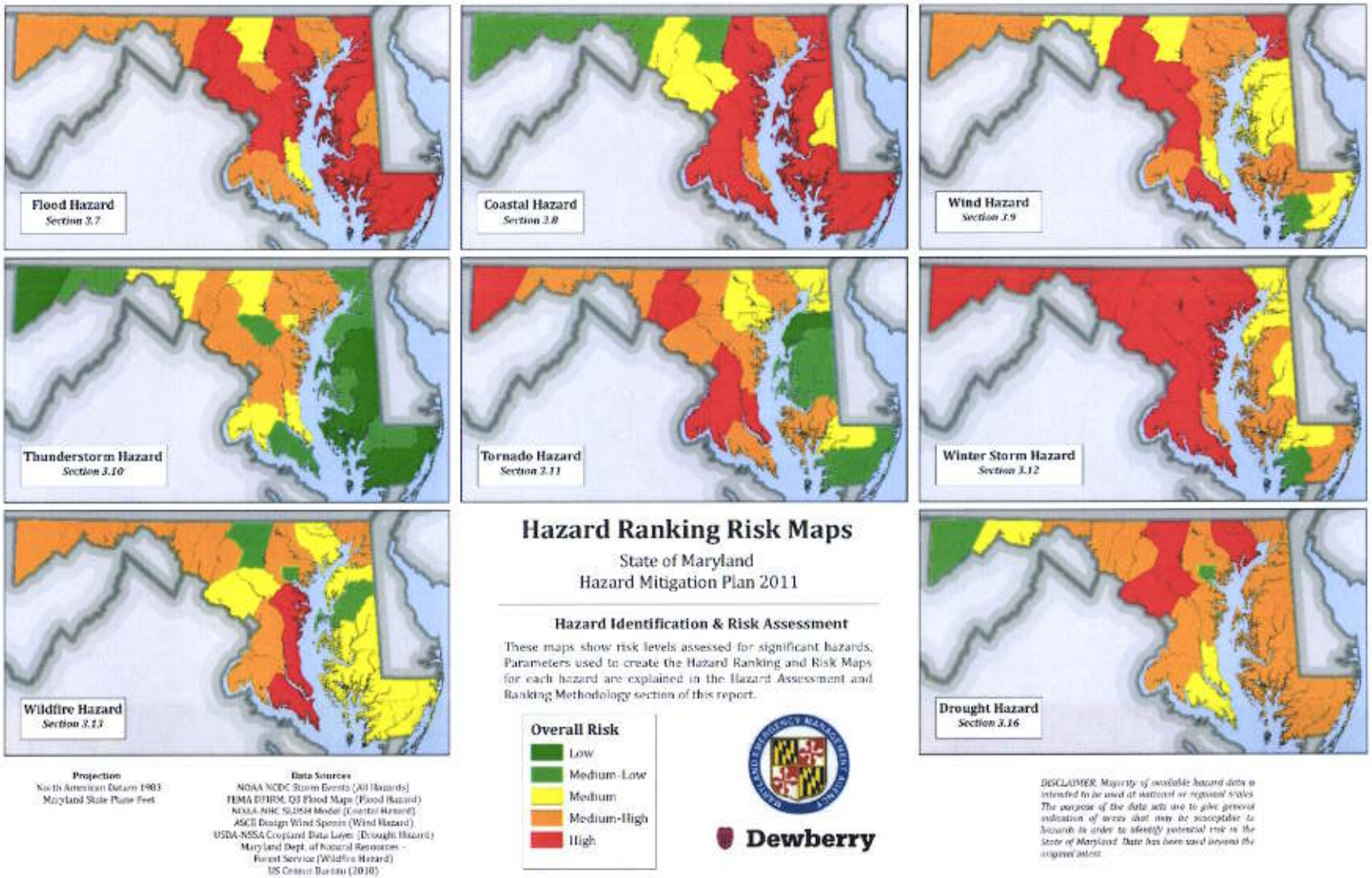

Figure 3-64. Overall Risk Ranking by Hazard.

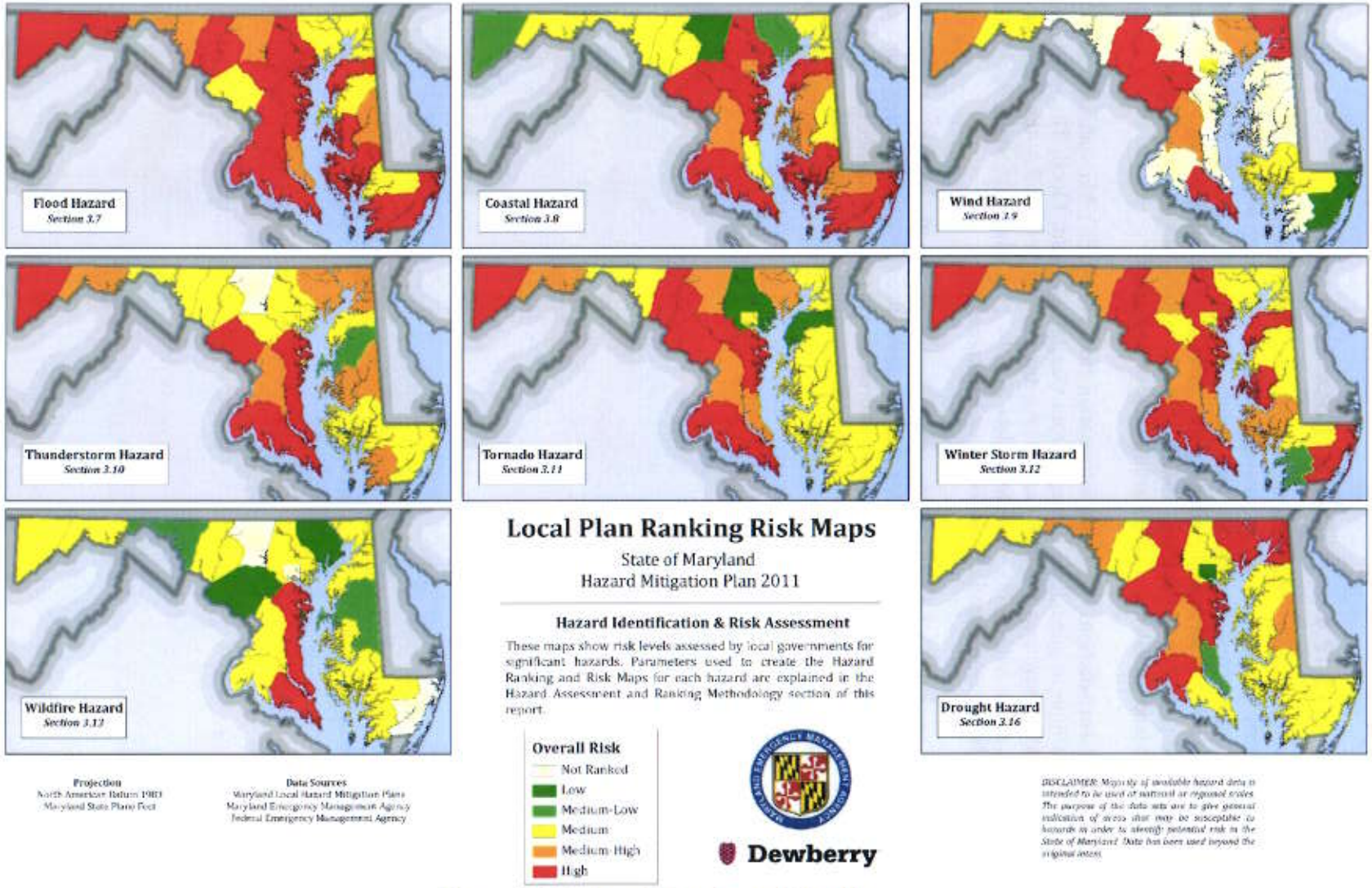

Figure 3-65. Local Plan Overall Rankings.

3.18.4 Overall Loss Estimates

The NCDC Storm Events database records damage costs associated with each type of hazard, and can be used to generate rough estimates of annualized losses for many of the weather-related natural hazards. Supplemental annualized loss values for flooding, hurricane winds, and earthquake have also been derived from the other sources, including HAZUS-MH MR 5 analysis as described in each individual hazard section. NCDC did not include any historical information about damages due to land subsidence (karst), earthquakes, or landslides.

Annualized Loss by Jurisdiction. Based on information from the NCDC, Maryland can expect approximately $70 million in annualized damages from Coastal, Drought, Flood, Thunderstorm, Tornado Wind, Winter Storm, and Wildfire hazards. As discussed in Section 3.3, this data does have limitations due to the availability of historic data and the possibility that some significant events may not have been reported and/or loss values under-reported.

The hazard specific sections (3.7-3.19) include information regarding the annualized loss by jurisdiction. The ranking and risk parameter maps show the annualized property and crop damages as established using NCDC data or other best-available data sources. The hazards that used an established method for calculating annualized loss (flood and earthquake) are explained in detail in those sections. Table 3-14 summarizes the annualized loss damages for each of the hazards by jurisdiction.

Table 3-114. Annualized Loss Estimated based on best available data by hazard.
Forest Service provided losses for wildfire, all other losses annualized from NCDC.

County/City	Coastal	Drought	Flood	Thunderstorm	Tornado	Wind	Winter Storm	Wildfire	Total Annualized
Years of Record	1993-2010	1995-2010	1993-2010	1956-2010	1950-2010	1956-2010	1993-2010	1998-2010	1950-2010
Allegany County	$71	$698,227	$2,326,745	$1,969	$143,014	$34,354	$90,989	$2,253	$3,297,622
Anne Arundel County	$4,580,765	$698,295	$214,357	$63,454	$171,475	$112,988	$48,807	$0	$5,890,141
Baltimore County	$6,694,136	$698,227	$256,942	$29,317	$992,123	$72,209	$89,752	$115	$8,832,821
Calvert County	$4,528,169	$320,774	$39,773	$6,096	$245,864	$68,355	$27,608	$340	$5,236,979
Caroline County	$670,290	$0	$553,503	$2,635	$7,845	$11,284	$18,768	$701	$1,265,026
Carroll County	$71	$556,072	$175,426	$16,171	$265,417	$76,843	$64,770	$188	$1,154,958
Cecil County	$670,290	$0	$437,367	$7,303	$120,882	$44,118	$30,504	$1,476	$1,311,940
Charles County	$4,597,806	$320,683	$19,785	$17,327	$2,366,329	$25,105	$27,608	$3,434	$7,378,077
Dorchester County	$483,745	$170,245	$0	$1,875	$189,717	$30,295	$75,665	$1,584	$953,126
Frederick County	$71	$698,233	$1,934,926	$45,370	$77,423	$65,977	$56,726	$1,452	$2,880,178
Garrett County	$71	$0	$257,128	$154	$84,559	$23,609	$18,533	$296	$384,350
Harford County	$4,455,718	$556,088	$274,483	$31,021	$149,371	$48,061	$61,699	$430	$5,576,871
Howard County	$0	$698,227	$19,656	$21,372	$102,614	$34,348	$50,039	$91	$926,347
Kent County	$670,290	$0	$74,030	$588	$14,676	$8,234	$18,768	$180	$786,766
Montgomery County	$0	$698,236	$1,534,251	$297,295	$120,115	$199,020	$53,198	$284	$2,902,399
Prince George's County	$4,455,718	$698,381	$164,152	$17,141	$2,338,650	$111,152	$48,807	$592	$7,834,593
Queen Anne's County	$670,290	$0	$296,545	$1,316	$24,939	$7,274	$18,768	$320	$1,019,452
St. Mary's County	$4,479,896	$320,646	$55,079	$14,466	$122,651	$64,669	$27,608	$716	$5,085,731
Somerset County	$68,357	$170,245	$0	$56	$1,864	$27,468	$75,665	$8,965	$352,620
Talbot County	$670,290	$0	$259,104	$42,862	$5,832	$6,621	$18,768	$370	$1,003,847
Washington County	$71	$698,252	$2,011,538	$3,866	$33,278	$84,950	$69,859	$192	$2,902,006
Wicomico County	$64,766	$170,245	$0	$723	$6,861	$25,745	$75,665	$661	$344,666
Worcester County	$357,701	$0	$316	$56	$17,357	$80,586	$152,762	$410	$609,188
City of Baltimore	$2,228,214	$0	$129,175	$896	$3,338	$15,601	$24,982	$0	$2,402,206
Grand Total	**$40,346,796**	**$8,171,076**	**$11,034,281**	**$623,329**	**$7,606,194**	**$1,278,866**	**$1,246,318**	**$25,050**	**$70,331,910**

Comparison with Local Plans. Local Plan Incorporation Section 3.6 includes the average ranking for the local plans. Several of the hazard categories that were addressed in the local plans were not considered in the state plan; Appendix H includes the full local plan review and analysis with these hazards included. MEMA has separate plans that address human caused hazards. Erosion, extreme heat, extreme cold, thunderstorm, lightning, hail, and tsunami have been included as textual descriptions in the major hazard sections. Of the hazards considered, the average rankings in local and state analysis are comparable. Minor differences in the local and statewide ranking can be seen in Table 3-52, which are further explained in the Hazard Ranking Section 3.5 and Local Plan Incorporation Section 3.6, the various plans included different hazard categories in the ranking. Overall, the local and statewide hazard rankings are similar in the relative threat to hazards impacting Maryland.

Comparison with Demographics, Land Use and Development. Section 3.2 of this plan describes the general land use and population trends in Maryland over the last few decades. Examination of the seven hazard categories that have high risk values for individual counties (coastal events, drought, flood, tornado, wildfire, wind, and winter storms) reveals that many of the counties that are given high risk values also have high population growth rates. The counties of Charles, St. Mary's, Calvert, Howard, Frederick, Harford, Cecil, Queen Anne's, Wicomico, and Carrol are all predicted to have a population growth rate of between 20 percent and 30 percent between 2000 and 2015, and all of these counties are rated at high risk for one or more hazard. These counties are already seeing increased development, and may have higher potential losses associated with hazards in the future.

Local hazard mitigation plans lacked detailed information about land use and future development planning. Generalized information about land use planning has been made at the State level using national datasets in each of the hazard sections. Land use planning, completed at local level, can reduce risk to the population and infrastructure by addressing the hazards that impact the jurisdiction. It is necessary for this to be done at the jurisdictional level since this is where planning, regulation, and taxation authorities are.

3.18.5 Limitations and Future Updates

It should be noted that the data sources used in this analysis are varied in their degree of completeness, accuracy, precision, etc; our ability to accurately prioritize some of the hazards would be improved with better information about them (e.g., landslide, karst, etc.). Further discussion on the data limitations and how the data was adapted for analysis is available in section 3.5 and in the hazard specific sections (3.7 – 3.19).

2014 Hazard Mitigation Plan Update. An attempt was made to include the "best available" data for this revision of the hazard mitigation plan. Spatial data is constantly changing and efforts are being made to increase the accuracy of this data by many local, state, and federal agencies. As this data is made available it will be used in revisions to this plan.

Tying HIRA to Mitigation Actions. Data limitations have been fully noted throughout this section. Some of the issues may be resolved through coordinated efforts of federal, state, and local agencies. Data creation and management issues will take more resources to resolve and incorporate into future updates to the *Maryland State Hazard Mitigation Plan.*

Chapter 4. Mitigation Strategy

2011 changes to this chapter include a new mitigation strategy planning process, updated 2008 mitigation strategies, new 2011 action plans, and a newly minted repetitive loss and severe repetitive loss strategy section. In order to complete this section, two Stakeholder meetings and a series of subcommittee conference calls were held to develop mitigation goals, objectives and actions.

4.1 Mitigation Strategy Planning Process

The *2011 Maryland State Hazard Mitigation Plan Update* is structured with a traditional hierarchy that begins with one mitigation goal supported by seven topical groupings of objectives with supporting mitigation actions, programs or projects. Accomplishment of objectives will depend on successful implementation of the supporting mitigation actions, strategies and projects. The mitigation goal from the *2008 Mitigation Plan* was reviewed, refined and adopted at the June 15, 2011, Stakeholders Meeting; objectives were added to help organize the actions initiated during that meeting and through follow-up Web-Ex meetings of the five subcommittees. Actions were developed by five subcommittees which formed during topical break-out sessions during the meeting:

1. Programs, Policy, Planning and Funding
2. Mitigation of High Hazard Structures
3. Local Planning Interface
4. 2014 Vulnerability Analysis
5. Education and Outreach

Each subcommittee was composed of Stakeholders, MAC members, subject matter experts, MEMA and FEMA staff. They were assisted by consulting facilitators and scribes. During these breakout sessions, the group members affirmed continuation of relevant 2008 Plan mitigation actions and initiated new ideas for the 2011 Plan Update. Some subcommittees continued to assign responsible party and timeframes for completion to various actions as time permitted. Follow-on conference calls and WebEx's were held with each subcommittee to solidify these actions and complete the STAPLEE ranking. STAPLEE represents Social, Technical, Administrative, Legal, Economic and Environmental factors used to rank mitigation strategies (see Table 2-3).

4.1.1 2008 Action Status Update

The status of the 2008 mitigation actions are captured in Appendix I of this plan update. During the 2011 update, each agency was given an opportunity to update the status of their 2008 strategies beginning in June 2011 through use of the project SharePoint site. Screen captures of the site follow:

By following the blue links on the right side of the page, 2008 action advocates were able to update their actions as required. An example of the program activities assigned to the Department of Housing and Community Development can be seen below. Agencies that were unable to update actions via the SharePoint site were provided digital copies via email for updating.

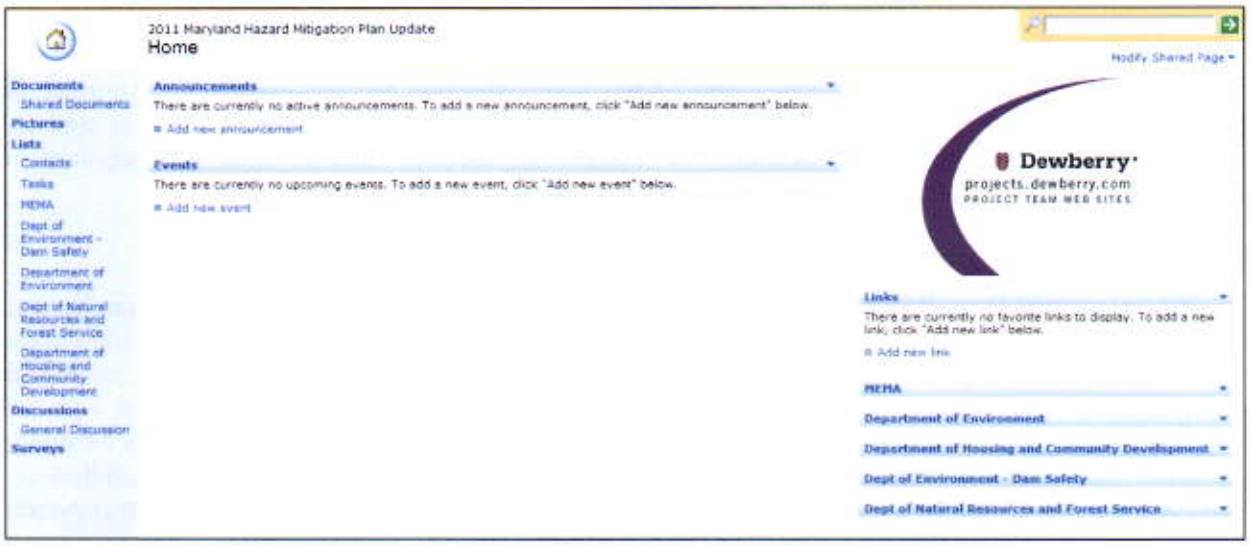

Figure 4-1. Maryland 2011 SharePoint Site Screen Capture

Title	Action	Status	Completion Date	Relevance	Comments
Strategy 7.6.3:	The Maryland Department of Housing and Community Development will continue to provide technical assistance to local government with the administration and enforcement of building codes	In progress			
Strategy 7.7.2:	The Maryland Department of Housing and Community Development will continue to provide technical assistance to local governments with the administration and enforcement of building codes				
Strategy 7.2.4:	The Department of Housing and Community Development will provide continued support to insure that local building codes are up to date and consistently enforced.				
Strategy 7.4.1:	Investigate increasing the minimum wind standard in the Statewide Building Code for critical facilities				Co-lead with MEMA

Figure 4-2. Maryland 2011 Mitigation Actions (2008) Online Tracking Tool

4.1.2 FEMA Unified Hazard Mitigation Assistance Grant Projects

In an effort to capture information on Maryland FEMA Unified Grant Mitigation Assistance funding levels (the primary source for funding 2008 eligible mitigation actions when funds are available), a spreadsheet tool highlighting grant obligations was developed; it is included in Appendix N. Beyond the scope of this plan update, this tracker tool can be used by MEMA mitigation grants staff to track all HMA grant activity and local plan update status. It will better inform the 2014 update. The tool has been provided to MEMA and FEMA Region III in digital format in Appendix N.

4.1.3 Local Mitigation Action Upload

A summary of actions from local hazard mitigation plans can be found in the Appendix H. Several summary screen captures of this data may be found in the local vulnerability analysis in Chapter 3 of the plan. This tool will be used for local plan tracking as plans are updated and local mitigation actions are implemented throughout the next planning cycle.

	Project Type							
County	Prevention Measures (Indicate: P-Plan, AS-Alert Systems, S-Structural Prevention, O-Other)	Property Protection Measures (Indicate: A-Acquired, L-Relocated, E-Elevated, R-Regulations, V-Vulnerability Analysis, O-Other)	Emergency Services Measures (Indicate: T-Training, E-Equipment, M-Mapping, D-Data collection, P-Planning, O-Other)	Structural Projects Measures (Indicate: M-Maintenance, N-New Structure, O-Other)	Natural Resource Protection Measures (Indicate: X-Yes)	Public Education and Awareness Measures (Indicate: T-Training, M-Public Meetings, P-Publications, O-Other)	NFIP (Indicate: X-NFIP Projects listed)	Community Rating System (CRS) (Indicate: X-CRS Projects Listed
Allegany	P, AS	A, O (Retrofit).	M, D			T	X	
Annapolis	P, S, AS		E		X	T, M, P, O - public radio and public access TV news releases		
Anne Arundel	P	A, L, E, V	T, E, P	N/A	X	T, M, P, O	X	N/A
Baltimore City	S	A, R	D, M	M	X	T, P	X	X
Baltimore		P	V	E, D, P	M, N, O		T, P, O	X
Calvert	P, AS, O (Page67-69, 75, and	R, V, L, E, O (Page 68, 69, and 57-66)	M, D, P, E, T (Page 75 & 63)	N & M (Page 68, 69, and 75)	X (Page68, 69, and 76)	M, P, T (Pages 93-95)	X (Page 83-85 and 30 thru 32)	X
Caroline	AS, P, S	A, E, V, O	T, E, D, O	M	X	T, M, P, O	X	X
Carroll	P, S	A, L, E	O	N, M	X	T	X	
Cecil	P	A, L, V	T, D, M			P, T	X	
Charles	P, AS, S	A, L, E, V	D, M	N	X	P, T, M	X	
Dorchester	P, AS	R, L, E	D, M, E, T		X	T, P	X	
Frederick	S, P, O (Monitoring Stream Gauges)	A, L, E, V	E, P, O	M		P, O (PSAs via Radio), M	X	X
Garrett	P, AS, O (Pages 40, 74, 76 and 77)	A, L, E, R, V (Pages 15, 51, 74 and 76)	T, E, O, P (Pages 74 thru 77)	N & M (Pages 15, 16, 74, 76 and 79)	X - (Page 76)	T, P, O, M (Page 76 & 79)	X - (Page 17, 48, and 75)	N/A - Garrett County does not participate due to staff constraints (Page 17)
Harford	P, AS, S	A, E, R, V	M, E, T, P	M, N	X	T, M, P	X	X

Figure 4-3. Local Plan Mitigation Actions Summary Tracker Tool Screen shot.

4.2 Goals, Objectives, and Actions

Using the process described above and in Chapter 2, the June 15, 2011, meeting attendees refined and finalized the 2008 mitigation goal as follows:

To protect life, property, and the environment from hazard events through:

- Increased public awareness of hazard events, mitigation and preparedness.
- Enhance coordination with jurisdictions to develop a relationship at the state and local level.
- Efficient use of State resources.

In addition, the following seven objectives were developed:

1. Provide state guidance and technical assistance to enhance mitigation planning and project efforts by public and private stakeholders.
2. Enable MEMA to encourage each Maryland county or municipality to secure funding and initiate critical facility mitigation by obtaining HMA subgrants.
3. Support Unified HMA grant programs that acquire and demolish hazard prone structures or elevate, retrofit and relocate existing structures and facilities (including non-residential structures) in vulnerable locations with a priority on repetitive loss and severe repetitive loss structures.
4. Develop a comprehensive mitigation and preparedness program to educate private and public stakeholders, academia, government employees and elected officials on the hazards pertinent to the State.
5. Identify both state and local statutory, regulatory or policy-based initiatives that support Maryland mitigation planning actions and leverage support for their inclusion in upcoming updates (i.e. building code regulations).
6. Promote, identify and undertake three infrastructure mitigation projects to improve the state's resiliency to potential hazards.

7. Integrate the mitigation planning process, including the hazard vulnerability assessment, into related local and state plans (i.e. environmental plans, land use plans, comprehensive plans, mitigation plans).

4.2.1 Action Prioritization

Mitigation actions were developed within the context of the statewide vulnerability analysis. Discussion occurred immediately following the presentation of the draft hazard identification, risk assessment and vulnerability analysis on June 15, 2011, so Stakeholders and the MAC were immersed in a totally new vision of Maryland's hazard vulnerability.

Actions were developed during the June meeting, where participants were divided into five topic-based subcommittees, facilitated by the project consultant. Baseline criteria for the projects were determined before project and strategy ideas were solicited. The Maryland Mitigation Idea Book featuring goals, objectives and mitigation actions from other state plans, was provided to participants to inspire state mitigation opportunities. A summary of each subcommittee's work follows:

Policy, Programs, Planning and Funding
The policy, programs, planning and funding group included participants from a range of state agencies as well as a number of local officials. During the June 15 meeting the group reviewed policy, programs, planning and funding mitigation strategies from the previous plan, to determine which actions should be continued. Most actions were carried forward in one manner or another. The group followed up through a WebEx meeting on June 21 to review the draft mitigation action plans and prioritize the actions. The group identified twenty actions that are intended to increase and improve the ability of state agencies and local jurisdictions to implement mitigation activities.

Mitigation of High Hazard Structures
The structures group included participants from a wide range of state agencies as well as local officials. The group reviewed code- and structure-related mitigation strategies from the 2008 Plan, all of which are completed or are ongoing. The group also identified nearly 30 new strategies related to retrofitting buildings, improving infrastructure and preserving life safety. These actions include statewide strategies as well as specific local actions to reducing losses from a number of natural hazards. A follow-on WebEx was conducted on June 24 to solidify actions and STAPLEE rankings.

Local Planning Interface
The local planning interface group included participants from Maryland state, county, and municipal levels of government. As this was a new subcommittee developed specifically for the *2011 Maryland State Hazard Mitigation Plan Update*, the subcommittee began by discussing their overall purpose, which was to establish additional points of connection or linkages between local and state hazard mitigation planning. This prompted a lively discussion which resulted in most of the identified actions from the 2008 Plan that were specific to local planning interface being carried forward, while six new actions were developed. These six new actions are inter-related in that they are directed toward establishing a clear method and standards for sharing local and state information throughout the hazard mitigation plan development process. To refine and prioritize the 2011 actions, the STAPLEE ranking system was used during a WebEx on 24 June 2011.

2014 Vulnerability Assessment
Subcommittee members of the 2014 vulnerability assessment group included local representatives and state agency personnel. Prior to the development of new actions, the subcommittee reviewed and updated 2008 mitigation actions relevant to the vulnerability assessment. The group then identified

nine 2011 mitigation actions dedicated to expanding the 2014 vulnerability assessment. A WebEx to finalize these actions and conduct the STAPLEE ranking was held on June 21, 2011.

Education and Outreach
The Education and Outreach group consisted of 14 participants from state and local agencies. The group first met on June 15, 2011, and developed a list of potential mitigation actions to be included in this update of the plan. These new actions were added to four actions continued from the 2008 Plan. The group reconvened by conference call and WebEx on June 22 to further refine and prioritize the list of mitigation actions. Actions which were deemed duplicative or of very low priority were deleted.

Mitigation actions finalized by each subcommittee were organized within objectives and evaluated using the STAPLEE criteria suggested in FEMA's Hazard Mitigation Planning How-to-Guide series. The STAPLEE criteria address feasibility, show in
The subcommittee members were asked to evaluate only the actions developed by their group. During the follow-up conference calls, members were provided an opportunity to evaluate each action on the seven criteria and associated sub criteria using a -1/0/1/NA scale. An evaluation of 1 was calculated as one point; an evaluation of –1 was calculated as negative one point, while an evaluation of 0 or Not Applicable (N/A) received 0 points. The score from one planning team member for an individual action, therefore, could range from -6 to +6. All of the scores were combined and averaged to determine a final score and ranking. Table 4-2 shows the score ranges and associated prioritization ranking.

4.3 Mitigation Action Plan

The action plans below group the actions developed into the subcommittee topic and indicate which objectives apply to the action. Each action plan includes:

- A general statement of the mitigation action;
- The hazard it is designed to mitigate (the primary hazard is denoted in bold);
- Applicable objective(s);
- Potential funding sources, if applicable;
- The agency assigned responsibility for carrying out the strategy (support agencies denoted in italics);
- Target completion date;
- Interim measure of success; and
- Priority.

This information is intended to assist the Mitigation Advisory Committee and MEMA in accomplishing each identified action.

Table 4-1, cost-effectiveness and environmental considerations among other factors.

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- Potential funding sources, if applicable;
- The agency assigned responsibility for carrying out the strategy (support agencies denoted in italics);
- Target completion date;
- Interim measure of success; and
- Priority.

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Table 4-1. STAPLEE Criteria

S Social	• Is the proposed action socially acceptable to the community(s)? • Are there equity issues involved that would mean that one segment of a community is treated unfairly? • Will the action cause social disruption?
T Technical	• Will the proposed action work? • Will it create more problems than it solves? • Does it solve a problem or only a symptom? • Is it the most useful action in light of other community(s) goals?
A Administrative	• Can the community(s) implement the action? • Is there someone to coordinate and lead the effort? • Is there sufficient funding, staff, and technical support available? • Are there ongoing administrative requirements that need to be met?
P Political	• Is the action politically acceptable? • Is there public support both to implement and to maintain the project?
L Legal	• Is the community(s) authorized to implement the proposed action? Is there a clear legal basis or precedent for this activity? • Are there legal side effects? Could the activity be construed as a taking? • Is the proposed action allowed by a comprehensive plan, or must a comprehensive plan be amended to allow the proposed action? • Will the community(s) be liable for action or lack of action? • Will the activity be challenged?
E Environmental	• How will the action affect the environment? • Will the action need environmental regulatory approvals? • Will it meet local and state regulatory requirements? • Are endangered or threatened species likely to be affected?
E Economic	• What are the costs and benefits of this action? • Do the benefits exceed the costs? • Are initial, maintenance, and administrative costs taken into account? • Has funding been secured for the proposed action? If not, what are the potential funding sources (public, non-profit, and private)? • How will this action affect the fiscal capability of the community(s)? • What burden will this action place on the tax base or local economy? • What are the budget and revenue effects of this activity? • Does the action contribute to other community goals, such as capital improvements or economic development? • What benefits will the action provide?

Table 4-2. Priority Ranking Categories

Priority Ranking	Distribution by Group					
	Planning, Policy, Programs and Funding	Education and Outreach Activities	Risk Assessment	Local Planning Interface	Mitigation of High Hazard Structures	TOTAL
High	0	16	8	4	16	44
Medium	8	11	3	5	12	39
Low	5	2	0	2	4	13

4.4.1 Mitigation Action Plan by Subcommittee Topic

Table 4-3. Mitigation Action Plan

ID #	Project Description	Objective	Lead/Support Agency	Funding Source	Target Completion Date	Interim Measure of Success	Priority
Programs, Planning, Policy and Funding							
PPP-1	Develop state wide strategy to provide funding and technical assistance to local jurisdictions for mitigation planning and project development.	1, 7	MEMA/Mitigation	EMPG; HMGP	Short-term	Within six months after plan adoption, MEMA has a draft strategy for review by State Mitigation Advisory Committee.	Medium
PPP-5	Work with state commercial insurance carriers to provide recommendations on preventative loss measures.	4	Maryland State Treasurer	Staff resources	Short-term	Within six months of plan adoption, hold meetings with each of the state's commercial insurers to discuss this initiative and assess viability.	Medium
PPP-6	Identify utilities and other facilities, that could contaminate the Potomac River and other major drinking water sources statewide, if impacted by disaster (i.e., chemical spill due to flood) and work with them to ensure appropriate risk reduction measures are in place.	2, 6	Maryland Department of Environment; Interstate Commission on the Potomac River Basin; SBRC	HMA funds; staff time	Long-term	Within nine months of plan adoption, identify likely facility owners that could have major impact on drinking water supply.	Medium
PPP-7	Broaden/increase participation in statewide lessons learned sessions post-event to share corrective after action plans.	1	MEMA/Operations	Staff resources	Short-term	Within three months of plan adoption, identify protocol for holding statewide information sharing sessions.	Low
PPP-8	Review how information is shared statewide (between MEMA and jurisdictions and among jurisdictions) during an incident or event, and implement corrective actions.	1	MEMA/Operations	Staff resources	Short-term	Within one year of plan adoption, complete an evaluation of current information sharing mechanisms and identify means to improve and increase information sharing mechanisms.	Medium

ID #	Project Description	Objective	Lead/Support Agency	Funding Source	Target Completion Date	Interim Measure of Success	Priority
PPP-9	Ensure the state is taking full advantage of Risk MAP and obtain full participation by all counties.	3	Maryland Department of Environment	FEMA Mapping Program	On-going	Within one year of plan adoption, assess Harford County's experience with Risk MAP pilot and adjust MD mapping program as needed.	Medium
PPP-10	Prioritize HMA funding for mitigation of repetitive loss properties and severe repetitive loss properties.	1, 2,3,	State Mitigation Advisory Committee	HMA funds	Short-term	Within three months of plan adoption, ensure that the State Mitigation Advisory Committee makes consideration of repetitive loss/severe repetitive loss status a major consideration in project selection.	Medium
PPP-11	Increase coordination and information sharing within watersheds and inter-state to better enable communities to mitigate cross-border impacts (e.g., understanding flood conditions upstream in PA).	1	Governor's Office/Director of Intergovernmental Affairs; MEMA/?? (SRBC? NWS?)	Staff resources	Short-term	Within six months of plan adoption, identify relevant stakeholders.	Low
PPP-14	Identify resources to support technical assistance and funding for state agencies for mitigation.	7	MEMA/Mitigation	Staff resources	Long-term	Within one year of plan adoption, secure resources for at least one new project for a state agency.	Low
PPP-18	Develop methodology to integrate state COOP plans with 2014 state hazard mitigation plan	7	MEMA/Planning	Staff resources	Short-term	Within six months of plan adoption, review state COOP and identify linkages with state HIRA.	Low
PPP-19	Require, through policy, that new state capital improvement projects incorporate hazard mitigation principles (e.g., prohibit new projects in hazard-prone areas such as floodplains or the coastal high hazard area; requiring above code design requirements for critical facilities).	5	MEMA/Mitigation; Governor's Office	Staff resources	Long-term	Within four months of plan adoption, identify process through which Executive Orders are developed.	Medium

ID #	Project Description	Objective	Lead/Support Agency	Funding Source	Target Completion Date	Interim Measure of Success	Priority
PPP-20	Maintain and implement the State of Maryland Drought Monitoring and Response Plan, which outlines the methods and steps the State will take to monitor and respond to drought conditions when they occur.	7	Maryland Department of Environment	Staff resources	On-going	Within one year of plan adoption, review drought plan and reaffirm content.	Medium
LP-7	Utilize the State Mitigation Advisory Committee and add local plan information affecting the State to quarterly agendas. Review regional trends and/or region specific mitigation strategies for inclusion into the *2011 Maryland State Hazard Mitigation Plan Update*.	1	MEMA	MEMA Staff Time	Ongoing	State Mitigation Advisory Committee meeting agendas/minutes	Medium
LP-8	Ensure that local flood damage prevention regulations are up to date and consistently enforced.	2, 3, 6	Maryland Department of Environment (MDE) – NFIP, FEMA CAP-SSSE and State Funding	State Funding	Ongoing	MDE - NFIP: Community Assessment Reports	High
Mitigation of Structures							
MS-1	Apply for mitigation grant funding to acquire and demolish homes or other structures identified by local governments to be in imminent danger of collapse due to sinkholes, landslide, coastal erosion or other forms of mass movement.	1, 3	MEMA/ Co-lead with MDE	HMA Programs	Ongoing	Identify grant source.	Low

ID #	Project Description	Objective	Lead/Support Agency	Funding Source	Target Completion Date	Interim Measure of Success	Priority
MS-2	Dredge shipping channel in the Port of Baltimore and Chesapeake Bay Shipping Channels to maintain interstate maritime commerce. Install intrusion detection as part of channelization process.	2, 6	USACE, MD Port Administration, USCG	USACE	Ongoing	Seek and obtain funding for project	Medium
MS-3	Conduct stream bank stabilization and channel improvements throughout the state.	2, 6	MDE, DNR and counties	DNR, County budgets	Ongoing	Prioritize stream bank hazard levels.	Medium
MS-4	Investigate increasing the minimum wind standard in the Statewide Building Code for critical facilities.	5, 6	MEMA	MEMA budget	Ongoing	Research other states or jurisdictions that have increased their building codes for wind standards.	High
MS-5	The Department of Housing and Community Development will provide continued support to ensure that local building codes are up to date and consistently enforced.	6	Housing and Community Development	HCD	Ongoing		High
MS-6	Incorporate climate change and coastal hazard considerations into building codes for coastal communities (e.g. freeboard, septic siting).	7	MDE, DNR	MEMA budget	Long Term	Determine appropriate climate change studies to utilize.	High
MS-7	Repair aging dam and levee structures.	2, 6	MD Dept of the Environment, USACE	MDE budget	Long Term	Prioritize aging dam and levee structures.	Medium
MS-8	Update automated control gates on aging dams and levees and link to warning systems. Make warning system data (alarms and video monitoring) available to state and local governments.	2, 6	MD Dam Safety (within MDE)	MDE budget	Long Term	Prioritize aging dam and levee structures.	Medium

ID #	Project Description	Objective	Lead/Support Agency	Funding Source	Target Completion Date	Interim Measure of Success	Priority
MS-9	Incorporate hazard and risk analysis into databases of publicly-owned structures.	7	DGS, local jurisdictions, USACE	DGS Budget and local jurisdictions' budgets	Long Term	Determine which publicly-owned facilities should be included in the database.	High
MS-10	Conduct a feasibility analysis for a temporary floodwall or other protective measure for Baltimore Harbor and other floodprone urban areas in the State.	2, 3, 6	MDE, MEMA, Baltimore EM/Planning, other urban EM	MDE Budget and local jurisdictions' budgets, HMA funding	Short Term	Identify sponsoring agency/budget for project.	Medium
MS-11	Identify flood protection techniques for floodprone wastewater treatment plants.	2, 3, 6	MDE, MEMA	HMA Programs	Short Term	Secure funding.	High
MS-12	Explore the development and implementation of a notification process similar to that required for schools for other critical and State-owned and critical facilities at risk, such as nursing homes.	2, 6	DGS, MEMA, Legislature	MEMA budget	Ongoing	Identify and research pilot communities with similar systems	Medium
MS-13	Install traffic maintenance and evacuation message signing along flood-prone highways in Cecil County. Investigate evacuation and detour messaging in other flood prone areas throughout the state.	2, 6	SHA	SHA budget	Ongoing	Secure message boards and solidify work schedule.	High
MS-14	Identify mitigation measures for nuclear power plant.	2, 6	Constellation Energy, NRC (Federal), Public Service Commission	NRC	Long Term	Develop nuclear mitigation actions work group.	High
MS-15	Develop and implement a plan to improve pump stations susceptible to damage in flood-prone areas.	2, 3, 6	MDE, local PW/PU departments	Local PW departments HMA programs	Long Term	Identify pump stations in flood-prone areas.	High

ID #	Project Description	Objective	Lead/Support Agency	Funding Source	Target Completion Date	Interim Measure of Success	Priority
MS-16	Identify flood prone roads and replace/mitigate undersized and clogged culverts.	2, 3, 6	MDOT	MDOT, HMA programs	Ongoing	Identify appropriate points of contact in each jurisdiction to help identify roadways.	High
MS-17	Install trash racks upstream of critical bridges to preserve structures.	2, 6	MDOT and local DOTs, DNR, MDE	MDOT	Ongoing	Secure funding.	High
MS-18	Reprofile and reconstruct roads in low-lying areas that are prone to flooding.	2, 3, 6	MDOT and local DOTs	MDOT	Long Term	Identify and prioritize low-lying roads that are prone to flooding.	High
MS-19	Support the construction of tornado safe rooms in critical facilities, public schools, or individual residences.	2, 6	DHR, MEMA	HMA Programs	Short Term	Seek and secure funding.	High
MS-20	Promote as a model tornado and high wind mitigation project the hardening of the La Plata police station. This project was funded as part of an effort to use HMGP funds to protect critical facilities and ensure continuity of operations.	2, 6	MEMA	HMA Programs		Seek and secure funding.	Low
MS-21	Assess all police and fire facilities, designated shelters, and other state structures statewide for current and potential use as safe rooms.	2, 6	Local jurisdictions, MEMA	HMA Programs	Short Term	Seek and secure funding.	High
MS-22	Develop shelter-in-place plans/provisions for public facilities.	2, 6	DGS, DHCD, DHR	DGS and MEMA Local Govt, NGOs Private	Ongoing	Develop plan table of contents and work plan to complete plan by 2013.	High
MS-23	Retrofit BWI airport to resist wind and blast.	2, 6	MAA	MAA	Long Term	Identify potential funding sources.	Medium

ID #	Project Description	Objective	Lead/Support Agency	Funding Source	Target Completion Date	Interim Measure of Success	Priority
MS-24	Retrofit BWI to include a safe room for travelers and employees in the event of a disaster.	2, 6	MAA	MAA	Short Term	Identify potential funding sources.	Medium
MS-25	Harden or develop MTA transit facilities to serve as safe rooms.	2, 6	MTA	MTA	Long Term	Seek and secure funding.	Medium
MS-26	Provide backup power (generators and hookups) for state shelters.	2, 6	DHR, Dept of Education, MEMA	DHR, HMGP 5% match	Short Term	Seek and secure funding.	Medium
MS-27	Within MDOT, harden police, fire, and EOC facilities to protect against wind and ensure effective COOP.	2, 6	MDOT	MDOT	Long Term	Seek and secure funding.	Medium
MS-28	Identify and mitigate sinkholes. Evaluate drainage in the area to prevent development of new sinkholes.	2, 6	MEMA, local jurisdictions, MDOT, DHCD, other agencies	HMA funding, local and State agency budgets, homeowners	Long Term	Identify points of contact within each jurisdiction to help identify sinkhole problem areas.	High
MS-29	Improve stormwater management throughout the state.	2, 3, 6	DNR and jurisdictions	DNR, County budgets	Long Term	Determine specific aspects that need to be improved.	High
MS-30	Maximize use of HMA grants for eligible mitigation projects such as acquisition/demolition, elevation, relocation and flood-proofing of nonresidential structures. Encourage local communities, partner agencies and universities to develop a list of pre-scoped mitigation projects.	2, 3, 6	Localities	Local EM departments	Short Term	Develop a working group to discuss mitigation projects state-wide.	Medium

ID #	Project Description	Objective	Lead/Support Agency	Funding Source	Target Completion Date	Interim Measure of Success	Priority
MS-31	Continue the strategic placement of dredged material containment islands to mitigate the effects of wave action and storm surge along populated shorelines and exposed wetland habitat of the Chesapeake Bay.	6	USACE	USACE	Ongoing		Low
PPP-17	Conduct detailed site assessment of critical facilities to develop site specific state mitigation actions.	2	Treasurer	Long-term	Within three months of plan adoption, develop short list of at-risk facilities.	Within three months of plan adoption, develop short list of at-risk facilities.	Low
MS-32	Examining the FEMA-MEMA repetitive loss and severe repetitive loss data sets to seek candidate properties that could potentially be mitigated through the FEMA RFC, SRL or other HMA funding programs or any other available funding sources on an annual basis. Prioritize jurisdictions that will receive planning & project grants through HMA programs to those jurisdictions with SRL and RL properties.	3	MEMA	Internal	Annually	N/A	High
2014 Vulnerability Assessment							
VA-1	Define "critical facility" for 2014 plan update.	7	MEMA	State agency funding	Short term	Contact appropriate local and state agencies to provide input on definition.	High
VA-2	Further develop, centralize and maintain a critical facility database.	2	MEMA	State agency funding	Long term	Convene a work group to discuss developing and maintaining a critical facility inventory.	High

ID #	Project Description	Objective	Lead/Support Agency	Funding Source	Target Completion Date	Interim Measure of Success	Priority
VA-3	Inventory hazard risks to state-owned facilities and identify their risks to hazards including climate change related (sea level rise, coastal and riverine stream erosion, and increased flooding) hazards.	2	Department of General Services, Treasurer's Office, Department of Management and Budget	FEMA Unified Hazard Mitigation Assistance funding	As funding is available	Convene a work group to discuss developing and maintaining a state-owned facility inventory.	High
VA-4	In coordination with the MSGIC and local jurisdictions, organize and convene a 2014 Vulnerability Assessment working group to discuss the review/refinement of the 2011 HIRA.	7	Maryland State GIS Council (MSGIC), MEMA, Governor's Office of Technology, State Climatologist	State agency funding	Short term	Integrate the existing HIRA data into the MD IMAC. Coordinate with NWS as appropriate.	High
VA-5	Develop tools, data templates, etc., to assist the jurisdictions in developing rating systems for vulnerability assessments and to ensure consistency across the state.	1, 7	MEMA	FEMA Unified Hazard Mitigation Assistance funding	Ongoing	Determine process for incorporating local plan hazard rankings into the State Mitigation Plan.	High
VA-6	Expand hazard profiles and mapping analysis for the 2011 hazards that are text-analysis only, in the 2014 vulnerability assessment.	7	MEMA	FEMA Unified Hazard Mitigation Assistance funding	Long term	In coordination with the MSGIC and local jurisdictions, organize and convene a 2014 Vulnerability Assessment working group to discuss the review/refinement of the 2011 HIRA.	High
VA-7	Determine feasibility of adding climate change as a ranking factor in the 2014 vulnerability assessment.	7	MEMA	FEMA Unified Hazard Mitigation Assistance funding	Long term	Develop tools, data templates, etc., to assist the jurisdictions in developing rating systems and to ensure consistency across the state.	Medium
VA-8	Determine best way to identify and quantify uninsured losses to incorporate into 2014 VA.	7	MEMA – IA, SBA, local jurisdictions	State agency funding, locality funding	As funding is available	Identify agencies that keep data on uninsured losses.	Medium

ID #	Project Description	Objective	Lead/Support Agency	Funding Source	Target Completion Date	Interim Measure of Success	Priority
VA-9	Determine feasibility of adding human-caused hazards into the 2014 VA (i.e., nuclear, terrorism, utilities)	7	MEMA	FEMA Unified Hazard Mitigation Assistance funding	Long term	Evaluate data available and level of effort required to add this to 2014 VA.	High
VA-10	Determine feasibility of adding human-health and safety risks in conjunction with other hazard occurrences (i.e., vector-borne illnesses, pandemic outbreaks, water contamination) in the 2014 VA.	7	MEMA	FEMA Unified Hazard Mitigation Assistance funding	Long term	Evaluate data available and level of effort required to add this to 2014 VA.	High
VA-11	Maintain access to the Data Exchange System NFIP database of repetitive loss properties through continued relationships with DEP's State NFIP Coordinator's office		MEMA	N/A	At least annually	Completed annually	High
VA-12	Continue to pursue and develop clean datasets. Improve existing geo-coding by researching matches for properties with incomplete addresses and out of date address based on rural road designations that have changed		MEMA	Internal	Annual	Performed annually	High
VA-13	Align Maryland RL property data, and SRL property data with validated FEMA NFIP RL and SRL property data, annually;		MEMA	Internal	Annual	Performed annually	High

ID #	Project Description	Objective	Lead/Support Agency	Funding Source	Target Completion Date	Interim Measure of Success	Priority
VA-14	Align Greatest Savings to the Fund (GSTF) data and the new 2011 methodology to inventory and further demonstrate the cost effectiveness of potential RL and SRL mitigation projects. Evaluate projects further for environmental soundness and technical feasibility to create successful HMA grant subapplications.		MEMA	Internal	Annual	Performed annually	High
VA-15	Update listing of completed SRL and RL mitigated properties and FEMA's RL database with Maryland's mitigated properties database annually. Update of the merged database can also occur at HMA grant close-out or whenever improved local data becomes available.		MEMA	Internal	Annual	Performed annually	High
VA-16	Complete FEMA Form AW-501s for each mitigated property. Provide to FEMA through current FEMA databases or submittal to the region upon project close out Archive at MEMA.		MEMA	internal	Upon project close out per mitigated property	N/A	HIGH
VA-17	Merge the ICC RL database with Maryland's mitigated properties database annually.						
PPP-13	Work with responsible state agencies to identify mitigation strategies for state-owned facilities. Hazards to be addressed include: flood, hurricane wind, tornado, landslide, sinkhole, dam inundation, wildfire, heavy snow, and shoreline erosion.	2, 6, 7	MEMA/Mitigation	HMA funds; staff time	Long-term	Within three months of plan adoption, develop short list of at-risk facilities. Complete project scoping sheets for high priority structures (initiated as part of plan update).	Medium

ID #	Project Description	Objective	Lead/Support Agency	Funding Source	Target Completion Date	Interim Measure of Success	Priority
PPP-17	MEMA will provide state direction to ensure that local jurisdictional plans must address the mitigation of severe repetitive loss and repetitive loss structures in the mitigation strategies section of every local jurisdiction §322 plan with SRL or RL properties.		MEMA	Internal	As each local plan enters its 5-year update phase	Inclusion in each local plan update	High
Local Planning Interface							
LP-1	Coordinate the distribution of mitigation related data produced by State agencies to local government entities and other State agencies. This data will include but not be limited to the State of Maryland Hazard Mitigation Plan, Maryland Hazard Analysis and Risk Assessment. These materials are important for both mitigation and other planning purposes. MEMA will also conduct training seminars for data recipients.	4	MEMA	FEMA: Hazard Mitigation Planning/ Management Costs - HMGP & PDM	Ongoing	Annual review at State Mitigation Advisory Committee meeting	High
LP-2	Establish MEMA virtual library – (such as the Legislative Information System LIS- for Legislature) planning documents, specifically hazard mitigation plans. In addition, provide virtual training, virtual updates and information.	1, 7	MEMA	FEMA: Hazard Mitigation Planning - HMGP & PDM	Short Term	Virtual Library	Medium

ID #	Project Description	Objective	Lead/Support Agency	Funding Source	Target Completion Date	Interim Measure of Success	Priority
LP-3	Ensure State HIRA data is provided to local government. Expand distribution to include Planning Departments, Public Works, and Emergency Services. Provide technical assistance as necessary.	1, 7	MEMA	FEMA: Hazard Mitigation Planning - HMGP & PDM	Short Term	Completed Distribution Listing	High
LP-4	Request that local governments advise MEMA when mitigation project locations are impacted by hazard events. Follow-up with regular contacts to ensure that information is consistently provided. Implement mechanisms and standards by which local mitigation related information may be shared with the State and stored.	1	MEMA & Local Jurisdictions	FEMA: Hazard Mitigation Planning - HMGP & PDM	Short Term	Distribution of standards and data upload mechanism	High
LP-5	Ensure that local hazard data is analyzed and incorporated into State data sets, specifically HIRA.	7	MEMA	FEMA: Hazard Mitigation Planning - HMGP & PDM	Long Term	2014 State Plan Update	Medium
LP-6	Request State level data standards for both format and content.	1, 7	Maryland State Geographic Information Committee (MSGIC)	State Funding	Short Term	Distribution of data standards	Medium
LP-9	Provide technical assistance to local government with the administration and enforcement of building codes.	1	Department of Housing and Community Development	State Funding	Ongoing	DHCD Reports	High
PPP-2	Update and distribute to counties, cities and towns the "Best Practices in Hazard Mitigation" to include projects since 2008 and exemplary planning practices.	1	MEMA/Mitigation	EMPG; HMGP	On-going	Within nine months after plan adoption, a data call for exemplary planning practices has been issued. In addition, new "best practice" projects have been identified.	Low

ID #	Project Description	Objective	Lead/Support Agency	Funding Source	Target Completion Date	Interim Measure of Success	Priority
PPP-4	Create and implement a more structured training program targeting smaller jurisdictions to provide hazard mitigation information strategies, resources and methodologies using a regional approach incorporating seminars, webinars and/or other communication methods.	1, 4	MEMA/Mitigation	EMPG; HMGP	As funding is available	Within one year of plan adoption, schedule and hold two training courses. Work with Maryland Emergency Management Association to utilize annual conference for outreach on mitigation.	Medium
PPP-12	Streamline information accessibility to jurisdictions, agencies and communities on funding sources, resources and mechanisms.	1	Maryland Department of Planning (MDP)	Staff resources	On-going	Within six months of plan adoption, ensure information on mitigation grants is included in on-line grants database, The Redbook, and in the Intergovernmental Monitor Newsletter.	Low
PPP-16	Provide guidance on how local jurisdictions can work with private entities to implement mitigation projects.	1	MEMA/Mitigation	HMA funds; staff time	Short-term	Within nine months of plan adoption, develop draft guidelines.	Medium
Education and Outreach							
EO-1	The Maryland Emergency Management Agency will continue to pursue public education initiatives concerning mitigation, including their information booth at the Maryland State Fair and information posted on the MEMA website.	4	MEMA	Internal agency funding, FEMA Unified HMA grand funding	Long Term	Identify sources of funding to execute initiatives	Medium
EO-2	Continue to sponsor and host the Annual Severe Storms Conference before the start of hurricane season.	4	MEMA	Internal agency funding	Ongoing	Solidify 2012 conference date and verify attendance.	High

ID #	Project Description	Objective	Lead/Support Agency	Funding Source	Target Completion Date	Interim Measure of Success	Priority
EO-3	Promote the use of NOAA weather radios and the satellite emergency alert and warning system by local governments.	1, 4	MEMA/ Co-lead with the Department of Housing and Community Development	EMPG funding, internal agency funding, local jurisdiction funding	Ongoing	Develop common message to disseminate to local jurisdictions regarding radio usage.	Medium
EO-4	The Maryland Department of the Environment will continue to implement the Drought Public Information Initiative, which disseminates public information provides education on appropriate water conservation activities for public and media.	4, 7	MDE	Internal agency funding	Long Term	Develop and/or ready for distribution at least one factsheet or brochure	Low
EO-5	Develop and execute Public Service Announcements.	4	Governor's Office/MEMA	Internal agency funding	Long Term	At least one PSA written and ready for production	High
EO-6	Provide factsheets and informational brochures on personal preparedness and hazards to the public.	4	MEMA	FEMA Unified HMA grant funding	Ongoing	Develop and/or ready for distribution at least one factsheet or brochure	High
EO-7	Continue reaching out to businesses electronically to notify of immediate hazards.	4	DBED	Internal agency funding	Long Term	Development of a plan detailing how this will work	Medium
EO-8	Continue providing businesses information on available SBA loans.	4	DBED	Internal agency funding	Long Term	Development of a plan or approach for accomplishing this action	Medium
EO-9	Develop literature on personal preparedness made available to the public at DHR customer service centers.	4	DHR/MEMA	MEMA internal funding	Long Term	Development of a plan to determine contents and potential sources for developing or securing this literature	Medium

ID #	Project Description	Objective	Lead/Support Agency	Funding Source	Target Completion Date	Interim Measure of Success	Priority
EO-10	Work with independent youth and socially vulnerable individuals in state care to develop emergency plans.	4	DHR	Internal agency funding	Long Term	Rollout to Foster Parents first, then Independent Youth, and finally other communities.	Medium
EO-11	Prepare and provide an Emergency Preparedness course provided to state employees to ensure safety of socially vulnerable individuals in state care.	1, 4	MEMA/DHR	Internal agency funding	Long Term	Rollout to Foster Parents first, then Independent Youth, and finally other communities.	High
EO-12	Develop/send E-Newsletters on preparedness.	4	MEMA	Internal agency funding	Short Term	Development of a template for such a newsletter	Medium
EO-13	Develop Preparedness tips through twitter / facebook / text messaging / email - work with state agencies to incorporate.	4	MEMA/DOIT/All Agencies	Internal Agency funding	Short Term	MEMA to initiate meeting with state agencies to discuss expansion of social media use.	High
EO-14	Provide list of hazard mitigation best practices to provide guidance and motivate local governments to reduce hazard impacts through mitigation.	1, 4	MEMA/Local government	Internal agency funding, FEMA Unified HMA grand funding	Short Term	Determine which practices should make the list	High
EO-15	Ensure a State representative is made available for local hazard mitigation outreach meetings.	4	MEMA	Internal Agency Funding	Ongoing	Review scheduled meetings to determine which representative might attend	Medium
EO-16	Develop public presentations to government leaders and legislators on the importance of emergency preparedness and hazards that the state faces.	1, 4	MEMA/MACO/MML/ State Agencies	Internal agency funding, FEMA Unified HMA grand funding	Long Term	Development of a presentation template that can be customized as needed	High

ID #	Project Description	Objective	Lead/Support Agency	Funding Source	Target Completion Date	Interim Measure of Success	Priority
EO-17	Maintain media advisory template based on risk.	4	MEMA	Internal Agency Funding	Ongoing	Ensure template is currently maintained.	High
EO-18	Offer a variety of emergency management training opportunities for state and local employees.	1, 4	State Universities/MEMA	EMPG funding, internal agency funding, local jurisdiction funding	Long Term	Determine and prioritize training topics	High
EO-19	Investigate emergency public broadcast protocol on telecommunication networks for notification of impending disaster	4	MEMA	Internal Agency Funding	Short Term	Set up a meeting with communications providers to discuss potential options	High
EO-20	Continue Coast Smart Program and expand outside of Coastal Region - Reaching out to EM and planning personnel.	4	DNR	Internal Agency Funding	Long Term	A plan for expansion of the program	High
EO-21	Reach out to civic organizations to become partners on emergency preparedness outreach programs.	4	MEMA	Internal Agency Funding	Long Term	Development of a list of which organizations with which to partner	High
EO-22	Investigate establishing training for developing multi-lingual Emergency Management representatives.	4	MEMA	Internal Agency Funding	Short Term	Determine languages needing to be included in investigation by March 2012.	High
EO-23	Push After Action Reports (AARs) and lessons learned to other jurisdictions' leaders, in the form of a newsletter coordinated amongst all state Offices of Emergency Management	1, 4	MEMA	FEMA Unified HMA grant funding	Ongoing	Develop newsletter template by January 2012.	Medium
EO-24	Investigate improving communication between state agencies' mitigation programs and activities.	4, 7	MEMA	Internal Agency Funding	Short Term	Solicit feedback from agencies to determine communication weaknesses and potential improvements	High

ID #	Project Description	Objective	Lead/Support Agency	Funding Source	Target Completion Date	Interim Measure of Success	Priority
EO-25	Enhance outreach to at risk neighborhoods and new populations at-risk due natural hazards including climate change.	1, 4	MEMA/DNR	Internal agency funding	Long Term	Prioritize neighborhoods to target	High
EO-26	Leverage relationships with universities/scientists to educate through Cooperative Extension on hazards and climate change.	4	UMD/DNR	Internal agency funding	Long Term	Set up a meeting with at least two universities to discuss	High
EO-27	Examine/investigate building hazards and climate change education into K-12 curricula and work with informal educators (museums, etc; i.e. St. Michaels) and establish life safety preparedness. [e.g. turn around, don't drown]	4	MSDE	Internal agency funding	Long Term	Development of an outline for potential approaches to incorporating into the curricula	Medium
PPP-3	Conduct training on mitigation planning and project development such as HAZUS-MH, BCA, G-level Coastal Construction, Residential retrofit, G-318, project development.	4	MEMA/Mitigation	EMPG; HMGP 5% initiative, FEMA HMTAP	As funding is available	Within one year of plan adoption, schedule and hold two training courses.	Low
PPP-15	Hold a state-wide dam safety conference, including upstream organizations from neighboring states.	4, 5	Maryland Department of Environment, Dam Safety Program	Staff resources; conference registrations; sponsorship	Short-term	Within one year of plan adoption, identify funding mechanism for conference.	Medium
E0-28	Develop and conduct education efforts that are targeted to repetitive loss property owners increase knowledge and awareness of mitigation grants by conducting various outreach activities.		MEMA	Internal	2013	N/A	High

ID #	Project Description	Objective	Lead/Support Agency	Funding Source	Target Completion Date	Interim Measure of Success	Priority
EO-29	Promoting mitigation of RL and SRL properties at regional meetings hosted by MEMA Regional Administrators attended by county and municipal emergency managers. These meetings will provide potential HMA grant sponsors with mitigation options information through a presentation and		MEMA	Internal	2012	N/A	High

4.5 Repetitive Loss and Severe Repetitive Loss Mitigation Strategies

Addressing the state's 11 Severe Repetitive Loss (SRL) properties compounded with more than 746 Repetitive Loss (RL) structures (according to a list obtained from the NFIP Data Exchange system on 08/04/2011) will require the combined efforts of agencies and organizations beyond the hazard mitigation program staff housed at MEMA.

Some of the partner organizations that can potentially assist in implementation of SRL and RL strategies outlined in this plan include:

1. Federal Emergency Management Agency (FEMA)
2. MEMA Recovery & Mitigation Division
3. Maryland USACE Silver Jackets Program
4. Maryland Association of Floodplain and Stormwater Managers (MAFSM)
5. Maryland Emergency Manager's Association
6. Local government floodplain managers and building officials

Maryland's approach to target mitigation of severe repetitive loss and repetitive loss is multi-tiered. Some activities must be coordinated and directed at the state level, as described in the Mitigation Actions section of this chapter, while others require the support of the local governments that serve as HMA project sponsors since most hazard mitigation of high hazard structures in the state occurs with the implementation of HMA grants.

Repetitive loss and severe repetitive loss structures, and their status have been fully analyzed through comparison analysis of all relevant property datasets as described in Section 3.7. These data sets will filed at MEMA and FEMA Region III in digital MS Excel format in Appendix M but they are redacted from the 2011 Plan Update due to Privacy Act requirements. The analysis will be performed annually and provided to FEMA Region III to capture the mitigation of RL or SRL properties through HMA grants, the NFIP Increased Cost of Compliance program CC use or other known means.

In acknowledgement of the importance of mitigation of repetitive loss and severe repetitive loss structures, significant mitigation actions in the 2011 Plan update address repetitive and severe loss mitigation. In addition, severe repetitive loss properties have been targeted in the 2010 Winter Storm Disaster Hazard Mitigation Grant Program (HMGP) application process.

Building upon this effort, Maryland will move forward in partnership with FEMA and local governments to use previous acquisition/demolition project marketing methods to target the next tier of priority SRL and RL property owners. With the next flooding or coastal storm disaster, it is highly likely that both the SRL and RL list will grow as flood insurance claims are paid. MEMA staff will manage the datasets with the tools created for the 2011 plan update in the following manner:

1. Maintain access to the Data Exchange System NFIP database of repetitive loss properties through continued relationships with DEP's State NFIP Coordinator's office;
2. Continue to pursue and develop clean datasets. Improve existing geo-coding by researching matches for properties with incomplete addresses and out of date address based on rural road designations that have changed;
3. Align Maryland RL property data, and SRL property data with validated FEMA NFIP RL and SRL property data, annually;
4. Align Greatest Savings to the Fund (GSTF) data and the new 2011 methodology to inventory and further demonstrate the cost effectiveness of potential RL and SRL mitigation projects. Evaluate

projects further for environmental soundness and technical feasibility to create successful HMA grant subapplications;

5. Update listing of completed SRL and RL mitigated properties and FEMA's RL database with Maryland's mitigated properties database annually. Update of the merged database can also occur at HMA grant close-out or whenever improved local data becomes available;
6. Complete FEMA Form AW-501s for each mitigated property. Provide to FEMA through current FEMA databases or submittal to the region upon project close out Archive at MEMA;
7. Merge the ICC RL database with Maryland's mitigated properties database annually; and
8. Ensure that the latitude and longitude of each property is gathered during project close-out as well as during sponsoring community three-year mitigation compliance inspection for completed properties. Update mitigated properties Excel workbooks to assure accurate status of mitigated repetitive and severe repetitive loss properties.

Creating a competitive FEMA HMA grant application can be challenging for already over-taxed local officials. Mentoring can be a highly effective tool to creating an eligible grant application. MEMA and FEMA will serve to facilitate this process assist grant participants with the HMA programs. In addition to mentoring local governments, the data analysis performed for the HIRA in the 2011 Plan Update Section 3.7 will be provided to counties to assist in targeting mitigation opportunities. This will be done by:

1. Providing state direction to ensure that local jurisdictional plans must address the mitigation of severe repetitive loss and repetitive loss structures in the mitigation strategies section of every local jurisdiction §322 plan with SRL or RL properties.
2. Examining the FEMA-MEMA repetitive loss and severe repetitive loss data sets to seek candidate properties that could potentially be mitigated through the FEMA RFC, SRL or other HMA funding programs or any other available funding sources on an annual basis;
3. Develop and conduct education efforts that are targeted to repetitive loss property owners increase knowledge and awareness of mitigation grants by conducting various outreach activities; and
4. Promoting mitigation of RL and SRL properties at regional meetings hosted by MEMA Regional Administrators attended by county and municipal emergency managers. These meetings will provide potential HMA grant sponsors with mitigation options information through a presentation and question/answer forum. A presentation on severe repetitive loss and repetitive loss property mitigation will be provided at the 2012 Maryland Floodplain Manager's Conference where the results of the initial 2011 analysis will be presented. In subsequent years annual updates will be provided; and
5. Participate in post-disaster briefings hosted by MEMA staff for local governments as an outreach activity following disasters which impact RL and SRL properties.

Federal disasters provide HMGP funds, injecting significant grant funding into impacted areas. Staff would present grant programs and their benefits as appropriate depending on the disaster and the community setting. This effort would greatly increase public awareness for those that are affected and continuously inconvenienced or displaced by flooding. Local governments would advertise the meeting in their daily or weekly publications. This mechanism may be especially effective in a post-flood disaster scenario when property owners are most cognizant of flood impacts and HMGP funds may be available to mitigate their homes. Local government participants may include local agencies such as the local emergency management agency, planning commission, conservation district, housing and redevelopment authority and the department of public works.

FEMA's HMA programs, particularly the severe repetitive loss (SRL) program and the Repetitive Flood Claims (RFC) program, were specifically created to reduce the impact that severe repetitive loss and repetitive loss properties have on the Flood Insurance Fund. FEMA's other three HMA grant programs,

Hazard Mitigation Grant Program (HMGP), Flood Mitigation Assistance (FMA) and Pre-Disaster Mitigation (PDM) program, are also good sources for structural mitigation funding, as are some federal Housing and Urban Development (HUD) Community Development and Block Grant (CDBG) grant program , and other state, local and privately funded efforts. Additional funding may be available through Maryland's Comprehensive Flood Management Grant Program (CFMGP) managed by MDE. However, no new requests have been made for funding since 2002 because the program is disaster-driven.

See COMAR 26.17.04 for more details:
http://www.dsd.state.md.us/comar/SubtitleSearch.aspx?search=26.17.05.

* MEMA will use these available programs, which are addressed in great detail in Appendix E, Capability Assessment, to fund mitigation of severe repetitive loss and repetitive loss structures. Both pre- and post- disaster funds will be prioritized toward mitigation of targeted RL and SRL properties:

1. Target severe repetitive loss properties and repetitive loss properties for mitigation through HMA funding through prioritization during annual HMA project review and prioritization process. Prioritize jurisdictions that will receive planning & project grants through HMA programs to those jurisdictions with SRL and RL properties;
2. Incorporate targeting of severe repetitive loss and repetitive loss properties into FEMA-Maryland Disaster Recovery Strategies:
    a. Prioritize HMGP funds for SRL and RL-listed properties.
    b. Form partnerships with FEMA-State Joint Field Offices (JFO) Mitigation team to conduct post-disaster HMGP outreach to targeted communities and properties owners. Coordinate with other Federal and state agencies to form partnerships to leverage other programs that could finance mitigation of additional structures.
    c. Use available staff to update Mitigated Properties datasets with geo-coding to more accurately depict repetitive and severe repetitive loss structures.
    d. Use JFO team to develop outreach strategies and tools (such as those referenced herein) to communicate mitigation opportunities at recovery centers, town hall meetings and through media releases.

Chapter 5 Coordination with Local Mitigation Planning Efforts

5.1 Introduction and Update Process Summary

On March 3, 2011, the State of Maryland's State Hazard Mitigation Officer convened the MAC to discuss the status of the 2011 Maryland State Hazard Mitigation Plan Update and develop a schedule to complete the update to the Plan. Maryland counties and municipalities along with key state agency officials and local emergency managers were invited to participate in the process through attendance at the June 15, 2011 workshop. At that workshop the draft revised hazard vulnerability analysis was presented followed by five small break out group discussions to formulate mitigation actions. Each participating local jurisdiction was invited to continue to support the development of new mitigation actions during a series of late June Web-ex meetings. Local jurisdictions were given the opportunity to attend one of six regional outreach workshops. Finally, the project e-newsletter, Hazardous Times, was distributed every Friday to each plan MAC member and stakeholder, including representatives from local governments.

Each current Maryland county or municipal local plan was reviewed and integrated into the vulnerability analysis chapter and for this update, local governments' current plan hazard rankings were incorporated into the state ranking algorithm. A workbook of the local plan HIRA results may be found in Appendix H and is further detailed in Chapter 3.

5.2 Local Hazard Mitigation Plan Development

A local hazard mitigation plan is an effective medium for establishing a community's commitment to preventing disaster losses through mitigation of high-risk property and infrastructure so that the risk of injury to people is reduced. By analyzing hazards and assessing risks, local officials gain knowledge of unique hazard characteristics of their community. Through the development and adoption of mitigation goals, objectives and strategies based on these hazard characteristics, local plans also serve as an important connection between the public interest and specific mitigation measures employed in both the pre- and post-disaster environments. Local hazard mitigation plans also satisfy statutory requirements such as the Disaster Mitigation Act of 2000 and *44 Code of Federal Regulations* so that localities maintain eligibility for FEMA's Unified Hazard Mitigation Assistance program grants.

A local hazard mitigation plan may also provide a vehicle by which citizens and specific stakeholder groups can learn about hazards and mitigation. This can lead to increased public awareness of the risks present in the community. Achieving widespread public awareness of hazards enables residents to make educated decisions on where to live, purchase property, or locate a business, and how to protect themselves and their property from the impacts of various hazards.

The State of Maryland recognizes that the development and implementation of local hazard mitigation plans is essential for the reduction of the State's long-term vulnerability to hazards. The State, through the MEMA, has therefore committed its resources to local hazard mitigation planning by coordinating planning initiatives within State government and among local governments.

5.2.1 Local Hazard Mitigation Planning Workshops

To help local governments meet local mitigation plan development and plan update requirements established in *44 CFR 201.6*, the State of Maryland offered a 2-day workshop which covered the fundamentals of the Hazard Mitigation Planning requirements for communities developing new or updating Local Hazard Mitigation Plans which address community priorities and needs. The FEMA G-318 Mitigation Planning Workshop was supported by the Risk MAP CAMPR program via Region III and was conducted November 3-5, 2010. The workshop described planning process, requirements for

stakeholder participation and the relationship between multi-hazard mitigation planning requirements that a community can use to assess their risk and develop effective Mitigation Strategies.

5.2.2 Developing Local Mitigation Planning Assistance Guides

Training aides have been distributed to Maryland communities engaged in local mitigation planning:

How to Guides

The primary training aide has been the *How to Guide* Series developed by FEMA. These have been critical tools vital to plan development, in particular in hazard identification and risk assessment. This series has been distributed widely to those engaged in local planning in printed, digital and CD formats.

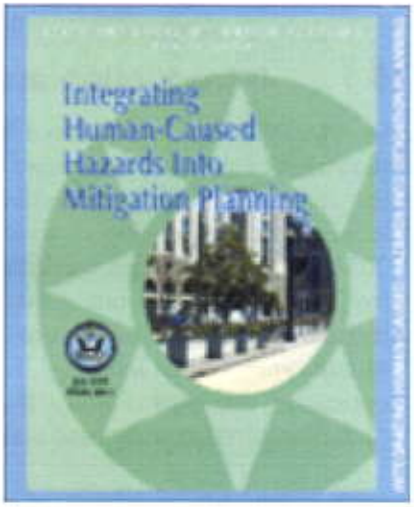

Figure 5-1. Guidance

5.2.3 Distribution of Hazard Mitigation Planning Funds

Local governments have relied upon MEMA for guidance and support of their mitigation planning initiatives during the initial planning cycle and the recent/ongoing local plan update cycle. MEMA hazard mitigation staff has worked with local governments to ensure that they have the resources necessary for effective and relevant hazard mitigation planning. The MEMA Hazard Mitigation program has facilitated funding (FEMA Pre-disaster Mitigation and Hazard Mitigation Grant Program 7 percent planning funds and Flood Mitigation Assistance (FMA)) and technical assistance, and provided planning assistance to the following local governments: Maryland's 23 counties and 123 of the State's 139 municipalities, including the cities of Baltimore and Annapolis, and the Town of Ocean City. Consequently, nearly all county and municipal jurisdictions throughout Maryland have FEMA-approved and locally adopted hazard mitigation plans in effect. Table 5-1 shows the few exceptions where local jurisdictions have not participated in the planning process, or did not locally adopt their hazard mitigation plans.

Table 5-1. Jurisdictions without Adopted HMPs

Jurisdiction	County
Barton	Allegany
Midland	Allegany
Lonaconing	Allegany
Chesapeake Beach	Calvert
Unincorporated Areas	Carroll
Preston	Caroline
Manchester	Carroll
New Windsor	Carroll
LaPlata	Charles
Indian Head	Charles
Burkittsville	Frederick
Emmitsburg	Frederick
Loch Lynn Heights	Garrett
Deer Park	Garrett
Mountain Lake Park	Garrett

Jurisdiction	County
St. Michaels	Talbot
Berlin	Worcester
Pocomoke	Worcester
Snow Hill	Worcester

Table 5-2 shows the status of the approved and pending approval, local hazard mitigation plans in the state of Maryland.

Table 5-2. Local Hazard Mitigation Plan Review Status

County	Plan Expires	Status
Allegany	10/18/2011	Update in process
Annapolis City	1/7/2010	Update in process
Anne Arundel	1/7/2010	Under FEMA review
Baltimore	1/12/2012	Update in process
Baltimore City	6/28/2011	Under MEMA review
Calvert	6/28/2010	Update in process
Caroline	4/12/2011	Under FEMA review
Carroll	n/a	Update in process
Cecil	4/26/2015	Approved and adopted
Charles	11/26/2011	Update in process
Dorchester	12/21/2010	Approved and Adopted
Frederick	9/4/2014	Approved and adopted
Garrett	4/13/2010	Update in process
Harford	12/3/2009	Draft under MEMA review
Howard	11/28/2010	Update in process
Kent	11/28/2010	Update in process
Montgomery	2/16/2012	Update in process
Ocean City	11/27/2011	Update in process
Prince George's	5/3/2010	Approved and Adopted
Queen Anne's	11/28/2010	Update in process
Somerset	12/19/2010	Update in process
St. Mary's	4/12/2011	Under FEMA review
Talbot	2/10/2010	Approved and Adopted
Washington	1/13/2011	Update in process
Wicomico	8/12/2010	Approved and Adopted
Worcester	2/5/2012	Under FEMA review
Worcester	2/5/2012	Approved and Adopted

Of the plans that are approved, MEMA has provided financial support through several federally-funded mitigation grant programs. These MEMA-administered programs include the Pre-Disaster Mitigation Grant Program (PDM), the Hazard Mitigation Grant Program (HMGP), and the Flood Mitigation Assistance Program (FMA).

PDM funds may be used by local governments for eligible, cost-effective hazard mitigation activities that support strategies and actions presented in the local government's mitigation plan. The program can also be used to support the update of a hazard mitigation plan. A 25 percent non-federal match is required for this program.

The HMGP is effective following a Presidential Disaster. The FEMA-Maryland Mitigation Strategy will determine priority use of the disaster-specific HMGP funds. Currently, up to 5 percent of HMGP monies may be used to support measures such as creating and enforcing effective building codes; application or increased rating in the Community Rating System, design and installation of Advance Warning systems and outreach & education programs. Up to 7 percent may be used to develop mitigation plan updates. No less than 88 percent of HMGP monies must be used for mitigation of residential or non-residential property, infrastructure or critical facilities that are included in a local mitigation plan's actions or strategies. Examples of projects include acquisition and demolition of flood-prone properties, installation of window and door shutters and hardening of critical facilities or wet or dry flood proofing of non-residential buildings. The program requires a 25 percent non-federal match.

The FMA program supports flood mitigation planning at the state and community level and implementation of flood mitigation projects. The program supports efforts to reduce or eliminate the long-term risk of flood damage to buildings, manufactured homes, and other insurable structures. Through approval of the repetitive/severe repetitive loss planning program initiatives included in the *2011 Maryland State Hazard Mitigation Plan Update* by FEMA, funding to mitigate the state's FEMA listed severe repetitive loss properties will only require a 10 percent non-federal match for the FMA program. Other FMA projects will require a 25 percent non-federal match. FEMA's other two mitigation grant programs, Repetitive Flood Claims program and the severe repetitive loss program are available to local governments for mitigation of flood-prone properties but they do not support mitigation-planning-related projects. These programs are described in the capabilities assessment section of the plan located in Appendix E.

For the 2011 Plan update, MEMA and its contractor have worked with FEMA HAZUS and Maryland Department of Planning datasets to validate State critical facilities databases. These were identified, geocoded, mapped and used in FEMA HAZUS-MH model runs to simulate the potential impacts of various flood, coastal storm and earthquake events. This information will be distributed to all Maryland counties, Ocean City, Annapolis, and the City of Baltimore for their use in local mitigation plan and emergency operation plan hazard assessment updates. This data can serve as the foundation for all risk assessment-based emergency management planning as well as comprehensive planning, environmental protection and land-use allocation efforts.

The revised Hazard Identification, Risk Assessment and Vulnerability Analysis will provide local governments with valuable site- specific information for use in their local hazard mitigation plans, as well as other planning and emergency management activities. More importantly, mapping products can help convey important messages to citizens and targeted high-risk stakeholder groups to increase their preparedness efforts. Remarkably, this information will be provided at no cost to the local governments.

5.2.4 Providing Technical Assistance

Development of local §322 plans is supported by MEMA's staff. This support includes:

- Participation in local meetings;
- Availability for consultation, trouble-shooting and technical assistance;
- Development of draft plan outlines for use at county or municipal levels;
- Compilation of hazard data at state level where possible for distribution to and use by county and municipal planning and emergency management staff (for consistency and to kick start the hazard assessment process where possible);

- Provision of local training workshops for local plan steering committee members and planning agency;
- Cross-walk review of draft plan sections and final plan prior to submission to FEMA Region III for final approval; and
- Provision of support to counties and municipalities during the local plan preparation, implementation, monitoring, evaluation and update process.

Additional technical assistance is also available through FEMA.gov independent Study courses and in-residence courses at the FEMA Emergency Management Institute in Emmitsburg, Maryland.

Further technical support has been provided to local governments by the MEMA throughout the mitigation plan development process. Both the State Hazard Mitigation Officer and the Local Mitigation Planner met with local planning teams from all 23 counties, Baltimore City, Ocean City, and Annapolis to review the local mitigation planning regulations after they were published during the first local plan development planning cycle. The Local Mitigation Planner and State Hazard Mitigation Officer have continued to meet with local mitigation planning teams and further advised them of local mitigation planning requirements, available data, and the planning process. They continue to meet regularly with local governments to assist them with their hazard mitigation plan updates.

Recognizing that the involvement of local land use planners is crucial to the development of
MEMA responds to all requests for assistance by providing information and project development support. No priority is assigned to these requests; however, with a need that often outpaces the grant funds available, MEMA has found it necessary to establish criteria in awarding mitigation planning and project grants. When evaluating mitigation assistance projects, members of the MAC and MEMA mitigation staff place the highest priority on the level of damage. The committee will evaluate and prioritize all eligible applications using the following Project Ranking Criteria:

- Nature of Hazard: frequency or severity of hazard or multiple hazards
- Environmental: impact on the built and/or natural environment
- Benefit-Cost Impact: cost per person or structure compared to benefits, mitigation of multiple hazards
- Community Impact: loss of life, health issues, ease of evacuation, loss of essential facilities, damage to critical facilities, and economic hardship for a community
- Other: consistency with state and local plans, availability of other measures to solve the problem and local match availability

The human impact of a proposed mitigation project is also considered. Factors included in the evaluation of human impacts are the number of persons protected by the project and the mitigation of repetitive loss properties. The final criterion considered by MEMA is a project's anticipated environmental impact. Initially, a project's environment impact may be in conflict with its human impact. A proposed elevation of a structure at-risk for flooding may have a positive human impact, but the acquisition and demolition of that structure would have a greater environmental impact.

These criteria were established as part of the development of the 2005 State Hazard Mitigation Plan, and have been continually applied by the SHMO and the MAC. For the 2011 Plan update, the MAC reviewed these criteria, and determined that they were still effective and reasonable, thus changes have not been made.

5.2.5 Existing Strategies and Effectiveness of Local Policies, Programs, and Capabilities

For the 2011 update, a Local Plan Upload workbook was developed in an effort to centralize critical information pertaining to all Maryland local/municipal hazard mitigation plans. This workbook, found in

Appendix H, includes information on each approved plan's vulnerability assessment, capability assessment, and mitigation strategy. The screenshot below highlights the vast array of mitigation strategies found in the local plan throughout the state. For this upload, mitigation strategies were categories by "type" typically seen in FEMA approved plans. These types include, Prevention Measures, Property Protection Measures, Emergency Services Measures, Structural Projects, Natural Resource Protection Measures, Public Education and Awareness Measures and NFIP projects. As seen below in the screenshot, most of the plans reviewed include a variety of these types of projects.

Additionally, the screenshot below highlights the capability assessment review of the local mitigation plans. As the review portrayed, the array of capabilities within the local communities touches upon most, if not all, of the capability assessment categories which are available to implement the mitigation strategies listed in the workbook.

	Project Type							
County	Prevention Measures (Indicate: P-Plan, AS-Alert Systems, S-Structural Prevention, O-Other)	Property Protection Measures (Indicate: A-Acquired, I-Relocated, E-Elevated, R-Regulations, V-Vulnerability Analysis, O-Other)	Emergency Services Measures (Indicate: T-Training, E-Equipment, M-Mapping, D-Data collection, P-Planning, O-Other)	Structural Projects Measures (Indicate: M-Maintenance, N-New Structure, O-Other)	Natural Resource Protection Measures (Indicate: X-Yes)	Public Education and Awareness Measures (Indicate: T-Training, M-Public Meetings, P-Publications, O-Other)	NFIP (Indicate: X-NFIP Projects listed)	Community Rating System (CRS) (Indicate: X-CRS Projects Listed)
Allegany	P, AS	A, O(Patrols),	M, O			T	X	
Annapolis	P, S, AS		E		X	T, M, P, O - public radio and public access TV news releases		
Anne Arundel	P	A, L, E, V	T, E, P	NA	X	T, M, P, O	X	NA
Baltimore City	S	A, R	D, M	M	X	T, P	X	X
Baltimore		P	V	E, D, P	M, N, O		T, P, O	X
Calvert	P, AS, C (Page67-69, 78, and	R, V, L, E, O (Page 68, 69, and 57-66)	M, D, P, E, T (Page 75 & 83)	N & M (Page 68, 69, and 76)	X (Page68, 69, and 76)	M, P, T (Pages 83-85)	X (Page 83-85 and 30 thru 32)	X
Caroline	AS, P, S	A, E, V, O	T, E, D, O	M	X	T, M, P, O	X	X
Carroll	P, S	A, L, E	D	N, M	X	T	X	
Cecil	P	A, L, V	T, D, M			P, T	X	
Charles	P, AS, S	A, L, E, V	D, M	N	X	P, T, M	X	
Dorchester	P, AS	R, L, E	D, M, E, T		X	T, P	X	
Frederick	S, P, O(Monitoring Stream Gauges)	A, L, E, V	E, P, O	M		P, O(PSAs via Radio), M	X	X
Garrett	P, AS, O (Pages 40, 74, 75 and 77)	A, L, E, R, V (Pages 15, 51, 74 and 76)	T, E, D, P (Pages 74 thru 77)	N & M (Pages 15, 16, 74, 76 and 79)	X - (Page 76)	T, P, O, M(Page 76 & 79)	X - (Page 17, 48, and 75)	NA - Garrett County does not participate due to staff constraints (Page 17)
Harford	P, AS, S	A, E, R, V	M, E, T, P	M, N	X	T, M, P	X	X

Figure 5-2. Local Mitigation Strategy Update Screenshot from Appendix H.

	Capability Assessment						
County	Grant Match	Local Funding	Technical Assistance	Education/ Outreach	Citizen Corp	National Flood Insurance Program	NFIP Community Rating System
Allegany	X	X		X		X	
Annapolis	X			X			
Anne Arundel	X	X	X	X	X	X	X
Baltimore City	X	X	X	X		X	
Baltimore			X	X		X	
Calvert	X - (Page 1, 11 and 70) - HMGP & PDM Grant Programs)	X - (Page 71, 83-85)	X (Page83 - Mapping and Prediction Services provided by County EMA with technical assistance from NWS and FEMA/MEMA/MDE (Planning and Zoning Departments)	X (Page 83 - Outreach Programs administered through EMA and assistance from MEMA/FEMA	X -(Page 1, 11,) "Calvert County Hazard Mitigation Planning Team" - comprised of government officials/citizens of Calvert County	X - (Page 83)Town/Municipal Officials are promoting the use of NFIP more and more with the help from MEMA/FEMA and possible funding from HMGP & FMA	Partial - The Town of North Beach is a participant in the CRS program but neither the Town of Chesapeake Beach or unincorporated Calvert County participate due to non-compliance in 1996 (Page 1, 31, and 68)
Caroline	X	X	X	X	X	X	X
Carroll	X	X	X	X		X	
Cecil			X	X	X	X	
Charles	X	X	X	X		X	
Dorchester	X	X	X	X		X	
Frederick	X	X	X	X		X	

Figure 5-3. Capability Assessment Screenshot from Appendix H.

5.3 State Review of Local Hazard Mitigation Plans

Once a jurisdiction has completed their mitigation plan, the plan will be submitted to MEMA for review. The SHMO or mitigation planner evaluates the plan for compliance with all applicable provisions of the Robert T. Stafford Disaster Relief and Emergency Assistance Act of 2000. MEMA will approve the plan or provide feedback regarding required revisions. If the local multi-hazard mitigation plan meets all applicable requirements, the plan will be forwarded to the Federal Emergency Management Agency for review or approval.

The local legislative approval process for mitigation plans will differ by jurisdiction, as plan approval requirements vary widely throughout Maryland. Generally it is recommended that plan updates be conditionally approved by FEMA prior to adoption by county or city elected boards.

5.4 Incorporating Local Mitigation Plan Results into the State Plan

The development and maintenance of local hazard mitigation plans involved the collection, analysis, and integration of the most current plan for each jurisdiction. The compilation of local plans resulted in an inventory of the assets that may be affected by hazards. Types of assets inventoried included populated areas, housing units, critical facilities, special facilities, infrastructure and lifelines, hazardous materials facilities and commercial facilities. Local Plans were integrated into the State Plan using the following methodology:

1. A matrix was developed that identified all of the hazards addressed by local mitigation plans statewide – this is presented in Chapter 3.
2. An average risk rating for each hazard was calculated including the local plan hazard ranking;
3. The average risk ranking was analyzed to determine if the local plans are consistent with the State Hazard Mitigation Plan; and
4. Mitigation Goals, Objectives, and Strategies from local plans were examined and summarized to inform the 2011 Plan Update to ensure consistency with the State Plan.

Figure 5-4 shows plan updates as of June 2011. To date, plan updates for most of the state's counties have been fully approved by MEMA and FEMA Region III. Several other plans are under review or revision and are anticipated to be fully approved within the next six months.

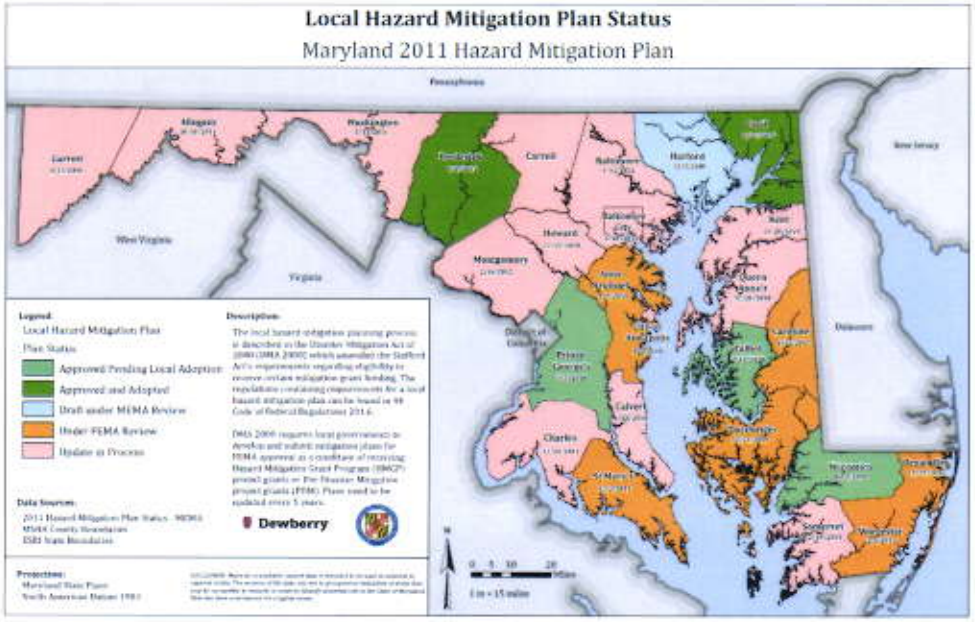

Figure 5-4. Local Hazard Mitigation Plan Status.

5.5 Repetitive Flood Loss Mitigation Strategies

5.5.1 Strategy Overview

Addressing the state's 11 FEMA-listed severe repetitive loss properties (May 2011) compounded with at least 746 repetitive loss structures will require the combined efforts of agencies and organizations beyond the hazard mitigation program staff housed at MEMA.

Maryland seeks to mitigate these structures to reduce the drain on the Flood Insurance Fund. To integrate initiatives discussed in Chapter 4 through local partnerships, a four-pronged strategy requiring a robust partnership between MEMA, DEP, the MAC and local governments with repetitive and severe repetitive loss properties is necessary:

1. Continue the commitment to maintain high levels of competence in grant management and responsive customer service to local governments through the Hazard Mitigation Grant Program (HMGP), Severe Repetitive Loss (SRL) program, Repetitive Flood Claims (RFC) program, Flood Mitigation Assistance (FMA) program (FMAP) and Pre-Disaster Mitigation (PDM) program. Additional funding opportunities, such as those offered by HUD or post-event NFIP Increased Cost of Compliance (ICC), will be used when available;
2. Enhance education efforts that increase the public's knowledge and awareness of mitigation grants by conducting various outreach activities, with focus on severe residential flood loss properties;
3. Provide detailed technical assistance seminars for repetitive loss and severe repetitive loss property owners so that these loss structures prioritized for mitigation assistance through HMGP, SRL, RFC, FMA, or PDM-C programs; and
4. Maximize flood mitigation opportunities immediately following flood emergencies and disasters by prioritizing severe repetitive (SRL) and repetitive loss (RL) properties for mitigation.

5.5.2 Partnerships

Achieving and working through this revised strategy will require the state to continue to reach out to others, making this a joint effort. The MEMA will continue to seek assistance to implement this strategy with the MAC, county and city government stakeholders.

Chapter 6 Plan Monitoring, Maintenance & Revision

6.1 Plan Monitoring Procedures

The 2011 *Maryland State Hazard Mitigation Plan* was initially approved during the fall of 2004. It was revised to an Enhanced plan one year later. The second full update to the plan was approved August 26, 2008. Approval of the plan on three year intervals is required by 44 Code of Federal Regulations for Maryland to continue eligibility for the post-disaster Public Assistance and HMGP, the Floodplain Management Assistance Program, Severe Repetitive Loss Program and the Pre-Disaster Mitigation Program. Each of Maryland's previous three plans, along with the 2011 revision, was prepared in partnership with MEMA's MAC. The 2011 plan is consistent with FEMA's Hazard Mitigation Plan guidance which now incorporates Flood Mitigation Assistance planning requirements which will make available 90 percent federal funding for mitigation of severe repetitive loss structures under the Severe Repetitive Loss and Flood Mitigation Assistance grant programs. As discussed in Chapter I (Introduction) and Chapter II (Planning Process), it was determined early in the plan update process that the plan would only address natural hazards.

When considering continuity of critical operations in the context of state services and facilities, the impacts of natural hazards can be similar or identical to the potential impact of a human-caused event. For example, in the aftermath of severe floods or winter storms, tens of thousands of residents may be without power, some for as long as a couple weeks. A human-caused event that causes failure of a power plant due to operation error or terrorism would have similar impacts to the state's critical facilities. In other words, a power outage is a power outage whether caused by downed lines and transformers from debris, snow, ice or mechanical failure. While the plan does not specifically consider human-caused hazards, many of the actions and strategies included in the plan also strongly support reduction of exposure to human-caused hazards. Thus, the *2011 Maryland State Hazard Mitigation Plan Update* is consistent with and complements other state emergency management plans which address specific human-caused hazards.

The mitigation plan was developed following an extensive verification of an inventory of state facilities and critical facilities. Natural hazards throughout the state were analyzed and the historical occurrence of significant events showed specific vulnerable structures. The analysis will also identify trends in the types of structures requiring FEMA Public Assistance Program funds for repair or replacement from repeated storm events. Once key state and local facilities were targeted as "vulnerable," mitigation efforts were presented in the Mitigation Strategies of the Plan Update (Chapter 4) Potential mitigation projects are presented in Project Scoping Evaluations (Appendix J).

As part of the 2011 plan update process, the progress of ongoing programs or projects were evaluated by agency personnel. Those which remain viable or reflect an ongoing program, activity or project are included in this plan update in Appendix I. In addition, the 2011 planning process has organized mitigation actions into five areas, as shown in Chapter 4 (Mitigation Strategy) and in a comprehensive MS Excel Workbook in Appendix I. New actions, strategies and projects were developed by the MAC and a Stakeholders group of state and local agency personnel during the June 15, 2011 meeting. Combined with the archival 2008 continued activities, these comprise the Mitigation Action Dataset for the 2011 plan.

The 2008 state actions were not tracked or monitored during the past three years. For the 2011 plan update, a tracking system has been created and organized in a manner to facilitate annual updating. In addition, specific annual update targets have been established with firm due dates in the maintenance schedule which follows in Section 6.5.

These actions include specific strategies to target the mitigation of repetitive and severe repetitive loss properties for mitigation. This plan update was revised to enable Maryland to qualify for 90 percent federal cost-share funding for targeted severe repetitive loss property mitigation through the Severe Repetitive Loss and Flood Mitigation Assistance Programs. The revised planning process involved a completely new Hazard Identification & Risk Assessment (HIRA) and Vulnerability Analysis. Numerous gaps in the 2008 HIRA data set were closed through the 2011 comprehensive data analysis process. Remaining gaps and resolution of identified problems with data are included in the strategies section and in the within the 2014 Vulnerability Analysis Mitigation Actions.

6.2 Tracking Strategies and Projects

The vision of the *2011 Maryland State Hazard Mitigation Plan Update* is intended to reduce or prevent injury from natural hazards to citizens, reduce damage to property and maintain operation of critical state and local facilities. The strategies are organized within the five groups were devised by Maryland state agencies, federal agency partners, and local emergency managers and planners. These strategies were determined during the June 15, 2011 Stakeholder's meeting and refined during the following two weeks. As described in Chapter IV, projects were prioritized through an on-line ranking process using STAPLEE where appropriate.

State hazard mitigation plans must be revised every three years. Maryland agencies that initiated a strategy or project in the 2008 plan were asked to report on the progress and accomplishments of each strategy and project during the spring 2011. They were also asked to evaluate the relevance of goals, objectives, strategies and projects that were not accomplished. Many of the projects that were identified in the 2008 plan were completed. However, due to funding constraints, additional strategies have not yet been initiated or completed. It should be noted that attempts to contact agency personnel listed in the 2008 plan as advocates for the mitigation actions is ongoing.

The MEMA Mitigation staff will maintain the MS Excel Mitigation Strategy Workbook (Appendix N) that has been developed with this plan. Tracking redundancy will be provided by the State Hazard Mitigation Officer and the Maryland Mitigation Advisory Committee. It is anticipated that major aspects of this task during the three year cycle following plan approval will include:

- Continued development of protocol for local data input;
- Inclusion of local §322 plan hazard databases from local HIRAs and local priority mitigation strategies (as resources allow);
- Expansion of state hazard historical data;
- Refinement of state agency facility inventories; and
- Continued expansion of databases to target "Critical Facilities" to enhance continuity of operations (COOP) of state services following emergencies and disasters.

A major aspect of maintaining the mitigation workbook is the ongoing upload of local 322 plan updates. Development of the local plans varies in terms of time schedule and methodology. It is the desire of the MEMA Hazard Mitigation Program to support local plan updates with more robust local vulnerability analysis using the revised state HIRA and state Vulnerability Analysis as a foundation. This includes incorporation of the HAZUS analysis performed for the 2011 state plan update as well as the updated local critical facilities information. A reasonable data transfer methodology will be developed to enable local planners to use state data that is appropriate for their mitigation planning purposes. A possible solution is to provide each local plan advocate a corresponding plan status workbook (Appendix H) and request annual reporting on local plan mitigation actions. A pilot could be used for several local plans and if successful, this method can be employed used annually at the beginning of the calendar year to gather the past's year's accomplishments. This provides a forum for state mitigation staff to interact with

local plan sponsors. Additionally, it allows the MEMA access to all local plan strategies and actions so that the state HMA program is deftly positioned to maximize use of post-disaster HMGP funds or other HMA grant funding opportunities by matching funding availability to local need.

An additional need is to disperse the new Hazard Identification, Risk Assessment and Vulnerability Analysis to local planners for use in their local plan updates. As local plans are updated, their HIRA information will be uploaded into the local plan tracker tool at the time the local plan is cross-walked so that local vulnerability as characterized in local plans is continually updated. This iterative process of updating the local plan data base to reflect annual accomplishment of mitigation actions and plan update HIRA data will facilitate a much easier local plan upload process for the 2013 update of the state plan.

6.3 Plan Maintenance

The MAC was designated by MEMA as the group to work with the federal hazard mitigation team on tasks requiring special expertise to accomplish Section 322 objectives and other State hazard mitigation needs such as HMGP project application evaluation. Designation of MAC members is accomplished by request from the MEMA Director to those State Agencies with hazard mitigation responsibilities. The MAC may include representatives of the following agencies:

- Maryland Emergency Management Agency
- Maryland Department of the Environment
- Department of Housing and Community Development
- Department of Natural Resources
- Maryland Department of Planning
- Maryland Insurance Administration
- Department of General Services
- Department of Transportation
- State Treasurer's Office
- Department of Human Resources
- Department of Economic and Community Development
- Maryland Emergency Management Association – Local Representative

The MAC bylaws were developed to define authority and responsibility of team members. While the MAC is generally limited to about 12 individuals, the State broadened 2011 plan update participation to other state agencies and local emergency managers and planners. As a result, more than 80 participated in the June 15, 2011 meeting. Additional stakeholders attended six regional outreach workshops.

To develop the 2011 plan mitigation strategies, a sub-committee structure was created to:

- **Facilitate** plan implementation;
- **Broaden** the emphasis on local plan integration;
- **Expand** the planning process to target appropriate mitigation actions;
- **Target** hazard mitigation education;
- **Support** modification of state facilities to minimize impacts from hazards.

Standing, ad-hoc Mitigation Sub-Committees will be convened, surveyed or engaged periodically as necessary during the 2011–2014 plan implementation cycle. These sub-committees will be responsible for:

1. Mitigation of Structures
2. Planning, Policy, Legislation and Funding
3. Education and Outreach
4. 2014 Vulnerability Analysis

5. Local Plan Integration

The MEMA hazard mitigation program staff, in consultation with key state agencies, federal partners and organizations will continue to direct implementation of the plan. MEMA serves as the lead coordinating agency for emergency management in Maryland, and thus will continue to lead the mitigation planning effort, including plan maintenance.

MEMA will track projects identified in both the State Hazard Mitigation plan and in local plans using the tracking spreadsheets that were developed for the 2011 plan Appendix I. These were modified from those developed during the 2008 plan update process. The State Mitigation Plan spreadsheets list jurisdiction specific mitigation strategies, records the type of project (i.e., elevation, zoning and land-use, or education), the estimated cost, the potential funding sources, the timeframe, and the plan approval dates. The projects are also identified as being in one of the five main mitigation categories of the State Hazard Mitigation Plan (Policy, Planning and Funding, Mitigation of High Hazard Structures, 2014 Vulnerability Analysis, Local Plan Integration and Education & Outreach). Polices may need revision and in some cases legislation may be necessary to facilitate accomplishment of key mitigation strategies. Sub-committee functions will continue as necessary to support implementation efforts.

The planning process timeline will be revised continually during the next three years to ensure that the 2014 plan revision can be prepared and submitted to FEMA within the required three-year time period. The planning process will emphasize the expanded vulnerability assessment of the database of local and state critical facilities and the re-development of strategies and projects to address the most vulnerable citizens and assets of the state. State or federal legislative, regulatory or rule changes or additions that have occurred during the period following approval of the 2008 plan have been integrated into the 2011 update.

The *State Hazard Mitigation Plan* was developed with the knowledge that it will be implemented in a dynamic and constantly changing environment. Thus, a clearly defined and regular monitoring, evaluation and updating process is essential. Such a process will allow the Maryland Emergency Management Agency to ensure the Plan's continued relevance through changing conditions. The plan will be evaluated annually and updated next in 2014, or when necessitated after a major disaster. The State's annual evaluation as well as review following a disaster will provide a basis for all subsequent revisions to the *State Hazard Mitigation Plan*.

Should a specific plan element or section require revision or amendment prior to the subsequent plan revision due to state or federal legislation or policy change, MEMA the MAC and inform all appropriate stakeholders before proposing the change or addendum to FEMA as quickly as is practicable.

6.4 Reporting

The sponsors of projects funded through the FEMA Unified Hazard Mitigation Assistance Program provide quarterly progress report throughout the duration of the project. MEMA consolidates these reports into a quarterly summary that is provided to FEMA. Projects that support specific aspects of the Mitigation Plan will be tracked on the Mitigation Strategies Spreadsheet so that specific FEMA-funded initiatives are tracked to achieve Mitigation Plan Strategies.

6.5 Expansion of Mitigation Advisory Committee and 2011 Plan Stakeholders

The MAC was first composed of representatives from state agencies. The 2011 MAC serves as an advisor to MEMA on prioritization of HMA subapplications as well as the state hazard mitigation process. MAC members are listed in Chapter 2 of this plan.

To seek diversity and support beyond the reach of MEMA and the MAC, a Stakeholder group of state agencies and local Emergency Managers and Planners was invited to participate in the 2011 update process. This expansion beyond just MEMA and the MAC will continue as implementation of this plan update ensues as many of these new stakeholders have lead responsibility for new mitigation actions. The next plan revision depicted in Table 6-1 will continue to refine the local plan critical facilities database through locations depicted in local HIRAs as well as the State inventory currently under revision.

Table 6-1. Schedule for Plan Maintenance and Revision

Task	Responsibility	Time Frame
1. Refine Planning Process and timeline for new plan development	MEMA Mitigation Staff Mitigation Advisory Committee	Ongoing
2. Expand data base	MEMA 2014 Vulnerability Analysis Sub-Committee	Ongoing
3. Pursue FY 2011, 2012 and 2013 Unified HMA Grant funding for "Critical" and "High" ranked strategies and projects. Continue to match available HMGP funds to priority projects, especially to mitigate severe repetitive and repetitive loss structures	MEMA Mitigation Staff Project sponsors	Ongoing
4. Continue working with local plan and state contacts on plan implementation – use the 2011 Mitigation Project Spreadsheet to track projects	MEMA Mitigation Staff Project sponsors	Initiated Fall, 2011 Ongoing
5. Use available tools and resources to apply vulnerability analysis to manmade hazard mitigation where cross-program relationships exist	MEMA Technological Hazard and Terrorism Planners; Hazard Mitigation Staff Geospatial Information System (GIS) database Commodity flow studies Local sample Hazmat Terrorism Consequence Management Plans State Agency COOP Plans	Ongoing
6. Convene the MAC to discuss plan implementation, the submittal of additional mitigation activities, and to lay the groundwork for future HIRA, Vulnerability Assessment and strategy changes to the State Plan	MEMA Mitigation Staff MAC 2014 Vulnerability Analysis Sub-Committee Members	MAC, quarterly Sub-committee: January 1, 2012 January 1, 2013 January 1, 2014
7. Evaluate progress on strategies and projects; upload annual report to the Mitigation Portal of the MEMA Website.	MEMA Mitigation Staff MAC Strategy & Project Sponsors	January 1, 2012 January 1, 2013 January 1, 2014
8. Upload Local Plan Updates	MEMA Mitigation Staff	January 1, 2012 January 1, 2013 January 1, 2014
9. Initiate review and revision of 2011 HIRA and Vulnerability Analysis	MEMA Mitigation Staff MAC 2014 Vulnerability Analysis Sub-Committee Members	July 1, 2013
10. Review current regulatory requirements for plan revision	MEMA Mitigation Staff	July 1, 2013

Task	Responsibility	Time Frame
11. Review and Update of 2011 Mitigation Goals and Strategies	MEMA Mitigation Staff Mitigation Council Committee Members Strategy and Project Sponsors	April 1, 2014
12. Draft Review	MEMA Mitigation Staff MAC and Stakeholders	July 1, 2014
13. Submit new Revised All-Hazard Mitigation Plan to FEMA	State Emergency Coordinator	August 1, 2014

6.6 Project Closeout

Project Closeout is the process that finalizes a completed mitigation project that FEMA has funded. Project close outs will continue to be conducted based on FEMA Region III closeout procedures in accordance with national and regional FEMA guidance along with MEMA financial management procedures, 2011, *Hazard Mitigation Grant Program, Policies, Procedures and Administrative Plan for Federal Disaster Assistance Declaration*, found in Appendix L.

6.6.1 Project Closeout

The subgrantee will notify the State Hazard Mitigation Officer (SHMO) when a project is ready to be closed. It is recognized that, based upon performance period deadlines, the SHMO may suggest project closure to FEMA. The six steps to closure of a project are:

1. Agreement between the subgrantee and the State that the project is ready to be closed. Should either not agree, the project manager or the SHMO would request an extension on behalf of the sub-grantee, in writing, outlining the justification for the request. The State request is supported with local documentation.
2. The sub-grantee, the State, and FEMA will coordinate to make sure that funds advanced through the program balance with funds expended by the State and sub-grantee. If there is disagreement between the expended funds and the grant amount, FEMA and the State take steps to reconcile and adjust final project expenditures justifying the need for an extension.
3. The State will submit to FEMA a complete project closeout report. The information and enclosures will include:
   a. Final Financial Tracking Report and Cover Letter
   b. Final Closeout Request of Credit Payment Request
   c. Photos, property survey inventory spreadsheet, copy of the referenced deed (if applicable)
4. The State will conduct site visits for all projects to ensure the approved scope of work was completed. The final closeout letter will provide confirmation that final inspection and all final payments have been made to project.
5. Sub-grantees have 30 days to appeal they do not agree with the State and FEMA's findings. The appeal process previously mentioned will be employed to appeal matters relating to closeout.
6. FEMA and the State will coordinate their financial systems to record the amount and date of the final payment(s). Financial files will be closed and excess funds will be de-obligated.

6.6.2 Program Closeout

When all projects under a single disaster are closed, the entire program is ready for closure. The steps that comprise program closeout are as follows:

1. The State will submit to FEMA a final project closeout report. The information and enclosures will include:
   a. Final Financial Tracking Report and Cover Letter

b. Final Closeout Request of Credit Payment Request
c. There will be agreement between FEMA and the State on the Final Claim Amount and concurrence date. The State will submit a concurrence letter and sign FEMA Form 425.
d. The project will be closed. FEMA and the State Hazard Mitigation Officer (SHMO) are responsible for ensuring that Federal and State records are available in the event of an audit.

2. All records will be maintained for a minimum three years.

6.7 Annual Reports

Prior to the 2008 Plan, a *State Hazard Mitigation Plan Annual Report* was developed during some years and was envisioned to be produced annually at the end of each calendar year. Staffing vacancies, lack of resources and scheduling conflicts prevented production of an annual report during the previous 2008 to 2011 state hazard mitigation planning cycle. With new hazard mitigation staff in place at MEMA along with a workbook of 2011 mitigation actions to facilitate reporting by each action's advocate, annual reporting will be reinstated at the end of the calendar year. It is envisioned that the annual report will be posted within the mitigation portal of the MEMA Website created for the 2011 Plan Update. The first Annual Report will be submitted in January 2012.

The annual report may include the following:

- A description of mitigation measures undertaken in the previous year.
- Estimation of the cost avoidance of all mitigation measures ever implemented through MEMA, to include projects completed in the previous year.
- Assessment of changes in existing conditions and development trends.
- An analysis of the impact of development trends on ongoing planning needs and an assessment of the State's capacity to address these needs.
- Recommendations for new initiatives, or changes to existing initiatives.
- Recommendations for revisions to the plan, if applicable.
- A work program for the coming calendar year identifying and prioritizing specific mitigation actions and projects to be initiated or continued.

Reports from previous years are archived in the 2008 Plan Appendices.

6.8 Plan Revision

MEMA's Mitigation staff will be responsible for ensuring that the *State Hazard Mitigation Plan* is updated in three year intervals, as directed by the Disaster Mitigation Act of 2000. The Mitigation Plan will also be reviewed by the State Mitigation Planner and SHMO immediately following a disaster declaration to inform the FEMA-Maryland Mitigation Strategy for the disaster, and to maintain the plan's currency. All components of the plan relating to the particular hazard or hazards associated with the disaster will be assessed to identify any needed revisions or adjustments. If it is determined that an update is necessary, the plan will be revised.

During the summer of 2013, MEMA's mitigation staff and the MAC will perform a comprehensive review of the plan to determine which areas require comprehensive updating to maintain FEMA mitigation planning compliance as well as to ensure that the plan meets the needs of all Marylanders to reduce injury to people and damage to property while protecting function of critical infrastructure. It is envisioned that the MAC and Stakeholders will be convened to participate in a formal planning process followed by a robust public outreach and review period.

After updates to the Hazard Mitigation Plan have been completed following the rough schedule outlined in Table 6-1, the plan will be posted on the MEMA website and made available for peer review. The revised plan will then be submitted to the Office of the Governor for review and approval. Through this

process, MEMA will ensure that the *State Hazard Mitigation Plan* continues to be a relevant and flexible document, which can be adapted to address changing needs and conditions within the State.

Appendix A - August 2011 Adoption Resolution

STATE OF MARYLAND
MILITARY DEPARTMENT

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GOVERNOR

ANTHONY G. BROWN
LIEUTENANT GOVERNOR

JAMES A. ADKINS
MAJOR GENERAL
THE ADJUTANT GENERAL

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As a condition of approval of a state hazard mitigation plan by the FEMA Regional Administrator, 44 CFR Part 201.4(c)(7) requires that the plan contain certain assurances. The state must assure that it will comply with federal statutes and regulations that pertain to grant funding, and will amend the plan to reflect changes in pertinent state or federal laws. Accordingly, under the authorities provided to the Maryland Emergency Management Agency through Executive Orders, the Maryland Emergency Management Agency pledges that it will continue to:

1. Comply with all applicable federal statutes and regulations in effect with respect to the periods for which it receives grant funding, in compliance with *44 CFR 13.11(c)*; and
2. Amend this plan whenever necessary to reflect changes in state or federal laws and statutes as required in *44 CFR 13.11(d)*.

Signed: Richard Muth

Name: Richard Muth

Title: Director, Maryland Emergency Management Agency

Date: 8/10/11

STATE OF MARYLAND
OFFICE OF THE GOVERNOR

MARTIN O'MALLEY
GOVERNOR

STATE HOUSE
100 STATE CIRCLE
ANNAPOLIS, MARYLAND 21401-1925
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TTY USERS CALL VIA MD RELAY

August 25, 2011

MaryAnn Tierney
Regional Administrator
FEMA Region III
One Independence Mall, Sixth Floor
615 Chestnut Street
Philadelphia, PA 19106-4404

Dear Ms. Tierney:

In accordance with the authority vested in me by the *Annotated Code of Maryland*, Public Safety, Article 14 Sections 106(b)(2) and (b)(4), I hereby approve and declare adopted the *2011 Maryland State Hazard Mitigation Plan Update*. This plan update shall be effective as of August 26, 2011.

The *2011 Maryland State Hazard Mitigation Plan Update* has been developed in conformity with Section 322 of the Robert T. Stafford Disaster Relief and Emergency Assistance Act and 44 CFR, Part §201 Mitigation Planning.

The efforts of many State and local departments and agencies were coordinated for the development and update of this plan. In the interest of all citizens and businesses in Maryland, let this *2011 Maryland State Hazard Mitigation Plan Update* continue to serve as an impetus for improved mitigation and recovery from disasters in the State of Maryland.

Sincerely,

Governor

Appendix B – Plan Crosswalk

Instructions for Using the Plan Review Crosswalk for Review of Standard State Hazard Mitigation Plans

Attached is a Plan Review Crosswalk based on the ***Multi-Hazard Mitigation Planning Guidance Under the Disaster Mitigation Act of 2000***, published by FEMA, with revisions dated November 2006. This Plan Review Crosswalk is consistent with the *Disaster Mitigation Act of 2000* (P.L. 106-390), enacted October 30, 2000 and *44 CFR Part 201 – Mitigation Planning, Interim Final Rule* (the Rule), published February 26, 2002.

SCORING SYSTEM

N – Needs Improvement: The plan does not meet the minimum for the requirement. Reviewer's comments must be provided.

S – Satisfactory: The plan meets the minimum for the requirement. Reviewer's comments are encouraged, but not required.

Each requirement includes separate elements. All elements of a requirement must be rated "Satisfactory" in order for the requirement to be fulfilled and receive a summary score of "Satisfactory." A "Needs Improvement" score on elements shaded in gray (recommended but not required) will not preclude the plan from passing.

Optional matrices for assisting in the review of sections on profiling hazards and assessing vulnerability are found at the end of the Plan Review Crosswalk.

The example below illustrates how to fill in the Plan Review Crosswalk.

Example

Assessing Vulnerability by Jurisdiction

Requirement §201.4(c)(2)(ii): *[The State risk assessment **shall** include an] overview and analysis of the State's vulnerability to the hazards described in this paragraph (c)(2), based on estimates provided in local risk assessments …. The State **shall** describe vulnerability in terms of the jurisdictions most threatened by the identified hazards, and most vulnerable to damage and loss associated with hazard event.*

Element	Location in the Plan (section or annex and page #)	Reviewer's Comments	SCORE N	SCORE S
A. Does the plan describe the State's vulnerability based on information from the local risk assessments?	Section III, pp. 12-28	The plan includes a description of local vulnerable structures. The plan presented a vulnerability summary by regions in the state. This information was collected from the approved plans on file.		✓
B. Does the plan present information on those jurisdictions that face the most risk?	Section III, pp. 30-36	The vulnerability description did not indicate which jurisdictions were the most vulnerable. **Required Revisions:** • Use the information provided in the summaries to determine which jurisdictions are most threatened by the identified hazards. • Identify which jurisdictions have suffered or are likely to suffer the most losses. • If data are not readily available, note these data limitations in the plan. Include actions in the mitigation strategy to obtain these data for the plan update.	✓	
		SUMMARY SCORE	✓	

Standard State Hazard Mitigation Plan Review and Approval Status

State Point of Contact: **Mark James**	**Address:** **5401 Rue Saint Lo Drive** **Reisterstown, MD 21136**
Title: **Acting State Hazard Mitigation Officer**	
Agency: **Maryland Emergency Management Agency**	
Phone Number: **(410) 517-3649**	**E-Mail:** **mjames@mema.state.md.us**

FEMA Reviewer: **Matt Mccullough / Therese Grubb**	**Title:** **Mitigation Planners**	**Date:** **8/12/11**
Date Received in FEMA Region [Insert #]		
Plan Not Approved		
Plan Approved		
Date Approved		

STANDARD STATE HAZARD MITIGATION PLAN SUMMARY CROSSWALK

The plan cannot be approved if the plan has not been formally adopted.

Each requirement includes separate elements. All elements of the requirement must be rated "Satisfactory" in order for the requirement to be fulfilled and receive a score of "Satisfactory." Elements of each requirement are listed on the following pages of the Plan Review Crosswalk. A "Needs Improvement" score on elements shaded in gray (recommended but not required) will not preclude the plan from passing. Reviewer's comments must be provided for requirements receiving a **"Needs Improvement"** score.

SCORING SYSTEM

Please check one of the following for each requirement.

N – Needs Improvement: The plan does not meet the minimum for the requirement. Reviewer's comments must be provided.

S – Satisfactory: The plan meets the minimum for the requirement. Reviewer's comments are encouraged, but not required.

Prerequisite	**NOT MET**	**MET**
Adoption by the State: §201.4(c)(6) and §201.4(c)(7)		

Planning Process	**N**	**S**
Documentation of the Planning Process: §201.4(c)(1)		
Coordination Among Agencies: §201.4(b)		
Program Integration: §201.4(b)		

Risk Assessment	**N**	**S**
Identifying Hazards: §201.4(c)(2)(i)		
Profiling Hazards: §201.4(c)(2)(i)		
Assessing Vulnerability by Jurisdiction: §201.4(c)(2)(ii)		
Assessing Vulnerability of State Facilities: §201.4(c)(2)(ii)		
Estimating Potential Losses by Jurisdiction: §201.4(c)(2)(iii)		
Estimating Potential Losses of State Facilities: §201.4(c)(2)(iii)		

Mitigation Strategy	**N**	**S**
Hazard Mitigation Goals: §201.4(c)(3)(i)		
State Capability Assessment: §201.4(c)(3)(ii)		
Local Capability Assessment: §201.4(c)(3)(ii)		
Mitigation Actions: §201.4(c)(3)(iii)		
Funding Sources: §201.4(c)(3)(iv)		

Coordination of Local Mitigation Planning	**N**	**S**
Local Funding and Technical Assistance: §201.4(c)(4)(i)		
Local Plan Integration: §201.4(c)(4)(ii)		
Prioritizing Local Assistance: §201.4(c)(4)(iii)		

Severe Repetitive Loss Mitigation Strategy
(only required for 90/10 under FMA & SRL)

	N	**S**
Repetitive Loss Mitigation Strategy: §201.4(c)(3)(v)		
Coordination with Repetitive Loss Jurisdictions §201.4(c)(3)(v)		

Plan Maintenance Process	**N**	**S**
Monitoring, Evaluating, and Updating the Plan: §201.4(c)(5)(i)		
Monitoring Progress of Mitigation Activities: §201.4(c)(5)(ii) and (iii)		

STANDARD STATE HAZARD MITIGATION PLAN APPROVAL STATUS

PLAN NOT APPROVED	
PLAN APPROVED	

See Reviewer's Comments

PREREQUISITE

Adoption by the State

Requirement §201.4(c)(6): *The plan **must** be formally adopted by the State prior to submittal to [FEMA] for final review and approval.*

Requirement §201.4(c)(7): *The plan **must** include assurances that the State will comply with all applicable Federal statutes and regulations in effect with respect to the periods for which it receives grant funding, in compliance with 44 CFR 13.11(c). The State will amend its plan whenever necessary to reflect changes in State or Federal laws and statutes as required in 44 CFR 13.11(d).*

Element	Location in the Plan (section or annex and page #)	Reviewer's Comments	SCORE NOT MET	SCORE MET
A. Has the State formally adopted the **new or updated** plan?		State Adoption will occur after FEMA "approval pending adoption" letter is received.		N/A
B. Does the plan provide assurances that the State will **continue to** comply with all applicable Federal statutes and regulations during the periods for which it receives grant funding, in compliance with 44 CFR 13.11(c), and will amend its plan whenever necessary to reflect changes in State or Federal laws and statutes as required in 44 CFR 13.11(d)?		State Adoption will occur after FEMA "approval pending adoption" letter is received.		N/A
		SUMMARY SCORE		X

PLANNING PROCESS: *§201.4(b): An effective planning process is essential in developing and maintaining a good plan.*

Documentation of the Planning Process

Requirement §201.4(c)(1): *[The State plan **must** include a] description of the planning process used to develop the plan, including how it was prepared, who was involved in the process, and how other agencies participated.*

Element	Location in the Plan (section or annex and page #)	Reviewer's Comments	SCORE N	SCORE S
A. Does the plan provide a narrative description of how the **new or updated** plan was prepared?	Chapter 2	Chapter 2 provides narrative detail of the planning process.		S
B. Does the **new or updated** plan indicate who was involved in the **current** planning process?	Sections 2.2, 2.3 & 2.4	Section 2.2 identifies parties responsible of the actual update. Section 2.3 identifies members of the Mitigation Advisory Committee. Section 2.4 details additional stakeholder involvement.		S
C. Does the **new or updated** plan indicate how other agencies participated in the **current** planning process?	Sections 2.3, 2.4, 2.5 Appendices F & K	Section 2.3 identifies the MAC, which is composed of members of various state agencies. Section 2.4 identifies the many opportunities for stakeholders to become involved in the planning process.		S

		Section 2.5 discusses how the members were kept up to date and how information was exchanged. A screenshot of the SharePoint site is provided. A table with profiles of all agencies involved in the planning process is provided. Appendix F provides the actual sign in sheets from each meeting. Appendix K provides a master compilation of all parties involved in the planning process, along with which agency they were representing and which portion of the plan update they participated in.		
D. Does the updated plan document how the planning team reviewed and analyzed each section of the plan?	Chapter 2 Section 2.1	Chapter 2 details the planning process and how each section was reviewed and analyzed. Section 2.1 provides an overview of the process to conduct a vulnerability assessment, review and update the mitigation actions, integrate local planning efforts, coordinate between agencies, and providing a plan to track updates. The rest of the chapter provides the details of how this was accomplished.		S
E. Does the updated plan indicate for each section whether or not it was revised as part of the update process?	Chapter 2 Section 2.1	Section 2.1 provides an overview of the planning process, including how the document was revised. In addition, each section of the document contains a summary of the process it went through in its revision.		S
		SUMMARY SCORE		S

Coordination Among Agencies

Requirement §201.4(b): *The [State] mitigation planning process* ***should*** *include coordination with other State agencies, appropriate Federal agencies, interested groups, and …. .*

Element	Location in the Plan (section or annex and page #)	Reviewer's Comments	SCORE N	SCORE S
A. Does the **new or updated** plan describe how Federal and State agencies were involved in the **current** planning process?	Sections 2.1, 2.2, 2.3, 2.4, 2.5 Appendices F & K	Section 2.1 provides a synopsis of the planning process. A review of this section makes evident that FEMA was involved in the current planning process at the very first, as well as all subsequent meetings where substantial goals were met and/or discussed. Section 2.2 details the actual Federal and State personnel involved in the actual update process. Section 2.3 identifies the MAC, which is composed of members of various state agencies. Section 2.4 identifies the many opportunities for stakeholders to become involved in the planning process. Section 2.5 discusses how the members were kept up to date and how information was exchanged. A screenshot of the SharePoint site is provided. A table with profiles of all agencies involved in the planning process is provided. Appendix F provides the actual sign in sheets from each meeting. Appendix K provides a master compilation of all parties involved in		S

		the planning process, along with which agency they were representing.		
B. Does the **new or updated** plan describe how interested groups (e.g., businesses, non-profit organizations, and other interested parties) were involved in the **current** planning process?	Sections 2.3, 2.4, 2.5 & 2.6 Appendices F & K	Section 2.3 identifies the MAC, which is composed of members of various state agencies. Section 2.4 identifies the many opportunities for stakeholders to become involved in the planning process. Section 2.5 discusses how the members were kept up to date and how information was exchanged. A screenshot of the SharePoint site is provided. A table with profiles of all agencies involved in the planning process is provided. Appendix F provides the actual sign in sheets from each meeting. Appendix K provides a master compilation of all parties involved in the planning process, along with which agency they were representing. Section 2.6 details public outreach efforts which included a weekly newsletter, an outreach website, a public survey, numerous regional public outreach meetings, as well as press releases in electronic and print formats.		S
C. Does the updated plan discuss how coordination among Federal and State agencies changed since approval of the previous plan?	Section 6.4	MEMA will continue to work with FEMA, and together will continue to foster the collaborative relationship formed during the 2011 update throughout the next planning cycle.		S
		SUMMARY SCORE		S

Program Integration

Requirement §201.4(b): *[The State mitigation planning process **should**] be integrated to the extent possible with other ongoing State planning efforts as well as other FEMA mitigation programs and initiatives.*

Element	Location in the Plan (section or annex and page #)	Reviewer's Comments	SCORE N	SCORE S
A. Does the **new or updated** plan describe how the State mitigation planning process is integrated with other ongoing State planning efforts?	Section 2.7	Section 2.7, titled *State Planning Integration*, details which state plans were incorporated into this planning process. At least one of these plans was still in a draft stage, which speaks to the level of involvement that each coordinating state agency had in the development of this plan.		S
B. Does the **new or updated** plan describe how the State mitigation planning process is integrated with FEMA mitigation programs and initiatives?	Appendix E	Appendix E identifies the FEMA programs that are currently available, and goes into detail on how the state has managed this FEMA funded program. The NFIP program for example is discussed in detail		S
		SUMMARY SCORE		S

RISK ASSESSMENT: *§201.4(c)(2): [The State plan must include a risk assessment] that provides the factual basis for activities proposed in the strategy portion of the mitigation plan. Statewide risk assessments must characterize and analyze natural hazards and risks to provide a statewide overview. This overview will allow the State to compare potential losses throughout the State and to determine their priorities for implementing mitigation measures under the strategy, and to prioritize jurisdictions for receiving technical and financial support in developing more detailed local risk and vulnerability assessments.*

Identifying Hazards

Requirement §201.4(c)(2)(i): *[The State risk assessment **shall** include an] overview of the type … of all natural hazards that can affect the State …* .

Element	Location in the Plan (section or annex and page #)	Reviewer's Comments	SCORE N	SCORE S
A. Does the **new or updated** plan provide a description of the type of **all natural hazards** that can affect the State? If the hazard identification omits (without explanation) any hazards commonly recognized as threats to the State, this part of the plan cannot receive a Satisfactory score.	Chapter 3.3.3	Chapter 3.3.3 provides an overview of the disasters assessed in this plan. These hazards were assessed based on federally declared disasters, NCDC data, previous versions of the plan, and local plan rankings. These plans include flooding, coastal hazards (hurricanes and tropical storms, nor'easters, sea level rise, tsunami, and shoreline erosion), high winds, lightening and hail, tornado, winter weather, wildfire, landslide, karst/sinkholes, drought, earthquake, dam failure, and mining hazards. Note, these are not all of the hazards that might affect Maryland, but rather those that affect Maryland annually and have the potential to cause fatalities, injuries, property damage, infrastructure damage, agricultural loss, damage to the environment, interruption of business, or other types of harm or loss.		S

Profiling Hazards

Requirement §201.4(c)(2)(i): *[The State risk assessment **shall** include an overview of the] location of all natural hazards that can affect the State, including information on previous occurrences of hazard events, as well as the probability of future hazard events, using maps where appropriate … .*

Element	Location in the Plan (section or annex and page #)	Reviewer's Comments	SCORE N	SCORE S
A. Does the risk assessment identify the **location** (i.e., geographic area affected) of each natural hazards addressed in the **new or updated** plan?	Figure 3.14 3.5.2 3.7.2 Flooding 3.8.2 Coastal Hazards 3.8.4.2 Seal Level Rise 3.8.5.2 Shoreline Erosion 3.8.6.2 Tsunami 3.9.2 High Winds 3.10.2 Lightning and Hail 3.11.2 Tornado 3.12.2 Winter Weather 3.13.2 Wildfire 3.14.2 Landslide 3.15.2 Karst/Sinkholes 3.16.2 Drought 3.17.2 Earthquake 3.18.2 Dam Failure	Figure 3.14 provides a map that ranks the Maryland Counties most affected by Federally Declared Disasters. Section 3.5.2 describes the ranking parameters used for each hazard ranking, including the geographic extent and what the data source is. The *Historical Occurrences* subsection of each hazard discusses historical occurrences of the hazard in the state. It details which jurisdictions were affected, when, and to what extent. Additionally, each hazards' section provides maps that rank the vulnerability of each county to that hazard for future risk, based on previous annualized losses and other information incorporated into the calculation. The Flooding section specifically addresses the number of NFIP policies and claim information in accordance with NFIP RL and SRL requirements, and organizes this information by county.		S
B. Does the **new or updated** plan provide information on **previous occurrences** of each hazard addressed in the plan?	3.3.1 Table 3.7 3.7.2 Flooding 3.8.2 Coastal Hazards 3.8.4.2 Seal Level Rise 3.8.5.2 Shoreline Erosion 3.8.6.2 Tsunami 3.9.2 High Winds 3.10.2 Lightning and Hail 3.11.2 Tornado 3.12.2 Winter Weather 3.13.2 Wildfire 3.14.2 Landslide 3.15.2 Karst/Sinkholes 3.16.2 Drought 3.17.2 Earthquake 3.18.2 Dam Failure 3.19.3 Mining Hazards	Section 3.3.1 and Table 3.7 Provides information on all declared disasters occurring within MD, including disaster number, date of disaster declaration, incident period, brief description and number of counties that declared. The *Historical Occurrences* subsection of each hazard section documents the occurrences of each hazard within the state according to NCDC and other data sources. Appendix I provides the information on the Local Upload, which discusses losses related to specific hazards.		S

	Appendix I			
C. Does the **new or updated** plan include the **probability of future events** (i.e., chance of occurrence) for each hazard addressed in the plan?	3.7.7 Flooding 3.8.3 Coastal Hazards 3.8.4.3 Seal Level Rise 3.8.5.3 Shoreline Erosion 3.8.6.3 Tsunami 3.9.3 High Winds 3.10.3 Lightning and Hail 3.11.3 Tornado 3.12.3 Winter Weather 3.13.3 Wildfire 3.14.3 Landslide 3.15.3 Karst/Sinkholes 3.16.3 Drought 3.17.3 Earthquake 3.18.3 Dam Failure	Each *Risk Analysis* within a specific hazard section discusses possibilities for future occurrences, including risk, impact and vulnerability. Calculations are based on historical frequency of occurrence using NCDC data.		S
		SUMMARY SCORE		S

Assessing Vulnerability

Requirement §201.4(c)(2)(ii): *[The State risk assessment **shall** include an] overview and analysis of the State's vulnerability to the hazards described in this paragraph (c)(2), based on estimates provided in local risk assessments as well as the State risk assessment. The State **shall** describe vulnerability in terms of the jurisdictions most threatened by the identified hazards, and most vulnerable to damage and loss associated with hazard events. State owned critical or operated facilities located in the identified hazard areas shall also be addressed … .*

Requirement §201.4(d): Plan must be reviewed and revised to reflect changes in development…

Assessing Vulnerability by Jurisdiction

Element	Location in the Plan (section or annex and page #)	Reviewer's Comments	SCORE N	SCORE S
A. Does the **new or updated** plan describe the State's vulnerability based on estimates provided in local risk assessments as well as the State risk assessment?	Section 3.6.4 3.7.7 Flooding 3.8.3 Coastal Hazards 3.8.4.3 Seal Level Rise 3.8.5.3 Shoreline Erosion 3.8.6.3 Tsunami 3.9.3 High Winds 3.10.3 Lightning and Hail	Section 3.6.4 describes how the local vulnerability is assessed. Most locals determine vulnerability based on total value of properties that are exposed. This results in some very large numbers. Additionally, for each hazard, detail is provided regarding risk and risk rankings. those jurisdictions determined to be at greatest risk are discussed in detail, including an explanation of the analysis process, and a review of what the local plan risk assessment says.		S

	3.11.3 Tornado 3.12.3 Winter Weather 3.13 .3 Wildfire 3.14.3 Landslide 3.15.3 Karst/Sinkholes 3.16.3 Drought 3.17.3 Earthquake 3.18.3 Dam Failure .			
B. Does the **new or updated** plan describe the State's vulnerability in terms of the jurisdictions most threatened and most vulnerable to damage and loss associated with hazard event(s)?	3.6.2 3.7.7 Flooding 3.8.3 Coastal Hazards 3.8.4.3 Seal Level Rise 3.8.5.3 Shoreline Erosion 3.8.6.3 Tsunami 3.9.3 High Winds 3.10.3 Lightning and Hail 3.11.3 Tornado 3.12.3 Winter Weather 3.13 .3 Wildfire 3.14.3 Landslide 3.15.3 Karst/Sinkholes 3.16.3 Drought 3.17.3 Earthquake 3.18.3 Dam Failure	Each specific hazard section discusses risk and vulnerability of specific counties, providing data on historical annualized events, losses, injuries, deaths, total exposure, crop and property damage, etc. At the end of the hazard section, an overall risk ranking map of the state by jurisdiction is provided.		S
C. Does the updated plan explain the process used to analyze the information from the local risk assessments, as necessary?	3.6.2 3.7.7 Flooding 3.8.3 Coastal Hazards 3.8.4.3 Seal Level Rise 3.8.5.3 Shoreline Erosion 3.8.6.3 Tsunami 3.9.3 High Winds 3.10.3 Lightning and Hail 3.11.3 Tornado 3.12.3 Winter Weather 3.13 .3 Wildfire 3.14.3 Landslide 3.15.3 Karst/Sinkholes 3.16.3 Drought 3.17.3 Earthquake 3.18.3 Dam Failure	Section 3.6.2 describes the compilation of local rankings and which hazards pose the greatest threat. Table 3.13 provides a graphic representation of individual hazard rankings. The risk assessment subsection of each specific hazard devotes a few paragraphs towards the analysis of each local risk assessment and how each was incorporated into the state plan, specific to that hazard, called Jurisdictional Risk.		S
D. Does the updated plan reflect changes in development for jurisdictions in hazard prone areas?	Section 3.2.5	Section 3.2.5 discusses state planning efforts such as *Smart Growth, Priority Places*, and *The Planning Act*. These programs are managed by the Maryland Department of Planning to ensure that development does not occur in hazard prone areas. These efforts are		S

		ongoing and incorporate new data as it develops.		
		SUMMARY SCORE		S

Assessing Vulnerability of State Facilities

Element	Location in the Plan (section or annex and page #)	Reviewer's Comments	SCORE N	SCORE S
A. Does the **new or updated** plan describe the types of State owned or operated critical facilities located in the identified hazard areas?	3.4 Table 3-9 Figure 3-18 3.6.5 3.7.3 Flooding 3.8.3 Coastal Hazards 3.8.4.3 Seal Level Rise 3.8.5.3 Shoreline Erosion 3.8.6.3 Tsunami 3.9.3 High Winds 3.10.3 Lightning and Hail 3.11.3 Tornado 3.12.3 Winter Weather 3.13 3 Wildfire 3.14.3 Landslide 3.15.3 Karst/Sinkholes 3.16.3 Drought 3.17.3 Earthquake 3.18.3 Dam Failure	Section 3.4 provides an overview of the critical facilities in the state, especially regarding how facility datasets were compiled. Table 3-9 provides a compilation of the types of critical facilities in each county and their value. Figure 3.18 maps the location of critical facilities in the state. Section 3.6.5 discusses critical facility data collection and table 3-16 provides data on each jurisdiction's critical facilities. The risk assessment subsection for each hazard describes what threats critical facilities face.		S
		SUMMARY SCORE		S

Estimating Potential Losses

Requirement §201.4(c)(2)(iii): *[The State risk assessment **shall** include an] overview and analysis of potential losses to the identified vulnerable structures, based on estimates provided in local risk assessments as well as the State risk assessment. The State **shall** estimate the potential dollar losses to State owned or operated buildings, infrastructure, and critical facilities located in the identified hazard areas.*

Requirement §201.4(d): Plan must be reviewed and revised to reflect changes in development…

Estimating Potential Losses by Jurisdiction

Element	Location in the Plan (section or annex and page #)	Reviewer's Comments	SCORE N	SCORE S
A. Does the **new or updated** plan present an overview and analysis of the potential losses to the identified vulnerable structures?	3.7.7 Flooding 3.8.3 Coastal Hazards 3.8.4.3 Seal Level Rise 3.8.5.3 Shoreline Erosion 3.8.6.3 Tsunami 3.9.3 High Winds 3.10.3 Lightning and Hail 3.11.3 Tornado 3.12.3 Winter Weather 3.13 .3 Wildfire 3.14.3 Landslide 3.15.3 Karst/Sinkholes 3.16.3 Drought 3.17.3 Earthquake 3.18.3 Dam Failure	Section 3.6 discusses the incorporation process. Section 3.6.4 provides an overall review of the local vulnerability analyses as they are presented in each local plan. Most locals determine vulnerability based on total value of properties that are exposed. This results in some very large numbers. Annualized losses are provided in the risk assessment subsection of each hazard analysis.		S
B. Are the potential losses based on estimates provided in local risk assessments as well as the State risk assessment?	3.6 3.6.4 3.7.7 Flooding 3.8.3 Coastal Hazards 3.8.4.3 Seal Level Rise 3.8.5.3 Shoreline Erosion 3.8.6.3 Tsunami 3.9.3 High Winds 3.10.3 Lightning and Hail 3.11.3 Tornado 3.12.3 Winter Weather 3.13 .3 Wildfire 3.14.3 Landslide 3.15.3 Karst/Sinkholes 3.16.3 Drought 3.17.3 Earthquake 3.18.3 Dam Failure	Local risk assessments from local plans were analyzed and incorporated. Section 3.6 discusses how each local plan was incorporated into the state plan. Section 3.6.4 specifically addresses local vulnerability and potential losses. Table 3.15 provides estimates for flood and hurricane losses where available. The risk assessment subsection for each hazard discusses the risk based on historical annualized occurrence and total exposure. This is based on state vulnerability assessment rather than the contents of local plans. The complete local plan upload document is available in Appendix I.		S

	Appendix I			
C. Does the updated plan reflect the effects of changes in development on loss estimates?	Section 3.2.5	Section 3.2.5 discusses state planning efforts such as *Smart Growth, Priority Places*, and *The Planning Act*. These programs are managed by the Maryland Department of Planning to ensure that development does not occur in hazard prone areas. These efforts are ongoing and incorporate new data as it develops.		S
		SUMMARY SCORE		S

Estimating Potential Losses of State Facilities

Element	Location in the Plan (section or annex and page #)	Reviewer's Comments	SCORE N	SCORE S
A. Does the **new or updated** plan present an estimate of the potential dollar losses to State owned or operated buildings, infrastructure, and critical facilities in the identified hazard areas?	3.4 Table 3-9 Figure 3-18 3.6.5 3.7.3 Flooding 3.8.3 Coastal Hazards 3.8.4.3 Seal Level Rise 3.8.5.3 Shoreline Erosion 3.8.6.3 Tsunami 3.9.3 High Winds 3.10.3 Lightning and Hail 3.11.3 Tornado 3.12.3 Winter Weather 3.13 3 Wildfire 3.14.3 Landslide 3.15.3 Karst/Sinkholes 3.16.3 Drought 3.17.3 Earthquake 3.18.3 Dam Failure	Section 3.4 provides an overview of the critical facilities in the state, especially regarding how facility datasets were compiled. Table 3-9 provides a compilation of the types of critical facilities in each county and their value. Figure 3.18 maps the location of critical facilities in the state. Section 3.6.5 discusses critical facility data collection and table 3-16 provides data on each jurisdiction's critical facilities. The risk assessment subsection for each hazard describes what threats critical facilities face.		S
		SUMMARY SCORE		S

MITIGATION STRATEGY: *§201.4(c)(3) [To be effective the plan must include a] Mitigation Strategy that provides the State's blueprint for reducing the losses identified in the risk assessment.*

Hazard Mitigation Goals

Requirement §201.4(c)(3)(i): *[The State mitigation strategy **shall** include a] description of State goals to guide the selection of activities to mitigate and reduce potential losses.*

Requirement §201.4(d): Plan must be reviewed and revised to reflect changes in development, progress in statewide mitigation efforts, and changes in priorities…

Element	Location in the Plan (section or annex and page #)	Reviewer's Comments	SCORE N	SCORE S
A. Does the **new or updated** plan provide a description of State mitigation **goals** that guide the selection of mitigation activities?	Section 4.1 & 4.2	Section 4.1 describes the Mitigation Strategy Planning Process, and 4.2 identifies the goal that guided the discussion and process of identifying other mitigation activities.		S
B. Does the updated plan demonstrate that the goals were assessed and either remain valid or have been revised?	Section 4.1 & 4.2	Section 4.1 identifies the process through which the mitigation goal was refined. Section 4.2 states the actual goal, as well as the seven objectives determined specifically for this plan.		S
		SUMMARY SCORE		S

State Capability Assessment ***Requirement §201.4(c)(3)(ii):*** *[The State mitigation strategy **shall** include a] discussion of the State's pre-and post-disaster hazard management policies, programs, and capabilities to mitigate the hazards in the area, including: an evaluation of State laws, regulations, policies, and programs related to hazard mitigation as well as to development in hazard-prone areas [and] a discussion of State funding capabilities for hazard mitigation projects … .*

Element	Location in the Plan (section or annex and page #)	Reviewer's Comments	SCORE N	SCORE S
A. Does the **new or updated** plan include an evaluation of the State's **pre-disaster** hazard management policies, programs, and capabilities?	Appendix E	Appendix E provides a description of the states capabilities. It discusses Federal and State partners' programs for mitigation and mitigation funding. It contains a discussion of the current as well as potential funding sources for pre aand post disaster hazard management policies, programs and capabilities. This information is provided in both narrative as well as a table form with a listing of the state's pre- and post-disaster hazard management programs, including those resources offered at the federal level: including the US Army Corps of Engineers, US Department of Agriculture, and resources offered by FEMA. As well as those offered at the state		S

		level, including programs provided by the Maryland Emergency Management Agency, the Maryland Department of Environment, et al. This table is extensive, identifying 26 different agencies with disaster management programs, of which, over 70 are listed.		
B. Does the **new or updated** plan include an evaluation of the State's **post-disaster** hazard management policies, programs, and capabilities?	Appendix E	Appendix E provides a description of the states capabilities. It discusses Federal and State partners' programs for mitigation and mitigation funding. It contains a discussion of the current as well as potential funding sources for pre and post disaster hazard management policies, programs and capabilities. This information is provided in both narrative as well as a table form with a listing of the state's pre- and post-disaster hazard management programs, including those resources offered at the federal level: including the US Army Corps of Engineers, US Department of Agriculture, and resources offered by FEMA. As well as those offered at the state level, including programs provided by the Maryland Emergency Management Agency, the Maryland Department of Environment, et al. This table is extensive, identifying 26 different agencies with disaster management programs, of which, over 70 are listed.		S
C. Does the **new or updated** plan include an evaluation of the State's policies related to **development in hazard prone areas**?	Appendix E	Discussion of these policies are incorporated into either the pre- or post- disaster mitigation programs tables. For example, one such program found in the second table is MEMA's Task Force on the Future for Growth and Development in Maryland, which discusses where development should and should not occur in Maryland.		S
D. Does the **new or updated** plan include a discussion of State **funding capabilities** for hazard mitigation projects?	Appendix E	Within Appendix E, There is a section that addresses *Potential Funding Sources* as well as *Traditional Funding Programs:* FEMA *Grant Programs*. These sections describe the primary sources of funding for mitigation projects. In addition to these, there are numerous grant and loan programs administered by other state and federal agencies which are designed to support mitigation activities.		S
E. Does the updated plan address any hazard management capabilities of the State that have changed since approval of the previous plan?	Appendix E Chapter 2	The capabilities assessment underwent a drastic revision, and went through numerous hands in many different state agencies in order to ascertain changes previous programs and new programs that have since been implemented. This documentation can be found in chapter 2, but the executive summary of Appendix E also discusses the update process.		S
		SUMMARY SCORE		S

Local Capability Assessment

Requirement §201.4(c)(3)(ii): *[The State mitigation strategy **shall** include] a general description and analysis of the effectiveness of local mitigation policies, programs, and capabilities.*

Element	Location in the Plan (section or annex and page #)	Reviewer's Comments	SCORE N	SCORE S
A. Does the **new or updated** plan present a general description of the local mitigation policies, programs, and capabilities?	Chapter 5 Appendix H	Chapter 5, *Coordination with Local Mitigation Planning Efforts* addresses local capabilities. Section 5.4, discusses types of strategies that are implemented. A screenshot of the tracking tool used is included, as well as a screenshot of the types of mitigation activities that are implemented by each county. Appendix H provides the actual local plan upload document, detailing local capabilities.		S
B. Does the **new or updated** plan provide a general analysis of the effectiveness of local mitigation policies, programs, and capabilities?	Sections 5.2.1- 5.2.6, 5.4, 5.5 & 5.6	Section 5.2, 5.2.1-5.2.4 discuss how the State works with locals to ensure effective mitigation planning. Section 5.2.6 discusses the types of local strategies that are currently documented in state plans. Section 5.3 discusses the review process that local plans undergo through state and federal review. This process addresses the effectiveness of local mitigation policies, programs, and capabilities.		S
		SUMMARY SCORE		S

Mitigation Actions

Requirement §201.4(c)(3)(iii): *[State plans **shall** include an] identification, evaluation, and prioritization of cost-effective, environmentally sound, and technically feasible mitigation actions and activities the State is considering and an explanation of how each activity contributes to the overall mitigation strategy. This section **should** be linked to local plans, where specific local actions and projects are identified.*

Requirement §201.4(d): Plan must be reviewed and revised to reflect changes in development, progress in statewide mitigation efforts, and changes in priorities…

Element	Location in the Plan (section or annex and page #)	Reviewer's Comments	SCORE N	SCORE S
A. Does the **new or updated** plan identify cost-effective, environmentally sound, and technically feasible mitigation actions and activities the State is considering?	Section 4.2.1 Appendix I	Section 4.2.1 Describes how the actions were developed in subcommittees, then prioritized and ranked according to STAPLEE criteria.		S
B. Does the **new or updated** plan evaluate these actions	Section 4.2.1	Section 4.2.1 provides a narrative description of how the actions		S

and activities?	Appendix I	were evaluated. Appendix I contains a table that provides the actual evaluation documentation.		
C. Does the **new or updated** plan prioritize these actions and activities?	Section 4.2.1 Appendix I	Section 4.2.1 provides a narrative description of how the actions were prioritized. Appendix I contains a table that provides the actual prioritization documentation.		S
D. Does the **new or updated** plan explain how each activity contributes to the overall State mitigation strategy?	Sections 4.1, 4.2, and 4.2.1 Appendix I	Section 4.1 describes the mitigation strategy planning process and how the subcommittees were developed. Section 4.2 and Section 4.2.1 explains how the actions contribute to the State's mitigation goal. Appendix I contains the worksheets used in this process.		S
E. Does the mitigation strategy **in the new or updated** section reflect actions and projects identified in local plans?	Sectionl 4.1.3 Appendix H	While the actual local actions statewide were not compiled, they were categorized by general strategy such as property protection, prevention, or emergency services measures. A screenshot of this table is provided in this same section. Appendix H provides documentation of the review of each jurisdictions' plan.		S
		SUMMARY SCORE		S

Funding Sources

Requirement §201.4(c)(3)(iv): *[The State mitigation strategy **shall** include an] identification of current and potential sources of Federal, State, local, or private funding to implement mitigation activities.*

Element	Location in the Plan (section or annex and page #)	Reviewer's Comments	SCORE N	SCORE S
A. Does the **new or updated** plan identify **current** sources of Federal, State, local, or private funding to implement mitigation activities?	Appendix E Chapter 5 Sections 5.2.1-5.2.3	The Capabilities Assessment discusses the different FEMA funds that are available through their grants programs. It also identifies other federal agencies that have mitigation grant programs that the state may be eligible for. The Capabilities Assessment in Appendix E also identifies numerous state programs that are either currently underway, or that are in development. These programs are developed using funds from those state agencies. Finally, Chapter 5 discusses funding availability, section 5.2.3, for local mitigation planning efforts, as well as technical assistance, section 5.2.1 & 5.2.2 that is also provided.		S
B. Does the **new or updated** plan identify **potential** sources of Federal, State, local, or private funding to implement mitigation activities?	Appendix E Chapter 5 Section 5.2.1-5.2.3	The Capabilities assessment discusses the different FEMA funds that are available through their grants programs. It also identifies other federal agencies that have mitigation grant programs that the		S

		state may be eligible for. The Capabilities Assessment in Appendix E also identifies numerous state programs that are either currently underway, or that are in development. These programs are developed using funds from those state agencies. Finally, Chapter 5 discusses funding availability, section 5.2.3, for local mitigation planning efforts, as well as technical assistance, section 5.2.1 & 5.2.2 that is also provided.		
C. Does the updated plan identify the sources of mitigation funding used to implement activities in the mitigation strategy since approval of the previous plan?	Section 4.1.2 Appendix N	Section 4.1.2 discusses FEMA unified Hazard Mitigation Assistance Grant Projects, which is the "primary source for funding 2008 eligible mitigation actions". Appendix N contains a spreadsheet tool highlighting grant obligations. The table in section 4.1.3 lists the mitigation actions for the upcoming cycle, as well as potential funding sources for those plans. Appendix I provides the follow-up on who was responsible for and who provided the funding for the mitigation actions from the previous cycle.		S
		SUMMARY SCORE		S

COORDINATION OF LOCAL MITIGATION PLANNING

Local Funding and Technical Assistance

Requirement §201.4(c)(4)(i): *[The section on the Coordination of Local Mitigation Planning* ***must*** *include a] description of the State process to support, through funding and technical assistance, the development of local mitigation plans.*

Element	Location in the Plan (section or annex and page #)	Reviewer's Comments	SCORE N	SCORE S
A. Does the **new or updated** plan provide a description of the State process to support, through funding and technical assistance, the development of local mitigation plans?	Chapter 5 Section 5.1-5.4	Section 5.2 describes the *Local Hazard Mitigation Plan Development* efforts that are currently in place. This includes both technical assistance, sections 5.2.1, 5.2.2 & 5.2.4, as well as funding sources, section 5.2.3.		S
B. Does the updated plan describe the funding and technical assistance the State has provided in the past three years to assist local jurisdictions in completing approvable mitigation plans?	Chapter 5 Sections 5.2.1-5.2.3	Section 5.2.1 describes a *Local Hazard Mitigation Planning Workshop* conducted in 2010. Section 5.2.2 describes planning guides that MEMA has developed and distributed to Maryland communities. Section 5.2.3 describes the current state of the local plans by jurisdiction, and how MEMA supported these efforts through grants programs.		S
		SUMMARY SCORE		S

Local Plan Integration

Requirement §201.4(c)(4)(ii): *[The section on the Coordination of Local Mitigation Planning **must** include a] description of the State process and timeframe by which the local plans will be reviewed, coordinated, and linked to the State Mitigation Plan.*

Requirement §201.4(d): Plan must be reviewed and revised to reflect changes in development, progress in statewide mitigation efforts, and changes in priorities…

Element	Location in the Plan (section or annex and page #)	Reviewer's Comments	SCORE N	SCORE S
A. Does the **new or updated** plan provide a description of the **process and timeframe** the State established to **review** local plans?	Section 4.1.3 Section 5.3	Section 4.1.3 describes the process of uploading the local mitigation actions into the document, which is used for plan tracking. Section 5.3 describes the process of state review of local plans. "The SHMO or mitigation planner evaluates the plan for compliance with all applicable provisions" of the Stafford Act and Emergency Assistance Act of 2000. The timeframe is "within 45 calendar days the SHMO will approve the plan or provide feedback."		S
B. Does the **new or updated** plan provide a description of the **process and timeframe** the State established to **coordinate and link** local plans to the State Mitigation Plan?	Section 5.3	Section 5.3 describes the process of coordinating and linking local plans to the state plan. It describes developing a standardized hazard ranking matrix, calculating an average risk rating, examining and summarizing mitigation goals, objectives and strategies, and linking all of this information with the state plan.		S
		SUMMARY SCORE		S

Prioritizing Local Assistance

Requirement §201.4(c)(4)(iii): *[The section on the Coordination of Local Mitigation Planning **must** include] criteria for prioritizing communities and local jurisdictions that would receive planning and project grants under available funding programs, which **should** include consideration for communities with the highest risks, repetitive loss properties, and most intense development pressures.*

*Further, that for non-planning grants, a principal criterion for prioritizing grants **shall** be the extent to which benefits are maximized according to a cost benefit review of proposed projects and their associated costs.*

Requirement §201.4(d): Plan must be reviewed and revised to reflect changes in development, progress in statewide mitigation efforts, and changes in priorities…

Element	Location in the Plan (section or annex and page #)	Reviewer's Comments	SCORE N	SCORE S
A. Does the **new or updated** plan provide a description of the criteria for prioritizing those communities and local jurisdictions that would receive planning and project grants under available mitigation funding programs?	Section 5.2.3	"The amount of funding each jurisdiction receives varies according to factors unique to the jurisdiction including population, level of risk, and complexity of the required risk assessment. Funding for plan updates have been prioritized based upon factors including level of planning required for the update and time until the update is required." Specific criteria can be found in the section of the plan discussing each hazard.		S
B. **For the new or updated plan, do** the prioritization criteria include, for non-planning grants, the consideration of the extent to which benefits are maximized according to a cost benefit review of proposed projects and their associated cost?	Section 5.2.3	"The amount of funding each jurisdiction receives varies according to factors unique to the jurisdiction including population, level of risk, and complexity of the required risk assessment."		S
C. **For the new or updated plan, do** the criteria include considerations for communities with the highest risk?	Section 5.2.3	"The amount of funding each jurisdiction receives varies according to factors unique to the jurisdiction including population, level of risk, and complexity of the required risk assessment."		S
D. **For the new or updated plan, do** the criteria include considerations for repetitive loss properties?	Section 5.2.3	"The amount of funding each jurisdiction receives varies according to factors unique to the jurisdiction including population, level of risk, and complexity of the required risk assessment. Funding for plan updates have been prioritized based upon factors including level of planning required for the update and time until the update is required."		S
E. **For the new or updated plan, do** the criteria include considerations for communities with the most intense development pressures?	Section 5.2.3	"The amount of funding each jurisdiction receives varies according to factors unique to the jurisdiction including population, level of risk, and complexity of the required risk assessment. Funding for plan updates have been prioritized based upon factors including level of planning required for the update and time until the update is required."		S
		SUMMARY SCORE		S

PLAN MAINTENANCE PROCESS

Monitoring, Evaluating, and Updating the Plan ***Requirement §201.4(c)(5)(i):*** *[The Standard State Plan Maintenance Process **must** include an] established method and schedule for monitoring, evaluating, and updating the plan.*

Element	Location in the Plan (section or annex and page #)	Reviewer's Comments	SCORE N	SCORE S
A. Does the **new or updated** plan describe the method and schedule for monitoring the plan? (e.g., identifies the party responsible for **monitoring**, includes schedule for reports, site visits, phone calls, and/or meetings)	Section 6.1	Procedures for monitoring are listed in section 6.1. Actual time frames and responsibilities are listed in table 6-1.		S
B. Does the **new or updated** plan describe the method and schedule for **evaluating** the plan? (e.g., identifies the party responsible for evaluating the plan, includes the criteria used to evaluate the plan)	Section 6.3	Section 6.3 states that the plan will be evaluated annually, as well as directly following a disaster.		S
C. Does the **new or updated** plan describe the method and schedule for **updating** the plan?	Section 6.3	Section 6.3 states that the plan will be updated again in 2014 or when necessitated after a major disaster.		S
D. Does the updated plan include an analysis of whether the previously approved plan's method and schedule worked, and what elements or processes, if any, were changed?	Section 6.1	"The 2008 state actions were not tracked or monitored during the past three years. For the 2011 plan update, a tracking system has been created and organized in a manner to facilitate annual updating."		S
		SUMMARY SCORE		S

Monitoring Progress of Mitigation Activities ***Requirement §201.4(c)(5)(ii):*** *[The Standard State Plan Maintenance Process **must** include a] system for monitoring implementation of mitigation measures and project closeouts.* ***Requirement §201.4(c)(5)(iii):*** *[The Standard State Plan Maintenance Process **must** include a] system for reviewing progress on achieving goals as well as activities and projects in the Mitigation Strategy.*

Element	Location in the Plan (section or annex and page #)	Reviewer's Comments	SCORE N	SCORE S
A. Does the **new or updated** plan describe how mitigation measures and project closeouts will be monitored?	Section 6.2 Appendices I & N Section 6.6 & 6.6.1	Section 6.2 describes that mitigation actions will be maintained using a Mitigation Strategy Workbook developed with the plan. It will be the responsibility of the Hazard Mitigation Planner to update this workbook, with the SHMO. This workbook can be found in Appendices I and N. Sections 6.6 and 6.6.1 describe project closeout procedures, which has been pulled directly from the February 22, 2011 Hazard Mitigation Grant Program, Policies, Procedures and Administrative Plan.		S

B. Does the **new or updated** plan identify a system for reviewing progress on achieving goals in the Mitigation Strategy?	Section 6.2 Appendices I & N	Section 6.2 describes the system for tracking the progress of achieving the mitigation strategies. Table 6.1 provides a summary of responsible parties and deadlines. The tracking process utilizes tracking worksheets found in appendices I & N.		S
C. Does the updated plan describe any modifications, if any, to the system identified in the previously approved plan to track the initiation, status, and completion of mitigation activities?	Section 6.1	"The 2008 state actions were not tracked or monitored during the past three years. For the 2011 plan update, a tracking system has been created and organized in a manner to facilitate annual updating."		S
D. Does the **new or updated** plan identify a system for reviewing progress on implementing activities and projects of the Mitigation Strategy?	Section 6.2 Appendices I & N	Section 6.2 describes the system for tracking the progress of achieving the mitigation strategies. Table 6.1 provides a summary of responsible parties and deadlines. The tracking process utilizes tracking worksheets found in appendices I & N.		S
E. Does the updated plan discuss if mitigation actions were implemented as planned?	Section 6.2 Appendix I	Section 6.2 discusses the implementation of actions listed in the 2008 plan. Appendix I provides a work sheet listing the 2008 actions according to responsible agency and provides an update on the status of that action.		S
		SUMMARY SCORE		S

SEVERE REPETITIVE LOSS STRATEGY *(only required for 90/10 under FMA & SRL)*

Repetitive Loss Mitigation Strategy

Requirement §201.4(c)(3)(v): *A State may request the reduced cost share authorized under §79.4(c)(2) of this chapter for the FMA and SRL programs, if it has an approved State Mitigation Plan … that also identifies specific actions the State has taken to reduce the number of repetitive loss properties (which **must** include severe repetitive loss properties), and specifies how the State intends to reduce the number of such repetitive loss properties.*

Element	Location in the Plan (section or annex and page #)	Reviewer's Comments	SCORE NOT MET	SCORE MET
A. Does the new or updated plan describe State mitigation goals that support the selection of mitigation activities for repetitive loss properties (see also Part 201.4(c)(3)(i))?	Sections 4.3.1 & 4.4 Appendix N	Appendix N provides a worksheet detailing the repetitive loss and the severe repetitive loss properties to be addressed by the mitigation actions. Section 4.4 describes how MEMA intends on managing Appendix N, as well as how MEMA will approach managing the FEMA funded programs. Section 4.3.1 lists the actions developed for this plan update. Mitigation actions that meet objective 3 address RL and SRL. Those actions are: PPP-9, 10; LP-8; MS-1, 10, 11, 15, 16, 29, 30.		S
B. Does the new or updated plan consider repetitive loss properties in its evaluation of the State's	Appendices E & N Sections 4.4, 5.2.3, 5.7, 5.7.1, &	Appendix E goes into detail regarding the programs that are implemented to reduce RL & SRL. There are numerous programs		S

hazard management policies, programs, and capabilities and its general description of the local mitigation capabilities (see also Part 201.4(c)(3)(ii))?	5.7.2	that managed by a variety of state agencies. Appendix N provides RL and SRL worksheets to track the actions taken to mitigate these properties. Section 4.4 describes the approach MEMA is taking towards managing FEMA grant programs. Section 5.2.3 describes how MEMA is working with local jurisdictions to manage FEMA grant programs and to assist in the mitigation of flood prone structures. Sections 5.7, 5.7.1, and 5.7.2 describe how MEMA is working with the locals and other state agencies to ensure that the properties identified as RL and SRL are mitigated.		
C. Does the new or updated plan address repetitive loss properties in its risk assessment (see also Part 201.4(c)(2))?	Section 3.7.5 Table 3.7-4 Figures 3.7-3, 3.7-4 & 3.7-5 Section 3.7.6	Section 3.7.5 discusses the NFIP, RL & SRL in MD. Table 3.7-4 provides a summary of RL and SRL properties, including total dollar values paid in Maryland, according to county. Figures 3.7-3, 3.7-4 &3.7-5 provides a graphic analysis of RL properties in the state of MD, ranked by county according to total dollar value paid out. Section 3.7.6 discusses mitigated repetitive loss properties and the system developed to maintain accurate data sets.		S
D. Does the new or updated plan identify, evaluate and prioritize cost-effective, environmentally sound, and technically feasible mitigation actions for repetitive loss properties (see also Part 201.4(c)(3)(iii))?	Section 3.7.6 Section 4.3.1 Section 4.4 Appendix I	Section 3.7.6 discusses mitigation of repetitive loss properties in a risk analysis context. It discuses national grant programs and provides tables illustrating which counties in the state contain properties being mitigated, and the types of mitigation actions being used. Section 4.3.1 lists the actions developed for this plan update. Mitigation actions that meet objective 3 address RL and SRL. Those actions are: PPP-9, 10; LP-8; MS-1, 10, 11, 15, 16, 29, 30. Section 4.4 addresses RL and SRL mitigation strategies directly. Appendix I provides the follow-up on 2008 mitigation actions, several of which concern repetitive loss and SRL.		S
E. Does the new or updated plan describe specific actions that have been implemented to mitigate repetitive loss properties, including actions taken to reduce the number of severe repetitive loss properties?	Appendix N Section 3.7.6 Section 4.3.1	Appendix N provides a detailed list which identifies current programs being managed by the state, and the properties which they address. This Appendix is actually a tracking tool, which details the properties being mitigated and the FEMA programs that they fall under. Section 3.7.6 discusses mitigation of repetitive loss properties in a risk analysis context. It discuses national grant programs and provides tables illustrating which counties in the state contain properties being mitigated, and the types of mitigation actions being used. Section 4.3.1 lists the actions developed for this plan update. Mitigation actions that meet objective 3 address RL and SRL. Those actions are: PPP-9, 10; LP-8; MS-1, 10, 11, 15, 16, 29, 30.		
F. Does the new or updated plan identify current and potential sources of Federal, State, local, or	Section 4.4	Section 4.4 addresses RL and SRL mitigation strategies, including partner organizations that can potentially assist in implementation		

private funding to implement mitigation activities for repetitive loss properties (see also Part 201.4(c)(3)(iv))?		of SRL and RL strategies outlined in this plan.		
		SUMMARY SCORE		

Coordination with Repetitive Loss Jurisdictions

Requirement §201.4(c)(3(v): *In addition, the plan* ***must*** *describe the strategy the State has to ensure that local jurisdictions with severe repetitive loss properties take actions to reduce the number of these properties, including the development of local mitigation plans.*

Element	Location in the Plan (section or annex and page #)	Reviewer's Comments	SCORE N	SCORE S
A. Does the new or updated plan provide a description of the State process to support, through funding and technical assistance, the development of local mitigation plans in communities with severe repetitive loss properties (see also Part 201.4(c)(4)(i))?	Section 5.2.3 Section 5.7, 5.7.1 & 5.7.2	Section 5.2.3 describes how MEMA is working with local jurisdictions to manage FEMA grant programs and to assist in the mitigation of flood prone structures. Sections 5.7, 5.7.1, and 5.7.2 describe how MEMA is working with the locals and other state agencies to ensure that the properties identified as RL and SRL are mitigated.		
B. Does the new or updated plan include considerations for repetitive loss properties in its criteria for prioritizing communities and local jurisdictions that would receive planning and project grants under available mitigation funding programs (see also Part 201.4(c)(3)(iii))?	.Section 5.2.3 Section 3.7.5	"The amount of funding each jurisdiction receives varies according to factors unique to the jurisdiction including population, level of risk, and complexity of the required risk assessment." Section 3.7.5 discusses the states management of the Repetitive Flood Claims Program, as well as other related programs.		
		SUMMARY SCORE		

Matrix A: Profiling Hazards

This matrix can assist FEMA in scoring each hazard. States may find the matrix useful to ensure that their plan addresses each natural hazard that can affect the State.

Completing the matrix is not required.

Note: First, check which hazards are identified in requirement §201.4(c)(2)(i). Then, place a checkmark in either the N or S box for each ***applicable*** *hazard. An "N" for any element of any identified hazard will result in a "Needs Improvement" score for this requirement. List the hazard and its related shortcoming in the comments section of the Plan Review Crosswalk.*

Hazard Type	Hazards Identified Per Requirement §201.4(c)(2)(i)	A. Location		B. Previous Occurrences		C. Probability of Future Events	
	Yes	N	S	N	S	N	S
Avalanche	☐	☐	☐	☐	☐	☐	☐
Coastal Erosion	☒	☐	☒	☐	☒	☐	☒
Coastal Storm	☒	☐	☒	☐	☒	☐	☒
Dam Failure	☒	☐	☒	☐	☒	☐	☒
Drought	☒	☐	☒	☐	☒	☐	☒
Earthquake	☒	☐	☒	☐	☒	☐	☒
Expansive Soils	☐	☐	☐	☐	☐	☐	☐
Extreme Heat	☒	☐	☒	☐	☒	☐	☒
Flood	☒	☐	☒	☐	☒	☐	☒
Hailstorm	☒	☐	☒	☐	☒	☐	☒
Hurricane	☒	☐	☒	☐	☒	☐	☒
Land Subsidence	☒	☐	☒	☐	☒	☐	☒
Landslide	☒	☐	☒	☐	☒	☐	☒
Levee Failure	☒	☐	☒	☒	☐	☒	☐
Severe Winter Storm	☒	☐	☒	☐	☒	☐	☒
Tornado	☒	☐	☒	☐	☒	☐	☒
Tsunami	☒	☐	☒	☐	☒	☐	☒
Volcano	☐	☐	☐	☐	☐	☐	☐
Wildfire	☒	☐	☒	☐	☒	☐	☒
Windstorm	☒	☐	☒	☐	☒	☐	☒
Other Mining Hazards	☒	☐	☒	☐	☒	☐	☐
Other Karst/Sinkhole	☒	☐	☒	☐	☒	☐	☒
Other _____	☐	☐	☐	☐	☐	☐	☐

To check boxes, double click on the box and change the default value to "checked"

Legend:
§201.4(c)(2)(i) Profiling Hazards
A. Does the risk assessment identify the location (i.e., geographic area affected) of each natural hazard addressed in the **new or updated** plan?
B. Does the plan provide information on previous occurrences of each hazard addressed in the **new or updated** plan?
C. Does the plan include the probability of future events (i.e., chance of occurrence) for each hazard addressed in the **new or updated** plan?

Matrix B: Assessing Vulnerability

This matrix can assist FEMA in scoring each hazard. States may find the matrix useful to ensure that their plan addresses each requirement. Note that this matrix only includes items for Requirements §201.4(c)(2)(ii) and §201.4(c)(2)(iii) that are related to specific natural hazards that can affect the State. **Completing the matrix is not required**.

Note: First, check which hazards are identified in requirement §201.4(c)(2)(i). Then, place a checkmark in either the N or S box for each ***applicable*** *hazard. An "N" for any element of any identified hazard will result in a "Needs Improvement" score for this requirement. List the hazard and its related shortcoming in the comments section of the Plan Review Crosswalk.*

Hazard Type	Hazards Identified Per Requirement §201.4(c)(2)(i)	§201.4(c)(2)(ii) Assessing Vulnerability					§201.4(c)(2)(iii) Estimating Potential Losses			
		1. Vulnerability by Jurisdiction		2. Vulnerability to State Facilities			3. Loss Estimate by Jurisdiction		4. Loss Estimate of State Facilities	
	Yes	N	S	N	S		N	S	N	S
Avalanche	☐	☐	☐	☐	☐		☐	☐	☐	☐
Coastal Erosion	☒	☐	☒	☐	☒		☐	☒	☐	☒
Coastal Storm	☒	☐	☒	☐	☒		☐	☒	☐	☒
Dam Failure	☒	☐	☒	☐	☒		☐	☒	☐	☒
Drought	☒	☐	☒	☐	☒		☐	☒	☐	☒
Earthquake	☒	☐	☒	☐	☒		☐	☒	☐	☒
Expansive Soils	☐	☐	☐	☐	☐		☐	☐	☐	☐
Extreme Heat	☒	☐	☒	☐	☒		☐	☒	☐	☒
Flood	☒	☐	☒	☐	☒		☐	☒	☐	☒
Hailstorm	☒	☐	☒	☐	☒		☐	☒	☐	☒
Hurricane	☒	☐	☒	☐	☒		☐	☒	☐	☒
Land Subsidence	☒	☐	☒	☐	☒		☐	☒	☐	☒
Landslide	☒	☐	☒	☐	☒		☐	☒	☐	☒
Levee Failure	☒	☐	☒	☐	☐		☐	☐	☐	☐
Severe Winter Storm	☒	☐	☒	☐	☒		☐	☒	☐	☒
Tornado	☒	☐	☒	☐	☒		☐	☒	☐	☒
Tsunami	☒	☐	☒	☐	☒		☐	☒	☐	☒
Volcano	☐	☐	☐	☐	☐		☐	☐	☐	☐
Wildfire	☒	☐	☒	☐	☒		☐	☒	☐	☒
Windstorm	☒	☐	☒	☐	☒		☐	☒	☐	☒
Other Mining Hazards	☒	☐	☐	☐	☐		☐	☐	☐	☐
Other Karst/Sinkhole	☒	☐	☒	☐	☒		☐	☒	☐	☒
Other _____	☐	☐	☐	☐	☐		☐	☐	☐	☐

To check boxes, double click on the box and change the default value to "checked."

Legend

§201.4(c)(2)(ii) Assessing Vulnerability by Jurisdiction (see element B)

1. Does the **new or updated** plan describe the State's vulnerability in terms of the jurisdictions most threatened and most vulnerable to damage and loss associated with hazard event(s)?

§201.4(c)(2)(ii) Assessing Vulnerability to State Facilities (see element A)

2. Does the **new or updated** plan describe the types of State owned or operated critical facilities located in the identified hazard areas?

§201.4(c)(2)(iii) Estimating Potential Losses by Jurisdiction (see element A)

3. Does the **new or updated** plan present an overview and analysis of the potential losses to the identified vulnerable structures?

§201.4(c)(2)(iii) Estimating Potential Losses of State Facilities (see element A)

4. Does the **new or updated** plan present an estimate of the potential dollar losses to State owned or operated buildings, infrastructure, and critical facilities in the identified hazard areas?

Appendix C – Glossary

Abandoned Mine Lands (AML)

Abandoned Mine Lands are generally characterized as mines that are no longer actively mined for their mineral resources. In West Virginia, mines that are included in the abandoned mine land inventory are those which were abandoned prior to August 3, 1977 for which there is no continuing reclamation responsibility.

Acid Mine Drainage

Water that is discharged from mining or mine-related operations which contains high levels of dissolved iron and aluminum sulfates in conjunction with pH values less than 4.5 (acidic). It is produced when oxygen dissolved in water reacts with pyretic (iron Sulfide) materials found in association with most coal deposits.

Asset

Any manmade or natural feature that has value, including, but not limited to people; buildings; infrastructure like bridges, roads, and sewer and water systems; lifelines like electricity and communication resources; or environmental, cultural, or recreational features like parks, dunes, wetlands, or landmarks

Base Flood

Flood that has a 1% probability of being equaled or exceeded in any given year. Also known as the 100-year flood.

Base Flood Elevation (BFE)

Elevation of the base flood in relation to a specified datum, such as the National Geodetic Vertical Datum of 1929. The Base Flood Elevation is used as the standard for the National Flood Insurance Program.

Bedrock

The solid rock that underlies loose material, such as soil, sand, clay, or gravel.

Building

A structure that is walled and roofed, principally above ground, and permanently affixed to a site. The term includes a manufactured home on a permanent foundation on which the wheels and axels carry no weight.

Coal Waste Impoundment

A basin constructed to permanently hold waste created during the process of mining and cleaning coal. Coal refuse disposed of in the impoundment is either coarse or fine. Fine refuse, also called slurry, is a combination of silt, dust, water, bits of coal and clay particles, is the most commonly disposed of material held in an impoundment. Coarse refuse consists of larger materials such as rocks and pieces of coal. The coarse refuse is used to construct the impoundment dam, which then holds the fine refuse or slurry, along with any chemicals used to wash and treat the coal at the coal preparation plant.

Community Rating System (CRS)

An NFIP program that provides incentives for NFIP communities to complete activities that reduce flood hazard risk. When the community completes specified activities, the insurance premiums of policyholders in these communities are reduced.

Contour

A line of equal ground elevation on a topographic (contour) map.

Critical Facility

Facilities that are critical to the health and welfare of the population and that are especially important following hazard events. Critical facilities include, but are not limited to, shelters, police and fire stations, and hospitals.

Debris

The scattered remains of assets broken or destroyed in a hazard event. Debris caused by a wind or water hazard event can cause additional damage to other assets.

Duration

How long a hazard event lasts.

Earthquake

A sudden motion or trembling that is caused by a release of strain accumulated within or along the edge of earth's tectonic plates.

Erosion

The wearing away of the land surface by detachment and movement of soil and rock fragments, during a flood or storm or over a period of years through the action of wind, water, or other geologic processes.

Extent

The size of an area affected by a hazard or hazard event.

Fault

A fracture in the continuity of a rock formation caused by a shifting or dislodging of the earth's crust, in which adjacent surfaces are differentially displaced parallel to the plane of fracture.

Flash Flood

A flood event occurring with little or no warning where water levels rise at an extremely fast rate.

Flood

A general and temporary condition of partial or complete inundation of normally dry land areas from (1) the overflow of inland or tidal waters, (2) the unusual and rapid accumulation or runoff of surface waters from any source, or (3) mudflows or the sudden collapse of shoreline land.

Flood Depth

Height of the floodwater surface above the ground surface.

Flood Elevation

Elevation of the water surface above an established datum, e.g. National Geodetic Vertical Datum of 1929, North American Vertical Datum of 1988, or Mean Sea Level.

Flood Hazard Area

The area shown to be inundated by a flood of a given magnitude on a map.

Flood Insurance Rate Map (FIRM)

Map of a community, prepared by FEMA that shows both the special flood hazard areas and the risk premium zones applicable to the community.

Floodplain

Any land area, including watercourse, susceptible to partial or complete inundation by water from any source.

Floodway

The channel of a river or other watercourse and the adjacent land areas that must be reserved in order to discharge the 1-percent-annual-chance flood without cumulatively increasing the water surface elevation by more than a designated height.

Frequency

A measure of how often events of a particular magnitude are expected to occur. Frequency describes how often a hazard of a specific magnitude, duration, and/or extent typically occurs, on average. Statistically, a hazard with a 100-year recurrence interval is expected to occur once every 100 years on average, and would have a 1 percent chance – its probability – of happening in any given year. The reliability of this information varies depending on the kind of hazard being considered.

Frostbite

Damage to body tissue caused by that tissue being frozen. Frostbite has three stages of progression: frostnip, superficial frostbite, and deep frostbite.

Frostnip

First stage of frostbite during which the individual experiences a pins and needles sensation with the skin turning very white and soft. No blistering occurs. This stage produces no permanent damage and may be reversed by soaking in warm water or breathing warm breath on the affected area.

Fujita Scale of Tornado Intensity

Rates tornados with numeric values from F0 to F5 based on tornado wind speed and damage sustained. An F0 indicates light damage such as broken tree limbs or signs, while an F5 indicates incredible damage was sustained.

Geographic Information Systems (GIS)

A computer software application that relates physical features on the earth to a database to be used for mapping and analysis.

Ground Motion

The vibration or shaking of the ground during an earthquake. When a fault ruptures, seismic waves radiate, causing the ground to vibrate. The severity of the vibration increases with the amount of energy released and decreases with distance from the causative fault or epicenter; but soft soils can further amplify ground motion.

Hazard

A source of potential danger or adverse condition. Hazards in this plan are both natural and technological in origin and include: floods/flash floods, droughts, wind, thunderstorms/lightning, winter storms, tornados, hurricanes, extreme heat, landslides, earthquakes, wildfires/fires, land subsidence, mining hazards, dam failures, hazardous materials, and nuclear accidents. These events are hazards when they have the potential to harm people or property.

Hazard Event

A specific occurrence of a particular type of hazard.

Hazard Identification

The process of identifying hazards that threaten an area.

Hazard Mitigation

Sustained actions taken to reduce or eliminate long-term risk from hazards and their effects.

Hazard Profile

A description of the physical characteristics of hazards and a determination of various descriptors including magnitude, duration, frequency, probability, and extent. In most cases, a community can most easily use these descriptors when they are recorded and displayed as maps.

HAZUS (Hazards US)

A GIS-based, nationally standardized hazard loss estimation tool developed by FEMA.

Hurricane

An intense tropical cyclone, formed in the atmosphere over warm ocean areas, in which wind speeds reach 74-miles-per-hour or more and blow in a large spiral around a relatively calm center or "eye." Hurricanes develop over the North Atlantic Ocean, northeast Pacific Ocean, or the South Pacific Ocean east of 160° longitude. Hurricane circulation is counter-clockwise in the Northern Hemisphere and clockwise in the Southern Hemisphere.

Hydrology

The science of dealing with the waters of the earth. A flood discharge is developed by a hydrologic study.

Hypothermia

The dropping of the body temperature to 95°F or below.

Infrastructure

Refers to the public services of a community that have a direct impact on the quality of life. Infrastructure includes communication technology such as phone lines or internet access, vital services such as public water supplies and sewer treatment facilities, and includes an area's transportation system such as airports, heliports; highways, bridges, tunnels, roadbeds, overpasses, railways, rail yards, depots; and waterways, canals, locks, seaports, ferries, harbors, dry-docks, piers and regional dams.

Intensity

A measure of the effects of a hazard event at a particular place.

Landslide

Downward movement of a slope and materials under the force of gravity.

Lateral Spreads

Develop on gentle slopes and entail the sidelong movement of large masses of soil as an underlying layer liquefies in a seismic event.

Magnitude

A measure of the strength of a hazard event. The magnitude (also referred to as severity) of a given hazard event is usually determined using technical measures specific to the hazard.

Mitigation Plan

A systematic evaluation of the nature and extent of vulnerability to effects of natural hazards typically present in the state and includes a description of actions to minimize future vulnerability to hazards.

National Flood Insurance Program (NFIP)

Federal program created by Congress in 1968 that makes flood insurance available in communities that enact minimum floodplain management regulations in 44 CFR §60.3.

National Weather Service (NWS)

Prepares and issues flood, severe weather, and coastal storm warnings and can provide technical assistance to federal and state entities in preparing weather and flood plans.

NEMIS

The National Emergency Management Information System (NEMIS) is an evolving agency-wide system of hardware, software, telecommunications and applications software that provides a new technology base to FEMA and its partners to perform the emergency management mission.

Nor'easter

An extra-tropical cyclone producing gale-force winds and precipitation in the form of heavy snow or rain.

Planning

The act or process of making or carrying out plans; the establishment of goals, policies and procedures for a social or economic unit.

Pre-Disaster Mitigation Program

The Pre-Disaster Mitigation (PDM) Program was authorized by §203 of the Robert T. Stafford Disaster Assistance and Emergency Relief Act (Stafford Act), 42 USC, as amended by §102 of the Disaster Mitigation Act of 2000. Funding for the program is provided through the National Pre-Disaster Mitigation Fund to assist states and local governments (to include Indian Tribal governments) in implementing cost-effective hazard mitigation activities that complement a comprehensive mitigation program.

Probability

A statistical measure of the likelihood that a hazard event will occur.

Recurrence Interval

The time between hazard events of similar size in a given location. It is based on the probability that the given event will be equaled or exceeded in any given year.

Repetitive Loss Property

A property that is currently insured for which two or more National Flood Insurance Program losses (occurring more than ten days apart) of at least $1000 each have been paid within any 10-year period since 1978.

Replacement Value

The cost of rebuilding a structure. This is usually expressed in terms of cost per square foot, and reflects the present-day cost of labor and materials to construct a building of a particular size, type and quality. In this plan, replacement values are largely based on insurance estimates.

Richter Scale

A numerical scale of earthquake magnitude devised by seismologist C.F. Richter in 1935.

Risk

The estimated impact that a hazard would have on people, services, facilities, and structures in a community; the likelihood of a hazard event resulting in an adverse condition that causes injury or damage. Risk is often expressed in relative terms such as a high, moderate, or low likelihood of sustaining damage above a particular threshold due to a specific type of hazard event. It also can be expressed in terms of potential monetary losses associated with the intensity of the hazard.

Riverine

Of or produced by a river.

Scale

A proportion used in determining a dimensional relationship; the ratio of the distance between two points on a map and the actual distance between the two points on the earth's surface.

Seismicity

Describes the likelihood of an area being subject to earthquakes.

Stafford Act

The Robert T. Stafford Disaster Relief and Emergency Assistance Act, PL 100-107 was signed into law November 23, 1988 and amended the Disaster Relief Act of 1974, PL 93-288. The Stafford Act is the statutory authority for most federal disaster response activities, especially as they pertain to FEMA and its programs.

State Hazard Mitigation Officer (SHMO)

The representative of state government who is the primary point of contact with FEMA, other state and federal agencies, and local units of government in the planning and implementation of pre- and post- disaster mitigation activities.

Structure

Something constructed. (See also Building)

Surface Faulting

The differential movement of two sides of a fracture – in other words, the location where the ground breaks apart. The length, width, and displacement of the ground characterize surface faults.

Tectonic Plate

Torsionally rigid, thin segments of the earth's lithosphere that may be assumed to move horizontally and adjoin with other plates. It is the friction between plate boundaries that cause seismic activity.

Topographic

Characterizes maps that show natural features and indicate the physical shape of the land using contour lines. These maps may also include manmade features.

Tornado

A violently rotating column of air extending ground-ward.

Tropical Cyclone

A generic term for a cyclonic, low-pressure system over tropical or sub-tropical waters.

Tropical Storm

A tropical cyclone with maximum sustained winds greater than 39 mph and less than 74 mph.

Tsunami

Great sea wave produced by submarine earth movement or volcanic eruption.

Vulnerability

Describes how exposed or susceptible to damage an asset is. Vulnerability depends on an asset's construction, contents, and the economic value of its functions. Like indirect damages, the vulnerability of one element of the community is often related to the vulnerability of another. For example, many businesses depend on uninterrupted electrical power – if an electric substation is flooded, it will affect not only the substation itself, but a number of businesses as well. Often, indirect effects can be much more widespread and damaging than direct ones.

Vulnerability Assessment

The extent of injury and damage that may result from a hazard event of a given intensity in a given area.

Wildfire

An uncontrolled fire spreading through vegetative fuels, exposing and possibly consuming structures.

Flood Zone

A geographic area shown on a Flood Insurance Rate Map (FIRM) that reflects the severity or type of flooding in the area.

Appendix D – Agency Profiles

Agency and Website	Biography	Programs, Funding Levels, Technical Assistance, Etc.
Federal Agencies		
Federal Emergency Management Agency www.fema.gov	The Federal Emergency Management Agency (FEMA) plays the most prominent role of all Federal agencies in floodplain management. FEMA's National Flood Insurance Program (NFIP) is a program that encourages property owners to buy federally backed flood insurance. The NFIP provides flood insurance to meet the rising costs of repairing damage caused by floods. Flood insurance is a better alternative than disaster assistance. The NFIP is based upon an agreement between local communities and the Federal government that if the community will enforce certain practices in the 100- year floodplain, then flood insurance will be available in the community. The NFIP is a voluntary program where communities elect to join and participate. However, if a community with identified flood hazard areas chooses not to participate, it will not be eligible for certain financial assistance in the event of a Presidentially declared disaster. To participate, communities must adopt a Floodplain Management Ordinance that requires a permit for all construction and development with FEMA mapped floodplains. This provides the basis for a local floodplain management program and should help the community identify its problems, develop resources to confront flooding problems, and establish realistic, achievable measures to reduce flooding risk in the community. FEMA publishes Flood Insurance Rate Maps (FIRMS) that show the flood risk areas within a community along with Flood Insurance Studies (FIS) that include 100-year flood elevations, floodways, stream profiles, discharge amounts and other hydrologic and hydraulic information pertinent to understanding flooding. Currently 258 localities within the State have had these studies prepared.	• Flood Mitigation Assistance • Sustainability/Sustainable Re-development • Mitigation Assistance Program • Community Assistance Program - State Support Services Element
Federal Highway Administration www.fhwa.dot.gov	FHWA is charged with the broad responsibility of ensuring that America's roads and highways continue to be the safest and most technologically up-to-date. Their annual budget of more than $30 billion is funded by fuel and motor vehicle excise taxes. The budget is primarily divided between two programs: Federal-aid funding to State and local governments; and Federal Lands Highways funding for national parks, national forests, Indian lands, and other land under Federal stewardship. Although State, local, and tribal governments own most of the Nation's highways, we provide financial and technical support to them for constructing, improving, and preserving America's highway system.	• The Federal-aid Highway Program • The Federal Lands Highway (FLH) Program • Emergency Relief Program
HUD Community Development and Block Grant www.hud.gov/offices/cpd/communitydevelopment/programs	The Community Development Block Grant (CDBG) program is a flexible program that provides communities with resources to address a wide range of unique community development needs. Beginning in 1974, the CDBG program is one of the longest continuously run programs at HUD. The	• Entitlement Communities Program • State Administered CDBG Program • Section 108 Loan Guarantee Program

Agency and Website	Biography	Programs, Funding Levels, Technical Assistance, Etc.
	CDBG program provides annual grants on a formula basis to 1209 general units of local government and States. The CDBG program works to ensure decent affordable housing, to provide services to the most vulnerable in our communities, and to create jobs through the expansion and retention of businesses. CDBG is an important tool for helping local governments tackle serious challenges facing their communities. The CDBG program has made a difference in the lives of millions of people and their communities across the Nation.	• HUD Administered Small Cities Program • Insular Areas Program • Disaster Recovery Assistance Program • Neighborhood Stabilization Program • Colonias Program • Renewal Communities/ Empowerment Zones/ Enterprise Communities (RC/EZ/EC) Program
Natural Resources Conservation Services of Maryland www.md.nrcs.usda.gov	A USDA program, NRCS puts nearly 70 years of experience to work in assisting owners of America's private land with conserving their soil, water, and other natural resources. Local, state and federal agencies and policymakers also rely on our expertise. We deliver technical assistance based on sound science and suited to a customer's specific needs. Cost shares and financial incentives are available in some cases. Most work is done with local partners. Our partnership with local conservation districts serves every county in Maryland and the District of Columbia. Participation in our programs is voluntary.	• Agricultural Management Assistance • Conservation Innovation Grants • Emergency Watershed Protection - Floodplain Easement • Wetlands Reserve Program
National Oceanic and Atmospheric Administration – National Weather Service www.noaa.gov	The National Weather Service (NWS) is concerned with the atmospheric events, and the monitoring and/or prediction of routine and destructive weather events. The NWS describes and predicts those processes of the hydrologic cycle, which impact the functioning of the nation's economy and communities. The information produced by the Weather Service takes the form of several different "products". One of the principal functions of the Weather Forecast Office (WFO) and Hydrologic Service Area (HAS) is issuance of river forecasts and flood warnings to the general public, specialized users and disseminating to media such as newspapers, radio and TV stations. The National Weather Service operates three specific programs related to water management. These include the River Forecast Centers and River Districts activities, the Flood and Flash Flood Warning program and the Hydrologic Services activities.	• StormReady Program • Integrated Flood Observing and Warning System • River Forecast Centers • River Districts activities • Flood and Flash Flood Warning program • Hydrologic Services activities.
Federal Mine Safety and Health Administration www.msha.gov	The mission of the Mine Safety and Health Administration (MSHA) is to administer the provisions of the Federal Mine Safety and Health Act of 1977 (Mine Act), as amended by the Mine Improvement and New Emergency Response Act of 2006 (MINER Act), and to enforce compliance with mandatory safety and health standards as a means to eliminate fatal accidents; to reduce the frequency and severity of nonfatal accidents; to minimize health hazards; and to promote improved safety and health conditions in the Nation's mines.	• Coal Mine Safety and Health Program • Metal and Nonmetal Mine Safety and Health Program • Educational Policy and Development • Office Assessments/Technical Support

Agency and Website	Biography	Programs, Funding Levels, Technical Assistance, Etc.
United States Forestry Service www.fs.fed.us	The U.S. Department of Agriculture Forest Service is a Federal agency that manages public lands in national forests and grasslands. The Forest Service is also the largest forestry research organization in the world, and provides technical and financial assistance to state and private forestry agencies. The Forest Serve has five main activities: 1) Protection and management of natural resources on National Forest System lands. 2) Research on all aspects of forestry, rangeland management, and forest resource utilization. 3) Community assistance and cooperation with State and local governments, forest industries, and private landowners to help protect and manage non-Federal forest and associated range and watershed lands to improve conditions in rural areas. 4) Achieving and supporting an effective workforce that reflects the full range of diversity of the American people. 5) International assistance in formulating policy and coordinating U.S. support for the protection and sound management of the world's forest resources.	• Stewardship Contracting • National Partnership Office
United States Army Corps of Engineers www.usace.army.mil	The U. S. Army Corps of Engineers (USACE) is involved with a variety of resource management activities in West Virginia. The State is divided between the three USACE Districts: Pittsburg, Huntington, and Baltimore. Planning activities done by the USACE for the management and development of water and related land resources are undertaken through various congressional authorizations. The USACE is known for its civil works projects for water resources development including flood control, navigation, water supply, environmental restoration, and recreation. These projects, by virtue of their complexity and expense are usually the result of the General investigations program (see below). Flood control measures may include dams, levees, floodwalls, and channel enlargements. Due to the magnitude and expense of these projects, Congress authorizes them through a Water Resources Development Act that is normally enacted every two years. USACE flood control measures, such as dams, floodwalls, channel modifications and non-structural measures require a local or nonfederal financial commitment for planning, design, construction and operations and maintenance of the structures. Nonstructural projects feature flood proofing, floodplain evacuations and flood warning and emergency evacuation systems that are effective in reducing flood damages.	• General Investigations Program • Continuing Authorities Program (CAP) • Planning Assistance to States Program • Technical and Engineering Assistance for Streambank Erosion • Emergency Flood Control Activities Disaster Assistance

Agency and Website	Biography	Programs, Funding Levels, Technical Assistance, Etc.
U.S. Army Corps of Engineers Silver Jackets www.iwr.usace.army.mil/nfrmp/state	The Silver Jackets Program is a program through which the US Army Corps of Engineers (USACE), the Federal Emergency Management Agency (FEMA), and other Federal agencies create an interagency team at the state level to develop and implement solutions to state natural hazard priorities. The Silver Jackets Program provides a formal and consistent strategy for an interagency approach to planning and implementing measures to reduce the risks associated with natural hazards. The program's primary goals are to leverage information and resources, improve public risk communication through a united effort, and create a mechanism to collaboratively solve issues and implement initiatives. To date, the Silver Jackets Program has initiated pilot programs in Ohio, Indiana and California. These teams have succeeded not only in improving communication, but also in leveraging resources and programs between Federal agencies. Since its inception in April of 2005, the Silver Jackets Program has greatly advanced its goal of providing a unified, point source of flood risk and hazard mitigation support. For the future, the Silver Jackets Program proposes continuing with team development on a state by state basis, with the ultimate objective of establishing an interagency team in every state. Each team will include FEMA, USACE, the State National Flood Insurance Program (NFIP) coordinator, and the State Hazard Mitigation Officer as standing members and lead facilitators. The program's desired outcomes are: ● Reduced flood risk ● Agencies better understand and leverage each other's programs ● Collaboration between various agencies, coordinated programs, cohesive solutions ● Multi-agency technical resource for state and local agencies ● Mechanism for establishing relationships to facilitate integrated solutions post-disaster	• National Flood Risk Management Program • National Nonstructural Flood Proof Committee Program • Disaster Assistance - A Guide to Recovery Programs • FEMA Hazard Mitigation Grant Program • National Hazard Mitigation Association • Association of State Floodplain Managers (ASFPM)
USDA – Farm Service Agency www.usda.gov/wps/portal/usda/usdahome	The Farm Service Agency's (FSA) mission is to respond to disasters affecting the agricultural producers of West Virginia by: Completing damage assessment procedures to determine the extent and type of damage along with what programs may be available and/or requested; Implementing farm programs like the Emergency Conservation Program (ECP) that will rehabilitate farmlands and restore farm structures to preexisting conditions; Crop Loss Disaster Assistance Program Payments to help stabilize farm income; Non-Insured Assistance Program (NAP) provides payments for qualified crop losses; Emergency Loans are low interest loans to provide funds needed to maintain the agricultural operations: Develop the programs to cover specific needs in the affected area, and; Assist other agencies as necessary.	• Emergency Conservation Program • Crop Loss Disaster Assistance Program Payments • Non-Insured Assistance Program • Emergency Loans

Agency and Website	Biography	Programs, Funding Levels, Technical Assistance, Etc.
	FSA provides the needed resources to stabilize farm income, protect farmlands and agricultural operations through the various cost share programs.	
USDA – Natural Resources Conservation Service www.nrcs.usda.gov	Under Public Law 83-566 (PL 566), the U.S. Natural Resources Conservation Service (NRCS) has the authority to assist local sponsors who are undertaking activities for the purpose of flood prevention, water conservation, fish and wildlife development, recreation, groundwater recharge, water quality management, and land conservation. The Act provides for technical, financial, and credit assistance by the US Department of Agriculture to local sponsors representing the people living in small watersheds. The NRCS's authority extends to all small watersheds with less than 250,000 acres. That distinction delineates the authorities of the NRCS and USACE. The NRCS has special authority under Public Law 78-534 (PL 534), for the Potomac Headwaters Drainage within West Virginia. Requests for PL 566 and PL 534 assistance are channeled through the West Virginia Conservation Committee, who approve applications for assistance and forward them to NRCS for action. If funding and staff resources are available, NRCS will prepare a watershed plan and if necessary a NEPA compliance document. Once a watershed plan is approved and authorized for operation, the sponsors are eligible for financial and technical assistance from NRCS for installation of the works of improvement. Through PL 566 and PL 534, NRCS can assist local sponsors in planning and implementing flood damage reduction projects. These projects are based on watersheds, rather than political boundaries. NRCS has the authority to plan and implement a full spectrum of flood damage reduction measures including structural (dams, channel improvements, dikes, etc.), nonstructural (flood warning systems, floodplain acquisition, relocation, retrofitting structures, etc.), and more innovative projects such as natural stream restoration. NRCS's authorities are unique in that assistance can also be provided to address land conservation issues on both public and private lands that impact flooding.	• Technical assistance in the form of floodplain management and watershed management studies • Emergency Watershed Protection assistance
U.S. Geological Survey – Water Resources Division http://water.usgs.gov	U.S. Geological Survey (USGS) is the Federal source for science about the Earth, its natural and living resources, natural hazards, and the environment. It stands as the sole science agency for the Department of the Interior. It is sought out by thousands of partners and customers for its natural science expertise and its vast earth and biological data holdings. The USGS is the science provider of choice in accessing the information and understanding to help resolve complex natural resource problems across the Nation and around the world.	• Cooperative Water Program • National Streamflow Information Program • National Water-Quality Assessment Program • Toxic Substances Hydrology (Toxics) Program • Groundwater Resources Program • Hydrologic Research and

Agency and Website	Biography	Programs, Funding Levels, Technical Assistance, Etc.
	In West Virginia, the USGS operates about 100 stream flow-gauging stations that transmit near real-time data via the World Wide Web at http://water.usgs.gov or directly to the National Weather Service for flood forecasting. Additional flood peak information is obtained from a network of 20 small streams equipped with creststage gauges. Stream flow information obtained from these gauging stations is analyzed periodically by the USGS to predict the magnitude and frequency of future floods. This flood information is the basis for FEMA floodplain studies as well as many other flood-related evaluations such as bridge and culvert design. These data provide the basic foundation for hazard mitigation planning. Information on the flow of rivers is a vital national asset that safeguards lives and property and ensures adequate water resources for a healthy economy.	Development • State Water Resources Research Institute Program • Hydrologic Networks and Analysis
State Agencies		
Maryland State Police www.mdsp.org	The Mission of the Maryland State Police is to protect the citizens of the State of Maryland from foreign and domestic security threats, to fight crime, and to promote roadway safety by upholding the laws of the State of Maryland. This will be accomplished through aggressive patrol, investigation, intelligence gathering and interdiction efforts; and by providing leadership and assistance to state and local agencies. We will be the model of a responsive, coordinated, composite statewide police department; independent yet supportive of allied law enforcement agencies. We are committed to the utmost professionalism in delivering all-encompassing police services focused on traffic safety, homeland security, crime reduction and criminal apprehension. We continually strive to develop the skills of our members and to efficiently and effectively manage our resources as we carry out our public responsibilities.	
The University of Maryland System www.umd.edu	The University of Maryland, College Park is a public research university, the flagship campus of the University System of Maryland, and the original 1862 land-grant institution in the State. It is one of only 62 members of the Association of American Universities, an organization composed of the leading research universities in the United States and Canada. The University of Maryland is committed to achieving excellence as the State's primary center of research and graduate education and the institution of choice for undergraduate students of exceptional ability and promise. The University counts among its greatest strengths -- and a major component of its excellence -- the diversity of its faculty, students, and staff. The University of Maryland, College Park is committed to equal educational opportunity and strives to hire a diverse faculty and staff of exceptional achievement through affirmative actions, to celebrate diversity in all of its programs and activities, and to recruit and retain qualified graduate and undergraduate minority students.	

Agency and Website	Biography	Programs, Funding Levels, Technical Assistance, Etc.
Maryland State National Guard www.md.ngb.army.mil	The Maryland Military Department will man, equip, train and deploy its National Guard units and soldiers and airmen in support of Federal missions as directed by the President of the United States. The Department will employ its citizen-soldiers and airmen, emergency management professionals, and its volunteer forces to coordinate and support state response to any major emergency or disaster, to support local governments, to coordinate assistance from the Federal government, and to respond to requests for assistance from other states. The Department will be one of the leading state agencies in caring for Maryland's servicemen and their families. The Department will provide civilian-based professional and technical support to the Maryland Military Department and its subordinate units and agencies.	• PTO Program • Soldier Resources • Soldier Care Form • Recruiting Assistance Program
Private/Community Organizations		
American Red Cross www.redcross.org	The American Red Cross (also known as the American National Red Cross) is a humanitarian organization that provides emergency assistance, disaster relief and education inside the United States. It is the designated U.S. affiliate of the International Federation of Red Cross and Red Crescent Societies. Today, in addition to domestic disaster relief, the American Red Cross offers compassionate services in five other areas: community services that help the needy; support and comfort for military members and their families; the collection, processing and distribution of lifesaving blood and blood products; educational programs that promote health and safety; and international relief and development programs. The American Red Cross is where people mobilize to help their neighbors—across the street, across the country, and across the world—in emergencies. Each year, in communities large and small, victims of some 70,000 disasters turn to neighbors familiar and new—the more than half a million volunteers and 35,000 employees of the Red Cross. Through nearly 700 locally supported chapters, more than 15 million people gain the skills they need to prepare for and respond to emergencies in their homes, communities and world.	• Blood Donation • C43Tissue Services • Plasma Services • Nucleic Acid Testing (NAT) • Leukoreduction • Cellular Therapies • Health and Safety Services • Disaster Services • Disaster Services Human Resources system • National Response Plan • Service to the Armed Forces
County Engineers Association http://countyengineers-md.org	In 1953, forty-one road engineers and public works officials gathered in Frederick, Maryland to form an organization that would raise the technical standards of public service by exchanging ideas and discussing shared problems in county engineering. That organization became known as the County Engineers Association of Maryland (CEAM). Membership now includes almost six hundred County, State, Municipal, and consulting engineers, as well as public works personnel, contractors, and suppliers.	

Agency and Website	Biography	Programs, Funding Levels, Technical Assistance, Etc.
	Today CEAM provides a forum for new ideas and is an advocate for the infrastructure needs of the entire state. It is the collective voice of those who are responsible for the basic services of government and whose jobs affect the health and safety of every citizen. The Association promotes professional education and an adherence to the highest standards of engineering, construction, management, and public policy. It maintains an active presence in the State capital, placing its public trust above all considerations, whether partisan or monetary.	
Maryland Association of Counties www.mdcounties.org	MACo provides a single voice for county government issues-advocating county positions before the Governor, the General Assembly, executive branch officials, and federal decision-makers. Each subdivision has representation on a Legislative Committee that determines MACo positions on legislative issues. The Committee meets weekly during the General Assembly Session to review legislation impacting county government. During the interim, the Committee plans MACo's legislative initiatives for the upcoming Session. The Committee and MACo staff study and track all proposed legislation affecting county government.	
Maryland Association of Floodplain and Stormwater Managers www.mafsm.org	MAFSM was organized in 2004 to: provide educational opportunities and dissemination of general and technical information to individuals concerned with sound floodplain and stormwater management; promote public awareness of sound floodplain and stormwater management and the linkages between them; encourage the exchange of information, ideas, experiences, etc., among the practitioners of floodplain and stormwater management; promote the professional status of floodplain and stormwater managers; Inform and provide technical information relative to legislation pertinent and necessary to the effective implementation of sound floodplain and stormwater management practices; and promote environmentally sound solutions to floodplain and stormwater problems. The Maryland Association of Floodplain and Stormwater Managers (MAFSM) provides educational opportunities and dissemination of general and technical information to individuals involved in furthering sound floodplain and stormwater management decisions. MAFSM promotes the professional status of floodplain and stormwater managers and encourages the exchange of information, ideas, and experiences among the practitioners of floodplain and stormwater management. The Association is organized exclusively for charitable, educational or scientific purposes within the meaning of Section 501 c (3) of the Internal Revenue Code.	
Maryland Association of Soil Conservation Districts	The MASCD promotes practical and effective soil, water, and related	

Agency and Website	Biography	Programs, Funding Levels, Technical Assistance, Etc.
	natural resources programs to all citizens through individual conservation districts on a voluntary basis through leadership, education, cooperation, and local direction. MASCD will be recognized and respected as the leading organization, independent, and capable of providing the best information for natural resource management.	
Maryland Emergency Management Association www.mdema.org	The Maryland Emergency Management Association promotes and supports an all-hazards approach to Emergency Management in the State of Maryland. Originally formed in 1986 as the Maryland Emergency Management and Civil Defense Association the organization was formed to promote and support adequate Emergency Management and Civil Defense in the State of Maryland; coordinate the efforts of all members in a common front to protect the lives and property of all persons within the State against natural or man-made disasters or enemy action; to evaluate and disseminate the common experience and collective judgment of those specialists trained in and responsible for Emergency Management and Civil Defense activities; serve as a clearing house for ideas, suggestions and courses of action between members; and to act in concert with and in a professional advisory capacity to other organizations regarding Emergency Management and Civil Defense. The original officers of the Association included John Schroeder from Prince Georges County as President, Owen Morris, Allegany County as Vice President, and Edward Lent, Prince Georges County, as the Secretary/Treasurer.	
Maryland Food Bank http://mdfoodbank.org	The Maryland Food Bank, an affiliate of Feeding America , was founded in 1979 to coordinate the procurement and distribution of food donations from manufacturers, wholesalers, retailers and government agencies to organizations providing free food to the state's hungry. The Maryland Food Bank operates from two facilities: one in Baltimore, serving all Maryland counties except Montgomery and Prince George's, and one in Salisbury, serving the Eastern Shore. Our Baltimore operation supplies five Regional Distribution Organizations with food. They are the Harford County Community Action Council, Garrett County Community Action Council, Washington and Frederick Counties' Food Resources, Inc., Southern Maryland Food Bank, and Western Maryland Food Bank. Our Mission: To lead the movement and nurture the belief that together we can improve the lives of Marylanders by ending hunger.	• Emergency Food Programs • Nonprofit networks to serve and distribute food

Agency and Website	Biography	Programs, Funding Levels, Technical Assistance, Etc.
Towson University www.towson.edu	Founded in 1866, Towson University is recognized among the nation's best regional public universities, offering more than 100 bachelor's, master's and doctoral degree programs in the liberal arts and sciences, and applied professional fields. With more than 21,000 students, Towson University is the second-largest public university in Maryland. As a metropolitan university, Towson combines research-based learning with practical application. Our many interdisciplinary partnerships with public and private organizations throughout Maryland provide opportunities for research, internships and jobs. Towson University is a founding member of the Coalition of Urban and Metropolitan Universities (CUMU).	
St. Mary's College www.smcm.edu	Since its founding, St. Mary's has been state-sponsored, publicly funded, administered by an independent Board of Trustees, actively non-sectarian, and devoted to providing an affordable liberal arts education. In 1840, the Maryland legislature authorized a lottery to finance the construction of a "female seminary" (girls' boarding school) in St. Mary's City; the school was incorporated by an act of legislation in 1846. In 1927, St. Mary's became Maryland's first junior college, and a 1964 name change to St. Mary's College of Maryland reflected the school's evolution into a four-year baccalaureate college. The state General Assembly designated the school Maryland's public honors college in 1992; the state also granted the College an institutional status designed to assure stable public funding.	

Appendix E – Capability Assessment

2011 Maryland State Capability Assessment

Executive Summary

This section outlines the many programs that Maryland state agencies have available to support mitigation activities, through funding or technical assistance. The process of identifying and updating these capabilities involved identifying the 2008 list of programs and updating their status through internet searches, phone calls, emails, and interviews. Additionally, the tables below include new programs that are applicable to mitigation that have been implemented during the last planning cycle.

The responsibility of identifying the capabilities of the state, within the context of hazard mitigation planning, as described under *44 C.F.R. § 201.2,* lies with the SHMO. Within the state of Maryland, this position falls under the oversight of the MEMA, created by Executive Order 01.01.1991.02. As such, the SHMO, along with other hazard mitigation planners, were the primary parties responsible for this update. Input during all stages of the update process came from members of the MAC and FEMA Region III. Final review came from the Governor's Office. For a complete discussion of the planning process, please refer to Chapter 2.

Implementation of the 2011 Maryland State Hazard Mitigation Plan Update

Implementation of this plan update could only have resulted from the continued efforts of the more than one hundred Stakeholders that supported the plan update process. For specific agency responsibilities, please refer to Chapter 2. For lists of contributors at all of the meetings, please refer to Appendix F.

The current economic environment has created great barriers to Maryland's mitigation capabilities. It has forced state programs to do more with less. As such, programs have been cut and funding is continually being reallocated. Despite this, however, the personnel staffing state agencies have continued to make great strides to prevent disasters from occurring, and to reduce the potential for catastrophic outcomes of disasters. In the end, funding is always the greatest challenge to implementation of worthwhile programs.

Challenges to planning have come in the form of identifying the responsible parties that have the ability to take the lead on a variety of mitigation actions. The HIRA and Mitigation Actions Meeting conducted on June 15, 2011 provided a great opportunity for many people from a variety of organizations and with diverse expertise to come together to discuss what hazards Maryland faces, and explore actions to mitigate those dangers. Many of the individuals that attended spoke about programs that their agency implements. Discussion included the opportunities for expansion of those programs to incorporate them appropriately into this update.

Floodplain Management in Maryland

Maryland has a number of programs designed to address floodplain management. The Maryland Department of Environment manages the Flood Mitigation Program, which is composed of seven other related programs. The Flood Mitigation Program works with Maryland's communities to reduce flooding risks and the potential for those floods to be affected by flooding. The seven programs include:

- Flood & Flood Relief Assistance;
- Comprehensive Flood Management Grant Program;
- Floodplain Management GIS Summary;
- Cooperating Technical Partner;
- Community Regulations for Floodplain Development;
- Flood Mitigation Task Force for Western Maryland;, and
- Floodplain Permitting.

These programs incorporate aspects of regional mapping, floodplain ordinance updates, working with FEMA on outreach and education, as well as the National Flood Insurance Program.

Additionally, MEMA works with the Maryland Department of Housing and Community Development to incorporate aspects of flood mitigation strategies into the statewide building code, known as the Maryland Building Performance Standards (MBPS). While construction that has already occurred within a floodplain cannot be mandatorily altered, new ordinances may be put in place which requires new construction to incorporate building standards that will prevent damage in the future. In certain instances, the state may purchase properties that have been determined to be "repetitive loss" or "severe repetitive loss" properties. Such properties may be purchased by the state, turned into open space, never to be built on again. Many of such programs are directly sourced by FEMA and oversight comes from the same.

Potential Funding Sources

Since the 2008 update to the plan, many of the same programs have remained in place. Such programs, as described above, are continuous and ongoing, however many of them are reliant upon funds provided through the Hazard Mitigation Grant Program, which, due to budget cuts has received considerable cut backs. As such, these programs may still be in existence *de jure*, but not *de facto*. FEMA is a significant contributor and oversees many of these projects, but many of the programs require a 25% or even 50% match by local or state government while still providing direct facilitation. This presents significant challenges in the current economy.

Traditional Funding Programs

FEMA Grant Programs

The following section describes FEMA's five hazard mitigation grant programs, known collectively as the Hazard Mitigation Assistance (HMA) programs.

As stated in the *FEMA Hazard Mitigation Assistance Unified Guidance (June 1, 2010), the Hazard Mitigation Grant Program (HMGP) may provide funds to States, Territories, Indian Tribal governments, local governments, and eligible private non-profits (PNPs) following a Presidential major disaster declaration. Further, HMGP is authorized by Section 404 of the Robert T. Stafford Disaster Relief and Emergency Assistance Act, as amended (the Stafford Act), Title 42, United States Code (U.S.C.) 5170c. The key purpose of HMGP is to ensure that the opportunity to take critical mitigation measures to reduce the risk of loss of life and property from future disasters is not lost during the reconstruction process following a disaster. HMGP is available, when authorized under a Presidential major disaster declaration, in the areas of the State requested by the Governor. The amount of HMGP funding available to the Applicant is based upon the estimated total Federal assistance to be provided by FEMA for disaster recovery under the Presidential major disaster declaration.*

Non-Disaster Unified Hazard Mitigation Assistance Programs

The Pre-Disaster Mitigation (PDM), Flood Mitigation Assistance (FMA), Repetitive Flood Claims (RFC), and Severe Repetitive Loss Pilot (SRL) programs may provide funds annually to States, Territories, Indian Tribal governments, and local governments.

Flood Mitigation Assistance (FMA) Program

As stated in the *FEMA Hazard Mitigation Assistance Unified Guidance (June 1, 2010), the FMA program is authorized by Section 1366 of the National Flood Insurance Act of 1968, as amended (NFIA), 42 U.S.C. 4104c, with the goal of reducing or eliminating claims under the National Flood Insurance Program (NFIP).*

Repetitive Flood Claims (RFC) Program

As stated in the *FEMA Hazard Mitigation Assistance Unified Guidance (June 1, 2010), the RFC program is authorized by Section 1323 of the NFIA, 42 U.S.C. 4030 with the goal of reducing flood damages to individual properties for which one or more claim payments for losses have been made under flood insurance coverage and that will result in the greatest savings to the National Flood Insurance Fund (NFIF) in the shortest period of time.*

Severe Repetitive Loss (SRL) Program

As stated in the *FEMA Hazard Mitigation Assistance Unified Guidance (June 1, 2010), the SRL program is authorized by Section 1361A of the NFIA, 42 U.S.C. 4102a, with the goal of reducing flood damages to residential properties that have experienced severe repetitive losses under flood*

insurance coverage and that will result in the greatest savings to the NFIF in the shortest period of time.

Pre-disaster Mitigation (PDM) Program

As stated in the *FEMA Hazard Mitigation Assistance Unified Guidance (June 1, 2009)*, the PDM program is authorized by Section 203 of the Stafford Act, 42 U.S.C. 5133 *the PDM program is designed to assist States, Territories, Indian Tribal governments, and local communities to implement a sustained pre-disaster natural hazard mitigation program to reduce overall risk to the population and structures from future hazard events, while also reducing reliance on Federal funding from future disasters.*

The table below, from FEMA's HMA program guidance, provides a summary of hazard mitigation activities eligible for funding through these programs.

FEMA Grant Program Eligible Activities	HMGP	PDM	FMA	RFC	SRL
1. Mitigation Projects	√	√	√	√	√
Property Acquisition and Structure Demolition	√	√	√	√	√
Property Acquisition and Structure Relocation	√	√	√	√	√
Structure Elevation	√	√	√	√	√
Mitigation Reconstruction					√
Dry Flood proofing of Historic Residential Structures	√	√	√	√	√
Dry Flood proofing of Non-residential Structures	√	√	√	√	
Minor Localized Flood Reduction Projects	√	√	√	√	√
Structural Retrofitting of Existing Buildings	√	√			
Non-structural Retrofitting of Existing Buildings and Facilities	√	√			
Safe Room Construction	√	√			
Infrastructure Retrofit	√	√			
Soil Stabilization	√	√			
Wildfire Mitigation	√	√			
Post-Disaster Code Enforcement	√				
5% Initiative Projects	√				
2. Hazard Mitigation Planning	√	√	√		
Source: FEMA Hazard Mitigation Assistance Unified Guidance (June 1, 2010)					

Pre-disaster Mitigation Programs

Pre-Disaster Mitigation Programs Capabilities Assessment					
Agency	**Programs, Plans, Policies, Regulations, Funding and Practices**	**Effect on Loss Reduction**		**Funding**	**Description**
		Support	**Facilitate**		
US Army Corps of Engineers	Flood Control Projects	√		√	Design and construction of local flood control projects not specifically authorized by Congress. State, political subdivisions and other local agencies established within state law with full authority and ability to undertake required legal and financial responsibilities.
	Riverbank Protection	√	√	√	Design & construction of stream and river bank protection projects to safeguard highways, highway bridges, essential public works, churches, hospitals, schools and other non-profit public critical facilities endangered by flood-caused erosion. State, political subdivisions and other local agencies established within state law with full authority and ability to undertake required legal and financial responsibilities.
	Flood Control Clearing	√	√	√	Design and construction of snagging and clearing projects for navigable waters and their tributaries to reduce potential flood damage State, political subdivisions and other local agencies established within state law with full authority and ability to undertake required legal and financial responsibilities.
	Floodplain Management	√	√		Technical assistance in identification of flood-prone areas, potential losses and the flood hazard of proposed building sites; guidance in land use management to prevent flood damage. Funding limitations set by District Office. State, political subdivisions and other public organizations.
U.S. Department of Agriculture	Watershed Protection Loans	√	√	√	Loans to assist local sponsors provide the local share of the cost of watershed improvements for flood prevention, irrigation, drainage, water quality management, sediment control, fish and wildlife management, public water supplies and water storage. Sponsoring local organizations such as soil and water conservation districts with authority under state law to obtain give security for and raise revenues to repay loans.

Pre-Disaster Mitigation Programs Capabilities Assessment					
Agency	**Programs, Plans, Policies, Regulations, Funding and Practices**	**Effect on Loss Reduction**		**Funding**	**Description**
		Support	**Facilitate**		
	Emergency Watershed Protection	√	√		Technical services to determine eligibility and to plan needed measures. Financial assistance to construct approved measures. Any state agency, county (or group of counties), municipality, town, soil and water conservation district, flood prevention or control district or any other non-profit agency with authority under state law to carry out, maintain and operate watershed improvement works.
	Resource Conservation & Development	√	√	√	Grants and technical assistance to aid public agencies in implementing long-range resource conservation and development programs, including flood control projects. Public agencies and non-profit organizations having legal authority to plan, install, operate and maintain community projects benefiting the public.
	Forest Land Flood Prevention	√	√		Technical assistance in planning and application of measures to protect public health and safety, reduce flood hazards and control sedimentation from forest and related lands when existing local, state and federal programs do not provide adequate facilities and funds for immediate protective action. Also provides assistance in preparing requests for Section 216 funds for emergency treatment of watersheds impaired by fire, flood, earthquake or other natural disasters. State and local governments
US Department of the Interior National Park Service	Rivers, Trails and Conservation Assistance Program				The mission of the Rivers, Trails and Conservation Assistance program (RTCA) is to assist community-led natural resource conservation and outdoor recreation initiatives. RTCA staff provide guidance to communities so they can conserve waterways, preserve open space, and develop trails and greenways.

Pre-Disaster Mitigation Programs Capabilities Assessment					
Agency	**Programs, Plans, Policies, Regulations, Funding and Practices**	**Effect on Loss Reduction**		**Funding**	**Description**
		Support	**Facilitate**		
FEMA	National Flood Insurance Program (NFIP)	√	√	√	In April 2004, the Maryland Department of the Environment signed a Cooperating Technical Partner (CTP) agreement with FEMA to create new floodplain maps for numerous Maryland jurisdictions. These new maps, called Digital Flood Insurance Rate Maps, or D-FIRMS, will replace the current Flood Insurance Rate Map panels. Users, including floodplain management and other planners, insurance agents, and homeowners, will be able to access these new digital maps via the Internet or print them out in a standard paper format. This new format will make use of new rainfall, topology, land use, and digital data as well as updated MDE bridges and roadways data. The original project duration was 2004-2008, and a total of 17 Maryland counties were included in this Wetlands and Waterways led project. MDE generated engineering models and Geographic Information System (GIS) data layers are the tools used to create the updated digital floodplain maps. Aside from the 17 counties that participated in this project, a number of other local governments such as Montgomery, Prince George's, Frederick, and Baltimore County and City were already working with FEMA's Map Modernization Program. Digital maps have already been completed for Harford and St. Mary's counties. As of February 2008, the hydraulic data that is required for the preparation of new digital floodplain maps has been created for the counties of Wicomico, Dorchester, Howard, and Somerset. MDE, having forwarded this data to FEMA for approval, anticipates that a final review will take place prior to the end of 2008. Updated and FEMA approved maps for the four counties should be available online by the end of this year. Field data collection and the modeling of waterways in Anne Arundel, Calvert, Cecil, and Talbot Counties continue. The map modernization process will also continue in 2008 and 2009 for the remaining jurisdictions. Map 3.1 Status of DFIRM Mapping in Maryland shows the status of the map modernization program in each Maryland jurisdiction.

Pre-Disaster Mitigation Programs Capabilities Assessment					
Agency	**Programs, Plans, Policies, Regulations, Funding and Practices**	**Effect on Loss Reduction**		**Funding**	**Description**
		Support	**Facilitate**		
	Flood Mitigation Assistance (FMA) Pre-Disaster Mitigation (PDM) Repetitive Flood Claims (RFC) Severe Repetitive Loss (SRL)	√	√	√	FMA, PDM, RFC and SRL may be used to enhance State mitigation planning (FMA, PDM), and implement structural flood mitigation programs to directly assist communities to reduce flood losses (FMA, PDM, RFC, SRL). State or communities can receive financial and technical support for flood mitigation planning and implementation of flood mitigation projects. FMA, RFC and SRL must be used for repetitive loss properties that are covered through the NFIP. In 2007, MDE began updating a GIS database by collecting the location of the repetitive loss structures using a Global Positioning System (GPS), vertical elevations in relation to the 100-year base flood elevation, digital photographs, and other information pertinent to the flood history of the structure.
	Community Assistance Program – State Support Services Element (CAP-SSSE)	√	√	√	Identify, prevent, resolve floodplain management issues and reduce flood hazards Communities participating in the National Flood Insurance Program are supported by the state NFIP coordinator's office. The Community Assistance Program (CAP) provides funding to States to provide technical assistance to communities in the National Flood Insurance Program (NFIP) and to evaluate community performance in implementing NFIP floodplain management activities. The CAP is intended to identify, prevent, and resolve floodplain management issues in participating communities before they develop into problems requiring enforcement action. The CAP program is administered by MEMA, and federal funds are passed through to MDE. This allows greater coordination between the agencies, particularly in the areas of work program and business plan development.
NOAA	National Ocean Service (NOS)				NOS works closely with many partner agencies to ensure that Ocean and Coastal and areas are safe, healthy, and productive. National Ocean Service scientists, natural resource managers, and specialists ensure safe and efficient marine transportation, promote innovative solutions to protect coastal communities, and conserve marine and coastal places.

Pre-Disaster Mitigation Programs Capabilities Assessment					
Agency	**Programs, Plans, Policies, Regulations, Funding and Practices**	**Effect on Loss Reduction**		**Funding**	**Description**
		Support	**Facilitate**		
	National Geodetic Service				Height Modernization with the goal of placing GPS base stations at various locations to measure topographic changes in the directions of latitude and longitude caused by subsidence or earthquakes, as well as to measure changes in height (elevation). Hydrography, measuring depths, the tides and currents of a body of water and establishment of the sea, river or lake bed topography and morphology. Hydrographical measurements will include the tidal, current and wave information of physical oceanography. Coastal geography, the study of the dynamic interface between the ocean and the land, incorporating both the physical geography (i.e coastal geomorphology, geology and oceanography) and the human geography (sociology and history) of the coast. It involves an understanding of coastal weathering processes, particularly wave action, sediment movement and weather, and also the ways in which humans interact with the coast. Coastal geography is that branch of geography, incorporating physical and human geography, which deals with the study of the dynamic interface between ocean and land.
	Marine Fisheries Service				NOAA's Marine Fisheries Service is designed to restore and enhance habitats that support valuable fisheries and protected resources, improve the quality of our water, provide recreational opportunities for the public's use and enjoyment and buffer our coastal communities from the impacts of storms and sea level rise.
	Center for Operational Oceanographic Products and Services (CO-OPS)				NOAA's Center for Operational Oceanographic Products and Services (CO-OPS) provides the national infrastructure, science, and technical expertise to monitor, assess, and distribute tide, current, water level, and other coastal oceanographic products and services that support NOAA's mission of environmental stewardship and environmental assessment and prediction. CO-OPS provides operationally sound observations and monitoring capabilities coupled with operational Nowcast Forecast modeling.
	Office of Coast Survey				NOAA's Office of Coast Survey ensures safe, efficient and environmentally sound marine transportation that brings an uninterrupted flow of people and goods into and out of our nation's ports.

Pre-Disaster Mitigation Programs Capabilities Assessment					
Agency	**Programs, Plans, Policies, Regulations, Funding and Practices**	**Effect on Loss Reduction**		**Funding**	**Description**
		Support	**Facilitate**		
	NOAA Coastal Services Center Grants Program				NOAA's Office of Ocean and Coastal Resource Management (OCRM) provides national leadership to state and territory coastal programs and estuarine research reserves to keep America's coasts healthy and resilient. OCRM activities are mandated by the Coastal Zone Management Act, MPA Executive Order, and Coral Reef Conservation Act. NOAA's Office of Response and Restoration (OR&R) protects coastal and marine resources, mitigates threats, reduces harm, and restores ecological function. The Office provides comprehensive solutions to environmental hazards caused by oil, chemicals, and marine debris. OR&R also assists local communities to revitalize waterfronts through environmental remediation and restoration. NOAA's National Weather Service (NWS) is tasked with providing "weather, hydrologic, and climate forecasts and warnings for the United States, its territories, adjacent waters and ocean areas, for the protection of life and property and the enhancement of the national economy." This is done through a collection of national and regional centers, and 122 local weather forecast offices (WFOs). Maryland is supported by four local weather offices. These offices and national centers provide public forecasts and warnings of hazardous weather phenomena and floods, and training programs on disaster safety guidelines. The NWS also provides educational materials for preventing injury that are readily available at the various NOAA websites providing information on impending hazardous weather conditions, including expected intensity. This information is also conveyed via various public and social media communication tools. NOAA's National Tsunami Hazard Mitigation Program (NTHMP), part of the NWS was established to create a coordinated national effort to assess tsunami threat, prepare community response, issue timely and effective warnings, and mitigate damage. Federal, state, and local government agencies are all involved in efforts to reduce the potential impacts of tsunamis through education, hazard assessment, mitigation planning, and other activities. NOAA's National Weather service operates a tsunami preparedness recognition program known as TsunamiReady that encourages communities to educate citizens on tsunami hazards, develop tsunami hazard plans, and establish local warning systems, among other things. In addition, NOAA provides leadership and funding for the National Tsunami Hazard Mitigation Program (NTHMP).

Pre-Disaster Mitigation Programs Capabilities Assessment					
Agency	**Programs, Plans, Policies, Regulations, Funding and Practices**	**Effect on Loss Reduction**		**Funding**	**Description**
		Support	**Facilitate**		
	Environmental Literacy Grants Program				Since 2005, NOAA's Office of Education has promoted the improvement of public environmental literacy through our Environmental Literacy Grants (ELG) program. These grants represent a significant portion of the Office of Education's efforts to support the agency's cross-cutting priority for increasing environmental literacy, stewardship, and informed decision-making among our nation's citizenry. Environmental Literacy Grants K-12 Education Funding Program NOAA Bay-Watershed Education and Training Grants Program
MEMA	Governor's Flood Mitigation Task Force				MEMA coordinated the activities of the Governor's Flood Mitigation Task Force for Western Maryland. This task force was established following two federally declared disasters in 1996 that caused severe flooding in Allegany, Frederick, Garrett, and Washington counties. The task force has overseen more than $60.5 million in mitigation and recovery projects, including over 300 acquisitions of residential properties. Though its final report to the governor was submitted in January, 1997, The Task Force continued to work on long term solutions to prevent or minimize flood disasters in western Maryland. The Task Force last met on November 18, 2002.
Maryland Department of Planning	The Allegany County Municipal Flood Mitigation and Revitalization Assistance Project				In 1999, Allegany County developed a Flood Mitigation Plan that recommended the acquisition of homes in flood prone areas, flood proofing homes in flood prone areas, and revisions to existing land use and floodplain management regulations. A hazard risk analysis was conducted and policies for mitigation of flood damage through stream basin planning were developed. Funding for the project was provided by the Appalachian Regional Commission, through a grant administered by the Maryland Department of Planning.
	The Patuxent River Commission				The Patuxent River Commission, created in 1980, is responsible for reviewing the operation of State and local agencies with regard to their impact on the Patuxent River and its watershed.
	Watershed Planning				The MDP provides planning support to local governments involved in integrated growth management, protection of resource lands, and watershed protection. Projects have been undertaken in Winter's Run in Harford County and the Patuxent River Watershed which encompasses parts of Anne Arundel, Calvert, Charles, Howard, Montgomery, Prince George's, and St. Mary's Counties.

Pre-Disaster Mitigation Programs Capabilities Assessment					
Agency	**Programs, Plans, Policies, Regulations, Funding and Practices**	**Effect on Loss Reduction**		**Funding**	**Description**
		Support	**Facilitate**		
Maryland Department of Natural Resources	Maryland's Coastal Program				The Maryland Coastal Program, which is funded by the Coastal Zone Management Act of 1972, is administered by the National Oceanic and Atmospheric Administration's (NOAA) Office of Ocean and Coastal Resource Management. In 1978, numerous state laws and policies were created to protect Maryland's coastal and marine resources while allowing for development. Together, they form Maryland's Coastal Program. The area covered by these laws adds up to roughly two-thirds of the state's land area and are comprised of approximately 68% of the State's residents. The program encourages partnerships while making available both funding and technical assistance to local governments, state agencies, educational institutions, and non-profits. The DNR, as the lead agency for this program, addresses non-point source pollution reduction, coastal hazards mitigation, habitat and living resources protection, and erosion.
	The Shore Erosion Control Program				The Shore Erosion Control Program contributes technical as well as financial assistance to Maryland property owners by resolving shoreline and stream bank erosion problems along the Chesapeake Bay and its tributaries. Over the past four decades, this program has assisted numerous property owners by completing more then 800 structural projects and 350 non-structural projects. Out of approximately 4,360 miles of tidal shoreline that exist throughout the Maryland portion of the Chesapeake Bay watershed, 1,341 miles (approximately 31%) are eroding at various yearly rates (the State is thus losing roughly 580 acres of land yearly). Additionally, 14,063 miles of fresh water streams are affected.

Pre-Disaster Mitigation Programs Capabilities Assessment					
Agency	**Programs, Plans, Policies, Regulations, Funding and Practices**	**Effect on Loss Reduction**		**Funding**	**Description**
		Support	**Facilitate**		
	Coastal Communities Initiative				The Coastal Communities Initiative is a funding resource that provides technical support to project applicants in coastal communities that are undergoing development pressures or are interested in economic growth while working to preserve sustainable natural environments. The goals of this program are: 1. Measurable improvements to local institutional, legal, and policy mechanisms that will balance growth, development, and economic changes with natural resources protection and coastal management concerns. 2. Measurable improvements in the knowledge of local land use decision makers, elected officials, developers, engineers, etc., about the links between land use and natural resources protection. Eligible projects include the modification of regulations to require low impact development, the creation of shoreline management plans, and the updating of ordinances, codes, and plans to address coastal and environmental issues. Community visioning, assistance with GIS mapping, mentoring, and facilitation support services are among the types of assistance that applicants can receive from DNR's Watershed Services Center and partners (Maryland Sea Grant, Chesapeake Bay Network for Education of Municipal Officials). Under this grant, applicants should expect to provide a dollar for dollar match (in-kind services are accepted). The project award maximum is $75,000.
	Engineering and Construction				The Engineering and Construction Unit of the Department of Natural Resources is responsible for recreational facility and waterway improvements, State facility and waterway design, engineering and construction management, and the maintenance of existing land and water based facilities.

Pre-Disaster Mitigation Programs Capabilities Assessment					
Agency	Programs, Plans, Policies, Regulations, Funding and Practices	Effect on Loss Reduction		Funding	Description
		Support	Facilitate		
	The Chesapeake Bay Critical Area Commission				The Chesapeake Bay Critical Area Commission protects nontidal wetlands and other resources that affect the health of the Chesapeake Bay. Nontidal wetlands are transitional areas between uplands and tidal zones that are covered with, or saturated by water for all or part of the year. Examples of nontidal wetlands are marshes, swamps, bogs, and streams that are not influenced by tidal waters. Nontidal wetlands provide important flood control benefits, are valuable areas for fish and wildlife habitat, and help to maintain water quality. The Chesapeake Bay Critical Area Protection Program created a 100-foot, naturally vegetated, forested buffer landward from the Mean High Water Line of tidal waters or from the edge of tidal wetlands and tributary streams. Acting as a water quality filter, this buffer is successful at reducing the impact of humans on habitats. To ensure better water quality and to protect wildlife habitats, all lands within 1,000 feet of tidal waters or adjacent tidal wetlands are designated as “Critical Areas.” The minimum standards established by the State and adopted by the local jurisdictions for the conservation of nontidal wetlands in the Critical Area include: (a) the establishment and maintenance of a vegetated buffer of 25 feet around areas identified as nontidal wetlands; (b) new development must not substantially damage or change the character of nontidal wetlands; (c) only new development that is intrinsically water-dependent, or of substantial economic benefit to the public, is allowed to disturb nontidal wetlands. In the event of such development, measures must be taken to replace lost nontidal wetlands and to provide for water quality benefits and habitat protection equal to or greater than that provided by the original wetlands.
	Maryland’s Green Infrastructure Network				The State of Maryland has enacted several land conservation programs, a variety of agricultural preservation efforts and private conservation easement agreements and regulations that help preserve wetlands and shorelines. These initiatives have addressed specific needs related to wetlands, endangered species, recreation, and farmland. The Maryland Green Infrastructure program builds upon these existing conservation programs by identifying, conserving, and connecting large contiguous areas of natural land and providing a focal point to coordinate existing conservation programs. As a result of the Program, the need for storm water management and flood control projects has been reduced statewide as flood prone properties, water resources, and wetlands have been acquired and protected.

Pre-Disaster Mitigation Programs Capabilities Assessment					
Agency	**Programs, Plans, Policies, Regulations, Funding and Practices**	**Effect on Loss Reduction**		**Funding**	**Description**
		Support	**Facilitate**		
	Maryland GreenPrint Program				In 2001, the State of Maryland established the GreenPrint program, which earmarked funds specifically to protect land through Maryland's land acquisition programs, including the Green Infrastructure Network, Rural Legacy Program, and Project Open Space. Through this program, the State has been able to acquire ecologically sensitive or hazard prone lands including forests, wetlands, and floodplains.
	Mid-Atlantic Interstate Forest Fire Protection Compact				The Mid-Atlantic Interstate Forest Fire Protection Compact (MAIFFPC) includes the states of Pennsylvania, Delaware, New Jersey, Maryland, Virginia, West Virginia, and Ohio. The purpose of the MAIFFPC is to promote effective prevention and control of wildfires in the Mid-Atlantic region by developing and integrating forest fire plans, developing and maintaining effective wildfire suppression programs in each of the member states, providing mutual aid for fire suppression, and training efforts. The MAIFFPC also acts as a liaison between various fire control agencies by facilitating the mobilization of fire fighting resources during periods of national emergencies. Member states of the MAIFFPC are responsible for protecting over 35,000,000 acres of woodlands in the Mid-Atlantic States.
	Open Burning Regulations				The DNR Maryland Forest Service enforces open air burning regulations within the State. These regulations apply to those activities occurring within 200 feet of woodland, or those activities adjacent to flammable materials that could ignite and carry fire to woodland. Under these regulations, a person may not engage in open air burning unless there is a natural or constructed fire break that is free of flammable material of at least 10 feet completely around the material to be burned, adequate personnel and equipment are present to prevent the fire from escaping, at least one responsible person remains at the location of the fire until the last spark is out, and burning occurs during the hours of 4:00 pm and 12:00 midnight.
	Program Open Space				Through Program Open Space, DNR aids in the return of developed floodplain properties to open space. Program Open Space provides funding to local government to purchase properties in floodplains and other critical areas. Through this program, the State's long term commitment to hazard mitigation and the conservation of natural resources are emphasized. Today in Maryland there are more than 4,000 individual county and municipal parks and conservation areas that exist because of Program Open Space.

Pre-Disaster Mitigation Programs Capabilities Assessment					
Agency	**Programs, Plans, Policies, Regulations, Funding and Practices**	**Effect on Loss Reduction**		**Funding**	**Description**
		Support	**Facilitate**		
	Smokey Bear's VIPs (Volunteers in Prevention)				Volunteers are recruited to provide forest fire prevention education and outreach to designated counties in the State. These volunteers act as representatives of the Maryland DNR Forest Service and they are responsible for communicating a forest fire prevention message to the public. They are required to complete a two hour training course given by the Maryland DNR Forest Service prior to participation in the program.
Maryland Department of the Environment	Comprehensive Flood Management Grant Program (CFMGP)				The Comprehensive Flood Management Grant Program (CFMGP), established in 1976, promotes the development of local flood management plans, funds watershed studies, and supports capital projects for flood control and watershed management. This program also provides for grants for the acquisition of flood damaged owner-occupied dwellings. Elevations and home relocations are also eligible for funding and acquired land is converted to open space in perpetuity. Since its inception in 1976, the program has received nearly $32 million in appropriations in general obligation bonds and pay-as-you-go funds. Over 400 properties have been removed from harms way. The CFMGP Program has traditionally provided the State match for FMAP and HMGP projects. Unfortunately no additional state funds have been allocated to the CFMGP since 2004. MEMA hazard mitigation staff will continue to work with MDE to secure funding for this important program in the future.
	Nontidal Wetlands Protection Act and Program				The Nontidal Wetlands Protection Act and Program was created by the MDE, DNR, the US Army Corps of Engineers, and the Maryland Historical Trust. The act regulates nontidal wetlands and state-wide waterways, works to ascertain that harmful activities are discontinued, and that mitigation in the form of compensation takes place to ensure that "no net loss" occurs in wetlands. The Act also allows for the development of watershed management plans that may become the basis for regulatory decisions (a number of plans have already been developed and adopted).

Pre-Disaster Mitigation Programs Capabilities Assessment					
Agency	**Programs, Plans, Policies, Regulations, Funding and Practices**	**Effect on Loss Reduction**		**Funding**	**Description**
		Support	**Facilitate**		
	Wetlands and Waterways Program				Staff of the MDE Wetlands and Waterways Program administers the regulatory and planning functions of the program that address the protection, conservation and management of the State's tidal and nontidal wetlands, waterways, and floodplains. Two major Maryland Wetlands and Waterways projects that focus on the prioritization of areas for restoration, preservation, and mitigation include one that is statewide and one that focuses only on the coastal bays watersheds (Worcester County). Both projects compiled historical and background data on the affected areas and concluded with a prioritization of sites and project ideas. Refer to the Maryland Department of the Environment for more details.
	Dam Safety Program				The Maryland Dam Safety Division is responsible for issuing waterway construction permits for new dams and ponds and permitting alterations to existing impoundment structures. The program is intended to protect public safety by ensuring that dams are properly built, maintained and operated. The Division also conducts construction inspections and works closely with dam owners and emergency management professionals to develop and exercise Emergency Action Plans to be used in the event of a dam failure.
	Stormwater Management Program				Maryland stormwater management efforts are respected throughout the nation. The Environment Article Title 4, Subtitle 2, Annotated Code of Maryland provides the state with the authority to manage stormwater runoff. In October of 2007 the "Stormwater Management Act" came into effect under the direction of the Maryland Department of the Environment. To meet the objectives of this act, MDE has already commenced addressing required revisions to the regulations. MDE has also started to update the 2000 Maryland Stormwater Design Manual as well as other guidance documents which together bring about improvements in water quality. During the past few decades, the Environmental Protection Agency (EPA) and the National Pollutant Discharge Elimination System (NPDES) program managed the regulation of municipal storm drainage systems. Together, NPDES designated local jurisdictions and the State are responsible for addressing the Clean Water Act plan implementation requirements. The State's storm water program is critical to assuring that successful growth related activities support the goals of the Clean Water Act while contributing to the restoration of the Chesapeake Bay.

Pre-Disaster Mitigation Programs Capabilities Assessment					
Agency	**Programs, Plans, Policies, Regulations, Funding and Practices**	**Effect on Loss Reduction**		**Funding**	**Description**
		Support	**Facilitate**		
Maryland Department of Housing and Community Development	Grant and Loan Program				Grant and loan programs administered by DHCD require flood insurance for any existing project located within a floodplain. In order for a building permit to be issued for new construction financed by DHCD, the project must be located outside of a designated 100-year floodplain, or the lowest occupied floor elevation must have a minimum of 12 inches of freeboard.
	Building Code Enforcement				Through continued training and educational seminars, DHCD continues to improve and enhance code enforcement practices and procedures. These activities enable building officials and others to learn from past experiences and stay up to date on current mitigation techniques while providing opportunities for partnerships with interests from private industry, including builders, suppliers, insurance representatives, and lenders.
Maryland Department of Transportation	Maryland Port Administration Hurricane Preparedness Plan				The Maryland Port Administration (MPA) hurricane preparedness plan identifies preparation procedures for a hurricane event. The plan seeks to minimize potential deaths, injuries, and property damage associated with hurricanes and tropical storms at MPA facilities. The plan also establishes policies for the restoration of MPA facilities to normal operations as soon as possible after a hurricane event.
	Sinkhole Mapping Program				The Maryland State Highway Administration (SHA) has commissioned the Maryland Geological Survey to prepare geologic maps for use as a predictive tool for sinkhole development. Mapping activities to identify locations where sinkholes might develop began in Frederick County in early 2000. The resulting maps and susceptibility index, a measure of the relative sinkhole susceptibility for each unit of area, will be used by the SHA, land use planners, and developers for assessing the likelihood of sinkhole development within the mapped areas. This information will allow the SHA to avoid building roads in areas known to be prone to sinkholes, which will help to prevent development in these areas. Once mapping of the Frederick Valley in Frederick County has been completed mapping of the Hagerstown Valley in Washington County will begin.
Natural Resources Conservation Services of Maryland	Voluntary Conservation and Stewardship Programs				A USDA program, NRCS puts nearly 70 years of experience to work in assisting owners of America's private land with conserving their soil, water, and other natural resources. Local, state and federal agencies and policymakers also rely on our expertise. We deliver technical assistance based on sound science and suited to a customer's specific needs. Cost shares and financial incentives are available in some cases. Most work is done with local partners. Our partnership with local conservation districts serves every county in Maryland and the District of Columbia. Participation in our programs is voluntary.

Pre-Disaster Mitigation Programs Capabilities Assessment					
Agency	Programs, Plans, Policies, Regulations, Funding and Practices	Effect on Loss Reduction		Funding	Description
		Support	Facilitate		
Maryland Association of Soil Conservation Districts	Soil Conservation				The MASCD promotes practical and effective soil, water, and related natural resources programs to all citizens through individual conservation districts on a voluntary basis through leadership, education, cooperation, and local direction. MASCD will be recognized and respected as the leading organization, independent, and capable of providing the best information for natural resource management.

Disaster Response, Recovery and Community Preparedness

Disaster Mitigation Programs Capabilities Assessment					
Agency	Programs, Plans, Policies, Regulations, Funding and Practices	Effect on Loss Reduction		Funding	Description
		Support	Facilitate		
FEMA	National Dam Safety Program (NDSP)	√	√	√	Grants to reduce the risks to life and property from dam failure, through the establishment and maintenance of an effective dam safety program. States with new and existing impoundment structures.
	Homeland Security Grant Program	√	√	√	The State Homeland Security Program (SHSP) enhances capabilities through planning, equipment, and training and exercise activities. The Citizen Corps Program engages citizens in personal preparedness, exercises, ongoing volunteer programs, and surge capacity response.

Disaster Mitigation Programs Capabilities Assessment					
Agency	**Programs, Plans, Policies, Regulations, Funding and Practices**	**Effect on Loss Reduction**		**Funding**	**Description**
		Support	**Facilitate**		
	Hazard Mitigation Grant Program (HMGP)	√	√	√	Grants to state and local governments to support hazard mitigation projects per the disaster-specific Mitigation Strategy sate priorities. Projects included incentive projects at up to 5% of the total HMGP allocation, planning projects at up to 7% of the allocation and structural projects that are cost-beneficial at >88% of the allocation.
	Forest Fire Suppression			√	Federal assistance under Section 420 of the Act is provided in accordance with continuing Federal-State agreement for Fire Suppression (the Agreement) signed by the Governor and Regional Director. The Agreement contains the necessary terms and conditions consistent with the provisions of applicable laws, Executive orders, and regulations, as the Associate Director may require and specifies the type and extent of Federal Assistance.
	Individual and Households Assistance Program (IHAP)	√	√	√	Federal law authorizes grants to disaster victims with disaster related expenses and needs that cannot be met through other available governmental disaster assistance programs. The Federal share of a grant to an individual family under this program shall be equal to 75% of the actual cost of meeting such an expense or need and shall be made only on condition that the remaining 25% of such costs is paid to the individual or family from funds made available by the State. No individual or family shall receive any grant or grants under this program aggregating more than a maximum amount established by Federal regulation with respect to any one major disaster. The State: Maintains an Individual and Family Grant Program Administrative Plan Coordinates administration of the Individual and Family Grant Program through WVDHSEM supervised by the State Coordinating Officer.

Disaster Mitigation Programs Capabilities Assessment					
Agency	**Programs, Plans, Policies, Regulations, Funding and Practices**	**Effect on Loss Reduction**		**Funding**	**Description**
		Support	**Facilitate**		
	Public Assistance	√	√	√	If damage sites have been surveyed during the Pre-disaster Damage Assessment, eligible applicants may apply for Immediate Needs Funding (INF) within days of the disaster to support repair of replacement of qualifying public infrastructure. INF may by up to 50% of the Federal share of the PDA estimate for emergency work (Categories A and B). Any up-front funds received by an applicant will be offset later against actual emergency work projects as they are received. The State provides a 25% match to federal fund. Subsequent to a disaster declaration by the President, FEMA provides assistance to state agencies, local governments and some private non-profit organizations for the repair and restoration of damaged public facilities. A grant is made to the state, which then authorizes sub-grants to eligible applicants. Funding is then provided on a cost share basis with percentages established in the FEMA-State Agreement, but requiring a federal share of no less than 75%. The purpose of this Public Assistance Administrative Plan Annex is to identify the roles and responsibilities of the State in administering the Public Assistance program and to outline staffing requirements and the policies and procedures to be used. Though section 406, mitigation is available to damaged elements of certain structures and can be mitigated if the project is eligible and proven cost-beneficial.
	Community Disaster Loans	√	√	√	Disaster-related expenses during the year of occurrence and the three succeeding fiscal years.
	Disaster Housing	√	√	√	Residents within Presidentially declared areas are eligible for temporary housing assistance: The FEMA Administrator or their designee determines that other circumstances necessitate temporary housing assistance. Home Repair Program: Home repairs may be provided to those eligible applicants: Who are owner-occupants of the primary residence to be made habitable Whose property can be made habitable by repairs to the essential living area within 30 days following feasibility determination. The FEMA Region III Director may extend this period.

Disaster Mitigation Programs Capabilities Assessment					
Agency	**Programs, Plans, Policies, Regulations, Funding and Practices**	**Effect on Loss Reduction**		**Funding**	**Description**
		Support	**Facilitate**		
	Regional Catastrophic Preparedness Grant Program (RCPGP)			√	Provides funding to support coordination of regional all-hazard planning for catastrophic events, including the development of integrated planning communities, plans, protocols, and procedures.
	Preparedness Grants (formerly known as the Infrastructure Protection Program)			√	Supports specific activities to strengthen security at ports and enhance transit, trucking and intercity bus systems
	Emergency Management Performance Grants (EMPG)			√	This program is a critical part of state and local governments' ability to operate, sustain, and enhance their emergency management programs' effectiveness.
	Community Emergency Response Teams	√	√	√	Provides grant funding to volunteer organizations that make local communities sage and prepare to respond to any emergency situation. CERT trains people to respond to communities in their own local communities.
	Educational outreach programs	√			Educational materials for preventing injury are readily available at the FEMA website. (FEMA, 2003c)
U.S. Army Corps of Engineers	Drought Assistance			√	Coordinate the development of drought plans and procedures for lakes and dams within the State under the jurisdiction of the Corps of Engineers. Provide information and reports as needed. Coordinate USACOE drought related activities. Provide water from USACOE reservoirs and dams, as available during emergencies.

Disaster Mitigation Programs Capabilities Assessment					
Agency	**Programs, Plans, Policies, Regulations, Funding and Practices**	**Effect on Loss Reduction**		**Funding**	**Description**
		Support	**Facilitate**		
USDA Rural Development	Rural Housing Service (RHS) Homeownership Loans	√	√	√	Loans for the purchase, construction, rehabilitation or relocation of a dwelling and related facilities for low or moderate-income persons in rural areas. RHS can help subsidize monthly mortgage payments, limiting these costs to no more than 30 percent of the adjusted monthly income of the applicant.
	Farm Service Agency Drought Assistance	√	√	√	Provide assessments of drought damages. Coordinate requests for drought related Presidential Declaration of Drought Emergency. Recommend federal drought assistance declaration to the Governor through Department of Emergency Management. Implement federal drought assistance programs. Administer drought-related relief.
	Very Low Income Housing Repair Loans and Grants: USDA Rural Development	√	√	√	Home improvement and repair loans and grants enable very-low and low-income rural homeowners to remove health and safety hazards from their homes and to make homes accessible for people with disabilities. Grants are available for people 62 years old and older who cannot afford to repay the part of the assistance received as a loan. An applicant must own and occupy a home in a rural area, be without sufficient income to qualify for a Section 502 loan, have sufficient income to repay the loan, and be a citizen of the U.S. or reside in the U.S. after having been legally admitted for permanent residence.
	Disaster Assistance	√	√	√	Emergency Conservation program shares with agricultural producers the cost of rehabilitating eligible farmlands damaged by natural disaster. . Farm Service Agency provides emergency loans to assist producers recover from production and physical losses due to drought, flooding, other natural disasters or quarantine. Natural Resources Conservation Service's Emergency Watershed Protection Program (EWP) provides emergency measures, including purchase of floodplain easements for runoff retardation and soil erosion prevention to safeguard lives and property from floods, drought, and the products of erosion on the watershed. Food and Nutrition Service's Food Distribution division has the primary responsibility of supplying food to disaster relief organizations.

Disaster Mitigation Programs Capabilities Assessment					
Agency	**Programs, Plans, Policies, Regulations, Funding and Practices**	**Effect on Loss Reduction**		**Funding**	**Description**
		Support	**Facilitate**		
	Emergency Food Stamp Program		√	√	Provides emergency food stamps to disaster victims
U.S. Department of Energy	Radiological Emergency Assistance		√	√	Provision of specialized services, advisory services, counseling and dissemination of technical information to assist in responding to incidents involving loss of control of radioactive materials and supporting efforts to protect public health and safety. For any person or organization with knowledge of an incident believed to involve ionizing radiation or radioactive material hazardous to health and safety.
	Disaster-related Power Outage			√	Implements emergency related functions under the Federal Response Plan.
	Radiological Emergency Assistance		√	√	Provision of specialized services, advisory services, counseling and dissemination of technical information to assist in responding to incidents involving loss of control of radioactive materials and supporting efforts to protect public health and safety. For any person or organization with knowledge of an incident believed to involve ionizing radiation or radioactive material hazardous to health and safety.
EPA	Superfund Amendment and Reauthorization Act (SARA), Title III	√	√		Support programs that are designed to improve emergency planning, preparedness, mitigation, response and recovery capabilities with special emphasis on emergencies associated with hazardous materials. For state and local governments and university-sponsored programs.
U.S. Department of Health and Human Services	Contaminated Food and Drugs	√	√	√	Through coordinated planning, advice, technical information, assistance and expertise can be provided to establish public health controls and to protect citizens from contaminated and unsafe food and drugs. Assists state and local agencies through the Department of Agriculture and Consumer Services and the Department of Health.

Disaster Mitigation Programs Capabilities Assessment					
Agency	**Programs, Plans, Policies, Regulations, Funding and Practices**	**Effect on Loss Reduction**		**Funding**	**Description**
		Support	**Facilitate**		
	Vector Control			√	Advice and technical assistance to prevent the spread of communicable diseases by disease-carrying animals or insects in the aftermath of a disaster.
U.S. Department of Housing and Urban Development	Comprehensive Planning Assistance	√	√		Grants to strengthen planning and decision-making capabilities of chief executives of state, regional and local agencies to promote more effective use of natural, economic and physical resources. Disaster mitigation and recovery planning are eligible activities. For state agencies designated by the Governor; counties, cities, regional and local planning agencies, local development districts, economic development districts and localities that suffered a major disaster.
Federal Bureau of Investigation	Victim Identification	√	√	√	Fingerprint identification of disaster victims For any authorized state or local law enforcement agency.
NOAA National Weather Service	Forecasts and Warnings	√	√	√	Pubic forecasts and warnings of hazardous weather phenomena and floods, and training programs on disaster safety rules. These are available to agencies and the public. Educational materials for preventing injury are readily available at the NOAA website and news of impending heat conditions, including expected intensity are broadcast on local radio, NOAA Weather Radio, and television stations.
Small Business Administration	Emergency Loans	√	√	√	The SBA offers three types of loans: Home Disaster Loans for homeowners and tenants to repair or replace disaster damages to real estate and/or personal property. Tenants are eligible for personal property losses only. Business Physical Disaster Loans are for businesses to repair or replace disaster damages to property owned by the business. These losses could be to real estate, machinery and equipment, leasehold improvements, inventory and supplies. Businesses of any size are eligible to apply. Economic Injury Disaster Loans are working capital loans for small businesses and small agricultural cooperatives to assist them through the disaster recovery period. These loans are available to applicants without credit available elsewhere.

Disaster Mitigation Programs Capabilities Assessment					
Agency	**Programs, Plans, Policies, Regulations, Funding and Practices**	**Effect on Loss Reduction**		**Funding**	**Description**
		Support	**Facilitate**		
U.S. Department of Housing and Urban Development	Housing Grants and Mortgage Insurance	√	√	√	– Community Development Block Grants: Grants to entitlement communities. Preferred use of funding is for long-term needs but may be used for emergency response activities. – Multi-family home mortgage insurance: Guaranteed/insured loans to finance the acquisition of proposed, under construction or existing single-family units. Homeowners are permitted to make a low down payment. For any person able to meet the cash investment, the mortgage payments and credit requirements. – Special Mortgage Insurance for Low and Moderate Income Families: Mortgage insurance for low and moderate-income families. The program can be used to finance rehabilitation of sub-standard properties. Anyone may apply; displaced households qualify for special terms. – Co-insurance: Joint mortgage insurance by the federal government and private lenders to facilitate homeownership financing Everyone eligible for mortgage insurance under the full insurance programs may apply for co-insured loans to lenders approved by HUD as co-insurers. The co-insuring lender (any mortgage approved by FSA), based upon the characteristics of the property and the credit qualifications of the borrower, determines whether to make the loan. – Manufactured Home Loan Insurance to Finance Purchase of Manufactured Homes: To make reasonable financing of manufactured home purchases. Provided private lending institutions with federal insurance when they make loans for the purchase of manufactured homes to be used as primary residences. All families are eligible to apply. – Major Home Improvements Loan Insurance: Federal insurance of loans to help families repair or improve existing residential structures outside urban renewal areas. The program provides for long-term insured mortgage financing of major improvements or alterations to structures containing up to four family units. For any owner of the property to be improved or the lessee under a 99-year renewable lease or a lease having an expiration date at least ten years beyond the maturity date of the mortgage. – Home Improvement Loan Insurance: For property owners and tenants under some conditions.

Disaster Mitigation Programs Capabilities Assessment					
Agency	**Programs, Plans, Policies, Regulations, Funding and Practices**	**Effect on Loss Reduction**		**Funding**	**Description**
		Support	**Facilitate**		
USDOT	Hazardous Materials Emergency Preparedness (HMEP) Grant Program		√	√	Used by WVDHSEM/State Emergency Response Commission to grants to active Local Emergency Planning Committees for education and training to public sector employees for the purpose of responding to chemical accidents/incidents.
U.S. Public Health Service	Emergency Health Assistance			√	Provides emergency health care assistance.
American Red Cross, Salvation Army, Department of Agriculture and Consumer Services, VOAD, food banks, Meals-on-Wheels	Food			√	Food can be provided to disaster victims and workers in several ways: Direct provision of foodstuffs donated by individuals and groups to disaster victims through distribution centers as described above. Direct grants for food purchase or food stamp allotments (through section 409) provided to disaster victims (described earlier in the Federal Assistance section). Meals provided at feeding centers of from mobile distribution canteens. Through section 410, provision of food stocks for emergency mass feeding or distribution to an area suffering a major disaster or emergency.
American Red Cross, Salvation Army, Maryland Volunteer Organizations Active in Disaster (VOAD)	Collection and Distribution of Donated Goods		√	√	Establish and manage centers for receipts and distribution of donated goods such as food, clothing, furniture, medical supplies, building materials, cleaning supplies, bedding, utensils and tools. This is usually organized with a designated distribution center.
Department of Social Services, Red Cross, Salvation Army, VOAD	Counseling		√	√	Crisis intervention counseling designed to assist disasters victims and responders in coping with their situation to avoid serious psychological impairment.

Disaster Mitigation Programs Capabilities Assessment					
Agency	**Programs, Plans, Policies, Regulations, Funding and Practices**	**Effect on Loss Reduction**		**Funding**	**Description**
		Support	**Facilitate**		
VOAD, Department of Health, AmeriCorps, NGOs	Homes Repair	√	√	√	Aid to homeowners to repair their homes in the absence of or to supplement FEMA's Minimal Repair Program. The ability of the listed agencies to provide assistance may vary for each event and is tied to the income level and demonstrated need of each victim.
VOAD, Maryland National Guard, AmeriCorps, Others	Personnel	√	√	√	Provision of personnel to supplement the labor necessary to respond to emergency disaster events, especially for clean-up and damaged home repair.
MEMA	Mapping of Priority Funding Areas in Hazard Zones				Established in 1997, the Priority Funding Areas (PFAs) Act directs available state funding for growth related infrastructure towards identified PFAs (places or communities where governments have chosen to spend available funds). Such funding can be used for those projects such as highways, water construction, and economic development. Standards and criteria, which included permitted density, water, and sewer availability, were established for both counties and municipalities. MEMA has partnered with the Towson University Center for Geographic Information Sciences to create statewide maps identifying where Maryland's Priority Funding Areas intersect with defined hazard areas. MEMA will use this information to explore the possibility of revisions to State planning policy to take into account known hazard areas
	Tidal Gauge Network				MEMA is currently exploring the use of Hazard Mitigation Grant Program funds to place additional tide gauges along the Chesapeake Bay. Water level information from these gauges will be available in real time via the Internet to State and local emergency management officials to assist with alert, warning, and response.
	Best Practices in Hazard Mitigation Publication				In the spring of 2004 MEMA published the Best Practices in Hazard Mitigation, Success Stories from Maryland. This publication recognized actions taken by the State and local governments to reduce loss of life and property damage associated with hazard events in Maryland. Distribution of this document to local planners, emergency management offices, and colleges and universities is on-going.

Disaster Mitigation Programs Capabilities Assessment					
Agency	**Programs, Plans, Policies, Regulations, Funding and Practices**	**Effect on Loss Reduction**		**Funding**	**Description**
		Support	**Facilitate**		
	An Assessment of Maryland's Vulnerability to Flood Damage				The Maryland Department of the Environment collaborated with the Eastern Shore Regional GIS Cooperative (ESRGC) at Salisbury University on a modeling project that would help to determine the risk of riverine and coastal flooding. To complete the report, ESRGC used FEMA's HAZUS-MH hazard vulnerability analysis modeling software, a product that allows for the generation of maps and tables that depict loss estimations from flooding for each county in Maryland.
	Repetitive Flood Loss Report				MEMA, through the Flood Mitigation Assistance Program, funded the creation of the Maryland Repetitive Flood Loss Property Report. This report was originally completed in June 2002 and revised in 2005. The project consisted of the identification and mapping of all repetitive loss properties within the State of Maryland. Mitigation strategies targeting these structures were then identified and prioritized. Repetitive loss properties were defined as National Flood Insurance Program insured structures that since 1978 have made two or more flood damage claims totaling $1,000 or more in a ten year period. Additional information for each repetitive loss property was also gathered, including the number of losses, relative loss amounts, and the latitude and longitude coordinates of each structure.
Maryland Department of Planning	Agricultural Preservation				The MDP maps prime and productive agricultural lands statewide and collects data on development pressures, State and local preservation easements, and local planning and zoning initiatives to preserve agricultural lands.
	Consolidated Technical Assistance Program				The Consolidated Technical Assistance Program (CTAP) is funded through the Appalachian Regional Commission's Area Development Allocation for Maryland. This program provides financial assistance to local governments in Garrett, Allegany and Washington counties. This program supports a wide array of projects including the development of sensitive area plans, the acquisition and development of greenways in floodplains, and flood mitigation projects.
	Demographic Database Development				The MDP maintains databases containing information on population, housing, employment, income, businesses, school enrollment, natural resources, and land use. These databases also include current electronic based maps with features such as street names, addresses, and parcel data. These databases have been utilized for several mitigation projects within the State.

Disaster Mitigation Programs Capabilities Assessment					
Agency	Programs, Plans, Policies, Regulations, Funding and Practices	Effect on Loss Reduction		Funding	Description
		Support	Facilitate		
	Development Pressure Mapping				The MDP has identified and mapped development pressures on resource lands and the degree of protection afforded to those lands by local zoning. This information is used in conjunction with data on land protected by easement in order to measure preservation efforts in the context of the threat posed by development.
	Economic Growth, Resource Protection and Planning Act of 1992				The Planning Act is intended to ensure that State Government activities and programs are consistent with the State's development policy. A total of eight visions are included in the Planning Act, which are implemented in part through MDP reviews of the required sensitive areas element of county and municipal comprehensive plans. Local governments are required to update, or at a minimum review, their plans once every six years. This element must address streams and their buffers, 100-year floodplains, steep slopes, endangered or threatened species habitats, and any other sensitive areas as may be identified by the local plan. The MDP then uses this element to develop land use planning recommendations for the specified sensitive areas, to establish funding resources for meeting the visions, and to ensure that development is taking place in suitable areas. Article 66B of the Planning Act addresses the sensitive areas required element of local comprehensive plans.2 Sensitive areas include wetlands, floodplains, and other environmentally sensitive lands where special attention must be paid. A number of publications, such as the "Preparing a Sensitive Areas Element" and "Sensitive Areas," also focus on identifying what sensitive areas may exist and on the resources available to help protect them. The 2006 MDP publication Revisiting the Comprehensive Plan: the Six Year Review guidance document encourages hazard mitigation planning with comprehensive planning.
	Land Preservation and Recreation Planning				The Maryland Department of Planning prepares guidelines for State and local land preservation and recreation plans. These plans address the four interrelated categories of recreation and resource protection, recreational lands and facilities, natural resource lands, and cultural heritage resources.

Disaster Mitigation Programs Capabilities Assessment					
Agency	**Programs, Plans, Policies, Regulations, Funding and Practices**	**Effect on Loss Reduction**		**Funding**	**Description**
		Support	**Facilitate**		
	Maryland Property View Database				The Maryland Property View Database is updated and maintained by the MDP. MD Property View is an electronic information system which contains data on every land parcel within the State. The records in this database contain over 100 data items for each parcel. Also contained within the database are scanned images of land parcels, satellite imagery, census data, zip code boundaries, land use and land cover data, and priority funding area boundaries.
	Rural Legacy Program				The Rural Legacy Program provides the focus and funding necessary to protect large, contiguous tracts of land and other strategic areas from development. The program also enhances natural resource, agricultural, forestry, and environmental protection through cooperative efforts within State government and between State and local governments and land trusts. Protection is provided through the acquisition of easements and fee estates and the supporting activities of Rural Legacy sponsors and local governments.
	Smart Growth				The Smart Growth and Neighborhood Conservation initiatives of the Maryland Department of Planning coordinate State expenditures with local growth plans. The MDP worked to develop the original Smart Growth legislation, which was adopted in 1997 and continues to work with local and State agencies to implement the program. Technical assistance is provided to private and public organizations which support growth that fosters livable communities, preserves and protects the environment, and makes efficient use of State resources.
	Task Force on the Future for Growth and Development in Maryland				This Task Force, created by House Bill 1141 in 2006, focuses on researching trends and population growth challenges as well as the impact of local policies on the environment and infrastructure. The group will study the linkage between smart growth, local land use plans, and various state-wide plans such as the state development, transportation, and housing plans. The Task Force also proposes that the state implement laws and recommendations that advance growth and development related best management practices. A final report of findings and recommendations was published in December, 2008. In January 2008, the 21 members of the Task Force were announced. The Task Force will be staffed by Maryland Department of Planning and will serve as the Governor's Smart Growth Advisory Board.

Disaster Mitigation Programs Capabilities Assessment					
Agency	**Programs, Plans, Policies, Regulations, Funding and Practices**	**Effect on Loss Reduction**		**Funding**	**Description**
		Support	**Facilitate**		
	Technical Assistance				The MDP offers training in the use of Maryland Property View and provides planning technical assistance and customized mapping services to local governments within the State. The MDP has also worked with the University of Maryland Urban Studies and Planning Program to develop and offer a certificate course in urban planning. This course is available to volunteer planning commissioners, zoning board members, realtors, elected and appointed officials, and others responsible for making decisions about future growth and development in Maryland. This course covers a range of planning topics including planning and zoning law, innovative planning tools, transportation, smart growth, housing, and economic development.
Maryland Department of Natural Resources	Maryland Shorelines Online				A product of the Maryland Coastal Program, Maryland Shorelines Online is a joint tool of the Maryland Department of Natural Recourses, the Towson University Center for Geographic Information Sciences, and the Maryland Geological Survey. This web based Geographical Information Systems (GIS) mapping tool provides a centralized site where Maryland communities and other stakeholders can access data on sea level rise and coastal hazards (i.e. erosion and other shoreline changes, coastal flooding). The tool provides best management practices and outreach resources. The GIS tool also provides an overview of laws, regulations, and permitting requirements that apply to coastal areas and are affected by sea level rise. The tool is targeted toward State and local planners who work with coastal issues, marine contractors, educators, and the general public. Technical and financial assistance, lesson plans for students, historical records on shoreline erosion, and the interactive map viewer Shorelines Changes Online are some of the resources available on the site. Also accessible is the Comprehensive Coastal Inventory Program (CCI) that provides maps, summary reports, tables, and photographs that outline the current status of coastal areas within the state. The site also provides links to remote sensing data resources and LIDAR (light detection and ranging) elevation data products. A total of seven LIDAR elevation data products have been developed. The Maryland Shorelines Online database was developed following an exhaustive survey of the State's entire tidal shoreline by boat. This survey took nearly four years to complete, and was the first such survey of its kind in the State.

Disaster Mitigation Programs Capabilities Assessment					
Agency	Programs, Plans, Policies, Regulations, Funding and Practices	Effect on Loss Reduction		Funding	Description
		Support	Facilitate		
	Endangered and Protected Species Protection				The Department of Natural Resources, in partnership with the U.S. Fish and Wildlife Service, administers funds to local jurisdictions that support projects that reduce the erosion of lands inhabited by protected freshwater mussels, the Delmarva Fox Squirrel, and other endangered and protected species.
	The Environmental Geology and Mineral Resources Program				The Environmental Geology and Mineral Resources Program is administered by the Maryland Geological Survey, a division within the DNR. Under the Program, investigations and surveys of the geology of Maryland are conducted to assess land resources and environmental hazards. An extensive project to digitize soil maps throughout the State is currently underway.
	The Rural Legacy Program				The Rural Legacy Program involves both the Department of Natural Resources and the Maryland Department of Planning. The program provides State funding to help local governments, landowners, and conservation organizations permanently preserve rural lands. It also encourages local governments and private land trusts to identify Rural Legacy areas and competitively apply for funds to create new or compliment existing land conservation efforts.
	Seismometer at Soldiers Delight Natural Environment Area				The Maryland Geological Survey, through funding from the Maryland Emergency Management Agency, has installed a seismometer at Soldiers Delight Natural Environmental Area. The seismometer was installed to aid in the evaluation of earthquake risk and to transmit earthquake information to emergency management personnel, the United States Geological Survey, and university seismic networks.
	Statewide Fire Monitoring System				The DNR Forest Service has installed and currently operates 12 automated Forest Technology Systems stations throughout the State. These stations collect fire weather data such as fuel moisture, humidity, temperature, and wind speed. This data is used by DNR Forest Service and Maryland's regional fire centers to determine fire danger ratings.
	Volunteer Fire Assistance Program				The DNR Volunteer Fire Assistance Program provides financial and technical assistance to State Foresters and other appropriate officials in order to organize, train, and equip fire departments in rural communities. A rural community may be an incorporated or unincorporated city or town having a population of 10,000 or less.

Disaster Mitigation Programs Capabilities Assessment					
Agency	**Programs, Plans, Policies, Regulations, Funding and Practices**	**Effect on Loss Reduction**		**Funding**	**Description**
		Support	**Facilitate**		
	Watershed Services				Within the Watershed Services unit of DNR are programs which address coastal and natural resource issues. Planning and coordination of coastal hazard issues are undertaken through the Coastal Zone Management Program. The Geographic Information Service provides and manages an array of digital geographic data of the State and the Watershed Management and Analysis provides natural resource data analysis services to the Department.
	Wind and Water Technical Assistance Program				The Maryland Geological Survey has contracted with the Center for Geographic Information Sciences (CGIS) at Towson University to create digital maps of parts of Baltimore City. These maps will illustrate the distribution and thickness of artificial fill in the densely populated area around the Inner Harbor. They will be used by local government officials to anticipate possible flooding caused by failure of the artificial fill during an earthquake event.

Disaster Mitigation Programs Capabilities Assessment					
Agency	Programs, Plans, Policies, Regulations, Funding and Practices	Effect on Loss Reduction		Funding	Description
		Support	Facilitate		
	A Sea Level Rise Response Strategy for the State of Maryland				Developed by a NOAA Coastal Management fellow at the Maryland Coastal Program, this strategy resulted in a proactive policy and implementation focused sea level rise planning framework which acknowledges that Maryland coastline sea level rise rates are approximately twice as high as worldwide rates. A Chesapeake Bay land subsidence rate that averages 1.3 mm per year causes much of this rise. In fact, having already risen one foot in the past century, sea level rise in Maryland is expected to rise 2-3 additional feet by 2100. An increase in coastal flooding, shoreline erosion, and salt-water integration with groundwater are among the outcomes of this phenomenon. Nationwide, following Louisiana and Southern Florida, the Chesapeake Bay region has been identified as the third most vulnerable region as far as sea level rise impacts are concerned. Recognizing the need for more data on the potential impacts of sea level rise, two assessment reports have been developed. The first of these reports, “Assessing the Economic Cost of Sea Level Rise”,3 was developed in 2001 by Towson University under the direction of the Maryland Coastal Program. The report focuses on coastal flooding resulting from sea level rise and the resulting economic impacts to Maryland communities within a pilot study area. The second report, “Determining Sea Level Inundation Potential”,4 was developed by DNR and the U.S. Geological Survey. Worcester and Dorchester Counties are the settings for this later study. Other DNR efforts to mitigate sea level rise include research support and the acquisition of high resolution topographic coastal data that is a basis for sea level rise inundation modeling. As a result of this modeling, which seeks to identify the impacts of both a gradual sea level rise and sea level rise that results from storm surge, sea level rise scenarios have been developed for Worcester, Dorchester, and Anne Arundel, and St. Mary’s Counties.

Disaster Mitigation Programs Capabilities Assessment					
Agency	**Programs, Plans, Policies, Regulations, Funding and Practices**	**Effect on Loss Reduction**		**Funding**	**Description**
		Support	**Facilitate**		
Maryland Department of the Environment	State Wetland Conservation Plan				The 2003 State Wetland Conservation plan was the product of a partnership between citizens, businesses, non-profits, and State, Federal and Local partners. It was created as a guide to integrate and improve upon all wetlands conservation and management related State, Local, Federal, and non-governmental programs. Funded by the Environmental Protection Agency, the plan provides historical wetlands acreage and distribution data and refers the reader to available wetland inventories and pertinent regulations. Just as importantly, the plan publicizes five major goals including the prioritization of areas for protection and an increase in the effectiveness of wetlands administration and regulations in Maryland.
	Database Development and Maintenance				The MDE, in cooperation with MEMA, developed and maintained data sets which may be used for hazard mitigation including digital floodplain boundaries, dam locations and safety classifications, hazardous materials storage and handling facility locations, and hazardous materials incidents and oil spills.
	Drought Public Information Initiative				The Water Management Administration of the MDE disseminates public information and provides education on appropriate drought activities and maintains a hotline for the public and media.
	Maryland Statewide Water Conservation Advisory Committee				The Maryland Statewide Water Conservation Advisory Committee was established by Executive Order in January 2000. The Committee charge was to set uniform indicators for evaluating drought conditions, consider water conservation efforts and the need for regional enhancements, assess well failures and programs for groundwater conservation, recommend mechanisms to address its findings, and respond to future droughts. Public education and outreach programs were also developed by the Committee. The Committee produced the State of Maryland Drought Monitoring and Response Plan which was published in November of 2000.
	Drought Monitoring and Response Plan				The State of Maryland Drought Monitoring and Response Plan outlines the methods and steps the State will take to monitor and respond to drought conditions when they occur.

Disaster Mitigation Programs Capabilities Assessment					
Agency	**Programs, Plans, Policies, Regulations, Funding and Practices**	**Effect on Loss Reduction**		**Funding**	**Description**
		Support	**Facilitate**		
	Mining Program				MDE designs and manages construction contracts for mining projects, including extensive earthmoving operations, acid mine drainage treatment systems, stream restoration, water supply replacement, and mine subsistence control. MDE also regulates existing mining operations and works with the mining industry to reclaim abandoned mines and reduce the risk of mass movements of soil associated with those mines.
	Public Water Supply				The MDE Water Supply Program staff works closely with the operators of Maryland's water supply systems, advising them of steps to take to protect their water supply facilities. A letter and informational checklist have been sent to all community water systems to help them to assess their vulnerability and determine actions to minimize the risk of terrorist attacks. MDE staff also continually update water systems with the latest developments such as security related information and FBI advisories. Maryland's water systems have taken extra precautions, such as increasing security and surveillance of key water facility components, increasing the frequency of water quality monitoring, and applying optimum treatment in order to protect the safety of the State's public water supply.

Disaster Mitigation Programs Capabilities Assessment					
Agency	Programs, Plans, Policies, Regulations, Funding and Practices	Effect on Loss Reduction		Funding	Description
		Support	Facilitate		
	Radiological Health Program				The Radiological Health Program (RHP) was developed to control and monitor uses of radiation and to protect the public and the environment from inadvertent and unnecessary radiation exposure. The RHP also provides information on radiation activities. The RHP's Radioactive Materials (RAM) Division regulates almost 600 hospitals, doctors' offices, manufacturing and construction industries, radiographers, and other radioisotope users. Maryland is also an Atomic Energy Act Agreement State, which gives the State the authority to function exactly as the U.S. Nuclear Regulatory Commission in issuing and inspecting RAM licenses and pursuing penalty assessments. Out-of-state radioactive material licensees must report to the RHP before working in hospitals, on roads, in buildings, or other projects requiring the use of radioisotopes. The RHP's Radiation Machines Division performs the registration and inspection of approximately 3,000 dental and veterinary x-ray facilities in the State. They also certify and register approximately 1,600 medical and academic facilities with x-ray machines and accelerators. Radiological Health Program staff respond to any actual or staged emergencies at the Calvert Cliffs Nuclear Power Plant in Maryland, the Peach Bottom Atomic Power Station in Pennsylvania, any industrial, medical or transportation accident, or other serious incident involving radiation.
	Voluntary Cleanup Program				Established by the state legislature in 1997, Maryland's Voluntary Cleanup Program (VCP) is administered by the Waste Management Administration's Department of Environmental Restoration and Redevelopment Program (WAS ERRP). The VCP mission is to provide State oversight for voluntary cleanups of properties contaminated with hazardous substances. The goal of the program is to increase the number of sites cleaned by streamlining the cleanup process, while ensuring compliance with existing environmental regulations. Projects range from simple sites with a limited amount of contaminated soil to complex sites with multiple contaminants in soil, groundwater, surface water, sediment, and air.

Disaster Mitigation Programs Capabilities Assessment					
Agency	**Programs, Plans, Policies, Regulations, Funding and Practices**	**Effect on Loss Reduction**		**Funding**	**Description**
		Support	**Facilitate**		
	High Hazard Dams GIS Project				In 2000, grant funding became available to MDE to create a desktop database of dam information. The first phase of this effort focused on high hazard dams. High hazard dams are defined as those dams which are located upstream of developed or urban areas. A failure of these dams would likely cause serious damage to homes, industrial and commercial buildings, and major public utilities. A failure of a high hazard dam would also likely result in the loss of more than six lives. For each dam in this category, the dam location and inundation area maps were digitized and Maryland Property View, a GIS database of ownership information, was overlaid on the inundation area maps to identify structures and infrastructure impacted under dam failure scenarios. Additionally, the name, height, storage capacity, and danger level of the nearest town downstream were added to the GIS database for each dam. Photographs and inspection reports were also included.
	West Nile Virus				The Maryland Department of the Environment is involved with the West Nile Virus and associated mosquito control issues through both the Governor's Pesticide Council and direct contact with representatives in the Department of Health and Mental Hygiene (DHMH) and the Maryland Department of Agriculture (MDA). MDE also issues licenses for the collection, hauling, recycling, and processing of scrap tires, through its Scrap Tire Program.
Maryland Department of Housing and Community Development	Smart Growth				As a partner in the State's Smart Growth initiative, the Department of Housing and Community Development encourages sustainable development practices and works toward preserving valuable natural resources from continued urban development. In existing communities, DHCD coordinates the revitalization of commercial and residential areas, builds and rehabilitates housing and infrastructure, and preserves historical and cultural resources.
	Community Development and Block Grants				Housing programs administered by DHCD may be used in conjunction with other funds to rebuild communities after a disaster. Community Development Block Grants (CDBG), available through a federally funded program sponsored by the Department of Housing and Urban Development (HUD) and administered in Maryland by DHCD may be used to acquire homes in hazard areas. These funds may also be used to finance renter and homeowner relocation costs when properties are acquired with monies from other sources.

Disaster Mitigation Programs Capabilities Assessment					
Agency	**Programs, Plans, Policies, Regulations, Funding and Practices**	**Effect on Loss Reduction**		**Funding**	**Description**
		Support	**Facilitate**		
Maryland Department of Transportation	Strategic Highway Safety Plan				In an effort to improve overall highway safety throughout the entire network, the State Highway Administration has developed the Maryland Strategic Highway Safety Plan. This plan establishes policies for significantly enhancing highway safety throughout the State. The plan specifically addresses 23 identified program areas within the broader topics of drivers, pedestrians and cyclists, trucks and busses, highways, emergency services, and program management.
	Local Highway Safety Plan				In an effort to better ensure that traffic safety issues and circumstances within local areas of the State are addressed, the SHA has designated Local Highway Safety Coordinators for each of Maryland's 23 counties and Baltimore City. The Coordinators work with local task forces to identify traffic safety issues and problems, develop appropriate countermeasures, and implement or advocate for solutions. They also serve as the focal point for communication and cooperation among local government agencies and the private sector on key traffic safety matters. Additionally, SHA field officials participate in damage assessments post disaster as needed.

Disaster Mitigation Programs Capabilities Assessment					
Agency	**Programs, Plans, Policies, Regulations, Funding and Practices**	**Effect on Loss Reduction**		**Funding**	**Description**
		Support	**Facilitate**		
Maryland Department of Business and Economic Development					The primary function of the Maryland Department of Business and Economic Development (DBED) is to influence the economic development of the State. DBED focuses on job creation, new business creation, and development. The agency targets small and minority business development, encourages the cultural development of the state's organizations, and makes training and financial resources available. The website ChooseMaryland5 is the primary gateway that the business community and citizens may use to access these many resources. DBED partners with MEMA during all stages of emergencies and supports disaster affected businesses by making available and coordinating economic resources that assist them in economic recovery. DBED staff work in the State Emergency Operations Center (SEOC) during activation, and sit on the State Mitigation Advisory Committee. They also participate in the State Incident Assistance Teams (IATs), staff the Joint Field Offices as needed, make available economic advisors, and partner with the Federal Response Team as needed (i.e. conducting damage assessments). Some of the activities that DBED performs include the assessment of the economic impacts of disaster events, disaster funding, the provision of referrals and information, and support to businesses and to travelers.

Disaster Mitigation Programs Capabilities Assessment					
Agency	Programs, Plans, Policies, Regulations, Funding and Practices	Effect on Loss Reduction		Funding	Description
		Support	Facilitate		
The Maryland Insurance Administration					The Maryland Insurance Administration (MIA), originally named the Maryland Insurance Division in 1872, is responsible for regulating the State's $26 billion insurance industry. The MIA is responsible for ensuring that the State's insurance regulations are adhered to by firms that provide property insurance and health plan coverage. Insurance rates are regulated by and approximately 110,000 producers and 1,500 insurance companies are licensed by MIA. This State agency also responds to consumer complaints, provides insurance related advice, and disburses educational materials (i.e. the 2006 disaster preparedness insurance guide). Online consumer targeted publications include those that explain available homeowners, auto, health, and life insurance products as well as those that assist property owners whose homes and businesses were damaged. Another service that MIA provides is assistance to citizens with filing claims. The MIA website6 is accessible during emergency events and the agency's Public Affairs Unit works with the media to ensure that their disaster related activities are publicized. Through this and other methods, MIA encourages participation in and advocates for the National Flood Insurance Program (NFIP). At the start of hurricane season MIA publicizes the importance of flood insurance and ensures that consumers are aware of the 30-day waiting period that exists prior to new insurance policies taking effect. In May of 2007, MIA released a press document that highlighted the fact that hurricane related flooding led to approximately $177 million in insured flood losses during the 2002 to 2006 hurricane seasons and that, as of the beginning of 2007, only about 3% of the State's households were insured for flooding. As in the 2006 flooding events, MIA supports localities with post disaster recovery. MIA also responds to emergencies and assigns staff to partner with other states agencies in the State Emergency Operations Center (SEOC) and in Disaster Recovery Centers (DRCs).

Disaster Mitigation Programs Capabilities Assessment					
Agency	Programs, Plans, Policies, Regulations, Funding and Practices	Effect on Loss Reduction		Funding	Description
		Support	Facilitate		
					Within the MIA, the lead for coordinating disaster response activities is the Consumer Education and Advocacy Unit (CEAU), which has a Consumer Education and Outreach section. This unit works directly with consumers on insurance related issues and takes part in public hearings such as those related to NFIP reforms. It is responsible for maintaining copies of disaster related publications and alerts that were disseminated to consumers and for ensuring that their website stays current. It also maintains a Carrier Reporting Database where insurance claim data that is provided by insurance providers is uploaded. MIA CEAU staff work with these insurance carriers and ensure that this database is an up to date source of the following data: the number of claims filed, the number of claims that were settled, the amounts paid out to those insured, as well as the physical locations of properties for which claims were filed. MIA's Disaster Response Plan is a resource document that supports the coordination of disaster response activities. Procedures for responding to emergencies as well as to consumer insurance related inquiries are outlined in this document. The document also outlines MIA's response and recovery role when partnering with other entities. The CEAU maintains an up to date contact database for Maryland licensed carriers as well as contact information for state, local, and federal officials that partner with MIA in its response and recovery role. The CEAU is also responsible for monitoring the WebEOC© tool that MEMA and partners use for event management. The CEAU also plays a role in maintaining disaster response and recovery supplies and it supports the Disaster Recovery Teams by ensuring that they stay up to date regarding consumer assistance procedures.

Appendix F – Planning Process Documents

For information specific to the Regional Open House Meetings, please refer to *Appendix O - Outreach and Education*.

Kick off meeting

Maryland Mitigation Plan Update ~~HIRA Meeting~~

~~March 3, 3011~~ Sign-in Sheet

May 12, 2011

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Meeting Agenda

- Welcome & Introductions
- Planning Process
- Plan Update Requirements & Data Availability
- Ranking Methodology, Risk & Vulnerability
- Evaluating 2008 Plan: Mitigation Actions, Program Capacity, Planning Integration, and Critical Facilities
- Plan Outcomes Exercise
- Wrap Up and Future Meetings

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Project Team

- MD Mitigation Advisory Committee: aka “the decision makers”
- Mark James, MEMA
- Deborah Mills, Project Manager, Dewberry
- Ryan Towell – Lead HIRA/Meteorologist, Dewberry
- Carrie Speranza– Lead Mitigation Actions Planner, Dewberry
- FEMA Region III Representatives– Tess Grubb, Matt McCullough

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Plan Update Process

- Data Collection; 2008 Plan Evaluation
- Hazard Identification & Risk Assessment Update
- Mitigation Goals, Strategies and Projects
  - revisions and additions
- Project Scoping
- Capability Assessment, Plan Maintenance
- Draft Plan Submittal and Review
- Plan Adoption
- Plan Submission to MEMA & FEMA

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It’s Your Plan!

We are here to:

- ✓Facilitate the process
- ✓Lend technical expertise & consultation
- ✓Do the heavy lifting

You need to:

- ➢Participate and contribute hazard information
- ➢Make the final decisions
- ➢Ensure a feasible plan that meets your needs

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Recommended Revisions per FEMA's previous plan review

- 2008 Cross Walk review
  - FEMA Region III Recommended revisions
  - MEMA Needs and Requests
  - Mitigation Advisory Committee Needs and Requests
- Incorporate these recommendations into the new plan

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Plan Update Requirements

- Must be updated every 3 years
- Re-assess Hazard Identification and Risk Assessment (HIRA)
  - Considers changes to hazards and vulnerability of people and assets
  - Address hazard events that have occurred since the last plan
- Incorporate local planning efforts with MD State Plan
- Report on progress with mitigation strategy to-date and discuss adjustments
- Address weaknesses identified in previous plan review

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Project Task	Mar 2011	April 2011	May 2011	June 2011	July 2011	Aug 2011	Sep 2011	Oct 2011	Nov 2011	Dec 2011	Jan 2011
1. Mitigation Committee Meetings	♦		♦		♦		♦				
2. Data Collection	♦										
3. 2008Plan Review / Local Plan Upload	♦	♦									
4. Capability Assessment		♦	♦								
5. Social Vulnerability Analysis	♦	♦									
6. HAZUS-MH Analysis	♦	♦	♦								
7. FMA RL & SRL Planning	♦	♦	♦	♦							
8. HIRA	♦	♦	♦	♦							
9. Goals, Strategies, & Projects			♦	♦							
10. Outreach				♦	♦	♦	♦	♦			
11. Draft Plan Sections Submittal and Review				♦	♦	♦					
12. Final Plan Submittal and Review					♦	♦					
13. Project Data Sheet Development						♦	♦				
14. Plan Distribution							♦	♦	♦		

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MARYLAND

Principal-in-Charge
Ernest Katzwinkel, PE, LEED

Quality Assurance Manager
Jane Sibley Frantz, AICP, CFM

Project Manager
Deborah Mills, CFM

HIRA/Vulnerability Analysis
Ryan Towell

HAZUS-MH Analysis
James Mawby
Ricardo Saavedra

HIRA
Janna Newman
Stuart Geiger
Corrine Bartshire
Rachael Heltz-Herman - QC

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Carrie Wilson Gonzalez
Stephanie Vallez
Ginni Melton
Laura Johnston
Mark Matulik - QC

Project Development
Julia Moline, EIT

Joe Klein – QC

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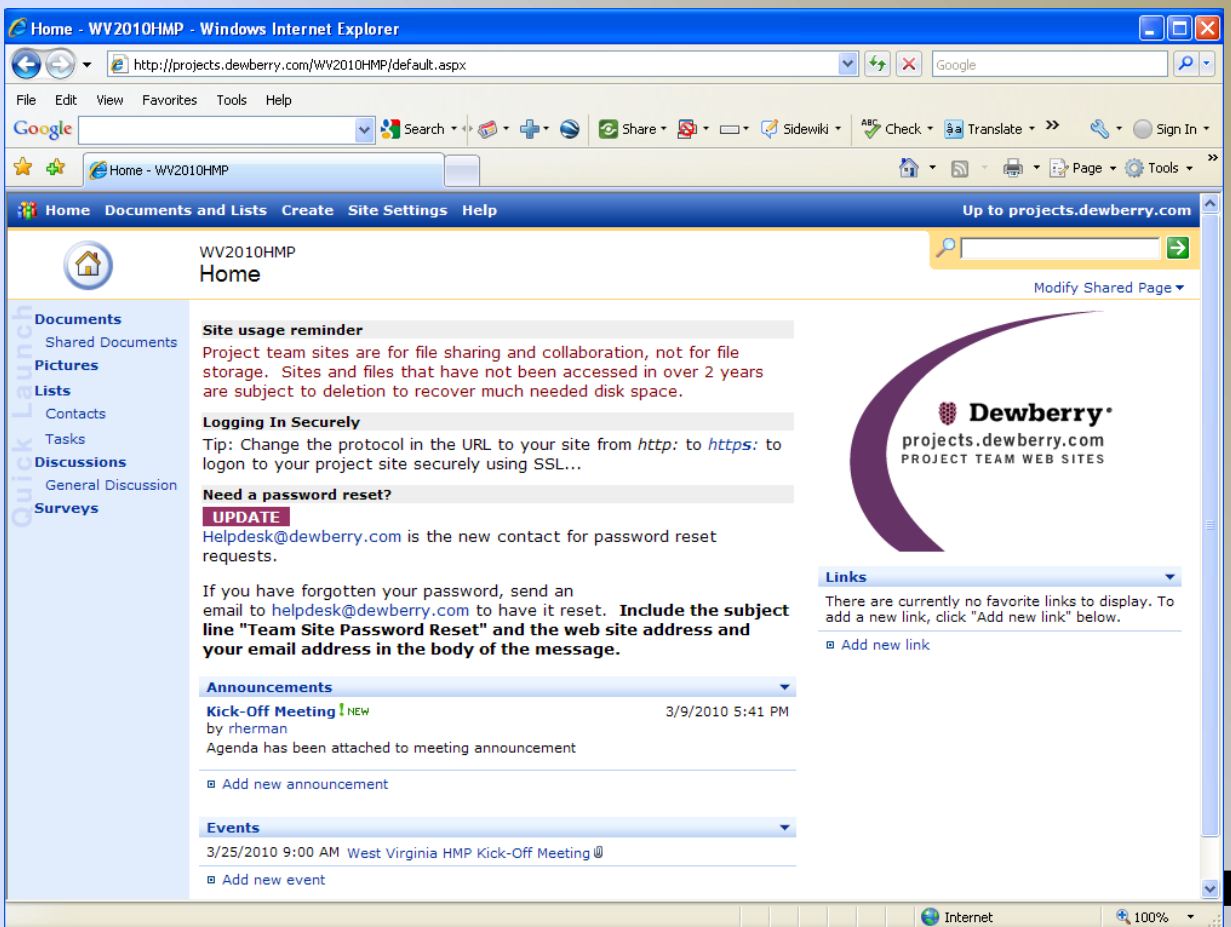
SharePoint

- http://projects.dewberry.com/2011MDHMP
- Requires:
  - **Username**
  - **Password**



Plan Update Requirements & Data Availability

- Overview of HIRA Planning Process
- Hazard Analysis consistent with State Hazards
- New Hazards to Consider?
- Data Needs:
  - Data Discrepancies from previous plans, what can be improved?
  - Critical Facilities and Assets
  - Hazard Specific Data Sources
- Local Hazard Mitigation Plan Incorporation

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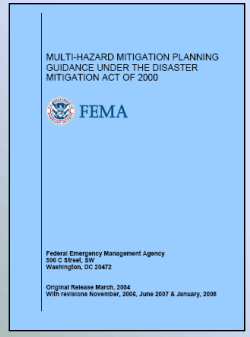
HIRA:
Hazard Identification & Risk Assessment

- Purpose: Provides a factual basis for prioritizing hazard mitigation activities
- Major components:
  - Identify and profile natural hazards affecting the state
  - Describe vulnerability to jurisdictions (cities and counties), and estimate losses
  - Describe vulnerability to state owned/operated facilities and critical facilities, and estimate losses
  - Incorporate findings of local plans



For more detailed explanation of plan requirements, refer to the “blue book”:

Federal Emergency Management Agency. (2008). “Multi-Hazard Mitigation Planning Guidance Under the Disaster Migitation Act of 2000.” Washington, D.C. Original Release March 2004, last revised January 2008.

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FEMA Guidance for HIRA

- Identify Hazards
  - Which hazards are significant enough to warrant investigation?
  - How is each hazard defined?

- Profiling Hazards
  - Identify Location (geographic areas affected) and Intensity
  - Information on Previous Occurrences
  - Probability of Future Events

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FEMA Guidance for HIRA

- Identify Hazards
  - Which hazards are significant enough to warrant investigation?
  - How is each hazard defined?

- Profiling Hazards
  - Identify Location (geographic areas affected) and Intensity
  - Information on Previous Occurrences
  - Probability of Future Events

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FEMA Guidance for HIRA

- Assessing Vulnerability (of Jurisdictions, and of State /Critical Facilities)
  - Consider Local Risk Assessments, processes used…
  - Jurisdictions most threatened & vulnerable to damage and loss
  - Facilities most threatened & vulnerable to damage and loss
  - *Updated plan needs to Reflect changes in development for jurisdictions in hazard prone areas*

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FEMA Guidance for HIRA

- Estimating Potential Losses (of Jurisdictions, and of State /Critical Facilities)
  - Analysis of potential losses by jurisdiction
  - Analysis of potential losses to the identified vulnerable structures
  - Potential losses ($$) based on estimates provided in local risk assessments and State risk assessment
  - *Updated plan needs to Reflect the effects of changes in development on loss estimates*

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Hazards Addressed

- Several hazards may impact Maryland; how do we determine the ones to focus on?
  - Local Plans
  - Declared Disasters
  - Availability of Data

2008 Plan Hazards:

Weather Related	Other Natural Hazards	Technological Hazards
Drought	Epidemic	Dam Failure
Flooding (Flash, Riverine, Tidal, Coastal)	Soil Movement	Fire and Explosion
Hurricane/Tropical Cyclone	Wildfire	Hazardous Material
Thunderstorm	Earthquakes	Transportation Accident
Winter Weather	Land Subsidence	Structure Fire
Extreme Heat	Expansive Soils	Terrorism
Lightning		
Hail		
Heavy Rain		
Extreme cold		
Heavy Snow		
Ice		

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2011 Hazards

Natural Hazards

- *Flood – inc. climate change, sea level rise, shoreline erosion, surge*
- *Wind – tornado and non-rotational, hurricane winds*
- *Wildfire*
- *Earthquake*
- *Land subsidence*
- *Karst – sinkholes*
- *Draught – extreme heat*
- *Winter Storm – sleet, extreme cold*

Human-caused Hazards

- *Dams*
- *Surface mining*
- *Dam Failure*
- *Fire and Explosion*
- *Hazardous Material*
- *Transportation Accident*
- *Structure Fire*
- *Terrorism*

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Improvements

Discussion with MAC

- ***What do you like about current plan?***
- ***Are there other efforts currently going on that we should be aware of?***
- ***Have the necessary people/departments been asked to participate?***
- ***How can this plan help your agency?***
- ***What would you like changed in this revision?***

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Data Discrepancies

Discussion with MAC

- ***What can be improved?***
- ***Tying HIRA to specific mitigation projects/activities***
- ***Does your locality/agency have new data sources that have been created since the 2008 plan update?***
- ***What types of data would you like to see in the 2011 update?***

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Data Needs: Building & Critical Facilities

- State Owned or Operated Facilities
- Local Data
  - Building Specific (year, materials, value…)
  - Infrastructure
- Critical/Essential Facilities
  - Local Facilities with Building Specific Parameters
  - HAZUS-MH default Data

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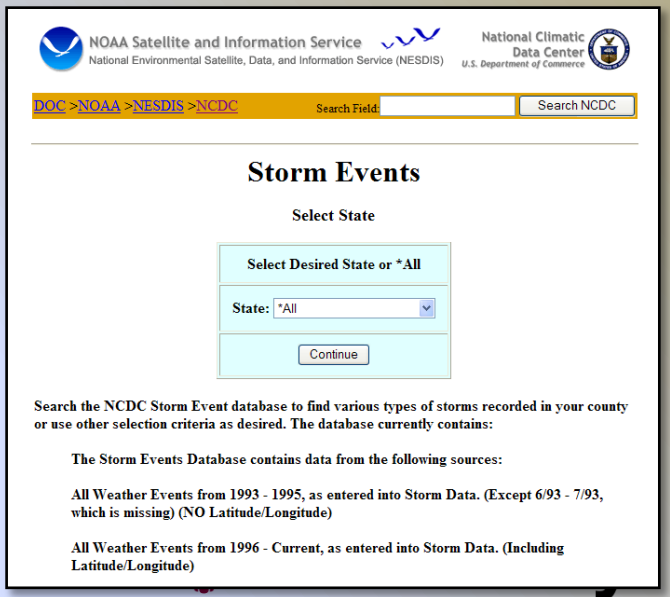
Historical Disaster Databases

- List of Federally Declared Disasters from FEMA
  - Jurisdictions declared
  - Nature of disaster
  - Type(s) of assistance provided
- National Climatic Data Center (NCDC) Storm Events Database
  - Area Impacted
  - Damages
  - Description of event
- Department of Forestry
- MD DNR
- MD DOT



NOAA Satellite and Information Service
National Environmental Satellite, Data, and Information Service (NESDIS)
National Climatic Data Center
U.S. Department of Commerce

DOC >NOAA >NESDIS >NCDC Search Field: Search NCDC

Storm Events

Select State

Select Desired State or *All

State: *All

Continue

Search the NCDC Storm Event database to find various types of storms recorded in your county or use other selection criteria as desired. The database currently contains:

The Storm Events Database contains data from the following sources:

All Weather Events from 1993 - 1995, as entered into Storm Data. (Except 6/93 - 7/93, which is missing) (NO Latitude/Longitude)

All Weather Events from 1996 - Current, as entered into Storm Data. (Including Latitude/Longitude)

Hazard Data Availability

- National Climatic Data Center (NCDC) Storm Events Database
  - NWS offices submit event reports to database, following a standard reporting protocol (what to report, and how to report it)
  - Includes location and time of event, property and crop damages, injuries and deaths
  - Data may be biased by population
  - Need to process data to assign all events/damages to specific jurisdictions

- Other Hazard-Specific Data
  - Hazard data used from 2008 Plan, National Data Sources, and sources provided by the MD Mitigation Advisory Committee

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HIRA Category	NCDC Categories Included
Drought	Drought Drought / Excessive Heat
Flood	Flooding Flash Flood / Minor Flooding River Flood Urban / Small Stream Flooding Coastal Flood / Storm Surge Tidal Flooding
High Wind	Wind Strong / High / Gusty Wind Thunderstorm Wind Dry / Wet Microburst High Wind and Seas Hurricane Tropical Storm
Tornado	Tornado Waterspout Funnel Cloud Land spout
Winter Storm	Blizzard Snow / Heavy Snow Ice / Ice Storm Snow / Sleet / Rain Winter Storm Winter Weather / Mix Freezing Rain
Wildfire	Wild / Forest Fire
Landslide	Mudslide Rockslide Landslide Debris Flow

Other event types in NCDC:

EXTREME COLD
EXTREME COLD/WIND CHILL
EXTREME WINDCHILL
EXCESSIVE HEAT
LIGHTING
LIGHTNING
AGRICULTURAL FREEZE
ASTRONOMICAL HIGH TIDE
BLACK ICE
Black Ice
COLD
Cold
Cold and Frost
COLD/WIND CHILL
DENSE FOG
DUST DEVIL
EXCESSIVE
FOG
FREEZE
FREEZING FOG
FROST
FROST/FREEZE
HAIL
HAIL DAMAGE
HEAT
HEAT WAVE
HEAVY RAIN
HEAVY SEAS
HEAVY SURF
HEAVY SURF/HIGH SURF
HIGH SURF
MONTHLY PRECIPITATION
MONTHLY RAINFALL
MONTHLY TEMPERATURE
PROLONG COLD
Prolong Cold
PROLONG WARMTH
RECORD COLD
RECORD HEAT
RECORD WARMTH
Record Warmth
RIP CURRENT
UNSEASONABLY COLD
UNSEASONABLY WARM
UNUSUALLY COLD
UNUSUALLY WARM

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Data Sources & Needs

- Demographics
  - Census Data
- Hazard Data
  - Flood: FEMA FIRMs, FEMA Rep Loss, NCDC & HAZUS-MH
  - Tornado: NCDC, NWS & SVRGIS
  - Wind: HAZUS-MH,NCDC & SVRGIS
  - Land & Mine Subsidence: USGS & MD Sources(?)
  - Severe Thunderstorms: NCDC & SVRGIS
  - Winter Weather: NCDC, NWS
  - Earthquake: HAZUS-MH
  - Wildfire: MDDOF & NCDC
- Land Use
  - State & Local Planning Efforts (population changes and/or shifts, changes in land use activities)
  - National Land Cover Data (NLCD)

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Data Transfer to Dewberry

- 2008 MD HMP GIS Database
  - State & Critical Facilities
  - Hazard Specific Data and/or Analysis
- State requests for NCDC Database
- GIS & Hazard Specific contacts
- Data used in previous or other planning efforts

Notify dmills@dewberry.com when uploading data to FTP:

ftp.dewberry.com

Username: 2011MDHMP

Password: IGHH2T

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Local HMP Integration

- 2008 MD HMP did not ***fully*** integrate local HMPs
- Local facilities were included in 2008 MD HMP
- 2008 MD HMP had a goal to integrate local plans

FEMA Guidance:

Assessing Vulnerability by Jurisdiction

A. *Does the new or updated plan describe the State's vulnerability based on estimates provided in local risk assessments as well as the State risk assessment?*

C. *Does the updated plan explain the process used to analyze the information from the local risk assessments, as necessary?*

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Local HMP Integration

2008 MD HMP list of upcoming local plan updates:

Table 4.1 Local Mitigation Plan Updates Underway

Jurisdiction	Update Due	Cost of Update	Funding Source
Cecil Co.	April 2009	$37,600	FMAP/Local
Frederick Co.	April 2010	$78,955	HMGP-1652/Local
Harford Co.	December 2009	$40,000	HMGP-1652/Local
Howard Co.	December 2009	$93,662	FMAP/PDM/Local
Prince George's Co.	May 2010	$360,000	PDM/Local*

FEMA Guidance:

Assessing Vulnerability by Jurisdiction

A. *Does the new or updated plan describe the State's vulnerability based on estimates provided in local risk assessments as well as the State risk assessment?*

C. *Does the updated plan explain the process used to analyze the information from the local risk assessments, as necessary?*

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Ranking
Methodology, Risk & Vulnerability

- Review of Existing Ranking
- Potential Methodology for Revision
- Determining Risk & Vulnerability
- Annualized Loss

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2008 Ranking Parameters

‘Composite Risk’ score factored frequency and severity of hazards

- Composite Risk score formula varied depending on the hazard type
- Composite Risk score *did not factor population*

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Example: 2008 Snow Risk

Jurisdiction	Snow Events Per Year	Snow Risk	Heavy Snow Events Per Year (12" or more)	Heavy Snow Risk	Average Snowfall Per Year (Inches)	Snowfall Risk	Mean Damage Per Event	Damage Risk	Average Risk*	Composite Risk
Allegany	3.65	5	0.63	5	54.8	4	518,236	4	4.67	5
Anne Arundel	1.47	3	0.19	3	19.4	3	370,954	3	3.00	3
Baltimore County	2.16	4	0.27	4	27.5	4	253,197	1	3.50	4
Calvert	0.81	1	0.14	2	17.1	3	511,561	4	2.17	2
Caroline	1.20	2	0.12	2	17.6	3	343,992	3	2.33	2
Carroll	2.30	4	0.32	4	35.7	4	240,000	1	3.50	4
Cecil	1.71	3	0.24	3	12.5	2	240,292	1	2.50	2
Charles	0.99	2	0.18	3	14.5	2	418,576	4	2.67	3
Dorchester	0.87	1	0.10	2	15.1	2	284,842	2	1.67	1
Frederick	2.90	4	0.22	3	27.1	4	239,411	1	3.17	4
Garrett	4.34	5	0.72	5	96.6	5	395,818	4	4.83	5
Harford	1.94	3	0.13	2	14.4	2	280,985	2	2.33	2
Howard	1.71	3	0.20	3	20.9	3	319,781	3	3.00	3
Kent	1.26	2	0.20	3	18.2	3	326,685	3	2.67	3
Montgomery	1.88	3	0.21	3	21.5	3	288,492	2	2.83	3
Prince George's	1.58	3	0.17	3	18.7	3	343,798	3	3.00	3
Queen Anne's	1.31	2	0.15	2	19.3	3	311,312	3	2.33	2
St. Mary's	1.04	2	0.24	3	17.8	3	395,903	4	2.83	3
Somerset	0.81	1	0.00	1	6.3	1	304,434	3	1.33	1
Talbot	1.35	2	0.11	2	13.6	2	305,067	3	2.17	2
Washington	2.60	4	0.36	4	30.5	4	216,329	1	3.50	4
Wicomico	0.90	1	0.04	1	11.6	2	276,504	2	1.33	1
Worcester	0.75	1	0.11	2	13.5	2	736,604	5	2.17	2
Baltimore City	1.77	3	0.27	4	27.5	4	308,285	3	3.50	4
Ocean City	0.51	1	0.11	2	13.5	2	483,640	4	2.00	2

*Average Risk=(2*Snow Risk+2*Heavy Snow Risk+Snowfall Risk+Damage Risk)/6

2008 Risk Ranking

Table 5.2

Jurisdiction	Weather-Related Hazards*															
	Drought	Extreme Heat	Thunderstorms	Lightning	Wind	Hail	Tornado	Hurricane/ Tropical Storm	Storm Surge (Category 1 Risk)	Tidal/Coastal Flooding	Heavy Rain	Flash Flooding	Riverine Flooding	Extreme Cold	Snow	Ice
Allegany	5	2	2	3	1	2	2	1	1	1	2	5	2	5	5	4
Anne Arundel	4	4	5	5	5	3	5	2	3	5	4	4	3	5	3	5
Baltimore County	5	4	5	5	4	4	4	2	2	3	4	5	2	5	4	4
Calvert	2	2	3	3	2	3	4	3	2	4	2	2	1	5	2	2
Caroline	3	5	2	2	2	3	2	4	1	3	4	2	1	5	2	2
Carroll	5	4	4	5	5	2	3	1	1	1	4	4	2	5	4	5
Cecil	4	5	3	4	3	2	3	4	2	1	3	3	3	5	2	3
Charles	2	3	4	3	3	4	5	2	2	3	2	2	1	5	3	2
Dorchester	2	1	2	1	1	3	3	4	5	5	3	2	1	3	1	2
Frederick	5	4	4	5	4	4	5	1	1	1	5	5	5	5	4	5
Garrett	3	1	2	3	2	2	4	1	1	1	2	3	5	1	5	4
Harford	5	4	5	4	3	4	4	2	2	2	4	4	1	5	2	4
Howard	5	4	3	3	3	4	3	1	1	1	4	3	2	5	3	5
Kent	3	5	2	3	2	2	2	4	3	4	3	1	1	5	3	3
Montgomery	5	4	5	5	5	5	3	1	1	1	4	5	4	5	3	5
Prince George's	4	4	5	4	4	4	5	3	1	1	5	4	3	5	3	5
Queen Anne's	3	5	2	1	1	1	3	4	3	3	4	2	1	5	2	3
St. Mary's	2	3	3	1	2	4	4	3	3	3	3	2	1	5	3	2
Somerset	1	1	1	1	1	3	1	5	5	3	1	3	1	3	1	3
Talbot	3	5	3	4	1	2	1	4	4	4	4	2	1	5	2	2
Washington	5	3	4	4	4	4	3	1	1	1	4	4	4	5	4	5
Wicomico	1	1	2	1	1	3	3	5	3	2	2	1	1	3	1	3
Worcester	1	1	2	2	2	2	3	5	4	5	2	2	1	3	2	3
Baltimore City	4	4	3	2	1	4	1	2	2	3	3	3	1	5	4	4
Ocean City	1	1	1	2	**	**	**	4	5	5	2	1	1	3	2	1

*5 = high risk; 4 = medium-high risk; 3 = medium risk; 2 = medium-low risk; 1 = low risk.

**Data not available at the municipal level.

indicates a relatively high hazard potential;
indicates a moderate hazard potential;
indicates a relatively low hazard potential.

2008 Risk Ranking

Table 5.2 Continued

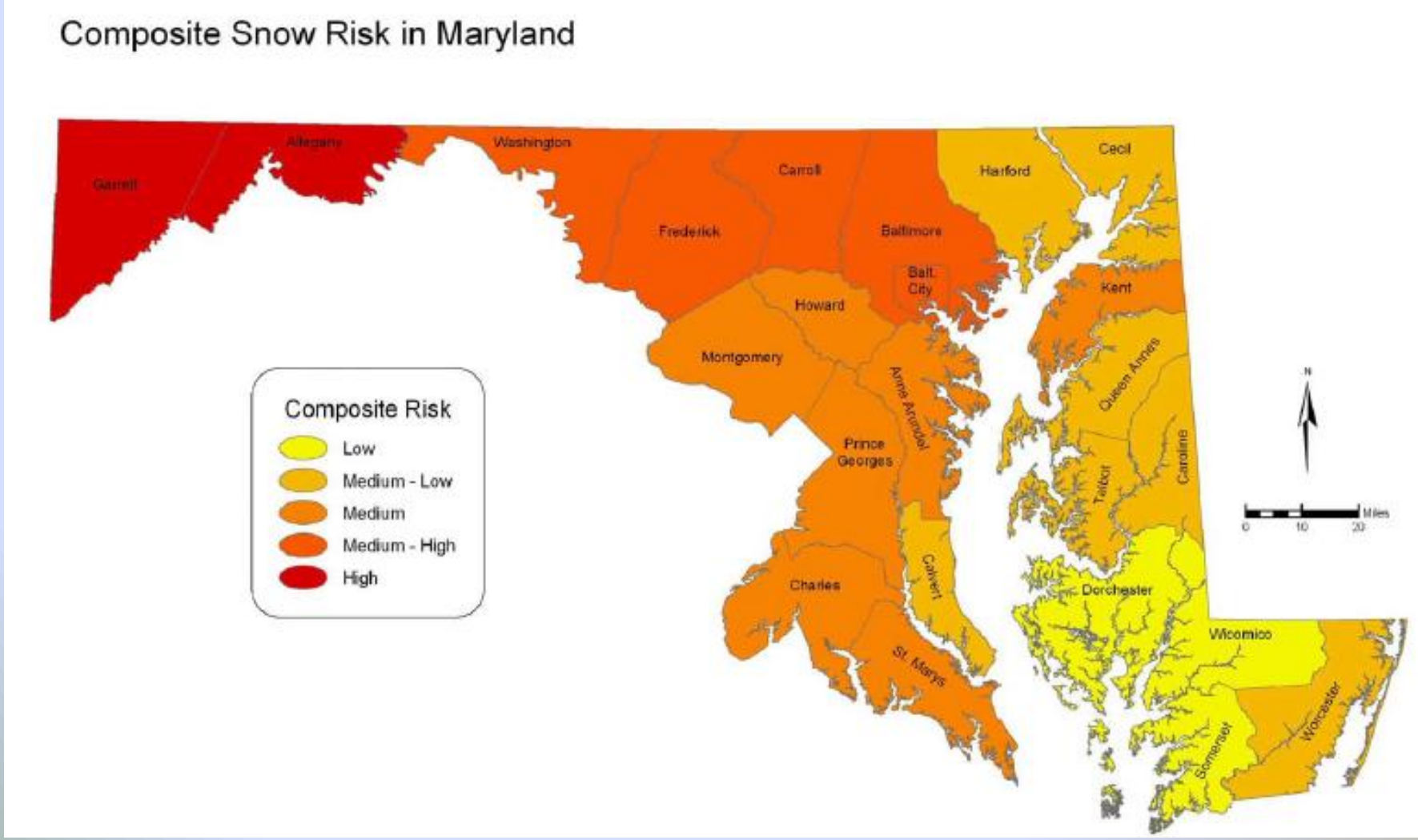
Jurisdiction	Other Natural Hazards*							Technological Hazards*						
	Earthquakes	Land Subsidence	Mass Movement	Expansive Soils	Wildfires	Brush Fires	Epidemics	Dam Failure	Structural Fires	Fixed-Site Hazardous Material Incidents	Transportation Hazardous Material Incidents	Radiological Emergency	Airplane Accidents	Rail Accidents
Allegany	1	5	3	3	5	2	1	2	4	1	1	1	2	5
Anne Arundel	3	3	5	3	1	5	2	3	3	4	4	3	5	3
Baltimore County	5	3	3	3	2	5	2	5	1	4	4	3	5	5
Calvert	2	1	3	1	3	3	2	2	1	1	1	5	1	1
Caroline	1	1	1	3	3	1	3	2	3	1	1	3	1	2
Carroll	4	5	1	4	2	3	1	2	2	1	1	3	5	4
Cecil	3	1	5	2	4	1	2	5	2	2	2	5	3	3
Charles	1	1	3	2	5	4	2	2	1	2	1	3	2	2
Dorchester	1	1	1	3	5	2	4	1	4	1	1	4	2	2
Frederick	1	5	3	4	3	4	2	3	2	2	2	3	5	3
Garrett	1	5	5	3	3	1	1	5	3	1	1	1	3	4
Harford	4	1	3	2	3	4	2	4	1	3	3	5	3	4
Howard	5	1	1	2	1	4	2	2	1	2	2	2	2	3
Kent	2	1	1	5	2	1	3	3	5	1	1	3	1	2
Montgomery	1	1	1	4	1	5	2	5	1	3	3	2	5	4
Prince George's	3	1	5	4	3	5	4	4	3	4	4	3	5	5
Queen Anne's	2	1	1	4	4	2	2	2	4	1	1	3	4	1
St. Mary's	1	1	3	2	4	3	3	1	4	1	2	4	3	1
Somerset	1	1	1	4	5	2	4	1	4	1	1	2	1	1
Talbot	1	1	1	4	3	1	3	1	3	1	1	3	2	1
Washington	2	3	3	5	4	3	3	5	3	1	3	2	2	4
Wicomico	1	1	1	4	4	3	4	3	3	2	1	2	4	1
Worcester	1	1	1	1	3	2	3	1	4	2	1	2	4	2
Baltimore City	2	3	5	5	**	5	5	2	5	3	5	3	2	5
Ocean City	1	**	**	**	**	**	**	**	**	1	1	1	2	**

*5 = high risk; 4 = medium-high risk; 3 = medium risk; 2 = medium-low risk; 1 = low risk.

**Data not available at the municipal level.

indicates a relatively high hazard potential;
indicates a moderate hazard potential;
indicates a relatively low hazard potential.

2008 Risk Ranking



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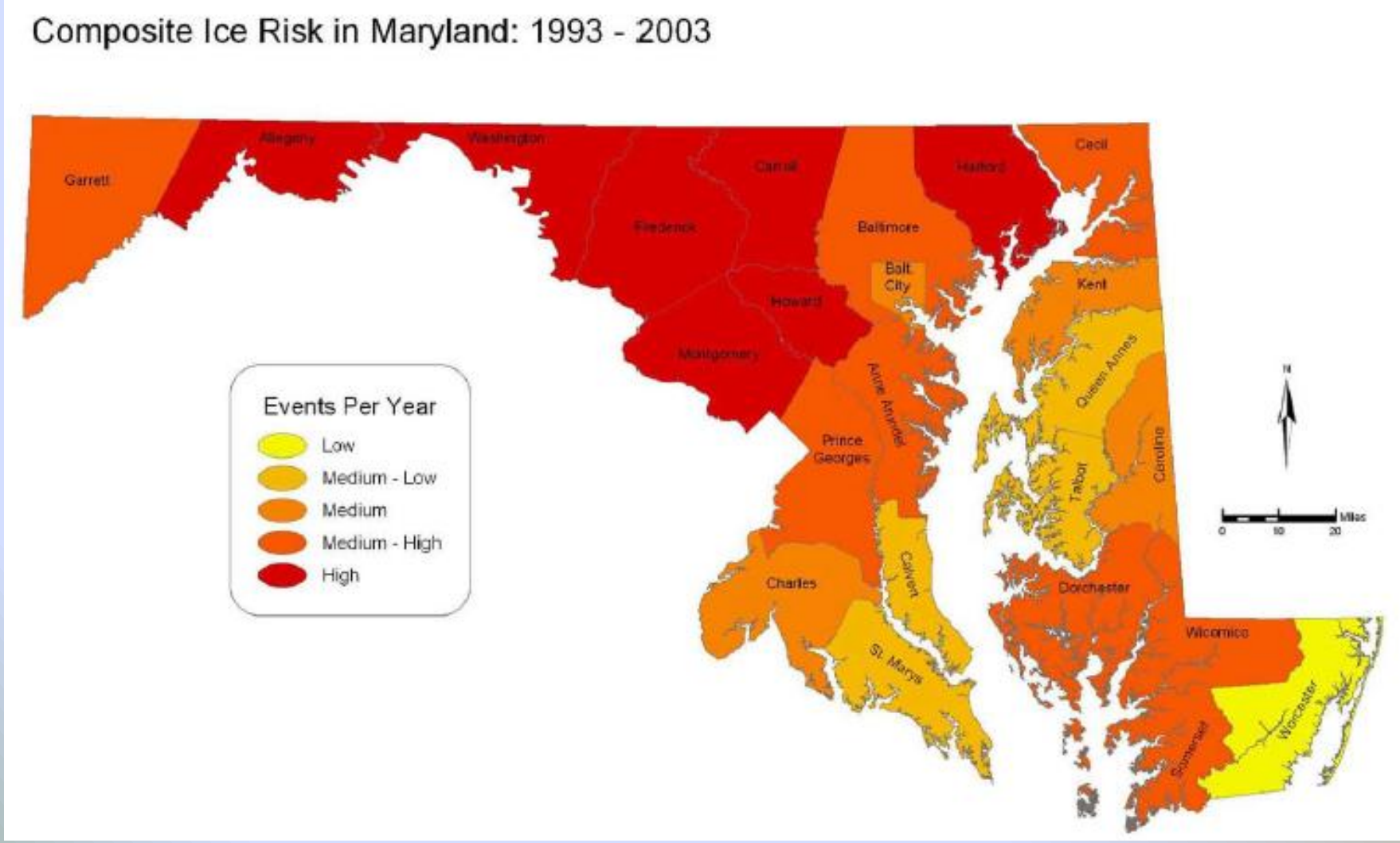
2008 Risk Ranking



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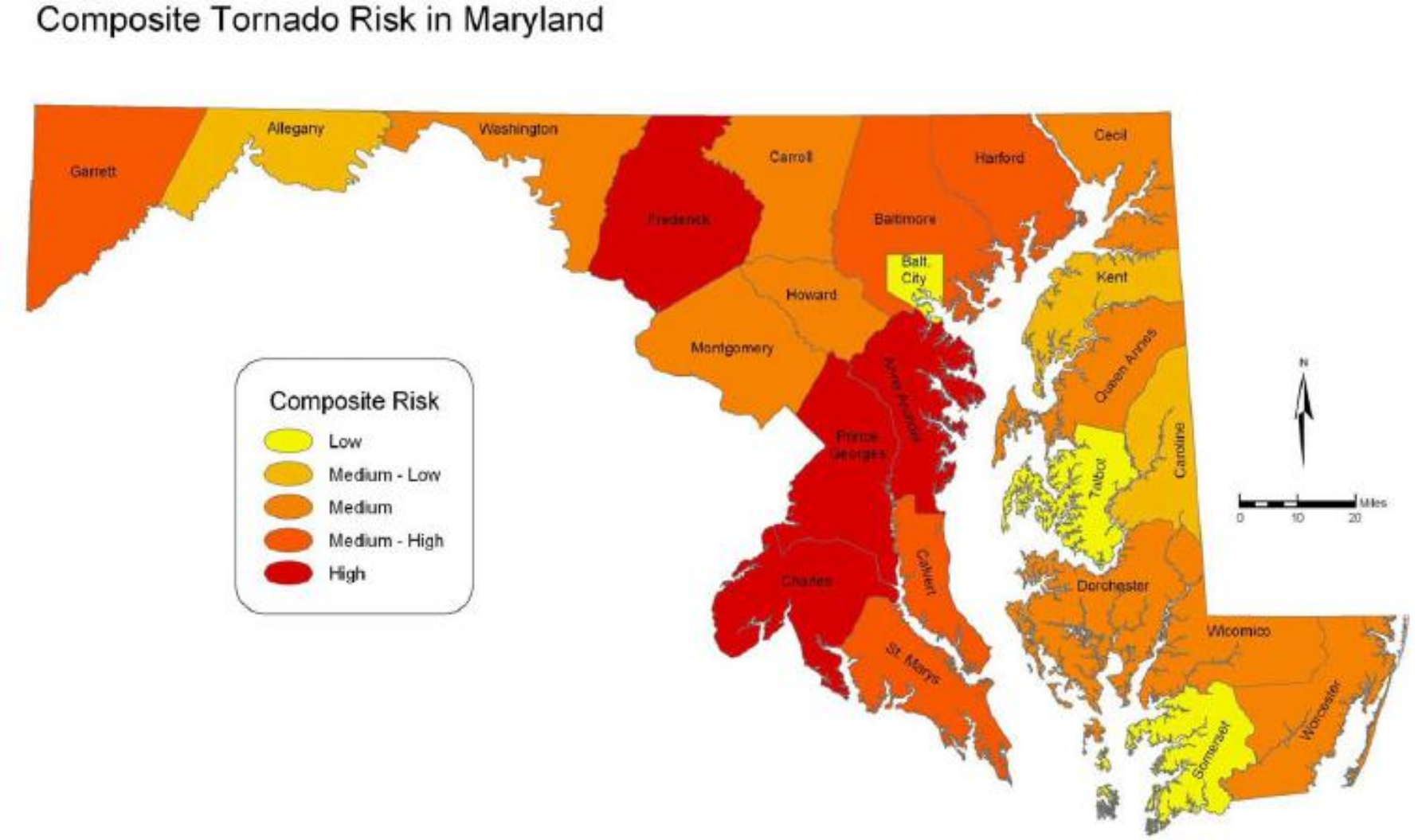
2008 Risk Ranking



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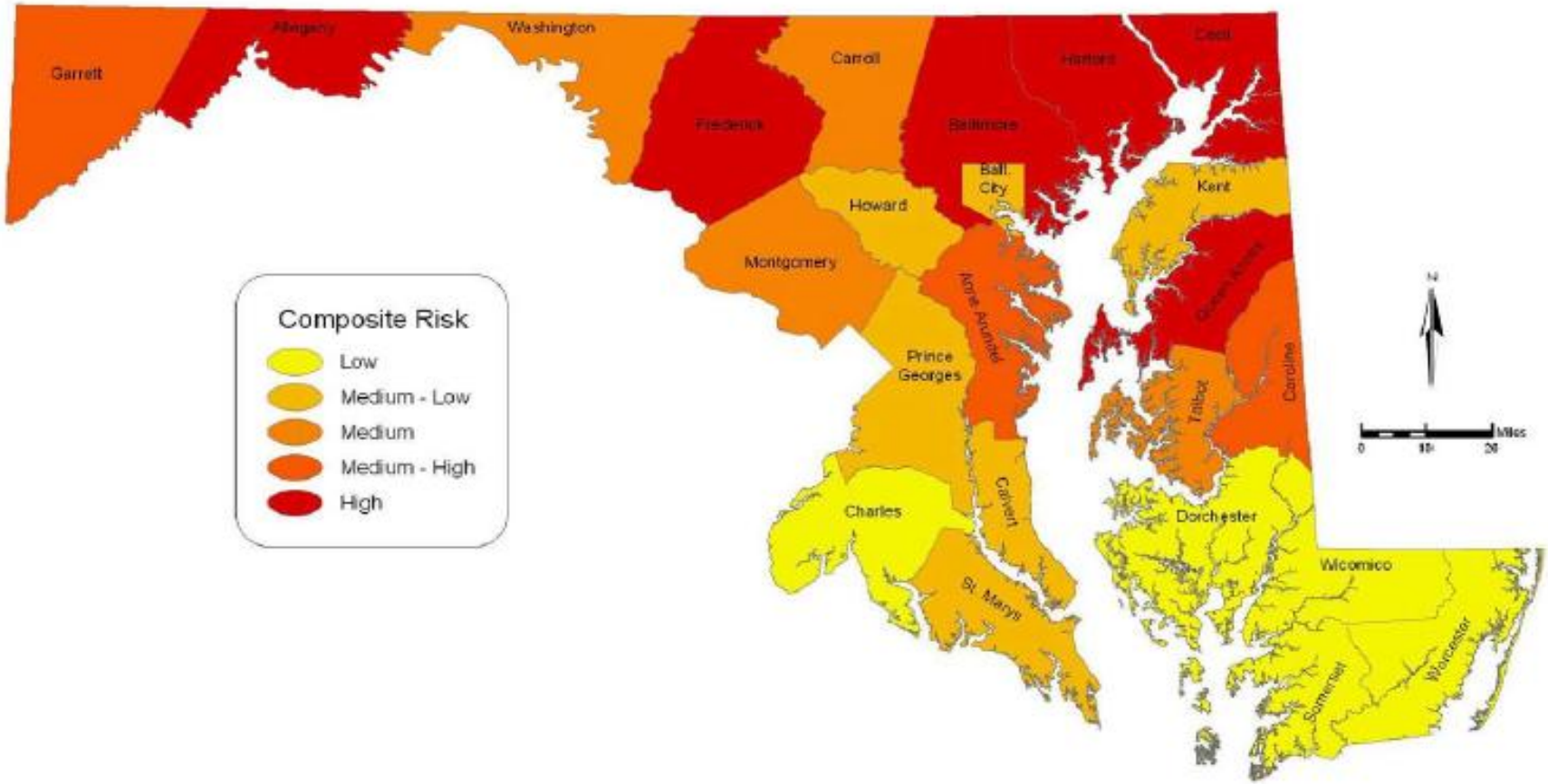
2008 Risk Ranking

Composite Flash Flooding Risk in Maryland: 1993 - 2003



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Hazard Ranking

- The purpose of the hazard identification and risk assessment is to provide a factual basis for developing mitigation strategies, and in so doing, to prioritize those jurisdictions which most threatened and vulnerable to natural hazards.

- FEMA guidance indicates that the jurisdictions at greatest risk to specific hazards should be identified, considering both the characteristics of the hazard and the jurisdictions' degree of vulnerability. A variety of analysis methods may be sufficient to meet these goals; FEMA does not mandate a specific analysis method.

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Hazard Ranking

- Many State plans have developed their own ranking system based on geographic data describing the incidence and/or severity of each hazard, as well as the populations vulnerable to each hazard.

- Examples of ranking methods used in other state/local plans:
  - Scoring systems based on expert judgment
  - Scoring systems based on GIS / Data analysis
  - Annualized loss ($) calculations

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Potential Hazard Ranking Option

- Rank hazard risk (from each hazard) in each jurisdiction, and at the composite State level
- This requires that hazard risks tabulated/accounted in some comparable system
- Jurisdictional hazard rankings have been determined based on a <u>scoring system</u> which considers a variety of relevant parameters:
  - Population and/or Population Density
  - Property & Crop Damage
  - Deaths/Injuries
  - Annualized Events
  - Geographic Extent

Population and/or Population Density, Property & Crop Damage: Census

Deaths/Injuries, Annualized Events, Geographic Extent: NCDC

Property & Crop Damage: Hazard-Specific Sources

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VA & West VA State Ranking Parameters

- "Semi-Quantitative" Scoring System
  - Actual Data Values grouped in categories 1-4 based on statistics
- NCDC Data with normalization (inflation …)
  - Limitations with probability & impact data
- Parameters Used:
  - Population Vulnerability (weight 0.5)
  - Population Density (weight 0.5)
  - Geographic Extent (weight 1.5)
  - Annualized Deaths & Injuries (weight 1)
  - Annualized Crop & Property Damage (weight 1)
  - Annualized Events (weight 1)

Jurisdictional Risk (RS):

RS = (0.5*(PV + PN)) + ID + EV + PD + CD + (1.5*GE)

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Table 3.5-1 Population Vulnerability (PV)

Rank	Description	
1	<= 0.229 %	of population
2	0.230% - 0.749%	of population
3	0.750% - 2.099%	of population
4	> = 2.100%	of population

Table 3.5-2 Population Density (PN)

Rank	Description	
1	<= 60.92	people/sq mi
2	60.93 – 339.10	people/sq mi
3	339.11 - 1,743.35	people/sq mi
4	>= 1,743.36	people/sq mi

Table 3.5-6 Annualized Events (EV)

Rank	Definition	
1	<= 0.09	events per year
2	0.10 – 0.99	events per year
3	1.00 – 4.99	events per year
4	>= 5.00	events per year

Table 3.5-4 Annualized Deaths & Injuries (ID)

Rank	Definition	
1	<= 1.019	D&I per year
2	1.020 – 6.279	D&I per year
3	6.280 – 13.199	D&I per year
4	>= 13.200	D&I per year

Table 3.5-5 Annualized Crop and Property Damage (CD, PD)

Rank	Definition: Crop Damage	Definition: Property Damage
1	<= $25,711 per year	<= $ 136,129 per year
2	$25,712 – $100,270 per year	$136,130 - $432,555 per year
3	$100,271 - $291,384 per year	$432,556 - $1,111,067 per year
4	>= $291,385 per year	>= $1,111,068 per year

Table 3.5-3 Geographic Extent : Percentage of a jurisdiction impacted by the hazard (GE)

Hazard	Description	Category Breaks	
		Rank	Description
Flood	Percent of a jurisdiction that falls within FEMA Special Flood Hazard Area (SFHA). *Data: FEMA Floodplains (DFIRMs)*	1	<=2.99%
		2	3.00-4.99%
		3	5.00 -9.99%
		4	>=10.00%
High Wind	Average maximum wind speed throughout the entire jurisdiction. *Data: HAZUS 3-second Peak Gust Wind Speeds*	1	<= 59.9
		2	60.0 - 73.9
		3	74.0 - 94.9
		4	>= 95.0
Wildfire	Percent of jurisdiction that falls within a "high" risk. *Data: VDOF Wildfire Risk Assessment*	1	<= 9.9%
		2	10.0% - 19.9%
		3	20.0% - 49.9%
		4	>= 50.0%
Karst	Percent of jurisdiction where the risk is "high" for karst related events. *Data: USGS Engineering Aspects of Karst*	1	<= 24.9%
		2	25.0% - 49.9%
		3	50.0% - 74.9%
		4	>= 75.0%
Landslide	Percent of jurisdiction where a high landslide risk exists. *Data: USGS Landslide Incidence & Susceptibility*	1	<= 24.9%
		2	25.0% - 49.9%
		3	50.0% - 74.9%
		4	>= 75.0%
Earthquake	Average 2500-year return period max percent of gravitational acceleration (PGA). *Data: HAZUS 2500-year PGA*	1	<= 0.069
		2	0.070 - 0.159
		3	0.160 - 0.299
		4	>= 0.300
Winter Storm	Average annual number of days receiving at least 3 inches of snow, calculated as an area-weighted average for each jurisdiction. *Data: NWS snowfall statistics*	1	<= 1.49
		2	1.50 - 1.99
		3	2.00 - 2.99
		4	>= 3.0
Tornado	Annual tornado hazard frequency (times one million), calculated as an area-weighted average for each jurisdiction. *Data: NCDC tornado frequency statistics*	1	<= 1.24
		2	1.25 - 9.99
		3	10.00 - 99.9
		4	>= 100.00

Jurisdictional Risk (RS):

$$RS = (0.5*(PV + PN)) + ID + EV + PD + CD + (1.5*GE)$$

RankingMethod_2-5-09.xlsx [Read-Only] - Microsoft Excel

Ranking Worksheet

LEGEND

PV - Population Vulnerability
I/D - Injuries and Deaths

PN - Pop Density
PD - Property Damage
CD - Crop Damage
GE - Geographic Extent
EV- Annualized Events
RS - Risk

Score Definitions

Score	Population Vulnerability Geometrical Interval	Injuries/Deaths (Natural Breaks)	Property Damage (Natural Breaks)	Crop Damage (Natural Breaks)	Geographic Extent: Flood	EQ	Hurricane Wind	Tornado	Winter	Landslide	Karst	Wildfire	Events	Pop Dens Geo Interval
	Definition (<)	Definition (>)	Definition (>)	Definition (>)	Definition (<)									
1	0%	0.00	0.00	0.00	0.00	0	0	0.00	0.0	0.00	0.00	0.00	0	0
2	0.2300%	1.02	136130.00	25712.00	3.00	0.07	60	1.25	1.5	25.00	25.00	10.00	0.10	60.93
3	0.7500%	6.28	432556.00	100271.00	5.00	0.16	74	10.00	2.0	50.00	50.00	20.00	1.00	339.11
4	2.1000%	13.20	1111068.00	291385.00	10.00	0.3	95	100.00	3.0	75.00	75.00	50.00	5.00	1743.36
-	5.6372%	55.00	2787588.57	3218982.39	100.00	1	300	316.00	7	100.00	100.00	100.00	10	8832.09
WEIGHT														

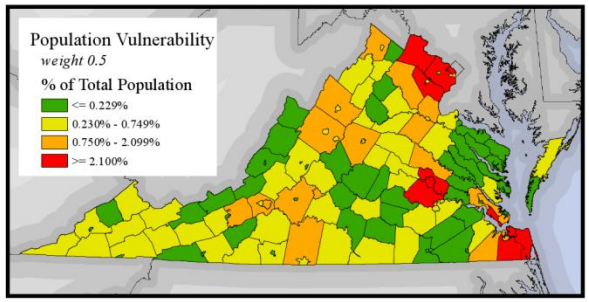
Score (>=)	Hazard Risk Rank	Score (>)	Total Rank
0	Low	0	Low
8.5	Med-Low	65	Mod.
10	Med	70	High
11.5	Med-High		
13	High		

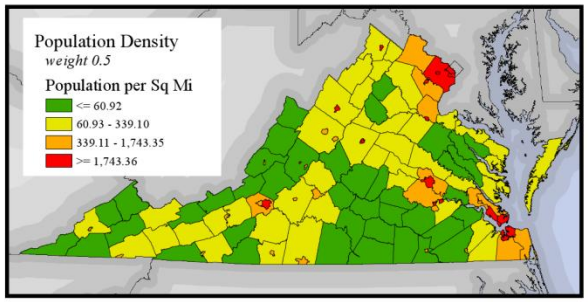
FIPS	County	Karst PV	Karst I/D	Karst PN	Karst PD	Karst CD	Karst GE	Karst EV	Karst RS	Karst Rank	Drought PV	Drought I/D	Drought PN	Drought PD	Drought CD	Drought GE	Drought EV	Drought RS	Drought Rank	Earthquake PV	Earthquake I/D	Earthquake PN	Earthquake PD	Earthquake CD	Earthquake GE	Earthquake EV	Earthquake RS	Earthquake Rank	Flood PV	Flood I/D	Flood PN	Flood PD	Flood CD	Flood GE	Flood EV	Flood RS	Flood Rank	PV
51001	Accomack	2	1	2	1	1	1	1	7.5	Low	2	1	2	1	3	1	2	10.5	Med	2	1	2	1	1	1	1	7.5	Low	2	1	2	1	1	4	2	13	High	2
51003	Albemarle	3	1	2	1	1	1	1	8	Low	3	1	2	1	2	1	3	11	Med	3	1	2	1	1	2	1	9.5	Med-	3	3	2	1	2	3	3	16	High	3
51510	Alexandria (c)	3	1	4	1	1	1	1	9	Med-	3	1	4	1	2	1	3	12	Med-	3	1	4	1	1	2	1	10.5	Med	3	1	4	1	1	4	3	15.5	High	3
51005	Alleghany	1	1	1	1	1	1	1	6.5	Low	1	1	1	1	1	1	2	7.5	Low	1	1	1	1	1	2	1	8	Low	1	3	1	2	1	2	3	13	High	1
51007	Amelia	1	1	1	1	1	1	1	6.5	Low	1	1	1	1	2	1	2	8.5	Med-	1	1	1	1	1	2	1	8	Low	1	1	1	1	1	3	2	10.5	Med	1
51009	Amherst	2	1	2	1	1	1	1	7.5	Low	2	1	2	1	4	1	3	12.5	Med-	2	1	2	1	1	2	1	9	Med-	2	2	2	2	1	3	3	14.5	High	2
51011	Appomattox	1	1	1	1	1	1	1	6.5	Low	1	1	1	1	4	1	3	11.5	Med-	1	1	1	1	1	2	1	8	Low	1	2	1	2	2	2	3	13	High	1
51013	Arlington	4	1	4	1	1	1	1	9.5	Med-	4	1	4	1	2	1	3	12.5	Med-	4	1	4	1	1	2	1	11	Med	4	3	4	3	3	1	3	17.5	High	4
51015	Augusta	3	1	2	1	1	3	1	11	Med	3	1	2	1	4	1	3	13	High	3	1	2	1	1	2	1	9.5	Med-	3	4	2	3	3	2	3	18.5	High	3
51017	Bath	1	1	1	1	1	1	1	6.5	Low	1	1	1	1	1	1	3	8.5	Med-	1	1	1	1	1	2	1	8	Low	1	1	1	3	1	2	3	12	Med-	1
51019	Bedford	3	1	2	1	1	1	1	8	Low	3	1	2	1	4	1	3	13	High	3	1	2	1	1	2	1	9.5	Med-	3	3	2	2	1	3	3	16	High	3
51515	Bedford (c)	1	1	3	1	1	1	1	7.5	Low	1	1	3	1	2	1	3	10.5	Med	1	1	3	1	1	2	1	9	Med-	1	2	3	1	1	3	3	13.5	High	1
51021	Bland	1	1	1	1	1	4	1	11	Med	1	1	1	1	4	1	2	10.5	Med	1	1	1	1	1	3	1	9.5	Med-	1	1	1	2	1	2	2	10	Med	1
51023	Botetourt	2	1	1	1	1	3	1	10	Med	2	1	1	1	4	1	2	11	Med	2	1	1	1	1	2	1	8.5	Med-	2	1	1	2	1	2	3	11.5	Med-	2
51520	Bristol (c)	1	1	3	1	1	4	1	12	Med-	1	1	3	1	2	1	3	10.5	Med	1	1	3	1	1	3	1	10.5	Med	1	1	3	1	1	3	2	11.5	Med-	1
51025	Brunswick	2	1	1	1	1	1	1	7	Low	2	1	1	1	4	1	2	11	Med	2	1	1	1	1	2	1	8.5	Med-	2	1	1	2	1	3	2	12	Med-	2
51027	Buchanan	2	1	1	1	1	1	1	7	Low	2	1	1	1	1	1	2	8	Low	2	1	1	1	1	3	1	10	Med	2	4	1	4	1	1	3	15	High	2
51029	Buckingham	1	1	1	1	1	1	1	6.5	Low	1	1	1	1	4	1	3	11.5	Med-	1	1	1	1	1	2	1	8	Low	1	2	1	1	1	3	3	12.5	Med-	1
51530	Buena Vista (c)	1	1	3	1	1	1	1	7.5	Low	1	1	3	1	2	1	3	10.5	Med	1	1	3	1	1	2	1	9	Med-	1	1	3	1	1	4	3	14	High	1
51031	Campbell	2	1	2	1	1	2	1	9	Med-	2	1	2	1	4	1	3	12.5	Med-	2	1	2	1	1	2	1	9	Med-	2	3	2	1	1	3	3	14.5	High	2
51035	Caroline	2	1	2	1	1	1	1	7.5	Low	2	1	2	1	1	1	2	8.5	Med-	2	1	2	1	1	2	1	9	Med-	2	1	2	1	1	4	3	14	High	2
51033	Carroll	2	1	1	1	1	1	1	7	Low	2	1	1	1	4	1	2	11	Med	2	1	1	1	1	2	1	8.5	Med-	2	1	1	1	1	1	2	8	Low	2
51036	Charles City	1	1	1	1	1	1	1	6.5	Low	1	1	1	1	2	1	2	8.5	Med-	1	1	1	1	1	2	1	8	Low	1	1	1	2	1	4	2	13	High	1

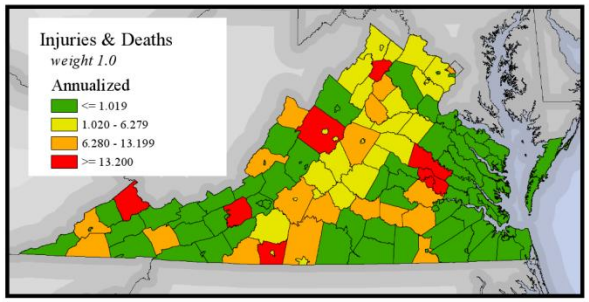
Definitions | Ranking Worksheet | I-F Data | Prop Data | Crop Data | GE | Events | PV | Population | PopDen

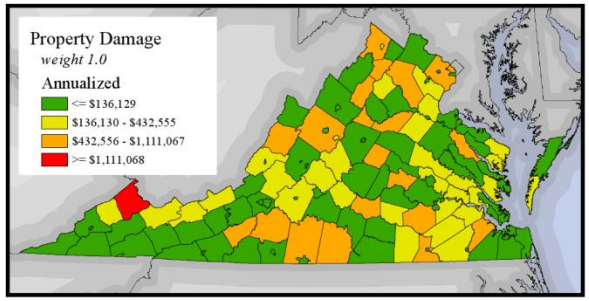
Ready

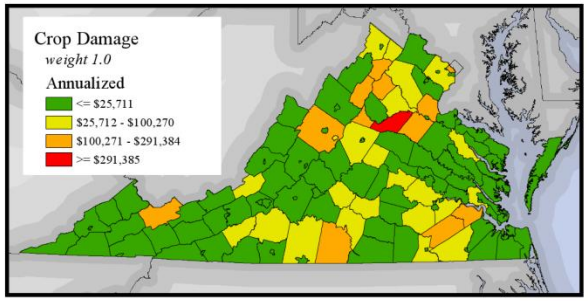
Figure 3.7-5: Flood Hazard Ranking Parameters and Risk Map

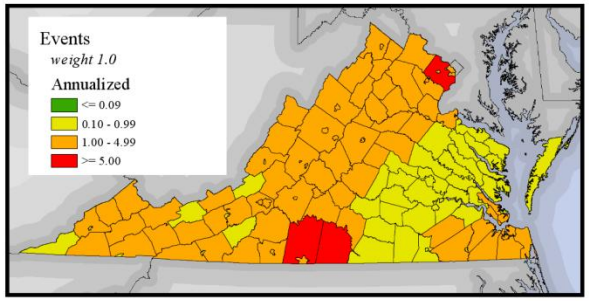


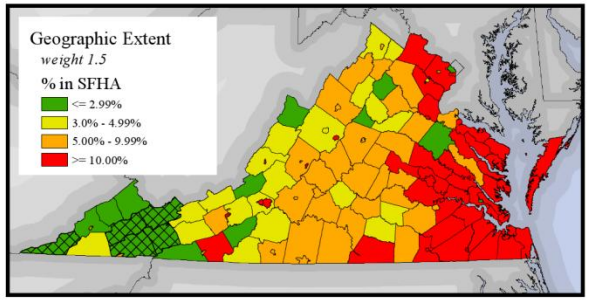


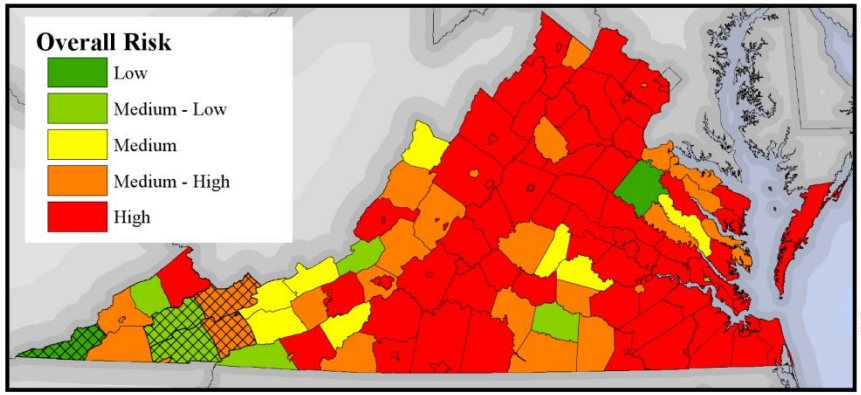












*No Digital FIRM Available

PROJECTION: *VA Lambert Conformal Conic*
North American Datum 1983

N
W E
S

HAZARD RANKING:

A number of factors have been considered in this risk assessment to be able to compare between jurisdictions and hazards. The factors have been added together to come up with the overall total ranking for each hazard.

Some factors were weighted based on imput from the HIRA sub-committee.

Section 3.5 explains each of the factors in detail.

Factors & Weighting Include:

- Population Vulnerability & Density 0.5 weighting
- Injuries & Deaths 1.0 weighting
- Crop & Property Damage 1.0 weighting
- Annualized Events 1.0 weighting
- Geographic Extent 1.5 weighting

DATA SOURCES:

CGIT Ranking Methodology
VGIN Jurisdicational Boundaries
ESRI State Boundaries

DISCLAIMER: Majority of available hazard data is intended to be used at national or regional scales. The purpose of the data sets are to give general indication of areas that may be susceptible to hazards. In order to identify potential risk in the Commonwealth available data has been used beyond the original intent.

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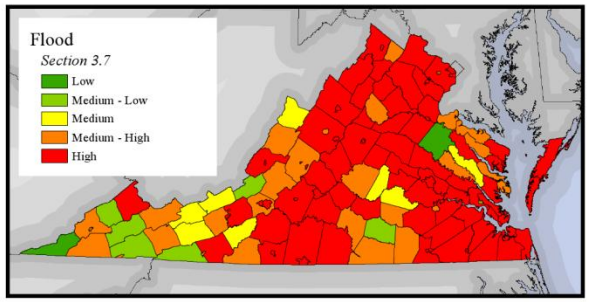
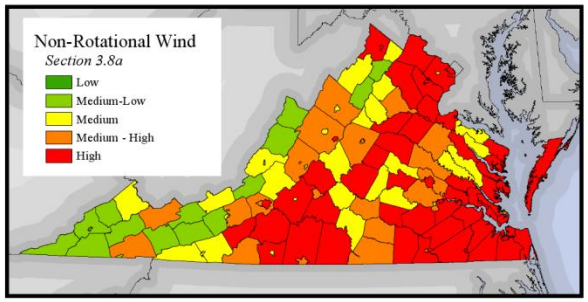
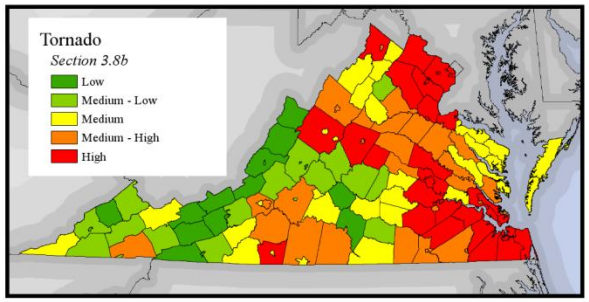
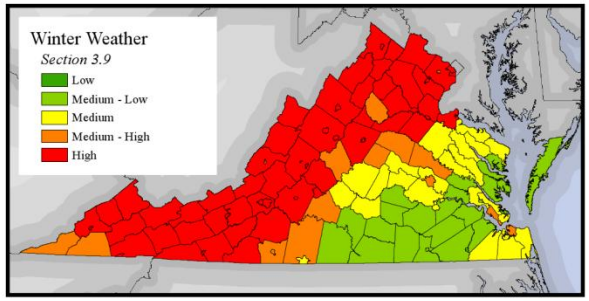
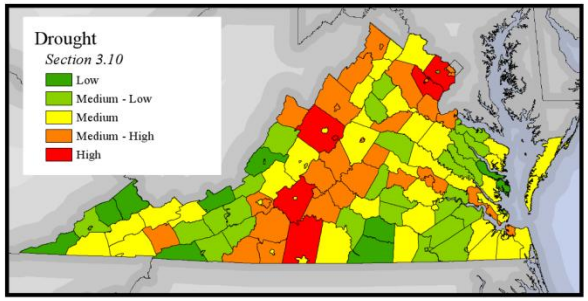
Figure 3.16-1: Hazard Ranking Risk Maps

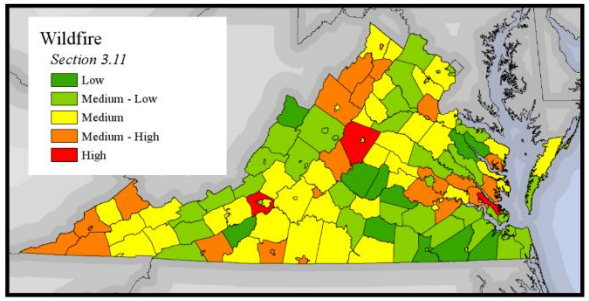


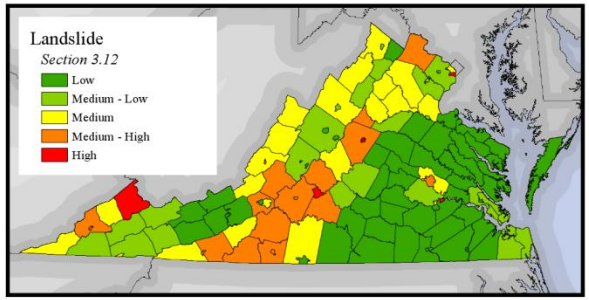


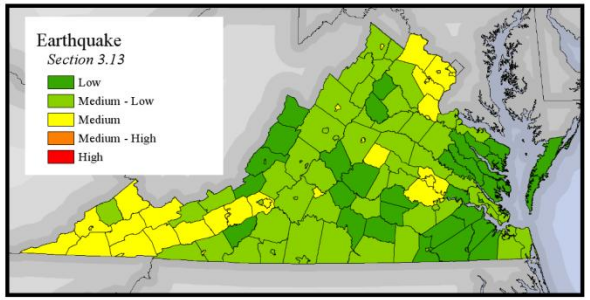


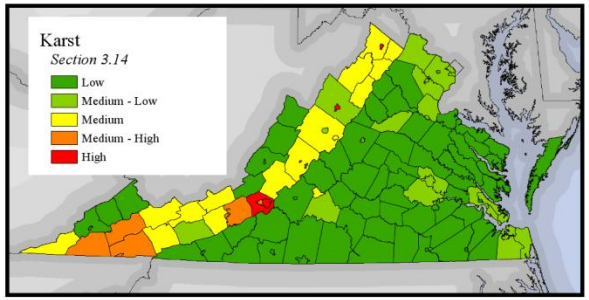












PROJECTION:

VA Lambert Conformal Conic
North American Datum 1983

DATA SOURCES:

CGIT Ranking Methodology
VGIN Jurisdicational Boundaries
ESRI State Boundaries

HAZARD RANKING:

A number of factors have been considered in this risk assessment to be able to compare between jurisdictions and hazards (Section 3.5). The factors have been added together to come up with the overall total ranking for each hazard.

Hazards were then added together to determine the overall risk to the Commonwealth. Figure 3.16-3 shows the overall result.

DISCLAIMER: Majority of available hazard data is intended to be used at national or regional scales. The purpose of the data sets are to give general indication of areas that may be susceptible to hazards. In order to identify potential risk in the Commonwealth available data has been used beyond the original intent.

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Social Vulnerability

- Who, What, Where …
- Parameters to be considered:

Elderly and Special Care Populations	Income
Socially Dependent	Race/Ethnicity
Immigrants	Gender

- Highlight areas for potential mitigation projects
- Everything is Relative

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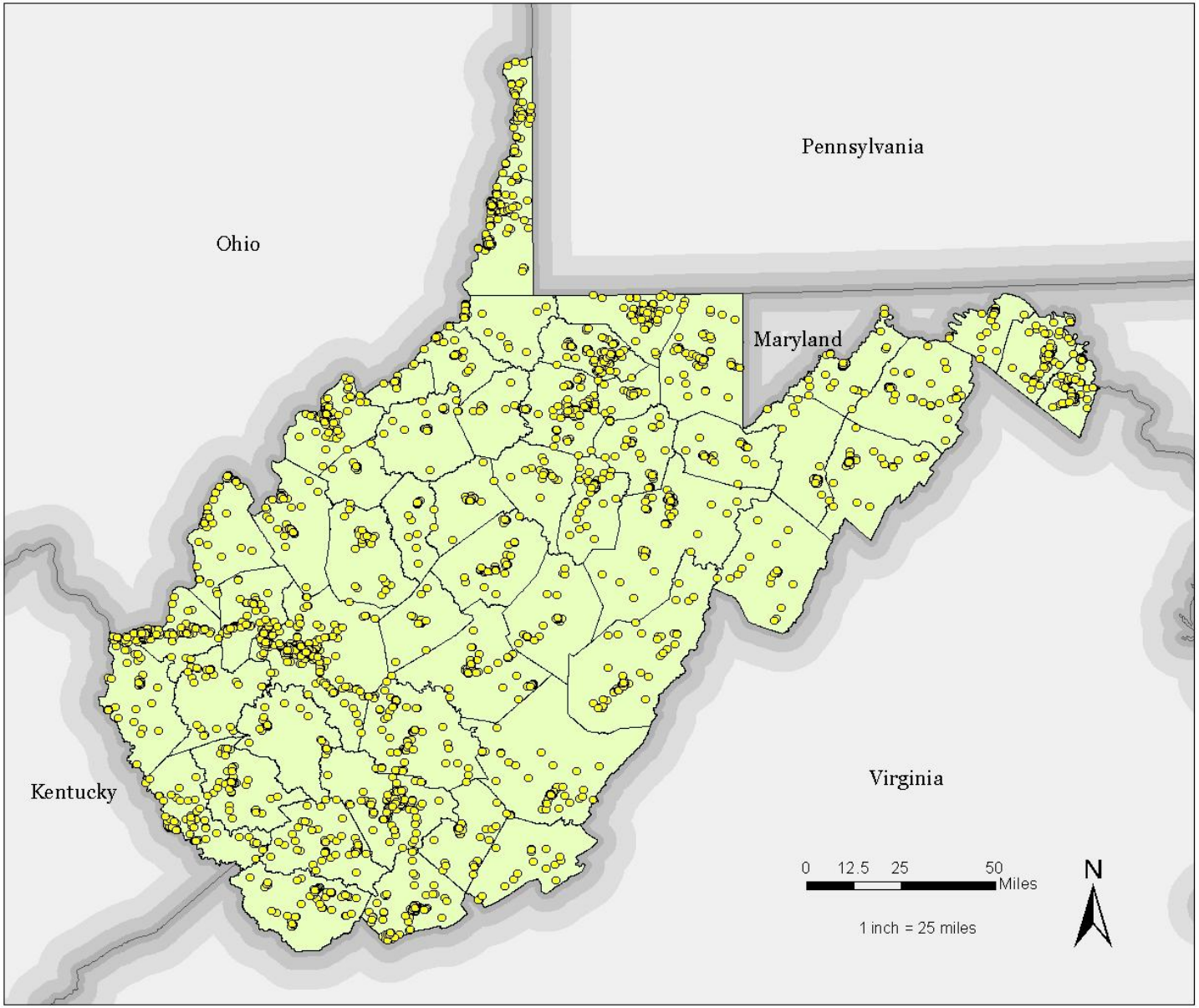
State & Critical Facilities Data

Type of Building	Number of Buildings	Total Building Value	Total Contents Value
Building	9,890	$11,309,047,288	$2,134,902,845
Highway Bridge	*118*	*$373,952,320*	*$0*
All other types	*1,027*	*$162,103,213*	*$37,464,044*
Observation Tower	*25*	*$39,748,246*	*$1,340,804*
Shelter-Shed-Rack	*872*	*$39,664,662*	*$11,972,705*
Communications Tower	*213*	*$29,554,639*	*$45,566,275*
Above ground Tank	*293*	*$27,060,956*	*$1,556,770*
Lightning Towers	*92*	*$16,388,742*	*$182,910*
Unknown	*41*	*$12,604,652*	*$1,349,939*
Dam	*1*	*$6,088,220*	*$953,188*
Mobile Home	80	$2,745,762	$1,169,485
Wall or Fence	*74*	*$1,894,329*	*$2,000*
Farm Silo	*10*	*$403,083*	*$80,000*
Total	**12,736**	**$12,021,256,112**	**$2,236,540,965**

- **State Owned/Insured Facilities**
  - WV Board of Risk
    - 152 Agencies Represented
    - 12,736 Records
  - **Geo-coded by Dewberry for 2010 plan update**
- **Local Critical/Essential Facilities- nearly 2,000**
  - Compilation of geospatial data on hospitals, schools, fire/rescue/police facilities, from various sources
  - Not a comprehensive dataset; improvements possible through better defined critical facilities, data standards, and local plan data.

Facility	Date Created	Feature Count	Source
EOC	2007	59	WV Dept. of Military Affairs and Public Safety, HSIP
Law Enforcement	2009	395	WVDMAPS, WVGISTC, HSIP
Fire Departments	2007	573	WVDMAPS, HSIP
Hospitals	2007, updated 2008	66	WV Health Care Authority, HSIP
Schools PreK- 12	2005	885	West Virginia Army National Guard

State Facilities of West Virginia



LEGEND

- State Owned Insured Structures
- County Boundaries

State Facilities

A database of State Facilities was provided by the WV Board of Risk on April 26, 2010. The properties were geographically referenced for spatial analysis and mapping using the address of each property. Of the 12,737 state properties, 46 could not be mapped because of address errors. A complete accuracy assessment of the remaining 12,691 properties was not conducted because it was beyond the scope of this study.

Data Sources

WV State Owned Insured Structures (WV Board of Risk, current as of 4/26/2010)
County Boundaries (WVGISTC)
Adjacent State Boundaries (nationalatlas.gov)

Projection

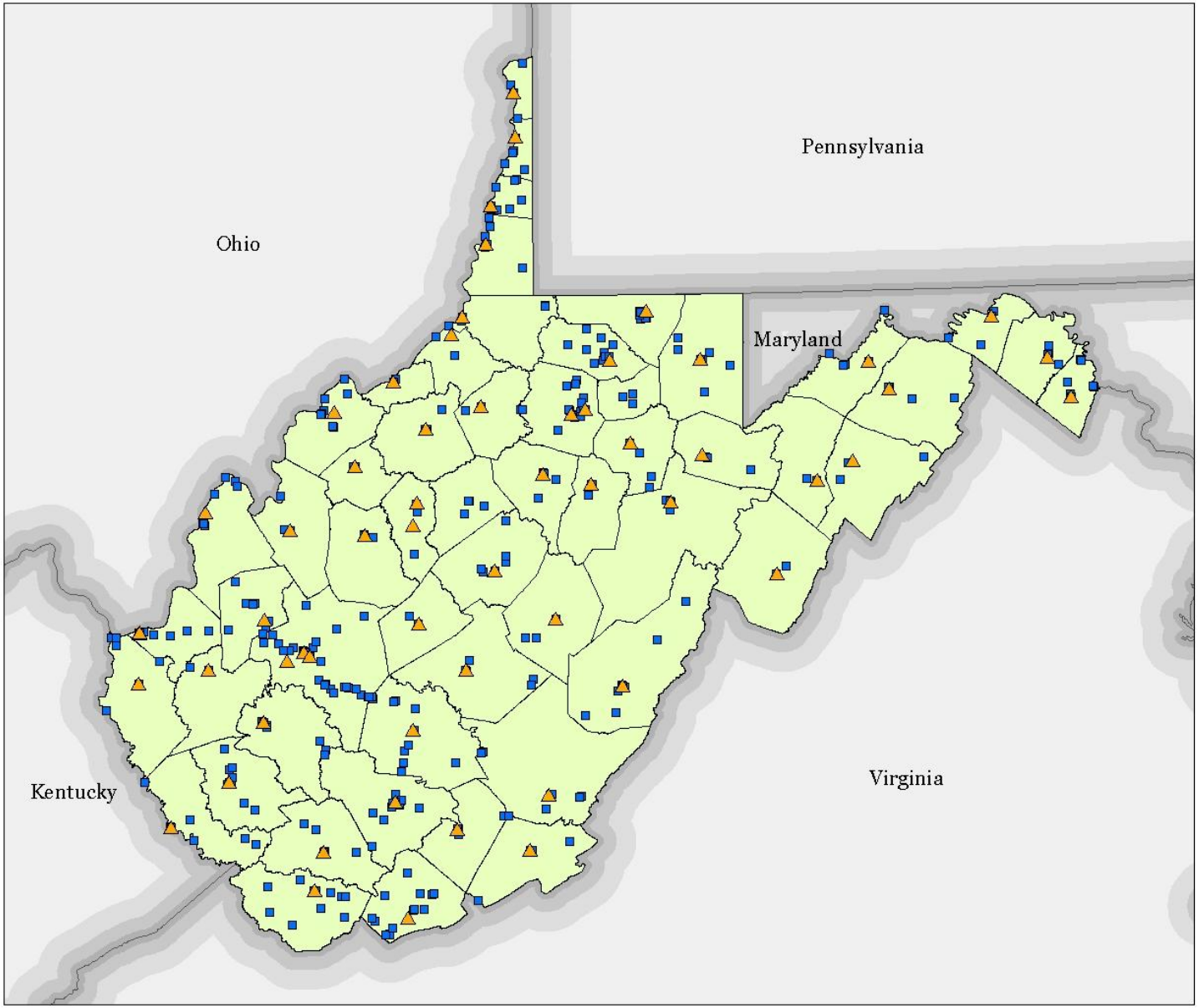
North American Datum 1983
Universal Transverse Mercator Zone 17 North

Dewberry

West Virginia GIS Technical Center

West Virginia Division of Homeland Security and Emergency Management

DISCLAIMER: Majority of available hazard data is intended to be used at national or regional scales. The purpose of the data sets are to give general indication of areas that may be susceptible to hazards. In order to identify potential risk in the State available data has been used beyond the original intent.



Critical Facilities Emergency Operations Centers & Police Departments

LEGEND

- Emergency Operations Centers
- Police Departments
- County Boundaries

0 12.5 25 50 Miles

1 inch = 25 miles

N

Data Sources

EOC, Police Dept, County Boundaries (WVGISTC)
Adjacent State Boundaries (nationalatlas.gov)

Projection

North American Datum 1983
Universal Transverse Mercator Zone 17 North

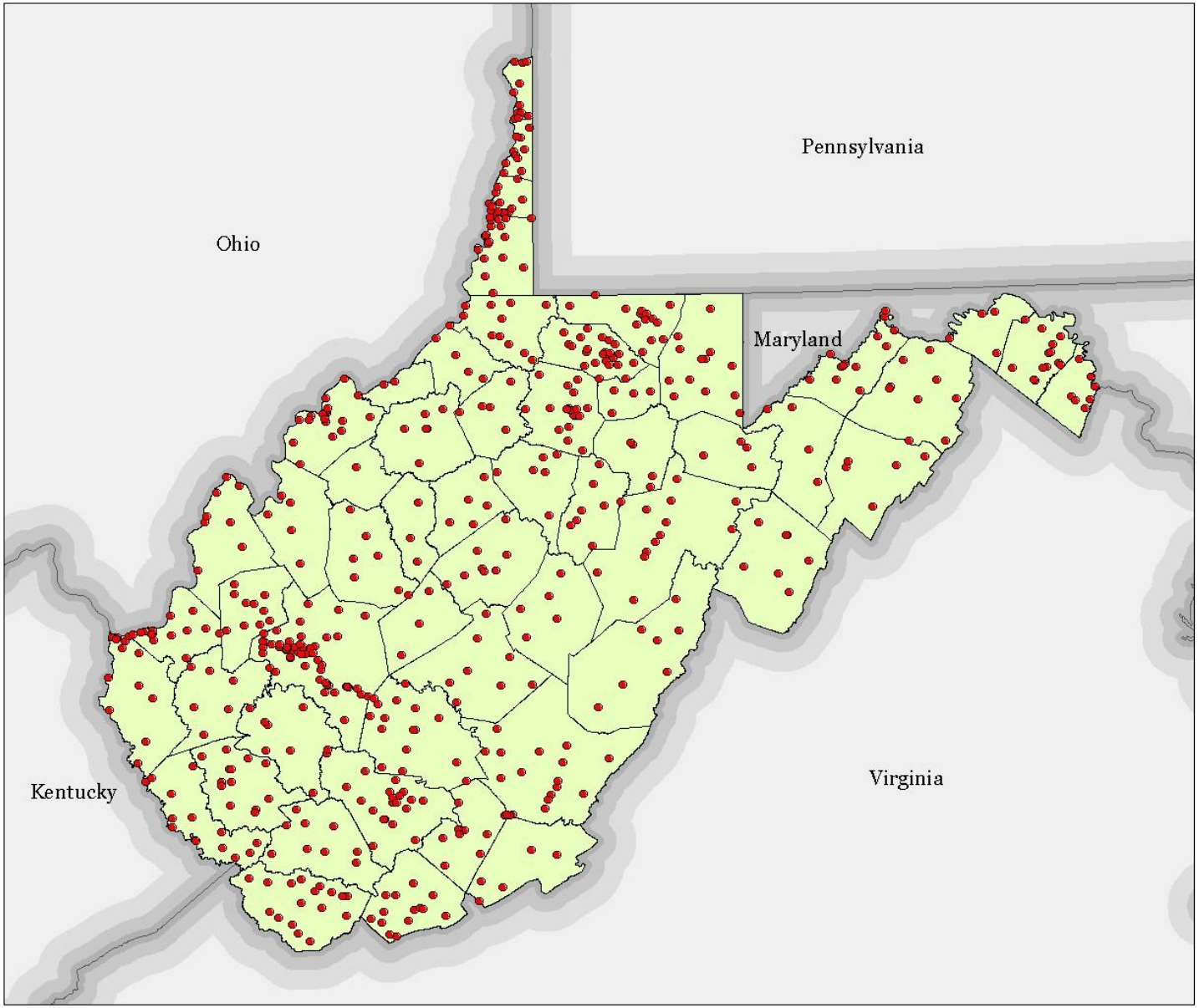
Dewberry

West Virginia GIS Technical Center

West Virginia Division of Homeland Security and Emergency Management

DISCLAIMER: Majority of available hazard data is intended to be used at national or regional scales. The purpose of the data sets are to give general indication of areas that may be susceptible to hazards. In order to identify potential risk in the State available data has been used beyond the original intent.

State of West Virginia
Enhanced Hazard Mitigation Plan 2010



Critical Facilities
Fire Departments

LEGEND

- Fire Departments
- County Boundaries

0 12.5 25 50 Miles

1 inch = 25 miles

N

Data Sources

Fire Departments, County Boundaries (WVGISTC)
Adjacent State Boundaries (nationalatlas.gov)

Projection

North American Datum 1983
Universal Transverse Mercator Zone 17 North

Dewberry

West Virginia GIS Technical Center

West Virginia Division of Homeland Security and Emergency Management

DISCLAIMER: Majority of available hazard data is intended to be used at national or regional scales. The purpose of the data sets are to give general indication of areas that may be susceptible to hazards. In order to identify potential risk in the State available data has been used beyond the original intent.

State of West Virginia
Enhanced Hazard Mitigation Plan 2010

Critical Facilities
Hospitals & Schools

Pennsylvania

Ohio

Maryland

Kentucky

Virginia

LEGEND

- Hospitals
- Schools
- County Boundaries

0 12.5 25 50 Miles

1 inch = 25 miles

N

Data Sources

Hospitals, Schools, County Boundaries (WVGISTC)
Adjacent State Boundaries (nationalatlas.gov)

Projection

North American Datum 1983
Universal Transverse Mercator Zone 17 North

Dewberry

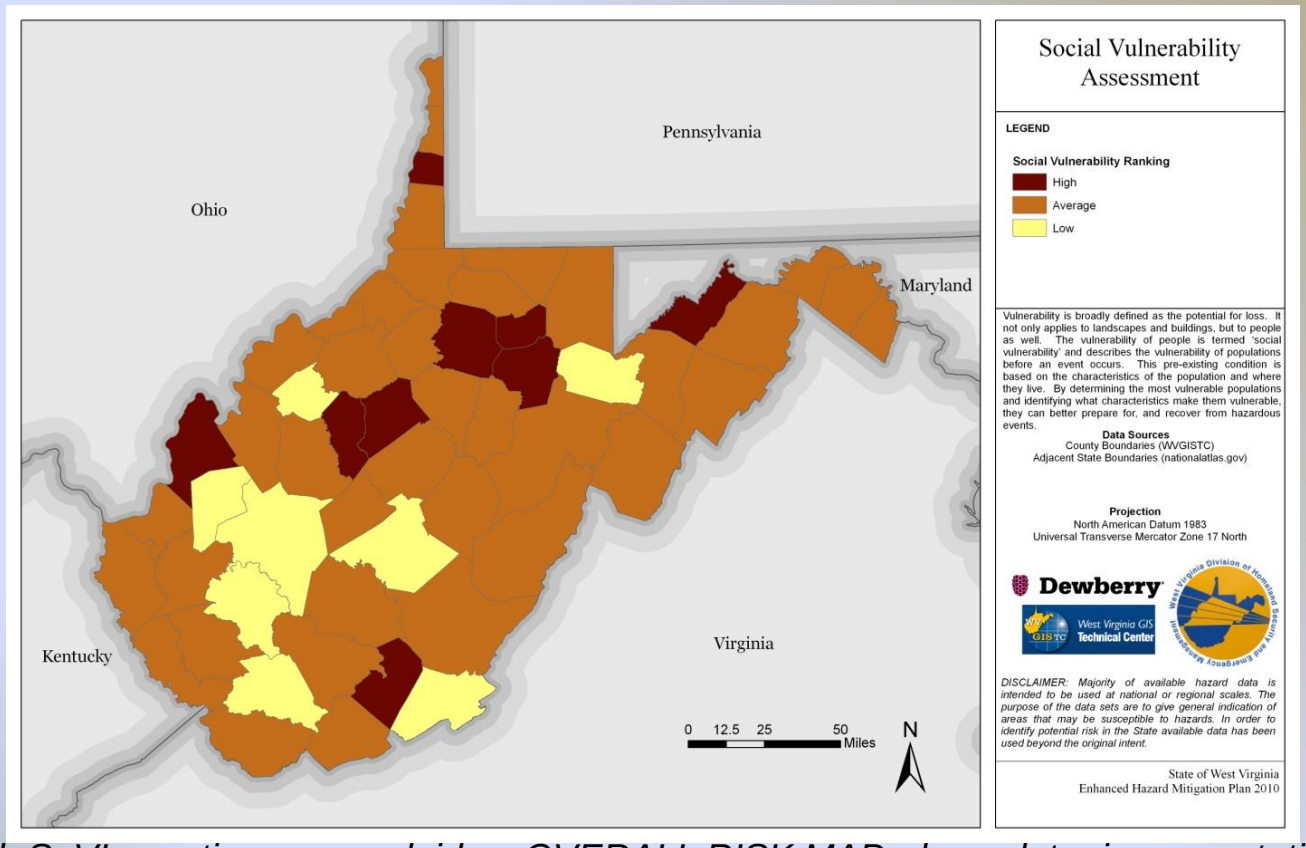
West Virginia GIS Technical Center

West Virginia Division of Homeland Security and Emergency Management

DISCLAIMER: Majority of available hazard data is intended to be used at national or regional scales. The purpose of the data sets are to give general indication of areas that may be susceptible to hazards. In order to identify potential risk in the State available data has been used beyond the original intent.

State of West Virginia
Enhanced Hazard Mitigation Plan 2010

West VA Vulnerability Analysis Results



**High SoVI counties are overlaid on OVERALL RISK MAP, shown later in presentation*

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HAZUS-MH Scenarios

- Modified Level I/Level II Analysis
  - MD(and national) data for building square footage, building value, population characteristics, costs of building repair and economic data (broken down by census division units)
    - Flood
    - Earthquake
    - Hurricane Winds

- *HAZUS is not required in Hazard Mitigation Plans, communities are encouraged to use HAZUS to form a scientific basis from which the mitigation strategy is developed.*

Dewberry®

High Wind: Jurisdictional Risk

County (HAZUS results)	Counties >$50K in Annualized Losses
Kanawha County	$104,720
Berkeley County	$97,300
Jefferson County	$91,310
Raleigh County	$65,740
Mercer County	$58,260
Greenbrier County	$54,380

- HAZUS-MH MR4
  - Annualized Loss = $1,468,890
  - Probabilistic Annualized Loss = Expected value of loss in any one year, developed by aggregating the losses and exceedance probabilities. S*imulation Period is100,000 years*
  - Module estimates direct and indirect economic losses due to hurricane speed winds.
    - Damage to buildings & contents
    - Economic loss (business interruptions)
    - Social Impacts
- NCDC Annualized Loss for Wind = $39,528,012

Dewberry®

2011 Vulnerability Analysis & Loss Estimation

Requirement §201.6(c)(2)(ii)(B): *[The plan **should** describe vulnerability in terms of an] estimate of the potential dollar losses to vulnerable structures identified in paragraph (c)(2)(ii)(A) of this section and a description of the methodology used to prepare the estimate … .*

- Annualized Loss to be based on:
  - HAZUS-MH
  - NCDC Storm Events
- Building Specific Analysis for Buildings & Critical Facilities
  - *Data Dependant*
- Social Vulnerability
- Development Trends
  - In areas of high risk?

Dewberry®

High Wind: Jurisdictional Risk

County (HAZUS results)	Counties >$50K in Annualized Losses
Kanawha County	$104,720
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    - Damage to buildings & contents
    - Economic loss (business interruptions)
    - Social Impacts
- NCDC Annualized Loss for Wind = $39,528,012

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Updates to HIRA

Next Steps…

- Data Collection for Hazards & Critical Facilities (On-going)
- Collection of Development and Land Use planning documents
- Inclusion of disasters/events since 2008 plan
- Conduct Hazard & Vulnerability Analysis
  - Ranking Methodology based on MAC decision & Available Data
  - Loss Estimation
  - HAZUS-MH Analysis for Flood, Earthquake and Hurricane Wind
- Map generation & Report writing
  - Reorganization of HIRA for better readability

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Evaluating HMP 2008

- Mitigation Actions
- Program Capacity
- Planning Integration
- Critical Facilities

➢ ***We'll contact each sponsoring agency with 2008 plan mitigation actions for a progress update.***

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EXERCISE
Plan Outcomes

- Put “Outcomes” at top of note cards
- List things you’d like to see in new plan
- List things you’d like to use plan for

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EXERCISE

Plan Outreach to Stakeholders

- Internal agency colleagues
- Special stakeholder groups
- “General” public

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Wrap Up & Future Meetings

- Project Schedule – Milestones

  March – April: data gathering, update of capability assessment, 2008 strategies, etc.
- Next Mitigation Advisory Committee Meetings:
  - June Meeting date: 15th or 16th; 9:30 – 3:00
  - July Meeting date: 19th, 20th or 21st; 9:30 - Noon
- Overview of Action Items

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Agenda

Wednesday, June 15, 2011 9:00 – 4:30 PM

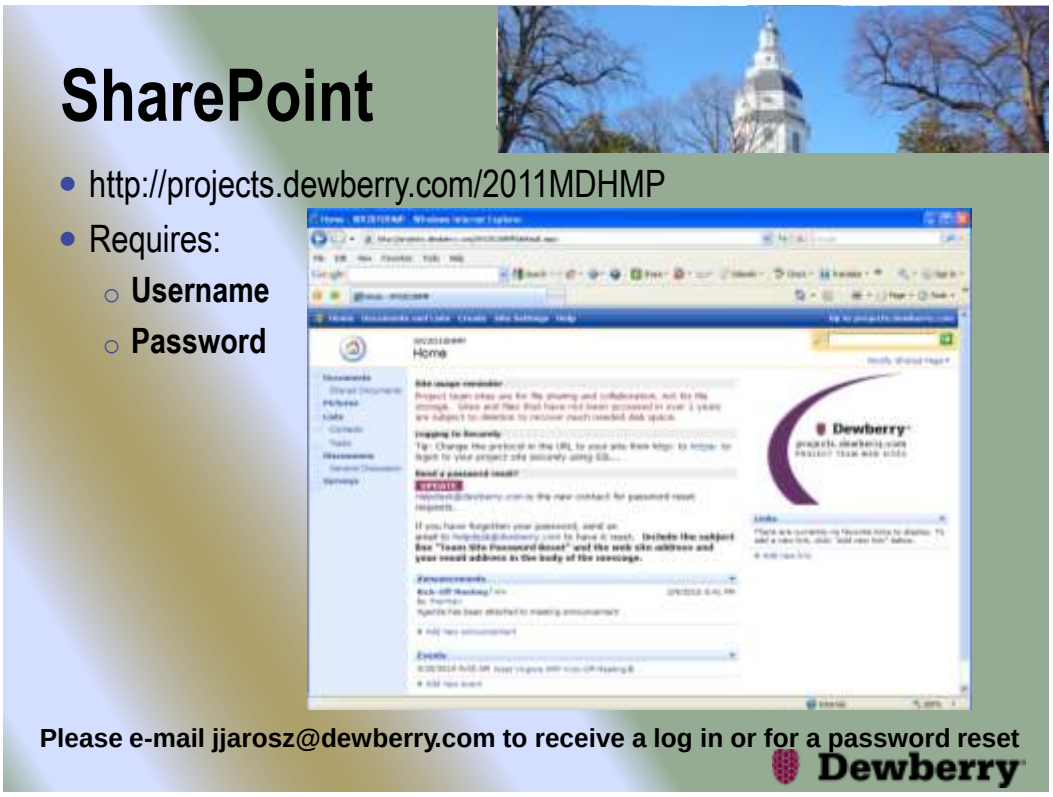
MEMA - Camp Fretterd Military Reservation

Description	Lead	Time
Welcome, Introductions and Today's Agenda • Planning Process Review • Progress to Date	Richard Muth, MEMA Executive Director Mark James, MEMA State Hazard Mitigation Officer Deborah Mills, CFM Dewberry	9:00 – 9:15
Hazard Identification, Risk Assessment (HIRA) and Vulnerability Analysis by Hazard	Rachael Heltz-Herman, Dewberry	9:15 – 10:15
BREAK		10:15 – 10:30
HIRA Review, continued	Ryan Towell Dewberry	10:30 – NOON
LUNCH – *Provided*		NOON – 12:45
Review and Validation of 2008 Plan Goals	Carrie Speranza	12:45
Small Group Discussions: Forming Mitigation Objectives and Actions • Planning, Policy & Funding • Education & Outreach • Mitigation of Structures • Local Planning Interface • 2014 Vulnerability Analysis	Deborah Mills Jane Sibley Frantz Ryan Towell Mark Matulik/ Julia Moline Ginny Smith Rachael Heltz-Herman	1:30- 3:30
Group Summaries	All	3:30 – 4:00
Next Steps • Next meeting at MEMA - July 20, 9:30AM	Deborah Mills	4:00 – 4:15

Dewberry Team:

Project Manager	Deborah Mills	703.849.0162 804.335.9946 c	dmills@dewberrry.com
Deputy Project Manager	Carrie Speranza	703.849.0367	csperanza@dewberry.com
Planning, Policy and Funding	Jane Sibley Frantz	703.849.0473	jfrantz@dewberry.com
Education & Outreach	Ryan Towell	703.849.0275	rtowell@dewberry.com
Mitigation of Structures	Mark Matulik Julia Moline	850.602.6987 703.849.0610	mmatulik@dewberry.com jmoline@dewberry.com

Local Planning Interface	Ginny Smith	301.724.7611	vsmith@ssplanninganddesign.com
2014 Vulnerability Analysis	Rachael Heltz-Herman	585-429-7448	rherman@dewberry.com



For access to our project ftp site please follow this link:
ftp.dewberry.com

In the upper right hand side of the window, click “Page” then “Open FTP Site in windows explorer”

username - 2011MDHMP
password - IGHH2T

Please note: Files that are not accessed within 5 days will be automatically removed by the system.

2011 Maryland All-Hazard Mitigation Plan Update

Maryland Emergency Management Agency

June 15, 2011

Hazard Identification and Risk Assessment Results

Mitigation Objectives and Actions

Supported by

Dewberry

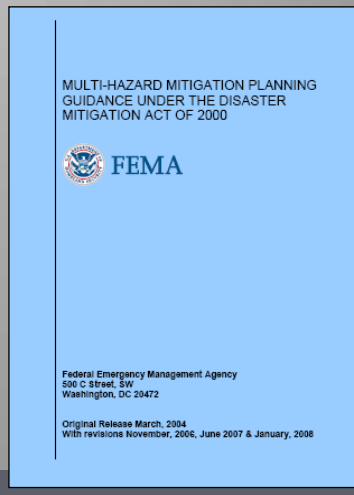
Photos: St. Mary's College of Maryland; FEMA

Agenda

- Welcome & Introductions
- Hazard Identification & Risk Assessment
  - Ranking Methodology
  - Hazard Specific Analysis
  - Overall HIRA Results
- Review and Validation of 2008 Plan Goals
- Small Group Discussions: Forming Mitigation Objectives and Actions
  - Group Summaries

HIRA:
Hazard Identification & Risk Assessment

- **Purpose:** Provides a factual basis for prioritizing hazard mitigation activities
- **Major components:**
  - Identify and profile natural hazards affecting the state
  - Describe vulnerability to jurisdictions (cities and counties), and estimate losses
  - Describe vulnerability to state owned/operated facilities and critical facilities, and estimate losses
  - Incorporate findings of local plans


MULTI-HAZARD MITIGATION PLANNING GUIDANCE UNDER THE DISASTER MITIGATION ACT OF 2000

FEMA

Federal Emergency Management Agency
500 C Street, SW
Washington, DC 20472

Original Release March, 2004
With revisions November, 2006, June 2007 & January, 2008

FEMA Guidance for HIRA

- **Identify Hazards**
- **Profiling Hazards**
- **Assessing Vulnerability of Local and State Critical Facilities**
- **Estimating Potential Losses to Local and State Critical Facilities**

Hazards "Ranked"

- Coastal
- Drought
- Earthquake
- Flood
- Karst/Sinkhole
- Landslide
- Thunderstorm
- Tornado
- Wildfire
- Wind
- Winter Storm

Hazards Discussed in Plan Narrative

- Shoreline Erosion
- Sea Level Rise
- Extreme Heat
- Extreme Cold
- Dam Failure
- Mining/Marcellus Shale

State and Critical Facilities

- State Contacts: State Treasurers and Maryland Planning Department, 2004/2008 HMP databases

- Data creation: Export of the state treasurer's database, the POI data from 2008 (MD property view dataset), and HAZUS data supplemented for schools, waste/potable pumping stations, police, fire stations.

2011 Maryland All-Hazard Mitigation Plan Update

Maryland Emergency Management Agency

State Facilities

County	# Facilities	Building Value	Contents Value	Total Value
Allegany	287	$1,027,890,770	$95,510,551	$1,123,401,321
Anne Arundel	605	$2,593,643,061	$282,640,884	$2,876,283,945
Baltimore City	765	$8,676,379,650	$905,331,784	$9,581,711,434
Prince George's	587	$3,729,268,822	$559,656,754	$4,288,925,576
Queen Anne's	94	$135,666,474	$45,278,433	$180,944,907
Washington	311	$419,419,195	$75,509,152	$494,928,346
Worcester	126	$81,417,285	$40,867,263	$122,284,548
Grand Total	**6,866**	**$38 billion**	**$4 billion**	**$42 billion**

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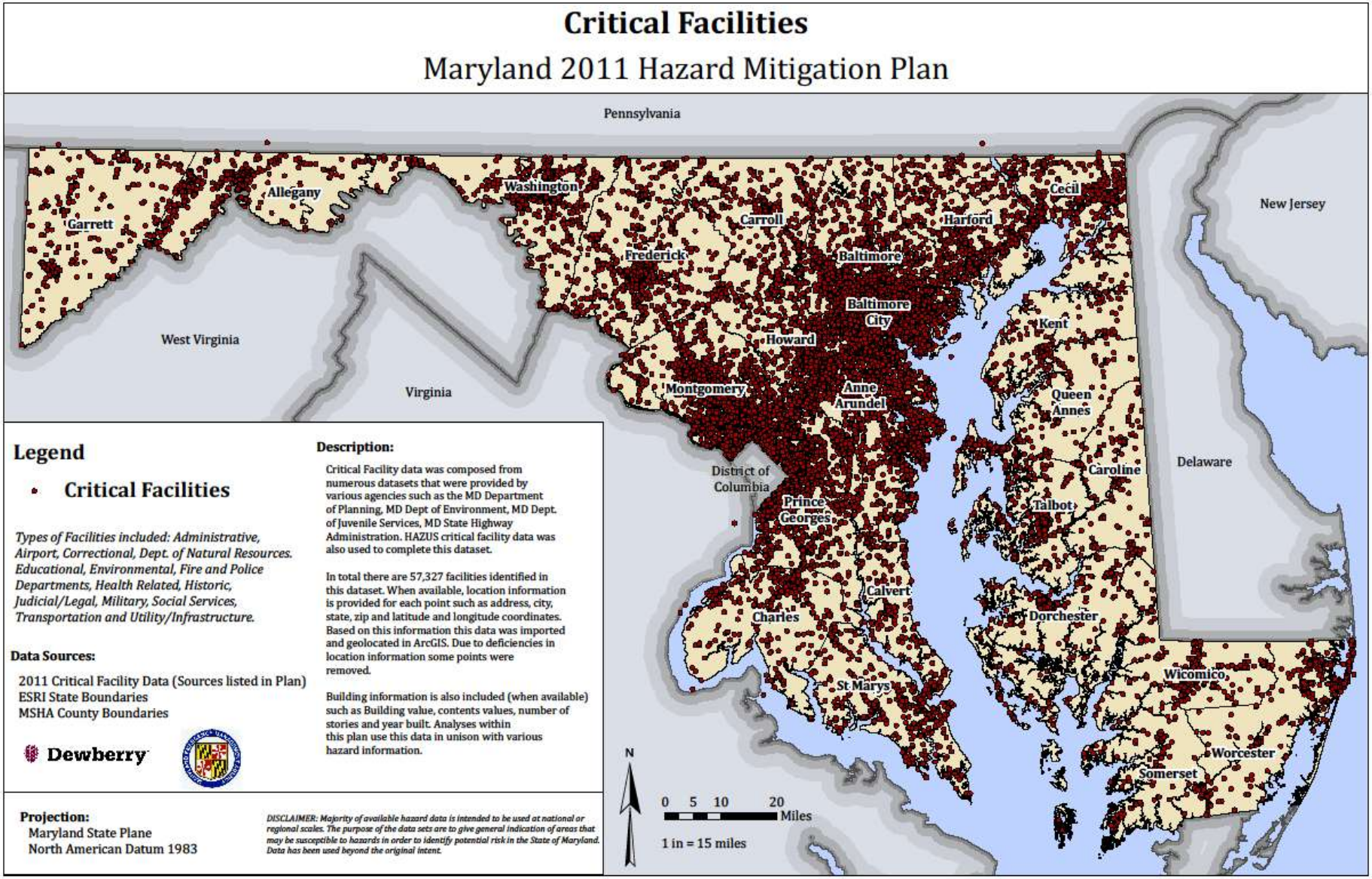
2011 Maryland All-Hazard Mitigation Plan Update

Maryland Emergency Management Agency



2011 Maryland All-Hazard Mitigation Plan Update

Maryland Emergency Management Agency

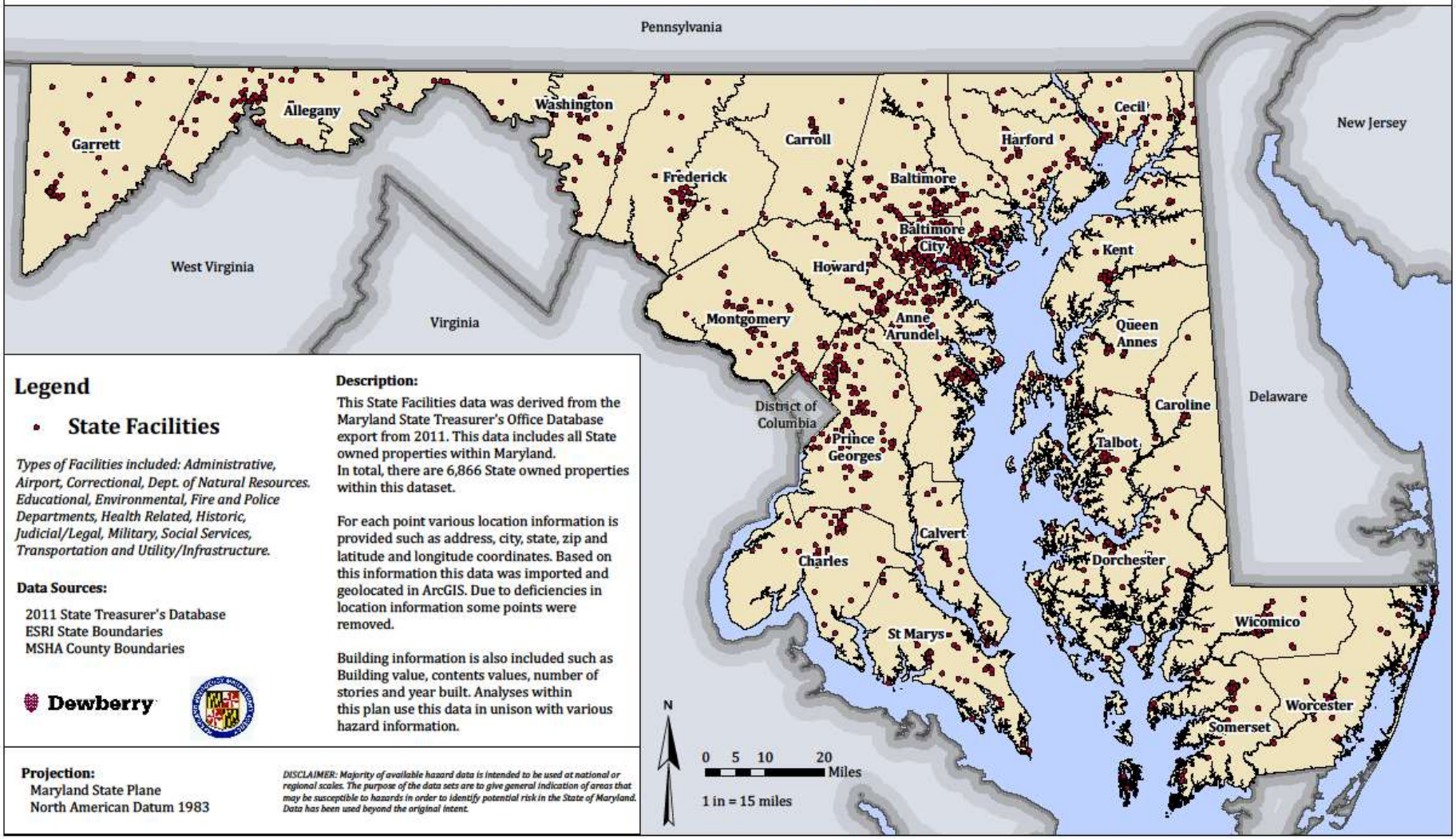
Facility Type/Agency	Examples of Facilities	State-Owned/ Critical	Number of Facilities included in Analysis	Source
Nuclear Power Plants	Calvert Cliffs	Critical	2	MEMA 2008 Plan
Dams (High, Significant and Low Hazard)	Liberty Dam	Critical	470	MDE
Large System Water Sources		Critical	242	MDE
Above Ground Storage Tanks		Critical	818	MDE
Underground Storage Tanks		Critical	31,658	MDE
Hazardous Waste Generators		Critical	12,189	MDE
Environmental Permit Holders		Critical	3,161	MDE
Correctional Facilities	Western MD Detention Center	Critical	56	MD Dept. of Juv. Services
Gas Chlorine Plants		Critical	208	MDE
Bridges and Overpasses		Critical	7,741	SHA
Hospitals and Nursing Homes	Frederick Memorial	Critical	329	MD Dept of Health & Hygiene, HAZUS
Waste Water Pumping Stations	Church Hill Waste Water Treatment Plant	Critical	213	Planning Office - Property View Dataset 2007, HAZUS
Fresh Water Pumping Stations	Mystic Harbour Water Treatment Plant	Critical	27	Planning Office - Property View Dataset 2007, HAZUS
Dock/Wharf	Public Landing Wharf, Seagirt Marine Terminal	Critical	178	Planning Office - Property View Dataset 2007, HAZUS
Airport (Public, Private, Non-Military, No state owned)	Potomac Airfield, St. Mary's County Airport	Critical	70	Planning Office - Property View Dataset 2007, HAZUS
School (Public, Private, Junior Colleges and Colleges. No school administration buildings)	Largo High School	Critical	2,429	Planning Office - Property View Dataset 2007, HAZUS
Fire Departments (Volunteer, municipal, jurisdictional and state)	City of Sailsbury Fire Department	Critical	694	Planning Office - Property View Dataset 2007, HAZUS
Police Departments (Volunteer, municipal, jurisdictional, sheriff locations and state)	Easton Police Department	Critical	214	Planning Office - Property View Dataset 2007, HAZUS
Emergency Operations Centers	Worcester Emergency Operations Center	Critical	30	Planning Office - Property View Dataset 2007, HAZUS

2011 Maryland All-Hazard Mitigation Plan Update

Maryland Emergency Management Agency

State Facilities

Maryland 2011 Hazard Mitigation Plan



Legend

- **State Facilities**

Types of Facilities included: Administrative, Airport, Correctional, Dept. of Natural Resources. Educational, Environmental, Fire and Police Departments, Health Related, Historic, Judicial/Legal, Military, Social Services, Transportation and Utility/Infrastructure.

Data Sources:

2011 State Treasurer's Database
ESRI State Boundaries
MSHA County Boundaries

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Description:

This State Facilities data was derived from the Maryland State Treasurer's Office Database export from 2011. This data includes all State owned properties within Maryland.
In total, there are 6,866 State owned properties within this dataset.

For each point various location information is provided such as address, city, state, zip and latitude and longitude coordinates. Based on this information this data was imported and geolocated in ArcGIS. Due to deficiencies in location information some points were removed.

Building information is also included such as Building value, contents values, number of stories and year built. Analyses within this plan use this data in unison with various hazard information.

Projection:
Maryland State Plane
North American Datum 1983

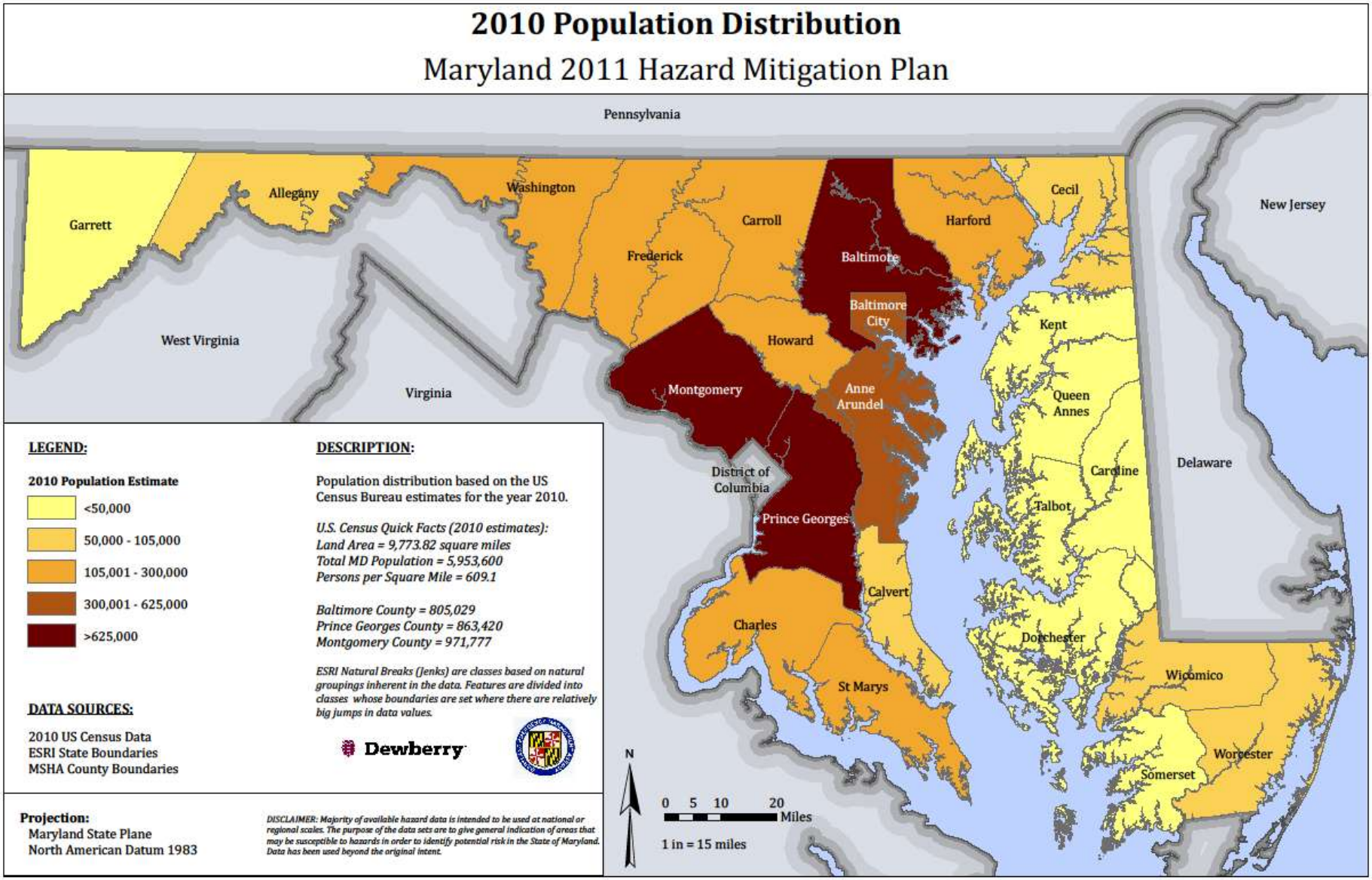
DISCLAIMER: Majority of available hazard data is intended to be used at national or regional scales. The purpose of the data sets are to give general indication of areas that may be susceptible to hazards in order to identify potential risk in the State of Maryland. Data has been used beyond the original intent.

Population

Population Data					
	2010 Population	Population Density (People per Sq Mile)	Total Housing Units	Housing Units Occupied	Housing Units Vacant
Allegany County	75,087	174.74	33,311	29,177	4,134
Anne Arundel County	537,656	1,285.85	212,562	199,378	13,184
Baltimore County	805,029	1,325.83	335,622	316,715	18,907
Calvert County	88,737	408.23	33,780	30,873	2,907
Caroline County	33,066	101.91	13,482	12,158	1,324
Carroll County	167,134	369.44	62,406	59,786	2,620
Cecil County	101,108	280.98	41,103	36,867	4,236
Charles County	146,551	256.09	54,963	51,214	3,749
Dorchester County	32,618	57.32	16,554	13,522	3,032
Frederick County	233,385	349.76	90,136	84,800	5,336
Garrett County	30,097	45.88	18,854	12,057	6,797
Harford County	244,826	546.38	95,554	90,218	5,336
Howard County	287,085	1,132.30	109,282	104,749	4,533
Kent County	20,197	70.97	10,549	8,165	2,384
Montgomery County	971,777	1,919.76	375,905	357,086	18,819
Prince George's County	863,420	1,735.62	328,182	304,042	24,140
Queen Anne's County	47,798	127.40	20,140	18,016	2,124
St. Mary's County	105,151	287.72	41,282	37,604	3,678
Somerset County	26,470	84.44	11,130	8,788	2,342
Talbot County	37,782	138.22	19,577	16,157	3,420
Washington County	147,430	315.29	60,814	55,687	5,127
Wicomico County	98,733	258.41	41,192	37,220	3,972
Worcester County	51,454	108.40	55,749	22,229	33,520
City of Baltimore	620,961	7,656.00	296,685	249,903	46,782

2011 Maryland All-Hazard Mitigation Plan Update

Maryland Emergency Management Agency



Social Vulnerability

- **The vulnerability of people is termed *'social vulnerability'* and describes the vulnerability of populations before an event occurs.**
- **Pre-existing condition that impacts:**
  - **Ability to prepare for event**
  - **Recover from event**
- **By determining the most vulnerable populations and identifying why they are at risk, we can tailor preparedness and recovery programs for hazard events.**

25 Social Vulnerability variables were measured and grouped into 6 Principal Components:

1. Socioeconomic Status
2. Age
3. Minorities (Asian, Hispanic) and Income
4. Gender and Birth Rate
5. Housing Stock and Education
6. Minorities (Native American)

Hazard Data Availability

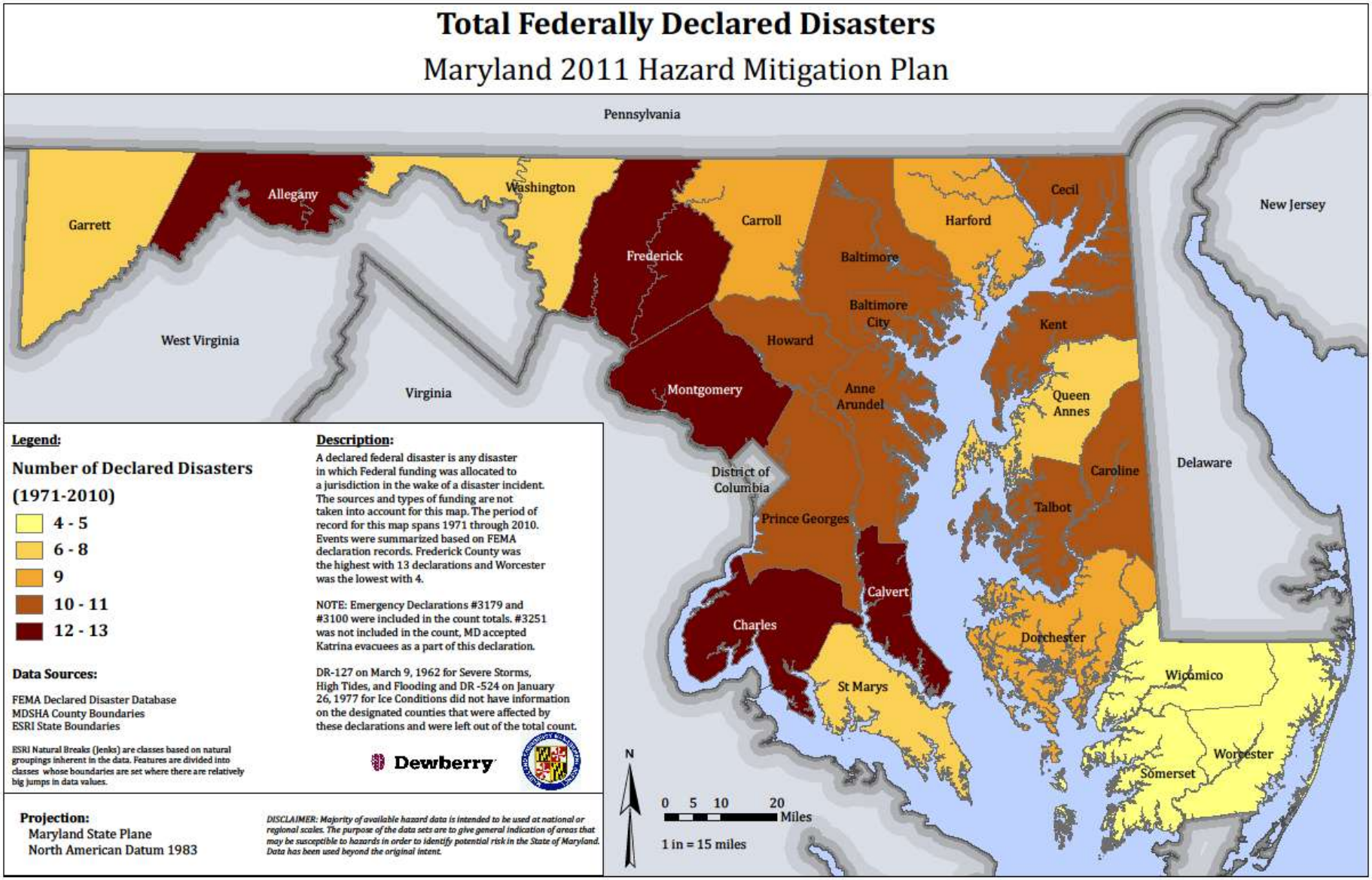
- Federally Declared Disasters
- National Climatic Data Center (NCDC) Storm Events Database
  - Local NWS Offices
  - Includes location and time of event, property and crop damages, injuries and deaths
  - Data may be biased by population
  - Need to process data to assign all events/damages to specific jurisdictions
- Other Hazard-Specific Data
  - Data from 2005/2008 Plans, National Data Sources, and MD MAC

Federally Declared Disaster History

- **23 Declared Disasters**
- **Disaster types:**
  - 12: Flooding
  - 9: Winter Storm
  - 7: Wind
  - 5: Coastal
  - 3: Tornado

2011 Maryland All-Hazard Mitigation Plan Update

Maryland Emergency Management Agency

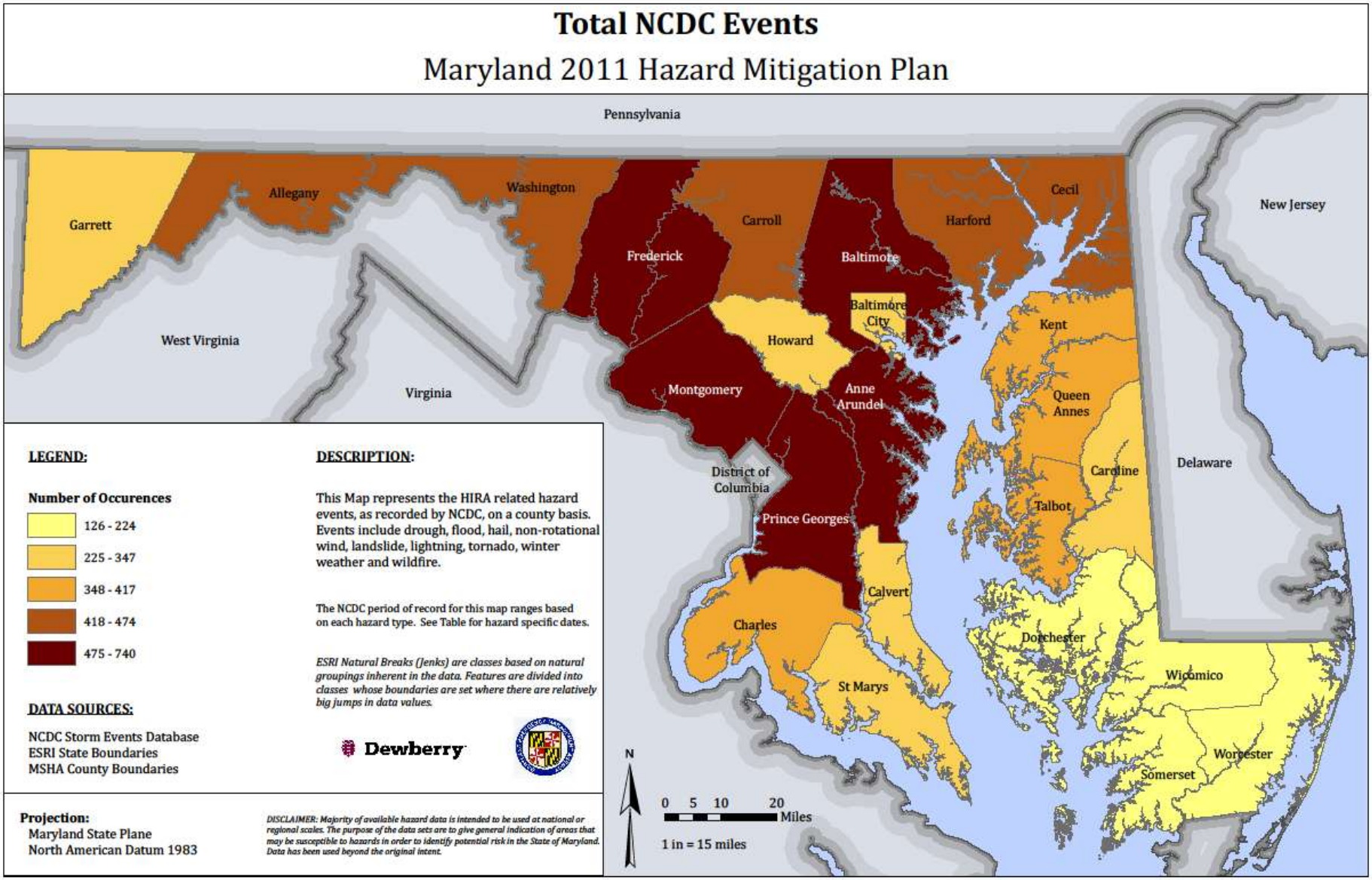


National Climatic Data Center (NCDC) Storm Events Database

- **Events records from 1950 – November 2010 (based on hazard type)**
- **Data Processing to be able to compare & rank hazards**
  - **Zonal Events**
  - **Normalizing by Number of Counties**
  - **Damage Inflation**
- ***Ranking Methodology Discussed Later in Presentation***

2011 Maryland All-Hazard Mitigation Plan Update

Maryland Emergency Management Agency

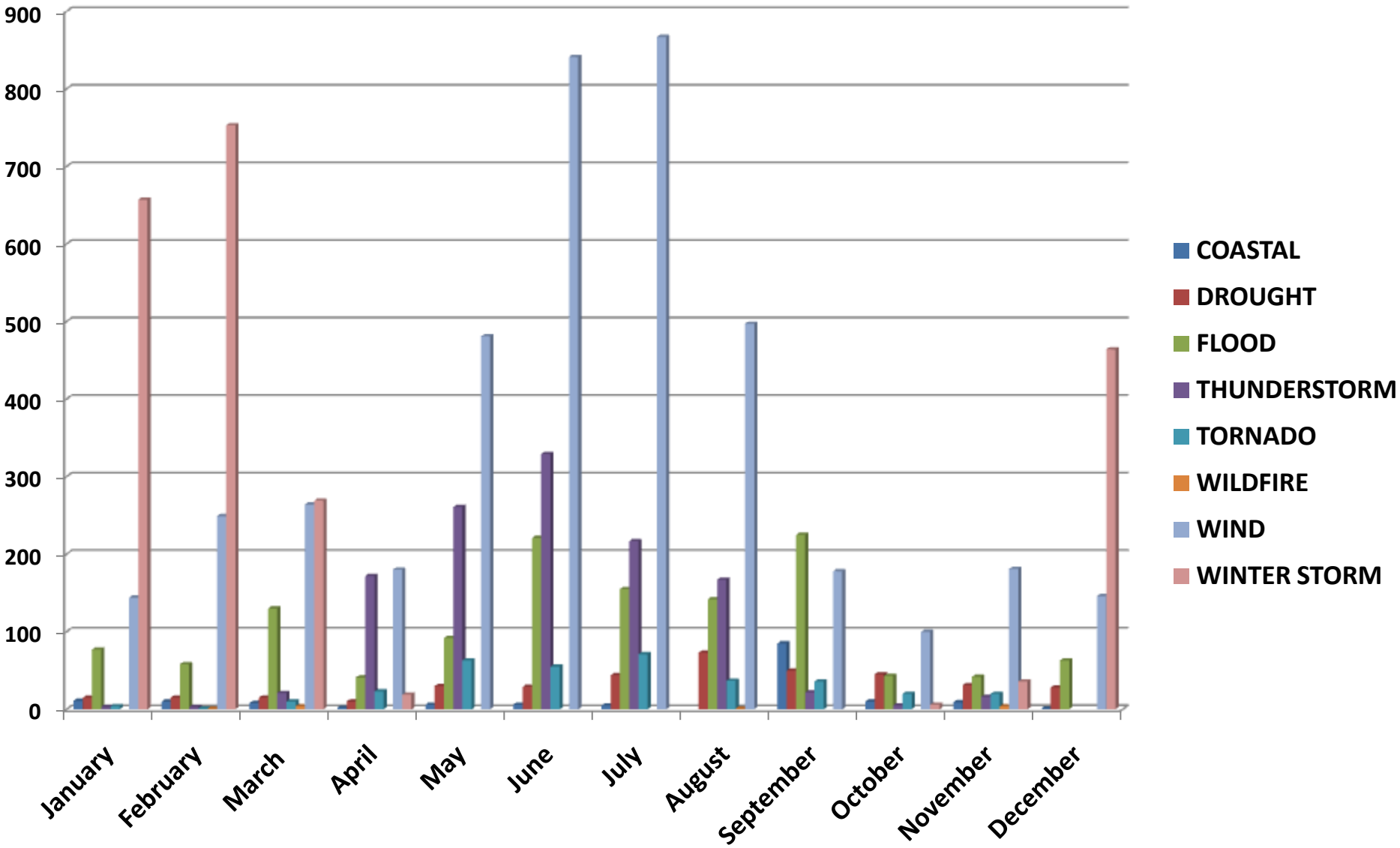


2011 Maryland All-Hazard

Hazard Type	Number of Events	Property Damage	Crop Damage	Deaths
Coastal	153	$725,247,221	$995,114	9
Drought	385	$0	$130,737,221	-
Flood	1,289	$196,971,952	$1,645,056	16
Thunderstorm	1,216	$33,461,165	$821,890	13
Tornado	340	$463,257,911	$719,906	7
Wildfire	10 (NCDC) 7,052 MD Forestry	$0 (NCDC) $325,656 MD Forestry	$0	0 (NCDC) 1 (MD Forestry)
Wind	4,128	$69,492,789	$844,951	8
Winter Storm	2,204	$22,406,447	$27,251	101
Total	**9,725**	**$1,510,837,483**	**$135,791,390**	**154**

2011 Maryland All-Hazard Mitigation Plan Update

Maryland Emergency Management Agency



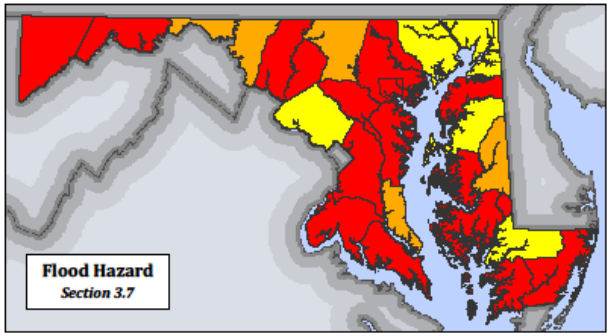
Local HMP Integration

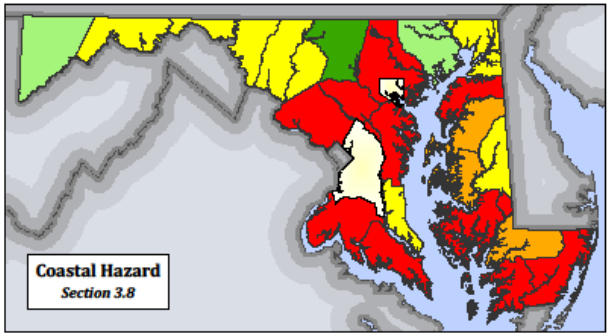
- 2008 plan Chapter 4 – State Support of Local Plans 2008 provides a summary of funding assistance and technical support
- Update will have a sub-section for Local Plan Incorporation
  - Comprehensive look at local plan hazard identification and ranking
  - Loss estimates & methodology

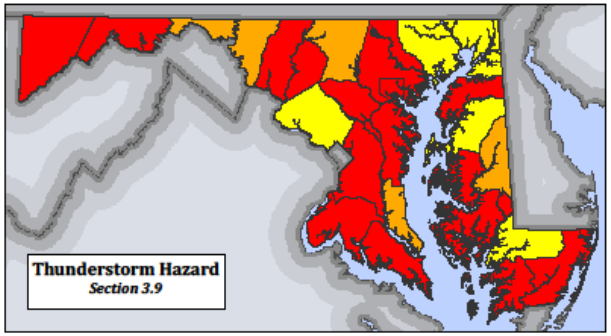
County	Coastal	Drought	Flood	Landslide	Thunderstorm	Tornado	Wildfire	Wind	Winter Storm	Karst	Earthquake
Allegany County	M	M	H	M-H	M-H	M-H	M	M	M-H	N/A	N/A
Anne Arundel County	H	H	H	N/A	H	H	H	N/A	H	N/A	H
Baltimore County	H	M	H	N/A	M	L	M	N/A	H	N/A	L
Calvert County	M	M-L	M-H	M-L	H	M-H	H	N/A	M-H	L	M
Caroline County	M	M-H	M-H	N/A	M-H	M	M-L	N/A	M	N/A	N/A
Carroll County	L	H	M-H	M-H	N/A	M-H	N/A	N/A	M-H	H	N/A
Cecil County	M	H	M	M-H	M-H	M	M	N/A	M	N/A	N/A
Charles County	H	H	H	L	H	H	M	N/A	H	N/A	L
Dorchester County	H	M	H	N/A	M	M	M	M	M-H	N/A	N/A
Frederick County	M	M	H	L	H	H	M	H	H	H	L
Garrett County	M-L	M	H	H	H	H	M	M-H	H	N/A	N/A
Harford County	M-L	H	M	N/A	M-H	M-H	L	M-H	M	N/A	N/A
Howard County	H	H	H	N/A	N/A	N/A	L	H	M	N/A	M
Kent County	H	M	H	M	M	L	M	N/A	H	N/A	N/A
Montgomery County	H	H	M	L	H	H	L	H	H	N/A	M
Prince George's County	N/A	M-H	H	M-H	M-H	N/A	M	M-H	M-H	N/A	L
Queen Anne's County	M-H	M	M	M-L	M-L	M	M-L	N/A	M	N/A	N/A
St. Mary's County	H	M	H	L	H	H	H	H	H	N/A	L
Somerset County	H	M	H	M-L	M-H	M	M	N/A	M-L	N/A	N/A
Talbot County	M-H	M	H	L	M-H	M	M	N/A	H	N/A	L
Washington County	M	M-H	M-H	M-L	M	M	M-L	N/A	M-H	M-L	N/A
Wicomico County	M-H	M	M	M-L	M	M	M	M	M	M-L	M-L
Worcester County	H	M	H	N/A	M	M	N/A	L	H	N/A	N/A
City of Baltimore	N/A	L	H	L	N/A	N/A	N/A	M	M	N/A	L
Average Local Plan Ranking (w weighting)	H	M-H	H	M	H	H	M-H	M-H	H	M	M-L
State Overall Ranking	M-H	M-L	M-H	L	M-H	M	M-H	H	H	L	L

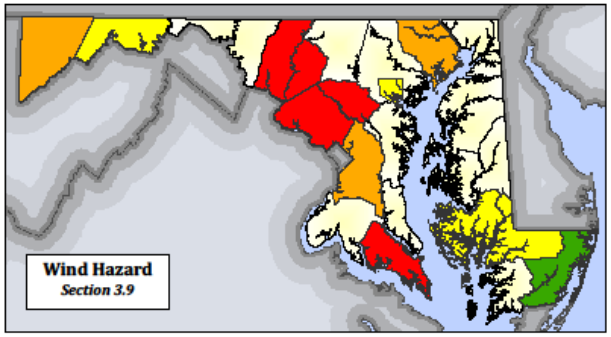
2011 Maryland All-Hazard Mitigation Plan Update

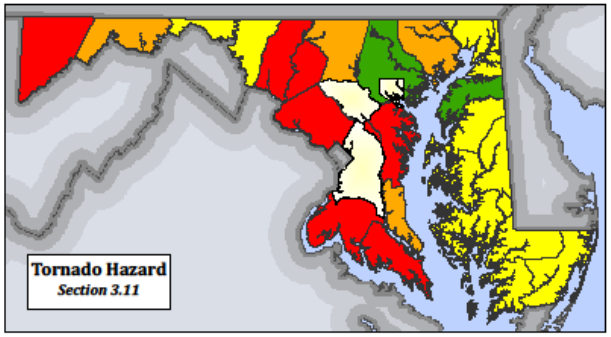
Maryland Emergency Management Agency

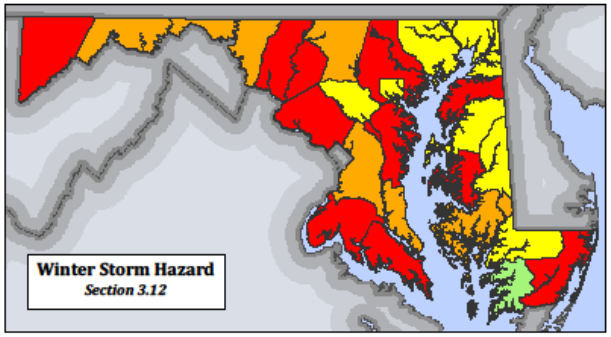


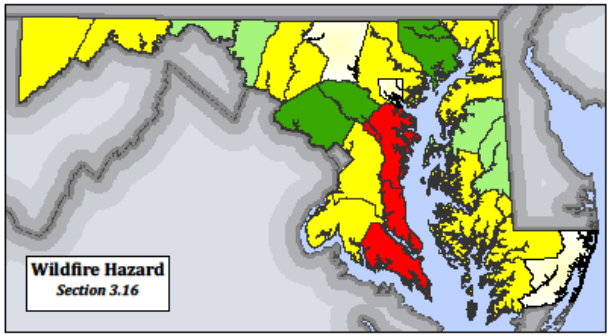












Local Plan Ranking Maps

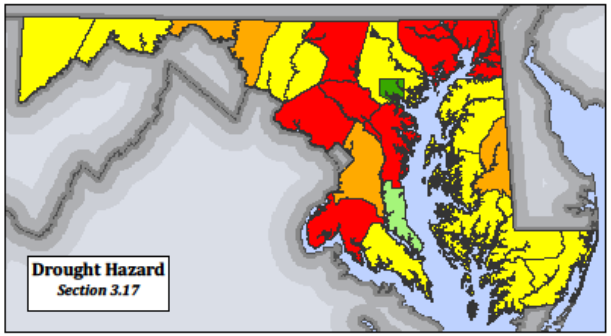
State of Maryland
Hazard Mitigation Plan 2011

Hazard Identification & Risk Assessment

These maps show risk levels assessed by local governments for significant hazards. Parameters used to create the Hazard Ranking and Risk Maps for each hazard are explained in the Hazard Assessment and Ranking Methodology section of this report.

Overall Risk

- High
- Medium-High
- Medium
- Medium-Low
- Low
- Not Ranked



Projection
North American Datum 1983
Maryland State Plane Feet

Data Sources
Maryland Local Hazard Mitigation Plans
Maryland Emergency Management Agency
Federal Emergency Management Agency

Dewberry

DISCLAIMER: Majority of available hazard data is intended to be used at national or regional scales. The purpose of the data sets are to give general indication of areas that may be susceptible to hazards in order to identify potential risk in the State of Maryland. Data has been used beyond the original intent.

Climate Change

- Considered as a potential *amplifier* of existing natural hazards (i.e. flooding, heat, drought, etc.)
- Discussion of projections as related to specific hazards
- Potential future impact on hazard:
    - Frequency
    - Intensity
    - Distribution

Hazard Ranking

- **The purpose of the hazard identification and risk assessment is to provide a factual basis for developing mitigation strategies; to *prioritize* those jurisdictions which most threatened and vulnerable to natural hazards.**

- **FEMA guidance indicates that the jurisdictions at *greatest risk* to specific hazards should be identified, considering both the characteristics of the hazard and the jurisdictions' degree of vulnerability.**

A variety of analysis methods may be sufficient to meet these goals; FEMA does not mandate a specific analysis method.

Hazard Ranking

Examples of ranking methods used in other state/local plans:

- **Scoring systems based on expert judgment**
- **Scoring systems based on GIS / Data analysis**
- **Annualized loss ($) calculations**

2011 Ranking Parameters

- **Parameters Used:**
  - Population Vulnerability (weight 0.5)
  - Population Density (weight 0.5)
  - Annualized Events (weight 1)
  - Deaths & Injuries (weight 1)
  - Annualized Property Damage (weight 1)
  - Annualized Crop Damage (weight 1)

Jurisdictional Risk (RS):

$$RS = (0.5*(PV + PN)) + EV + I + D + PD + CD$$

2011 Maryland All-Hazard Mitigation Plan Update

Maryland Emergency Management Agency

Ranking Worksheet

WEIGHTING		
Population Vulnerability	*PV*	0.5
Population Density	*PN*	0.5
Injuries	*IN*	1
Deaths	DT	1
Property Damage (Annualized)	*PD*	1
Crop Damage (Annualized)	*CD*	1
Geographic Extent (Hazard Dependent)	*GE*	1.5
Events (Annualized)	*EV*	1

Score (>=)	Hazard Risk Rank
0	Low
10	Medium-Low
13	Medium
16	Medium-High
19	High

	2010 Census Data		NCDC Data		
Score	Pop Vul Geo Interval	Pop Density Geo Interval	Annualized Events	Property Damage (Natural Breaks)	Crop Damage (Natural Breaks)
1	0.00	0	0	$0.00	$0.00
2	0.85	174.7392	0.11	$296,923.48	$31,752.13
3	2.25	546.3805	1.01	$992,006.62	$170,245.40
4	6.12	1,919.76	2.51	$2,366,097.20	$320,773.92
-	17.00	8,000.00	500.00	$7,000,000.00	$700,000.00

(SORTED BY FIPS CODE)			POPULATION		COASTAL								DROUGHT							
County	Local Plans	FIPS	*PV*	*PN*	*IN*	*DT*	*PD*	*CD*	*GE*	*EV*	*RS*	*Rank*	*IN*	*DT*	*PD*	*CD*	*GE*	*EV*	*RS*	*Rank*
Allegany County	Allegany	24001	2	2	1	1	1	1	1	1	8.5	Low	1	1	1	4	1	2	12.5	Medium-Low
Anne Arundel County	Anne Arundel	24003	4	3	4	4	4	1	2	2	21.5	High	1	1	1	4	1	2	14	Medium
Baltimore County	Baltimore	24005	4	3	4	4	4	1	2	2	21.5	High	1	1	1	4	2	3	16.5	Medium-High
Calvert County	Calvert	24009	2	2	4	4	4	1	2	2	20	High	1	1	1	4	2	2	14	Medium
Caroline County	Caroline	24011	1	1	4	1	2	1	1	2	12.5	Medium-Low	1	1	1	1	4	4	15	Medium
Carroll County	Carroll	24013	3	2	1	1	1	1	1	1	9	Low	1	1	1	4	4	2	17.5	Medium-High
Cecil County	Cecil	24015	2	2	1	1	2	1	2	2	12	Medium-Low	1	1	1	1	4	3	15	Medium
Charles County	Charles	24017	3	2	4	4	4	1	2	2	20.5	High	1	1	1	3	2	2	13.5	Medium
Dorchester County	Dorchester	24019	1	1	1	1	2	1	4	2	14	Medium	1	1	1	2	2	2	11	Medium-Low
Frederick County	Frederick	24021	3	2	1	1	1	1	1	2	10	Medium-Low	1	1	1	4	4	2	17.5	Medium-High
Garrett County	Garrett	24023	1	1	1	1	1	1	1	1	7.5	Low	1	1	1	1	1	2	8.5	Low
Harford County	Harford	24025	3	3	4	4	4	1	2	2	21	High	1	1	1	4	3	2	16.5	Medium-High
Howard County	Howard	24027	3	3	1	1	1	1	1	1	9.5	Low	1	1	1	4	3	2	16.5	Medium-High
Kent County	Kent	24029	1	1	4	1	2	1	2	2	14	Medium	1	1	1	1	4	4	15	Medium
Montgomery County	Montgomery	24031	4	3	1	1	1	1	1	1	10	Medium-Low	1	1	1	4	3	2	17	Medium-High
Prince George's County	Prince George's	24033	4	3	4	4	4	1	1	2	20	High	1	1	1	4	1	2	14	Medium
Queen Anne's County	Queen Anne's	24035	1	1	4	1	2	1	2	2	14	Medium	1	1	1	1	4	4	15	Medium
St. Mary's County	St. Mary's	24037	2	2	4	4	4	1	2	2	20	High	1	1	1	3	2	2	13	Medium
Somerset County	Somerset	24039	1	1	1	1	1	1	4	2	13	Medium	1	1	1	2	2	2	11	Medium-Low
Talbot County	Talbot	24041	1	1	4	1	2	1	3	2	15.5	Medium	1	1	1	1	4	4	15	Medium
Washington County	Washington	24043	3	2	1	1	1	1	1	1	9	Low	1	1	1	4	3	2	16	Medium-High
Wicomico County	Wicomico	24045	2	2	1	1	1	1	2	2	11	Medium-Low	1	1	1	2	3	2	13.5	Medium
Worcester County	Worcester	24047	2	1	1	1	2	1	4	3	15.5	Medium	1	1	1	1	3	2	12	Medium-Low
City of Baltimore	Baltimore City	24510	4	4	4	4	3	1	2	2	21	High	1	1	1	1	1	2	11.5	Medium-Low

Ranking Sources

- **Coastal**: NOAA NCDC Storm Events (1993-2010), NOAA-NHC SLOSH Model
- **Drought**: NOAA NCDC Storm Events (1995-2010), USDA-NSSA Cropland Data Layer (2008)
- **Flood**: NOAA NCDC Storm Events (1993-2010); FEMA DFIRM, Q3 Flood Maps
- **Landslide**: USGS-NLHP (2001)
- **Thunderstorm**: NOAA NCDC Storm Events (1956-2010)
- **Tornado**: NOAA NCDC Storm Events (1950-2010)
- **Wildfire**: NOAA NCDC Storm Events (2001-2006), MD Dept of Natural Resources – Forest Service (1998-2010)
- **Wind**: NOAA NCDC Storm Events (1956-2010)
- **Winter Storm**: NOAA NCDC Storm Events (1993-2010)
- **Land Subsidence**: Maryland Geological Survey
- **Earthquake**: FEMA HAZUS-MH Earthquake Model

Hazard Ranking Results

Drought

- Data: USDA-NSSA Cropland Data Layer (2008)
- NCDC Annualized Loss: $8,171,076 (crop damages)

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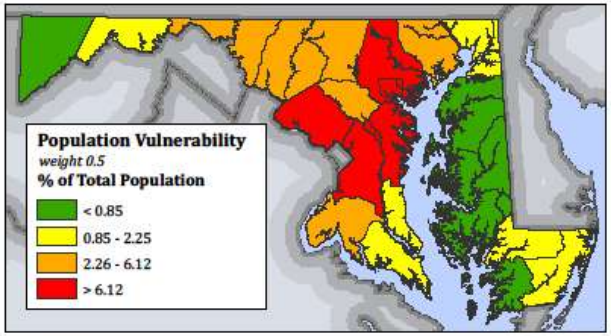

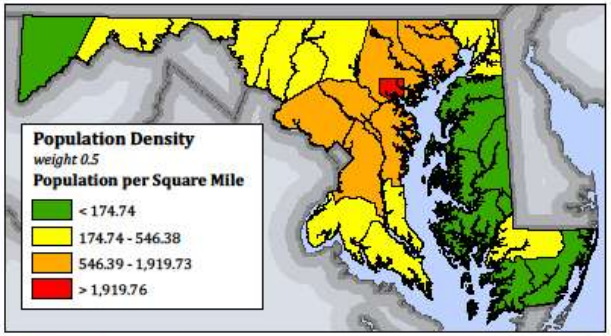

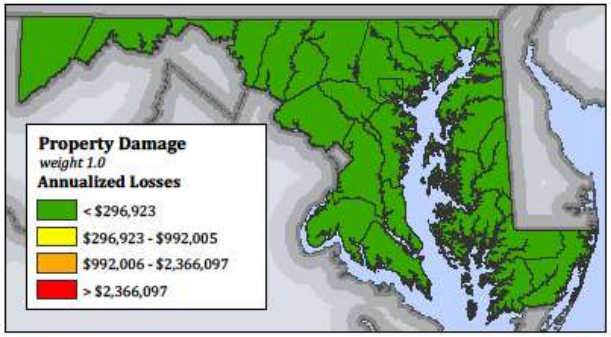

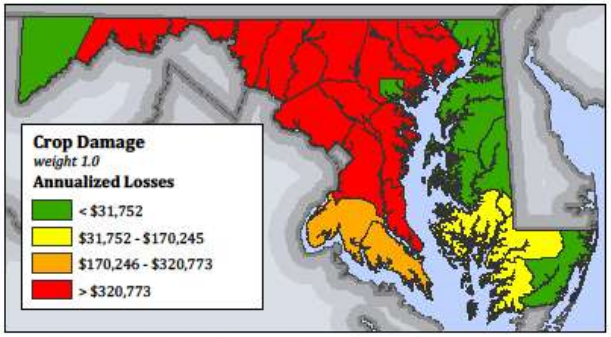

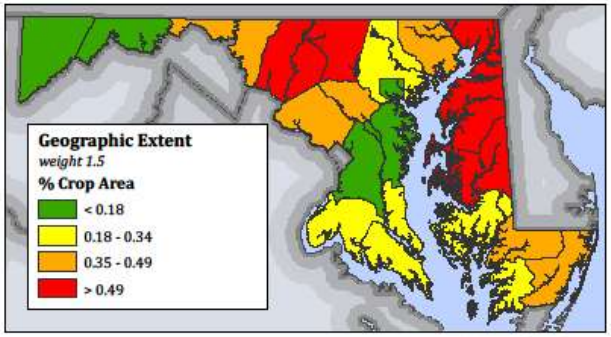

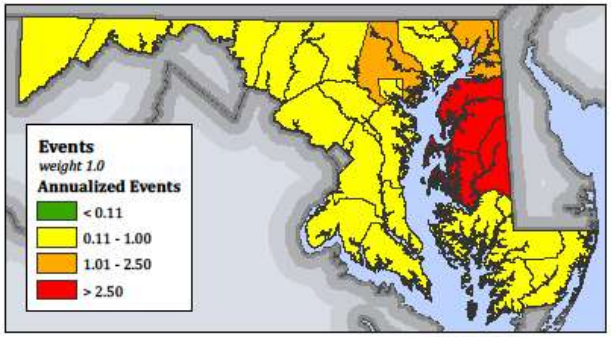

Drought Hazard Ranking & Risk Map

A number of factors have been considered in this risk assessment to be able to compare between jurisdictions and hazards. The factors have been added together to calculate the overall total ranking for each hazard.

*Risk = PV*0.5+PN*0.5+IN*1.0+DT*1.0+ PD*1.0+CD*1.0+CD*+GE*1.5+1.0+EV*1.0*

where
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CD=Crop Damage
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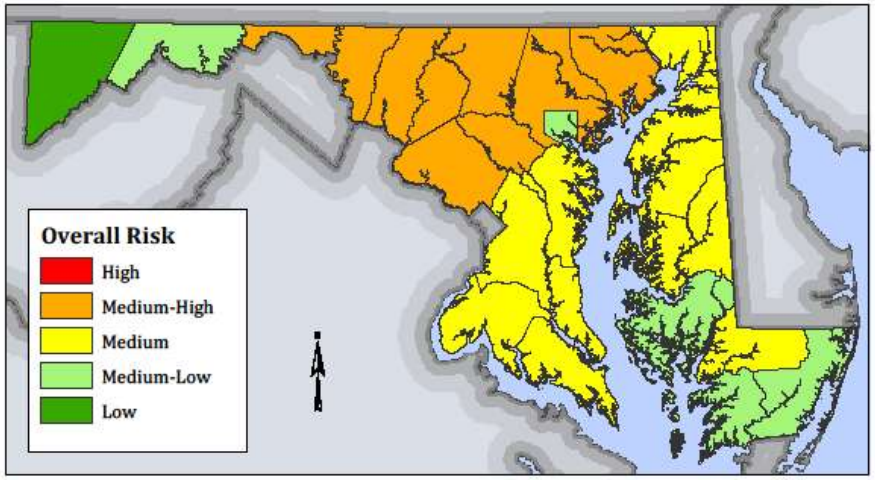
EV=Events



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Data Sources
NOAA NCDC Storm Events (1995-2010)
USDA-NSSA Cropland Data Layer (2008)
MSHA State & County Boundaries
ESRI State Coundaries

Projection
North American Datum 1983
Maryland State Plane Feet

Dewberry

State of Maryland Hazard Mitigation Plan 2011

Flood

- State Contact: Kevin Wagner MD Dept of Environment Water Management Administration for RL/SRL and Mitigated Properties
- Data: DFIRMS, Q3
- Annualized Loss: $11,034,278

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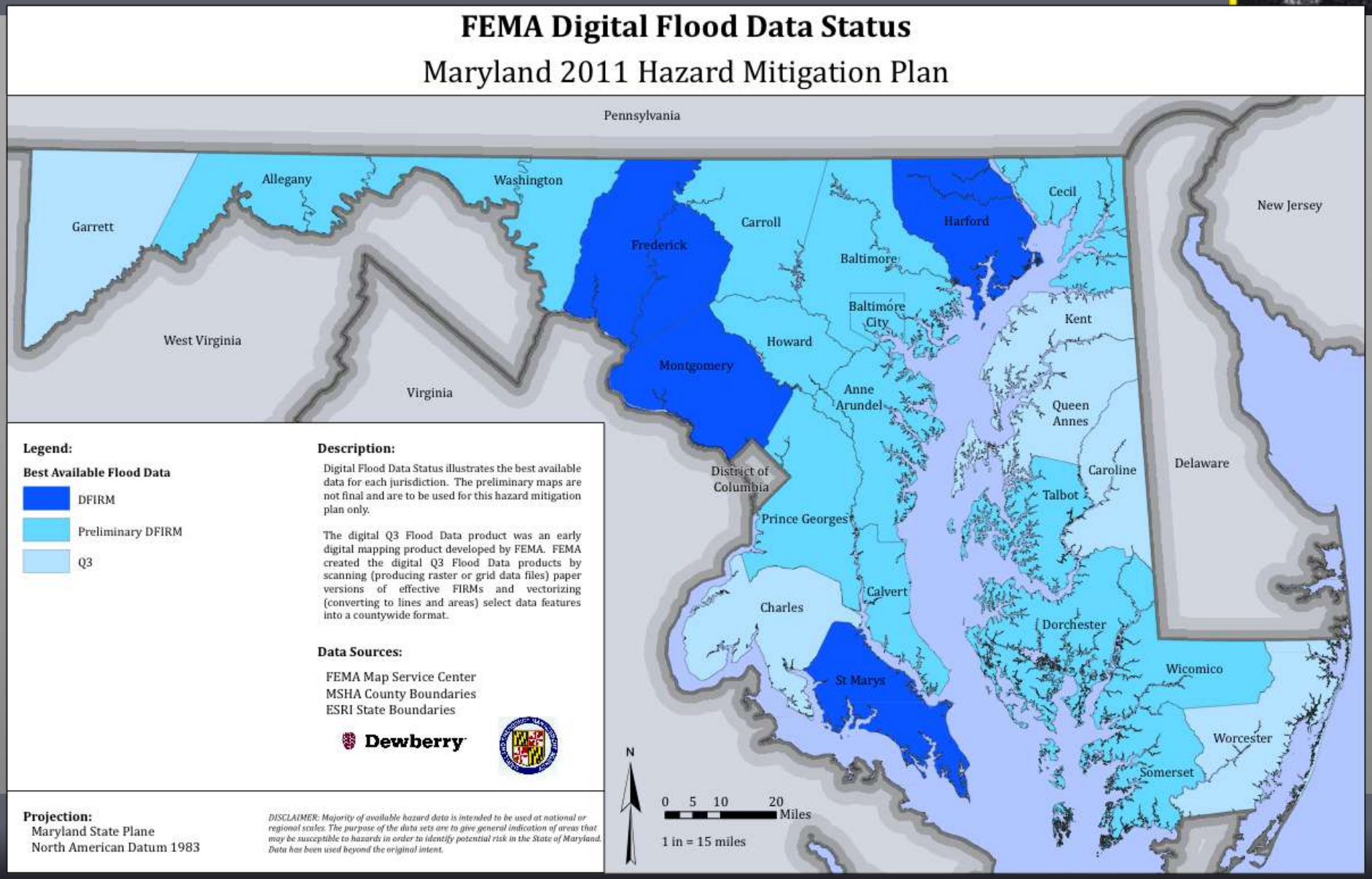
Maryland Emergency Management Agency



National Flood Insurance Program

- Maryland has more than 69,300 NFIP policies in-force (as of 3-31-2011)
  - 14,688 total losses for a total of $239,746,468 payments

- <u>Repetitive Loss (RL) property</u>
  - 887 RL properties in Maryland
    - 2,132 Total Losses
    - $55,623,130 paid on Claims
- <u>Severe Repetitive Loss (SRL) property</u>
  - 53 SRL properties in Maryland

RL/SRL Total Paid on Claims (>$5 Million)

- City of Baltimore = $8,591,844
- Baltimore County = $9,091,932
- Anne Arundel County = $7,947,886
- Worcester County = $5,301,139

Mitigated Properties

- Repetitive Loss Properties
  - 154 of 887 mitigated (17%)
- Program Areas (273 properties in Maryland):
  - 99/00 Supplemental (1)
  - Floyd Supplemental (9)
  - FMA (33)
  - HMGP (198)
  - LPDM (4)
  - PDM (28)

Status	99/00 Supplemental	Floyd Supplemental	FMA	HMGP	LPDM	PDM	Total
Approved			2	138			140
Closed	1	9	19	43			72
Not Approved / Denied			2	2	2	16	22
Obligated			9		1	12	22
Pending					1		1
Void			1	4			5
Withdrawn				11			11

2011 MITIGATION ACTION: Development of Mitigation Grants Workbook

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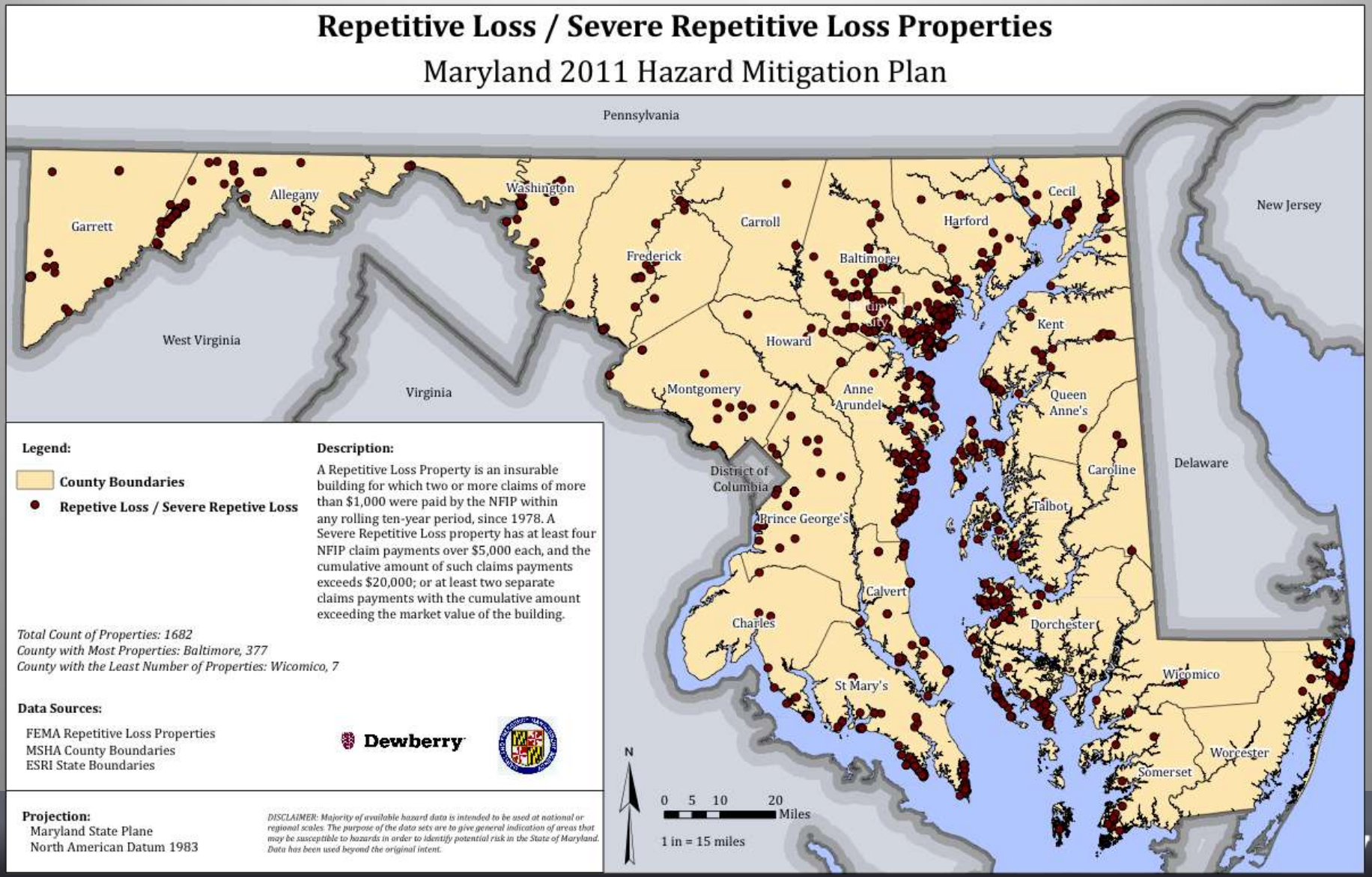

HAZUS Analysis

- FEMA HAZUS-MH MR5 county-wide analysis in progress
  - Create as many DFIRM-based Depth Grids as possible
  - Improve upon typical Level 1

July 20, 2011 meeting to discuss results

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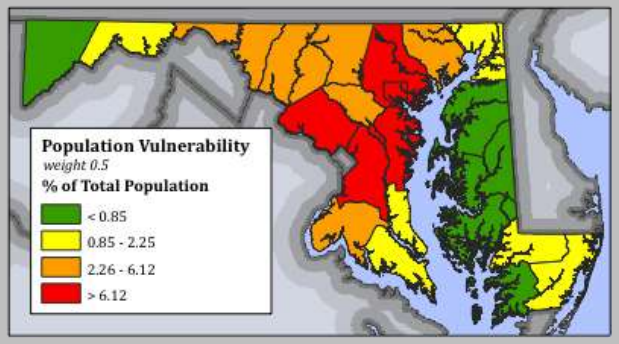

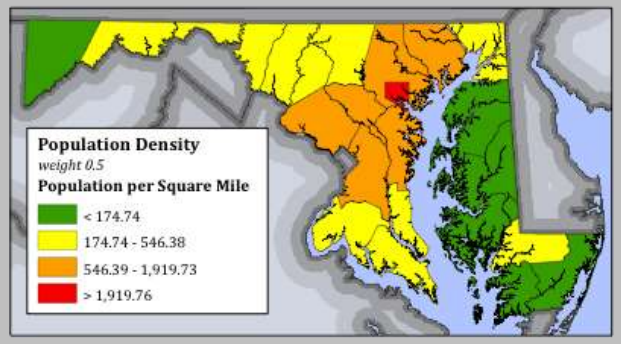

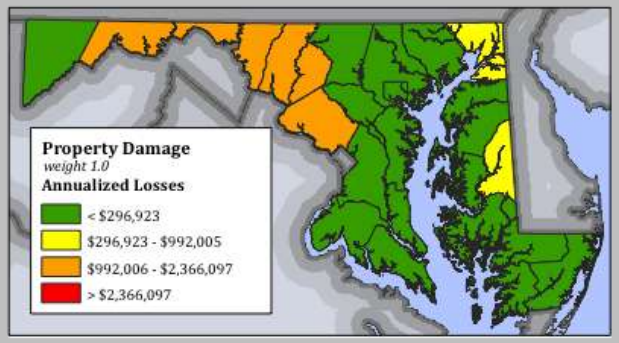

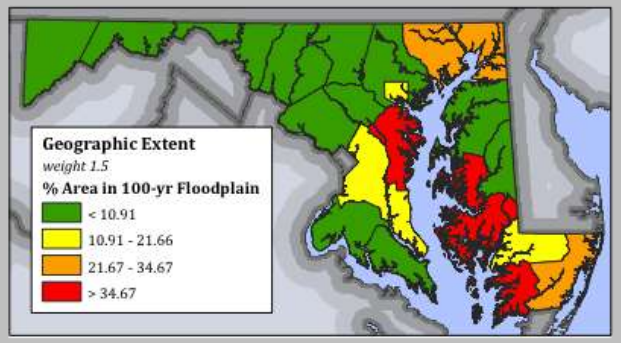

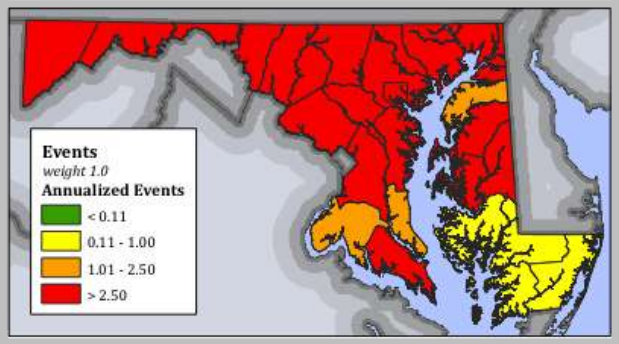

Flood Hazard Ranking & Risk Map

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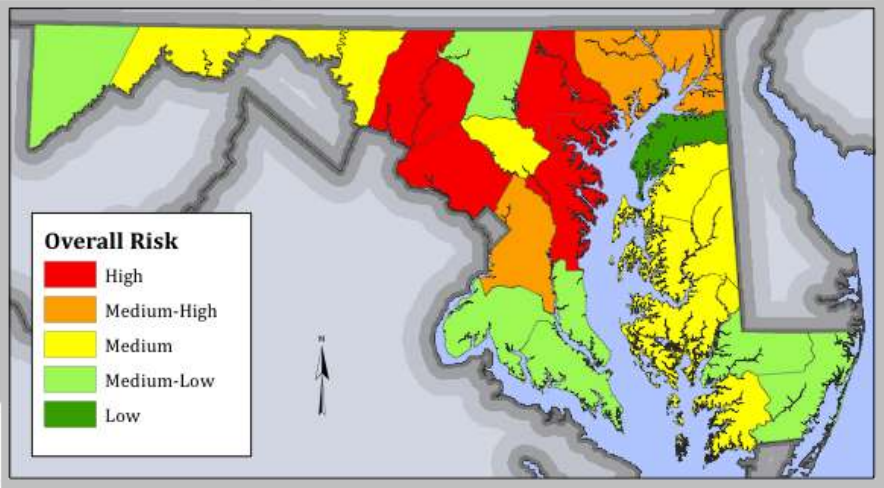

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Projection
North American Datum 1983
Maryland State Plane Feet

Dewberry

Coastal

- NCDC Annualized Loss: $40,346,796
- HAZUS-MH MR5 Annualized Loss: $21.1 million

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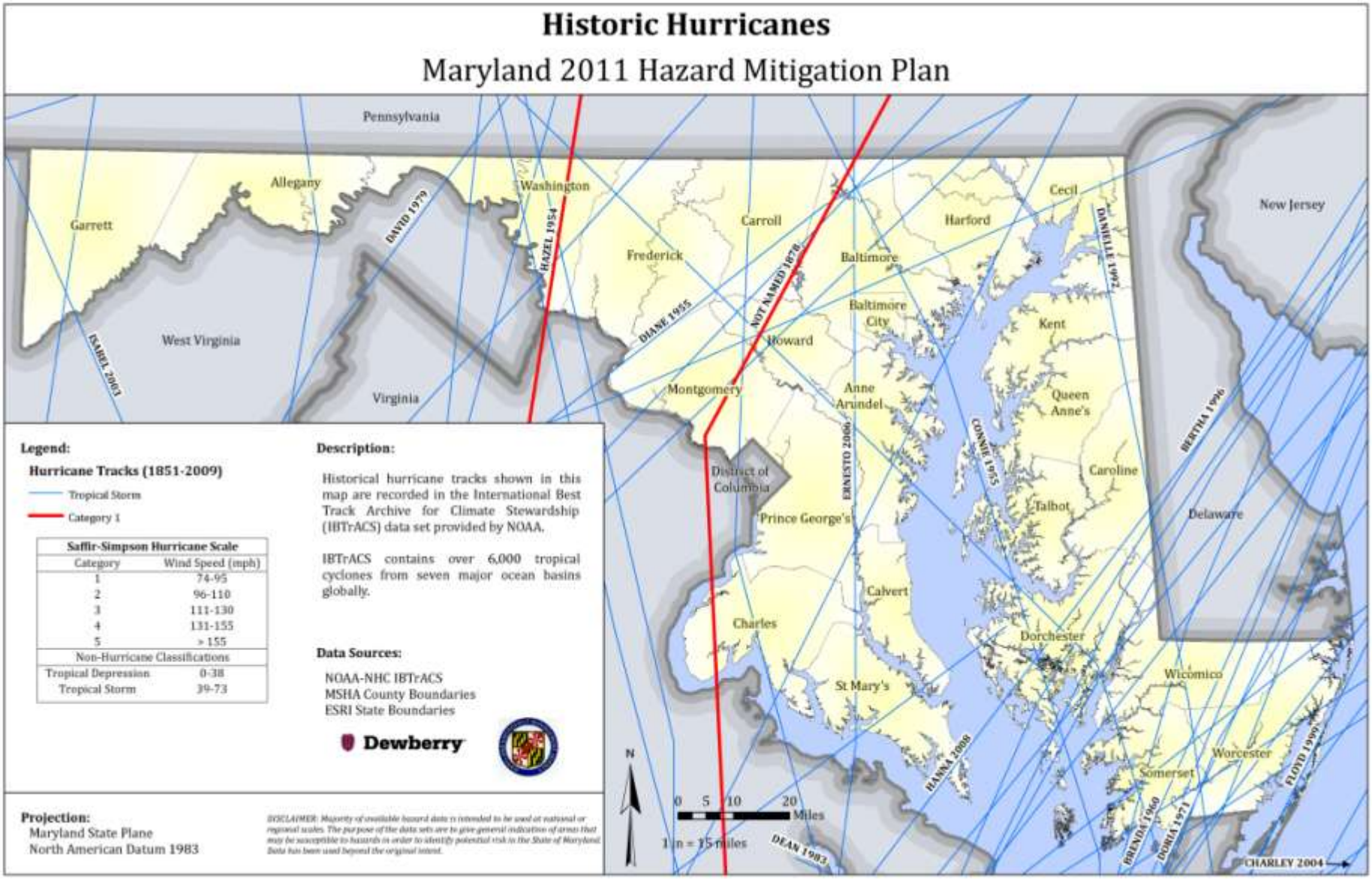

HAZUS Analysis

- Annualized Loss $21.1 million
  - Building Occupancy
  - Building Type

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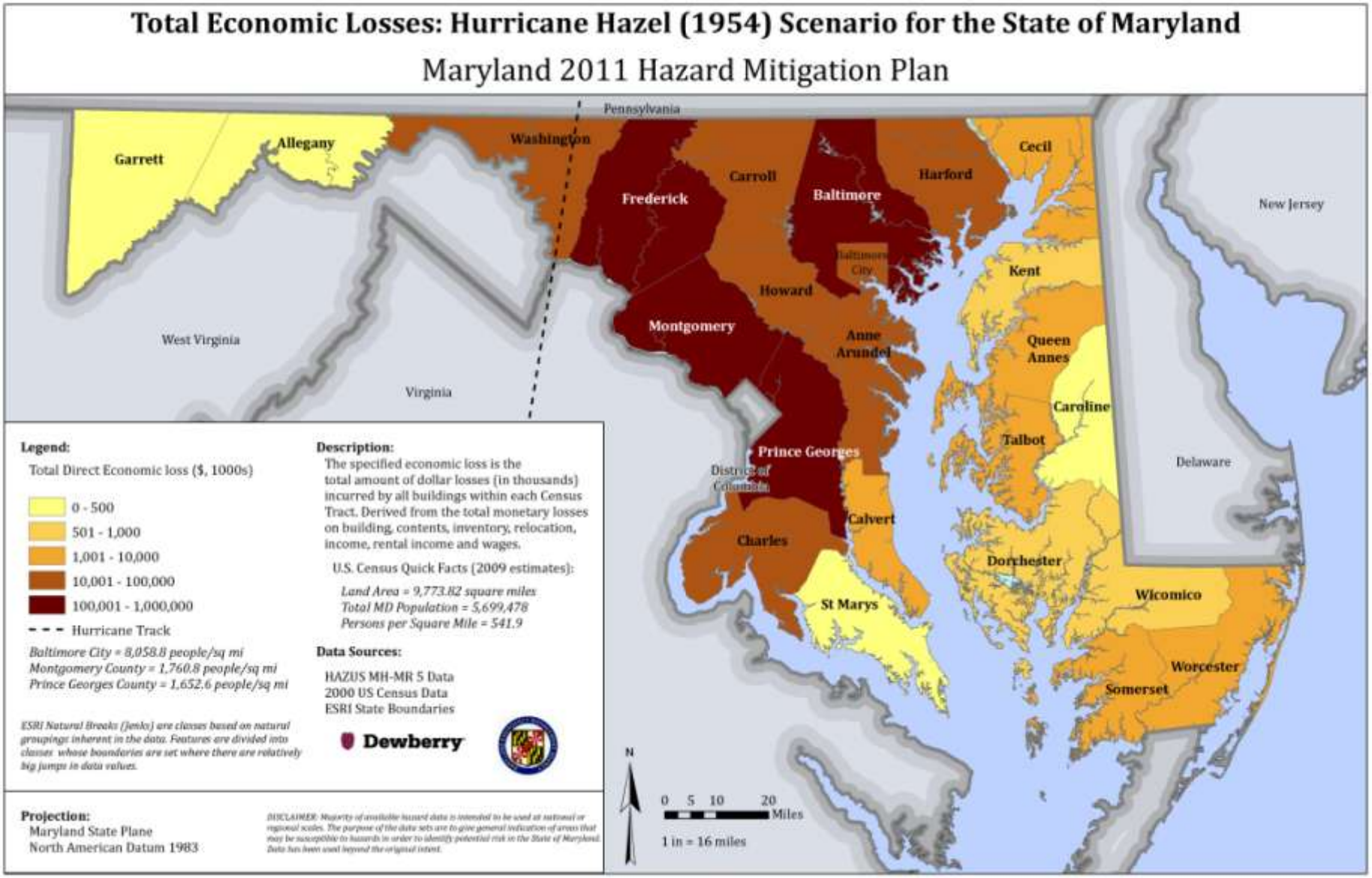

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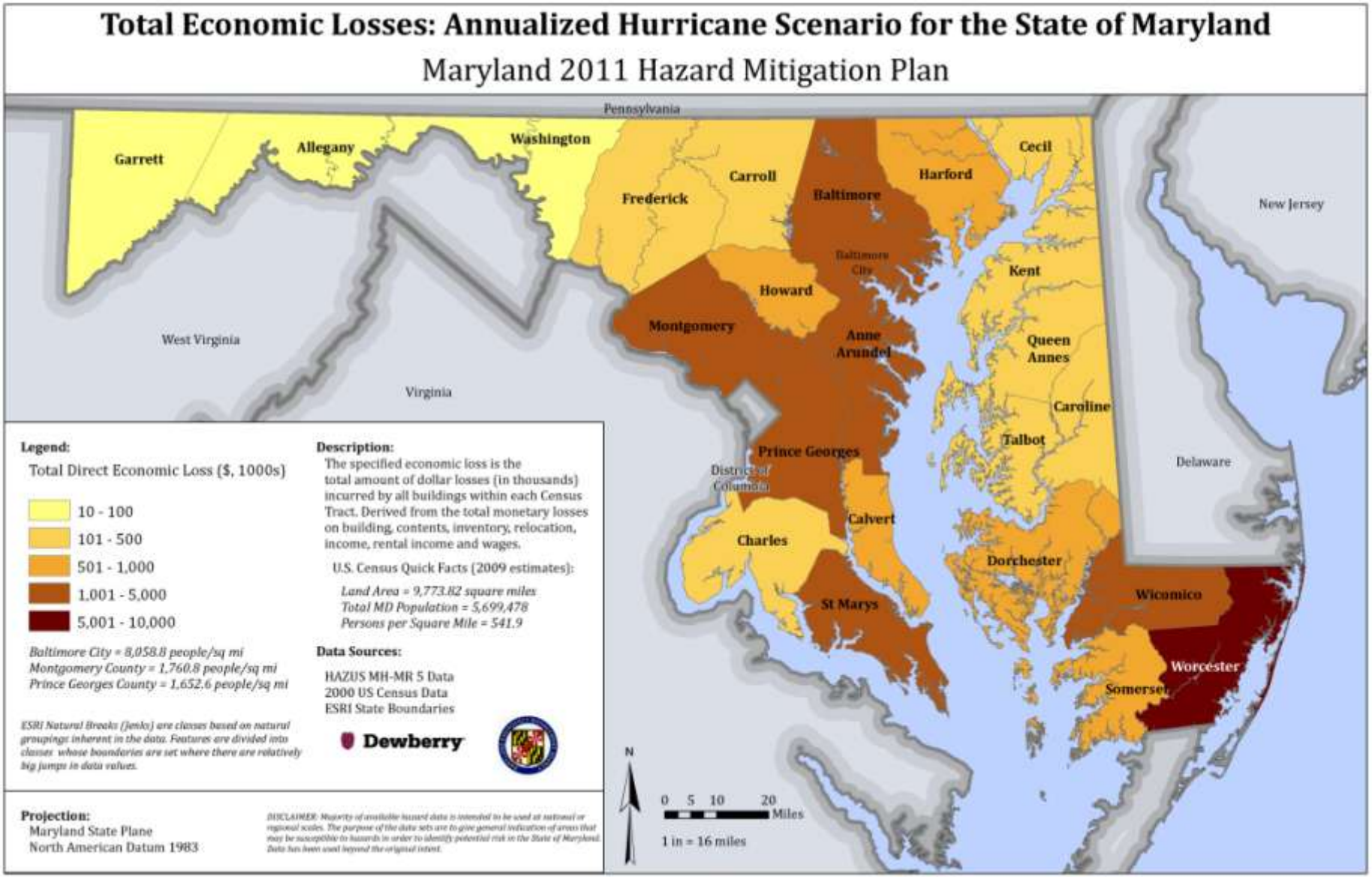

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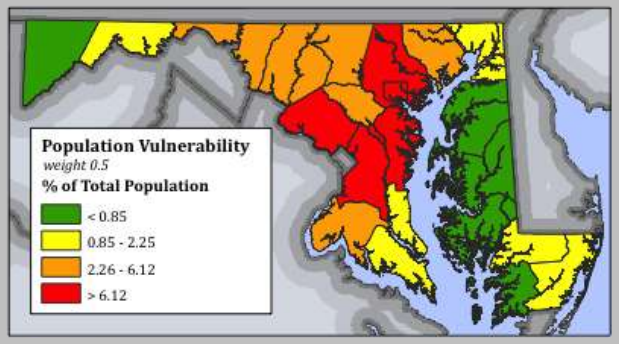

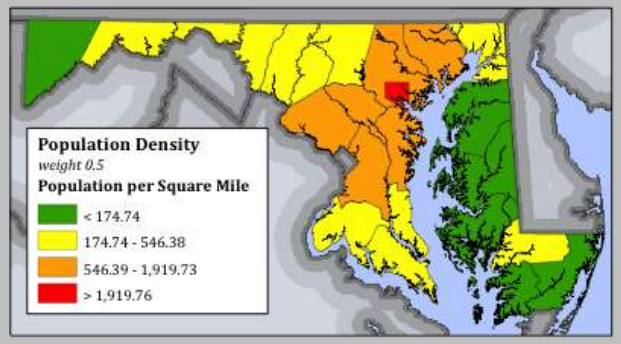

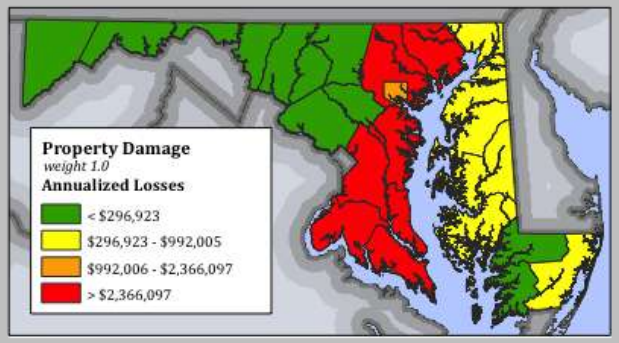

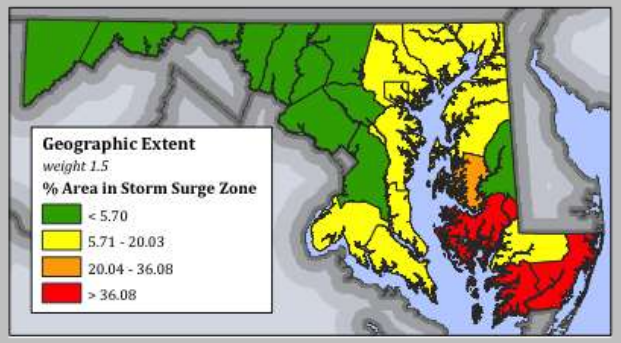

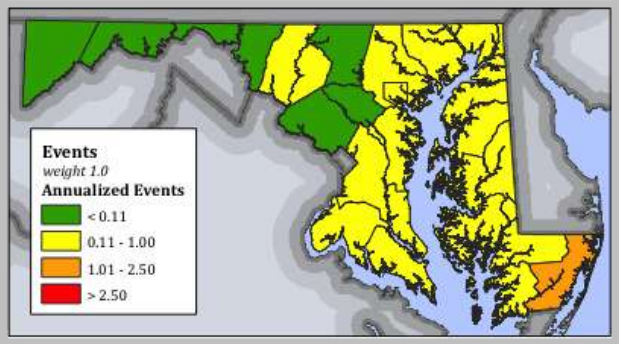

Coastal Hazard Ranking & Risk Map

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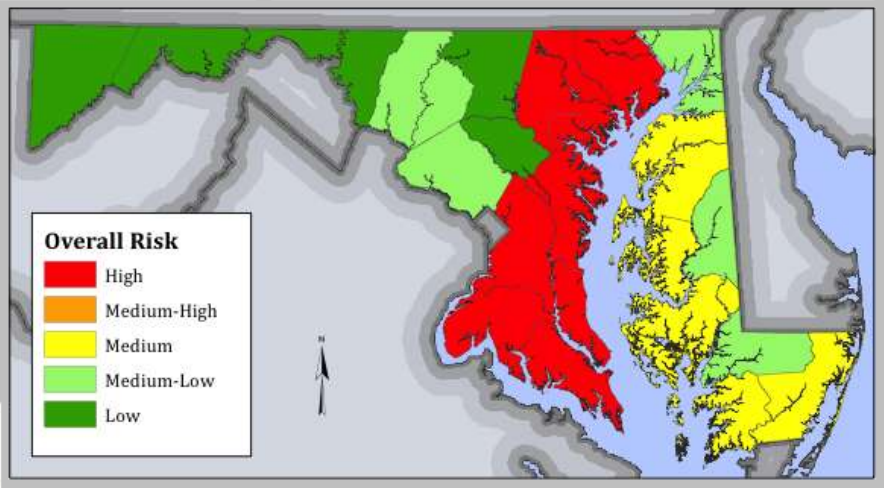

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Dewberry

Sea Level Rise

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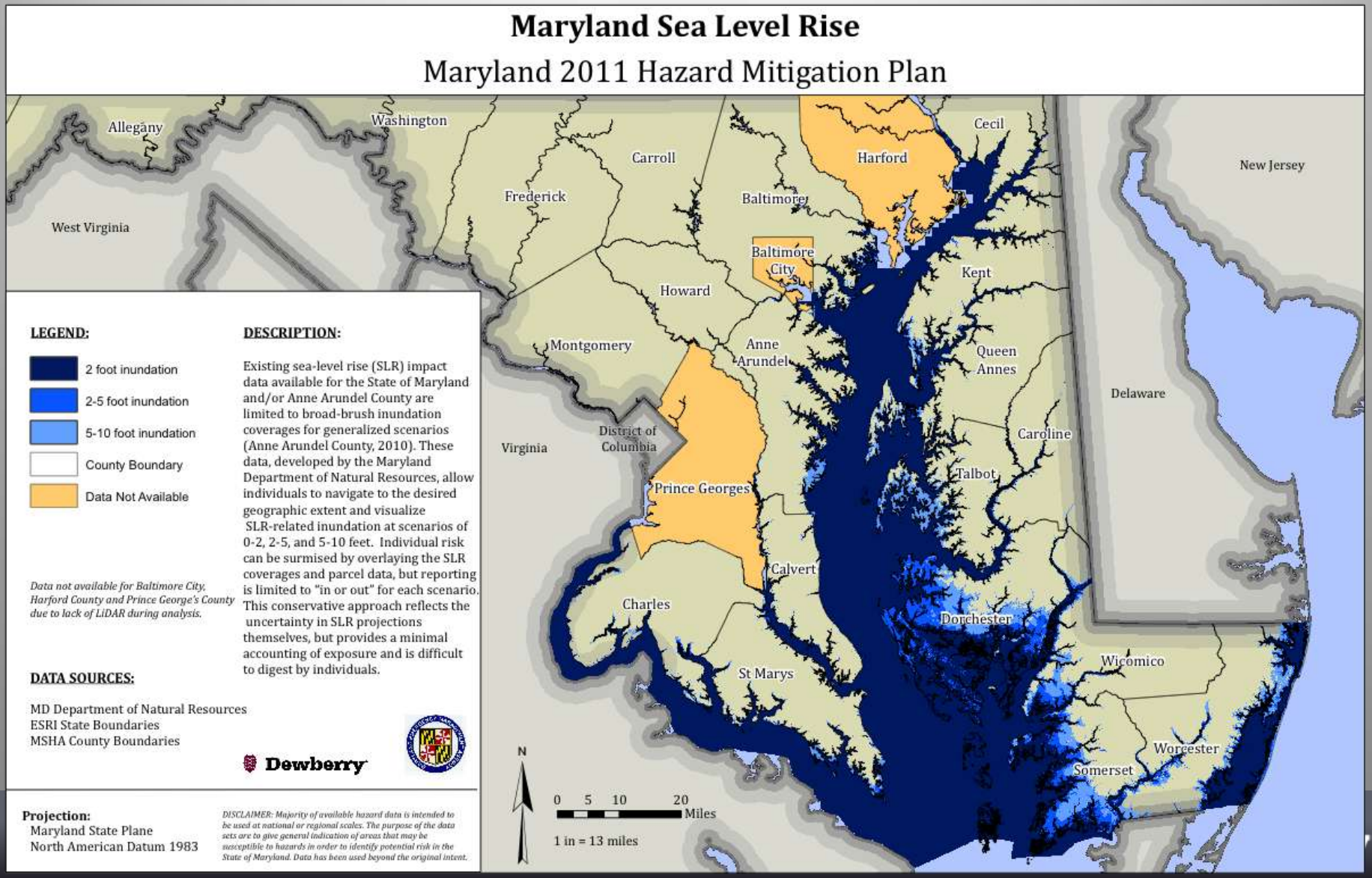

Shoreline Erosion

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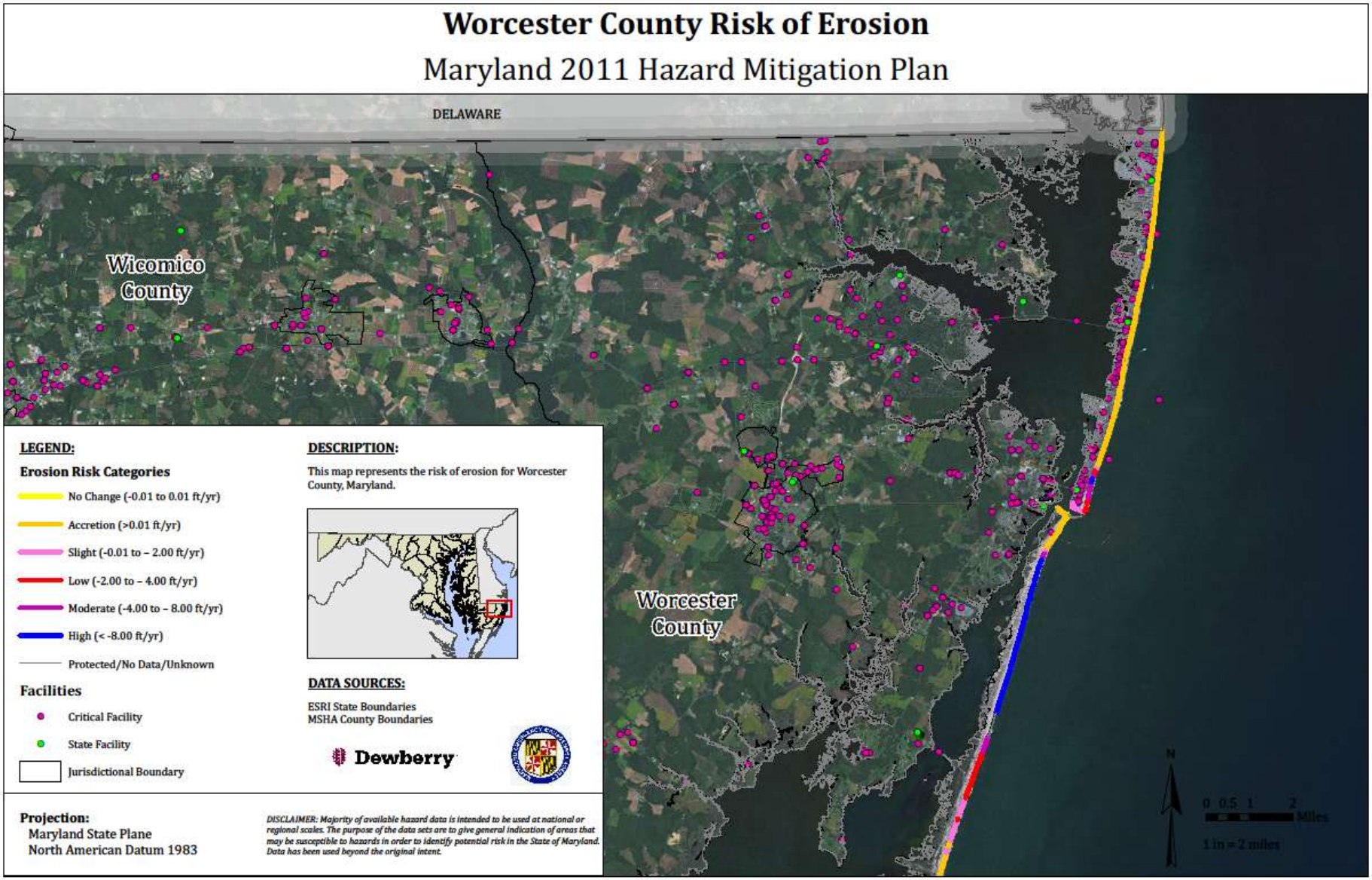

Wind

- NCDC Annualized Loss: $1,278,868
- Facilities in High Hazard Jurisdictions:
  - 1,377 State Facilities
  - 5,681 Critical Facilities

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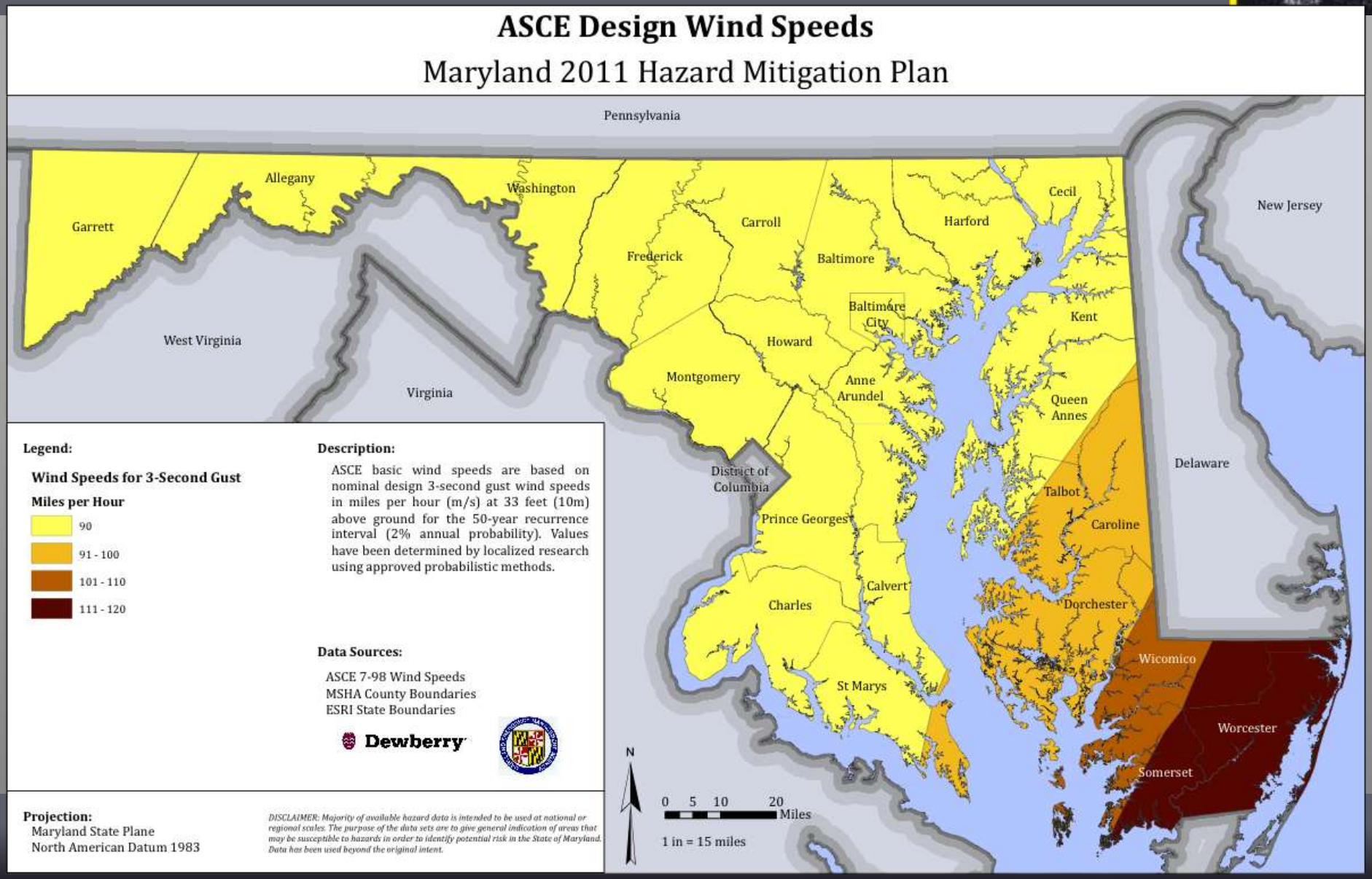

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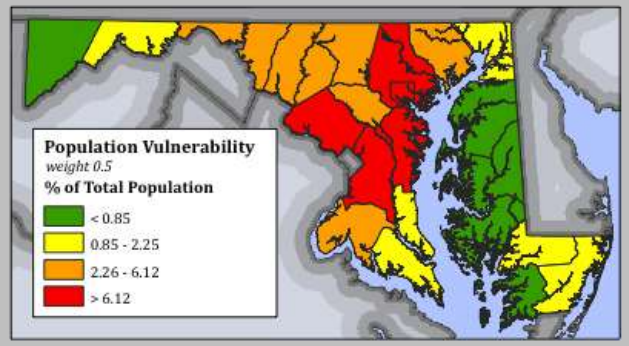

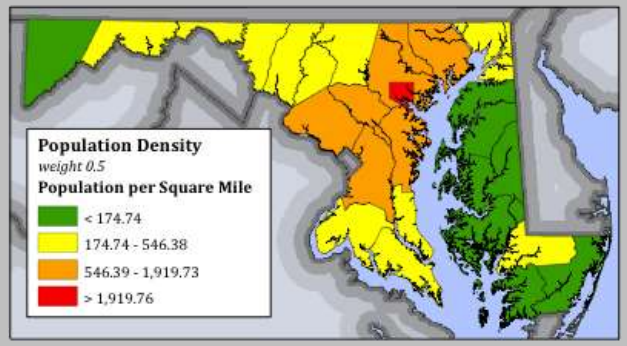

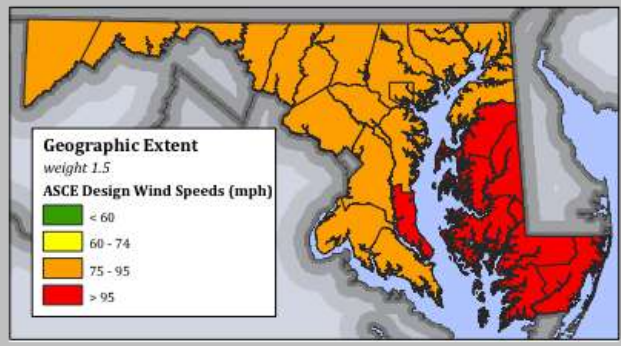

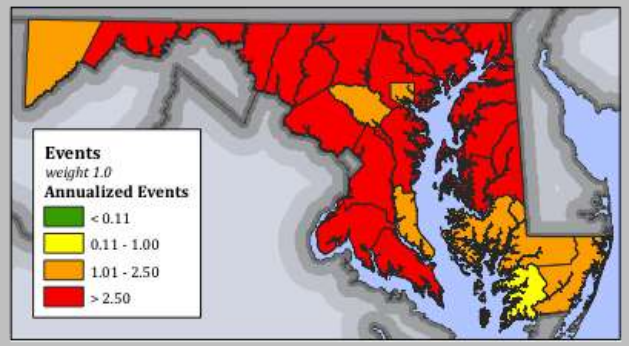

Wind Hazard Ranking & Risk Map

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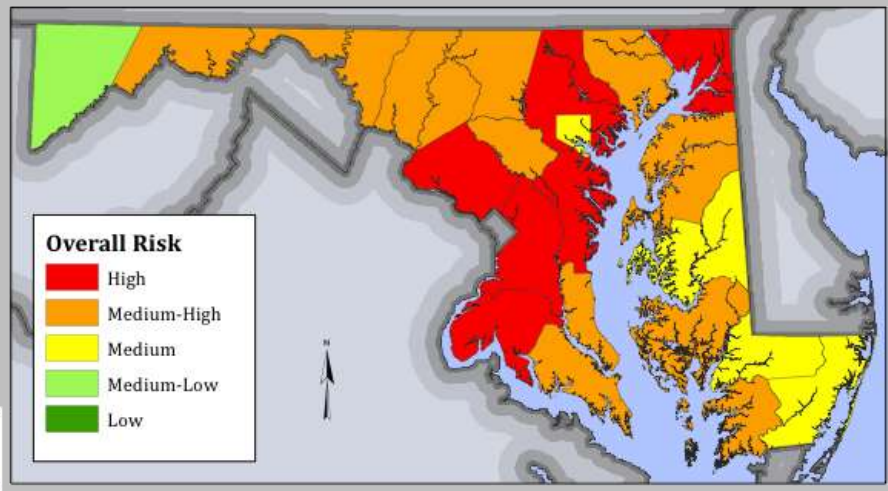
EV=Events



DISCLAIMER: Majority of available hazard data is intended to be used at national or regional scales. The purpose of the data sets are to give general indication of areas that may be susceptible to hazards in order to identify potential risk in the State of Maryland. Data has been used beyond the original intent.

Data Sources
NOAA NCDC Storm Events (1956-2010)
ASCE Design Wind Speeds
MSHA State & County Boundaries
ESRI State Coundaries

Projection
North American Datum 1983
Maryland State Plane Feet

Dewberry

Landslide

- Data: USGS Landslide Incidence and Susceptibility

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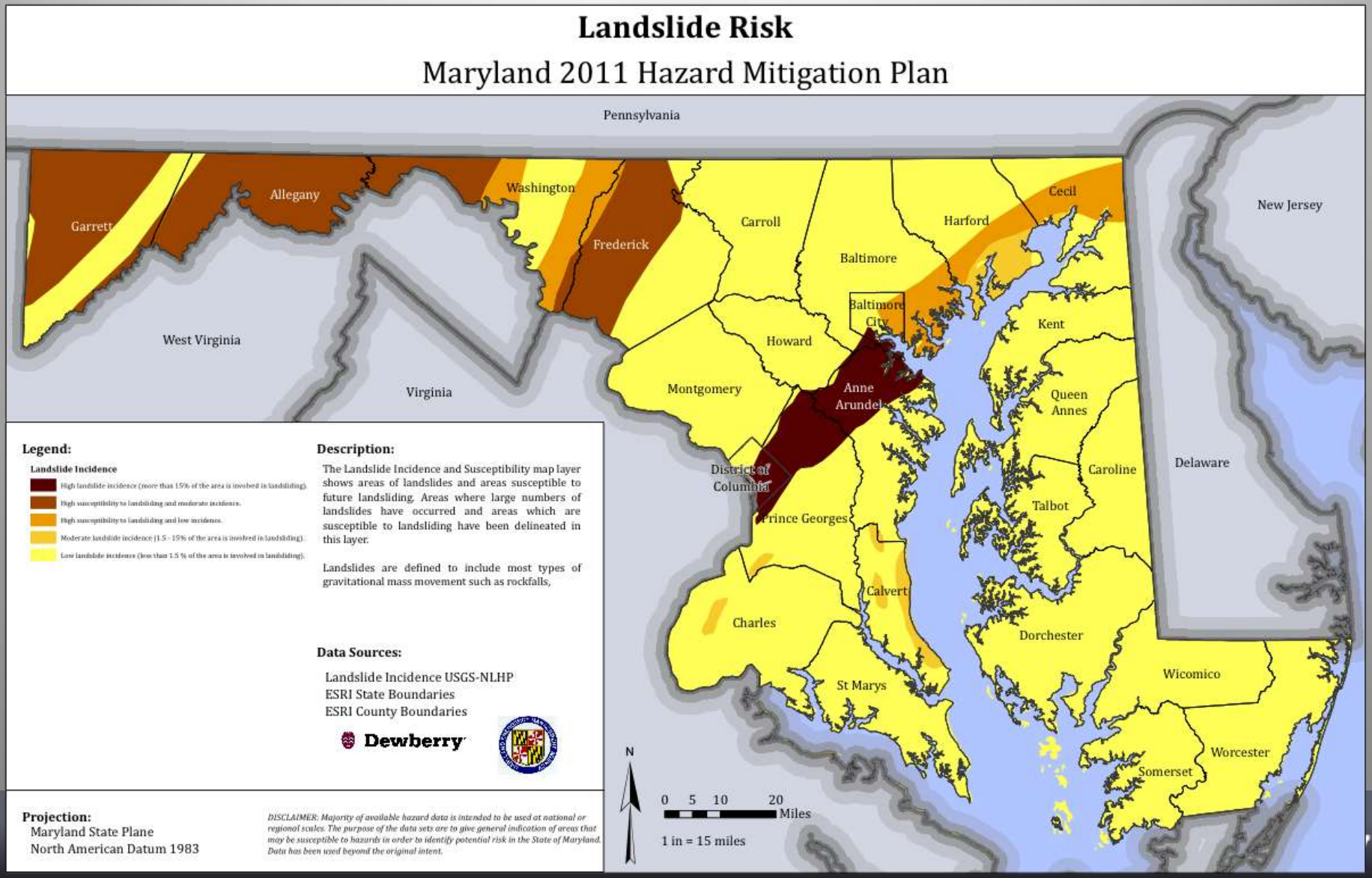

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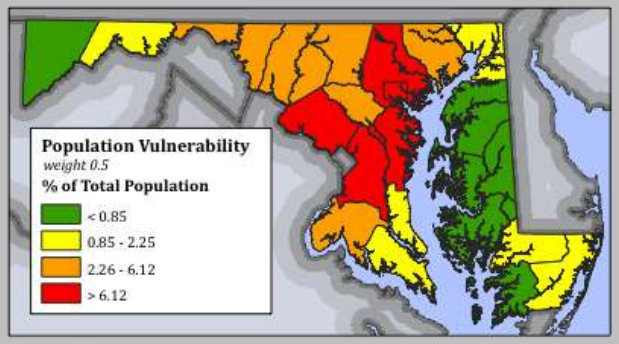
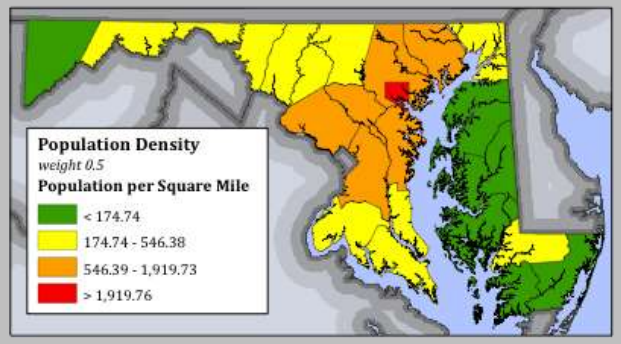
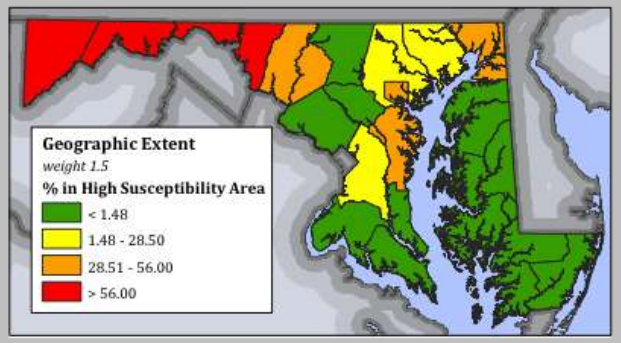
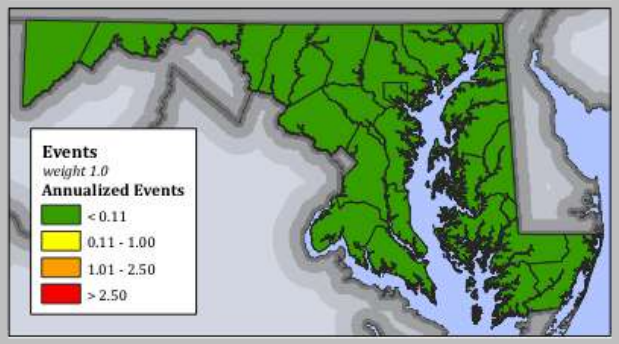
Maryland Emergency Management Agency







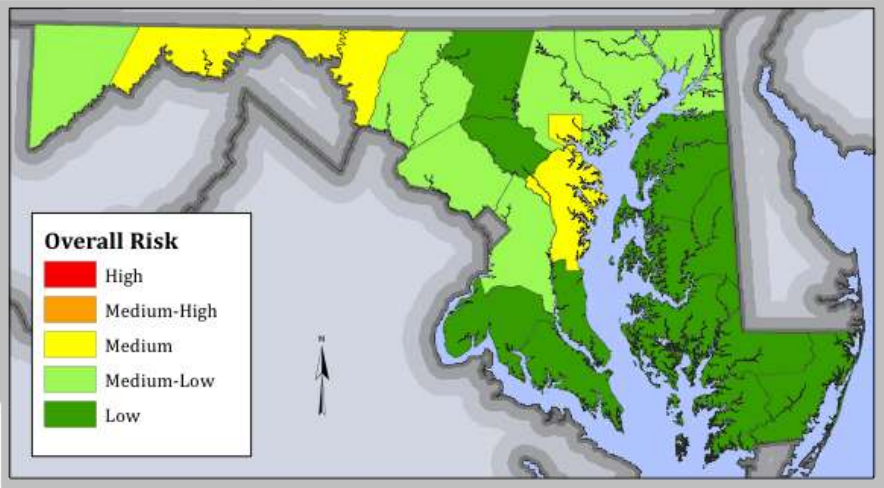


Landslide Hazard Ranking & Risk Map

A number of factors have been considered in this risk assessment to be able to compare between jurisdictions and hazards. The factors have been added together to calculate the overall total ranking for each hazard.

*Risk = PV*0.5+PN*0.5+IN*1.0+DT*1.0+ PD*1.0+CD*1.0+CD*+GE*1.5+1.0+EV*1.0*

where
PV=Population Vulnerability
PN=Population Density
IN=Injuries
DT=Deaths
PD=Property Damage
CD=Crop Damage
GE=Geographic Extent
EV=Events



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Data Sources
USGS-NLHP (2001)
MSHA State & County Boundaries
ESRI State Coundaries

Projection
North American Datum 1983
Maryland State Plane Feet

Dewberry

Thunderstorm

- NCDC Annualized Loss: $623,328
- Facilities in High Hazard Jurisdictions:
  - 2,464 State Facilities
  - 32,219 Critical Facilities

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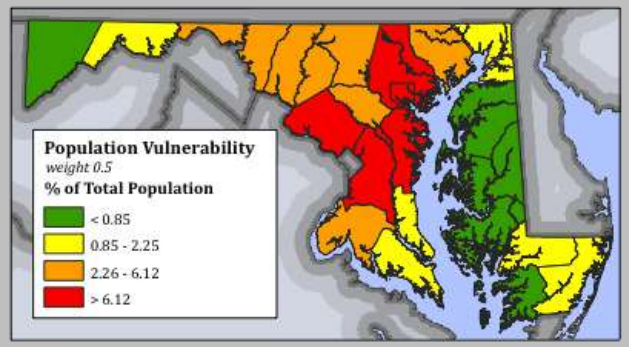
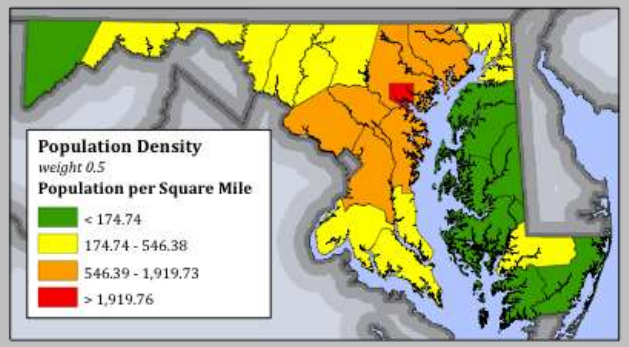
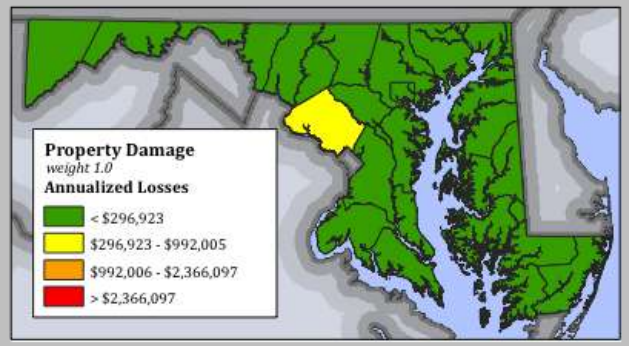
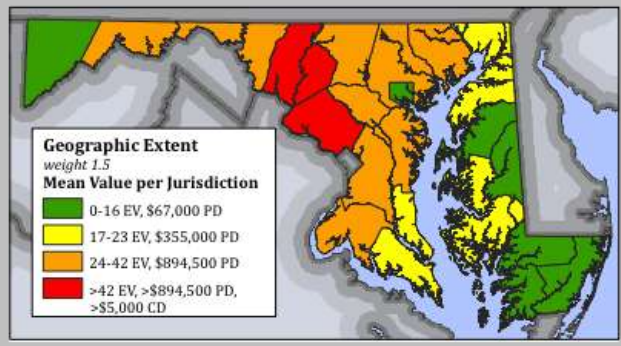
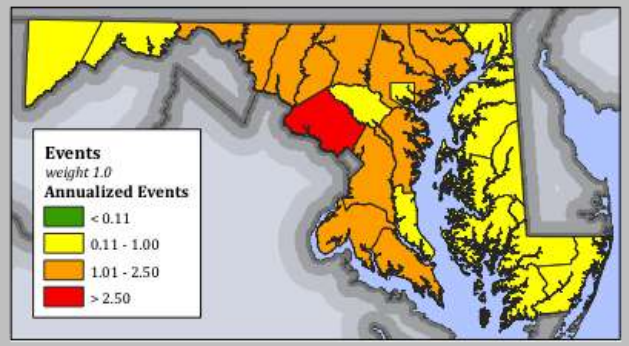
Maryland Emergency Management Agency









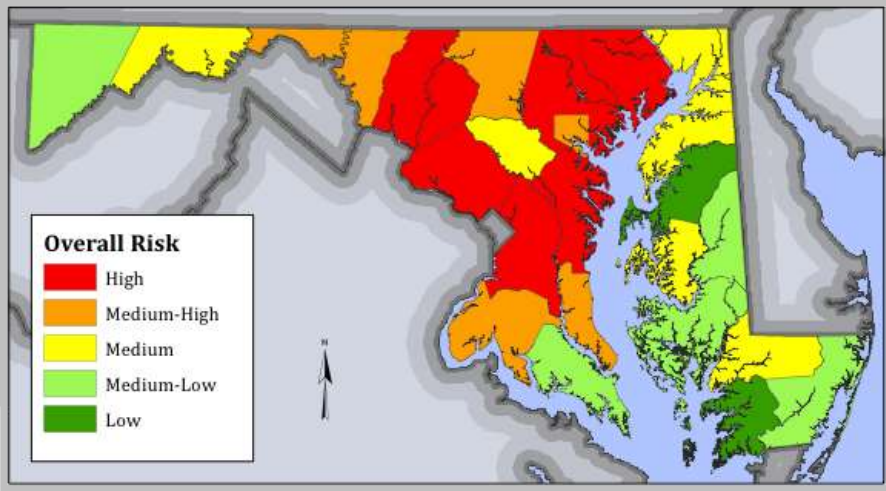


Thunderstorm Hazard Ranking & Risk Map

A number of factors have been considered in this risk assessment to be able to compare between jurisdictions and hazards. The factors have been added together to calculate the overall total ranking for each hazard.

*Risk = PV*0.5+PN*0.5+IN*1.0+DT*1.0+ PD*1.0+CD*1.0+CD*+GE*1.5+1.0+EV*1.0*

where
PV=Population Vulnerability
PN=Population Density
IN=Injuries
DT=Deaths
PD=Property Damage
CD=Crop Damage
GE=Geographic Extent
EV=Events



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Data Sources
NOAA NCDC Storm Events (1956-2010)
MSHA State & County Boundaries
ESRI State Coundaries

Projection
North American Datum 1983
Maryland State Plane Feet

Dewberry

Tornadoes

- NCDC Annualized Loss: $7,606,194
- Facilities in High Hazard Jurisdictions:
  - 1,141 State Facilities
  - 9,754 Critical Facilities

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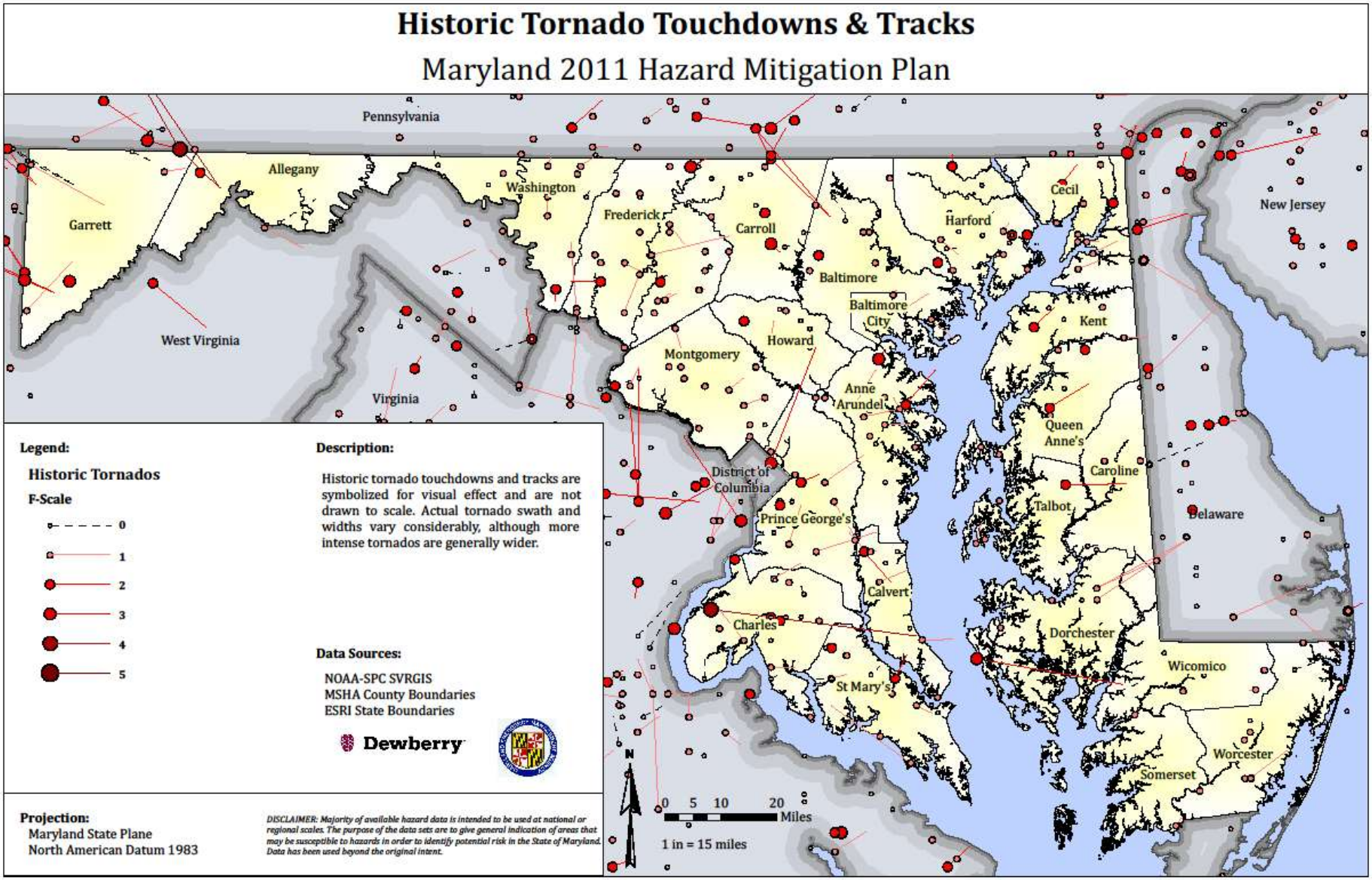
Maryland Emergency Management Agency



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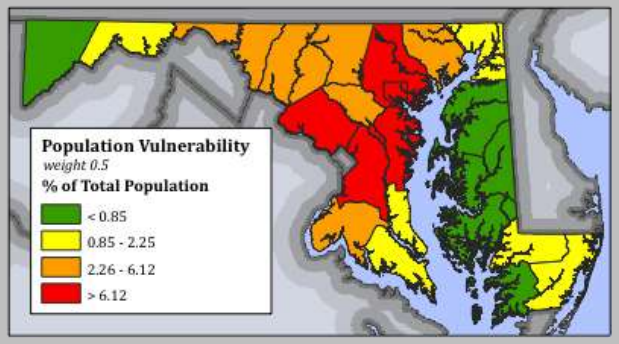
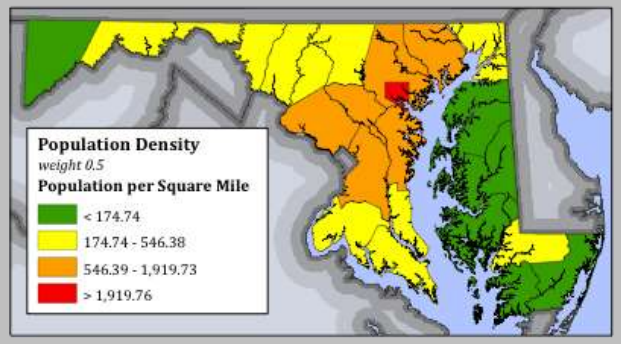
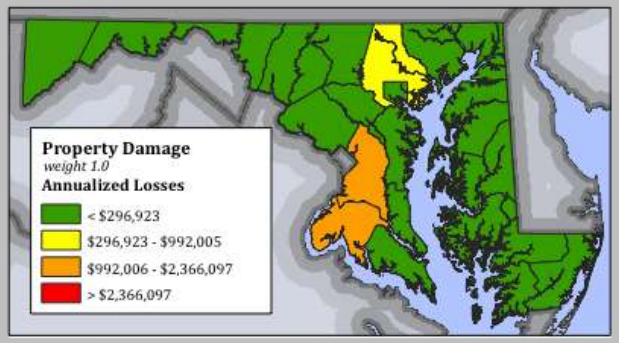
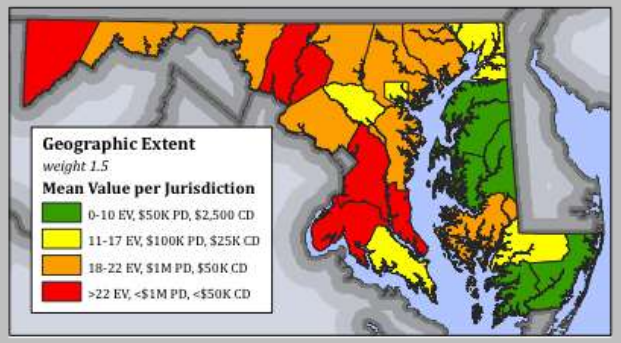
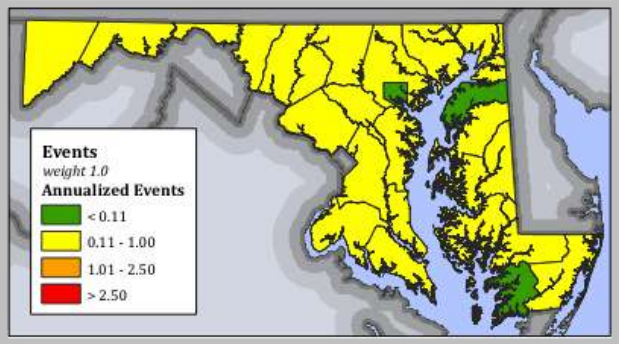
Maryland Emergency Management Agency









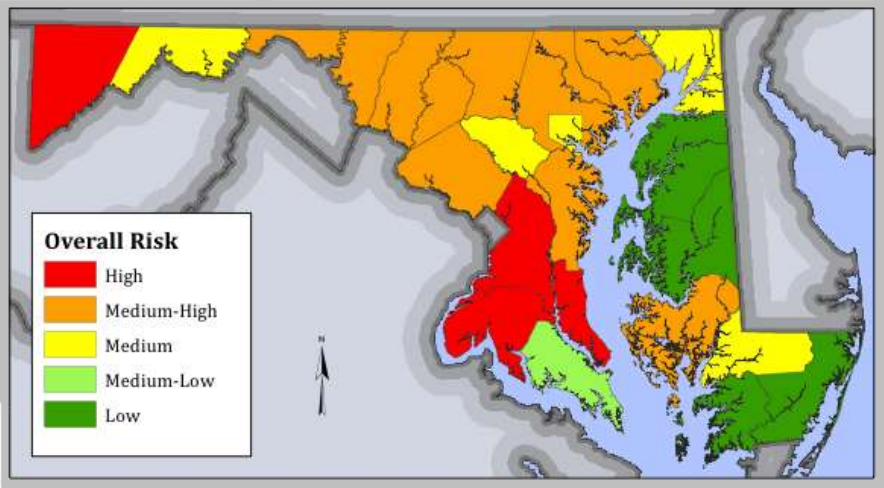


Tornado Hazard Ranking & Risk Map

A number of factors have been considered in this risk assessment to be able to compare between jurisdictions and hazards. The factors have been added together to calculate the overall total ranking for each hazard.

*Risk = PV*0.5+PN*0.5+IN*1.0+DT*1.0+ PD*1.0+CD*1.0+CD*+GE*1.5+1.0+EV*1.0*

where
PV=Population Vulnerability
PN=Population Density
IN=Injuries
DT=Deaths
PD=Property Damage
CD=Crop Damage
GE=Geographic Extent
EV=Events



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Data Sources
NOAA NCDC Storm Events (1950-2010)
MSHA State & County Boundaries
ESRI State Coundaries

Projection
North American Datum 1983
Maryland State Plane Feet

Dewberry

Wildfire

- State Contact: Robert Feldt, Maryland DNR Forest Service
- Data: Wildfire Risk Assessment and Statistics on historic events
- DNR FS Annualized Loss: $25,050

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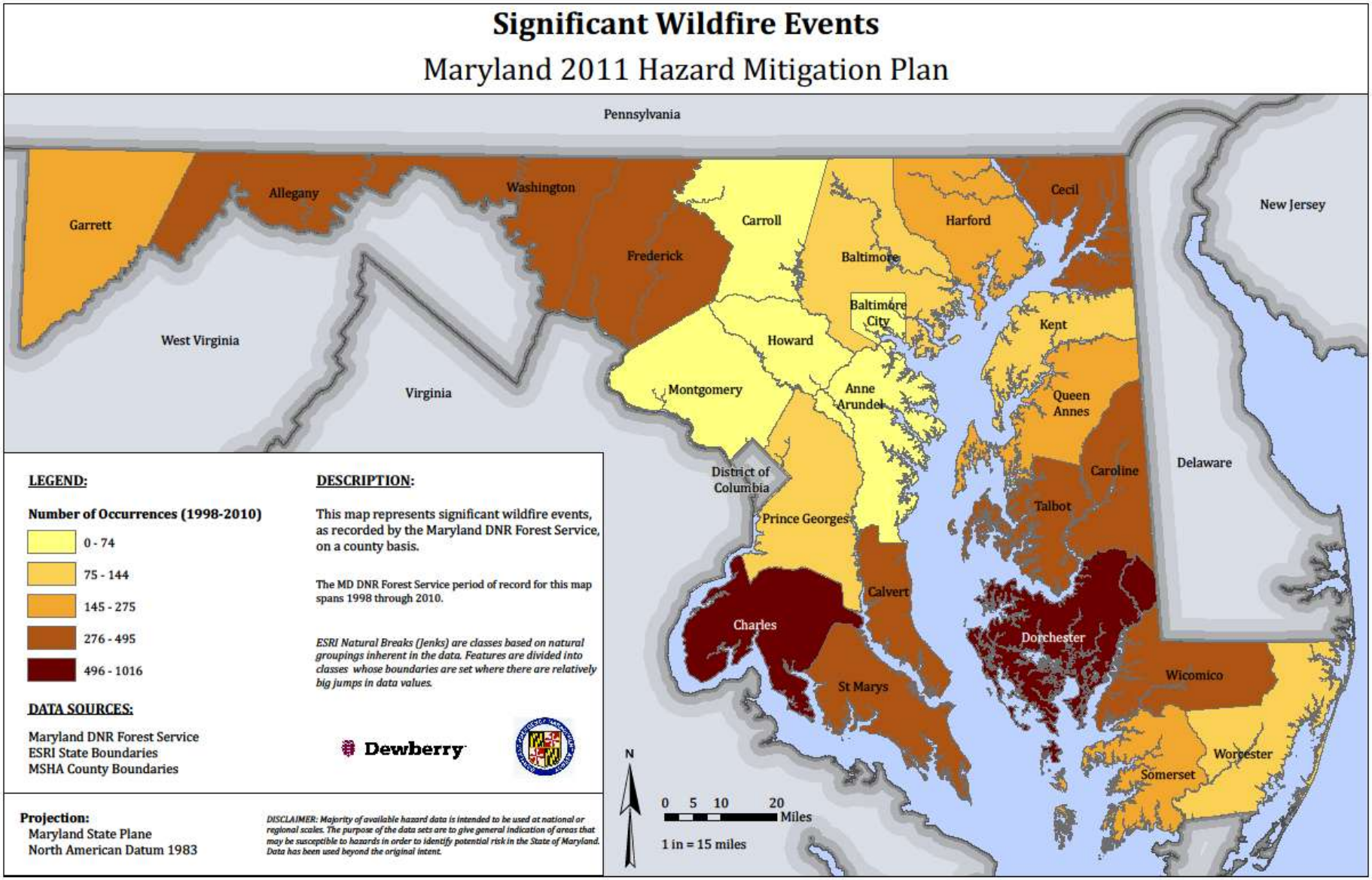
Maryland Emergency Management Agency



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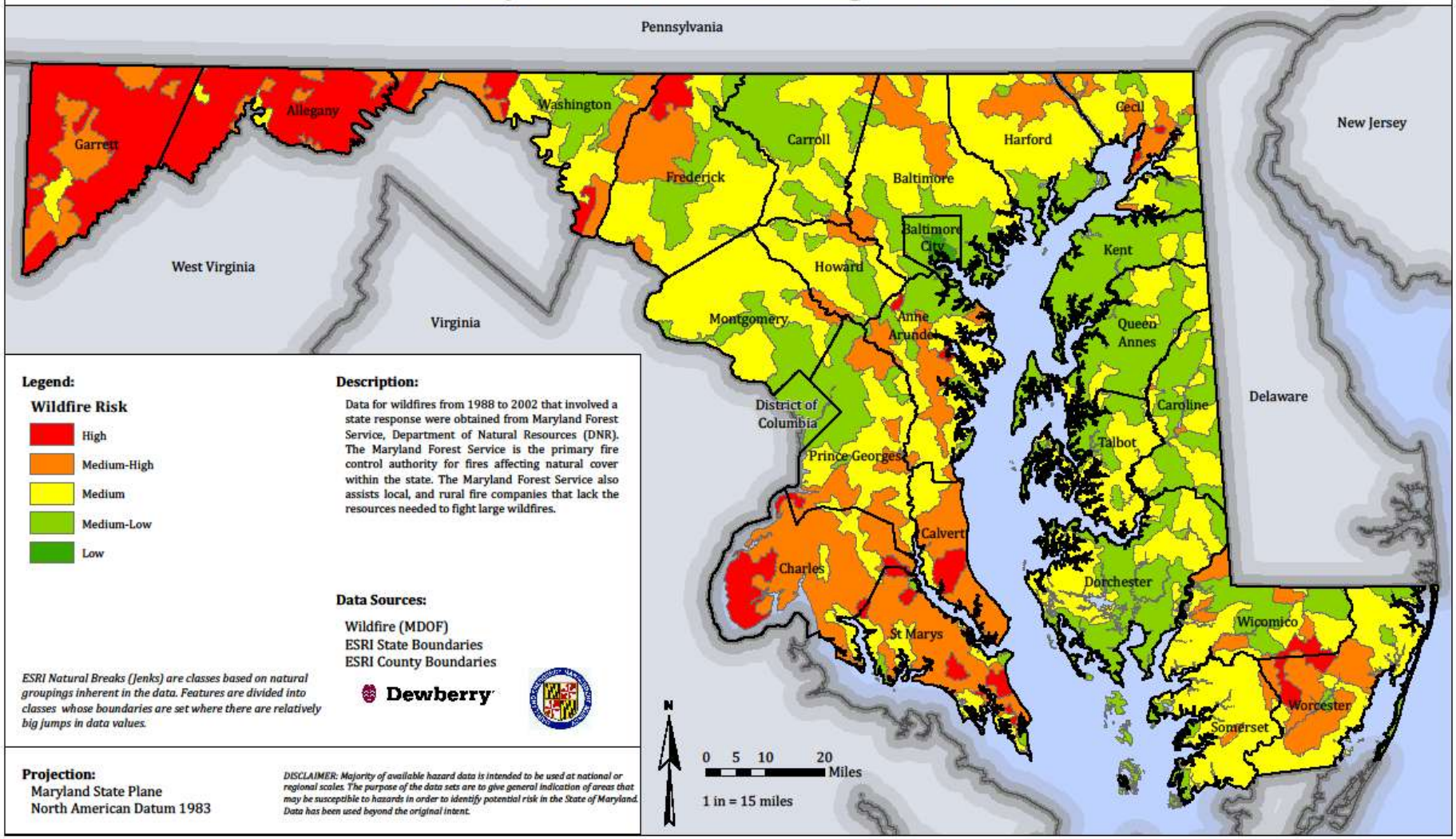
Maryland Emergency Management Agency



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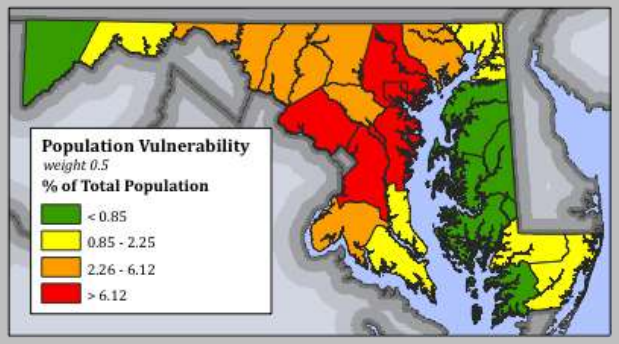
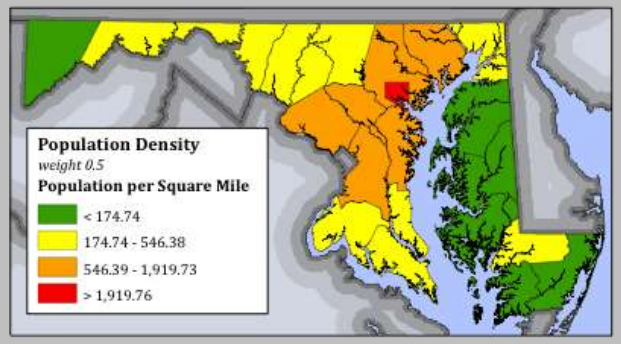
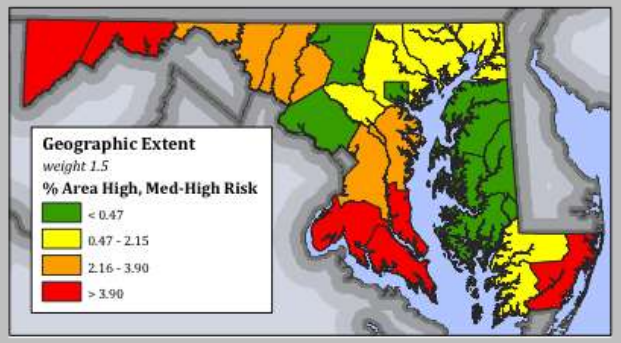
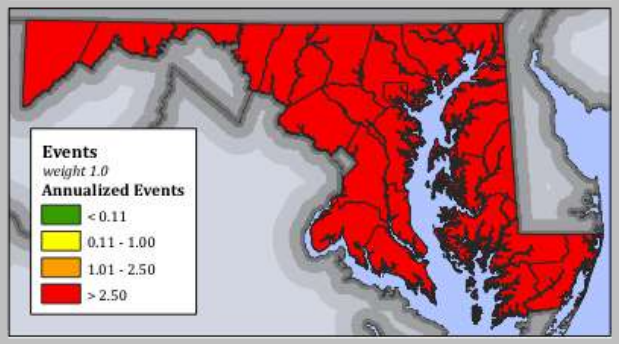
Maryland Emergency Management Agency







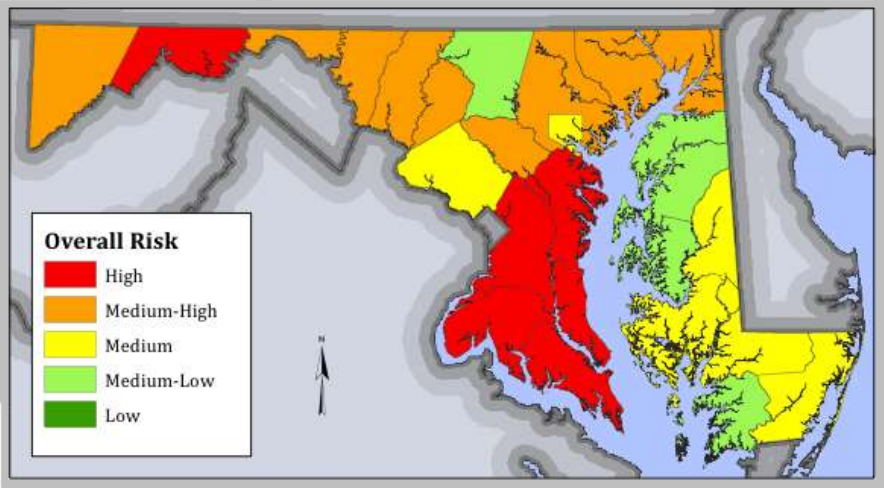


Wildfire Hazard Ranking & Risk Map

A number of factors have been considered in this risk assessment to be able to compare between jurisdictions and hazards. The factors have been added together to calculate the overall total ranking for each hazard.

*Risk = PV*0.5+PN*0.5+IN*1.0+DT*1.0+ PD*1.0+CD*1.0+CD*+GE*1.5+1.0+EV*1.0*

where
PV=Population Vulnerability
PN=Population Density
IN=Injuries
DT=Deaths
PD=Property Damage
CD=Crop Damage
GE=Geographic Extent
EV=Events



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Data Sources
NOAA NCDC Storm Events (2001-2006)
Maryland Department of Natural Resources – Forest Service (1998-2010)
MSHA State & County Boundaries
ESRI State Coundaries

Projection
North American Datum 1983
Maryland State Plane Feet

Dewberry

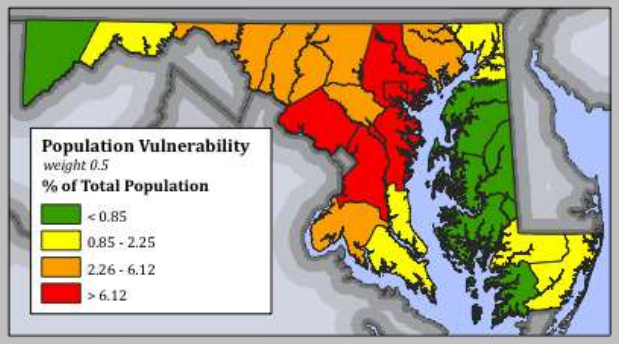
Winter Storm

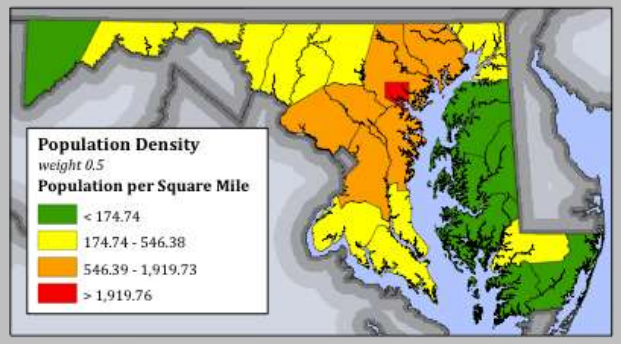
NCDC Annualized Loss: $1,246,317

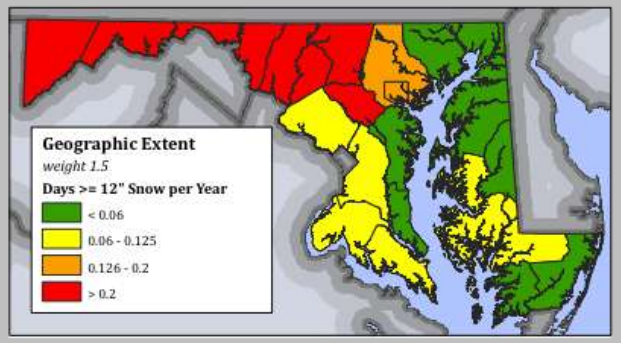
- Facilities in High Hazard Jurisdictions:
  - 1,671 State Facilities
  - 9,722 Critical Facilities

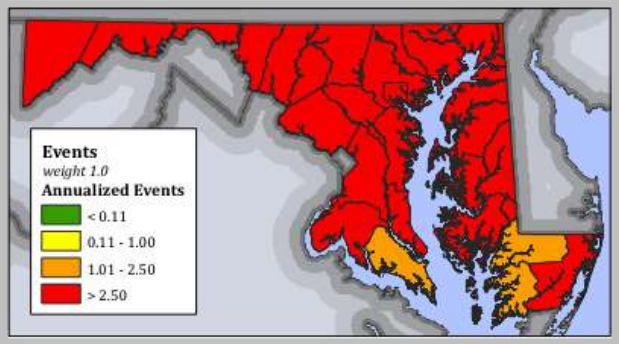
2011 Maryland All-Hazard Mitigation Plan Update

Maryland Emergency Management Agency







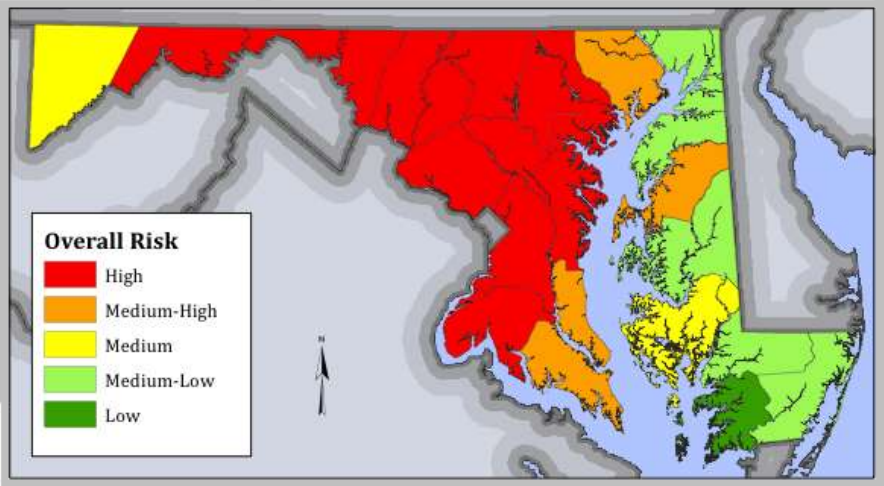


Winter Storm Hazard Ranking & Risk Map

A number of factors have been considered in this risk assessment to be able to compare between jurisdictions and hazards. The factors have been added together to calculate the overall total ranking for each hazard.

*Risk = PV*0.5+PN*0.5+IN*1.0+DT*1.0+ PD*1.0+CD*1.0+CD*+GE*1.5+1.0+EV*1.0*

where
PV=Population Vulnerability
PN=Population Density
IN=Injuries
DT=Deaths
PD=Property Damage
CD=Crop Damage
GE=Geographic Extent
EV=Events



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Data Sources
NOAA NCDC Storm Events (1993-2010)
MSHA State & County Boundaries
ESRI State Coundaries

Projection
North American Datum 1983
Maryland State Plane Feet

Dewberry

Karst/Sinkhole

- State Contact: Maryland Geological Survey: Heather Quinn
- Data: Digitized 1968 Geologic Map of MD grouped formations in four categories (High, Moderate, Moderately Low, and Low) based on relative risk

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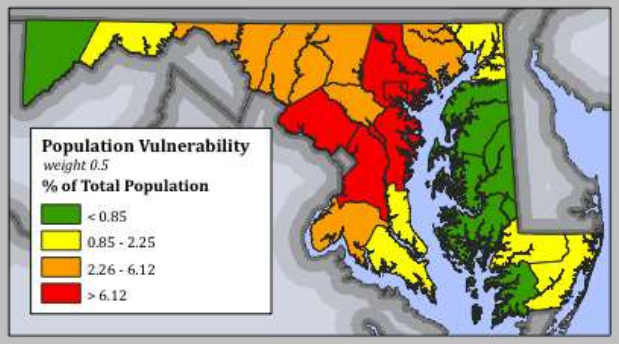
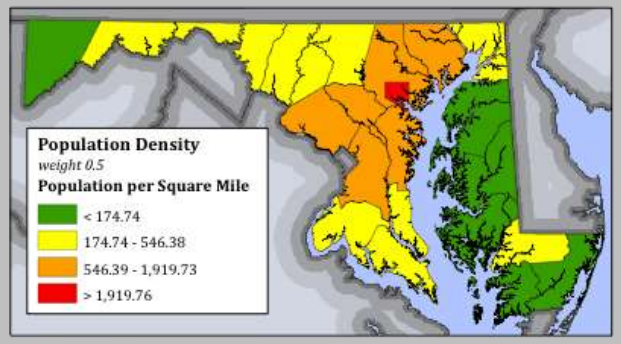
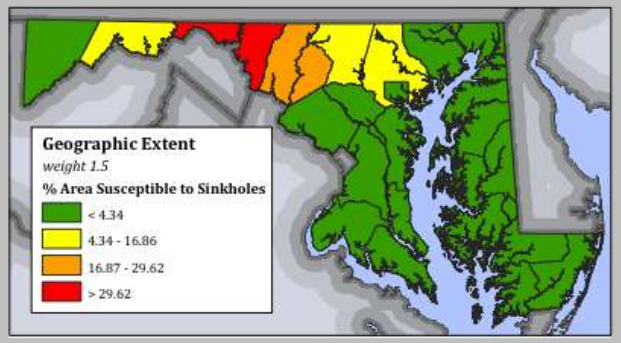
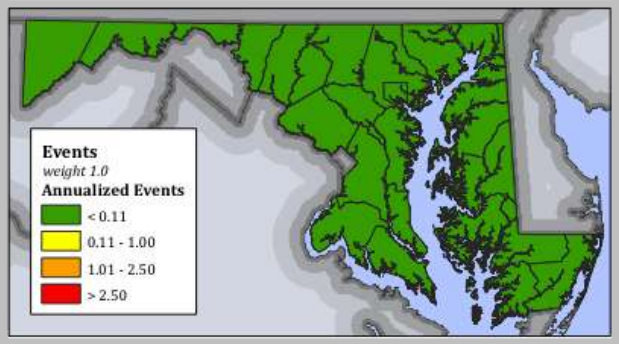
Maryland Emergency Management Agency







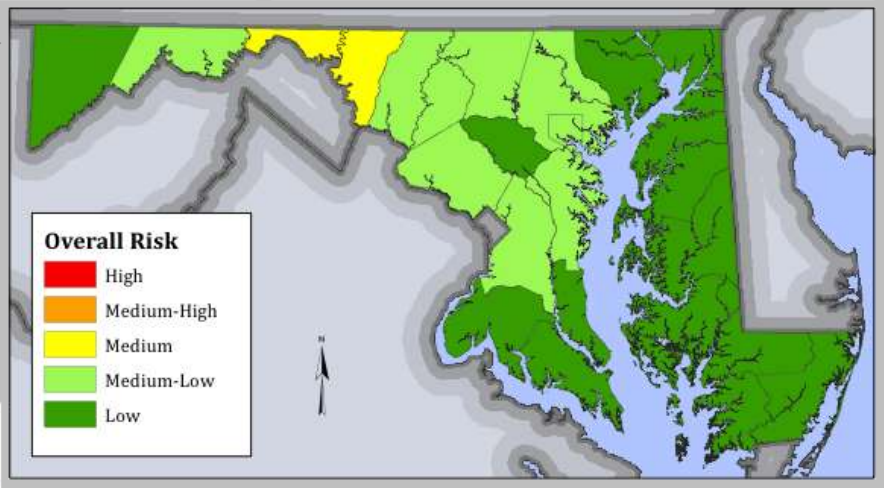


Land Subsidence Hazard Ranking & Risk Map

A number of factors have been considered in this risk assessment to be able to compare between jurisdictions and hazards. The factors have been added together to calculate the overall total ranking for each hazard.

*Risk = PV*0.5+PN*0.5+IN*1.0+DT*1.0+ PD*1.0+CD*1.0+CD*+GE*1.5+1.0+EV*1.0*

where
PV=Population Vulnerability
PN=Population Density
IN=Injuries
DT=Deaths
PD=Property Damage
CD=Crop Damage
GE=Geographic Extent
EV=Events



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Data Sources
Maryland Geological Survey
MSHA State & County Boundaries
ESRI State Coundaries

Projection
North American Datum 1983
Maryland State Plane Feet

Dewberry

Earthquake

- State Contact: Maryland Geological Survey Richard Ortt
- Data: HAZUS-MH MR5, USGS Significant Earthquakes, USGS/HAZUS Peak Ground Acceleration (PGA)

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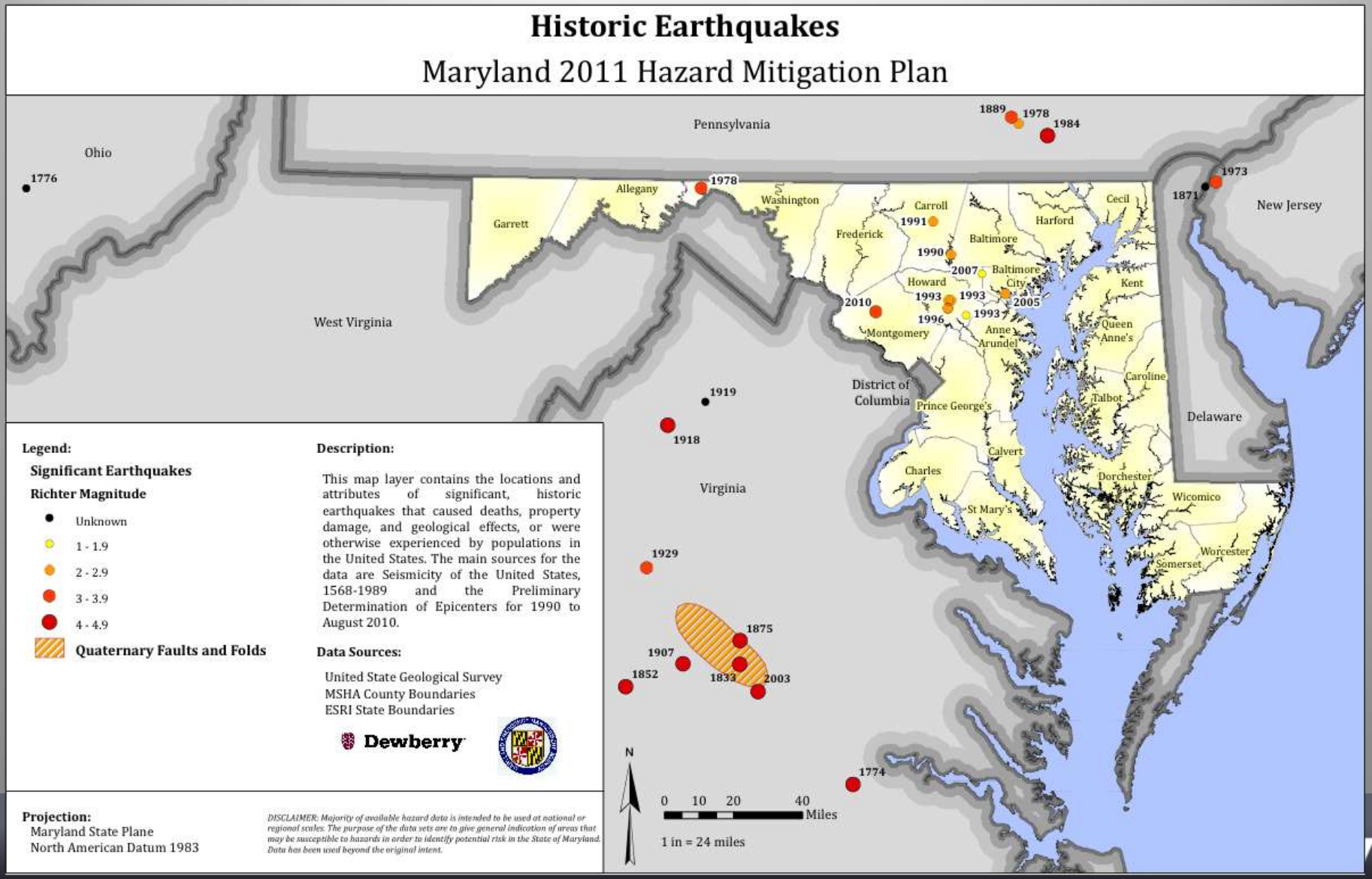
Maryland Emergency Management Agency



HAZUS Analysis for Earthquake

- Annualized Loss $15.1 million
  - Building Occupancy
  - Building Type

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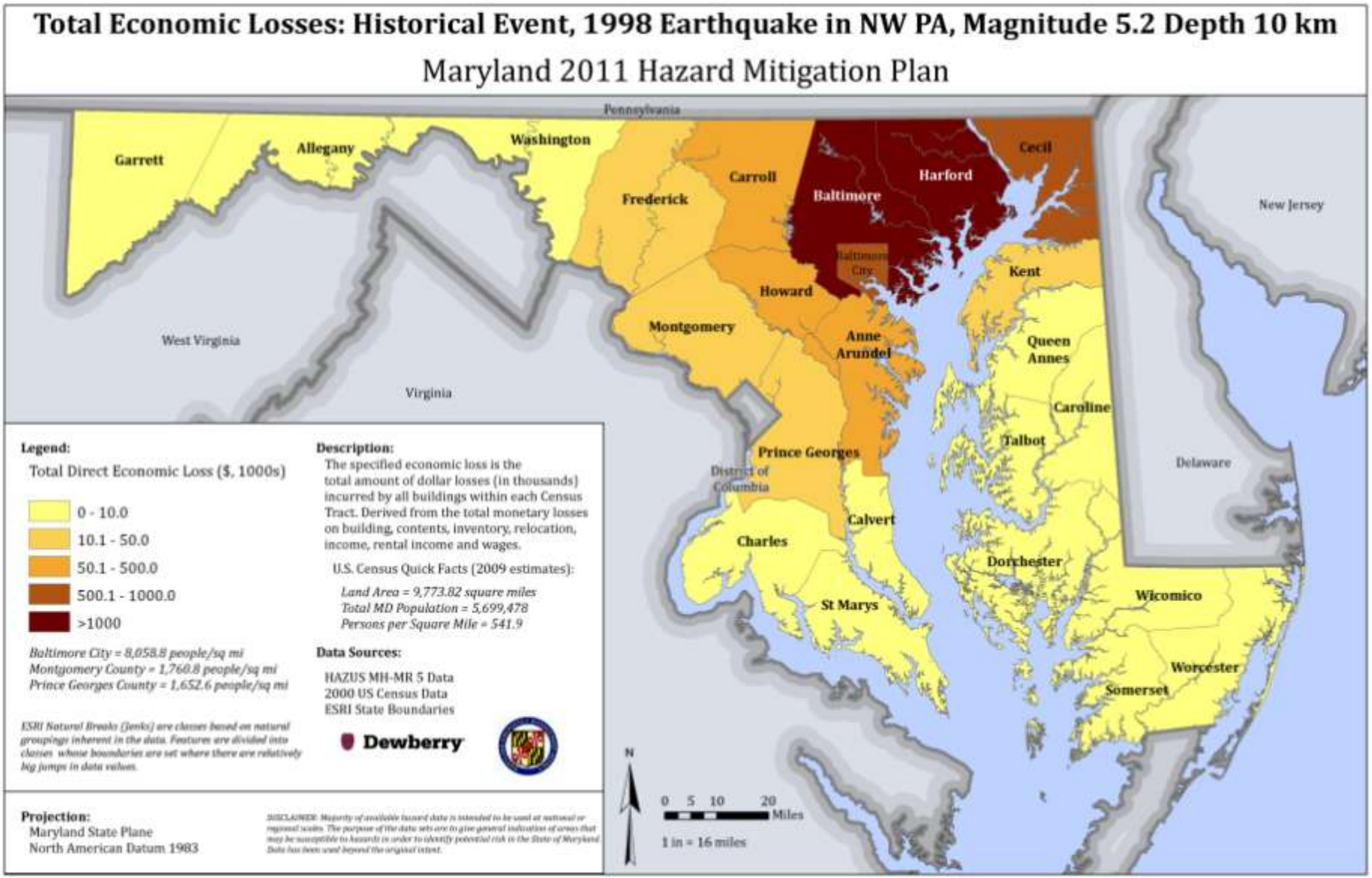
Maryland Emergency Management Agency



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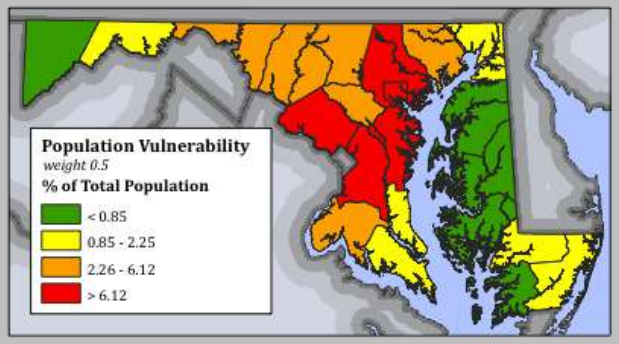
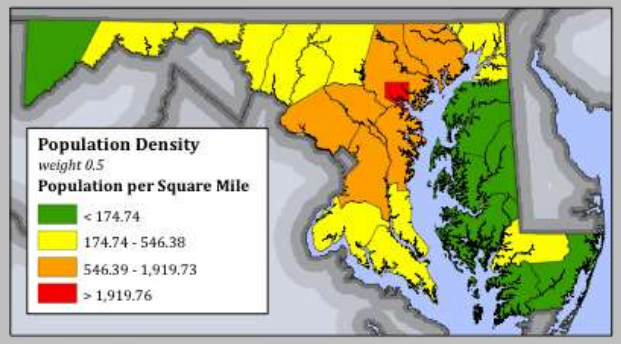
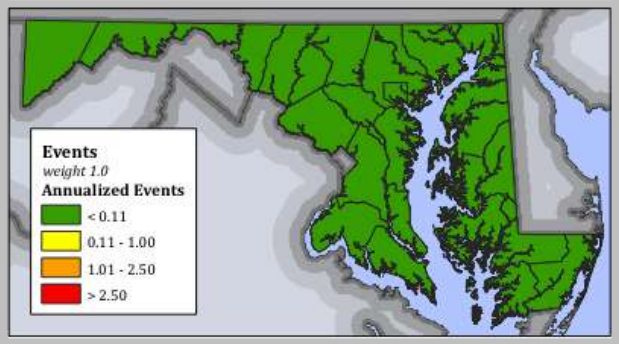




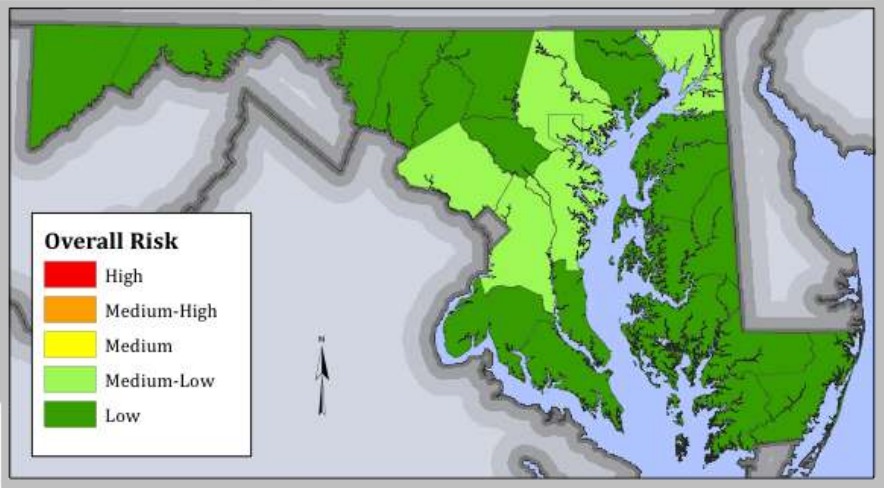


Earthquake Hazard Ranking & Risk Map

A number of factors have been considered in this risk assessment to be able to compare between jurisdictions and hazards. The factors have been added together to calculate the overall total ranking for each hazard.

*Risk = PV*0.5+PN*0.5+IN*1.0+DT*1.0+ PD*1.0+CD*1.0+CD*+GE*1.5+1.0+EV*1.0*

where
PV=Population Vulnerability
PN=Population Density
IN=Injuries
DT=Deaths
PD=Property Damage
CD=Crop Damage
GE=Geographic Extent
EV=Events



DISCLAIMER: Majority of available hazard data is intended to be used at national or regional scales. The purpose of the data sets are to give general indication of areas that may be susceptible to hazards in order to identify potential risk in the State of Maryland. Data has been used beyond the original intent.

Data Sources
FEMA HAZUS-MH Earthquake Model
MSHA State & County Boundaries
ESRI State Coundaries

Projection
North American Datum 1983
Maryland State Plane Feet

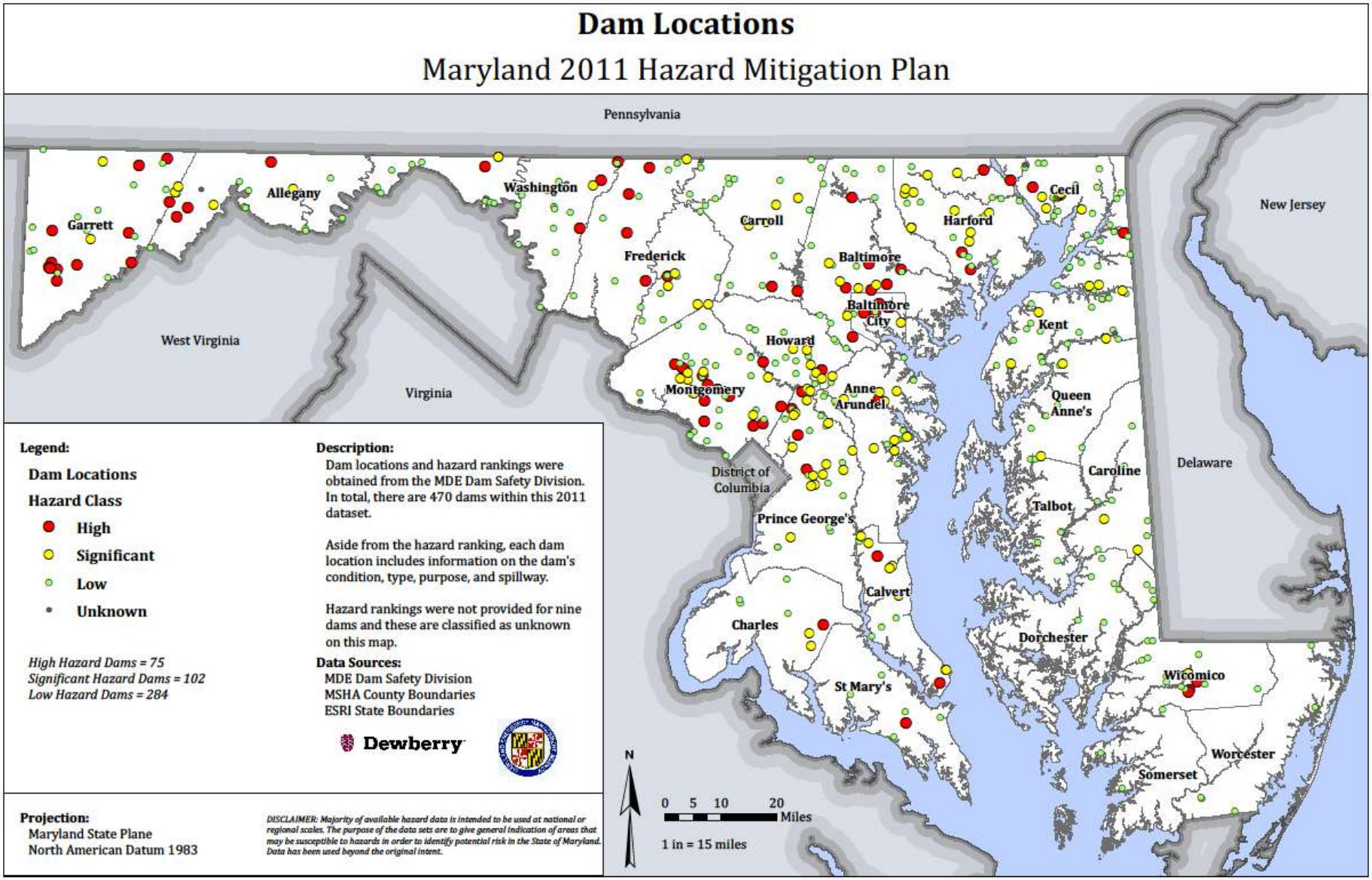
Dewberry

Dam Inundation

- State Contact: Hal Van Aller, MDE Dam Safety Division
- Data: Dam locations and hazard ranking, dam inundation studies

2011 Maryland All-Hazard Mitigation Plan Update

Maryland Emergency Management Agency



Abandoned Mines & Marcellus Shale

- Mike Garner MDE, Abandoned Mine Land Division
- Peter Yencsik, Maryland Minerals, Oil & Gas Division Land Management Administration

2011 Maryland All-Hazard Mitigation Plan Update

Maryland Emergency Management Agency

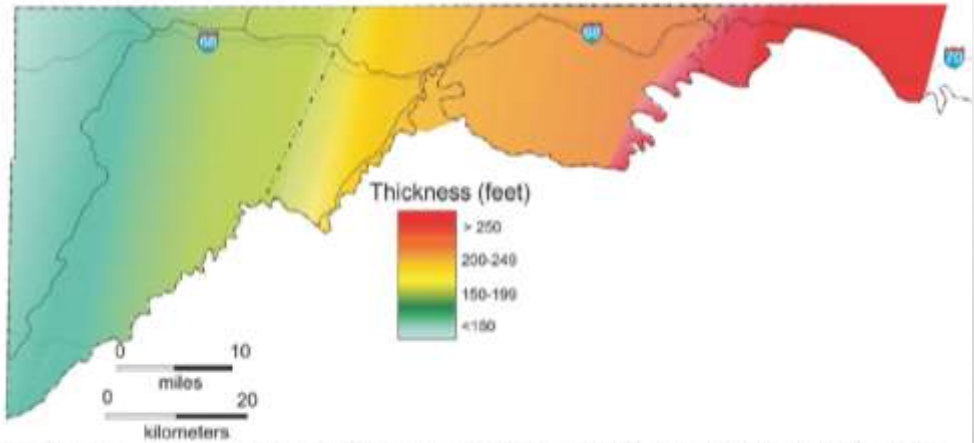
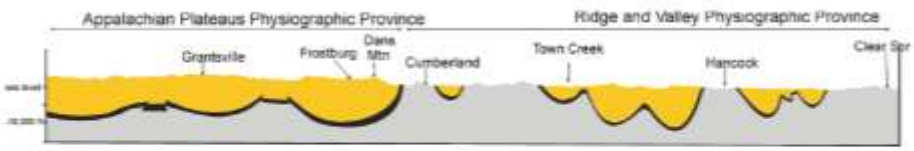
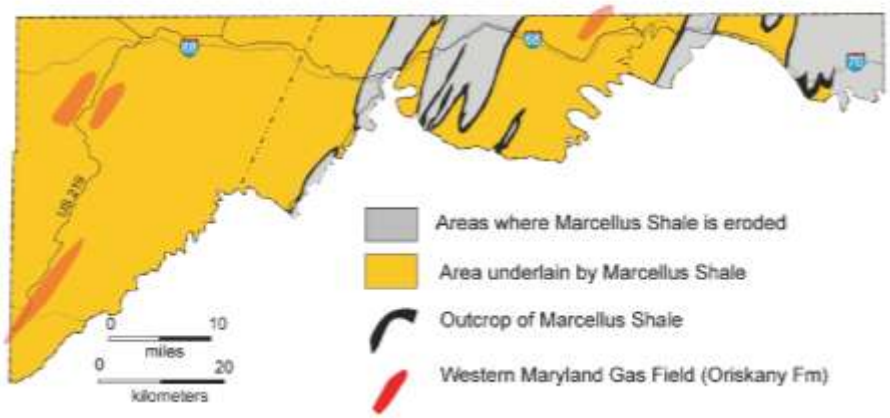


Figure 3. Generalized thickness trends within the Marcellus Shale in Maryland.





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Overall Results

Ranking and Annualized

Summarized

2011 Maryland All-Hazard Mitigation Plan Update

Maryland Emergency Management Agency

County	Number of Facilities in Sinkhole Prone Areas	Number of Facilities in Flood Zone	Number of Facilities in Wildfire Risk Zone
Allegany	146 (21 State Owned)	181 (7 State Owned)	725 (145 State Owned)
Anne Arundel	1	443 (16 State Owned)	51 (1 State Owned)
Baltimore	967 (9 State Owned)	718 (63 State Owned)	0
Frederick	1176 (58 State Owned)	331 (5 State Owned)	91 (63 State Owned)
Garrett	107 (85 State Owned)	128 (5 State Owned)	488 (203 State Owned)
Harford	2	319 (3 State Owned)	0
Howard	25 (10 State Owned)	255(4 State Owned)	0
Washington	1925 (169 State Owned)	239 (6 State Owned)	53 (7 State Owned)

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OVERALL RISK

High	Medium- High	Medium	Medium-Low	Low	Text Descriptions
Wind	Coastal	Tornado	Drought	Landslide	Shoreline Erosion
Winter Storm	Flood			Karst/Sinkhole	Sea Level Rise
	Thunderstorm			Earthquake	Extreme Heat
	Wildfire				Extreme Cold
					Dam Failure
					Mining/Marcellus Shale

2011 Maryland All-Hazard Mitigation Plan Update

Maryland Emergency Management Agency

Hazard Type	NCDC			
	Years of Record	Annualized Property Damage	Annualized Crop Damage	Total Annualized Loss
High Wind	1956-2010	$1,263,505	$15,363	$1,278,868
Winter Storm	1993-2010	$1,244,803	$1,514	$1,246,317
Coastal	1993-2010	$40,291,512	$55,284	$40,346,796
Flood	1993-2010	$10,942,886	$91,392	$11,034,278
Thunderstorm	1956-2010	$608,385	$14,943	$623,328
Wildfire	2001-2006	$0	$0	$0
Tornado	1950-2010	$7,594,392	$11,802	$7,606,194
Drought	1995-2010	$0	$8,171,076	$8,171,076
Landslide	-	$0	$0	$0
Karst/Sinkhole	-	$0	$0	$0
Earthquake	-	$0	$0	$0
Total		**$62 M**	**$8.4 M**	**$70 M**

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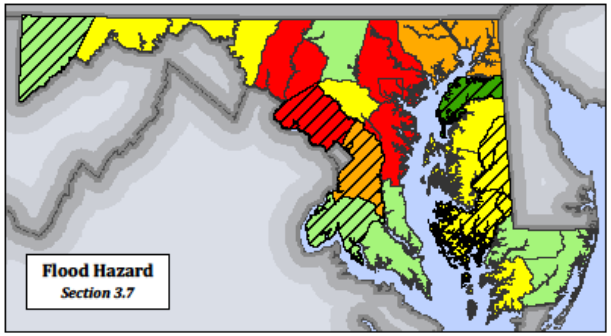
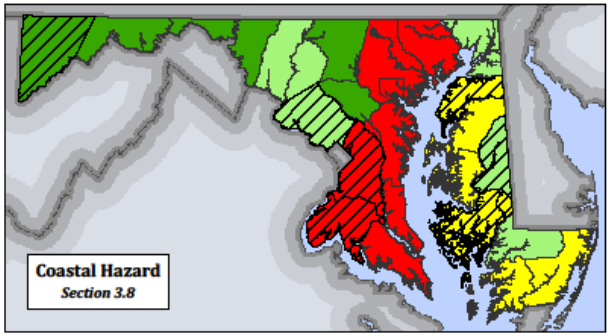
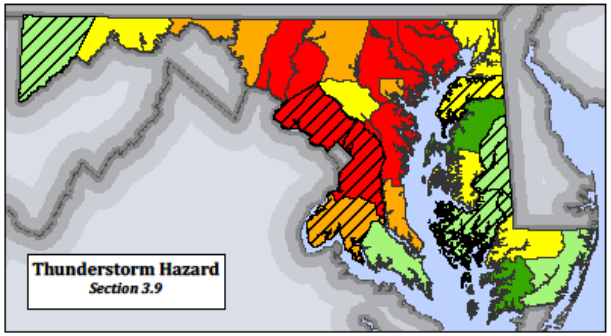
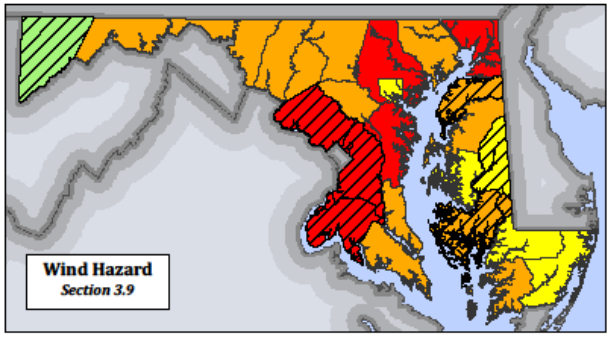
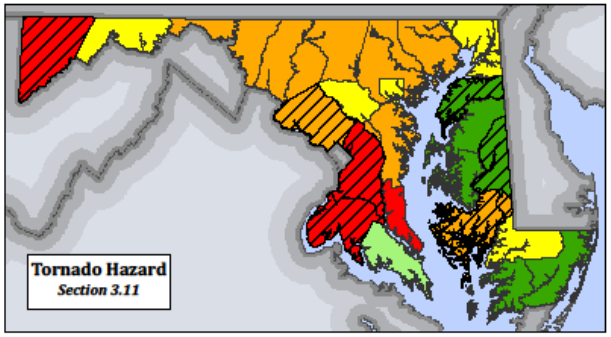
Maryland Emergency Management Agency

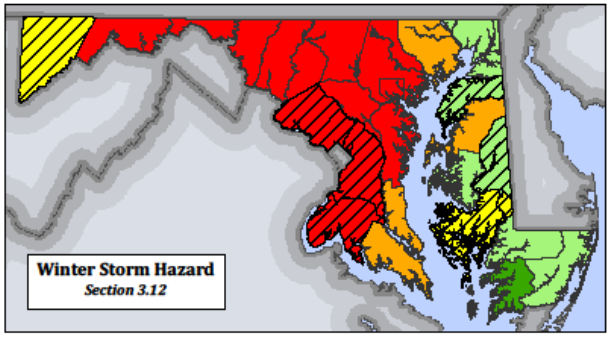


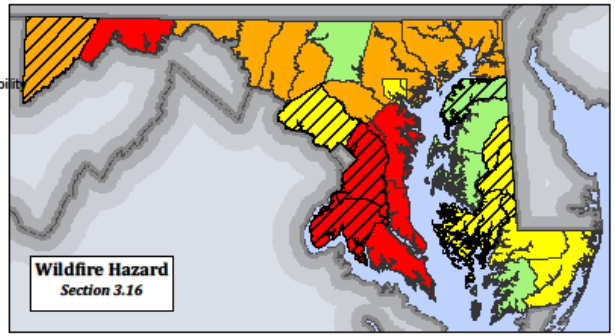












Hazard Ranking Risk Maps

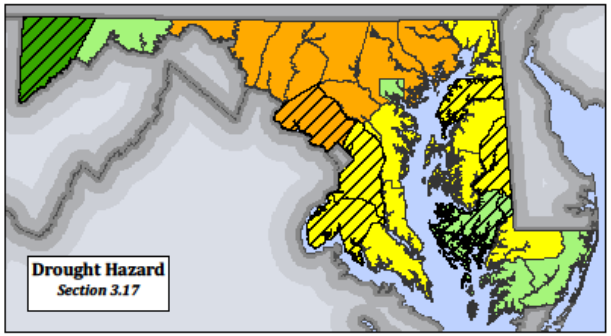
State of Maryland
Hazard Mitigation Plan 2011

Hazard Identification & Risk Assessment

These maps show risk levels assessed for significant hazards. Parameters used to create the Hazard Ranking and Risk Maps for each hazard are explained in the Hazard Assessment and Ranking Methodology section of this report.

Social Vulnerability

The vulnerability of people is termed 'social vulnerability' and describes the vulnerability of populations before an event occurs. By determining vulnerable populations and identifying what characteristics make them vulnerable, they can better prepare for, and recover from hazardous events.



Data Sources
NOAA NCDC Storm Events (1950-2010)
FEMA DFIRM, Q3 Flood Maps
NOAA-NHC SLOSH Model
Maryland Department of Natural Resources – Forest Service (1998-2010)
USDA-NSSA Cropland Data Layer (2008)
U.S. Census Bureau (2010)
Projection
North American Datum 1983
Maryland State Plane Feet

Overall Risk	Social Vulnerability
High	High
Medium-High	
Medium	
Medium-Low	
Low	

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Using HIRA Results to Inform Mitigation Strategies

- Development & maintenance of spatial data for critical & state facilities
- Hazard Specific GIS data development (i.e. digitizing Landslide Maps & Slide-Prone Areas)
- Continue to mitigate RL & SRL properties

Workshop Definitions

- ***Goal:*** **general guideline that describes what Maryland would like to achieve**
- ***Action:*** **more specific than a goal with identified responsible parties, timeframes, and potential funding sources**

Verification of 2008 Plan Goal

To protect life, property, and the environment from hazard events in the State of Maryland through:

- *Increased public awareness of hazard events, mitigation and preparation.*
- *Enhance coordination with jurisdictions to develop a relationship at the state and local level.*
- *Efficient use of State resources*

New Potential Goals

Small Break-out Group Assignments

Group Name	Dot Color	Room assignment
Education & Outreach	Green	Classroom 2
Planning, Policy, Programs	Blue	Classroom 3
Structures	Red	Classroom 4
2014 Vulnerability Assessment	None	Classroom 5
Local Planning Interface	Yellow	Classroom 6

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1. Pick up Lunch in Classroom 1
2. Review Hazard Maps
3. Review Mitigation Action Book
4. Record Mitigation Actions and Strategies
   - Idea
   - Responsible Organization
5. Group Recording and Discussion
6. Report back at 3:30

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Small Group Report Out

- Planning, Programs & Funding
- Vulnerability 2014
- Mitigation of Buildings
- Education & Outreach
- Local Plan Integration

Project Scoping

- Pre-positions Maryland for grant management development
- *Not* FEMA Grant Application
- Engineers do site visit to provide mitigations, cost and benefit estimates, feasibility analysis

2011 Maryland All-Hazard Mitigation Plan Update

Maryland Emergency Management Agency

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Next Steps:

Schedule	Activity
June 16 – July 1	Break-out groups complete actions
July	Regional Public Outreach Meetings
July	Complete HAZUS
Early July	Project Portal and Survey Posted to MEMA Website
July – August	Project Scoping Site Visits
July 20	**Final Meeting; MEMA**
August	Complete Plan

Maryland Hazard Mitigation Plan Update – HIRA and Strategies Meeting
June 15, 2011 Sign-in Sheet

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Maryland Hazard Mitigation Plan Update – HIRA and Strategies Meeting
June 15, 2011 Sign-in Sheet

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Dave Larsen	N.R.P	410-271-7397		dlarsen@dnr.state.md.us.
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T				

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Maryland Hazard Mitigation Plan Update – Local Planning Interface Group
June 15, 2011 Sign-in Sheet

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John Scarborough	Queen Anne's County	410-758-0925	410-758 3341	jscarborough@qac.org
Dave Church	Salisbury/Wicomico P&Z	410-548-4860	—	dchurch@wicomicocounty.org
Steve Flickinger	Cecil Co. DES	410392 2037		steve.flickinger@ccdps.org

Maryland Hazard Mitigation Plan Update – Education and Outreach Group
June 15, 2011 Sign-in Sheet

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Tuesday 10 - 11:30

Maryland Hazard Mitigation Plan Update – Policy, Programs, Planning Group
June 15, 2011 Sign-in Sheet

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Gene Gruber	FEMA	215-931-5669		Gene.Gruber@dhs.gov
Mia Liley	State Treasurer	410-260-7235		mliley@treasurer.state.md.us
MARK JAMES	MEMA	410 517 3649		MJAMES@MEMA.STATE.MD.US

Maryland Hazard Mitigation Plan Update – Structures Group
June 15, 2011 Sign-in Sheet

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Dan McMullen	MDA	410 841-5853		mcmulldf at mda.state.md.us
Laurelle Bradshaw-Lee	MOTAP	443-324-6663		dbradshaw@mdta.state.md.us
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Margaret Fisher	DGS	410-767-1615		margaret.fisher@dgs.state.md.us
KEN NAUMANN	BALTIMORE COUNTY DPW - SOLID WASTE	410-887-8693		KNAUMANN@BALTIMORECOUNTYMD.GOV
Perry Jones	Town of Union Bridge	410-775-2711		perryjonesjr@yahoo.com
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MICHAEL HAYMAN	Wicomico County WCDPW	410 548 4812		mhayman@wicomicocounty.org
Kenneth Hranicky	Baltimore City Planning	410 396 9508		Kenneth.hranicky@baltimorecity.gov
BEN MARTINEZ	MAA / BWI	410-859-7346		BMARTINEZ@BWIAIRPORT.COM
JOSEPH GECKLE	SHA	410-582-5552		JGECKLE@SHA.STATE.MD.US
Mark Harris	MDOT	410-865-1128		mharris@mdot.state.md.us

Schedule webex: _____
[for next week]

Maryland Hazard Mitigation Plan Update – Vulnerability Assessment Group
June 15, 2011 Sign-in Sheet

Name	Department/Organization	Phone	Fax	E-mail
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Dan Nelson	MSP	4107994548		DNELSON@MDSP.ORG
Tyneine Wells	Prince George's Co OHS	301883-3300		TNWELLS@CO.PG.MD.US
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Zoe Johnson	DNR	410 260 8741		zjohnson@dnr.state.md.us
Bill Carroll	MEMA	410-517-3624		wcarroll@mema.state.md.us
DAN NELSON	MSP	410 799-4548		DNELSON@MDSP.ORG.

From: James, Mark [mjames@mema.state.md.us]
Sent: Friday, June 24, 2011 4:56 PM
To: Speranza, Carrie; Mills, Deborah; Jarosz, Jacob; Mawby, James; Matthew.Mccullough@dhs.gov; Herman, Rachael; Towell, Ryan; Therese.Grubb@dhs.gov; abposey@annapolis.gov; awilliams@mde.state.md.us; arm@doa.state.md.us; amoredock@kentgov.org; bkearney@ccg.carr.org; Bmartinez@bwiairport.com; bpratt@srbc.net; rnelson@oceancitymd.gov; bphillips@ci.cambridge.md.us; brhode@oceancitymd.gov; fenwicjr@co.cal.md.us; chaywood@icprb.org; Chuck.Crisostomo@montgomerycountymd.gov; Chris Piscitelli; cmacey@aacounty.org; clmarnold5@gmail.com; dcornwell@howardcountymd.gov; david.mcmillan@baltimorecity.gov; dnelson@mdsp.org; dbradshaw@mdta.state.md.us; dkloid@mta.maryland.gov; dlarsen@dnr.state.md.us; dbohanno@dhr.state.md.us; david.mcmillan@baltimorecity.gov; dchurch@wicomicocounty.org; dumling@allconet.org; ddodson@energy.state.md.us; Landon@dhcd.state.md.us; Erika@portdeposit.org; fbender@psc.state.md.us; Gene.Gruber@dhs.gov; gwalzl@cityoffrederick.com; gharding@dllr.state.md.us; gvernon@howardcountymd.gov; jfox@dbm.state.md.us; jparks@eslc.org; jallenby@dnr.state.md.us; JHalka@dnr.state.md.us; jash@mdp.state.md.us; JScarborough@qac.org; Zeller, John; jgeckle@sha.state.md.us; Jhatchette@mdinsurance.state.md.us; cooleenkate@comcast.net; khenry@co.worcester.md.us; Kenneth.Hranicky@baltimorecity.gov; knaumann@baltimorecountymd.gov; ken.miller@doit.state.md.us; klewis@washco-md.net; kskogsberg@mdot.state.md.us; gordonl@djs.state.md.us; ljploener@harfordpublicsafety.org; Lmontgomery@dpscs.state.md.us; mgriswold@dnr.state.md.us; margaret.fisher@dgs.state.md.us; mbilger@mdsp.org; mcohoon@talbotcountymd.gov; mewers@baltimorecountymd.gov; mharris@mdot.state.md.us; mhubbard@baltimorecountymd.gov; Mmartin@dpscs.state.md.us; mtkropp@harfordcountymd.gov; mboldosser@talbotcountymd.gov; mhayman@wicomicocounty.org; mliley@treasurer.state.md.us; pspring@dhr.state.md.us; patrick.marchman@dhs.gov; perryljonesjr@yahoo.com; pdeitchman@msde.state.md.us; Ralcorta@miemss.org; rkonrad@cityoffruitland.com; bryan@collegeparkmd.gov; rblewis@mdsp.org; sanderson@washco-md.net; smooney@frederickcountymd.gov; Steve.Flickinger@ccdps.org; sgarvin@docogonet.com; swelzant@baltimorecountymd.gov; tlavalle@choosemaryland.org; TNWells@co.pg.md.us; zjohnson@dnr.state.md.us; azawicki@dllr.state.md.us; brhode@oceancitymd.gov; rblewis@mdsp.org; chaywood@icprb.org; Charles.Crisostomo@montgomerycountymd.gov; ddodson@energy.state.md.us; Gene.Gruber@dhs.gov; gwalzl@cityoffrederick.com; gvernon@howardcountymd.gov; jfox@dbm.state.md.us; jdelude@greensboromd.com;

Jessica.Pitts@mdcourts.gov; jbalay@srbc.net; kskogsberg@mdot.state.md.us; mtkropp@harfordcountymd.gov; mboldosser@talbotcountymd.gov; martinsadditions@verizon.net; aowsley@eslc.org; SPatswald@FrederickMDPolice.org; dnelson@mdsp.org; dbohanno@dhr.state.md.us; Elliot.Schlanger@doit.state.md.us; gmellin@howardcountymd.gov; jnagro@collegeparkmd.gov; kbencala@icprb.org; gordonl@djs.state.md.us; mgriswold@dnr.state.md.us; mharris@mdot.state.md.us; Mmartin@dpscs.state.md.us; pjpudlkewicz@harfordcountymd.gov; pdeitchman@msde.state.md.us; emergencymanagement@frederickcountymd.gov; tlavalle@choosemaryland.org; zkershner@cityoffrederick.com; awilliams@mde.state.md.us; bfrank@mdot.state.md.us; CStelzer@dnr.state.md.us; emergencymanagement@frederickcountymd.gov; JHalka@dnr.state.md.us; jgeckley@sha.state.md.us; Jhatchette@mdinsurance.state.md.us; Robin.Danforth@dhs.gov; rlewis@mdsp.org; TNWells@co.pg.md.us; zjohnson@dnr.state.md.us; abposey@annapolis.gov; cmacey@aacounty.org; david.mcmillan@baltimorecity.gov; gleblanc@ci.cambridge.md.us; jlaws@wicomicocounty.org; dcornwell@howardcountymd.gov; bpratt@srbc.net; fenwicjr@co.cal.md.us; crystal.newman@dhs.gov; dbradshaw@mdta.state.md.us; Landon@dhcd.state.md.us; FMcGrath@sha.state.md.us; jallenby@dnr.state.md.us; jchang@umm.edu; knaumann@baltimorecountymd.gov; Michael.J.DaPonte@uscg.mil; Lmontgomery@dpscs.state.md.us; margaret.fisher@dgs.state.md.us; unionbr@carr.org; mhayman@wicomicocounty.org; Steve.Flickinger@ccdps.org; amoredock@kentgov.org; bkearney@ccg.carr.org; dchurch@wicomicocounty.org; dkibler@greensboromd.com; DSMandell@annapolis.gov; dumling@allconet.org; manager@chevychasesection5.org; jparks@eslc.org; martinsadditions@verizon.net; JScarborough@qac.org; Kenneth.Hranicky@baltimorecity.gov; mbilger@mdsp.org; mcohoon@talbotcountymd.gov; msokilich@talbotcountymd.gov; bryan@collegeparkmd.gov; sanderson@washco-md.net; MemaStaff

Subject: MEMA - Maryland Hazard Mitigation Plan Update

TO: Local Jurisdictions; EOC Reps; MEMA Staff
ACTION: Situational Awareness

Thank you for participating in the HIRA Committee initial meeting that was held on June 15, 2011. The Maryland Emergency Management Agency is continuing their efforts to update the 2008 Maryland State Hazard Mitigation Plan and are on track for a draft plan to be completed by July 8, 2011.

Once again we are kindly asking for your agency's assistance and participation in the plan update process because of your resources and responsibility to Maryland's citizens and natural resources. We request that you or your designated alternate reserve the morning of July 20, 2011 for a half day meeting where components of our update will be presented and an opportunity for feedback will be offered (see agenda below).

The meeting will be held at the Armory located at the Camp Fretterd Military Reservation, 5401 Rue Saint Lo Drive, Reisterstown Maryland 21136. Breakfast will be served at 8:30 AM. Please reply to this invitation by Friday, July 13, 2011 so that we can properly prepare and plan for this event. If you have any questions, please contact me.

Thank you for your support and assistance.

Mark D James
Acting State Hazard Mitigation Officer
Maryland Emergency Management Agency
Camp Fretterd, 5401 Rue Saint Lo Drive,
Reisterstown, MD 21136
410 517 3649

Agenda

Wednesday, July 20, 2011 9:00 – 12:00 PM
MEMA – The Armory, Camp Fretterd Military Reservation

Description	Lead	Time
Welcome, Introductions and Today's Agenda • Planning Process Review • Progress to Date	Richard Muth, MEMA Executive Director Mark James, MEMA State Hazard Mitigation Officer Deborah Mills, CFM Dewberry	9:00 – 9:15
Regional Outreach Meetings	Ginny Smith S&S Planning	9:15 – 10:00
BREAK		10:00 – 10:15
HAZUS	Ryan Towell Dewberry	10:15 – 11:00
Next Steps and Small Group Discussions: Draft Plan	Deborah Mills	11:00- 12:00

Maryland Hazard Mitigation Plan Update – Final Draft Plan Meeting
July 20, 2011 Sign-in Sheet

Name	Department/Organization	Phone	Fax	E-mail
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Mark Hanna	MDOT	410-865-1028		mhanna@mdot.state.md.us
Arielle Solomon	DHR/UMBC	202 642-4175		ai.solomon@umbc.edu
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Angela Gaze	Howard County	410.706.6532		Aso@HowardCountymd.gov.
Steve Patswald	Frederick Police	301-600-1208		spatswald@frederickmdpolice.org

13 28

Name	Department/Organization	Phone	Fax	E-mail
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David McMillan	M&EM Baltimore City	410 396 6179		David_McMillan@baltimorecity.gov
Ed Larson	DHCD	410.514.7444		LARSONS@MDHOUSING.ORG
Bruce Kearney	CC County Planner	410 386-2185		bkearney@ccg.com.org

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Maryland Hazard Mitigation Plan Update – Final Draft Plan Meeting
July 20, 2011 Sign-in Sheet

Name	Department/Organization	Phone	Fax	E-mail
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Philip Deitchman	MSDE	410-767-0153		pdeitchman@msde.state.md.us
Michael Hayman	Wicomico County Dept. of Public Works	410.726.1944	410.548.4817	mhayman@wicomicocounty.org
Kevin Wagner	MDE	410-537-3914	410-537-	kwagner@mde.state.md.us
Rainer Dombrowsky	MEMA	410 517 3628	410	rdombrowsky@mema.state.md.us
Marcus Grisold	DNR	443 564 1707		mgrisold@dnr.state.md.us
Jim Fox	DBM	410-767-5886		JFOX@DBM.STATE.MD.US
Steve Welzant	Balt. Co OEM	410-887-5976		swelzant@baltimorecountymd.gov
Laurie Karafin	MEMA Volunteer	410-496-3141		sacredmoo@yahoo.com
Jesse Ash	MDP	410 767 4457		JASH@MDP.STATE.MD.US

10/28

2011 Maryland All-Hazard Mitigation Plan Update

Maryland Emergency Management Agency

August 2011

Supported by

Dewberry

Photos: St. Mary's College of Maryland, FEMA

Agenda

- 9:00 – 9:15 - Welcome & Introductions
  - Planning Process Review
  - Progress to Date
- 9:15 – 10:00 - Regional Outreach Meetings
- 10:00 – 10:15 - Break
- 10:15 – 11:00 - HIRA Updates and HAZUS
- 11:00 – 12:00 - Small-Group Discussions: Draft Plan

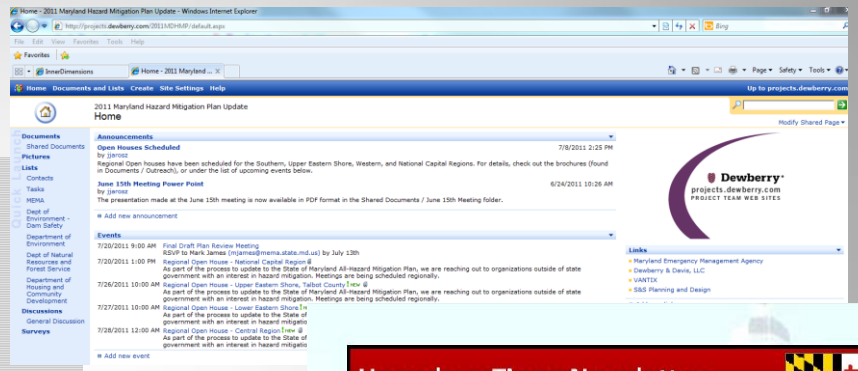
Progress

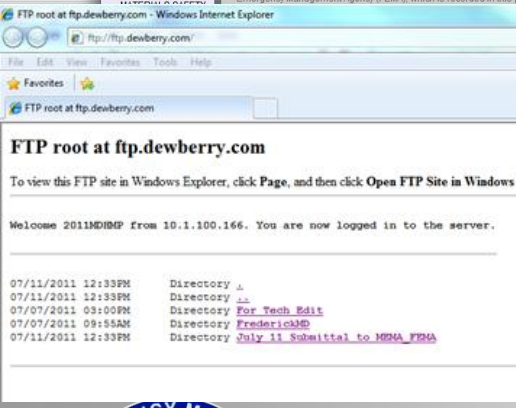
- Six main chapters;
- Compilation of 17 technical appendices;
- Coordination of dozens of federal, state and local agencies;
- Conducting hundreds of analysis to identify risk and vulnerabilities;
- Conducting numerous public outreach meetings;
- Designing a dedicated public outreach website; and,
- Identified 100 mitigation actions to protect Maryland residents' lives and property

2011 Maryland All-Hazard Mitigation Plan Update

Maryland Emergency Management Agency

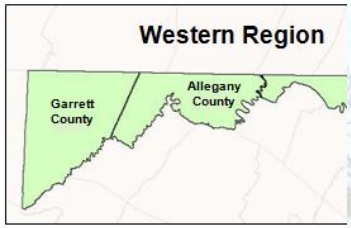
Outreach





Western Region Open House

Date: 29 June 2011
Time: 9-10:30 AM
Location: Allegany County Public Safety Building; 11400 PPG Road SE; Cumberland, MD 21502
Western Region Jurisdictions: Garrett, Allegany, Washington



Attendees included agenc representatives as follows

- ✓ Health Department;
- ✓ Board of Education;
- ✓ Sheriff's Office;
- ✓ Planning Department
- ✓ Emergency Management;
- ✓ Emergency Services.

Hazardous Times Newsletter

2011 Maryland State Hazard Mitigation Plan Update

Local Hazard Ranking Risk Maps Teaser

Next week, the first draft iteration will be submitted to MEMA and FEMA for review. In the interim, we would like to pique your interest and anticipation for the forthcoming plan by showcasing a few of the updated Hazard Ranking Risk Maps (below). These maps were presented at the June 15th HIRA and Mitigation Strategies Meeting, where we received considerable feedback.

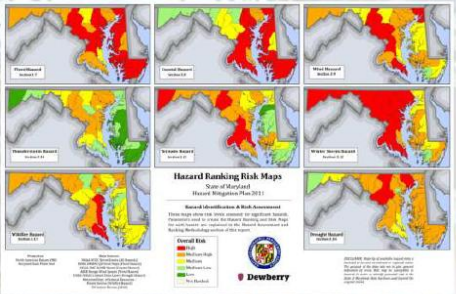
These maps utilize a vast amount of data, which was attained from a variety of sources. It has required the coordination of federal, state and local agencies, followed by detailed analysis.

"It wasn't raining when Noah built the ark."

- Howard Ruff

Executive Summary

The *2011 Maryland State Hazard Mitigation Plan Update* Draft is due next week. This week has resulted in the completion of the HIRA maps, finalization of the mitigation actions, the writing of several chapters, and the completion of many of the appendices, including the plan crosswalk. This week's headline: the Hazard Ranking Risk Maps.



Each ranking map is a compilation of several other maps that chart data such as total number of injuries, total number of deaths, total amount of crop damage, total amount of property damage, etc. In all, 14 were compiled for the Vulnerability Assessment section of this plan.

Dewberry

Capabilities Assessment

- Appendix E addresses all of Maryland's mitigation programs
- Over 25 Federal and State Agencies managing over 75 different types of mitigation programs
- If you have information on mitigation programs currently underway, we would like to talk to you

June 15th Meeting

- Over 100 participants
- Discussion of preliminary HIRA results
- Provided feedback and additional data
- Discussed actions to be taken to reduce Maryland's vulnerability to those hazards

Mitigation Actions

- Five subcommittees addressing:
  - -Programs, Policy, Planning and Funding
  - -Mitigation of High Hazard Structures
  - -Local Planning Interface
  - -2014 Vulnerability Analysis
  - -Education and Outreach
- Resulted in 100 new actions for the next 3 year planning cycle

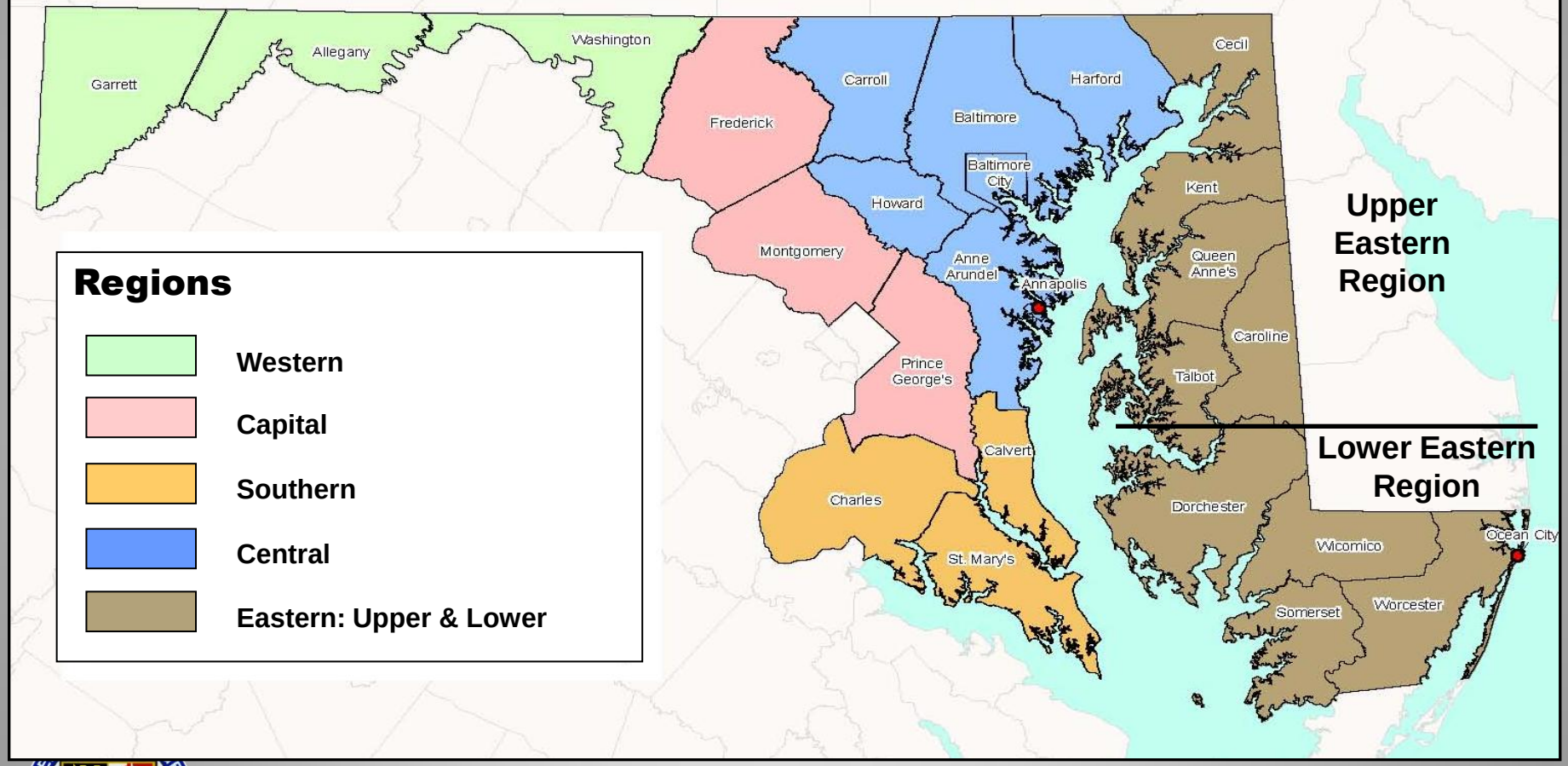
Regional Open Houses

Outreach effort targeted to organizations outside of state government with an interest in hazard mitigation

2011 Maryland All-Hazard Mitigation Plan Update

Maryland Emergency Management Agency

MEMA Regions



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MEMA Regional Administrators

- Assisted in Coordination Efforts
- Conference Calls
- Scheduling-Limited Timeframe: June/July 2011

Coordination

- **Step 1: Conference Call with all Jurisdictions**
- **Step 2: Invitation/Brochure-Local POC**
- **Step 3: Distribution**

Brochure

Come and Join Us!

Open House

Date: July 7, 2011

Time: 11:00 AM

Location:

Constellation Energy

Joint Information Center

100 Skipjack Road

Prince Frederick, MD 20678

DIRECTIONS:

Directions North of Prince Frederick (in Calvert County):

- Follow Route 4 south to Prince Frederick, MD.
- Turn Right on **HALLOWING POINT RD/MD-231** (intersection at ***Prince Frederick Ford Dealership)*** - go 4 mi.
- Turn Right on **SKIPJACK RD** - go 0.1 mi (Calvert County Industrial Park)
- Arrive at **100 SKIPJACK RD** on the Left

Directions South of Prince Frederick (in Calvert County):

- Follow Route 4 north to Prince Frederick , MD
- Turn Left on **HALLOWING POINT RD/MD-231** (intersection at ***Prince Frederick Ford Dealership)*** - go 4 mi.
- Turn Right on **SKIPJACK RD** - go 0.1 mi (Calvert County Industrial Park)
- Arrive at **100 SKIPJACK RD** on the Left

Directions East of Prince Frederick:

- Follow **Prince Frederick RD/MD-231** east
- Continue on **HALLOWING POINT RD/MD-231** (intersection at ***Prince Frederick Ford Dealership)*** - go 4 mi.
- Turn Left on **SKIPJACK RD** - go 0.1 mi (Calvert County Industrial Park)
- Arrive at **100 SKIPJACK RD** on the Left

Directions South of Prince Frederick (in St. Mary's County):

- Follow Route 5 north to Prince Frederick , MD
- Turn Right on **HALLOWING POINT RD/MD-231** (intersection at ***Prince Frederick Ford Dealership)*** - go 4 mi.
- Turn Left on **SKIPJACK RD** - go 0.1 mi (Calvert County Industrial Park)
- Arrive at **100 SKIPJACK RD** on the Left

STATE OF MARYLAND

2011 All-Hazard Mitigation Plan Update

Come Join Us!

PLANNING FOR TODAY AND TOMORROW

Brochure

Why Plan?

The Disaster Mitigation Act of 2000 (DMA 2000) is legislation aimed at improving the hazard mitigation planning process. This legislation reinforces the importance of mitigation planning and emphasizes planning for disasters before they occur.

Section 322 specifically addresses mitigation planning at the state and local levels. State governments have certain responsibilities for implementing Section 322, including:

- Preparing and submitting a state mitigation plan; required by law to be reviewed and updated every three years
- Providing technical assistance and training to local governments to assist them in developing local hazard mitigation plans and applications for hazard mitigation grant funding
- Reviewing local hazard mitigation plans

DMA 2000 is intended to facilitate cooperation between state and local authorities. It encourages and rewards local, tribal, and state pre-disaster planning and promotes sustainability as a strategy for disaster resistance.

What is the Purpose of "Open Houses"?

As part of the process to update to the State of Maryland All-Hazard Mitigation Plan, outreach efforts targeted to organizations outside of state government with an interest in hazard mitigation are underway. Various "Open Houses" will be conducted across the State during June/July 2011.

Southern Region Open House
July 7, 2011

Who Should Attend?

Potential attendees include a cross-section of organizations with an interest in hazard mitigation, and are as follows:

- Public Officials
- Local Emergency Managers
- Fire & Rescue
- Local Planners
- Local Transportation
- Local Public Works
- Local Schools
- Local Utilities
- Architects and Engineers
- American Red Cross
- Business Continuity Planners
- Hazard Experts from State and Federal Agencies
- SHA District Office Staff
- Colleges and Universities
- Non-profit Organizations
- Businesses

Meeting Agenda

July 7, 2011 **11:00 AM**

Welcome/Why Are We Here?

What is Hazard Mitigation? Why Plan?
(Discussion of the linkages between the State and the Local Plans)

What are the State's Hazards of Concern?
(Overview of the State's Hazard Identification and Risk Assessment (HIRA) results, specifically Regional results)

Hazard Mitigation Strategies

Questionnaire

Where Do We Go From Here?

PLANNING FOR TODAY AND TOMORROW

Questions regarding the "Open House" please contact John Robert Fenwick at Calvert County Dept. of Public Safety.

Bobby Fenwick, Division Chief
Phone: 410-535-1600

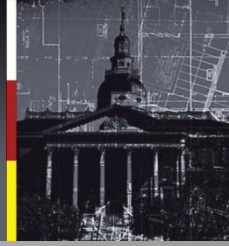
POC

Open House Schedule

- Western Region – June 29th
- Southern Region – July 7th
- National Capital Region – July 20th
- Upper Eastern Shore Region – July 26th
- Lower Eastern Shore Region – July 27th
- Central Region – July 28th

2011 Maryland All-Hazard Mitigation Plan Update

Maryland Emergency Management Agency



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- Public Officials
- Local Emergency Managers
- Fire & Rescue
- Local Planners
- Local Transportation
- Local Public Works
- Local Schools
- Local Utilities
- Architects and Engineers
- American Red Cross
- Business Continuity Planners
- Hazard Experts from State & Federal
- SHA District Office Staff
- Colleges and Universities
- Non-profit Organizations
- Businesses

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HIRA Results – Western Region Comments

- Pleased to learn that their local HIRA results had been incorporated into the scoring system utilized in the State's HIRA.
- Frustration over FEMA disaster guidelines specific to winter storm disaster declarations.

HIRA Results – Western Region

- Concerns voiced re: use of population and population density in the HIRA scoring system ranking parameters.
- Participants questioned whether or not variables such as household income and the age of housing stock were considered in the planning process.
- Social vulnerability has been considered and incorporated in the planning process using data from the American Communities Survey, 2005-2009 estimates data.

HIRA Results – Southern Region

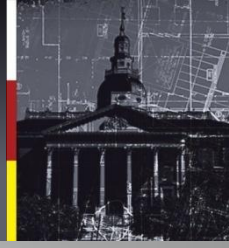
- Pleased to learn that their local HIRA results had been incorporated into the scoring system utilized in the State's HIRA.
- Concerns were voiced by the Southern Region participants re: limited focus of the HIRA, specifically the exclusion of other types of hazards such as radiological.

HIRA Results – Southern Region

- Calvert Cliffs Nuclear Power Plant is located within the Southern Region
- A liquid natural gas facility and two main pipelines. The presence of these facilities within the Region, pose unique planning challenges.

2011 Maryland All-Hazard Mitigation Plan Update

Maryland Emergency Management Agency



Questionnaire: Western Region

June 29, 2011 QUESTIONAIRE

2011 State of Maryland All-Hazard Mitigation Plan
Western Region Open House Meeting

Results & Comments from the 2011 Western Region Open House Questionnaire are listed below in red.

Section I: Hazard Identification & Risk

1. **How concerned are you about the following hazards affecting your community?**

(Place an X in the corresponding column for each hazard)

Hazard Types	Extremely Concerned	Very Concerned	Concerned	Somewhat Concerned	Not Concerned
Flood		X			
High Wind			X		
Thunderstorm		X			
Wildfire			X		
Land Subsidence: Karst/Sinkholes			X		
Landslide			X		
Earthquake				X	
Winter Storm		X			
Tornado		X			
Drought			X		
Coastal				X	
Other: Epidemic/pandemic/common disease					
Other: Food/water/environmental health issues.					

2. **Rationale for adding hazards above:**

Comments:

- Public health hazards need to be identified especially with the newly implemented public health capabilities;
- Hazards considered for this plan should be beyond that of natural. More "All-Hazards Mitigation Plan" approach.

Questionnaire Page 2

Additional Hazards:

- **Epidemic**
- **Environmental Health**

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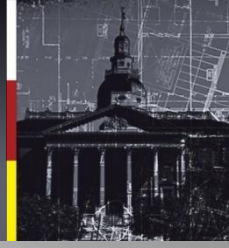
Maryland Emergency Management Agency



Questionnaire: Western Region

3. Why are you concerned or not concerned about particular hazard(s)? Please explain.

Comments:

- Floods and winter storms represent significant threats to the county. Affecting nearly all citizens. Significant costs and are lives are impacted;
- Flooding in Westernport;
- Winter storms and the snow loads that accompany them on flat roofs in the schools.
- Winter storm – frequency of events and their severity;
- Flooding – valleys and topography create severe flood situations;
- Wildfire – high number of wildfires and the large amount of woodlands in the region;
- Flood – Hancock transportation for schools/Williamsport area near the Potomac;
- Winter storms – Flat roof schools, and the Cascade/Hancock area;
- Rural counties with limited resources;
- Flood, winter storms, and thunderstorms affect people/homes and roadway closures;
- Winter storms are of great concern since FEMA guidelines require a "new record" to be set for reimbursement;
- Historical experience; also, an event may occur with less frequency, but its impact of any occurrence may be severe;
- Because public health hazards are essential to address and protect our community and residents.

Section II: Mitigation Strategies

4. Which mitigation strategies have worked well in your community or for your organization? (Please identify and explain why?)

Comments:

- Flood Buyouts;
- Need for greater state and federal investment in stream restoration, flood warning, and structural flood damage reduction projects;
- Open communication and collaboration with all potential affected agencies, municipalities, and departments;
- Annual emergency plan meetings;
- Property acquisitions in Hancock from flood prone areas;
- Working within county and partner agencies of review and revision of emergency service functions in county's emergency plans;
- Utilization of project open space for flood mitigation efforts.

5. Which groups should the State work with to reduce hazard losses (please identify)?

Comments:

- Planning, public works, watershed associations;
- Local jurisdictions;
- Board of Education – Security;
- County commissioners – to identify financial needs;
- Government officials;
- Department of Health and Mental Hygiene work with other ESF leads, ie: ESF 6 sheltering is the primary role for department of social services with head quarters support.

Hazard Concerns:

6 Winter Storms

5 Flooding

Successful Mitigation Strategies:

- **Flood Acquisition Projects**

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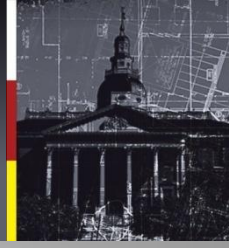
Maryland Emergency Management Agency



Questionnaire: Western Region

6. What is the State of Maryland doing to effectively reduce your organization's risk from hazards? (Please list any state laws, programs, policies, or regulations which help reduce your organization's vulnerability to hazards)

Comments:

- Grant funding continuance;
- Resource provisions;
- Emergency plan update at each school year;
- Providing grant funding – Pre Disaster Mitigation grant, commodity flow studies;
- Hazard mitigation planning process opportunity;
- Meetings;
- Provides guidance to the public health.

7. What should the State's mitigation priorities be?

For the State as a whole (please explain)?

Comments:

- Flood loss prevention-costs are investment in prevention, not repetitive expense outlays;
- Enhance state plans;
- Planning together.

For the local level (please explain)?

Comments:

- Enhance local plans;
- Planning together.

8. Anything else you would like the State to consider pertaining to hazard mitigation?

Comments:

- Need to modify prioritization scheme to allow rural jurisdiction to be treated fairly;
- More local funding for mitigation and planning;
- The wind ranking seemed low for Washington County, considering the numbers of events were high;
- The rankings are population bias. Need to adjust the formula to accurately portray the rural areas;
- Formula seems to be biased based too much toward metro areas due to population and density;
- Population isn't necessarily the overriding criteria that should weight the rankings – per capita income and demographic composition is also critical to realize a more accurate assessment;
- Not to lose money for mitigation and planning;
- Population weights tend to skew funding amounts for western regions, which will be impacted by any disaster within their region, as well as in the National Capital Region which will want to flee west.

5 Comments concerning Population & Pop. Density within Formula

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Questionnaire: Southern Region

Comments provided on the questionnaire with the most frequency included:

- areas of repetitive flooding,
- erosion related issues,
- the threats posed by the nuclear power plant, gas pipelines
- the numerous hard targets located within the Region.

Outcomes

- Additional Stakeholder Input
- Regional Perspective
- Future Ideas-Direction

Outreach Efforts-Main Ingredients

- Regional Administrators
- Local EM Staff/POC
- Refreshments
- Collection of Participant Comments

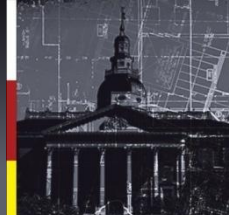
Hazard Identification and Risk Analysis

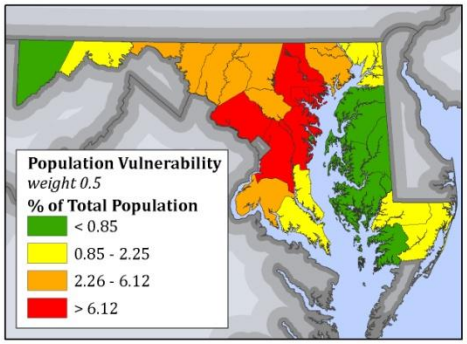
Updated Hazard Ranking Maps:

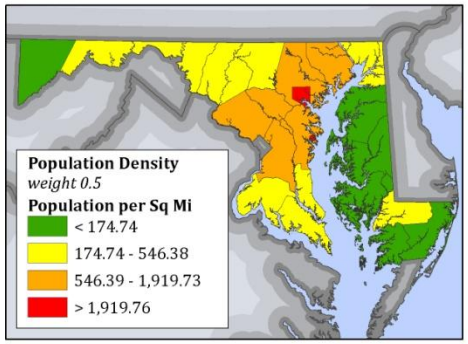
- ✓Based on MEMA / local feedback
- ✓Incorporates local plan hazard ranking

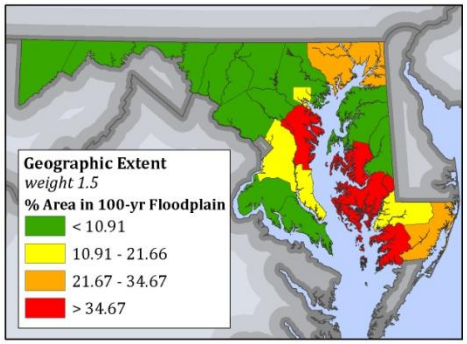
2011 Maryland All-Hazard Mitigation Plan Update

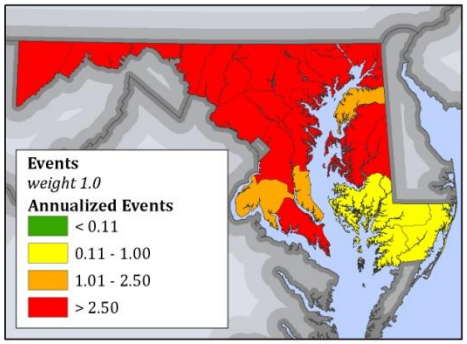
Maryland Emergency Management Agency

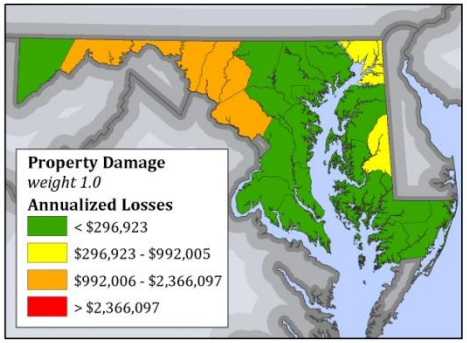


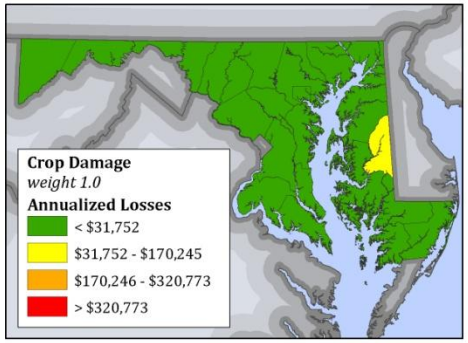


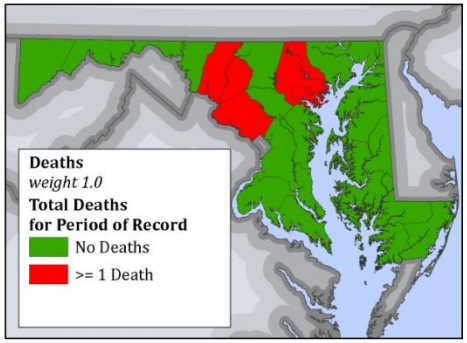


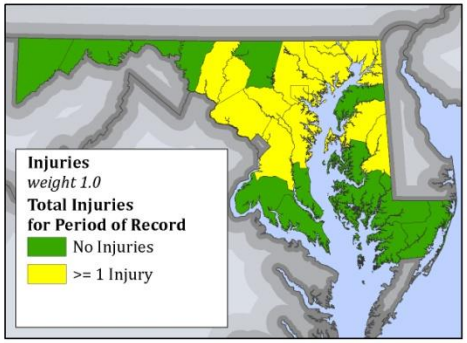


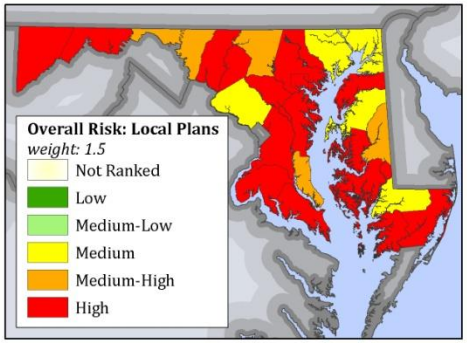












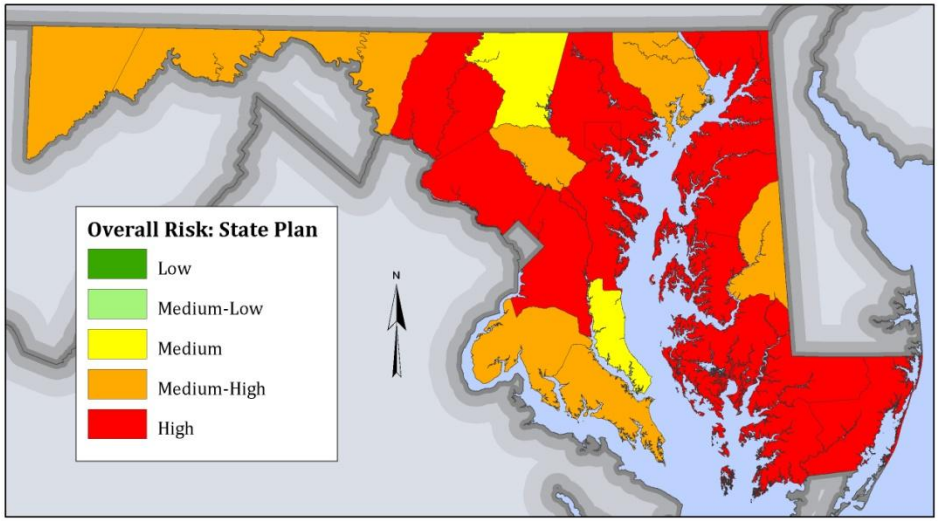
Flood Hazard Ranking & Risk Map

State of Maryland
Hazard Mitigation Plan 2011

Hazard Identification & Risk Assessment

A number of factors have been considered in this risk assessment to be able to compare between jurisdictions and hazards. The factors have been added together to calculate the overall total ranking for each hazard.

*Risk= PV*0.5+PN*0.5+GE*1.5+EV*1.0+ PD*1.0+CD*1.0+DT*1.0+IN*1.0+LP*1.5*
where
PV=Population Vulnerability
PN=Population Density
GE=Geographic Extent
EV=Events
PD=Property Damage
CD=Crop Damage
DT=Deaths
IN=Injuries
LP=Local Plan Risk Assessment



Data Sources
Maryland Emergency Management Agency
Federal Emergency Management Agency
Maryland Local Hazard Mitigation Plans
NOAA NCDC Storm Events (1993-2010)
FEMA DFIRM, Q3 Flood Maps
MSHA State & County Boundaries
ESRI State Boundaries

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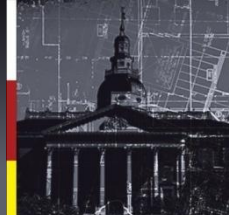
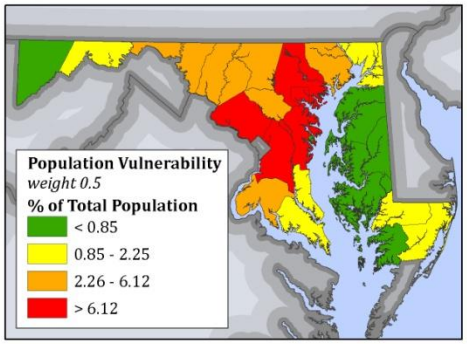
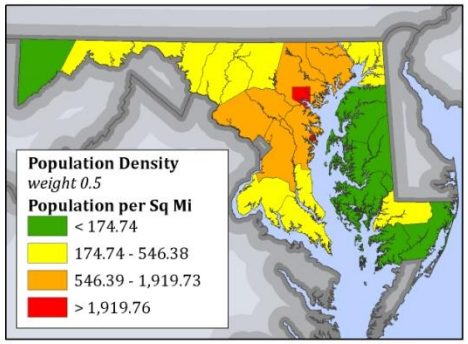
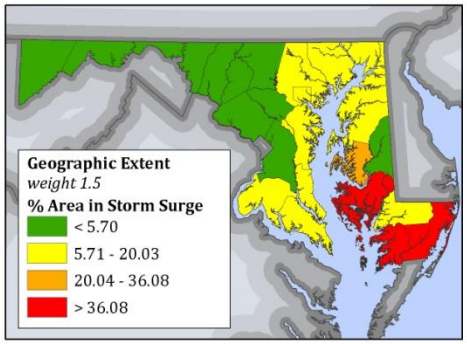
2011 Maryland All-Hazard Mitigation Plan Update

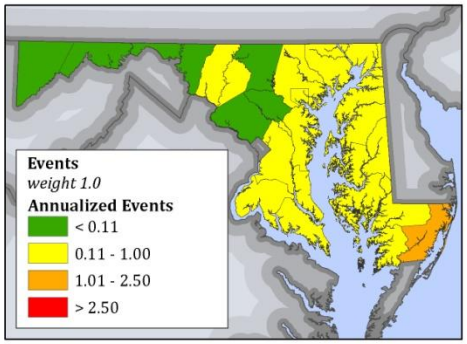
Maryland Emergency Management Agency

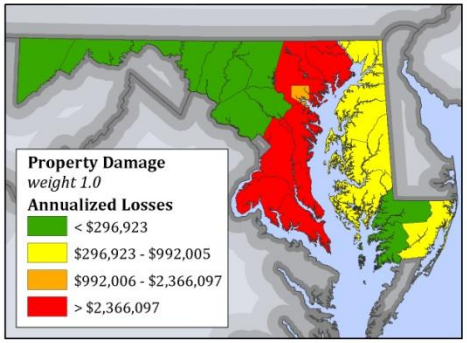


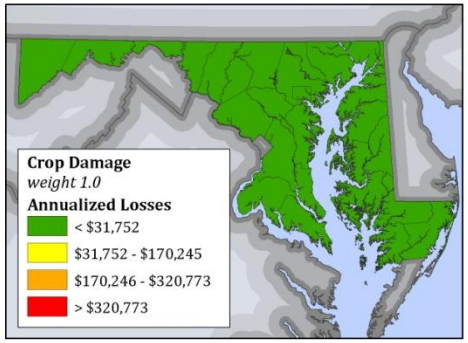


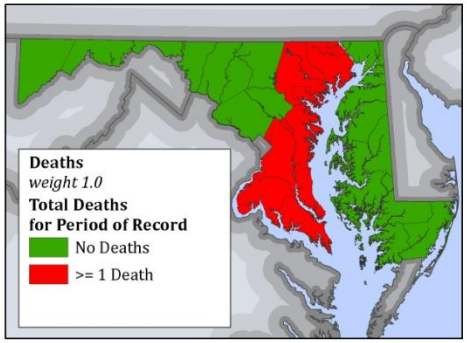


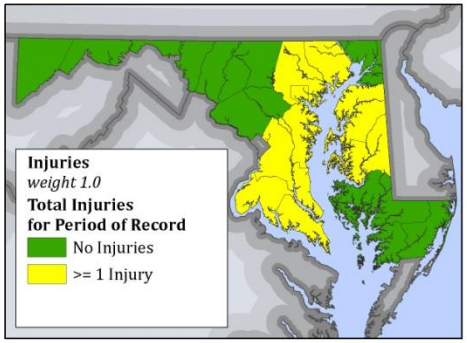


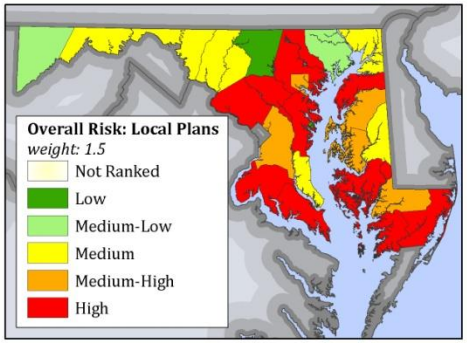












Coastal Hazard Ranking & Risk Map

State of Maryland
Hazard Mitigation Plan 2011

Hazard Identification & Risk Assessment

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where

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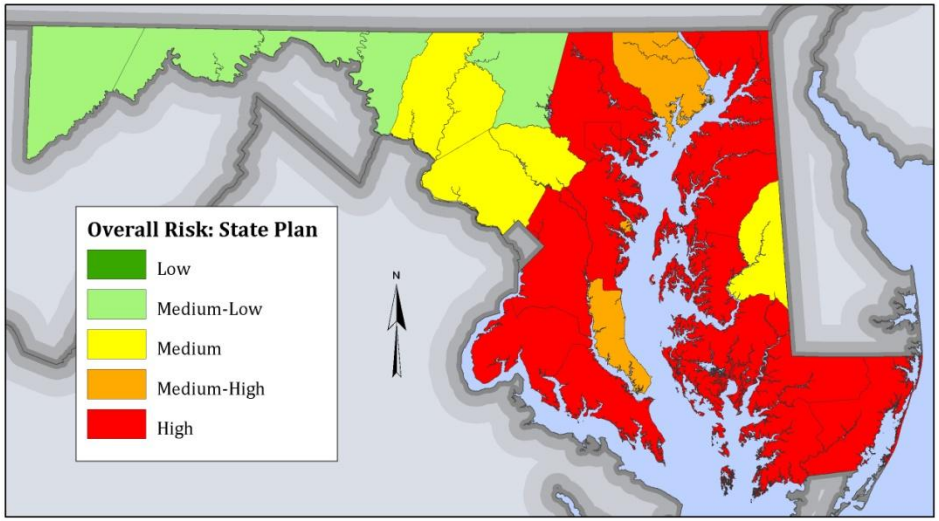

Data Sources
Maryland Emergency Management Agency
Federal Emergency Management Agency
Maryland Local Hazard Mitigation Plans
NOAA NCDC Storm Events (1993 - 2010)
NOAA-NHC SLOSH Model
MSHA State & County Boundaries
ESRI State Boundaries

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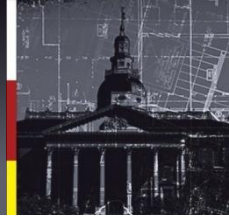
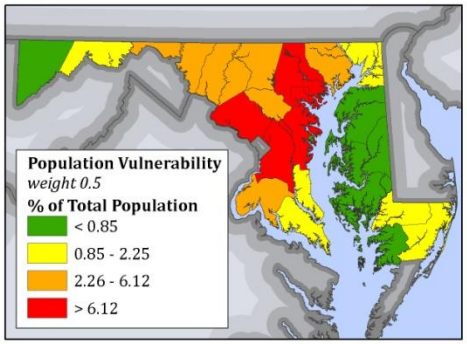
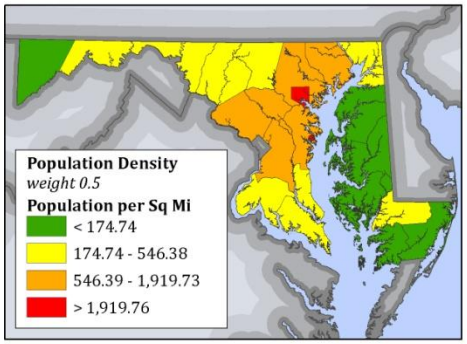
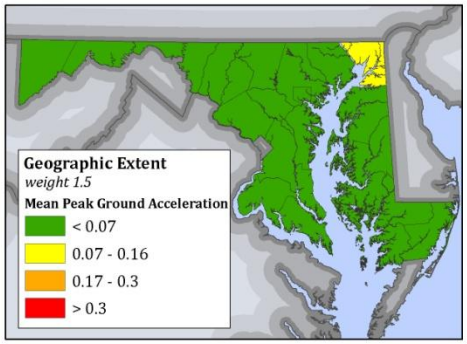
2011 Maryland All-Hazard Mitigation Plan Update

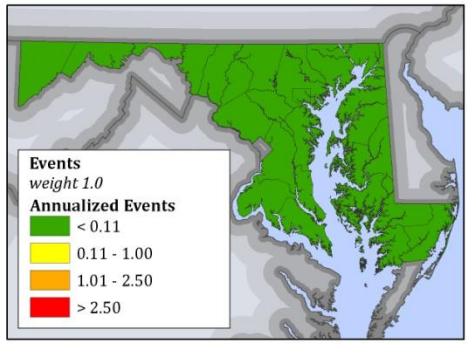
Maryland Emergency Management Agency

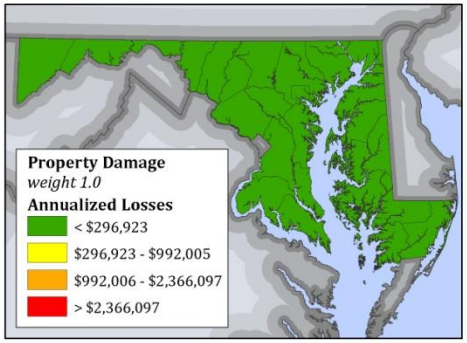


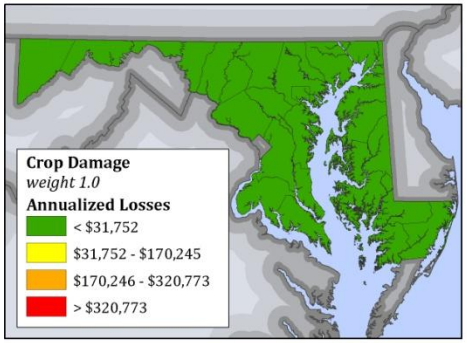


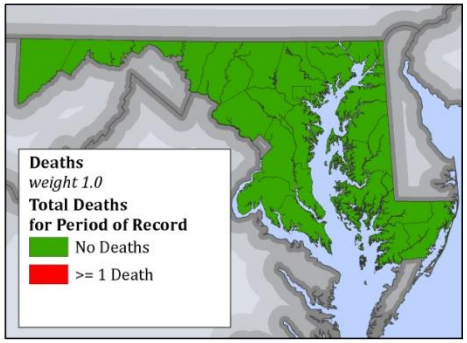


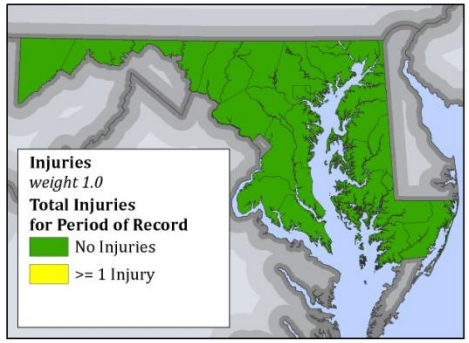


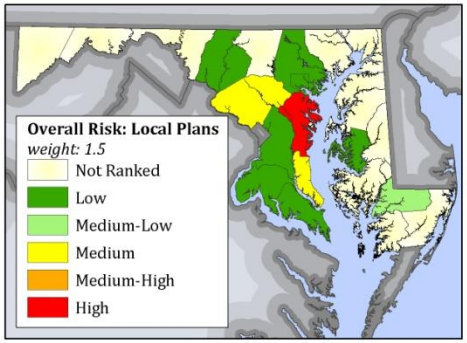












Earthquake Hazard Ranking & Risk Map

State of Maryland
Hazard Mitigation Plan 2011

Hazard Identification & Risk Assessment

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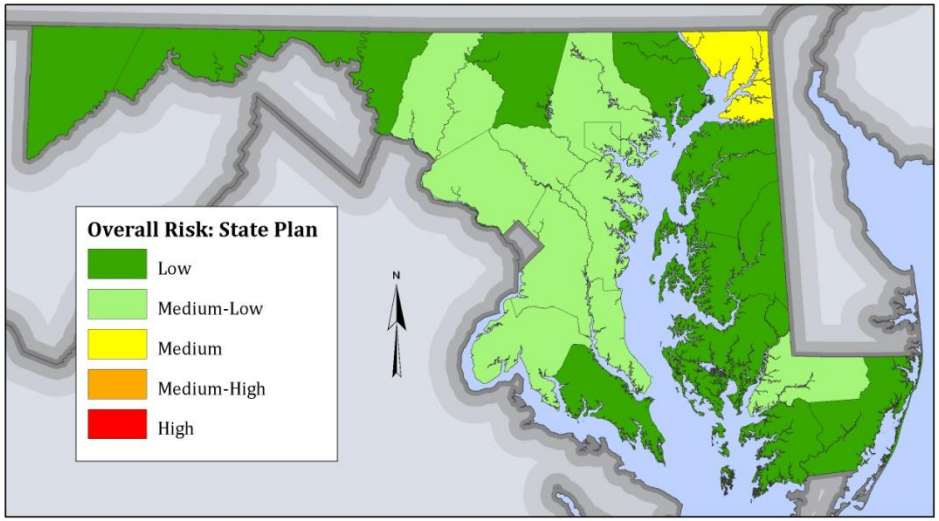

Data Sources
Maryland Emergency Management Agency
Federal Emergency Management Agency
Maryland Local Hazard Mitigation Plans
FEMA HAZUS-MH Earthquake Model
MSHA State & County Boundaries
ESRI State Boundaries

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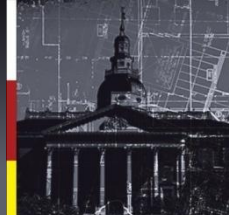
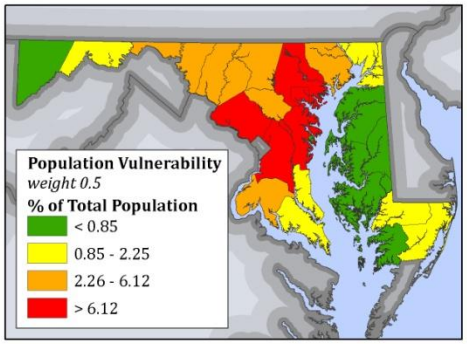
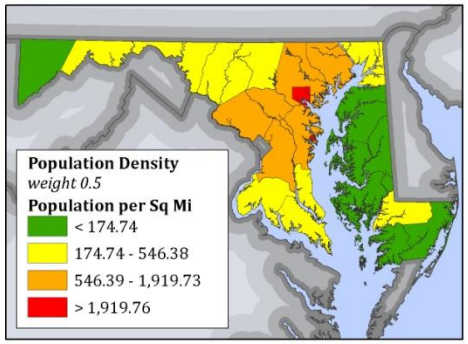
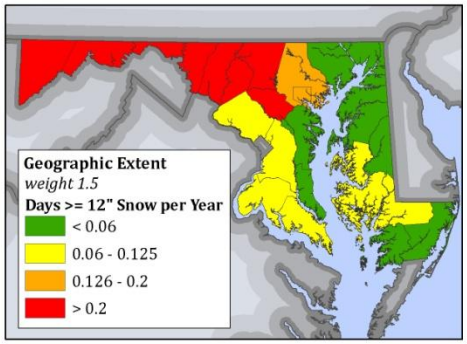
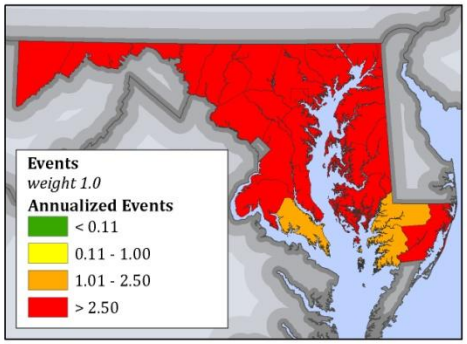
Maryland Emergency Management Agency

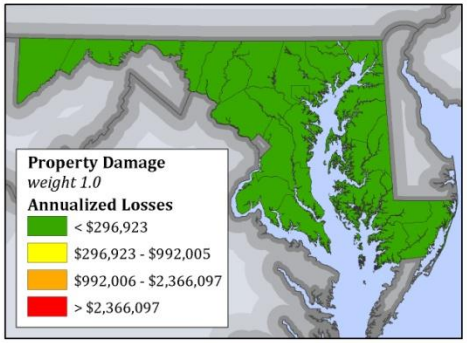


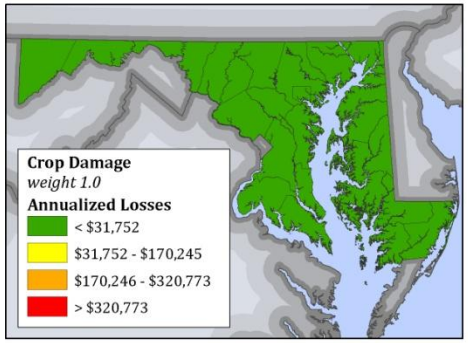


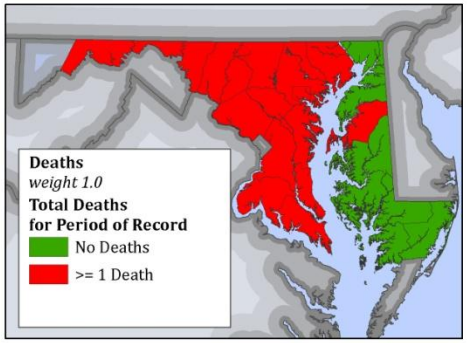


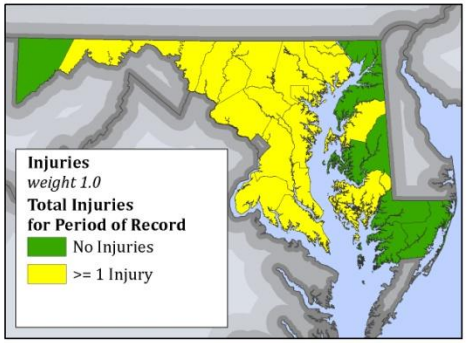


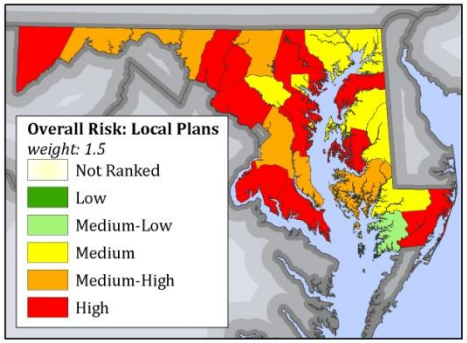












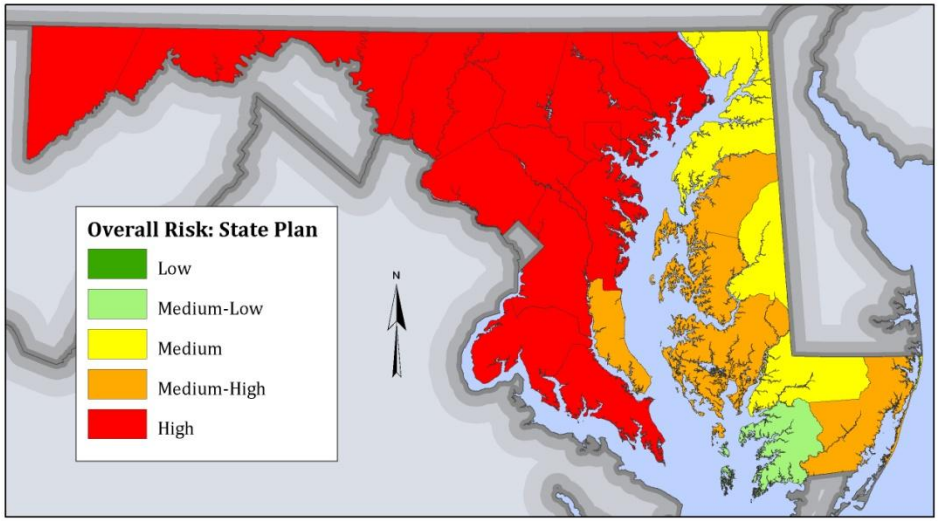
Winter Storm Hazard Ranking & Risk Map

State of Maryland
Hazard Mitigation Plan 2011

Hazard Identification & Risk Assessment

A number of factors have been considered in this risk assessment to be able to compare between jurisdictions and hazards. The factors have been added together to calculate the overall total ranking for each hazard.

*Risk= PV*0.5+PN*0.5+GE*1.5+EV*1.0+ PD*1.0+CD*1.0+DT*1.0+IN*1.0+LP*1.5*
where
PV=Population Vulnerability
PN=Population Density
GE=Geographic Extent
EV=Events
PD=Property Damage
CD=Crop Damage
DT=Deaths
IN=Injuries
LP=Local Plan Risk Assessment

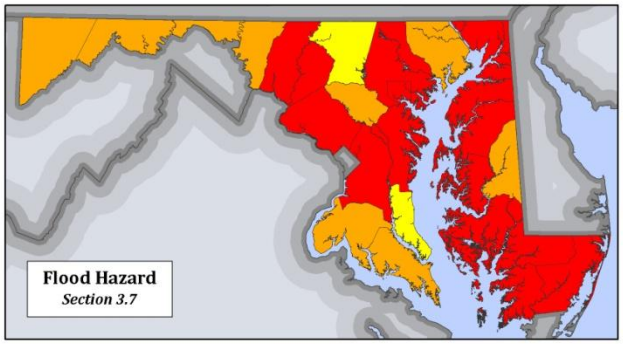


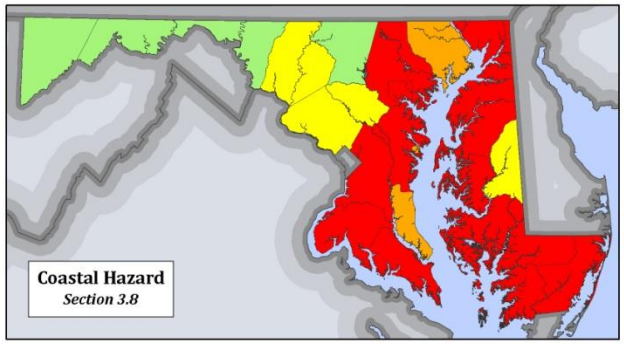
Data Sources
Maryland Emergency Management Agency
Federal Emergency Management Agency
Maryland Local Hazard Mitigation Plans
NOAA NCDC Storm Events (1993-2010)
MSHA State & County Boundaries
ESRI State Boundaries

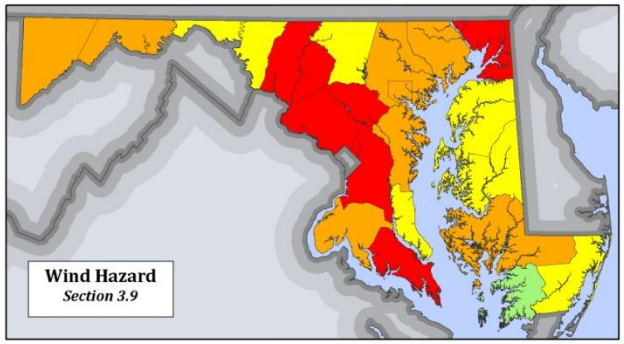
Dewberry

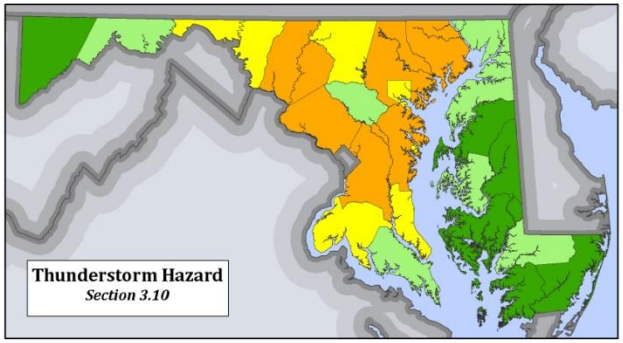
2011 Maryland All-Hazard Mitigation Plan Update

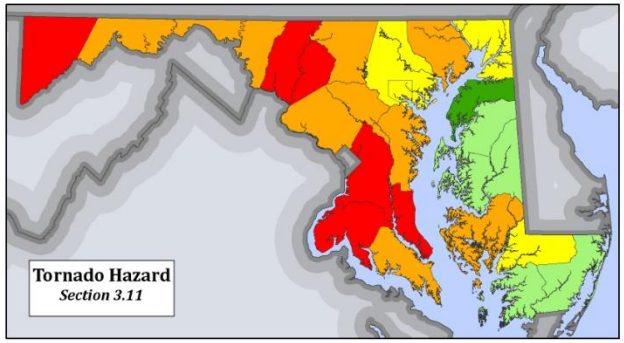
Maryland Emergency Management Agency

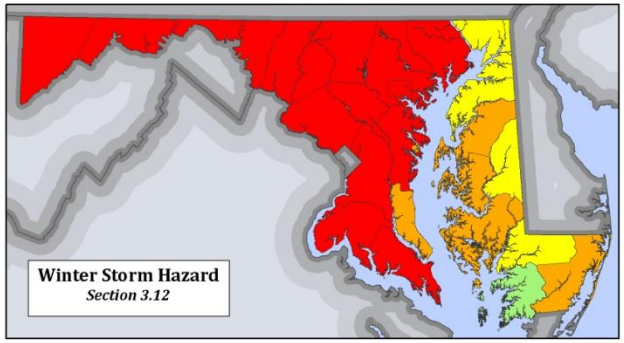


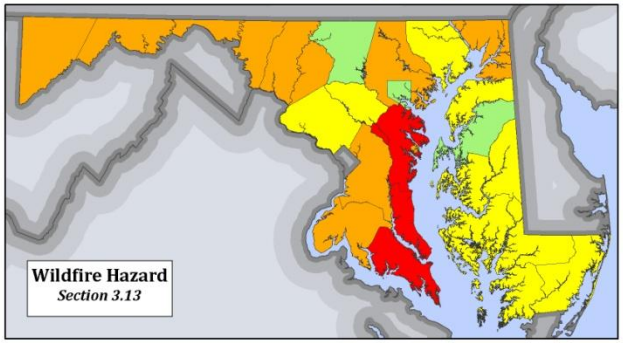












Hazard Ranking Risk Maps

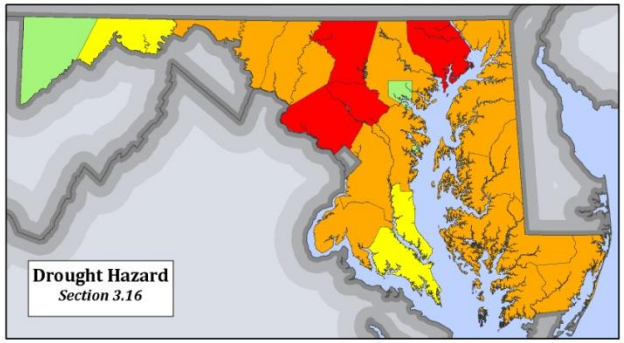
State of Maryland
Hazard Mitigation Plan 2011

Hazard Identification & Risk Assessment

These maps show risk levels assessed for significant hazards. Parameters used to create the Hazard Ranking and Risk Maps for each hazard are explained in the Hazard Assessment and Ranking Methodology section of this report.

Overall Risk

- Low
- Medium-Low
- Medium
- Medium-High
- High



Projection
North American Datum 1983
Maryland State Plane Feet

Data Sources
NOAA NCDC Storm Events (All Hazards)
FEMA DFIRM, Q3 Flood Maps (Flood Hazard)
NOAA-NHC SLOSH Model (Coastal Hazard)
ASCE Design Wind Speeds (Wind Hazard)
USDA-NSSA Cropland Data Layer (Drought Hazard)
Maryland Dept. of Natural Resources – Forest Service (Wildfire Hazard)
US Census Bureau (2010)

Dewberry

DISCLAIMER: Majority of available hazard data is intended to be used at national or regional scales. The purpose of the data sets are to give general indication of areas that may be susceptible to hazards in order to identify potential risk in the State of Maryland. Data has been used beyond the original intent.

HAZUS

What is HAZUS Level 2?

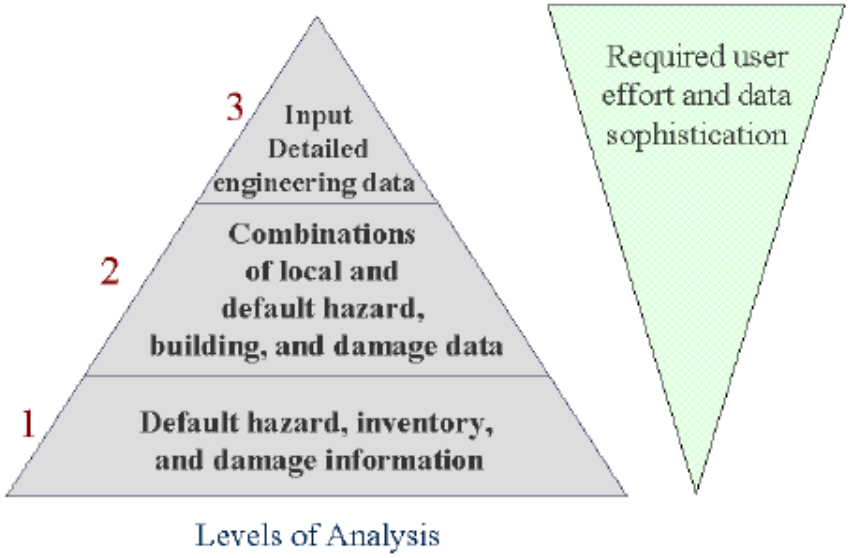


Figure 1.2 Levels of Analysis and User Sophistication

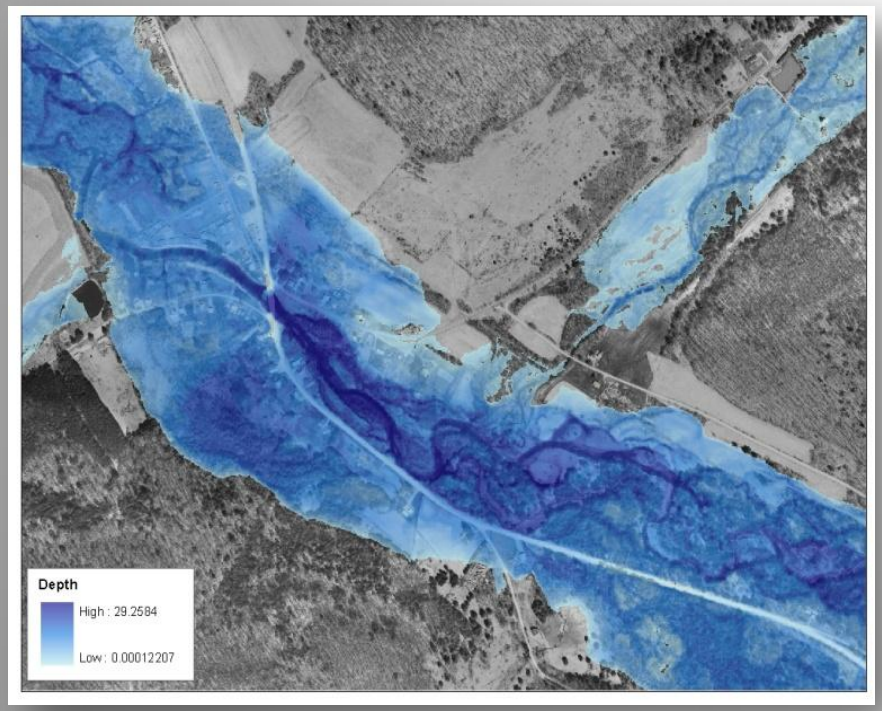
Image Source: Hazus®-MH MR5 User Manual; Pg. 1-5

This project improved:

- **Certain essential facilities:**
  - **Locations based on State-provided databases**
- **DFIRM Flood Hazard (User-Defined Depth Grid)**

HAZUS

What is a Depth Grid?



- **Geospatial data set (i.e., GIS) that shows the difference between flood elevation and ground elevation.**

(Water Surface – Ground Surface) = Depth of water

HAZUS – Point Facility Improvements

Location updates to facilities:

- **Essential Facilities**
- **Transportation**
- **Utilities**

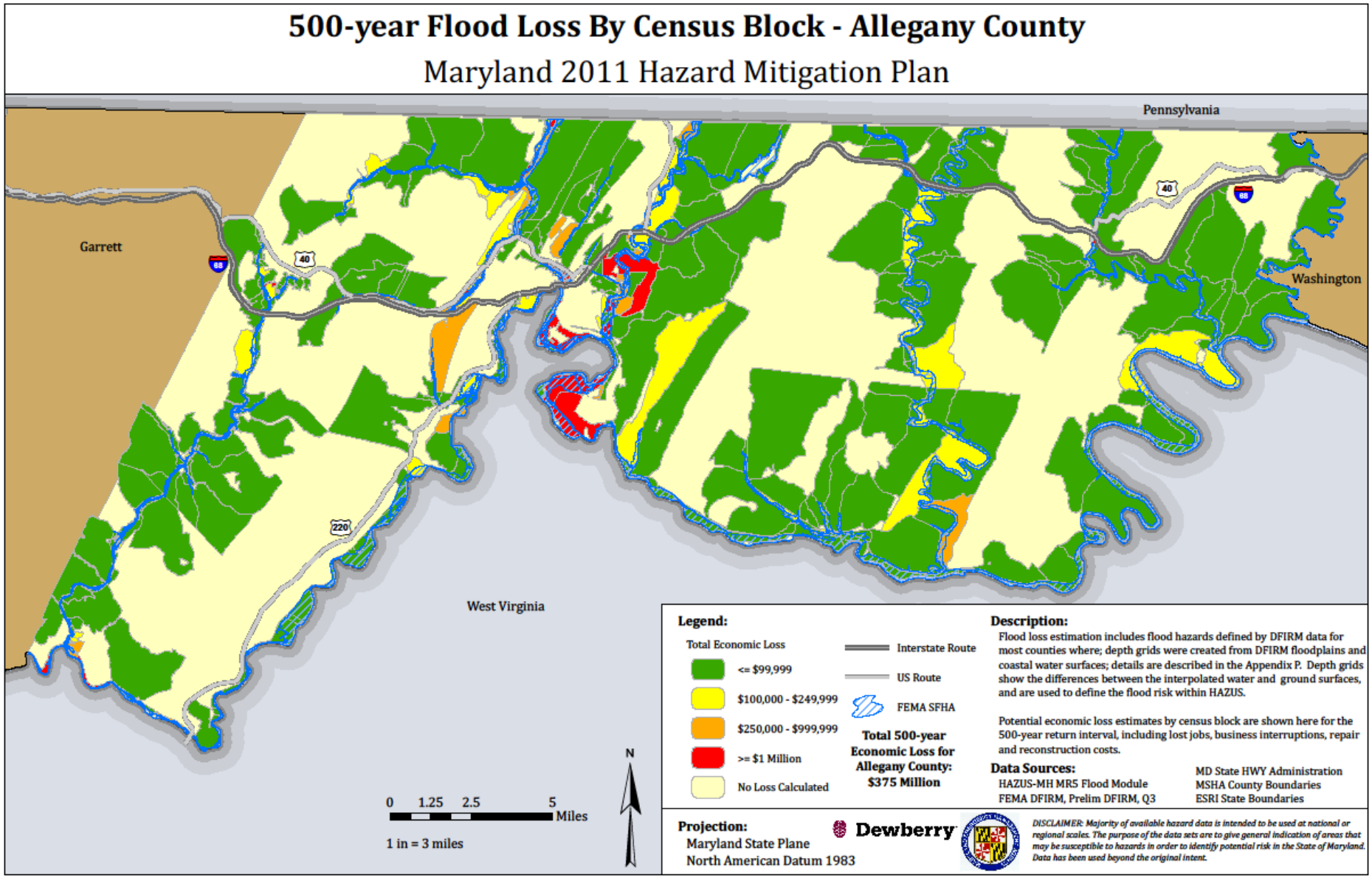
Improvements based on 2007 Points of Interest & State Treasurer database.

HAZUS – MD State Flood Totals

Event	Total Loss	Building Loss	Contents Loss	Inventory Loss	Relocation Cost	Income Loss	Rental Income Loss	Wage Loss	Direct Output Loss
100 yr	$9.12*B*	$4.39*B*	$4.46*B*	$135.43*M*	$7.37*M*	$14.04*M*	$3.66*M*	$50.46*M*	$61.85*M*
500 yr	$11.16*B*	$5.23*B*	$5.57*B*	$175.23*M*	$9.71*M*	$17.87*M*	$4.90*M*	$73.34*M*	$79.88*M*

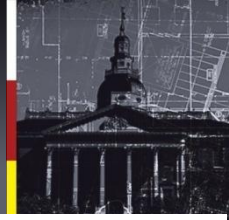
2011 Maryland All-Hazard Mitigation Plan Update

Maryland Emergency Management Agency



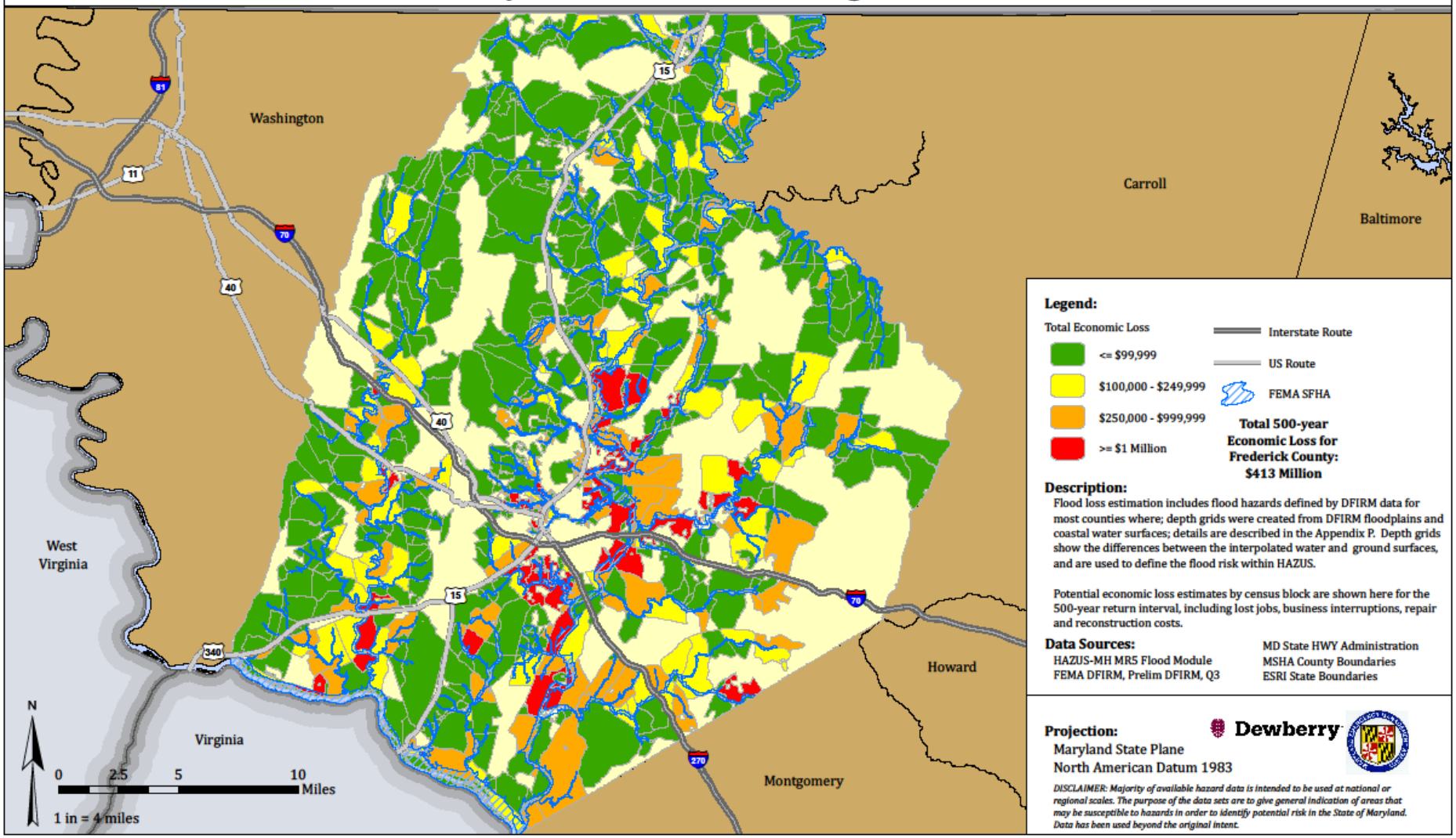
2011 Maryland All-Hazard Mitigation Plan Update

Maryland Emergency Management Agency



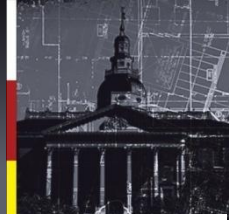
Estimated 500-year Flood Loss By Census Block - Frederick County

Maryland 2011 Hazard Mitigation Plan



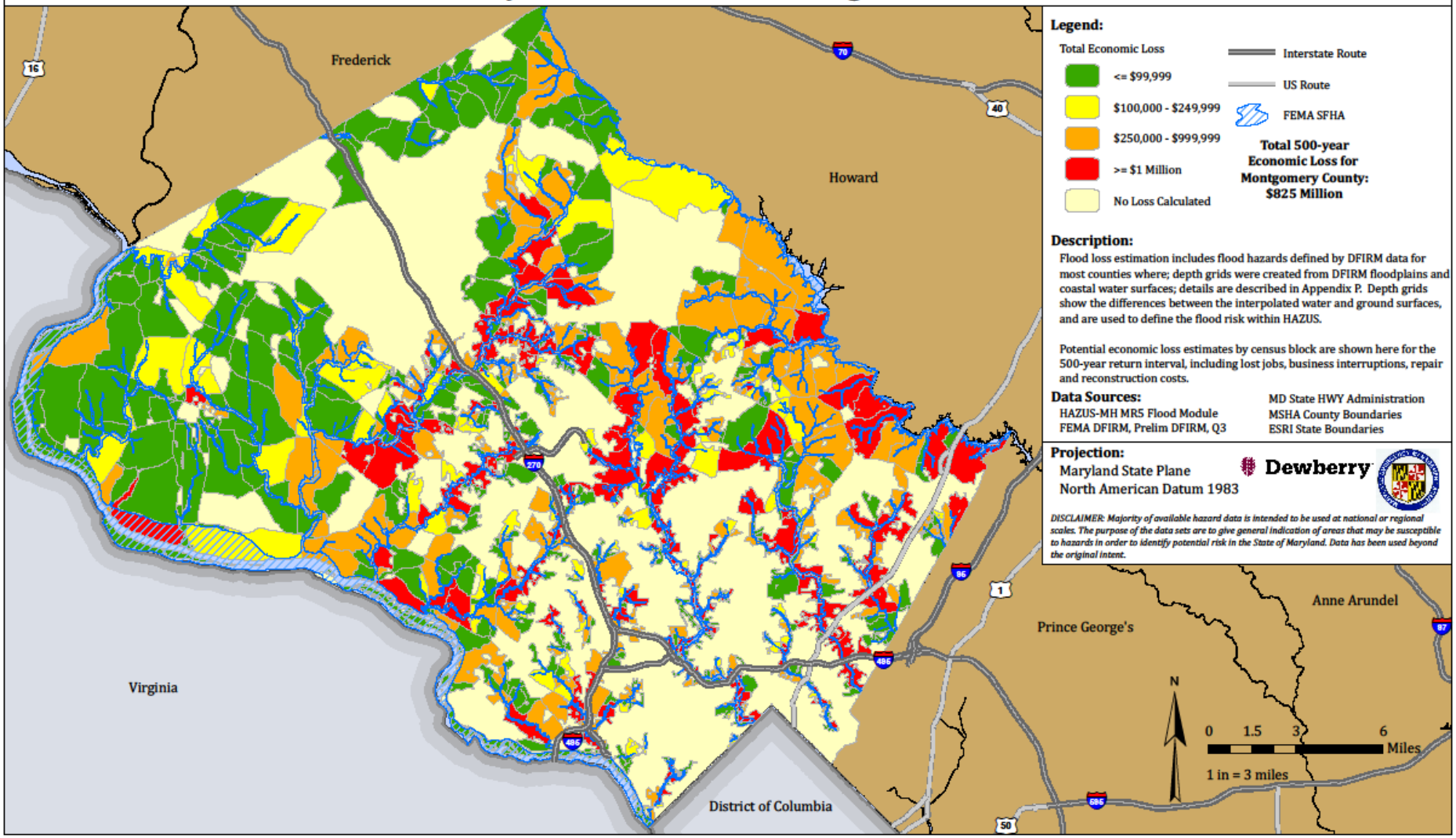
2011 Maryland All-Hazard Mitigation Plan Update

Maryland Emergency Management Agency



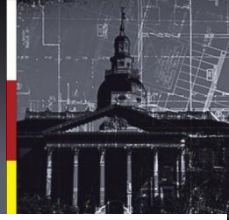
Estimated 500-year Flood Loss By Census Block - Montgomery County

Maryland 2011 Hazard Mitigation Plan



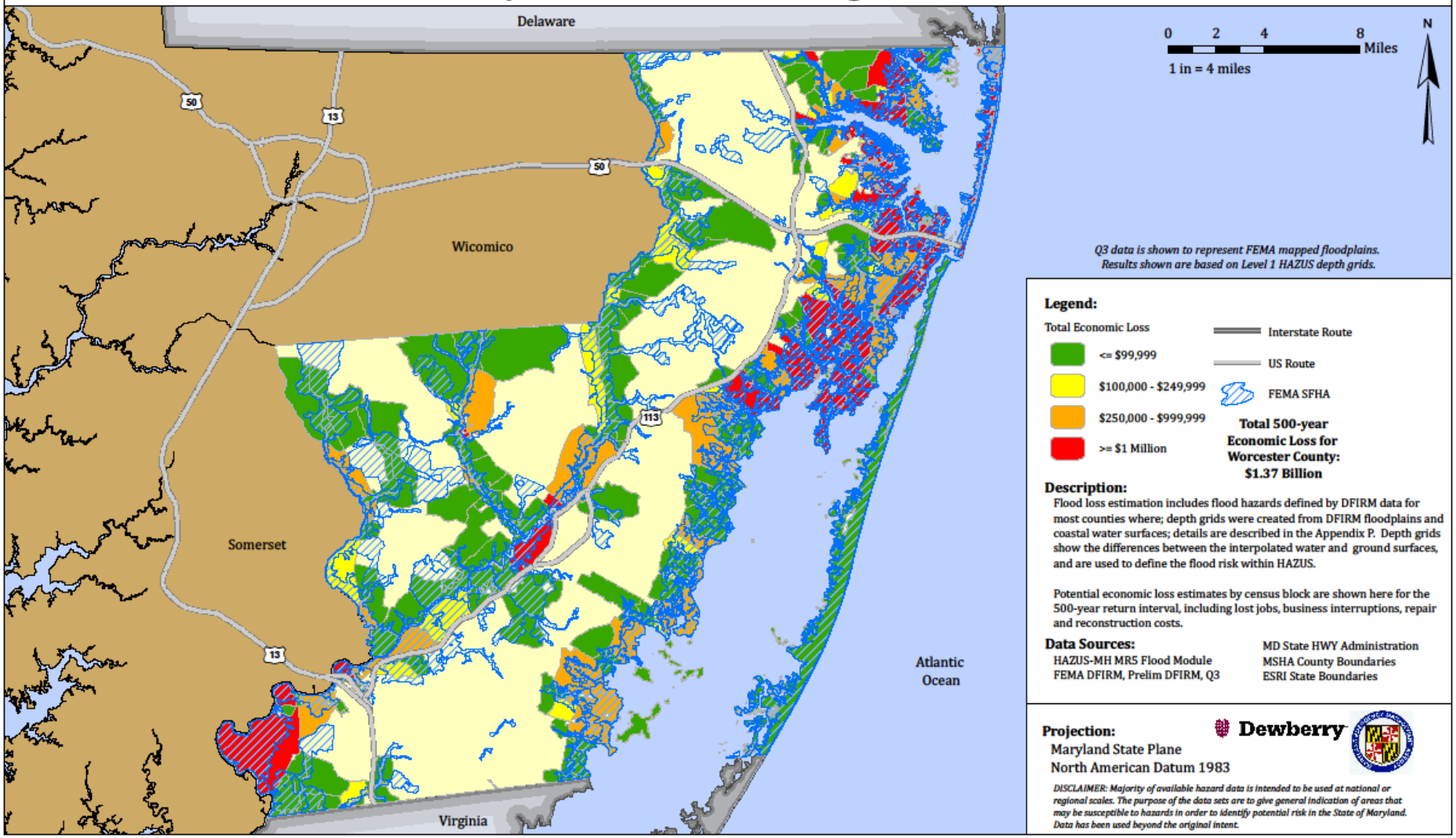
2011 Maryland All-Hazard Mitigation Plan Update

Maryland Emergency Management Agency



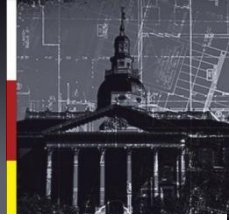
Estimated 500-year Flood Loss By Census Block - Worcester County

Maryland 2011 Hazard Mitigation Plan



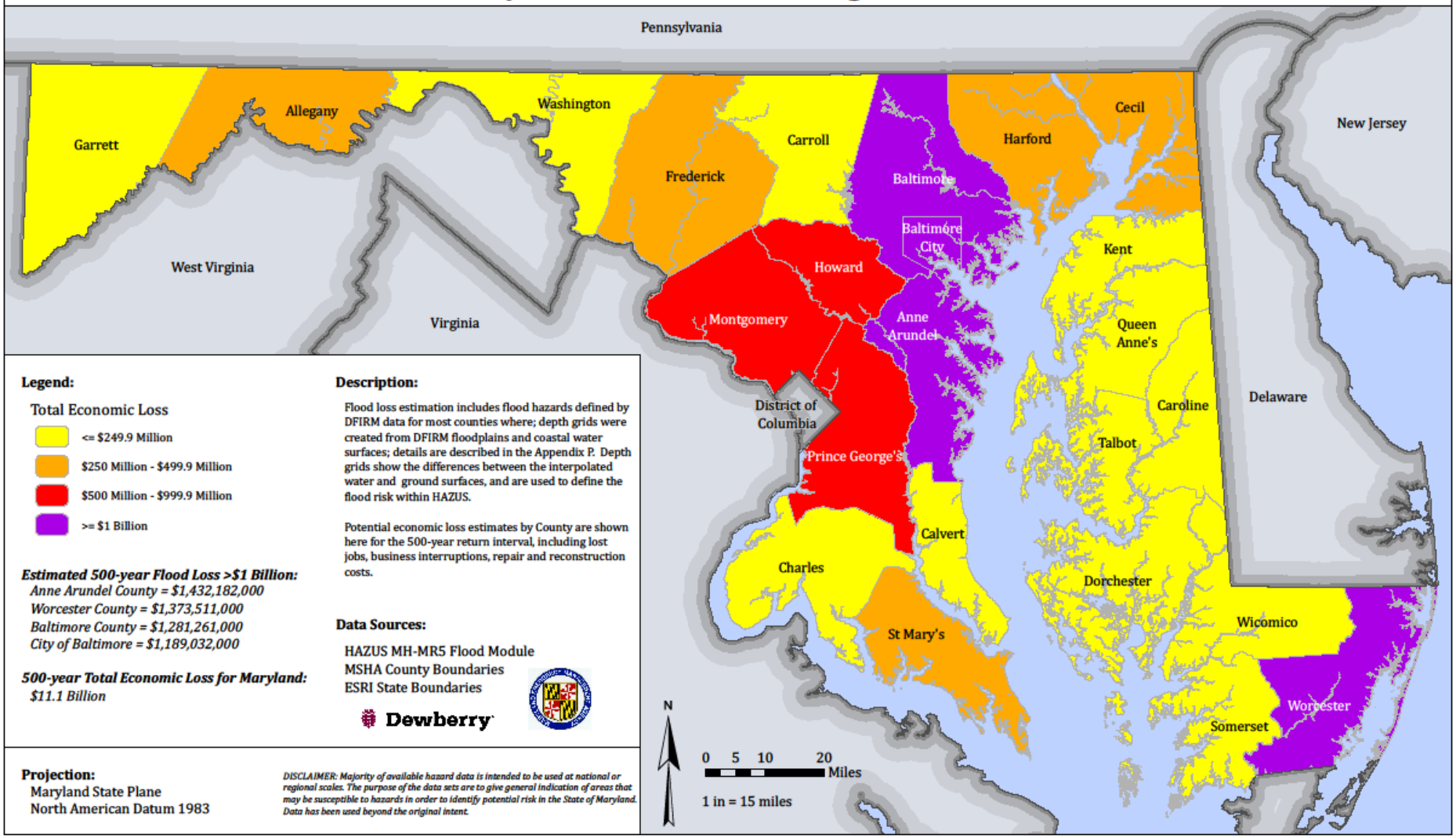
2011 Maryland All-Hazard Mitigation Plan Update

Maryland Emergency Management Agency



Estimated 500-year Flood Loss By County

Maryland 2011 Hazard Mitigation Plan



Legend:

Total Economic Loss

- <= $249.9 Million
- $250 Million - $499.9 Million
- $500 Million - $999.9 Million
- >= $1 Billion

Estimated 500-year Flood Loss >$1 Billion:

Anne Arundel County = $1,432,182,000
Worcester County = $1,373,511,000
Baltimore County = $1,281,261,000
City of Baltimore = $1,189,032,000

500-year Total Economic Loss for Maryland:

$11.1 Billion

Description:

Flood loss estimation includes flood hazards defined by DFIRM data for most counties where; depth grids were created from DFIRM floodplains and coastal water surfaces; details are described in the Appendix P. Depth grids show the differences between the interpolated water and ground surfaces, and are used to define the flood risk within HAZUS.

Potential economic loss estimates by County are shown here for the 500-year return interval, including lost jobs, business interruptions, repair and reconstruction costs.

Data Sources:

HAZUS MH-MR5 Flood Module
MSHA County Boundaries
ESRI State Boundaries

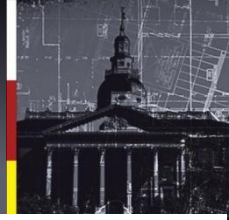
Dewberry

Projection:
Maryland State Plane
North American Datum 1983

DISCLAIMER: Majority of available hazard data is intended to be used at national or regional scales. The purpose of the data sets are to give general indication of areas that may be susceptible to hazards in order to identify potential risk in the State of Maryland. Data has been used beyond the original intent.

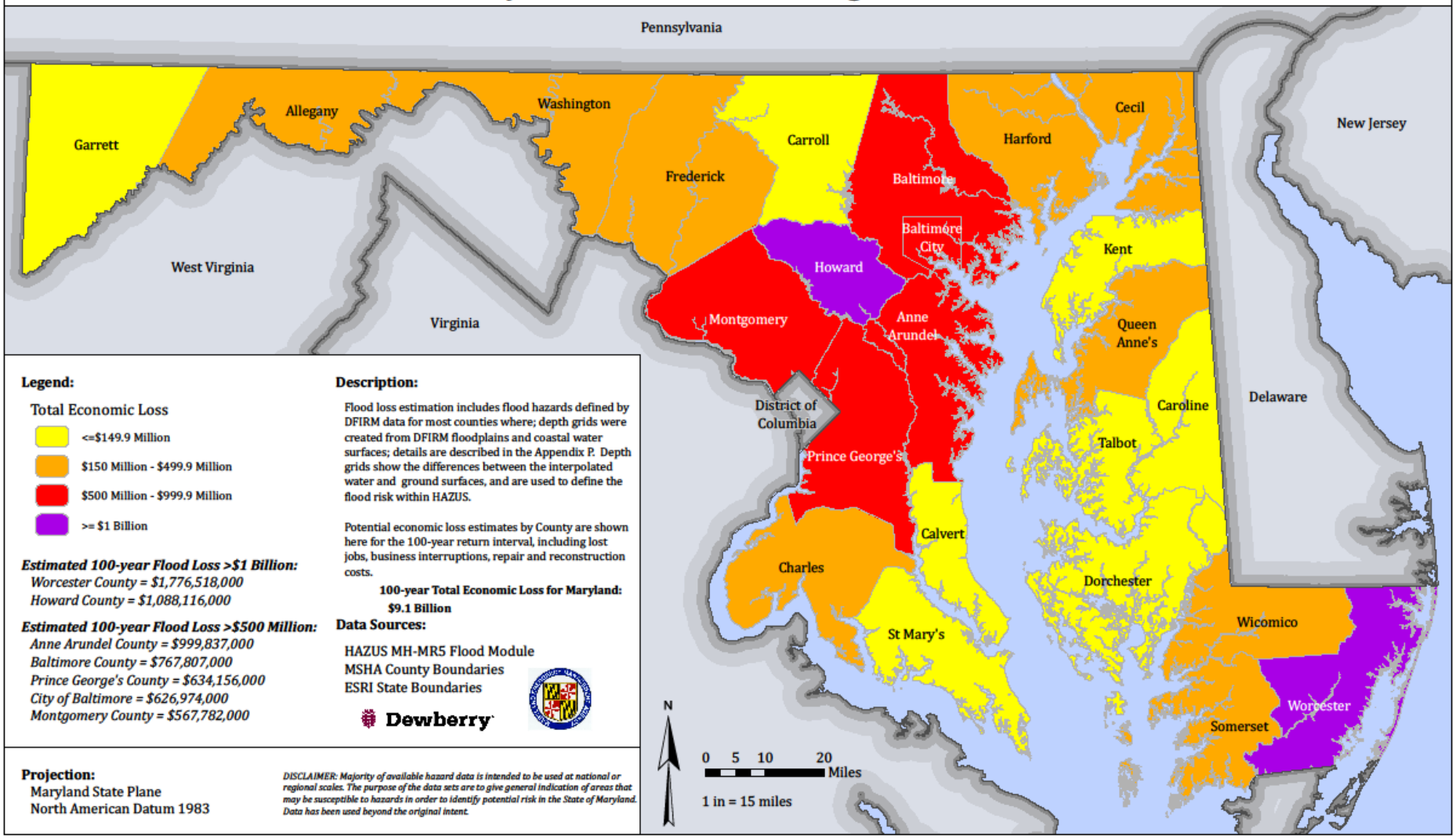
2011 Maryland All-Hazard Mitigation Plan Update

Maryland Emergency Management Agency



Estimated 100-year Flood Loss By County

Maryland 2011 Hazard Mitigation Plan



Legend:

Total Economic Loss

- <=$149.9 Million
- $150 Million - $499.9 Million
- $500 Million - $999.9 Million
- >= $1 Billion

Estimated 100-year Flood Loss >$1 Billion:

Worcester County = $1,776,518,000
Howard County = $1,088,116,000

Estimated 100-year Flood Loss >$500 Million:

Anne Arundel County = $999,837,000
Baltimore County = $767,807,000
Prince George's County = $634,156,000
City of Baltimore = $626,974,000
Montgomery County = $567,782,000

Description:

Flood loss estimation includes flood hazards defined by DFIRM data for most counties where; depth grids were created from DFIRM floodplains and coastal water surfaces; details are described in the Appendix P. Depth grids show the differences between the interpolated water and ground surfaces, and are used to define the flood risk within HAZUS.

Potential economic loss estimates by County are shown here for the 100-year return interval, including lost jobs, business interruptions, repair and reconstruction costs.

100-year Total Economic Loss for Maryland:
$9.1 Billion

Data Sources:

HAZUS MH-MR5 Flood Module
MSHA County Boundaries
ESRI State Boundaries

Dewberry

Projection:
Maryland State Plane
North American Datum 1983

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HAZUS- MH Flood Modeling

- **HAZUS results will be provided for every county and Baltimore City**
- **Provides 500-year impact and loss predictions for:**
  - **future comprehensive planning**
  - **floodplain ordinance higher standards**
  - **sea level rise**
  - **climate change purposes**

Next Steps: Draft Review

- Comments due Monday, August 1, 2011
- Draft is available at: ftp.dewberry.com (see July 20 Meeting Agenda); www.mema.state.md.us
- Final draft will be compiled, submitted to MEMA/FEMA
- Final MEMA/FEMA comments incorporated
- Governor O'Malley Adoption prior to August 26
- FEMA Approval NLT August 26, 2011

Appendix G – HAZUS Analysis Documents

This appendix is available for electronic review by contacting the Maryland State Hazard Mitigation Officer:

Mark D James
Acting State Hazard Mitigation Officer
Maryland Emergency Management Agency
Camp Fretterd, 5401 Rue Saint Lo Drive,
Reisterstown, MD 21136
410 517 3649
mjames@mema.state.md.us

Appendix H – Local Plan Upload

This appendix is available for electronic review by contacting the Maryland State Hazard Mitigation Officer:

Mark D James
Acting State Hazard Mitigation Officer
Maryland Emergency Management Agency
Camp Fretterd, 5401 Rue Saint Lo Drive,
Reisterstown, MD 21136
410 517 3649
mjames@mema.state.md.us

Appendix I – State Mitigation Actions Upload and Tracker Tool

This appendix is available for electronic review by contacting the Maryland State Hazard Mitigation Officer:

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Acting State Hazard Mitigation Officer
Maryland Emergency Management Agency
Camp Fretterd, 5401 Rue Saint Lo Drive,
Reisterstown, MD 21136
410 517 3649
mjames@mema.state.md.us

Appendix J – Project Scoping

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Acting State Hazard Mitigation Officer
Maryland Emergency Management Agency
Camp Fretterd, 5401 Rue Saint Lo Drive,
Reisterstown, MD 21136
410 517 3649
mjames@mema.state.md.us

Appendix K – Mitigation Action Committee and Stakeholder List

Mitigation Advisory Committee and Stakeholder List								
Name	Affiliation	Email	Phone	Address	Committee Members	May 12th	June 15th	July 20th
*Matthew McCullough	FEMA R3	Matthew.Mccullough@dhs.gov	(215)931-5587	615 Chestnut Street Philadelphia, PA 19106-4404		x	x	
*Tess Grub	FEMA R3	Therese.Grubb@dhs.gov	(215)931-5528	615 Chestnut Street Philadelphia, PA 19106-4404			x	
*Gene Gruber	FEMA R3	Gene.Gruber@dhs.gov	(215)931-5669	615 Chestnut Street Philadelphia, PA 19106-4404			x	
*Karen Helbrecht	FEMA Risk Assessment Division - Headquarters	karen.helbrecht@dhs.gov						
*Patrick Marchman	FEMA R3	patrick.marchman@dhs.gov	(202)646-2675				x	
*Robin Danforth	FEMA R3	robin.danforth@dhs.gov						
*Elizabeth Ranson	FEMA R3	elizabeth.ranson@dhs.gov					x	
*Bill Carroll	MEMA	wcarroll@mema.state.md.us	(410)517-3624		x		x	
*Richard Muth	MEMA	RMuth@mema.state.md.us					x	
*Margo Warnick	MEMA	mwarnick@mema.state.md.us	(410)517-5120		x	x		
*Kelly McGuire	MEMA	kmcguire@mema.state.md.us	(443)865-9511				x	
*Kristen McMenamin	MEMA	kmcmenamin@kentgov.org			x			
*Mark James	MEMA	Mjames@mema.state.md.us	(410)517-3649			x	x	
Al Posey	City of Annapolis Emergency Management	abposey@annapolis.gov	(410) 216-9167 x11	929 West St, Suite 209, Annapolis, MD 21401			x	
Alan Williams	MD Department of the Environment	awilliams@mde.state.md.us	(410)537-3994	1800 Washington Blvd, Baltimore, MD 21230			x	
Allen Myers	MD Dept. of Aging	arm@ooa.state.md.us	(410)767-1071				x	
Amy G. Moredock	Kent County Department of Zoning	amoredock@kentgov.org	(410)778-7473	400 High Street, Chestertown, MD, 21620	x		x	
Barbara Kearney	Carroll County Department of Planning	bkearney@ccg.carr.org	(410)386-2145 (410)386-2139	225 South Center St. Room 204, Westminster, MD 21157			x	
Ben Martinez	BWI/MAA	Bmartinez@bwiairport.com	(410)854-7346				x	
Benjamin A. Pratt P.E.	Susquehana River Basin Commission	bpratt@srbc.net	(717)238-0423 Ext. 212	1721 N. Front St. Harrisburg, PA, 17102			x	
Bob Nelson	Ocean City Planning	rnelson@oceancitymd.gov	(410)510-5377				x	
Bob Phillips	City of Cambridge	bphillips@ci.cambridge.md.us	(443)205-5030				x	
Bob Rhode	Ocean City Department of Emergency Services	brhode@oceancitymd.gov	(410)723-6650	6501 Coastal Highway, Ocean City, MD, 21842			x	
Bob Ryan	City of College Park	bryan@collegeparkmd.gov	(240)487-3570	4601 A. Calvert Rd. College Park, MD 20740			x	
Bobby Fenwick	Calvert County Department of Emergency Services Calvert Co EMA	fenwicjr@co.cal.md.us	(301)855-1243 x2301 (410)535-1600	175 Main Street, Prince Frederick, MD 20678			x	
Carlton Haywood	Interstate Commission on the Potomac River Basin	chaywood@icprb.org	(301)274-8105	51 Monroe St. Ste PE-08, Rockville, MD 20850			x	
Catherine McCall	MD Department of Natural Resources				x			
Charles P. Crisostomo	Montgomery Co Office of Emergency Management & Homeland Security	Charles.Crisostomo@montgomerycountymd.gov Chuck.Crisostomo@montgomerycountymd.gov	(240)777-2328	P.O. Box 4117, Gaithersbury, MD, 20878			x	
Chris Piscitelli	MDVA	Ctpiscitelli@verizon. Net	(410)923-6981				x	
Christina M. Macey	Anne Arundel County Office of Emergency Management	cmacey@aacounty.org	(410)222-0612				x	
Craig Arnold	Exelon Power Corporation, Conowingo Dam	clmarnold5@gmail.com	(519)659-0930				x	
Dan Cornwell	Howard County OEM	dcornwell@howardcountymd.gov	(410)313-5911 (301)674-5324	6751 Columbia Gateway Dr. Suite 400, Columbia, MD 21048			x	
Dan McMullen	MD Depart of AgricultureOffice of the Secretary	mcmulldf@mda.state.md.us david.mcmillan@baltimorecity.gov	(410)841-5853	50 Harry Truman Parkway Annapolis, Md. 21401			x	
Dan Nelson	MD State Police	dnelson@mdsp.org	(410) 799-4548				x	
Danielle Bradshaw-Lee	MDTA Airport/Seaport & MVA Division	dbradshaw@mdta.state.md.us	(410)537-7733 (443)324-6663	4330 Broening Highway, Baltimore, Maryland			x	
Dave Kloid	MTA Police	dkloid@mta.maryland.gov	(410)454-1642				x	
Dave Larsen, Captain	NRP	dlarsen@dnr.state.md.us	(410)271-7397	580 Taylor Avenue Annapolis, Maryland 21401			x	
David E. Bohannon, Esq.	Department of Human Resources	dbohanno@dhr.state.md.us	(410)767-7927				x	
David B. McMillan	Mayors Office of Emergency Management	david.mcmillan@baltimorecity.gov	(410)396-6179	1201 E. Cold Spring Lane, Baltimore, MD 21239			x	
David Church	Salisbury/Wicomico County Department of Planning, Zoning & Community Development	dchurch@wicomicocounty.org	(410)548-4860	125 N. Division St. Room 203, Salisbury, MD 21801			x	
Dave Guignet	MDE	dguignet@mde.state.md.us			x			
David Umling	City of Cumberland	dumling@allconet.org	(301)759-6503	57 North Liberty St. Cumberland, MD, 21502			x	
Devon Dodson	MD Energy Administration MIA	ddodson@energy.state.md.us	(410)260-7257 (410)260-7655				x	
Ed Landon	MD Department of housing & Community Development	Landon@dhcd.state.md.us Landon@MDHousing.org	(410) 514-7444	100 Community Place, Crownsville, MD 21032	x		x	
Erika Quesenbery	Town of Port Deposit	Erika@portdeposit.org	(410)378-2121				x	
Frank Bender	MDPSC	fbender@psc.state.md.us	(410)236-3201				x	
Gene Walzl, P.E.	City of Frederick	gwalzl@cityoffrederick.com	(301)600-1405 (301)600-1836	140 W. Patrick St., Frederick, MD 21701			x	
Grant Harding	DLLR	gharding@dllr.state.md.us	(410)767-2198				x	
Gregory Vernon	Howard County Dept. of Planning and Zoning	gvernon@howardcountymd.gov	(617)974-4066	3430 Courthouse Dr. Ellicot City, MD 21403			x	
James Fox	MD Department of Budget Management	jfox@dbm.state.md.us		580 Taylor Avenue, E-2 Annapolis, MD 21401			x	
Jared Parks	Eastern Shore Land Conservancy	jparks@eslc.org	(410)827-9756 Ext. 167	P.O. Box 169 Queenstown, MD 21658			x	
Jeff Allenby	Maryland Dept of Natural Resources	jallenby@dnr.state.md.us	(410)268-8743 (802)233-4012 (410)260-8743	580 Taylor Avenue, E-2 Annapolis, MD 21401			x	
Jeff Halka	MD Geological Survey	JHalka@dnr.state.md.us	(410)554-5503	2300 Saint Paul Street, Baltimore, MD 21218			x	
Jesse Ash	MDP	jash@mdp.state.md.us	(410)767-4453		x	x	x	
John Scarborough	Queen Anne's County Department of Public Works	JScarborough@qac.org	(410)758-0925				x	
John Zeller	MEMA	jzeller@mema.state.md.us	(410)517-5110				x	
Joseph Geckle	Maryland State Highway Administration	jgeckle@sha.state.md.us	(410)582-5552	7419 Connelley Dr., Hanover, MD 21076			x	
Joy Hatchette	MD Insurance Administration	Jhatchette@mdinsurance.state.md.us	(410)468-2029	200 Saint Paul Place Suite 2700, Baltimore, MD 21202	x		x	
Kathleen Barry	Preston	cooleenkate@comcast.net	(410)673-7174				x	
Kelly L. Henry	Worcester County Department of Development Review and Permitting	khenry@co.worcester.md.us	(410)632-1200x1130				x	
Kenneth Hranicky	City of Baltimore Planning Department	Kenneth.Hranicky@baltimorecity.gov	(410)396-9508				x	
Kenneth J. Naumann	Baltimore County, Bureau of Solid Waste Management	knaumann@baltimorecountymd.gov	(410)887-8693	111 W. Chesapeake Ave. Towson, MD 21204 Room 225			x	
Kenny Miller	DOIT	ken.miller@doit.state.md.us	(410)260-4044				x	
Kevin Lewis	WC DES	klewis@washco-md.net	(240)313-4363				x	
Kevin Wagner	MDE	kwagner@mde.state.md.us	410-537-3914		x	x		
Kristen Skogsberg	Maryland Department of Transportation	kskogsberg@mdot.state.md.us	(410)865-1178				x	
Lauren Gordon	Department of Juvenile Services	gordonl@djs.state.md.us	(410)230-3346	120 W. Fayette St. Baltimore MD, 21201			x	
Linda Ploener	Harford Co DEO	ljploener@harfordpublicsafety.org	(410)638-4029				x	
Luke Montgomery, Major	DPSCS	Lmontgomery@dpscs.state.md.us	(410)585-3913 (410)277-9484	6776 Reisterstown Rd. Baltimore, MD 21215			x	
Marcus Griswold	Maryland Dept of Natural Resources	mgriswold@dnr.state.md.us		580 Taylor Avenue, E-2 Annapolis, MD 21401			x	
Margaret Fisher	Department of General Services	margaret.fisher@dgs.state.md.us	(410)767-1615	301 W. Preston St. Room 1309, Baltimore, MD 21201	x	x	x	
Mark Bilger	Office of the State Fire Marshal	mbilger@mdsp.org	(410)836-4844	2 South Bond Street ST 401 Belair, MD 21014			x	
Mark Cohoon	Talbot County Department of Public Works	mcohoon@talbotcountymd.gov	(410)770-8183	215 Bay St. Suite 6, Easton, MD 21601			x	

Mitigation Advisory Committee and Stakeholder List								
Name	**Affiliation**	**Email**	**Phone**	**Address**	**Committee Members**	**May 12th**	**June 15th**	**July 20th**
Mark Ewers	Baltimore County	mewers@baltimorecountymd.gov	(410)887-2235				x	
Mark Harris	Maryland Department of Transportation	mharris@mdot.state.md.us	(410)865-1128	1201 Corporate Drive, Hanover MD. 21076	x		x	
Mark Hubbard	Baltimore County	mhubbard@baltimorecountymd.gov	(410)887-5996				x	
Mark Martin	MD DOC	Mmartin@dpscs.state.md.us	(410)585-3908	6776 Reisterstown Rd. Baltimore, MD 21215			x	
Matt Kropp	Harford County Department of Zoning	mtkropp@harfordcountymd.gov	(410)638-3103 Ext. 1364	220 S. Main Street, Bel Air, MD. 21014			x	
Michael Boldosser	Talbot County Emergency Services	mboldosser@talbotcountymd.gov	(410)770-8166	605 Port St Easton, MD 21601			x	
Michael Hayman	Wicomico County Dept. of Public Works, Roads Division	mhayman@wicomicocounty.org	(410)548-4872	28440 Owens Branch Road, Salisbury, MD 21803			x	
Mia Liley	STO	mliley@treasurer.state.md.us	(410)260-7239		x	x	x	
Pam Spring	DHR	pspring@dhr.state.md.us	(410)767-7797		x		x	
Perry Jones, Mayor	Town of Union Bridge	unionbr@carr.org perryljonesjr@yahoo.com	(410)775-2711				x	
Phillip Deitchman	Maryland State Department of Education	pdeitchman@msde.state.md.us	(410)767-0153				x	
Richard Alcorta, Dr	MIEMSS	Ralcorta@miemss.org	(410)706-0880				x	
Rick Albee	City of Frederick	Ralbee@cityoffrederick.com	(301)600-1405				x	
Rick Konrad	City of Fruitland	rkonrad@cityoffruitland.com	(410)848-2900				x	
Ron Lewis B.S., Capt.	Maryland State Police	rblewis@mdsp.org	(410)799-4548				x	
Sam Anderson	Washington County, MD Emergency Management	sanderson@washco-md.net	(240)313-4371	16232 Elliott Parkway, Williamsport, MD 21795			x	
Seamus Mooney	Frederick County Department of Emergency Preparedness	emergencymanagement@frederickcountymd.gov smooney@frederickcountymd.gov	(301)600-1746	340 Montevue Lane, Frederick, MD 21702			x	
Stephen Flickinger	Cecil County Department of Emergency Services	Steve.Flickinger@ccdps.org	(410)392-2037		x		x	
Steve Garvin	Dorchester Co EMD	sgarvin@docogonet.com	(410)228-1818				x	
Steven Welzant	Baltimore Co OEM	swelzant@baltimorecountymd.gov	(410)887-5996				x	
Tim La Valle	Department of Business and Economic Development	tlavalle@choosemaryland.org	(410)767-2202	401 East Pratt Street, Baltimore, MD 21202	x	x	x	
Tyrone N. Wells	Prince George's County Office Of Homeland Security	TNWells@co.pg.md.us	(301)883-3307 (301)883-3300	9200 Basil Court, Suite 308 Largo, MD 20774			x	
Zoë Johnson	Maryland Dept of Natural Resources	zjohnson@dnr.state.md.us	(410)260-8741		x		x	

Appendix L – Hazard Mitigation Grant Program Administration

Due to the sensitive nature of this appendix its contents can be requested for review by contacting the Maryland State Hazard Mitigation Officer:

Mark D James
Acting State Hazard Mitigation Officer
Maryland Emergency Management Agency
Camp Fretterd, 5401 Rue Saint Lo Drive,
Reisterstown, MD 21136
410 517 3649
mjames@mema.state.md.us

Appendix M – Repetitive and Severe Repetitive Loss Tracker

Due to the sensitive nature of this appendix its contents can be requested for review by contacting the Maryland State Hazard Mitigation Officer:

Mark D James
Acting State Hazard Mitigation Officer
Maryland Emergency Management Agency
Camp Fretterd, 5401 Rue Saint Lo Drive,
Reisterstown, MD 21136
410 517 3649
mjames@mema.state.md.us

Appendix N – Hazard Mitigation Assistance Grants Workbook

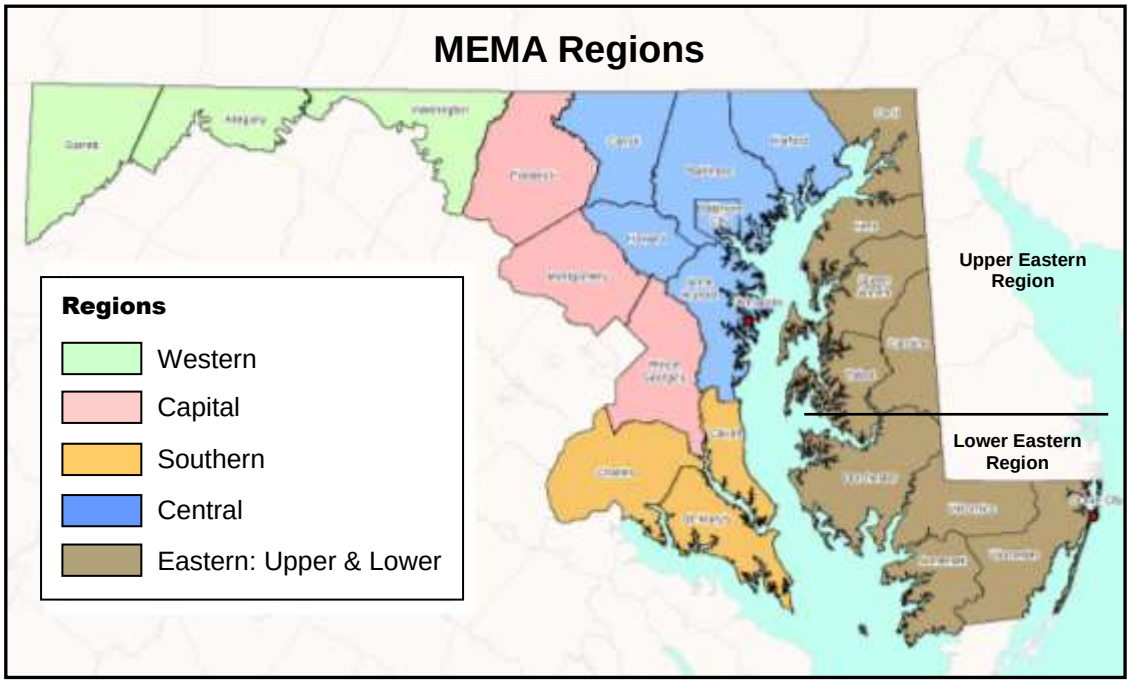
Due to the sensitive nature of this appendix its contents can be requested for review by contacting the Maryland State Hazard Mitigation Officer:

Mark D James
Acting State Hazard Mitigation Officer
Maryland Emergency Management Agency
Camp Fretterd, 5401 Rue Saint Lo Drive,
Reisterstown, MD 21136
410 517 3649
mjames@mema.state.md.us

Appendix O – Outreach and Education

Regional Open House Meetings

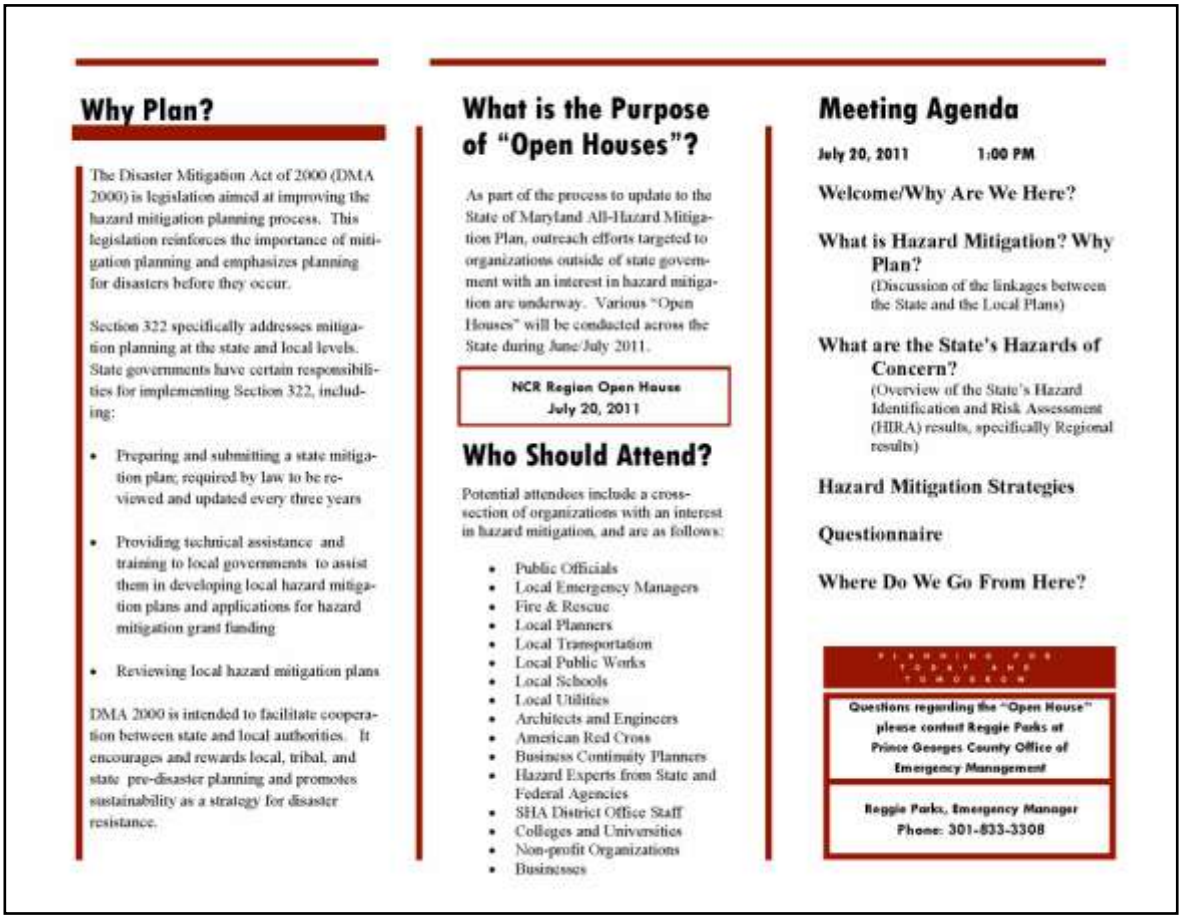
As part of the process to update to the State of Maryland All-Hazard Mitigation Plan, outreach efforts targeted to organizations outside of state government with an interest in hazard mitigation were conducted within the five Maryland Emergency Management Agency (MEMA) designated regions. However, due to the number of jurisdictions within the Eastern Region, the region was divided into the Upper and Lower Eastern Regions as shown on the map below.



"Open Houses" conducted around the state were held in June/July of 2011. Invitees included a cross-section of organizations with an interest in hazard mitigation, and were as follows:

- Public Officials
- Local Emergency Managers
- Fire & Rescue
- Local Planners
- Local Transportation
- Local Public Works
- Local Schools
- Local Utilities
- Architects and Engineers
- American Red Cross
- Business Continuity Planners
- Hazard Experts from State & Federal
- SHA District Office Staff
- Colleges and Universities
- Non-profit Organizations
- Businesses

In order to maximize participation and coordination, MEMA Regional Administrators worked with the counties within their Region to determine the date, time and meeting location for their Region's Open House. Following the establishment of the meeting logistics, each county was provided an email invitation and brochure for distribution. Each brochure contained a local point of contact, ensuring that invitees had the opportunity to obtain additional information from a designated contact within their own jurisdiction. This level of coordination conveyed the partnership and linkage between the State and Local hazard mitigation planning update process.



Why Plan?

The Disaster Mitigation Act of 2000 (DMA 2000) is legislation aimed at improving the hazard mitigation planning process. This legislation reinforces the importance of mitigation planning and emphasizes planning for disasters before they occur.

Section 322 specifically addresses mitigation planning at the state and local levels. State governments have certain responsibilities for implementing Section 322, including:

- Preparing and submitting a state mitigation plan; required by law to be reviewed and updated every three years
- Providing technical assistance and training to local governments to assist them in developing local hazard mitigation plans and applications for hazard mitigation grant funding
- Reviewing local hazard mitigation plans

DMA 2000 is intended to facilitate cooperation between state and local authorities. It encourages and rewards local, tribal, and state pre-disaster planning and promotes sustainability as a strategy for disaster resistance.

What is the Purpose of "Open Houses"?

As part of the process to update to the State of Maryland All-Hazard Mitigation Plan, outreach efforts targeted to organizations outside of state government with an interest in hazard mitigation are underway. Various "Open Houses" will be conducted across the State during June/July 2011.

NCR Region Open House
July 20, 2011

Who Should Attend?

Potential attendees include a cross-section of organizations with an interest in hazard mitigation, and are as follows:

- Public Officials
- Local Emergency Managers
- Fire & Rescue
- Local Planners
- Local Transportation
- Local Public Works
- Local Schools
- Local Utilities
- Architects and Engineers
- American Red Cross
- Business Continuity Planners
- Hazard Experts from State and Federal Agencies
- SHA District Office Staff
- Colleges and Universities
- Non-profit Organizations
- Businesses

Meeting Agenda

July 20, 2011 1:00 PM

Welcome/Why Are We Here?

What is Hazard Mitigation? Why Plan?
(Discussion of the linkages between the State and the Local Plans)

What are the State's Hazards of Concern?
(Overview of the State's Hazard Identification and Risk Assessment (HIRA) results, specifically Regional results)

Hazard Mitigation Strategies

Questionnaire

Where Do We Go From Here?

PLANNING FOR TODAY AND TOMORROW

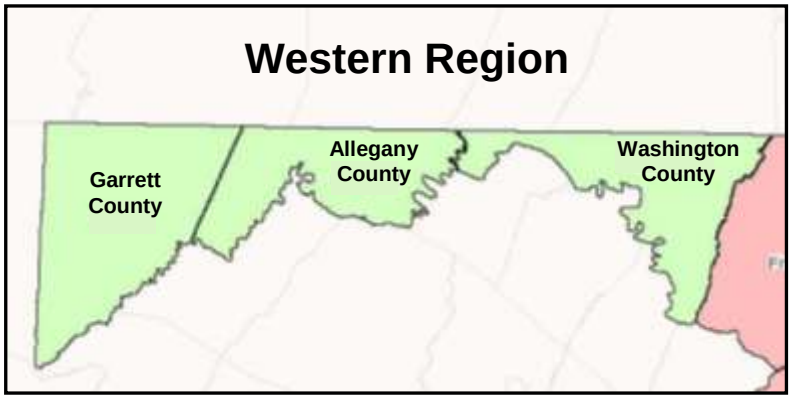
Questions regarding the "Open House" please contact Reggie Parks at Prince George County Office of Emergency Management

Reggie Parks, Emergency Manager
Phone: 301-833-3308

In order to adequately discuss the State of Maryland All-Hazard Mitigation Plan Update process, a presentation of background information specific to hazard mitigation was necessary and yielded audience comments. This information included examples of hazard mitigation from various agency perspectives, such as Public Works, Planning, and the Board of Education perspectives, just to name a few. The benefits of hazard mitigation and how mitigation has been implemented by their own jurisdictions were discussed at the Open Houses as well. Additional information regarding each Regional Open House is presented on the following pages.

Western Region Open House

Date: 29 June 2011
Time: 9-10:30 AM
Location: Allegany County Public Safety Building; 11400 PPG Road SE; Cumberland, MD 21502
Western Region Jurisdictions: Garrett, Allegany, Washington



Attendees included agency representatives as follows:

- ✓ Health Department;
- ✓ Board of Education;
- ✓ Sheriff's Office;
- ✓ Planning Department;
- ✓ Emergency Management;
- ✓ Emergency Services.

The Open House consisted of a power-point presentation and a facilitated comment/response session. The presentation's focus was the results of the Maryland Hazard Identification and Risk Assessment (HIRA), specifically the results for Garrett, Allegany, and Washington counties. The Western Region participants were pleased to learn that their local HIRA results had been incorporated into the scoring system utilized in the State's HIRA. However, concerns were voiced by the Western Region participants pertaining to the use of population and population density in the HIRA scoring system ranking parameters. Participants questioned whether or not variables such as household income and the age of housing stock were considered in the planning process. In fact, social vulnerability has been considered and incorporated in the planning process utilizing data from the American Communities Survey, 2005-2009 estimates data. In addition, participants discussed their frustration over FEMA disaster guidelines specific to winter storm disaster declarations. Following the HIRA presentation participants were given a questionnaire and a comment/response session ensued. The questionnaires was discussed by the overall group, however each participant completed and submitted their forms prior to departure. The participant sign-in sheet along with the compiled questionnaire for the Western Region Open House has been included.

State of Maryland All-Hazard Mitigation Plan Update
Western Region Open House
29 June 2011

Name	Department/ Organization	Phone	Email
Shawn Stoner	WCHD	240-313-3410	shawnstoner@rlhmk.state.md.us
Sam Billotti	WCSO	240-313-2174	sbillotti@washco-md.net
Bob Fallon	ACPS	301-757-2063	[illegible]@acps.k12.md.us
Richard King	ACPS	301-759-2000	Richard.King@ACPS.k12.md.us
James Evans	ACPS	301-769-2000	[illegible]
[illegible]	WC DES		
Sam Anderson	Washco DES	240 313 4371	[illegible]
Erica Mowbray	MEMA	443865 8802	emowbray@mema.state.md.us
Phil Hager	Allegany Planning	301/876-9555	phil.hager@allconet.org
Steve Ganley	Wash. Co. Public Schools	301-766-8757	ganleste@wcboe.k12.md.us
Christian Hall	ACDPSHS	301-876-9155	chall@allconet.org
Susan Lee	ACDPS	301-876-9155	slee@allconet.org
Charles Summers	Wash. Co. Emerg. Services	240-313-2924	CSummers@WASHCO-MD.NET
Dick Deeve	ACDPS	301-876-9155	[illegible]
Roger Bennett	ACDPS	301-876-9155	[illegible]

June 29, 2011 QUESTIONAIRE

2011 State of Maryland All-Hazard Mitigation Plan
Western Region Open House Meeting

Results & Comments from the 2011 Western Region Open House Questionnaire are listed below in red.

Section I: Hazard Identification & Risk

1. **How concerned are you about the following hazards affecting your community?**

(Place an X in the corresponding column for each hazard)

Hazard Types	Extremely Concerned	Very Concerned	Concerned	Somewhat Concerned	Not Concerned
Flood		X			
High Wind			X		
Thunderstorm		X			
Wildfire			X		
Land Subsidence: Karst/Sinkholes			X		
Landslide			X		
Earthquake				X	
Winter Storm		X			
Tornado		X			
Drought			X		
Coastal				X	
Other: Epidemic/pandemic/common disease					
Other: Food/water/environmental health issues.					

2. **Rationale for adding hazards above:**

Comments:

- Public health hazards need to be identified especially with the newly implemented public health capabilities;
- Hazards considered for this plan should be beyond that of natural. More "All-Hazards Mitigation Plan" approach.

Questionnaire Page 2

3. Why are you concerned or not concerned about particular hazard(s)? Please explain.

Comments:

- Floods and winter storms represent significant threats to the county. Affecting nearly all citizens. Significant costs and are lives are impacted;
- Flooding in Westernport;
- Winter storms and the snow loads that accompany them on flat roofs in the schools.
- Winter storm – frequency of events and their severity;
- Flooding – valleys and topography create severe flood situations;
- Wildfire – high number of wildfires and the large amount of woodlands in the region;
- Flood – Hancock transportation for schools/Williamsport area near the Potomac;
- Winter storms – Flat roof schools, and the Cascade/Hancock area;
- Rural counties with limited resources;
- Flood, winter storms, and thunderstorms affect people/homes and roadway closures;
- Winter storms are of great concern since FEMA guidelines require a "new record" to be set for reimbursement;
- Historical experience; also, an event may occur with less frequency, but its impact of any occurrence may be severe;
- Because public health hazards are essential to address and protect our community and residents.

Section II: Mitigation Strategies

4. Which mitigation strategies have worked well in your community or for your organization? (Please identify and explain why?)

Comments:

- Flood Buyouts;
- Need for greater state and federal investment in stream restoration, flood warning, and structural flood damage reduction projects;
- Open communication and collaboration with all potential affected agencies, municipalities, and departments;
- Annual emergency plan meetings;
- Property acquisitions in Hancock from flood prone areas;
- Working within county and partner agencies of review and revision of emergency service functions in county's emergency plans;
- Utilization of project open space for flood mitigation efforts.

5. Which groups should the State work with to reduce hazard losses (please identify)?

Comments:

- Planning, public works, watershed associations;
- Local jurisdictions;
- Board of Education – Security;
- County commissioners – to identify financial needs;
- Government officials;
- Department of Health and Mental Hygiene work with other ESF leads, ie: ESF 6 sheltering is the primary role for department of social services with head quarters support.

6. **What is the State of Maryland doing to effectively reduce your organization's risk from hazards? (Please list any state laws, programs, policies, or regulations which help reduce your organization's vulnerability to hazards)**

Comments:

- Grant funding continuance;
- Resource provisions;
- Emergency plan update at each school year;
- Providing grant funding – Pre Disaster Mitigation grant, commodity flow studies;
- Hazard mitigation planning process opportunity;
- Meetings;
- Provides guidance to the public health.

7. **What should the State's mitigation priorities be?**

For the State as a whole (please explain)?

Comments:

- Flood loss prevention-costs are investment in prevention, not repetitive expense outlays;
- Enhance state plans;
- Planning together.

For the local level (please explain)?

Comments:

- Enhance local plans;
- Planning together.

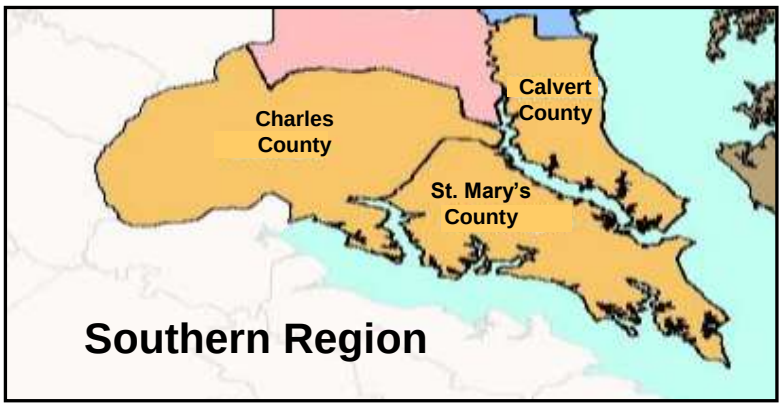
8. **Anything else you would like the State to consider pertaining to hazard mitigation?**

Comments:

- Need to modify prioritization scheme to allow rural jurisdiction to be treated fairly;
- More local funding for mitigation and planning;
- The wind ranking seemed low for Washington County, considering the numbers of events were high;
- The rankings are population bias. Need to adjust the formula to accurately portray the rural areas;
- Formula seems to be biased based too much toward metro areas due to population and density;
- Population isn't necessarily the overriding criteria that should weight the rankings – per capita income and demographic composition is also critical to realize a more accurate assessment;
- Not to lose money for mitigation and planning;
- Population weights tend to skew funding amounts for western regions, which will be impacted by any disaster within their region, as well as in the National Capital Region which will want to flee west.

Southern Region Open House

Date: 7 July 2011
Time: 11:00 AM-12:30 PM
Location: Constellation Energy-Joint Information Center
100 Skipjack Road
Prince Frederick, MD 20678
Southern Region Jurisdictions:
Charles, Calvert, St. Mary's



Attendees included agency representatives as follows:

- ✓ Health Department;
- ✓ Land Use & Growth Management Dept.;
- ✓ Planning Department;
- ✓ Emergency Management;
- ✓ Emergency Services.

The Open House consisted of a power-point presentation and a facilitated comment/response session. The presentation's focus was the results of the Maryland Hazard Identification and Risk Assessment (HIRA), specifically the results for Charles, Calvert, and St. Mary's counties. The Southern Region participants were pleased to learn that their local HIRA results had been incorporated into the scoring system utilized in the State's HIRA. However, concerns were voiced by the Southern Region participants pertaining to the limited focus of the HIRA, specifically the exclusion of other types of hazards such as radiological. Calvert Cliffs Nuclear Power Plant is located within the Southern Region, as well as a liquid natural gas facility and two main pipelines. The presence of these facilities within the Region, pose unique planning challenges. Following the HIRA presentation and discussion, the questionnaire was discussed by the overall group. Each participant completed and submitted their forms prior to departure. Comments provided on the questionnaire with the most frequency included areas of repetitive flooding, erosion related issues, and the threats posed by the nuclear power plant, gas pipelines and the numerous hard targets located within the Region. The participant sign-in sheet along with the compiled questionnaire for the Southern Region Open House has been included.

State of Maryland All-Hazard Mitigation Plan Update
Southern Region Open House
7 July 2011

Name	Department/ Organization	Phone	Email
SUE VEITH	St. MARY'S CO DLUGM	301-475-4200 x1547	sue.veith@stmarysmd.com
JENN BALLARD	St. MARY'S County	301-475-4200 x1535	jenn.ballard@stmarysmd.com
MARY BETH COOK	CALVERT County P&Z	410-535-2348	cookmb@co.cal.md.us
Gerald Gardiner Jr.	St. Mary's Co. Public Safety	301 475 4200	gerald.gardiner@stmarysmo.com
MARK PETTIT	St. Marys Em. Services Tech	301/475-4200 2120	mpettit@stmarysMD.com
Michelle Lilly	Charles Co EmSrvs.	301-609-3429	lillym@charlescounty.org
BRIAN FICKE	CCNPP / EMER PREP.	410 495 2082	brian.ficke@cengllc.com
Bobby Fenwick	Calvert County Emerg Mgt	410 535/600 x2301	fenwicjr@co.cal.md.us
Melanie Gardiner	St. Mary's Co. Health Dept.	301 475. 4405	gardinerm@smhd.com
John Boyles	St Mary's Co. Health Dept	301 475 4295	boylesj@smhd.com
MARY LILLY	CHARLES COUNTY DEPARTMENT OF HEALTH	301. 609. 6762	MLILLY@dhmh.STATE.MD.US
Kelly McGuire	MEMA	443 865 - 9511	kmcguire@mema.state.md.us
Tom Mattingly	St Mary's Co. Public Safety	301-475-4200 ext 2121	tjr.mattingly@stmarysmd.com

July 7, 2011 QUESTIONAIRE

2011 State of Maryland All-Hazard Mitigation Plan
Southern Region Open House Meeting

Results & Comments from the 2011 Southern Region Open House Questionnaire are listed below in red.

Section I: Hazard Identification & Risk

1. **How concerned are you about the following hazards affecting your community?**

(Place an X in the corresponding column for each hazard)

Hazard Types	Extremely Concerned	Very Concerned	Concerned	Somewhat Concerned	Not Concerned
Flood	X				
High Wind			X		
Thunderstorm		X			
Wildfire				X	
Land Subsidence: Karst/Sinkholes				X	
Landslide				X	
Earthquake				X	
Winter Storm		X			
Tornado		X			
Drought			X		
Coastal	X				
Other: Shoreline Erosion	X				
Other: Sea-Level Rise		X			
Other: Upland Slope Erosion	X				
Other: Radiological/Nuclear		X	X		
Other: Gas Pipeline		X			
Other: Cliff Erosion	X				
Other: Terrorist Hard Targets (No Ranking)					

Questionnaire Page 2

2. Rationale for adding hazards above:

Comments:

- Calvert County has been experiencing severe erosion along the cliffs that are endangering existing homes;
- Radiological – Calvert Cliffs nuclear plants:
- Terrorist Hard Targets - Patuxent River, Coast Guard station at St. Indigoes, Cove Point Landing plant, Calvert Cliffs NPP, GenOn Oil pipeline are all targets of concern;
- Calvert County – we have a nuclear power plant and liquid natural gas facility and two main pipelines;
- Within 10 mile radius of Calvert Cliffs Nuclear Power Plant.

3. Why are you concerned or not concerned about particular hazard(s)? Please explain.

Comments:

- Concerned due to affects on local government & public safety;
- Concerned with anything that will affect St. Mary's County;
- Drought and Coastal Flooding – wide spread financial impact since many citizens work in vacation/fishing/farming related industries;
- Low concern is based on planning and regulation, high concern is based on preparedness of citizens;
- Shoreline erosion due to major storms affect many older communities – the soils and daily wave action result in significant risk to structures;
- Sea-level rise poses a threat to low-lying areas developed and underdeveloped – loss of marsh and riparian forest increases risk;
- Extremely erodible soils prevalent in Southern Maryland result in major gulling, down cutting, and undermining of infrastructure (roads/SWM, sewer, dwellings) just regular rain events have runoff that can result in major impacts;
- My responses were based on risk and planning needs;
- Weather – flooding, winds, severe heat/cold caused a history of large impact on St. Mary's County infrastructure (power, transportation).

Section II: Mitigation Strategies

4. Which mitigation strategies have worked well in your community or for your organization? (Please identify and explain why?)

Comments:

- Pre-planned and exercise drills;
- Public Safety web sites, Code Red (Reverse 911), Sirens, Education, Preparedness direct mailers;
- USDA/SCD/USGS – need better guidance for protection of soils with a K value of 35 or greater;
- We are beginning this process, therefore, I can not answer at this time;
- EMA coordination activities, trainings, and drills.

5. Which groups should the State work with to reduce hazard losses (please identify)?

Comments:

- Local Emergency Management and Government entities;
- Federal bases;
- NAWTC Patuxent River;

- Public Works, SMECO Power Co.;
- Private industry and citizens;
- County commissioners need to steer "political will";
- State Highway – stop putting roads below BFE;
- Planning and growth management through local emergency management;
- Floodplain residents, residents and businesses in nuclear impact zone.

6. **What is the State of Maryland doing to effectively reduce your organization's risk from hazards? (Please list any state laws, programs, policies, or regulations which help reduce your organization's vulnerability to hazards)**

Comments:

- Climate change;
- Communications protection.

7. **What should the State's mitigation priorities be?**

For the State as a whole (please explain)?

Comments:

- High wind and flood;
- Coastal hazards;
- Regulations and rules to avoid new development in areas with multiple high/ medium-high risks;
- Transportation hazards.

For the local level (please explain)?

Comments:

- Coastal flooding seems to be the most frequent and impact on the most uninsured losses;
- Coastal hazards;
- Transportation hazards;
- Weather related hazards.

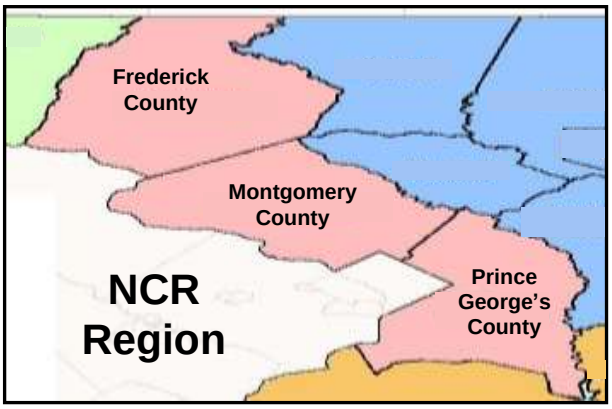
8. **Anything else you would like the State to consider pertaining to hazard mitigation?**

Comments:

- Sea Level Rise;
- Erosion of Cliffs;
- Coastal Flooding;
- Coastal flooding related to climate change and increased sea-level;
- Project idea for St. Mary's – Route 5, flat iron/Indian bridge always floods out where the St. Mary's River overbanks;
- Would like to see the state consider options for management of hazard mitigation funds. Such as management of open space projects, house raisings, and other repetitive loss structure mitigation at the state level vs. forcing counties to manage projects for citizens;
- Provide more local funding to support staff and projects.

National Capital Region Open House

Date: 20 July 2011
Time: 1:00 PM-2:30 PM
Location: Fire Service Building
6820 Webster Street
Landover Hills, MD 20784
National Capital Region Jurisdictions:
Frederick, Montgomery, Prince George's



Attendees included agency representatives as follows:

- ✓ Health Department;
- ✓ Transportation;
- ✓ American Red Cross;
- ✓ Planning Department;
- ✓ Emergency Mgt;
- ✓ Education;
- ✓ Emergency Services;
- ✓ Public Utilities.

The Open House consisted of a power-point presentation and a facilitated comment/response session. The presentation's focus was the results of the Maryland Hazard Identification and Risk Assessment (HIRA), specifically the results for Frederick, Montgomery, and Prince George's counties. The National Capital Region participants were pleased to learn that their local HIRA results had been incorporated into the scoring system utilized in the State's HIRA. However, concerns were voiced by National Capital Region participants pertaining to the differences between the State hazard ranking scale and the local hazard ranking scales. For instance, the State hazard ranking scale includes medium-high and medium-low, whereas some of the local hazard ranking scales do not include these two categories. Participants expressed that going forward the State may want to provide some recommendations/guidelines to facilitate improved cohesion and linkages between the State and local plans. Following the HIRA presentation and discussion, the questionnaire was discussed by the overall group. Each participant completed and submitted their forms prior to departure. Comments provided on the questionnaire with the most frequency included the identification of additional hazards in the Maryland HIRA and problems resulting from mass power outages.

State of Maryland All-Hazard Mitigation Plan Update
NCR Region Open House
20 July 2011

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State of Maryland All-Hazard Mitigation Plan Update
NCR Region Open House
20 July 2011

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July 20, 2011 QUESTIONAIRE

2011 State of Maryland All-Hazard Mitigation Plan
National Capital Region Open House Meeting

Responses & Comments from the 2011 National Capital Region Open House Questionnaire are listed below in red.

Section I: Hazard Identification & Risk

1. **How concerned are you about the following hazards affecting your community?**

(Place an X in the corresponding column for each hazard)

Hazard Types	Extremely Concerned	Very Concerned	Concerned	Somewhat Concerned	Not Concerned
Flood		X			
High Wind		X			
Thunderstorm		X			
Wildfire			X		
Land Subsidence: Karst/Sinkholes			X		
Landslide				X	
Earthquake					X
Winter Storm		X			
Tornado		X			
Drought				X	
Coastal					X
Other: Major Fire					
Other: Power Outage					
Other: Hurricane					
Other: Crime/Active Shooter					
Other: Dam Failure					
Other: Public Health					
Other: Special Events					
Other: HazMat/Chemical					

Questionnaire Page 2

2. Rationale for adding hazards above:

Comments:

- In recent years, the fragile power system has extended many of these emergencies for beyond the length of time;
- MC Costumer Service receives many calls from public about power outage and chemical hazards seeking assistance;
- PEPCO-power outages;
- MC has house fires on a daily basis;
- Weapons have been seized on Bowie State University;
- Dam failure is classified statewide and should be scored;
- PG County is a very densely populated. Therefore, dealing with an emergency will quickly be overwhelmed with the population demand;
- Power outages affect all of the region and require MCDOT assistance;
- CSX trains through the City of Bowie and two large interstate highways with hazardous materials carriers.

3. Why are you concerned or not concerned about particular hazard(s)? Please explain.

Comments:

- Power outages can create security risks to community, etc;
- The PG jail sits on what is/and was wetlands. Land settling/sinking a major concern and is already present;(mentioned twice)
- High winds and how PEPCO and BGE respond to outages;
- There are particular incidents of greater concern due to unique circumstances. For example, in Montgomery County winter and thunderstorms are greater concerns because of poor electrical reliability;
- Guns and drugs in schools;
- Public Works-clean-up of hazards and maintaining infrastructure;
- The need to supply electrical service;
- Emergency preparedness;
- Flood-PG county maintains six levees that feed into the Anacostia River and has an extremely high amount of impervious surfaces;
- Winter storms in PG County are not as big of a concern as we effectively handle them as they come. Not much you can do to mitigate;
- Severe winter storms and high winds can make the region impassable, affecting life and property and negatively impacting local economy;
- Drought-no farming; served by two water systems;
- Flood-few floodplains that affect homes/interstate;
- Not many landslides or sinkholes. Concerned about wildfires and storms because of sometimes inability to plan long-range since they're all different.

Section II: Mitigation Strategies

4. Which mitigation strategies have worked well in your community or for your organization? (Please identify and explain why?)

Comments:

- Public relations;

- PG County has done a lot of work over the last ten years to update pumping stations, generators, etc. The county is also doing a lot of work with MDE to decrease imperious surfaces;
- Relocation and stream improvement;
- Having a plan in place on the local level has been instrumental in helping the county react when a hazard occurs;
- Well established Emergency Preparedness Plan has served well;
- PEPCO has an annual corporate wide disaster exercise and action meeting after to evaluate our response practices;
- Full-time planning department works with county planning for reference development, roads, public safety response and codes.

5. Which groups should the State work with to reduce hazard losses (please identify)?

Comments:

- FEMA, MEMA, Red Cross, National Guard, Public Safety, Public Works and Transportation;
- Continue MEMA outreach to local emergency managers and elected/appointed officials;
- MC Homeland Security, MCDOT;
- In MC-emergency management group;
- Bradford pear tree replacement program;
- Local governments, emergency managers, public safety, public works;
- Local municipalities, Non-profit agencies, Red Cross, HHS agencies and churches;
- Public safety, Universities, Arenas, Hotels, Educational, Public Works, Hospitals, Parks Service, Military, Health Department, IT;
- Utilities – their performance impacts state/local performance. Greater oversight needs to occur.

6. What is the State of Maryland doing to effectively reduce your organization's risk from hazards? (Please list any state laws, programs, policies, or regulations which help reduce your organization's vulnerability to hazards)

Comments:

- Provides funding for improvement projects at facility Capital Improvement Plan;
- EPA, MDE, NPDES permits, guidelines, etc. being more strictly enforced;
- HIRA, DMA, COOP, Operation Plans;
- Building codes and dam regulations;
- Making grant money available to mitigate hazards;
- Enforcing state regulations for back-up generators and critical care facilities, most facilities can not supply the building's need due to lack of generator capacity;
- Require that all UMD schools have a workable emergency management plan;
- More regulation of the Utility Companies-especially PEPCO;
- State's use of MEMA to train cities, groups, individuals is productive.

7. What should the State's mitigation priorities be?

For the State as a whole (please explain)?

Comments:

- Do utilities such as PEPCO get captured?;
- Infrastructure-electrical poles, tree replacements, housing, utility lines;

- More local input into state mitigation plan;
- Safety of citizens and first responders. Returning to "normal' operations.

For the local level (please explain)?

Comments:

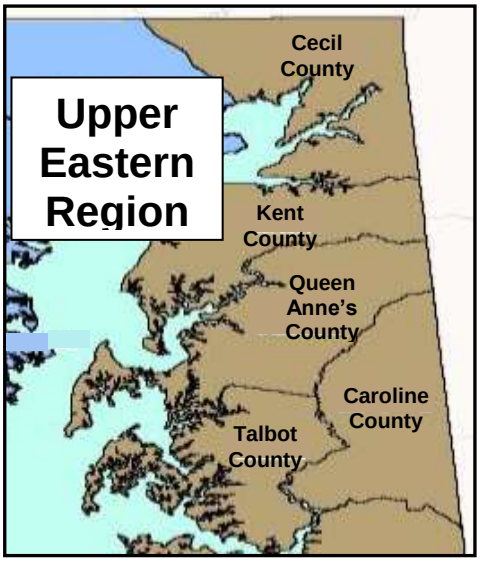
- Disappointed in SHA's efforts to upgrade roadway infrastructure in a timely basis;
- Do utilities such as PEPCO get captured?;
- Flooding, snow removal, thunderstorms, tornados.

8. Anything else you would like the State to consider pertaining to hazard mitigation?

Comments:

- The calculated annual loss is not accurate. While I recognize the difficulty of assessing losses from sub-disaster declaration events, these calculations are of no value and yet they impact the scale;
- State effort to follow up on local data (MDE?) emergency plans lacking;
- The state needs to encourage the electrical utilities to better prepare for outages due to storms;
- Help identify funding to be more proactive;
- I am concerned about the grouping of coastal hazards except wind. I think we should try and set the categories of types of hazards and possibly the scale statewide;
- The population ranking should be re-evaluated due to lager jurisdictions getting higher rankings based on population;
- Better data capture for high frequency, lower impact events (i.e. thunderstorms). Minor storms add up, but will not capture the scrutiny of a tornado.

Upper Eastern Region Open House



Date: 26 July 2011
Time: 10:00 AM-11:30 AM
Location: Maryland Fire and Rescue Institute
Upper Eastern Shore Regional Training Center
601 Safety Drive
Centreville, MD 21617
Upper Eastern Region Jurisdictions:
Cecil, Kent, Queen Anne's, Caroline, Talbot

Attendees included agency representatives as follows:

- ✓ Health Department;
- ✓ Transportation;
- ✓ American Red Cross;
- ✓ Planning Department;
- ✓ Emergency Mgt;
- ✓ Chamber of Commerce;
- ✓ Emergency Services.

The Open House consisted of a power-point presentation and a facilitated comment/response session. The presentation's focus was the results of the Maryland Hazard Identification and Risk Assessment (HIRA), specifically the results for Cecil, Kent, Queen Anne's, Caroline and Talbot counties. The Upper Eastern Region participants were pleased to learn that their local HIRA results had been incorporated into the scoring system utilized in the State's HIRA. However, concerns were voiced by participants pertaining to the differences between the State's identified hazards and the hazards identified at the local level. The previous versions of the Maryland Hazard Mitigation Plan identified many more hazards and did not group hazards. For instance, the State's previous HIRA identified Thunderstorm, Wind, Hurricane/Tropical Storm, and Tidal/Coastal Flooding separately. Participants expressed that going forward the State may want to provide some recommendations/guidelines to facilitate improved cohesion and linkages between the State and local plans. Following the HIRA presentation and discussion, the questionnaire was discussed by the overall group. Each participant completed and submitted their forms prior to departure. Comments provided on the questionnaire with the most frequency included the identification of additional hazards in the Maryland HIRA and problems resulting from repetitive flooding.

State of Maryland All-Hazard Mitigation Plan Update
Upper Eastern Region Open House
26 July 2011

Name	Department/ Organization	Phone	Email
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July 26, 2011 QUESTIONAIRE

2011 State of Maryland All-Hazard Mitigation Plan
Upper Eastern Regional Open House Meeting

Responses & Comments from the 2011 Upper Eastern Region Open House Questionnaire are listed below in red.

Section I: Hazard Identification & Risk

1. **How concerned are you about the following hazards affecting your community?**

(Place an X in the corresponding column for each hazard)

Hazard Types	Extremely Concerned	Very Concerned	Concerned	Somewhat Concerned	Not Concerned
Flood	X				
High Wind		X			
Thunderstorm		X			
Wildfire				X	
Land Subsidence: Karst/Sinkholes				X	
Landslide					X
Earthquake					X
Winter Storm		X			
Tornado		X			
Drought		X			
Coastal		X			
Other: Fire (Single Family & Multi-family)					
Other: Power Outage					
Other: Hurricane/ Nor'easter					
Other: Technological Failure					
Other: Dam Failure					
Other: Radiological					
Other: Transportation Accident					
Other: HazMat					

Questionnaire Page 2

2. **Rationale for adding hazards above:**

Comments:

- Queen Anne's – extremely prone to flooding
- Add HazMats due to massive quantity of HazMats
- Transportation Accidents – interstate, rail and air
- Radiological – Peach Bottom
- Dam Failure – High/Significant Hazard ranked dams
- Red Cross is concerned with meeting immediate emergency needs
- Power Outages create need to support vulnerable populations and power to critical facilities and functions
- Very concerned about riverine flooding
- Kent Co. – lack of personnel in main agencies which are needed during an event to adequately cover the County

3. **Why are you concerned or not concerned about particular hazard(s)? Please explain.**

Comments:

- Talbot Co. – 600+ miles of shoreline
- Queen Anne's Co. – 260 miles of shoreline
- Concern of road flooding which cause businesses to close
- Floods – same roads close all the time (usually closed for several days)
- Drought/Winter Storm – elderly
- Raise Winter Storm hazard ranking on Eastern Shore
- Earthquake and landslide is not a major concern
- Caroline Co. – can become an island, all routes around the County have been flooded
- Power Outages
- Queen Anne's Co. have several areas that are flooded or become small islands during rain events
- Lack of back-up/redundancy with utilities

Other comments you would like to make:

Comments:

- Blizzard impact is severe; snow drifts, power outages, isolates small towns
- Queen Anne's Co. – has very limited resources, no hospital
- Bridge closures with high winds
- Isolated portions of the population

Section II: Mitigation Strategies

4. **Which mitigation strategies have worked well in your community or for your organization? (Please identify and explain why?)**

Comments:

- Dutchman's Lane, Easton/Bottomless Culvert – project to reduce road flooding
- House elevation
- Adopting new building/development/open space/erosion codes and ordinances
- Preplanning/training
- Federalsburg-Barrier Rocks project – acquisition project
- Stream bank stabilization

July 26, 2011 QUESTIONAIRE

- Conservation Easements specifically in coastal areas – shorelines

5. Which groups should the State work with to reduce hazard losses (please identify)?

Comments:

- Planning and Zoning, Public Works & EM
- Local Agencies
- EMS, Public Works, Local Communities
- EMS, Law Enforcement, Public Works
- Local and Municipal agencies
- County Departments and Municipalities
- Push for more preservation in the coastal zones
- Local government agencies and departments
- MACO/MML

6. What is the State of Maryland doing to effectively reduce your organization's risk from hazards? (Please list any state laws, programs, policies, or regulations which help reduce your organization's vulnerability to hazards)

Comments:

- Assistance from MD MEMA SHMO has been excellent
- Communication has improved specific to mitigation
- Information sharing and warnings

7. What should the State's mitigation priorities be?

For the State as a whole (please explain)?

Comments:

- Increase capacity of highway system – another way of crossing the Bay
- Communication with local jurisdictions
- Flood mitigation along with prioritize of mitigation projects and funding
- Snow emergencies, wind and flooding
- Planning to keep people closer to where they work – leads to less infrastructure that would be impacted by natural hazards
- Reduce repetitive losses

For the local level (please explain)?

Comments:

- Assistance with vulnerable properties
- Generators in local shelters
- Generators

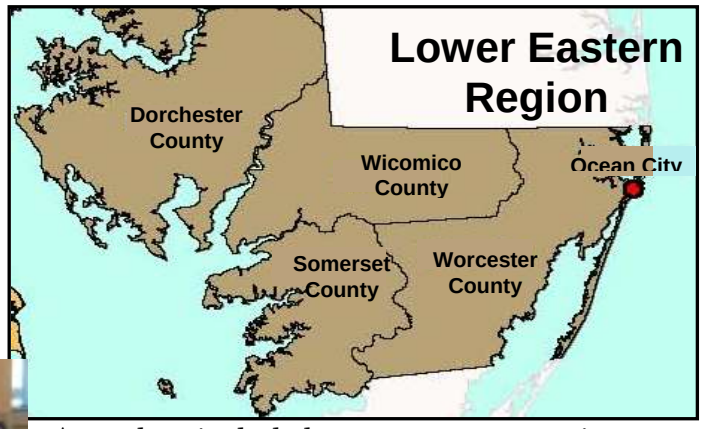
8. Anything else you would like the State to consider pertaining to hazard mitigation?

Comments:

- Evacuation routes along Route 50/30 corridor during peak tourist season
- Generators
- Creating/recreating barrier islands on the coast
- Deal with Conowingo Dam – the sediment and bay shore erosion issues that the dam causes

Questionnaire Page 4

Lower Eastern Region Open House



Date: 27 July 2011
Time: 10:00 AM-11:30 AM
Location: Wor-Wic Community College
32000 Campus Drive
Salisbury, MD 21804
Lower Eastern Region Jurisdictions:
Dorchester, Wicomico, Somerset, Worcester

Attendees included agency representatives as follows:

- ✓ Health Department;
- ✓ Transportation;
- ✓ American Red Cross;
- ✓ Planning Department;
- ✓ Emergency Mgt;
- ✓ Education;
- ✓ Emergency Services;
- ✓ Municipalities;
- ✓ Public Utilities.

The Open House consisted of a power-point presentation and a facilitated comment/response session. The presentation's focus was the results of the Maryland Hazard Identification and Risk Assessment (HIRA), specifically the results for Dorchester, Wicomico, Somerset, and Worcester counties. The Lower Eastern Region participants were pleased to learn that their local HIRA results had been incorporated into the scoring system utilized in the State's HIRA. However, concerns were voiced by participants pertaining to the differences between the State HIRA and the local HIRA. For instance, the State's identified hazards and criteria for ranking hazards differed from the local HIRA's. Participants expressed that going forward the State may want to provide some recommendations/guidelines to facilitate improved cohesion and linkages between the State and local plans. Additionally, Ocean City and Worcester Counties questioned the lack of distinction for Ocean City, which has always developed their own plan and is recognized by MEMA as a separate jurisdiction. Following the HIRA presentation and discussion, the questionnaire was discussed by the overall group. Each participant completed and submitted their forms prior to departure. Comments provided on the questionnaire with the most frequency included the identification of additional hazards in the Maryland HIRA and problems resulting from seasonal population surge.

State of Maryland All-Hazard Mitigation Plan Update
Lower Eastern Region Open House
27 July 2011

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State of Maryland All-Hazard Mitigation Plan Update
Lower Eastern Region Open House
27 July 2011

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July 27, 2011 QUESTIONAIRE

2011 State of Maryland All-Hazard Mitigation Plan
Lower Eastern Regional Open House Meeting

Responses & Comments from the 2011 Lower Eastern Region Open House Questionnaire are listed below in red.

Section I: Hazard Identification & Risk

1. **How concerned are you about the following hazards affecting your community?**

(Place an X in the corresponding column for each hazard)

Hazard Types	Extremely Concerned	Very Concerned	Concerned	Somewhat Concerned	Not Concerned
Flood	X				
High Wind		X			
Thunderstorm		X			
Wildfire			X		
Land Subsidence: Karst/Sinkholes				X	
Landslide					X
Earthquake					X
Winter Storm	X				
Tornado			X		
Drought			X		
Coastal		X			
Other: Terrorism					
Other: Nor'easter					
Other: Radiological					
Other: HazMat Transportation					

2. **Rationale for adding hazards above:**

Comments:

- **High population concentrations**
- **Limited ingress/egress for Ocean City - 2 bridges**
- **Terrorism – targets: population centers**
- **Tornado – water spout over water**
- **Dorchester Co. – proximity to Calvert Cliffs Nuclear Power Plant**

Questionnaire Page 2

- Flooding during thunderstorms
- Repetitive flooding in City of Salisbury
- Daily transportation of fuel

3. Why are you concerned or not concerned about particular hazard(s)? Please explain.

Comments:

- Ocean City – seasonal tourist destination; housing values; structures built prior to codes
- Impact on school system
- Worcester Co. – flooding and coastal issues; large number of canals and streams inside of communities
- Safe and effective evacuation routes
- Coastal community population density change due to seasonal population – should be factored into HIRA scoring system
- Flooding impacts public transportation

Other comments you would like to make:

Comments:

- Use of schools as shelters
- Wildfires in Worcester Co. expected risk ranking to be higher due to density of forest in central portion of the County
- Winter Storms are becoming more frequent and severe
- Coastal category is covering too many types of hazards; Nor'easters and Hurricanes
- High Winds

Section II: Mitigation Strategies

4. Which mitigation strategies have worked well in your community or for your organization? (Please identify and explain why?)

Comments:

- Code Enforcement
- Ocean City – Dune Protection
- Public Outreach
- Stormwater Management
- Interoperability between county schools, first responders and public works
- Acquisition of repetitive loss properties
- House elevations
- Agency meetings and preplanning
- Preparedness planning with partners
- Elevation Projects
- Improvements to highway/road way drainage
- Clearing storm drains prior to major storm event
- Public Information

5. Which groups should the State work with to reduce hazard losses (please identify)?

Comments:

- Public Works, EM and Planning
- County Commissioners and Planning Commissioners

- County Roads
- Power Companies
- DNR and Army Core of Engineers

6. What is the State of Maryland doing to effectively reduce your organization's risk from hazards? (Please list any state laws, programs, policies, or regulations which help reduce your organization's vulnerability to hazards)

Comments:

- Coastal Bay Critical Area Program
- New Misc. Utility Law
- Hurricane Evacuation Plan
- Private Companies

7. What should the State's mitigation priorities be?

For the State as a whole (please explain)?

Comments:

- Ensuring evacuation routes are sufficient
- Review issues with State Roads in the counties
- Coastal Flooding
- Financial assistance for coastal municipalities
- Standardization between State and Local HIRA

For the local level (please explain)?

Comments:

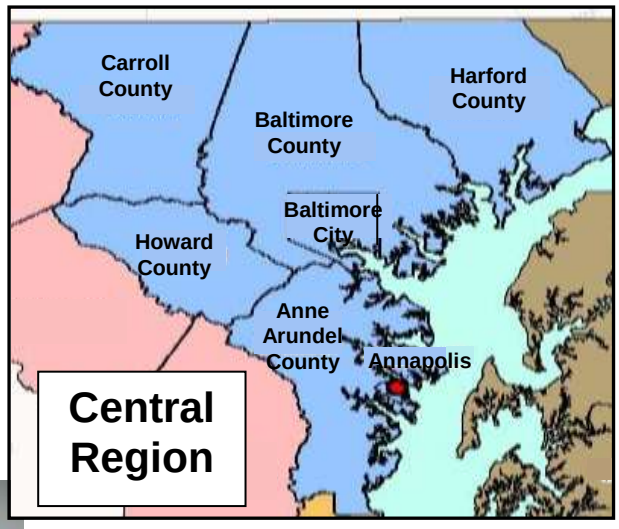
- Provide templates for various mitigation projects
- Coastal Flooding

8. Anything else you would like the State to consider pertaining to hazard mitigation?

Comments:

- Use of same point system in assessing risk for every county, region and hazard
- Bay – Smith Island
- Population density changes in Worcester Co. due to seasonal population
- How is Worcester Co. a 'Low Risk' for Wind, would have expected this to be a 'High Risk'
- Drought and Wildfires in Somerset Co.
- Winter Storm loss prevention
- Winter Storm – road icing
- Completion of additional mitigation projects; do not require a local match

Central Region Open House



Date: 28 July 2011
Time: 10:00 AM-11:30 AM
Location: Baltimore County Public Safety
700 East Joppa Road
Towson, MD 21286
Central Region Jurisdictions:
Carroll, Baltimore, Harford, Howard, Baltimore City, Anne Arundel

Attendees included agency representatives as follows:

- ✓ Transportation;
- ✓ Emergency Mgt;
- ✓ Emergency Services;
- ✓ Public Works.

The Open House consisted of a power-point presentation and a facilitated comment/response session. The presentation's focus was the results of the Maryland Hazard Identification and Risk Assessment (HIRA), specifically the results for Carroll, Baltimore, Harford, Howard, Baltimore City, and Anne Arundel counties. The Central Region participants were pleased to learn that their local HIRA results had been incorporated into the scoring system utilized in the State's HIRA. However, concerns were voiced by Central Region participants pertaining to the differences between the State hazard ranking scale and the local hazard ranking scales. Participants expressed that going forward the State may want to provide some recommendations/guidelines to facilitate improved cohesion and linkages between the State and local plans. Additionally, City of Annapolis questioned the lack of distinction for their jurisdiction from Anne Arundel County, considering that the City develops their own plan and is recognized by MEMA as a separate jurisdiction. Following the HIRA presentation and discussion, the questionnaire was discussed by the overall group. Each participant completed and submitted their forms prior to departure. Comments provided on the questionnaire with the most frequency included problems with public utilities and the need for additional hazard mitigation planning guidance from the State for future planning cohesiveness between the State and local plans.

State of Maryland All-Hazard Mitigation Plan Update
Central Region Open House
28 July 2011

Name	Department/ Organization	Phone	Email
Terry Curtis	Balt. Co. DPW Storm Drains	410 887 3711	tcurtis@baltimore countymd.gov
Matthew Almes	AACPS	410-360-0138	malmes@aacps.org
Dan Cornwell	Ho Co OEM	301-674-5324	dcornwell@howardcountymd.gov
Mark Hubbard	Balto County OEM	410-887-8114	mhubbard@baltimorecountymd.gov
Steve Welzant	Balto. County OEM	410 887 5996	swelzant@baltimorecountymd.gov
John E. Dulena	MEMA	443 865 8638	JDULENA@MEMA.STATE.MD.US
Dave Mandell	Annapolis OEM	410 216 9167	dsmandell@annapolis.gov
David McMillan	Baltimore City Emergency Management	410 396 6188	david.mcmillan@baltimorecity.gov
Bob Yatsuk	AACPS	410-222-5083	ryatsuk@aacps.org
Jay Ringgold	Balt. Co. OEM	410-887-5996	JRINGGOLD@BALTIMORECOUNTYMD.GOV
Mark Ewers	Balto Co OEM	410-887-2275	mewers@baltimorecountymd.gov

July 28, 2011 QUESTIONAIRE

2011 State of Maryland All-Hazard Mitigation Plan
Central Regional Open House Meeting

Responses & Comments from the 2011 Central Region Open House Questionnaire are listed below in red.

Section I: Hazard Identification & Risk

1. **How concerned are you about the following hazards affecting your community?**

(Place an X in the corresponding column for each hazard)

Hazard Types	Extremely Concerned	Very Concerned	Concerned	Somewhat Concerned	Not Concerned
Flood		X			
High Wind		X			
Thunderstorm	X				
Wildfire				X	
Land Subsidence: Karst/Sinkholes				X	
Landslide					X
Earthquake				X	
Winter Storm		X			
Tornado		X			
Drought				X	
Coastal	X				
Other: Heat Wave					
Other: Utility Failure					
Other: Man-made Hazards					

2. **Rationale for adding hazards above:**

Comments:

- Extreme Heat caused nine (9) deaths in MD this summer alone
- Frequency and severity of recent events
- Extreme Heat temperatures

3. **Why are you concerned or not concerned about particular hazard(s)? Please explain.**

Comments:

- Power Failure & Wind – frequency of recent events and impacts

Questionnaire Page 2

- High winds may affect multiple level structures and utilities

Other comments you would like to make:

Comments:

- Why not include Extreme Heat
- Impacts from future hazard events will be greater due to population growth and development

Section II: Mitigation Strategies

4. Which mitigation strategies have worked well in your community or for your organization? (Please identify and explain why?)

Comments:

- Home elevation
- Culvert cleaning
- Road surface – pre-treat for winter storm
- Elevation
- Stormwater Management Program
- Enforcement of regulations
- Baltimore Co. building codes require new construction to be 2 feet above BFE

5. Which groups should the State work with to reduce hazard losses (please identify)?

Comments:

- EM, First Responders, Public Works and Utility Companies
- Coastal residents and high risk facilities
- EM, Public Works and Schools
- Developers
- Citizens – they do not seem to understand their impact

6. What is the State of Maryland doing to effectively reduce your organization's risk from hazards? (Please list any state laws, programs, policies, or regulations which help reduce your organization's vulnerability to hazards)

Comments:

- Publicize Hazard Mitigation Plan to increase awareness
- Need mitigation planning team
- Need planning process guidance/template similar to PA
- Mitigation grants and technical assistance

7. What should the State's mitigation priorities be?

For the State as a whole (please explain)?

Comments:

- Critical Infrastructure
- Utilities and aging infrastructure
- Curb development explosion in Ocean City
- Address repetitive loss properties/areas
- Flooding and coastal

For the local level (please explain)?

Comments:

- Severe Weather
- Power/ Water Supply, Failure
- Flooding and coastal

8. Anything else you would like the State to consider pertaining to hazard mitigation?

Comments:

- Dams – almost all dams in MD are over 50 years old

Why Plan?

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What is the Purpose of "Open Houses"?

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Central Region Open House
July 28, 2011

Who Should Attend?

Potential attendees include a cross-section of organizations with an interest in hazard mitigation, and are as follows:

- Public Officials
- Local Emergency Managers
- Fire & Rescue
- Local Planners
- Local Transportation
- Local Public Works
- Local Schools
- Local Utilities
- Architects and Engineers
- American Red Cross
- Business Continuity Planners
- Hazard Experts from State and Federal Agencies
- SHA District Office Staff
- Colleges and Universities
- Non-profit Organizations
- Businesses

Meeting Agenda

July 28, 2011 10:00 AM

Welcome/Why Are We Here?

What is Hazard Mitigation? Why Plan?

(Discussion of the linkages between the State and the Local Plans)

What are the State's Hazards of Concern?

(Overview of the State's **H**azard **I**dentification and **R**isk **A**ssessment (HIRA) results, specifically Regional results)

Hazard Mitigation Strategies

Questionnaire

Where Do We Go From Here?

PLANNING FOR TODAY AND TOMORROW

Questions regarding the "Open House" please contact Linda Ploener at Harford County Division of Emergency Operations

Linda Ploener, Emergency Planner
Phone: 410-638-4029

Come and Join Us!

Open House

Date: July 28, 2011

Time: 10:00 AM

Location:

Baltimore County

Public Safety Building

4th Floor Conference Room

700 East Joppa Road

Towson, MD 21286

DIRECTIONS:

Directions for Carroll County:

- Traveling **South** on **I-795** toward **Owings Mill/Baltimore**
- Merge onto **I-695 East/Baltimore Beltway Inner Loop** via **Exit 1A** on the **Left** toward **Towson**
- Merge onto **Dulaney Valley Road/MD-146 South** via **Exit 27** toward **Towson**
- Turn **Left** onto **Fairmount Avenue**
- Turn **Slight Right** to stay on **Fairmount Avenue**
- Turn **Left** onto **East Joppa Road**
- Arrive at **700 East Joppa Road** on the **Left**

Directions for Hartford County:

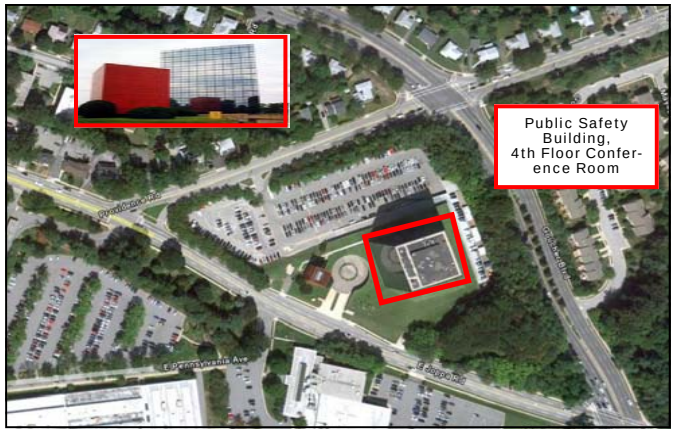
- Follow **US-1 South**
- Take the **White Marsh Blvd/MD-43** ramp toward **I-695 West**
- Keep **Right** at the fork to go on **MD-43 West/White Marsh Blvd**
- Merge onto **I-695 West/Baltimore Beltway Outer Loop**
- Take **Exit 28**, **Providence Road**
- Take ramp toward **Towson**
- Turn **Slight Right** onto **Providence Road**
- Turn **Left** onto **East Joppa Road**
- Arrive at **700 East Joppa Road** on the **Left**

Directions for Howard County:

- Traveling on US-29 North/Columbia Pike
- Merge onto I-70 East via Exit 25A toward Baltimore
- Merge onto I-695 North/Baltimore Beltway Inner Loop via Exit 91B toward New York/I-95 North/Towson
- Merge onto **Dulaney Valley Road/MD-146 South** via **Exit 27** toward **Towson**
- Turn **Left** onto **Fairmount Avenue**
- Turn **Slight Right** to stay on **Fairmount Avenue**
- Turn **Left** onto **East Joppa Road**
- Arrive at **700 East Joppa Road** on the **Left**

Directions for Anne Arundel County, Baltimore City & City of Annapolis:

- Follow **I-97 North** toward **Baltimore**
- Take exit **Left** toward **I-895 North/Baltimore Harbor/Tunnel Thruway**
- Take the **I-895 North** exit on the **Left** toward **Baltimore Harbor**
- Merge onto **I-895 Spur North**
- **I-895 Spur North** becomes **I-895 North/Harbor Tunnel TRWY**
- **I-895 North/Harbor Tunnel TRWY** becomes **I-95 North**
- Merge onto **I-695 West/Baltimore Beltway Inner Loop** via **Exit 64** toward **Towson**
- Take **Exit 28**, **Providence Road**
- Take ramp toward **Towson**
- Turn **Slight Right** onto **Providence Road**
- Turn **Left** onto **East Joppa Road**
- Arrive at **700 East Joppa Road** on the **Left**



STATE OF MARYLAND

2011 All-Hazard Mitigation Plan Update

Come Join Us!

PLANNING FOR TODAY AND TOMORROW

Come and Join Us!

Open House

Date: July 27, 2011

Time: 10:00 AM

Location:

WOR-WIC

Community College

Student Center, Room 302

32000 Campus Drive

Salisbury, MD 21804

DIRECTIONS:

Directions from the West:

- Traveling **East** on **Route 50**, approaching **Salisbury**
- Take the **Route 50 bypass** toward Ocean City
- Exit at the **Route 50 East** to **Ocean City ramp**
- Turn **Right** at the **Second** stoplight at **Walston Switch Road**
- The Next **Left** turn is the entrance to the campus

Directions from the East

- Traveling **West** on **Route 50**, go past the signs for Willards, Pittsville and Parsonsburg until you see the signs for the college and **Waltston Switch Road**
- Turn **Left** onto **Walston Switch Road**
- The Next **Left** turn is the entrance to the campus

Directions from the North:

- Traveling **South** on **Route 13**, approaching **Salisbury**
- Take the **Route 13 bypass** toward Norfolk
- Exit at the **Route 50 East** to **Ocean City ramp**
- Turn **Right** at the **Second** stoplight at **Walston Switch Road**
- The Next **Left** turn is the entrance to the campus

Directions from the South:

- Traveling **North** on **Route 13**, approaching **Salisbury**
- Take the **Route 13 bypass** toward Dover
- Exit at the **Route 50 East** to **Ocean City ramp**
- Turn **Right** at the Second stoplight at **Walston Switch Road**
- The Next **Left** turn is the entrance to the campus

STATE OF MARYLAND

2011 All-Hazard Mitigation Plan Update

Come Join Us!

PLANNING FOR TODAY AND TOMORROW

Why Plan?

The Disaster Mitigation Act of 2000 (DMA 2000) is legislation aimed at improving the hazard mitigation planning process. This legislation reinforces the importance of mitigation planning and emphasizes planning for disasters before they occur.

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DMA 2000 is intended to facilitate cooperation between state and local authorities. It encourages and rewards local, tribal, and state pre-disaster planning and promotes sustainability as a strategy for disaster resistance.

What is the Purpose of "Open Houses"?

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Lower Shore/Eastern Region Open House
July 27, 2011

Who Should Attend?

Potential attendees include a cross-section of organizations with an interest in hazard mitigation, and are as follows:

- Public Officials
- Local Emergency Managers
- Fire & Rescue
- Local Planners
- Local Transportation
- Local Public Works
- Local Schools
- Local Utilities
- Architects and Engineers
- American Red Cross
- Business Continuity Planners
- Hazard Experts from State and Federal Agencies
- SHA District Office Staff
- Colleges and Universities
- Non-profit Organizations
- Businesses

Meeting Agenda

July 27, 2011 10:00 AM

Welcome/Why Are We Here?

What is Hazard Mitigation? Why Plan?
(Discussion of the linkages between the State and the Local Plans)

What are the State's Hazards of Concern?
(Overview of the State's **H**azard **I**dentification and **R**isk **A**ssessment (HIRA) results, specifically Regional results)

Hazard Mitigation Strategies

Questionnaire

Where Do We Go From Here?

PLANNING FOR TODAY AND TOMORROW

Questions regarding the "Open House" please contact David Shipley at Wicomico County Department of Emergency Services

Dave Shipley, Assistant Director
Phone: 410-548-4809

Come and Join Us!

Open House

Date: July 20, 2011

Time: 1:00 PM

Location:

Fire Service Building

6820 Webster Street

Landover Hills, MD 20784

DIRECTIONS:

Directions for Frederick and Montgomery Counties:

- Follow **I-270** south toward Washington
  — Frederick: go 33 mi.
  — Montgomery: go 11.1 mi.
- I-270 becomes **I-495 east/Capital Beltway/I-495 Innerloop** - go 15.7 mi.
- Take **Exit 20B**, **MD-450 west** toward **Bladensburg**
- Take a slight right onto **Annapolis Road/MD-450 west** - go 2 mi.
- Turn Right onto **68 Avenue**
- Turn Right onto **Webster Street**
- Arrive at **6820 Webster Street** on the Left

Directions for Southern Prince George's County:

- Follow **I-495 north/I-95 north/Capital Beltway/I-495 Outerloop** toward **Baltimore/College Park**- go 11.2 mi.
- Take **Exit 19B** onto **US-50 west** toward **Washington**
- Take **Exit 5** onto **MD-410 west/Annapolis Road**
- Turn Right onto **68 Avenue**
- Turn Right onto **Webster Street**
- Arrive at **6820 Webster Street** on the Left

STATE OF MARYLAND

2011 All-Hazard Mitigation Plan Update

Come Join Us!

PLANNING FOR TODAY AND TOMORROW

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NRC Region Open House
July 20, 2011

Who Should Attend?

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- Public Officials
- Local Emergency Managers
- Fire & Rescue
- Local Planners
- Local Transportation
- Local Public Works
- Local Schools
- Local Utilities
- Architects and Engineers
- American Red Cross
- Business Continuity Planners
- Hazard Experts from State and Federal Agencies
- SHA District Office Staff
- Colleges and Universities
- Non-profit Organizations
- Businesses

Meeting Agenda

July 20, 2011 1:00 PM

Welcome/Why Are We Here?

What is Hazard Mitigation? Why Plan?

(Discussion of the linkages between the State and the Local Plans)

What are the State's Hazards of Concern?

(Overview of the State's **H**azard **I**dentification and **R**isk **A**ssessment (HIRA) results, specifically Regional results)

Hazard Mitigation Strategies

Questionnaire

Where Do We Go From Here?

PLANNING FOR TODAY AND TOMORROW

Questions regarding the "Open House" please contact Reggie Parks at Prince Georges County Office of Emergency Management

Reggie Parks, Emergency Manager
Phone: 301-833-3308

Come and Join Us!

Open House

Date: July 7, 2011

Time: 11:00 AM

Location:

Constellation Energy

Joint Information Center

100 Skipjack Road

Prince Frederick, MD 20678

DIRECTIONS:

Directions North of Prince Frederick (in Calvert County):

- Follow Route 4 south to Prince Frederick, MD.
- Turn Right on **HALLOWING POINT RD/MD-231 (**intersection at ***Prince Frederick Ford Dealership)*** - go 4 mi.
- Turn Right on **SKIPJACK RD** - go 0.1 mi (Calvert County Industrial Park)
- Arrive at **100 SKIPJACK RD** on the Left

Directions South of Prince Frederick (in Calvert County):

- Follow Route 4 north to Prince Frederick , MD
- Turn Left on **HALLOWING POINT RD/MD-231 (**intersection at ***Prince Frederick Ford Dealership)*** - go 4 mi.
- Turn Right on **SKIPJACK RD** - go 0.1 mi (Calvert County Industrial Park)
- Arrive at **100 SKIPJACK RD** on the Left

Directions East of Prince Frederick:

- Follow **Prince Frederick RD/MD-231** east
- Continue on **HALLOWING POINT RD/MD-231 (**intersection at ***Prince Frederick Ford Dealership)*** - go 4 mi.
- Turn Left on **SKIPJACK RD** - go 0.1 mi (Calvert County Industrial Park)
- Arrive at **100 SKIPJACK RD** on the Left

Directions South of Prince Frederick (in St. Mary's County):

- Follow Route 5 north to Prince Frederick , MD
- Turn Right on **HALLOWING POINT RD/MD-231 (**intersection at ***Prince Frederick Ford Dealership)*** - go 4 mi.
- Turn Left on **SKIPJACK RD** - go 0.1 mi (Calvert County Industrial Park)
- Arrive at **100 SKIPJACK RD** on the Left

STATE OF MARYLAND

2011 All-Hazard Mitigation Plan Update

Come Join Us!

PLANNING FOR TODAY AND TOMORROW

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Southern Region Open House
July 7, 2011

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Meeting Agenda

July 7, 2011 11:00 AM

Welcome/Why Are We Here?

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(Overview of the State's **H**azard **I**dentification and **R**isk **A**ssessment (HIRA) results, specifically Regional results)

Hazard Mitigation Strategies

Questionnaire

Where Do We Go From Here?

PLANNING FOR TODAY AND TOMORROW

Questions regarding the "Open House" please contact John Robert Fenwick at Calvert County Dept. of Public Safety.

Bobby Fenwick, Division Chief
Phone: 410-535-1600

Come and Join Us!

Open House

Date: July 26, 2011

Time: 10:00 AM

Location:

Upper Eastern Shore

Regional Training Center

601 Safety Drive

Centreville, MD 21617

DIRECTIONS:

Directions for Cecil & Kent Counties:

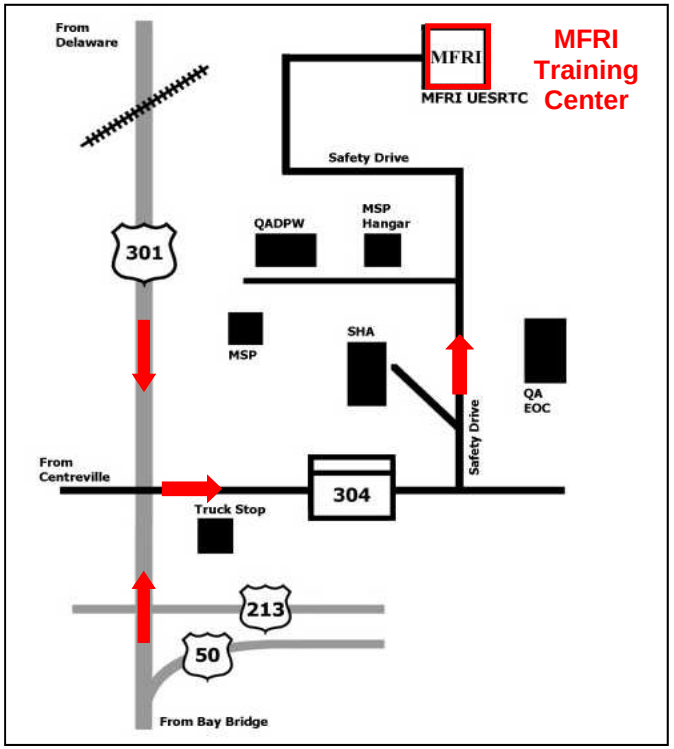
- Follow **US-301 south/Blue Star Memorial Highway**
  - Cecil County— 45.9 mi
  - Kent County—6.1 mi
- Turn Left onto **MD-304/Ruthsburg Road/Centreville– Ruthsburg Road**
- Continue to follow **MD-304/Ruthsburg Road**
- Turn Left onto **Safety Drive**
- Arrive at **601 Safety Drive** on the Left

Directions for Talbot County:

- Follow Ocean GTWY/US-50 west toward **Kennedy Street**- go 11.0 mi.
- Turn Slight Right onto **MD-213/Centreville Road** - go 4.2 mi
- Merge onto **US-301/Blue Star Memorial Highway** toward Wilmington— go 3.0 mi
- Turn Slight Right onto **Ruthsburg Road/MD-304 -** go 0.3 mi
- Turn Left onto **Safety Drive**
- Arrive at **601 Safety Drive** on the Left

Directions for Caroline County:

- Follow MD-404 west/Shore Highway - go 7.6 mi.
- Turn Right onto **MD-309/Starr Road** - go 2.0 mi
- Turn Left onto **Ruthsburg Road/MD-304 -** go 3.9 mi
- Turn Right onto **Safety Drive**
- Arrive at **601 Safety Drive** on the Left



STATE OF MARYLAND

2011 All-Hazard Mitigation Plan Update

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Upper Shore/Eastern Region Open House
July 26, 2011

Who Should Attend?

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- Public Officials
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Meeting Agenda

July 26, 2011 10:00 AM

Welcome/Why Are We Here?

What is Hazard Mitigation? Why Plan?

(Discussion of the linkages between the State and the Local Plans)

What are the State's Hazards of Concern?

(Overview of the State's **H**azard **I**dentification and **R**isk **A**ssessment (HIRA) results, specifically Regional results)

Hazard Mitigation Strategies

Questionnaire

Where Do We Go From Here?

PLANNING FOR TODAY AND TOMORROW

Questions regarding the "Open House" please contact Edward Stoner at Queen Anne's County Department of Emergency Management

Ed Stoner, Emergency Planner
Phone: 410-758-4500

Come and Join Us!

Open House

Date: June 29, 2011

Time: 9:00 AM

Location: Allegany County

Dept. of Public Safety

11400 PPG Road, SE

Cumberland, MD 21502

DIRECTIONS:

Directions from Garrett County:

- Follow I-68/US-40 East toward Cumberland
- Take Exit 43B, MD 51/Industrial Boulevard
- Continue 5.5 miles on Industrial Boulevard
- Turn right onto PPG Road, SE - go 0.9 miles
- Arrive at Allegany County Public Safety Building on the right.

Directions from Washington County:

- Follow I-70 West toward Hancock
- Take Exit 1A to I-68/US-40 West toward Cumberland
- Take Exit 43B, MD 51/Industrial Boulevard
- Turn left onto Howard Street
- Turn right on to MD-51/Industrial Boulevard—continue 5.5 miles on MD-51/Industrial Boulevard
- Turn right onto PPG Road, SE - go 0.9 miles
- Arrive at Allegany County Public Safety Building on the right.

Directions for Allegany County:

- Follow MD 51/Industrial Boulevard
- Continue 5.5 miles on Industrial Boulevard
- Turn right onto PPG Road, SE - go 0.9 miles
- Arrive at Allegany County Public Safety Building on the right.

STATE OF MARYLAND

2011 All-Hazard Mitigation Plan Update

Come Join Us!

PLANNING FOR TODAY AND TOMORROW

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Western Region Open House
June 29, 2011

Who Should Attend?

Potential attendees include a cross-section of organizations with an interest in hazard mitigation, and are as follows:

- Public Officials
- Local Emergency Managers
- Fire & Rescue
- Local Planners
- Local Transportation
- Local Public Works
- Local Schools
- Local Utilities
- Architects and Engineers
- American Red Cross
- Business Continuity Planners
- Hazard Experts from State and Federal Agencies
- SHA District Office Staff
- Colleges and Universities
- Non-profit Organizations
- Businesses

Meeting Agenda

June 29, 2011 9:00 AM

Welcome/Why Are We Here?

What is Hazard Mitigation? Why Plan?

(Discussion of the linkages between the State and the Local Plans)

What are the State's Hazards of Concern?

(Overview of the State's **H**azard **I**dentification and **R**isk **A**ssessment (HIRA) results, specifically Regional results.)

Hazard Mitigation Strategies

Questionnaire

Where Do We Go From Here?

PLANNING FOR TODAY AND TOMORROW

Questions regarding the "Open House" please contact Richard DeVore at Allegany County Dept. of Public Safety

Richard "Dick" DeVore, Director
Phone: 301-876-9155

Hazardous Times Newsletter

2011 Maryland State All-Hazard Mitigation Plan Update

"It wasn't raining when Noah built the ark."

- Howard Ruff

Last week resulted in a strong push forward on the Maryland HMP 2011 Update. The HIRA team got a lot accomplished in preparation for the meeting on Wednesday, including completion of the hazards ranking, the critical facilities database, and HAZUS analysis for earthquake and Hurricane Wind. This progress will allow the meeting on Wednesday to begin discussing goals and objectives for hazard mitigation in the meeting on Wednesday, The beginning of the next phase of the project.

Hazard Identification & Risk Analysis

- The ranking of hazards has been completed using Dewberry's ranking methodology.
- The HIRA GIS team has finalized the state and critical facilities GIS database.
- Hazard analysis, including intersecting critical facilities with hazard areas is nearing completion.
- Map and plan templates have been developed and approved by MEMA.
- Creation of depth grids for HAZUS flood analysis is ongoing.
- HAZUS analysis performed for Earthquake and Hurricane Wind.

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Public Outreach

The public outreach website, being developed by VANTIX, is currently under construction. We are brainstorming layout possibilities, but still trying to identify MEMA's webmaster.

S&S Planning will be joining the MEMA Regional Administrators weekly conference call on Monday, June 13th to discuss scheduling of the Regional "Open Houses" slated for July.

Other Plan Components

- Updating the 2008 Capability Assessment is currently underway.
- 2008 agency mitigation actions have been sent out to committee members for updating.
- Agency biographies (for the plan appendices) are being updated.

Upcoming Meetings

- Wednesday, June 15th @ 9AM - Camp Fretterd, 5401 Rue Saint Lo Drive, Reisterstown, MD 21136 – Hazard Identification and Risk Assessment and Mitigation Actions Meeting.

Immediate Next Steps

- The focus this week will be on the Hazard Identification and Risk Assessment and Mitigation Actions Meeting which will provoke a wealth of ideas for further analysis and review.

Project Information

Dewberry

Dewberry Team:			
Project Manager	Deborah Mills	703.849.0162 804.335.9946 c	dmills@dewberrry.com
Deputy Project Manager	Carrie Speranza	703.849.0367	csperanza@dewberry.com
Hazard Identification and Risk Assessment Leads	Ryan Towell Rachael Heltz-Herman	703.849.0275 585-429-7448	rtowell@dewberry.com rherman@dewberry.com
Public Outreach	Ginny Smith	301.724.7611	vsmith@ssplanninganddesign.com

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Hazardous Times Newsletter

2011 Maryland State All-Hazard Mitigation Plan Update

Hazard Identification & Risk Analysis

- Committee feedback is being incorporated into mapping and HIRA section.
- Alteration are being made to the hazard ranking to account for local plan rankings.
- Availability of Individual Assistance (IA) data for flood losses is being looked into by FEMA Region III.
- Incorporation of National Flood Insurance Program (NFIP) policy and claim information, Repetitive Loss/Severe Repetitive Loss, and Mitigated Property information being investigated for inclusion in flood section.
- Additional data sources from state agencies are being investigated.
- Hazard analysis, including intersecting critical and state facilities with hazard areas is nearing completion.

"It wasn't raining when Noah built the ark."

- Howard Ruff

This week resulted in the culmination of months of planning and hard work effort from dozens of people. The June 15th HIRA and Mitigation Actions Meeting was a success, with the total number of participants nearing 100. The Dewberry team presented the results of the Hazard Identification and Risk Analysis, and facilitated the committee towards refining the plan's 2008 goal. Participants then divided into sub-committees to discuss mitigation actions to be completed within the next three year planning cycle. This meeting was a monumental effort, its outcomes positive. The results will be included in the 2011 plan.

Public Outreach

The public outreach website, being developed by VANTIX, is currently under construction. We are working with MEMA webmasters and the Public Information Officer on content. We hope to have it up and running in early July.

S&S Planning has scheduled the first "Open House". For dates see below.

Other Plan Components

- Updating the 2008 Capability Assessment is still underway.
- 2008 agency mitigation actions have been sent out to committee members for updating.
- Action sub-committees are finalizing the actions identified at the June 15 meeting.

Dewberry

Upcoming Meetings

- Western Region Open House: Wednesday, June 29th, 2011; 9-10:30 AM @ Allegany County Department of Public Safety Building (11400 PPg Rd, SE, Cumberland, MD 21502)
- Final Plan Draft Review Meeting: Wednesday, July 20th, 2011; 9AM-12PM @ Camp Fretterd (5401 Rue Saint Lo Drive, Reisterstown, MD 21136)

Immediate Next Steps

- Next week, the sub-committees will converge in a WebEx forum to discuss priority ratings, feasibility, funding possibilities, and lead agencies on the actions discussed at the June 15th meeting.

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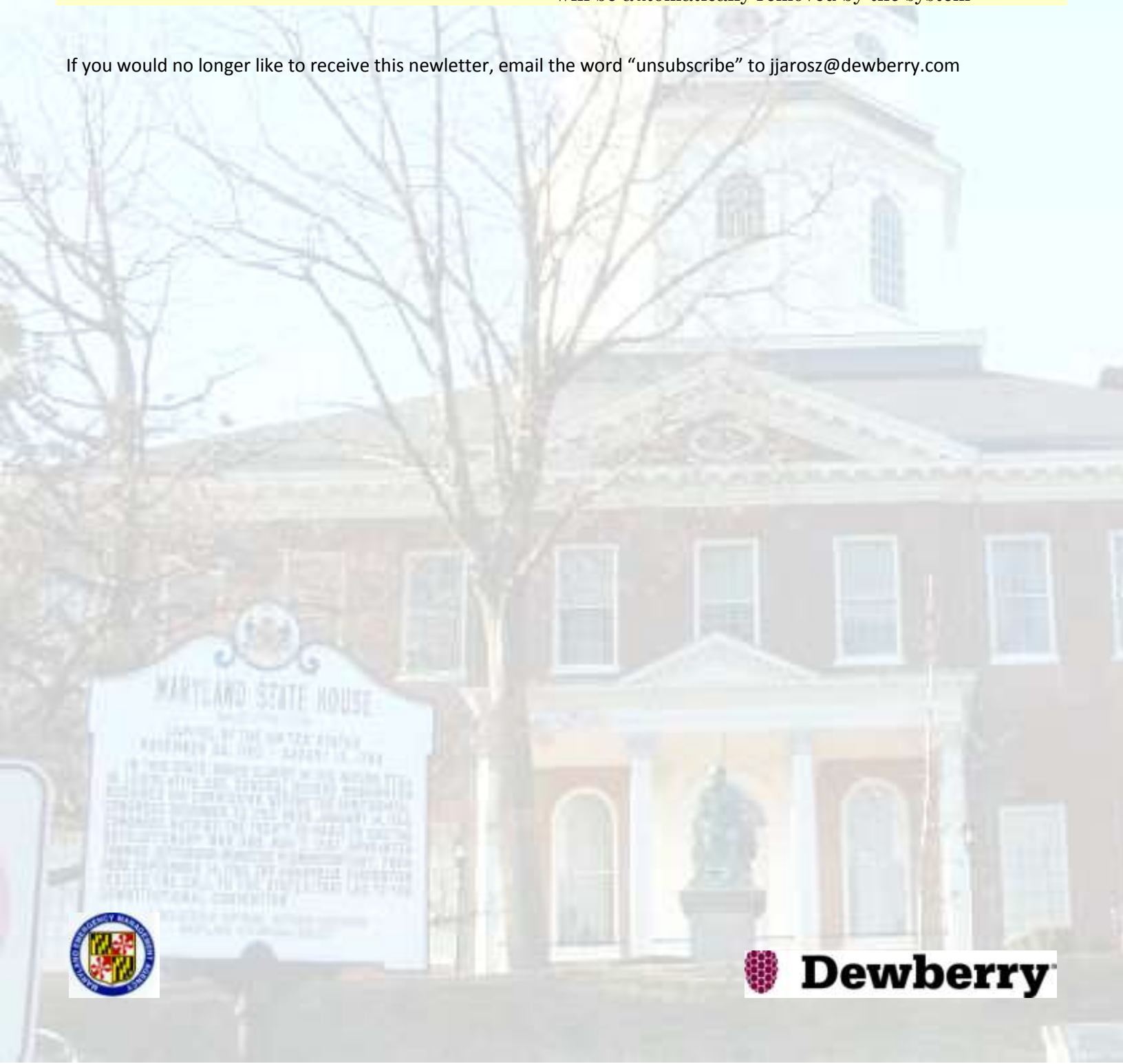

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Hazardous Times Newsletter

2011 Maryland State All-Hazard Mitigation Plan Update

"It wasn't raining when Noah built the ark."

- Howard Ruff

Executive Summary

As we move forward with this project, each individual involved continuously reaffirms their dedication to the protection of life and property within the great state of Maryland. This week has proven, it requires the constant communication and coordination of many government agencies and private firms. This dedication was especially proven by the convergence of nearly 100 people at the HIRA and Mitigation Strategies meeting last week, but also by the second meeting of the five subcommittees, via WebEx this week. There, the groups refined the strategies developed this week, which will literally determine the course of mitigation action and risk reduction in the state of Maryland over the next three years. Despite current economic hardships that face every state in this Union, the Maryland Emergency Management Agency continues to pursue its passion for and express its devotion to the protection of the Maryland constituency.

Project Scoping

We are looking for specific, bricks-and-mortar projects for the Scoping phase of the plan update. Scoping involves evaluating hazard-prone buildings and infrastructure, problematic stream channels, potential safe rooms, and other candidates for mitigation and identifying specific mitigation actions that can reduce losses at that location. The outcome of scoping is a worksheet with structure and project information, a preliminary cost estimate, and a preliminary benefit-cost ratio that can serve as the basis for a future mitigation grant application.

Candidates for mitigation scoping include:

- Hazard-prone residential areas
- Hazard-prone public facilities such as wastewater treatment plants
- Structures that can serve as safe rooms
- Roads and bridges that frequently flood
- Channels and culverts that are inadequately sized
- Wildland-urban interfaces
- Other physical projects

Dewberry

To be successful in project scoping, the following information is useful:

- Photos of the structure/site
- Structure plans and drawings (where applicable)
- Damage history documentation (such as insurance claims, loss of function, etc.)
- Documentation of historic or environmental issues at the site

Public Outreach

The public outreach website, being developed by VANTIX, is currently under construction. We are working with MEMA webmasters and the Public Information Officer on content. We hope to have it up and running in early July.

S&S Planning has scheduled the two "Open House". For dates and locations see below.

Other Plan Components

- Updating the 2008 Capability Assessment is still underway. We are coordinating with other Maryland agencies to identify what programs have undergone updates, and what new programs may exist.
- The 2008 mitigation actions have been sent out to committee members for updating. We have heard from many of them, but we are still working to identify the right individuals to address some of them.
- Most of the2011 action sub-committees have already met via WebEx earlier this week to further refine and redefine them. Most of the actions have already been assigned to an agency.

Hazard Identification & Risk Analysis

- The HIRA team finalized fine-tuning of the hazard ranking based on feedback provided from the June 15, 2011 HIRA meeting held at MEMA.
- Additional data was received this week from various state agencies and is being incorporated into the hazard analysis.
- GIS analysis and mapping continues and is entering the final stages.
- The team is making significant (and on schedule) progress in tackling the massive task of updating, reformatting and writing up each of the HIRA's hazard sections.
- Depth grid creation is nearing completion for Maryland counties in preparation for HAZUS riverine flood analysis.

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Upcoming Meetings

- Western Region Open House: Wednesday, June 29th, 2011; 9-10:30 AM @ Allegany County Department of Public Safety Building (11400 PPg Rd, SE, Cumberland, MD 21502)
- Southern Region Open House, Thursday, July 7th, 2011; 11AM @ Constellation Energy Joint Information Center (100 Skipjack Rd, Prince Frederic, MD 20678)
- Final Plan Draft Review Meeting: Wednesday, July 20th, 2011; 9AM-12PM @ Camp Fretterd (5401 Rue Saint Lo Drive, Reisterstown, MD 21136). RSVP to Mark James (mjames@mema.state.md.us) by July 13th

Immediate Next Steps

- The next steps are to finalize the mitigation actions that were discussed in the subcommittees, complete the HIRA process, work with the outreach committee to inform the public and incorporate local ideas, and follow-up with agencies responsible for the actions outlined in the previous plan. All this must be completed in time for a draft plan deadline of July 8th.

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Public Outreach	Ginny Smith	301.724.7611	vsmith@ssplanninganddesign.com
Project Scoping	Julia Moline Jake Jarosz	703.849.0610 703.849.0535	jmoline@dewberry.com Jjarosz@dewberry.com

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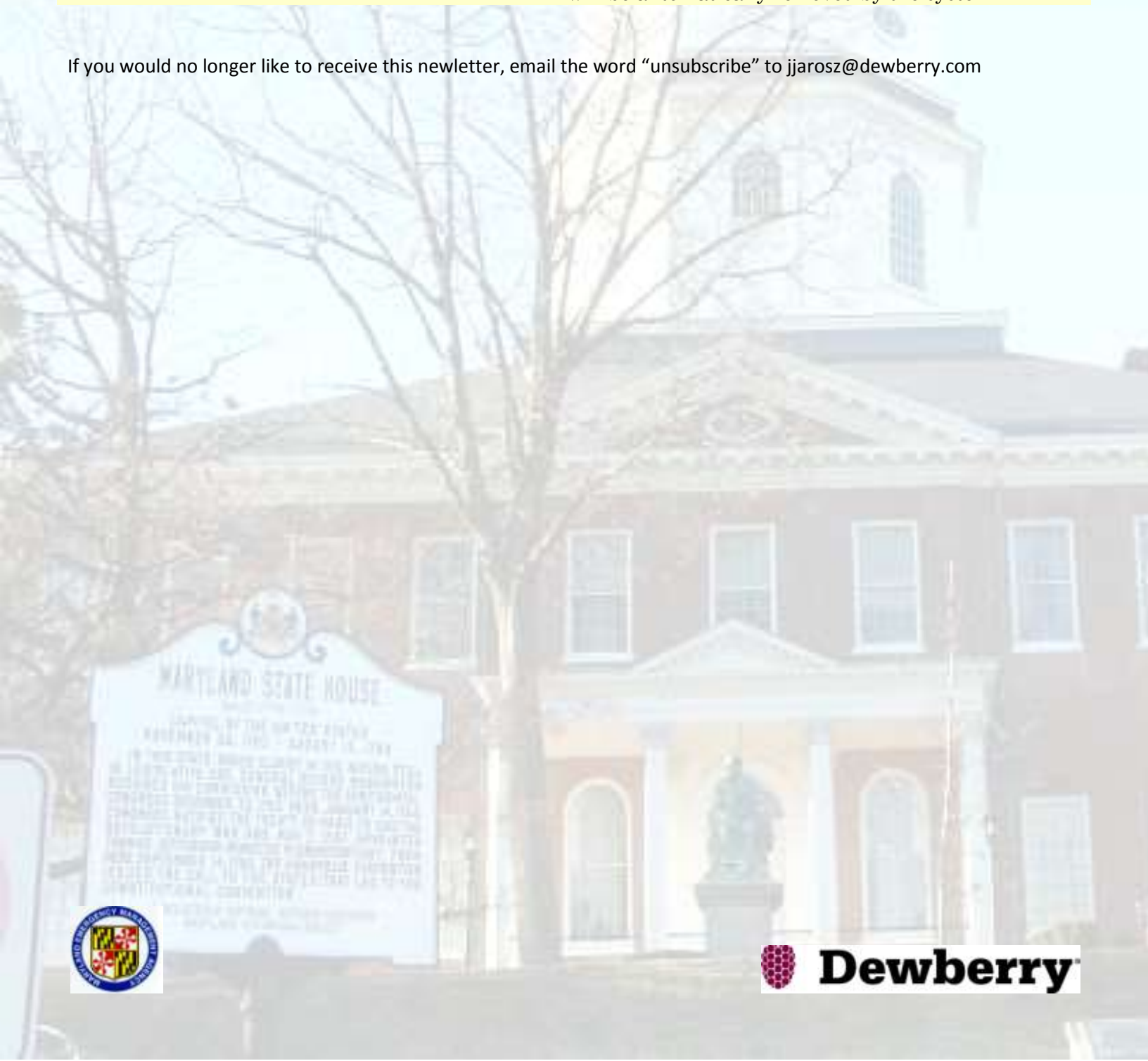

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Hazardous Times Newsletter

2011 Maryland State All-Hazard Mitigation Plan Update

Hazard Identification & Risk Analysis

- The monumental task of ranking hazards by county to determine vulnerability has begun and is expected to be completed by early to mid week next week.
- The HIRA team has reached out to eight different state and federal agencies in seeking the most current and up to data hazard data.
- Map and plan templates have been developed and approved by MEMA.
- Local plan review has been completed and plan section writing has begun.
- Background map creation (watersheds, jurisdictions, transportation…) started earlier this week.

"It wasn't raining when Noah built the ark."

- Howard Ruff

The purpose of this weekly publication is to inform the Committee and other stakeholders on the status of the project and plan update. Here you'll find the latest news on the Hazard Identification and Risk Assessment (HIRA), agency mitigation action development, public outreach initiatives, committee meetings, as well as information on any next steps.

Dewberry is pleased to be a part of this very important project, and we want to make sure that you are well informed of its progress.

Dewberry

Public Outreach

The public outreach website, being developed by VANTIX, is currently under construction. S&S Planning is also working to solidify dates for regional public outreach meetings.

Other Plan Components

- Updating the 2008 Capability Assessment is currently underway.
- 2008 agency mitigation actions have been sent out to committee members for updating.
- Agency biographies (for the plan appendices) are being updated.

Upcoming Meetings

- Monday, June 6th @ 9AM – Conference Call with MEMA & HIRA team to discuss HIRA ranking
- Wednesday, June 15th @ 9AM - Camp Fretterd, 5401 Rue Saint Lo Drive, Reisterstown, MD 21136 – Hazard Identification and Risk Assessment and Mitigation Actions Meeting.
    - RSVP to Mark James no later than June 7th

Immediate Next Steps

- Risk Analysis will begin on state and critical facilities once the database is finalized and approved by MEMA.

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Hazardous Times Newsletter

2011 Maryland State All-Hazard Mitigation Plan Update

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Executive Summary

As the due date for the draft plan, July 8th, quickly approaches, we have been working vigorously towards the plans completion. So vigorously in fact that it often resembles a beehive with multiple parts moving independently of one another, but all reporting to the same queen bee. Regardless of such inane analogies, the push this week has been on finalization of many of the plans components, such as review of the previous plans actions and finalization of the new ones, while we have been concurrently kicking off new portions of the project, such as public outreach, which is headlining this week's article. We are still looking for scoping projects though, so if you know of any areas that may benefit from a physical mitigation project please review the section devoted to that aspect of the plan update later in this newsletter. As always, we are indebted to the many driven and devoted individuals who have contributed to this plan update, and this newsletter is dedicated to you.

Regional Open Houses Underway

The subcontractor S&S Planning and Design has been spearheading the local outreach effort and is making great progress. So far three Regional Open Houses have been scheduled, with one having already taken place this week!! It went off with great success, attracting 15 attendees, not counting facilitators, and lasting 1 ½ hours. Highlights include:

- Representation of a variety of agencies including: Health Department, Board of Education, Sheriff's Office, Planning Department, Emergency Services, MEMA-Regional Administrator;
- Distribution and collection of questionnaires;
- Presentation and discussion of state HIRA, specifically "Hazard Rankings";

The reason behind doing this is to solicit input from organizations outside of state government.. Such outreach ensures that the state is indeed working at the behest of the people, and this first Open House has proven to be an effective tool to solicit such information. We hope you'll come visit us at the next one!!

Dewberry

Project Scoping

We are looking for specific, bricks-and-mortar projects for the Scoping phase of the plan update. Scoping involves evaluating hazard-prone buildings and infrastructure, problematic stream channels, potential safe rooms, and other candidates for mitigation and identifying specific mitigation actions that can reduce losses at that location. The outcome of scoping is a worksheet with structure and project information, a preliminary cost estimate, and a preliminary benefit-cost ratio that can serve as the basisfor a future mitigation grant application.

Candidates for mitigation scoping include:

- Hazard-prone residential areas
- Hazard-prone public facilities such as wastewater treatment plants
- Structures that can serve as safe rooms
- Roads and bridges that frequently flood
- Channels and culverts that are inadequately sized
- Wildland-urban interfaces
- Other physical projects

To be successful in project scoping, the following information is useful:

- Photos of the structure/site
- Structure plans and drawings (where applicable)
- Damage history documentation (such as insurance claims, loss of function, etc.)

Hazard Identification & Risk Ansalysis

- The HIRA team finalized fine-tuning of the hazard ranking based on feedback provided from the June 15, 2011 HIRA meeting held at MEMA.
- The vulnerability analysis is being edited for quality control.
- HAZUS flood runs continue.

Public Outreach

The public outreach website, being developed by VANTIX, is currently under construction. We are working with MEMA webmasters and the Public Information Officer on content. We hope to have it up and running in early July.

Other Plan Components

- The update to the Capability Assessment is 90% complete, requiring only minor changes to content.
- The 2008 mitigation actions follow-up is also nearing completion.
- All but one sub-committee has finalized their list of mitigation actions for addition to the 2011 plan update. Thanks to all for their dedication and participation!!

Dewberry

Upcoming Meetings

- **Final Plan Draft Review Meeting**
  Wednesday, July 20th, 2011; 9AM-12PM
  Camp Fretterd (5401 Rue Saint Lo Drive, Reisterstown, MD 21136)
  RSVP to Mark James (mjames@mema.state.md.us) by July 13th

Regional Open Houses

- **Western Region Open House**
  Wednesday, June 29th, 2011 @ 9-10:30AM
  Allegany County Department of Public Safety Building
  11400 PPg Rd, SE, Cumberland, MD 21502
- **Southern Region Open House**
  Thursday, July 7th, 2011 @ 11AM
  Constellation Energy Joint Information Center
  100 Skipjack Rd, Prince Frederic, MD 20678
- **National Capital Region Open House**
  Wednesday, July 20th, 2011 @ 1PM
  Fire Service Building
  6820 Webster St., Landover Hills, MD 20784

Immediate Next Steps

Next week is a race to the finish. All sections are either already being scrutinized for quality control or are being finalized. The draft plan deadline is July 8th.

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Hazardous Times Newsletter

2011 Maryland State Hazard Mitigation Plan Update

Local Hazard Ranking Risk Maps Teaser

Next week, the first draft iteration will be submitted to MEMA and FEMA for review. In the interim, we would like to pique your interest and anticipation for the forthcoming plan by showcasing a few of the updated Hazard Ranking Risk Maps (below). These maps were presented at the June 15th HIRA and Mitigation Strategies Meeting, where we received considerable feedback.

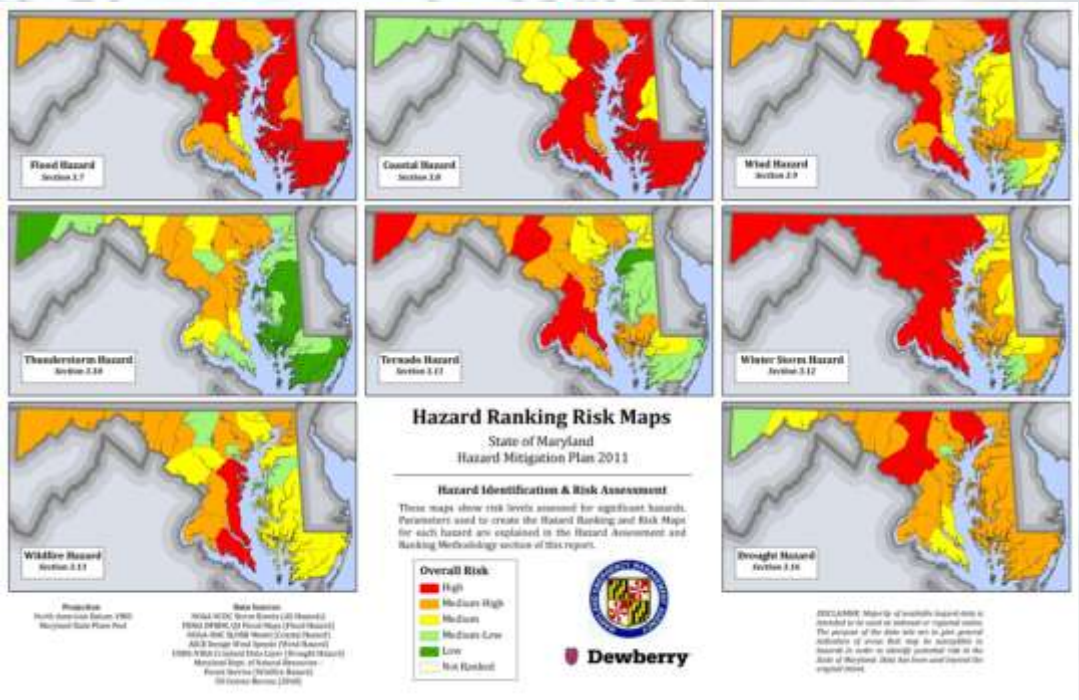
These maps utilize a vast amount of data, which was attained from a variety of sources. It has required the coordination of federal, state and local agencies, followed by detailed analysis.

"It wasn't raining when Noah built the ark."

- Howard Ruff

Executive Summary

The *2011 Maryland State Hazard Mitigation Plan Update* Draft is due next week. This week has resulted in the completion of the HIRA maps, finalization of the mitigation actions, the writing of several chapters, and the completion of many of the appendices, including the plan crosswalk. This week's headline: the Hazard Ranking Risk Maps.



Each ranking map is a compilation of several other maps that chart data such as total number of injuries, total number of deaths, total amount of crop damage, total amount of property damage, etc. In all, 14 were compiled for the Vulnerability Assessment section of this plan.

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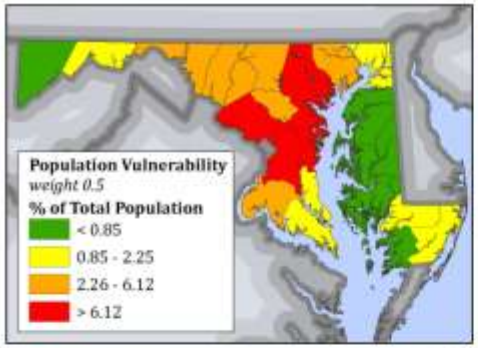
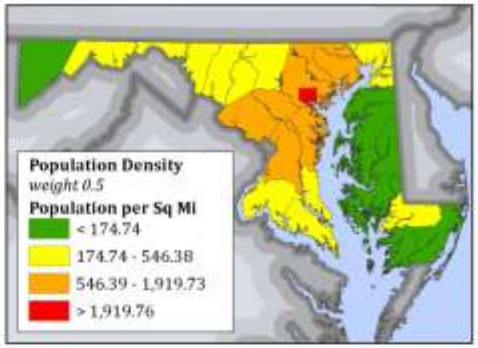
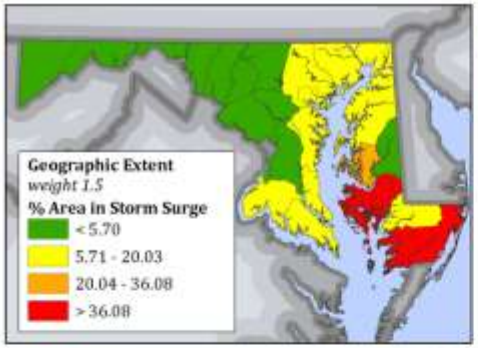
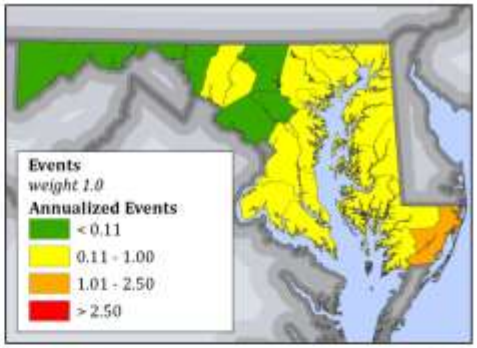
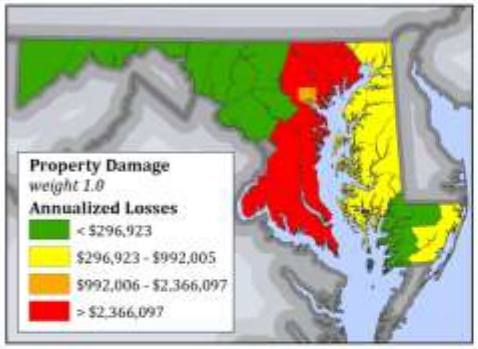
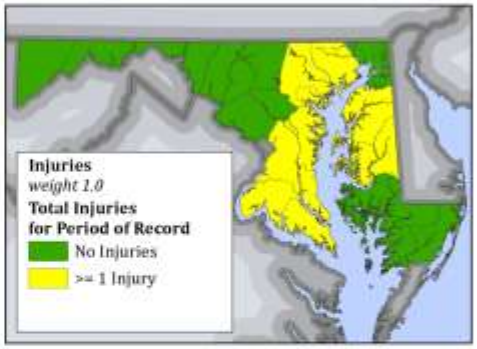


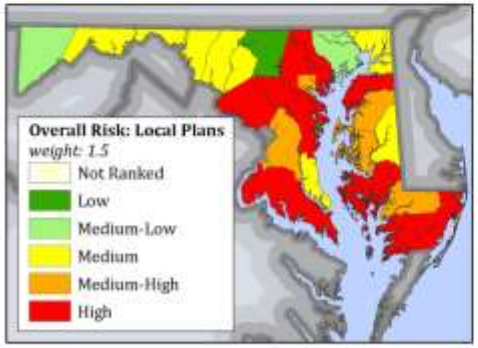












Coastal Hazard Ranking & Risk Map

State of Maryland
Hazard Mitigation Plan 2011

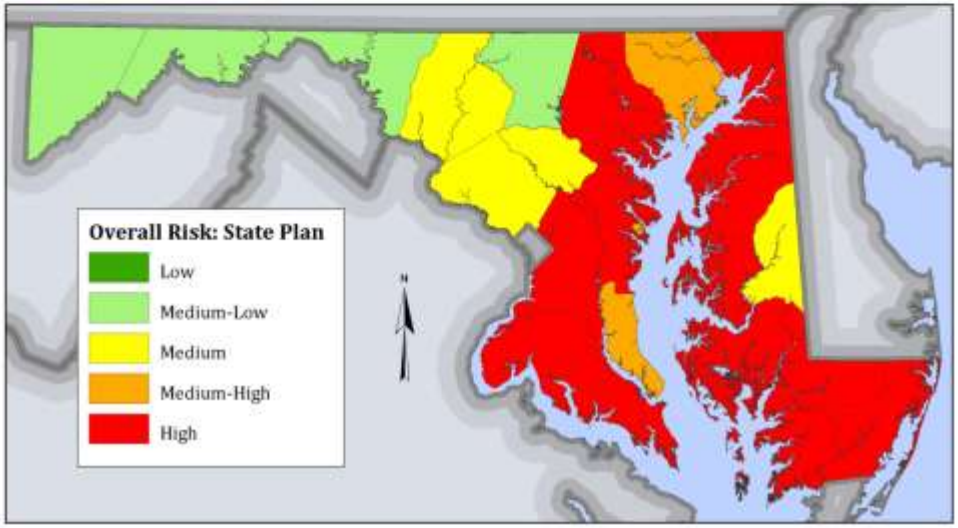
Hazard Identification & Risk Assessment

A number of factors have been considered in this risk assessment to be able to compare between jurisdictions and hazards. The factors have been added together to calculate the overall total ranking for each hazard.

*Risk= PV*0.5+PN*0.5+GE*1.5+EV*1.0+ PD*1.0+CD*1.0+DT*1.0+IN*1.0+LP*1.5*

where

PV=Population Vulnerability
PN=Population Density
GE=Geographic Extent
EV=Events
PD=Property Damage
CD=Crop Damage
DT=Deaths
IN=Injuries
LP=Local Plan Risk Assessment



Data Sources
Maryland Emergency Management Agency
Federal Emergency Management Agency
Maryland Local Hazard Mitigation Plans
NOAA NCDC Storm Events (1993 - 2010)
NOAA-NHC SLOSH Model
MSHA State & County Boundaries
ESRI State Boundaries

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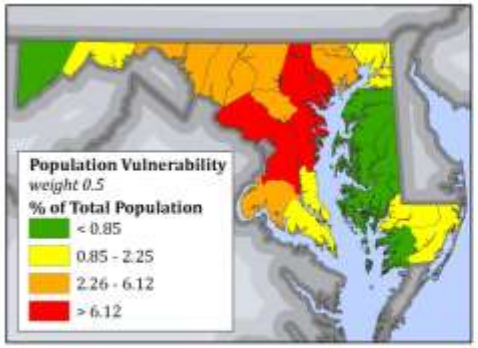
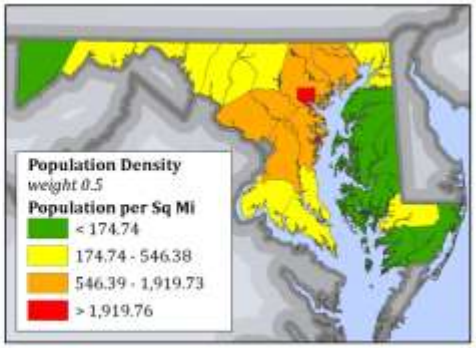
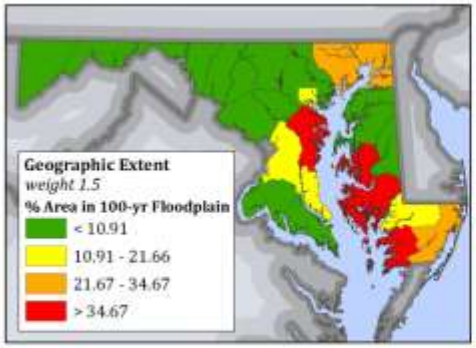
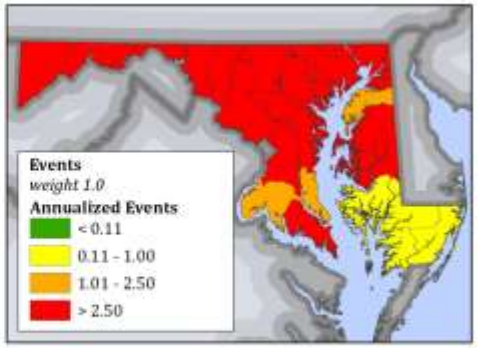
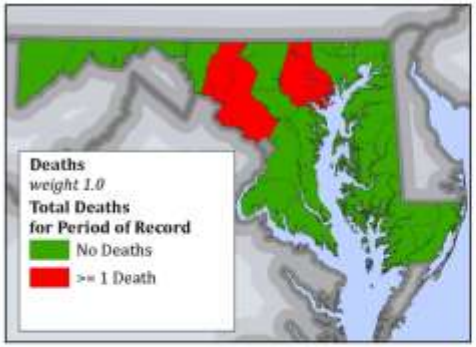
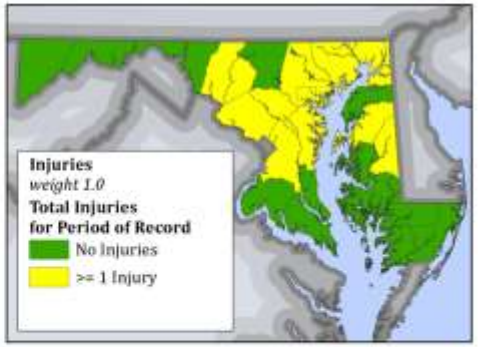


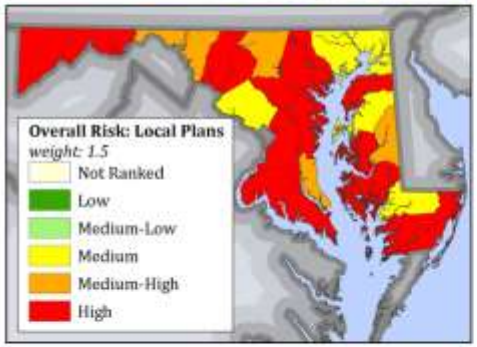












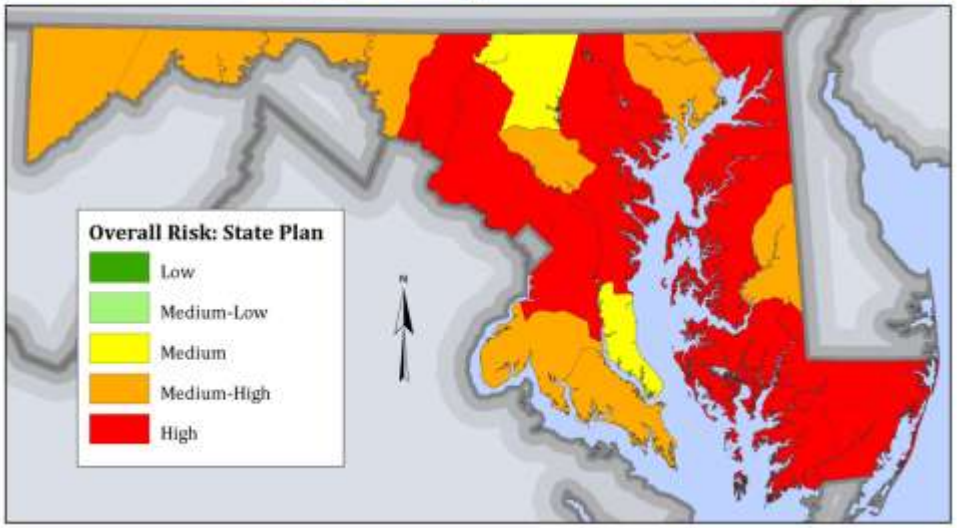
Flood Hazard Ranking & Risk Map

State of Maryland
Hazard Mitigation Plan 2011

Hazard Identification & Risk Assessment

A number of factors have been considered in this risk assessment to be able to compare between jurisdictions and hazards. The factors have been added together to calculate the overall total ranking for each hazard.

*Risk= PV*0.5+PN*0.5+GE*1.5+EV*1.0+ PD*1.0+CD*1.0+DT*1.0+IN*1.0+LP*1.5*
where
PV=Population Vulnerability
PN=Population Density
GE=Geographic Extent
EV=Events
PD=Property Damage
CD=Crop Damage
DT=Deaths
IN=Injuries
LP=Local Plan Risk Assessment



Data Sources
Maryland Emergency Management Agency
Federal Emergency Management Agency
Maryland Local Hazard Mitigation Plans
NOAA NCDC Storm Events (1993-2010)
FEMA DFIRM, Q3 Flood Maps
MSHA State & County Boundaries
ESRI State Boundaries

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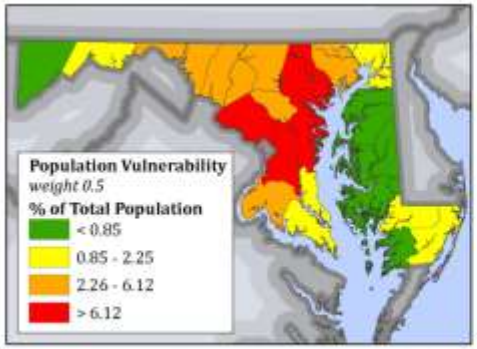

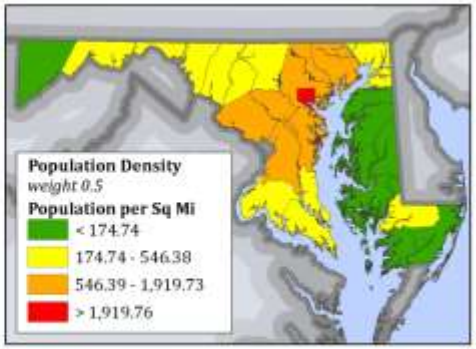

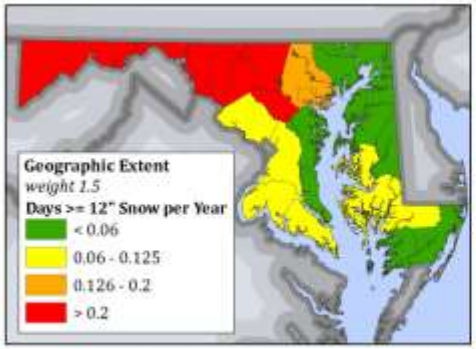

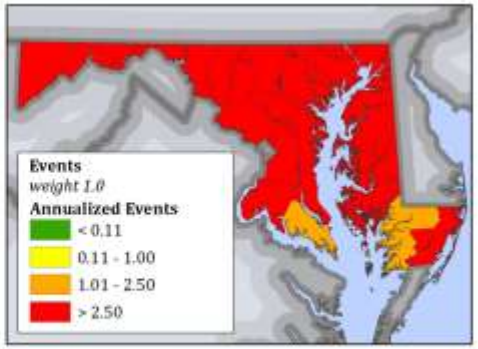

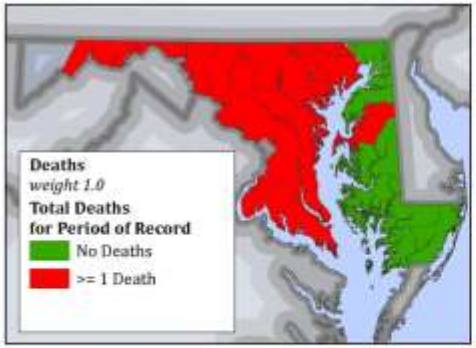

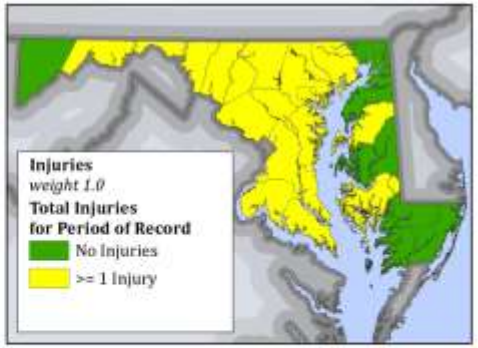

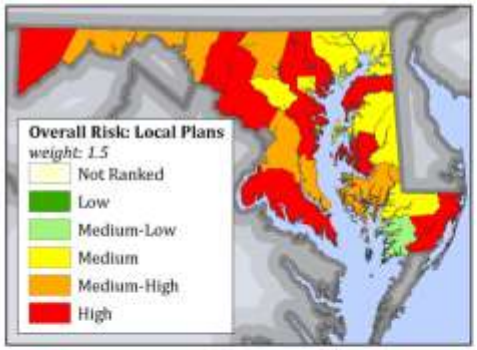

Winter Storm Hazard Ranking & Risk Map

State of Maryland
Hazard Mitigation Plan 2011

Hazard Identification & Risk Assessment

A number of factors have been considered in this risk assessment to be able to compare between jurisdictions and hazards. The factors have been added together to calculate the overall total ranking for each hazard.

*Risk= PV*0.5+PN*0.5+GE*1.5+EV*1.0+ PD*1.0+CD*1.0+DT*1.0+IN*1.0+LP*1.5*
where
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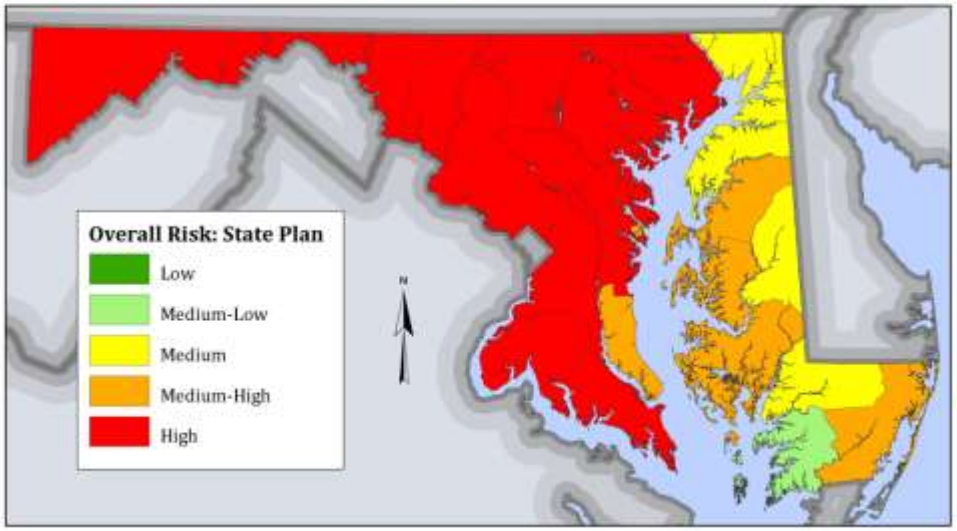

Data Sources
Maryland Emergency Management Agency
Federal Emergency Management Agency
Maryland Local Hazard Mitigation Plans
NOAA NCDC Storm Events (1993-2010)
MSHA State & County Boundaries
ESRI State Boundaries

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Project Scoping

We are looking for specific, bricks-and-mortar projects for the Scoping phase of the plan update. Scoping involves evaluating hazard-prone buildings and infrastructure, problematic stream channels, potential safe rooms, and other candidates for mitigation and identifying specific mitigation actions that can reduce losses at that location. The outcome of Scoping is a worksheet with structure and project information, a preliminary cost estimate, and a preliminary benefit-cost ratio that can serve as the basis for a future mitigation grant application. Please submit your potential sites for Scoping to Julia Moline (jmoline@dewberry.com).

Candidates for mitigation scoping include:

- Hazard-prone residential areas
- Hazard-prone public facilities such as wastewater treatment plants
- Structures that can serve as safe rooms
- Roads and bridges that frequently flood
- Channels and culverts that are inadequately sized
- Wildland-urban interfaces
- Other physical projects

To be successful in project scoping, the following information is useful:

- Photos of the structure/site
- Structure plans and drawings (where applicable)
- Damage history documentation (such as insurance claims, loss of function, etc.)

Regional Open Houses Underway

The subcontractor S&S Planning and Design has been spearheading the local outreach effort and is making great progress. So far three Regional Open Houses have been scheduled, with one having already taken place this week! It went off with great success, attracting 15 attendees, and lasted just over an hour. Highlights include:

- Representation of a variety of agencies including: Health Department, Board of Education, Sheriff's Office, Planning Department, Emergency Services, MEMA-Regional Administrator;
- Distribution and collection of questionnaires;
- Presentation and discussion of state HIRA, specifically "Hazard Rankings";

FEMA requires at least two outreach activities per the mitigation planning guidance, in an effort to obtain input from partner organizations and external stakeholders. We hope you are able to visit us at one of the upcoming meetings.

Upcoming Meetings

- **Final Plan Draft Review Meeting**
  Wednesday, July 20th, 2011; 9AM-12PM
  Camp Fretterd (5401 Rue Saint Lo Drive, Reisterstown, MD 21136)
  RSVP to Mark James (mjames@mema.state.md.us) by July 13th

Regional Open Houses

- **National Capital Region Open House**
  Wednesday, July 20th, 2011 @ 1PM
  Fire Service Building
  6820 Webster St., Landover Hills, MD 20784
- **Upper Eastern Shore Regional Open House**
  Thursday, July 26th, 2011 @ 10AM
  Regional Training Center
  601 Safety Drive, Centerville, MD 21617

Immediate Next Steps

Over the weekend we will be formatting and doing final checks on all sections of the plan. Next week the public outreach website should be up and running with a basic review of the update process, quick access to ranking maps and a survey, as well as an accessible version of the DRAFT plan.

Project Information

Dewberry Team:			
Project Manager	Deborah Mills	703.849.0162 804.335.9946	dmills@dewberrry.com
Deputy Project Manager	Carrie Speranza	703.849.0367	csperanza@dewberry.com
Hazard Identification and Risk Assessment Leads	Ryan Towell Rachael Heltz-Herman	703.849.0275 585.429.7448	rtowell@dewberry.com rherman@dewberry.com
Public Outreach	Ginny Smith	301.724.7611	vsmith@ssplanninganddesign.com
Project Scoping	Julia Moline	703.849.0610	jmoline@dewberry.com

Project SharePoint Site:
For access please follow this link:
http://projects.dewberry.com/2011MDHMP

Site Requires and Username and Password. Please email Jake Jarosz (jjarosz@dewberry.com) to receive login information.

If you misplace your SharePoint username/password, please email helpdesk@dewberry.com for a password reset.

Project ftp site:
For access please follow this link:
ftp.dewberry.com

In the upper right hand side of the window, click "Page" then "Open FTP Site in windows explorer"

username - 2011MDHMP
password - IGHH2T

Please note: Files that are not accessed within 5 days will be automatically removed by the system

If you would no longer like to receive this newsletter, email the word "unsubscribe" to jjarosz@dewberry.com

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MARYLAND EMERGENCY
MANAGEMENT AGENCY

Welcome to the Outreach Website for the

2011 MARYLAND STATE HAZARD MITIGATION PLAN UPDATE

This site is dedicated to receiving input from Marylanders on what you think you are at greatest risk for and how Maryland Government should act in order to prevent disasters. These disaster prevention techniques are determined through a process that is determined by the Federal Emergency Management Agency (FEMA), which is recorded in this plan. This plan undergoes a mandatory update every three years in order to incorporate the most recent data, and to determine what actions and programs should be taken over the next three years in order to mitigate the effects of natural hazards.

On this website, you'll find hazard maps sharing what we have determined to be the greatest threats to the state, ranked according to county, a survey, which will allow you to provide your thoughts on what we, the Maryland Emergency Management Agency, should do in order to reduce the threat to life and property. For those who would like to review and comment on the draft plan, you will find a copy of that document below. We are also conducting numerous "Open Houses" by region. At the bottom of this page, you will find dates and locations of open forums that will discuss the hazards Marylanders face, and what actions need to be taken to reduce the effects of these hazards.

We hope you'll take the time to contribute to this plan update.

Please check back on this site in mid-August for an update on the final plan. Thanks for your interest and concern in preparing, responding, recovering and mitigating Maryland's priority natural hazards.

LOCAL RANKING MAPS

These maps show risk levels assessed by local governments for significant hazards. To review the maps, click the following link:

MEMA LOCAL RANKING MAPS

GIVE US YOUR OPINIONS

MEMA News Portal - Windows Internet Explorer

http://www.mema.state.md.us/newsroom/post/2011/08/03/Highlights-of-the-2011-Maryland-State.aspx

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Favorites | MEMA News Portal

Problem Solver | Maryland.gov | Online Services | State Agencies | Phone Directory

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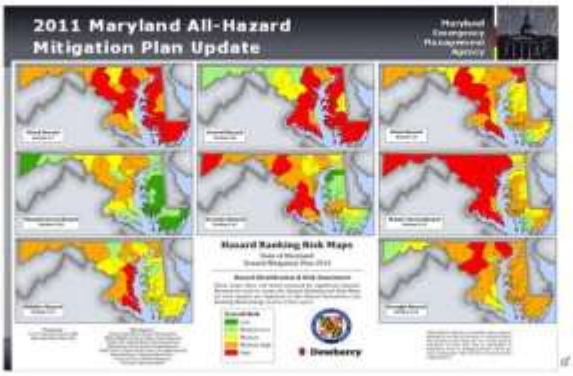
<< Cooling Centers |

Highlights of the 2011 Maryland State Hazard Mitigation Plan Update

By Mema_Admin

August 3, 2011

Reisterstown, MD – *The Draft 2011 Maryland State Hazard Mitigation Plan Update* is ready for public review. The plan's public outreach website is located at http://www.mema.state.md.us/MitigationOutreach. This site contains a summary of the hazards facing Maryland and includes maps that identify each Maryland jurisdictions' potential vulnerability to a wide range of natural hazards. The site also contains a survey to solicit input from Maryland residents on the greatest dangers facing their region, and what they think can be done to mitigate against natural hazards. The plan update was led by the Maryland Emergency Management Agency and enables the state to remain eligible for FEMA post-disaster and mitigation grant funds.



For more information, contact Rachael Herman at rherman@dewberry.com

Month List

2011
- February (1)
- March (4)
- April (6)
- May (12)
- June (3)
- July (4)
- August (1)

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Month List

2011
- August (1)
- July (4)
- June (3)
- May (12)
- April (6)
- March (4)
- February (1)

Twitter

July 22, 14:18
There is currently an extreme heat warning in most of MD. Here's a list of Cooling Centers

http://www.mema.state.md.us/newsroom/2011/02/default.aspx

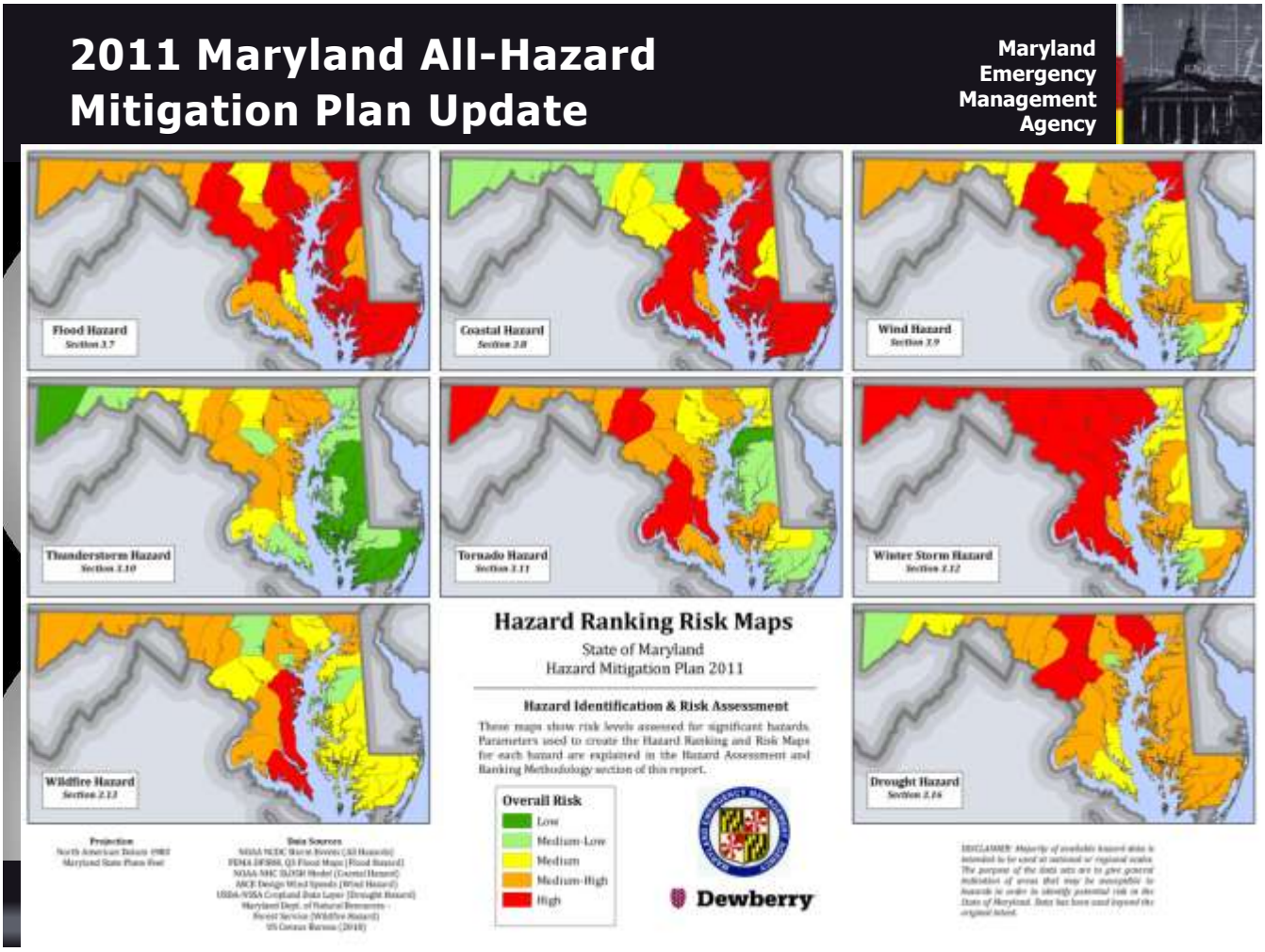
Internet | Protected Mode: On

100%

FOR IMMEDIATE RELEASE
MEDIA ADVISORY
July 21, 2011

Highlights of the 2011 Maryland State Hazard Mitigation Plan Update

Reisterstown, MD – *The Draft 2011 Maryland State Hazard Mitigation Plan Update* is ready for public review. The plan's public outreach website is located at http://www.mema.state.md.us/MitigationOutreach. This site contains a summary of the hazards facing Maryland and includes maps that identify each Maryland jurisdictions' potential vulnerability to a wide range of natural hazards. The site also contains a survey to solicit input from Maryland residents on the greatest dangers facing their region, and what they think can be done to mitigate against natural hazards. The plan update was led by the Maryland Emergency Management Agency and enables the state to remain eligible for FEMA post-disaster and mitigation grant funds.



For more information, contact Rachael Herman at rherman@dewberry.com

For more information on the Maryland Emergency Management Agency, please visit:
www.mema.state.md.us

2011 Maryland All-Hazard Mitigation Plan Update

Maryland Emergency Management Agency

August 2011

Supported by

Dewberry

Greetings!

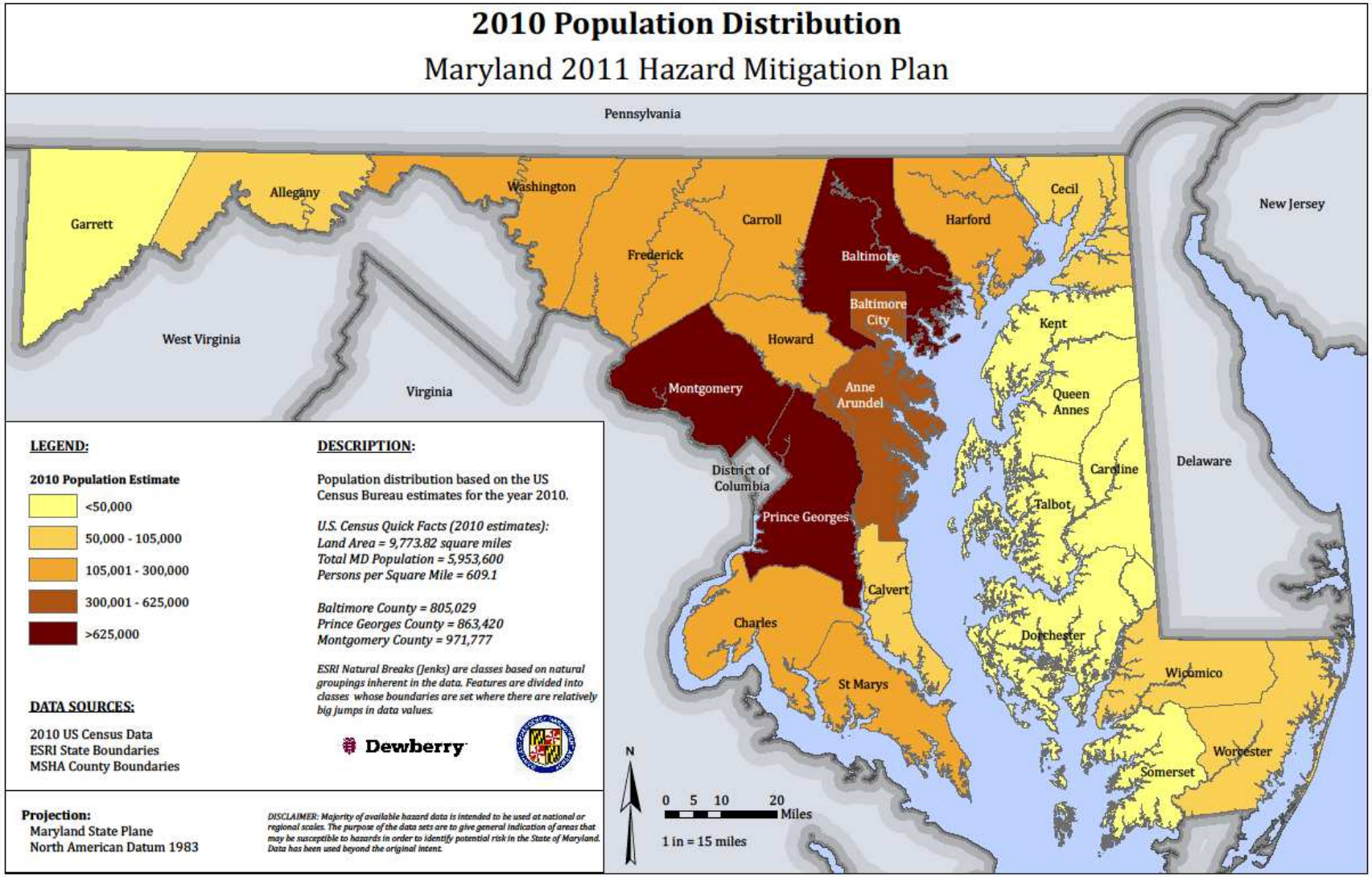
The purpose of this document is to allow you to review the findings of our most recent study, the 2011 Maryland State Hazard Mitigation Plan Update Vulnerability Analysis. In short, the purpose of this analysis is to help guide and prioritize mitigation actions that can be taken to reduce the threat to life and property in the state of Maryland. Additionally, the Federal Emergency Management Agency's (FEMA) Unified Hazard Mitigation Assistance Program is intended to help fund actions that will prevent loss of life and property; this analysis helps prioritize those grants.

What you will find on the following pages are maps that indicate the level of risk associated with each hazard identified in the plan. These maps were created using a compilation of information from multiple sources that document previous occurrences of such data. For a detailed accounting of this process, please review the draft *2011 Maryland State Hazard Mitigation Plan Update* found here on the MEMA website.

After reviewing the maps, please take a moment to complete our online survey located on the main page. Your opinion, as a Maryland resident, is important to us and your responses will be incorporated into the plan update where appropriate. In addition, we also holding regional open houses to discuss the results of this analysis, the dates and times can be found here.

Population Density

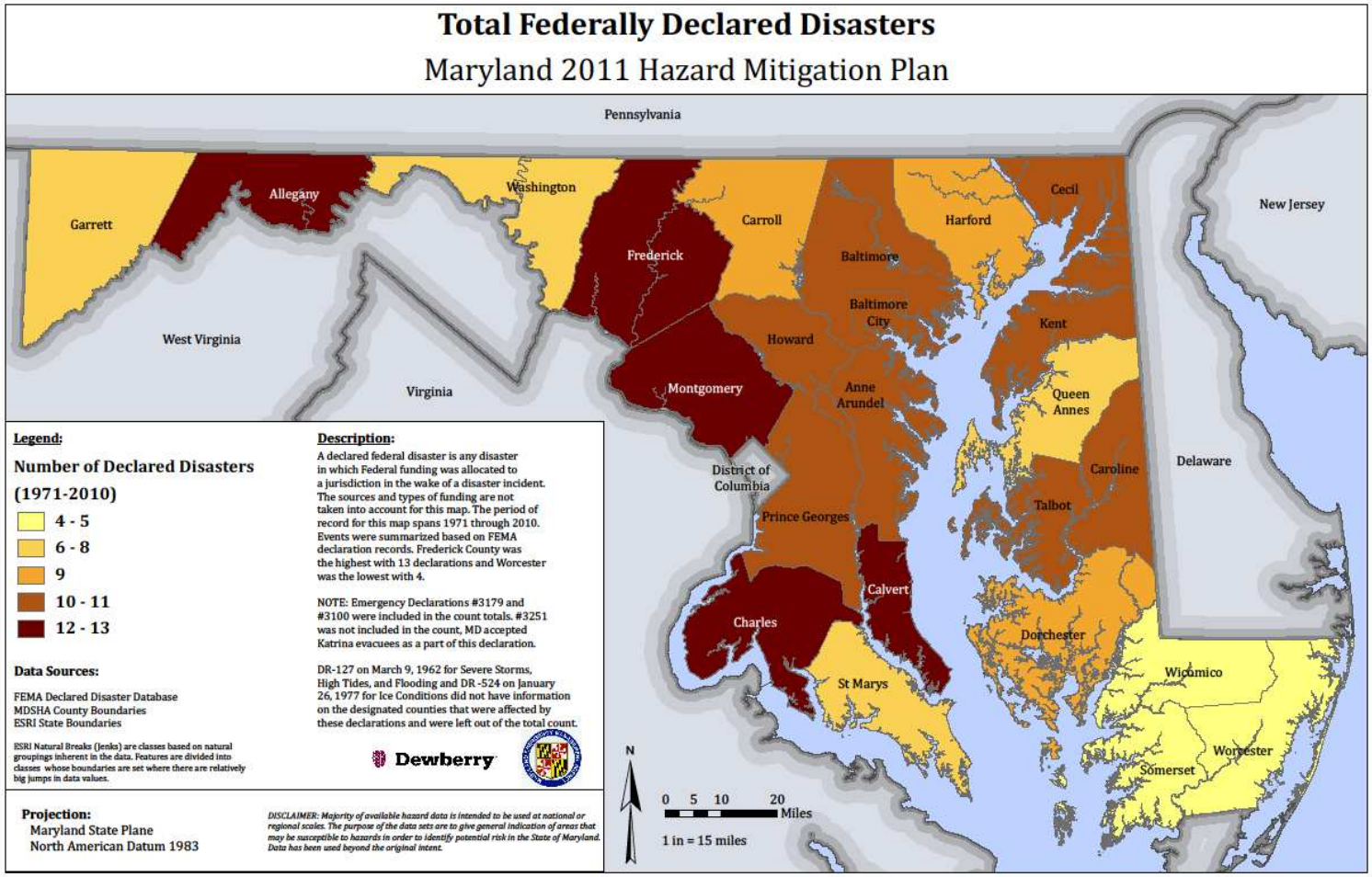
Identifying where people live is important so that we can focus our mitigation actions on where it will have the greatest impact. This map highlights where people live throughout the state.



Declared Disasters

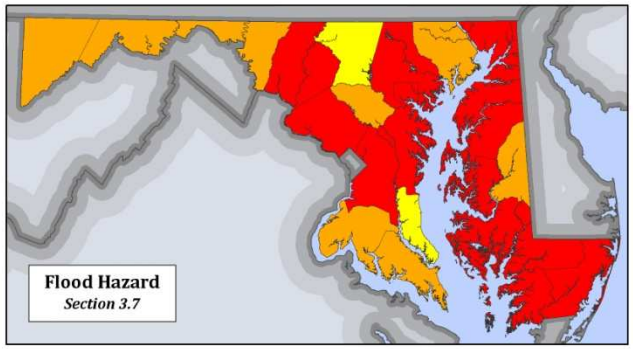
In Maryland, there have been 23 Federally Declared Disasters since 1971. Those disasters include:
- 12: Flooding
- 9: Winter Storm
- 7: Wind
- 5: Coastal
- 3: Tornado

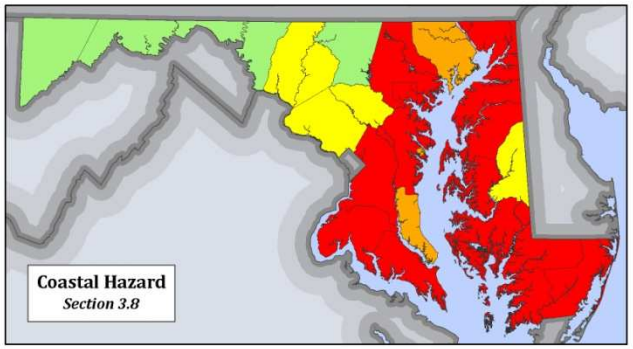
This map identifies where those disasters occurred.

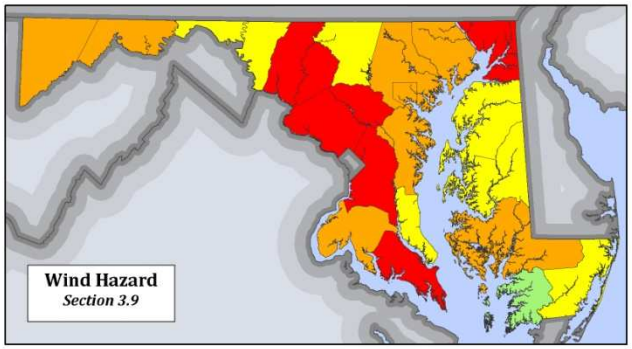


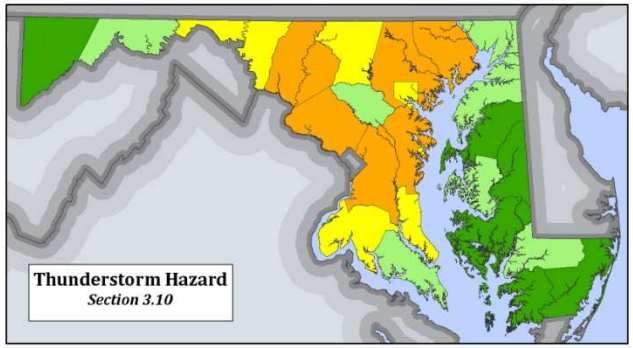
Overall Risk - Statewide

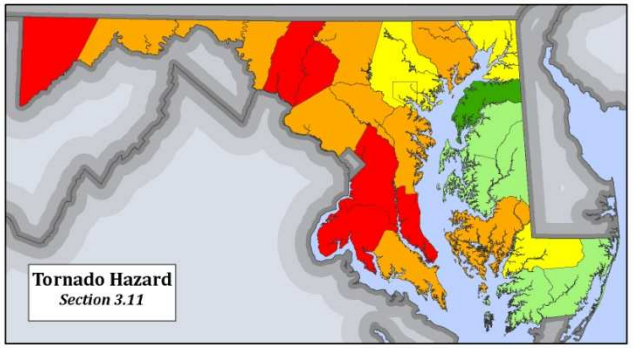
This is an overall summary of what hazards pose the greatest threat to which counties.

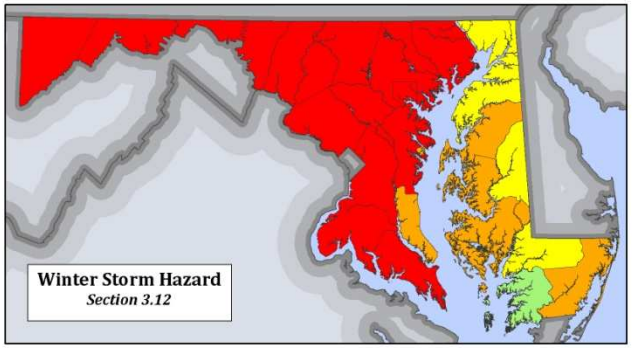


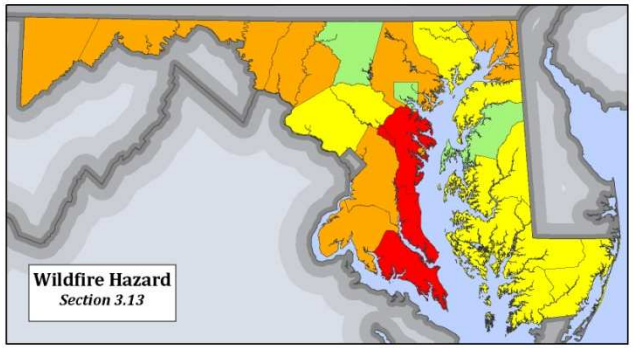












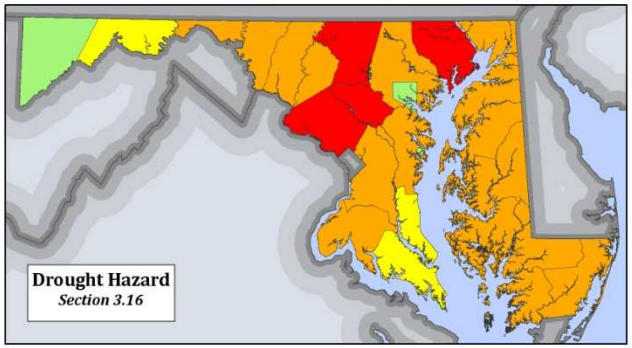
Hazard Ranking Risk Maps

State of Maryland
Hazard Mitigation Plan 2011

Hazard Identification & Risk Assessment

These maps show risk levels assessed for significant hazards. Parameters used to create the Hazard Ranking and Risk Maps for each hazard are explained in the Hazard Assessment and Ranking Methodology section of this report.

Overall Risk
- High
- Medium-High
- Medium
- Medium-Low
- Low
- Not Ranked



Projection
North American Datum 1983
Maryland State Plane Feet

Data Sources
NOAA NCDC Storm Events (All Hazards)
FEMA DFIRM, Q3 Flood Maps (Flood Hazard)
NOAA-NHC SLOSH Model (Coastal Hazard)
ASCE Design Wind Speeds (Wind Hazard)
USDA-NSSA Cropland Data Layer (Drought Hazard)
Maryland Dept. of Natural Resources – Forest Service (Wildfire Hazard)
US Census Bureau (2010)

DISCLAIMER: Majority of available hazard data is intended to be used at national or regional scales. The purpose of the data sets are to give general indication of areas that may be susceptible to hazards in order to identify potential risk in the State of Maryland. Data has been used beyond the original intent.

Coastal Hazard Ranking & Risk Map

State of Maryland
Hazard Mitigation Plan 2011

Hazard Identification & Risk Assessment

A number of factors have been considered in this risk assessment to be able to compare between jurisdictions and hazards. The factors have been added together to calculate the overall total ranking for each hazard.

*Risk= PV*0.5+PN*0.5+GE*1.5+EV*1.0+ PD*1.0+CD*1.0+DT*1.0+IN*1.0+LP*1.5*
where
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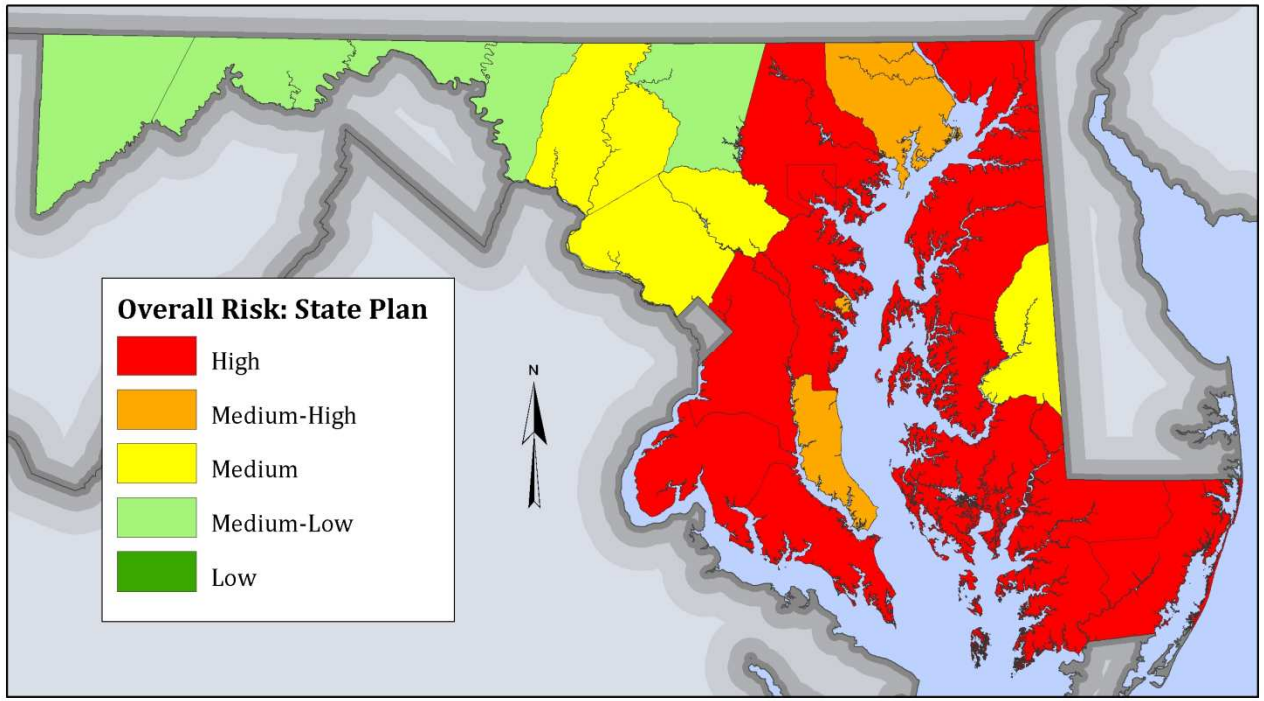

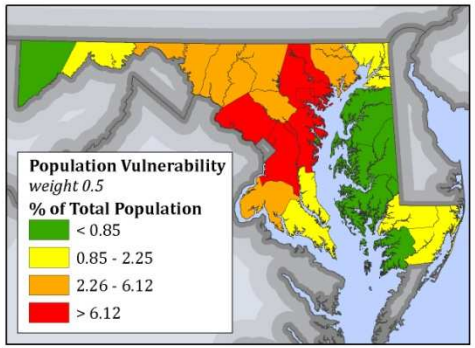

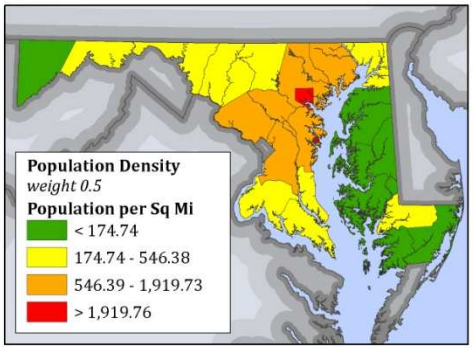

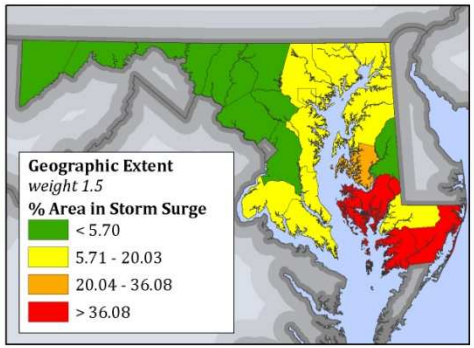

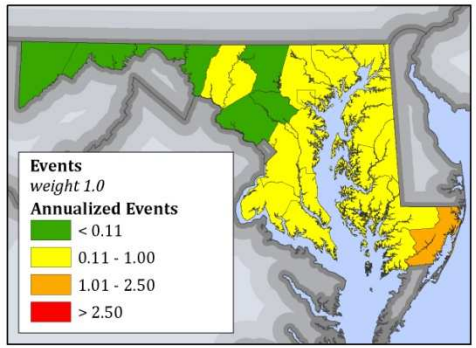

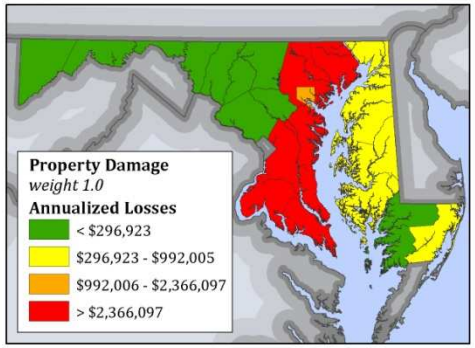

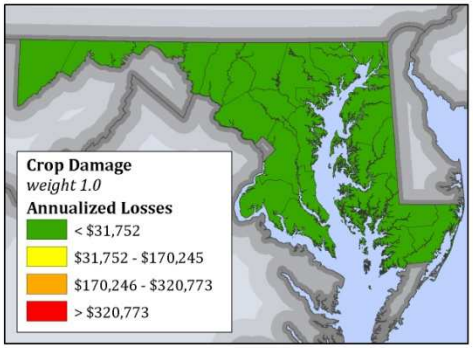

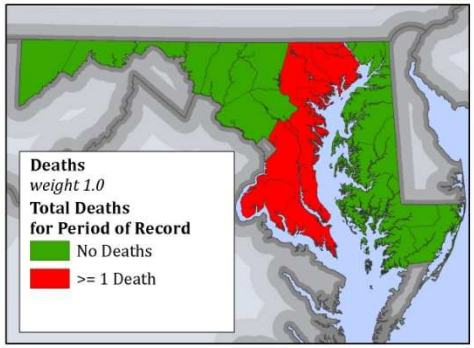

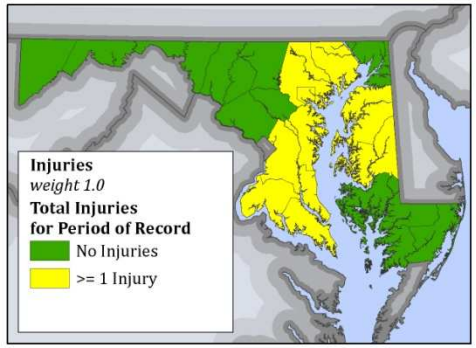

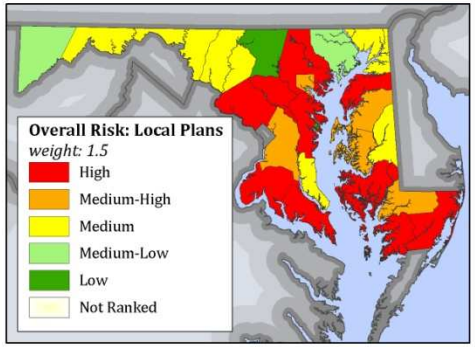

Coastal Hazard Ranking & Risk Map

State of Maryland
Hazard Mitigation Plan 2011

Hazard Identification & Risk Assessment

A number of factors have been considered in this risk assessment to be able to compare between jurisdictions and hazards. The factors have been added together to calculate the overall total ranking for each hazard.

*Risk= PV*0.5+PN*0.5+GE*1.5+EV*1.0+ PD*1.0+CD*1.0+DT*1.0+IN*1.0+LP*1.5*
where
PV=Population Vulnerability
PN=Population Density
GE=Geographic Extent
EV=Events
PD=Property Damage
CD=Crop Damage
DT=Deaths
IN=Injuries
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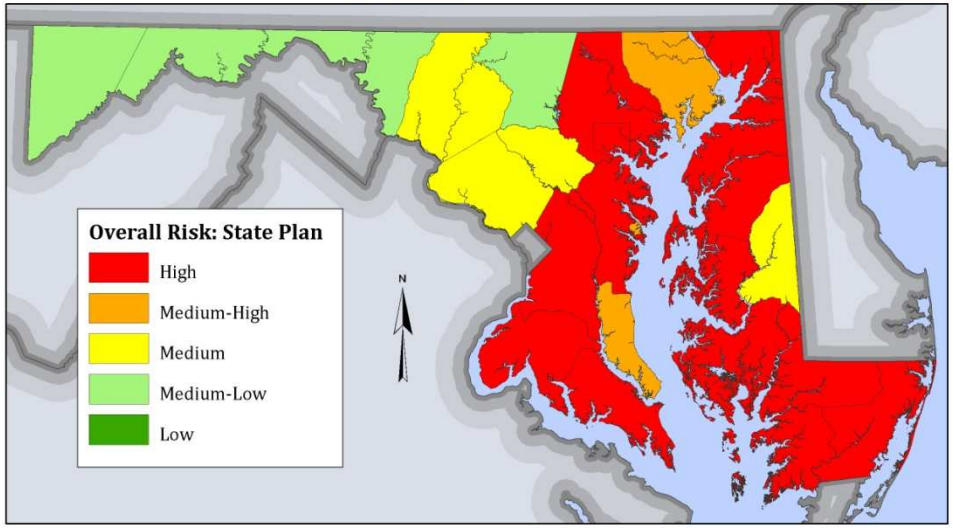

Data Sources
Maryland Emergency Management Agency
Federal Emergency Management Agency
Maryland Local Hazard Mitigation Plans
NOAA NCDC Storm Events (1993 - 2010)
NOAA-NHC SLOSH Model
MSHA State & County Boundaries
ESRI State Boundaries

Dewberry

Drought Hazard Ranking & Risk Map

State of Maryland
Hazard Mitigation Plan 2011

Hazard Identification & Risk Assessment

A number of factors have been considered in this risk assessment to be able to compare between jurisdictions and hazards. The factors have been added together to calculate the overall total ranking for each hazard.

*Risk= PV*0.5+PN*0.5+GE*1.5+EV*1.0+ PD*1.0+CD*1.0+DT*1.0+IN*1.0+LP*1.5*
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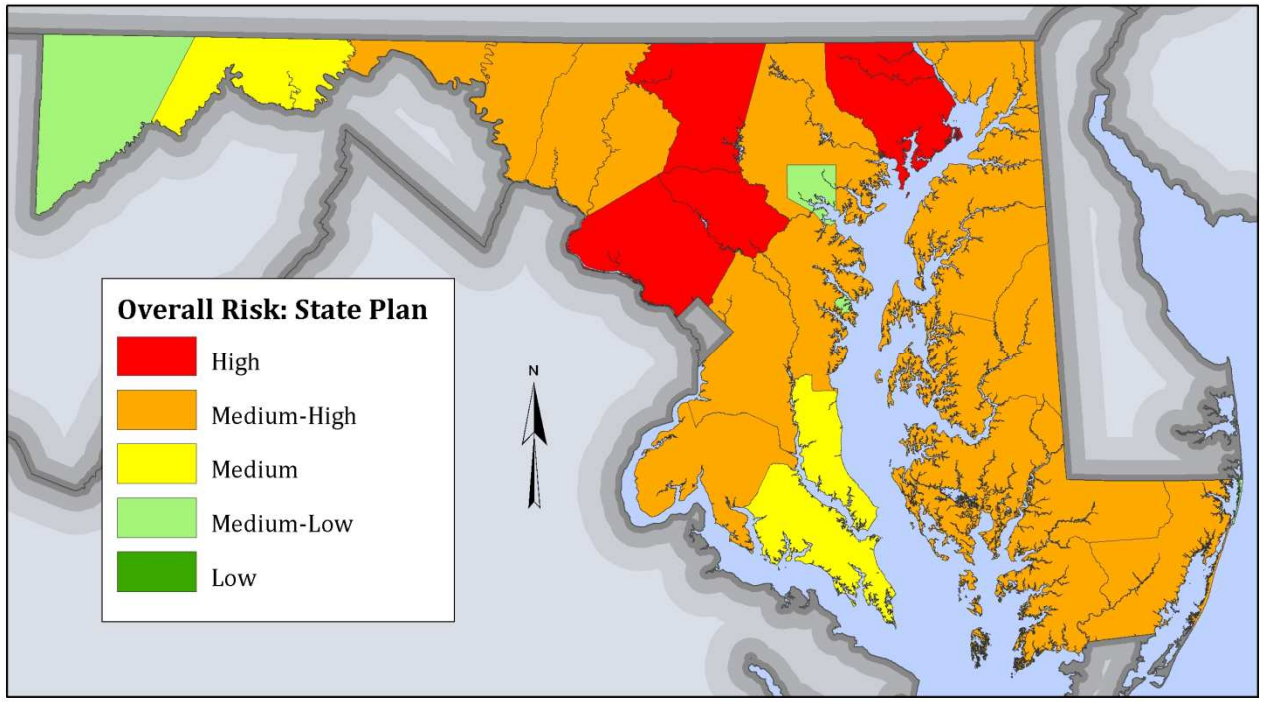

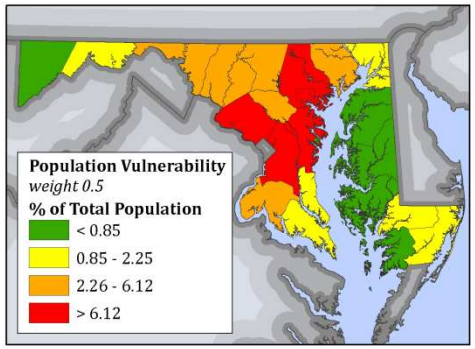

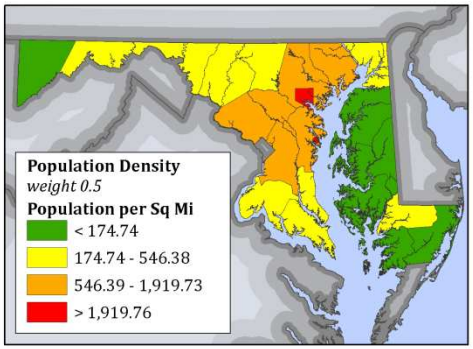

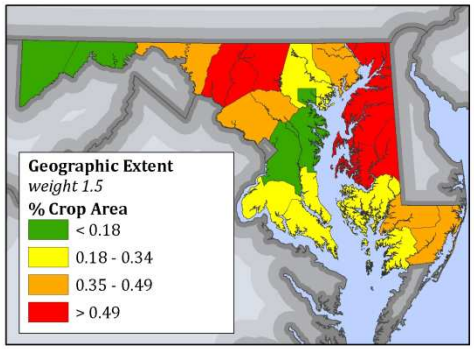

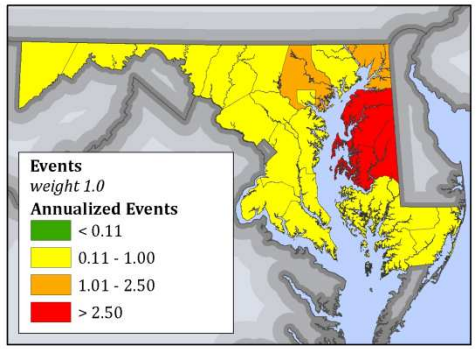

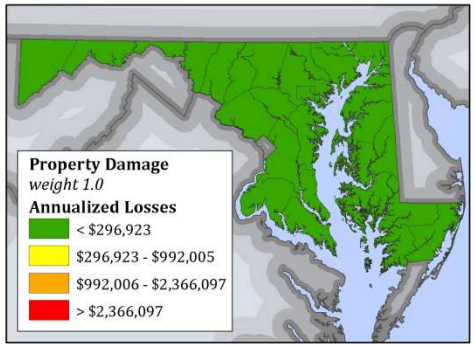

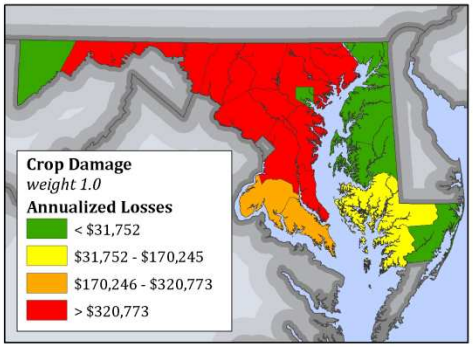

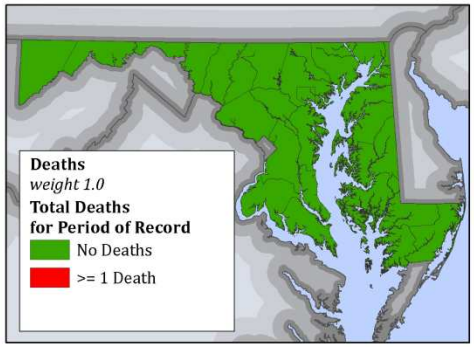

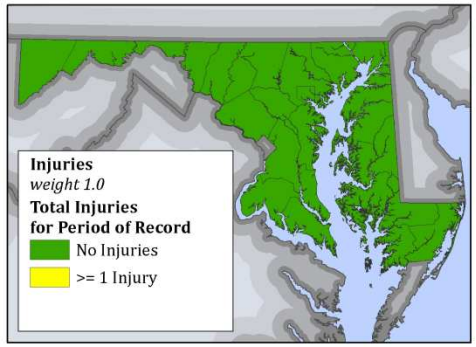

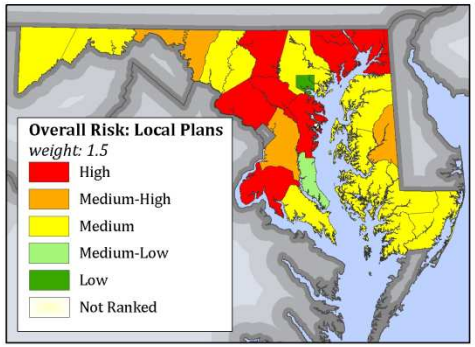

Drought Hazard Ranking & Risk Map

State of Maryland
Hazard Mitigation Plan 2011

Hazard Identification & Risk Assessment

A number of factors have been considered in this risk assessment to be able to compare between jurisdictions and hazards. The factors have been added together to calculate the overall total ranking for each hazard.

*Risk= PV*0.5+PN*0.5+GE*1.5+EV*1.0+ PD*1.0+CD*1.0+DT*1.0+IN*1.0+LP*1.5*
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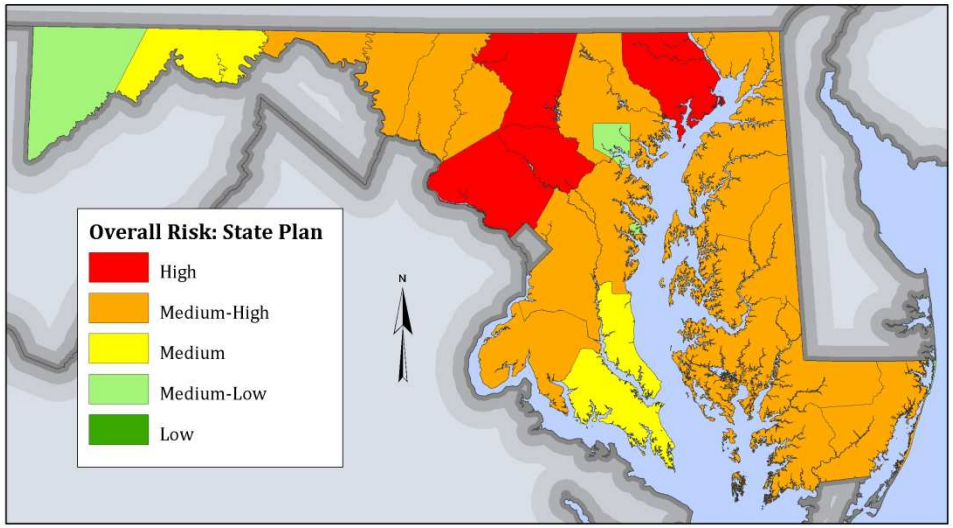

Data Sources
Maryland Emergency Management Agency
Federal Emergency Management Agency
Maryland Local Hazard Mitigation Plans
NOAA NCDC Storm Events (1995-2010)
USDA-NSSA Cropland Data Layer (2010)
MSHA State & County Boundaries
ESRI State Boundaries

Dewberry

Earthquake Hazard Ranking & Risk Map

State of Maryland
Hazard Mitigation Plan 2011

Hazard Identification & Risk Assessment

A number of factors have been considered in this risk assessment to be able to compare between jurisdictions and hazards. The factors have been added together to calculate the overall total ranking for each hazard.

*Risk= PV*0.5+PN*0.5+GE*1.5+EV*1.0+ PD*1.0+CD*1.0+DT*1.0+IN*1.0+LP*1.5*
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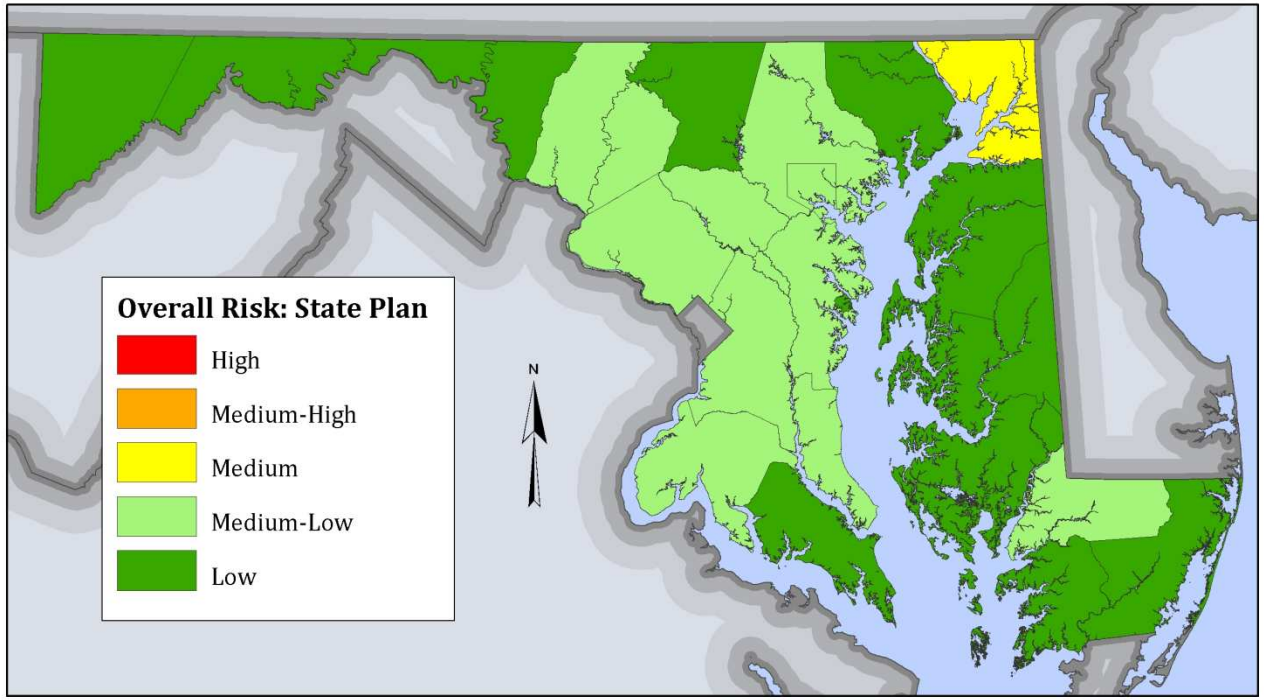

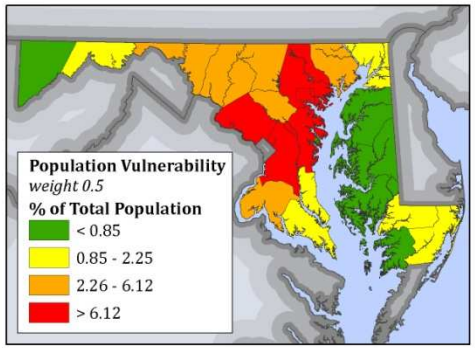

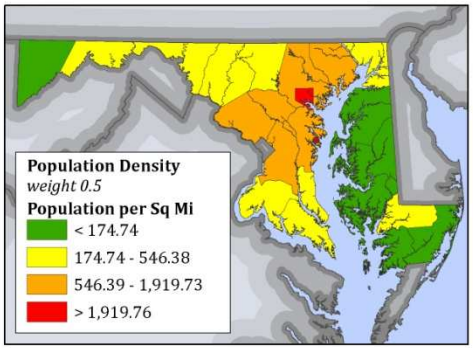

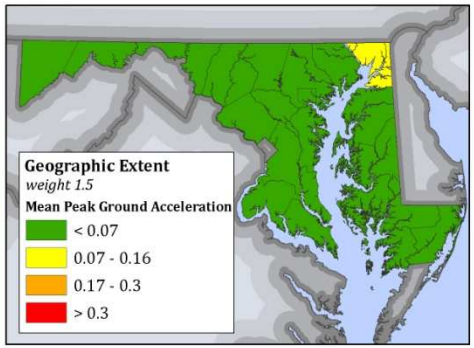

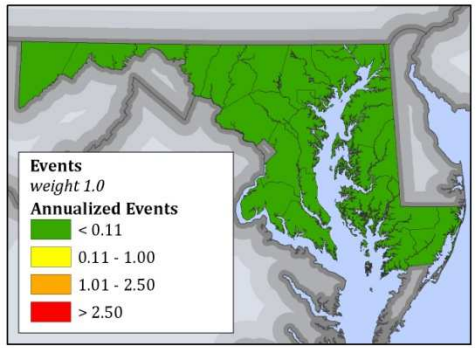

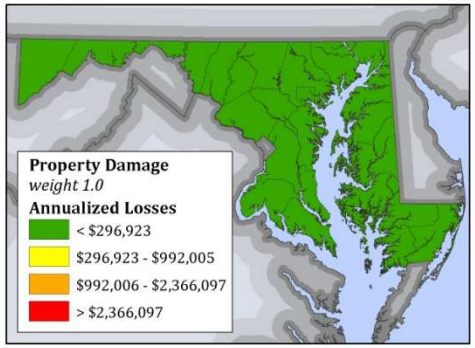

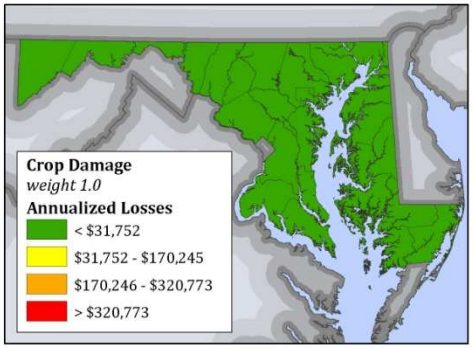

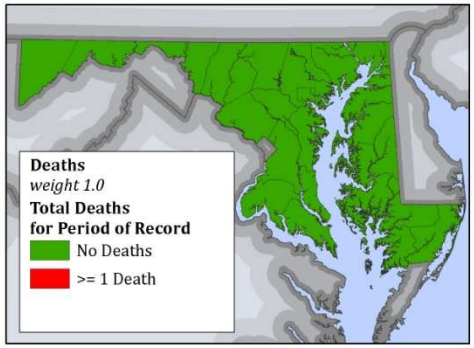

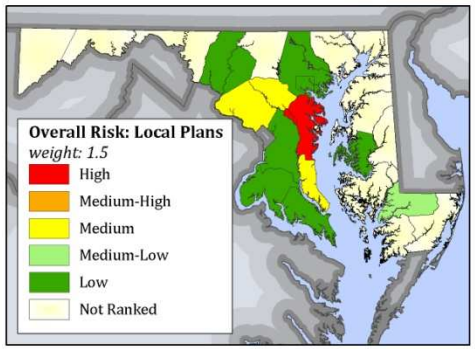

Earthquake Hazard Ranking & Risk Map

State of Maryland
Hazard Mitigation Plan 2011

Hazard Identification & Risk Assessment

A number of factors have been considered in this risk assessment to be able to compare between jurisdictions and hazards. The factors have been added together to calculate the overall total ranking for each hazard.

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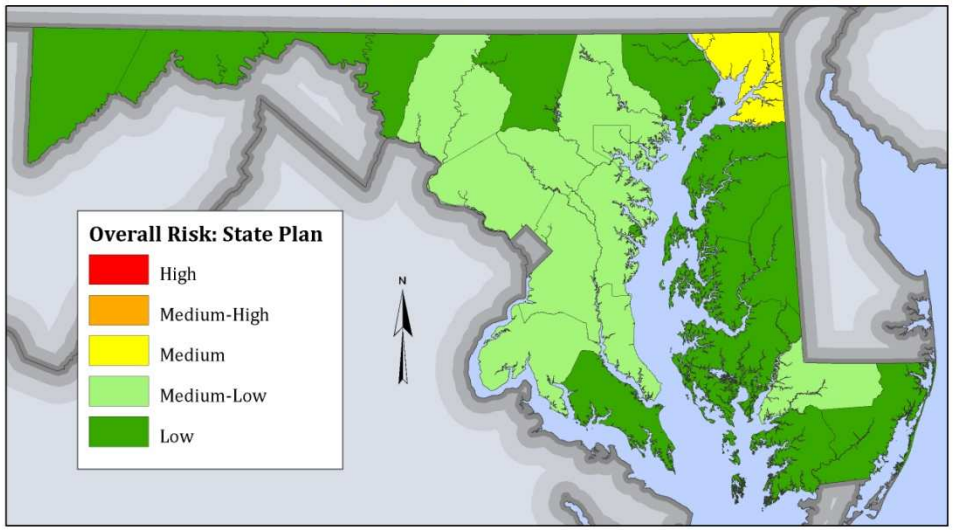

Data Sources
Maryland Emergency Management Agency
Federal Emergency Management Agency
Maryland Local Hazard Mitigation Plans
FEMA HAZUS-MH Earthquake Model
MSHA State & County Boundaries
ESRI State Boundaries

Dewberry

Flood Hazard Ranking & Risk Map

State of Maryland
Hazard Mitigation Plan 2011

Hazard Identification & Risk Assessment

A number of factors have been considered in this risk assessment to be able to compare between jurisdictions and hazards. The factors have been added together to calculate the overall total ranking for each hazard.

*Risk= PV*0.5+PN*0.5+GE*1.5+EV*1.0+ PD*1.0+CD*1.0+DT*1.0+IN*1.0+LP*1.5*
where
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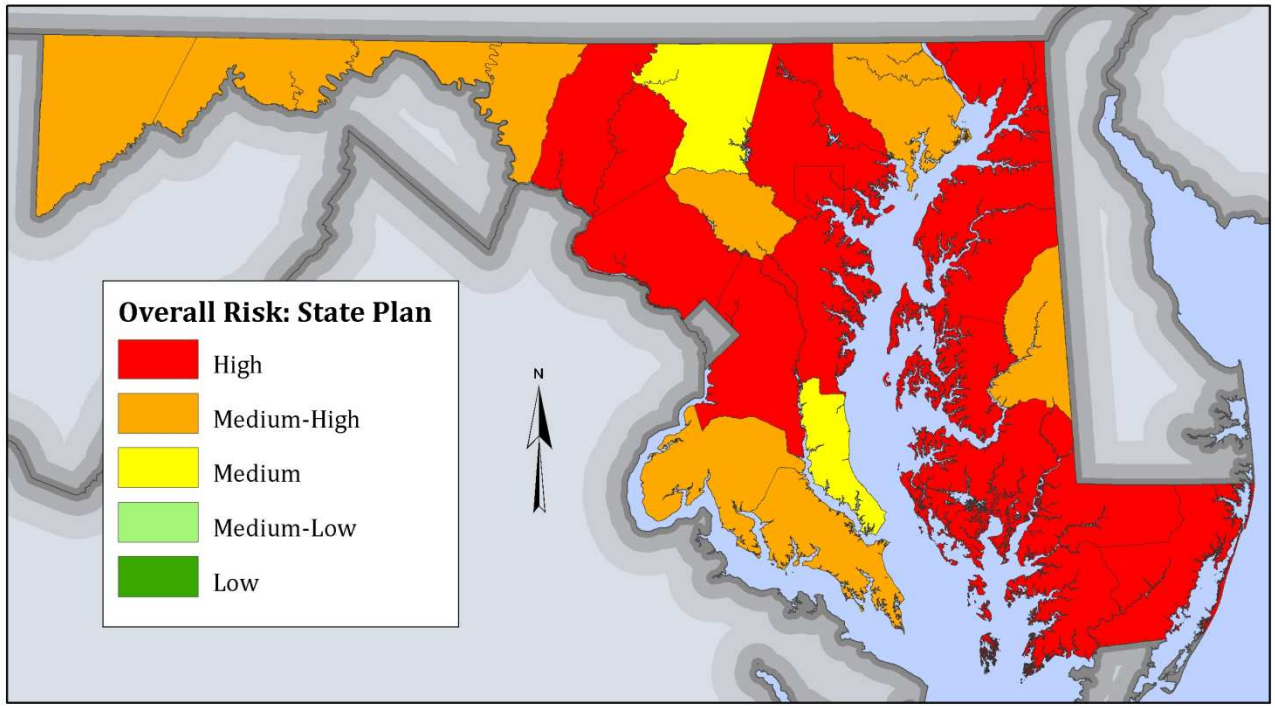

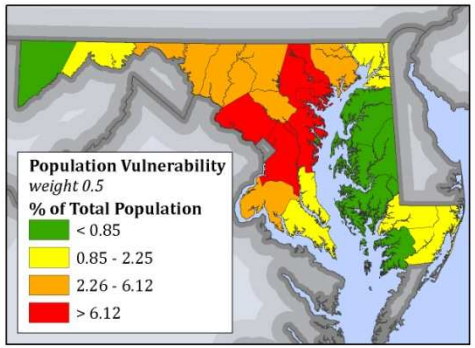

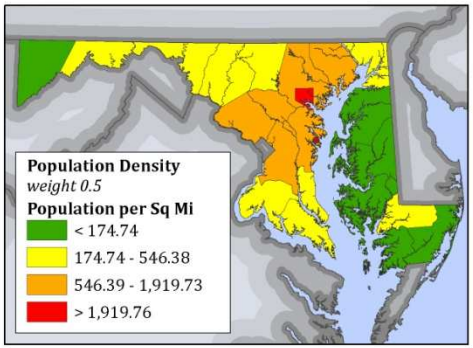

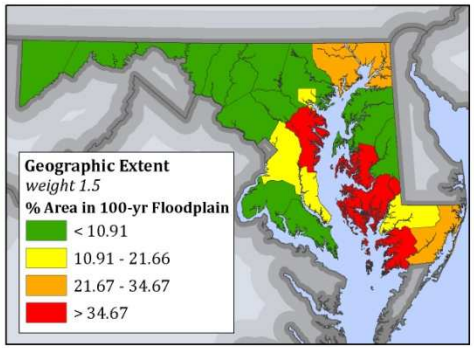

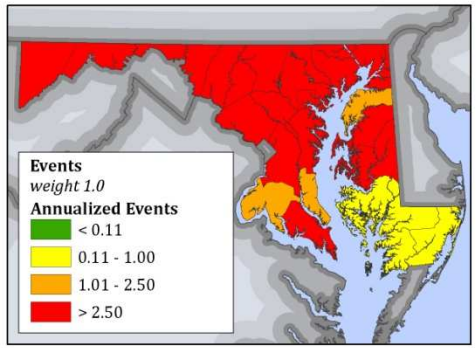

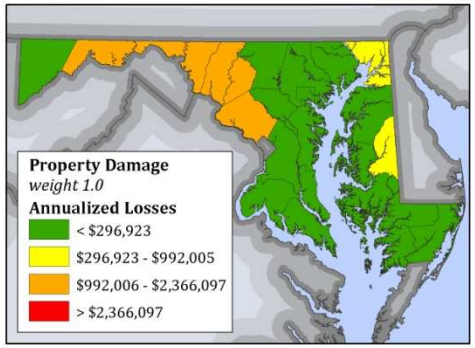

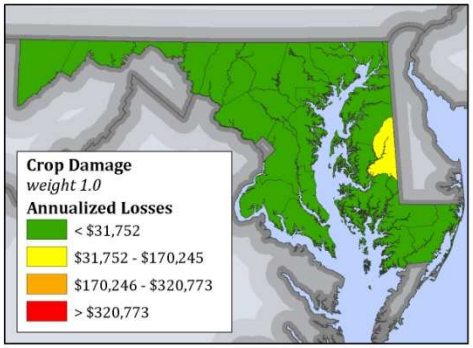

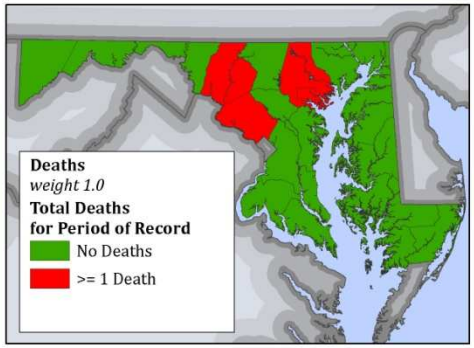

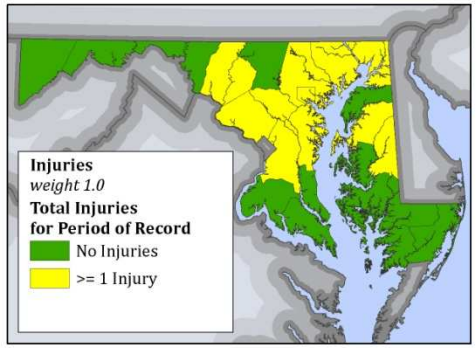

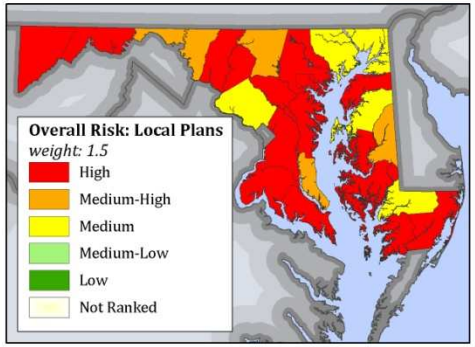

Flood Hazard Ranking & Risk Map

State of Maryland
Hazard Mitigation Plan 2011

Hazard Identification & Risk Assessment

A number of factors have been considered in this risk assessment to be able to compare between jurisdictions and hazards. The factors have been added together to calculate the overall total ranking for each hazard.

*Risk= PV*0.5+PN*0.5+GE*1.5+EV*1.0+ PD*1.0+CD*1.0+DT*1.0+IN*1.0+LP*1.5*
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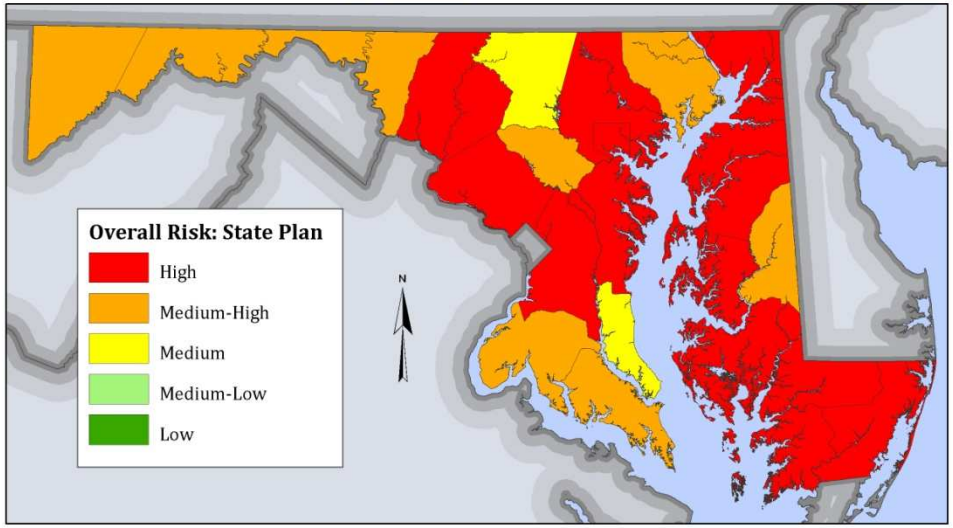

Data Sources
Maryland Emergency Management Agency
Federal Emergency Management Agency
Maryland Local Hazard Mitigation Plans
NOAA NCDC Storm Events (1993-2010)
FEMA DFIRM, Q3 Flood Maps
MSHA State & County Boundaries
ESRI State Boundaries

Dewberry

Landslide Hazard Ranking & Risk Map

State of Maryland
Hazard Mitigation Plan 2011

Hazard Identification & Risk Assessment

A number of factors have been considered in this risk assessment to be able to compare between jurisdictions and hazards. The factors have been added together to calculate the overall total ranking for each hazard.

*Risk= PV*0.5+PN*0.5+GE*1.5+EV*1.0+ PD*1.0+CD*1.0+DT*1.0+IN*1.0+LP*1.5*
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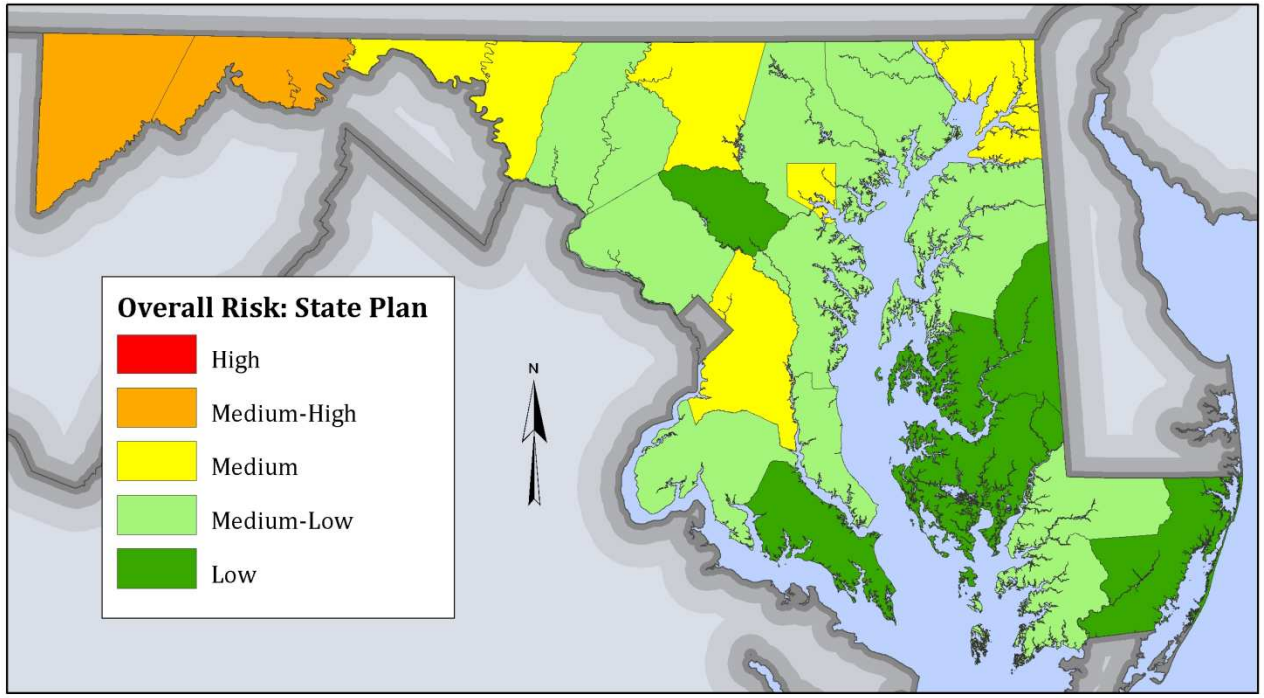

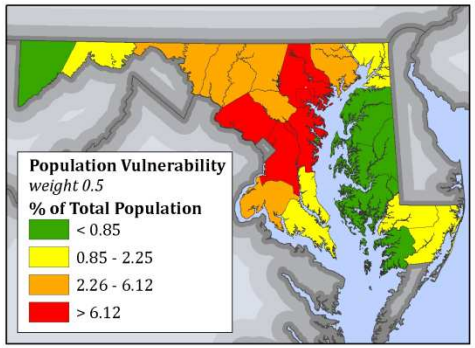

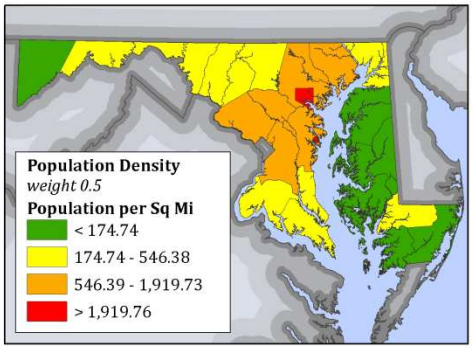

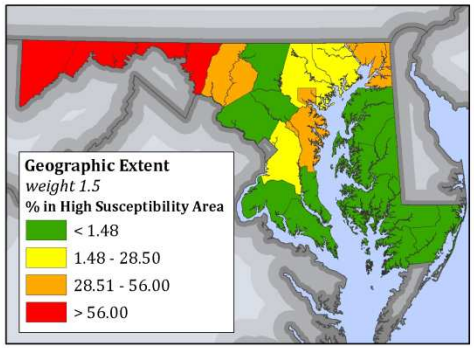

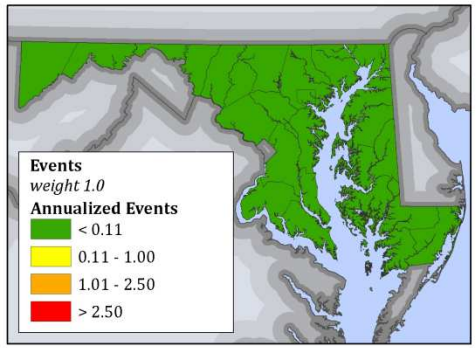

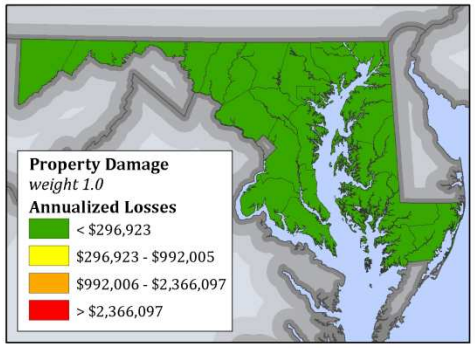

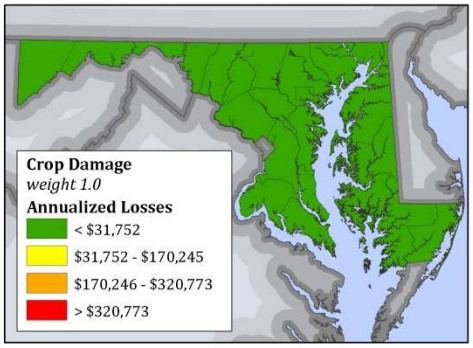

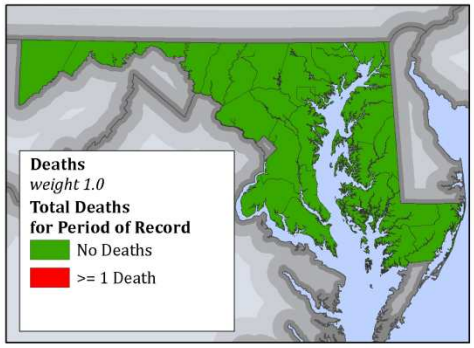

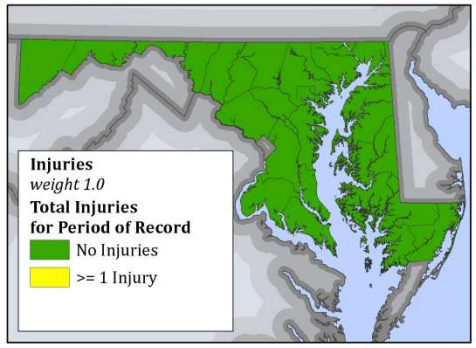

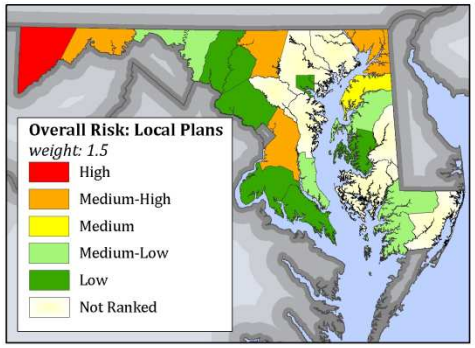

Landslide Hazard Ranking & Risk Map

State of Maryland
Hazard Mitigation Plan 2011

Hazard Identification & Risk Assessment

A number of factors have been considered in this risk assessment to be able to compare between jurisdictions and hazards. The factors have been added together to calculate the overall total ranking for each hazard.

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PN=Population Density
GE=Geographic Extent
EV=Events
PD=Property Damage
CD=Crop Damage
DT=Deaths
IN=Injuries
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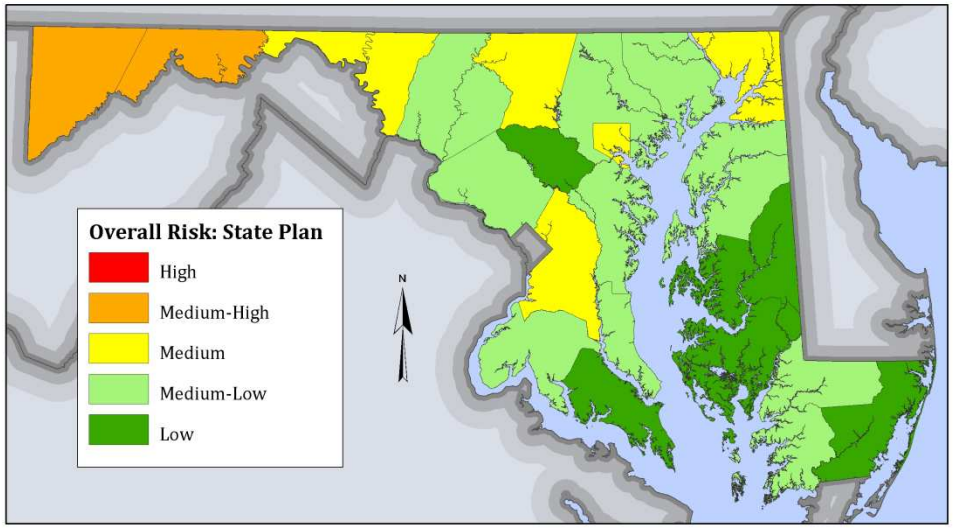

Data Sources
Maryland Emergency Management Agency
Federal Emergency Management Agency
Maryland Local Hazard Mitigation Plans
USGS-NLHP (2001)
MSHA State & County Boundaries
ESRI State Boundaries

Dewberry

Land Subsidence
Hazard Ranking & Risk Map

State of Maryland
Hazard Mitigation Plan 2011

Hazard Identification & Risk Assessment

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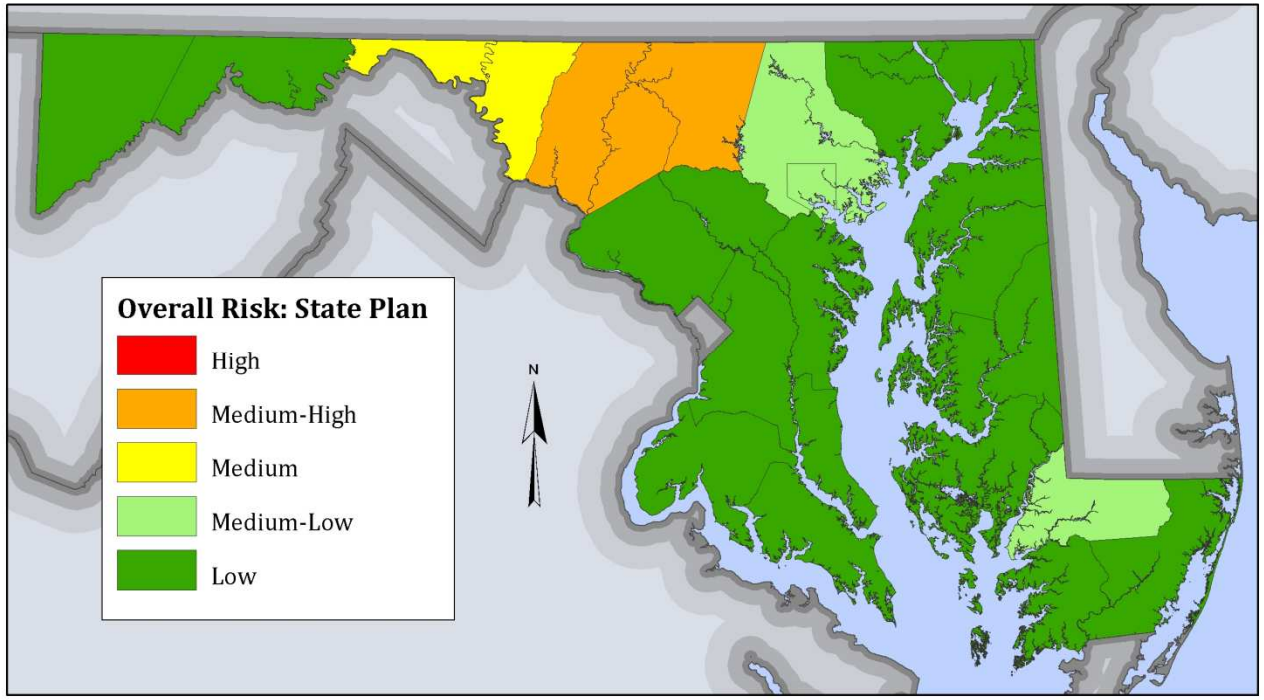

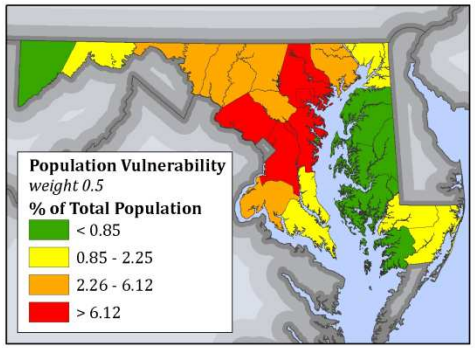

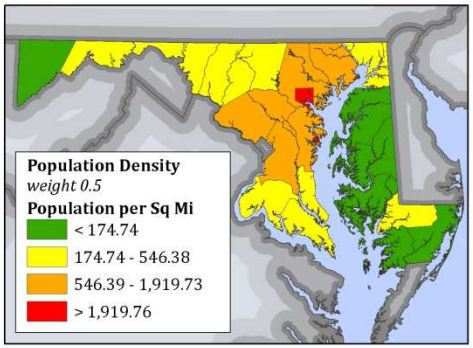

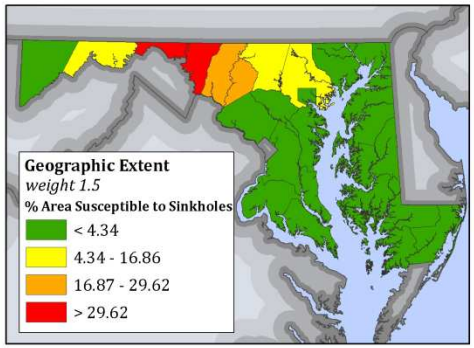

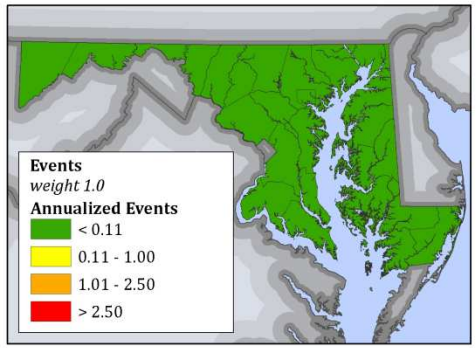

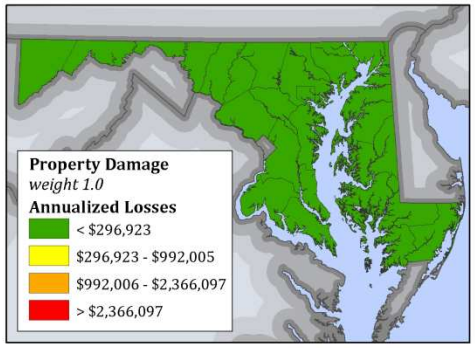

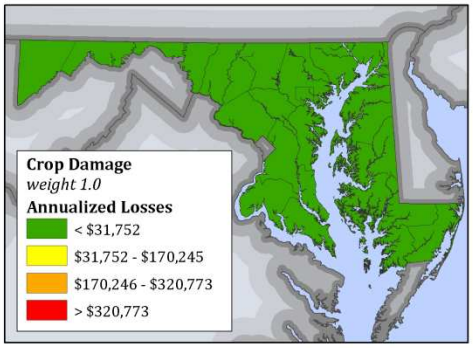

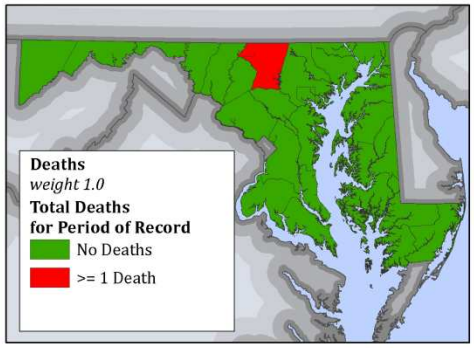

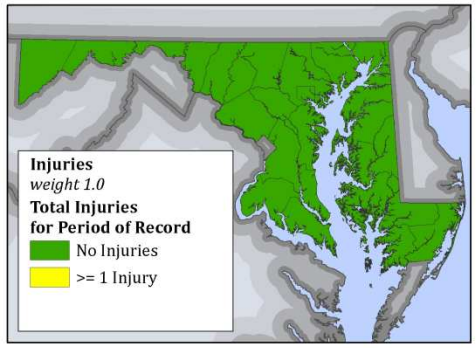

Land Subsidence Hazard Ranking & Risk Map

State of Maryland
Hazard Mitigation Plan 2011

Hazard Identification & Risk Assessment

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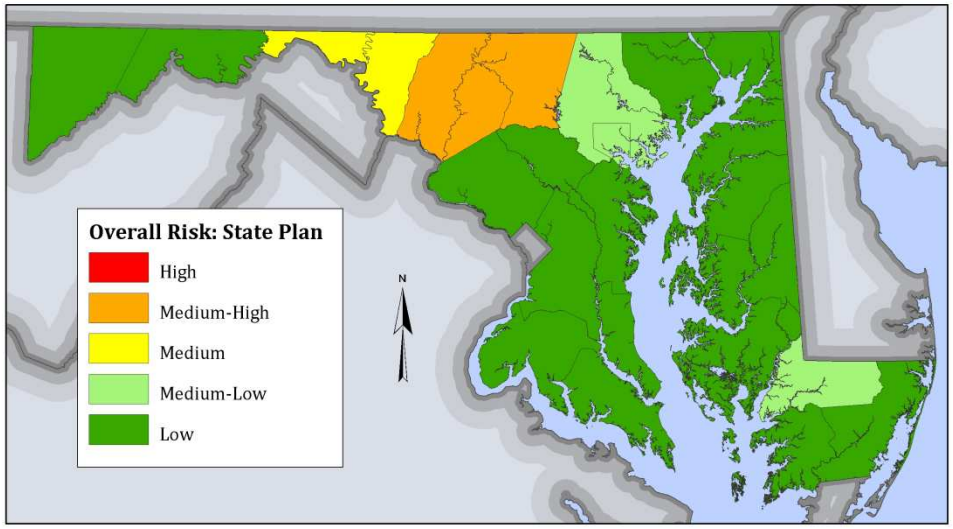

Data Sources
Maryland Emergency Management Agency
Federal Emergency Management Agency
Maryland Local Hazard Mitigation Plans
Maryland Geological Survey
MSHA State & County Boundaries
ESRI State Boundaries

Dewberry

Thunderstorm
Hazard Ranking & Risk Map

State of Maryland
Hazard Mitigation Plan 2011

Hazard Identification & Risk Assessment

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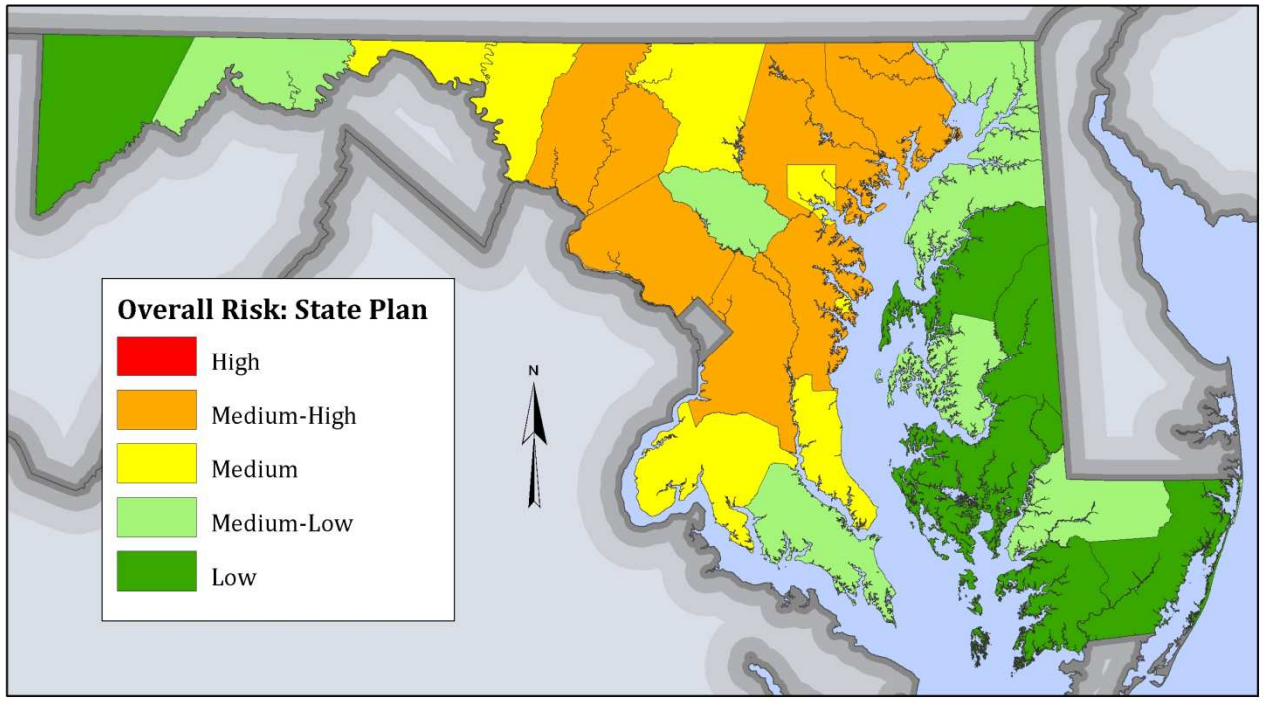

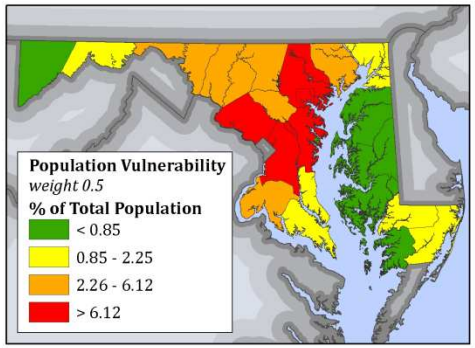

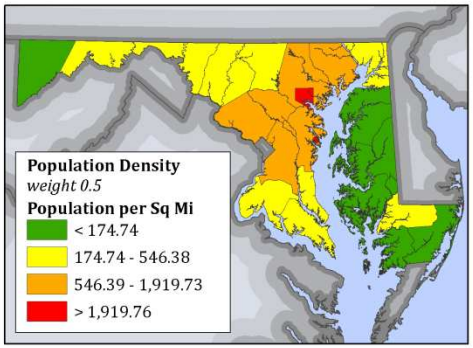

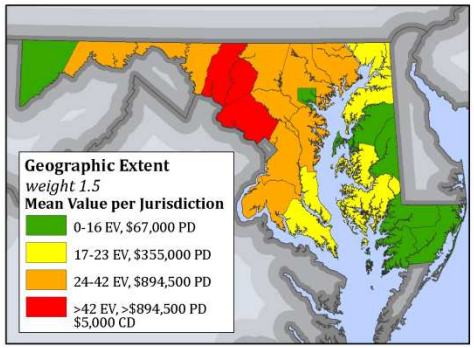

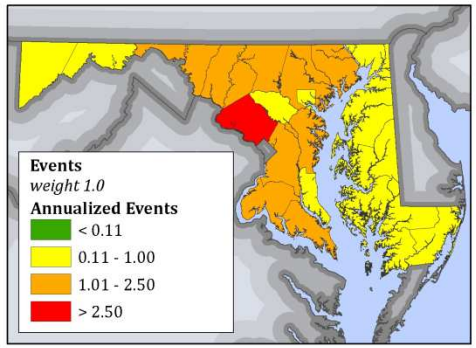

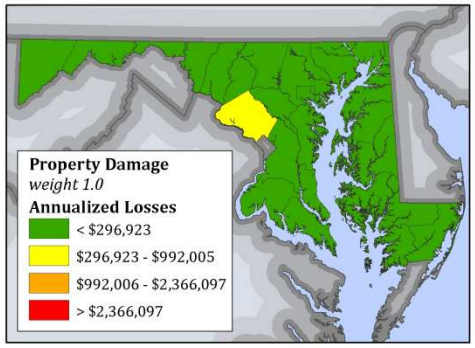

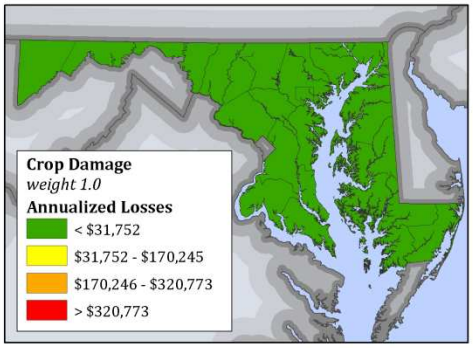

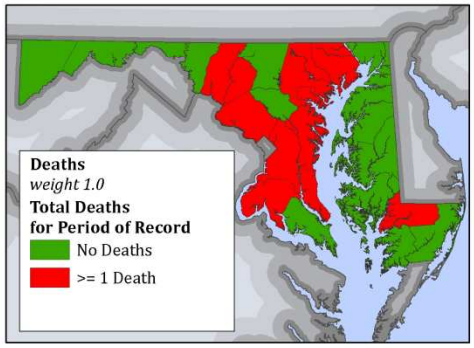

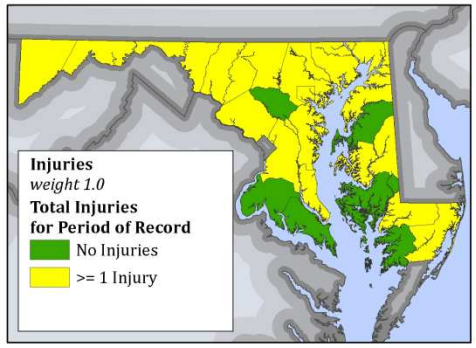

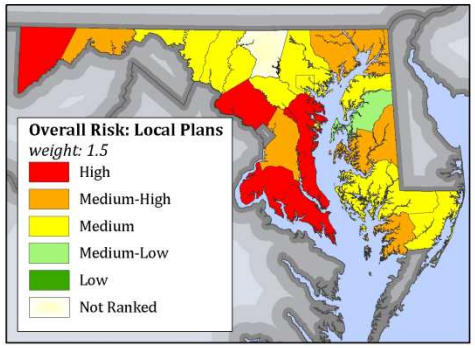

Thunderstorm Hazard Ranking & Risk Map

State of Maryland
Hazard Mitigation Plan 2011

Hazard Identification & Risk Assessment

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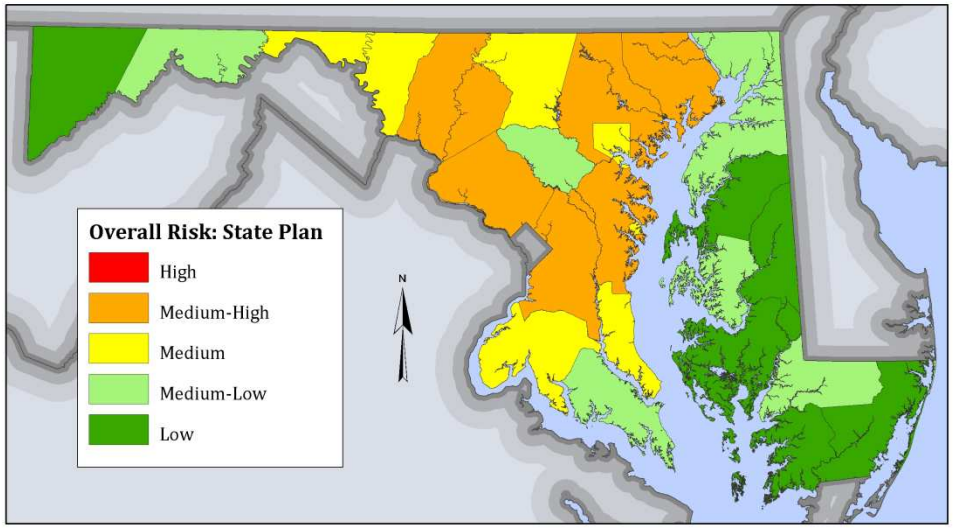

Data Sources
Maryland Emergency Management Agency
Federal Emergency Management Agency
Maryland Local Hazard Mitigation Plans
NOAA NCDC Storm Events (1956-2010)
MSHA State & County Boundaries
ESRI State Boundaries

Dewberry

Tornado Hazard Ranking & Risk Map

State of Maryland
Hazard Mitigation Plan 2011

Hazard Identification & Risk Assessment

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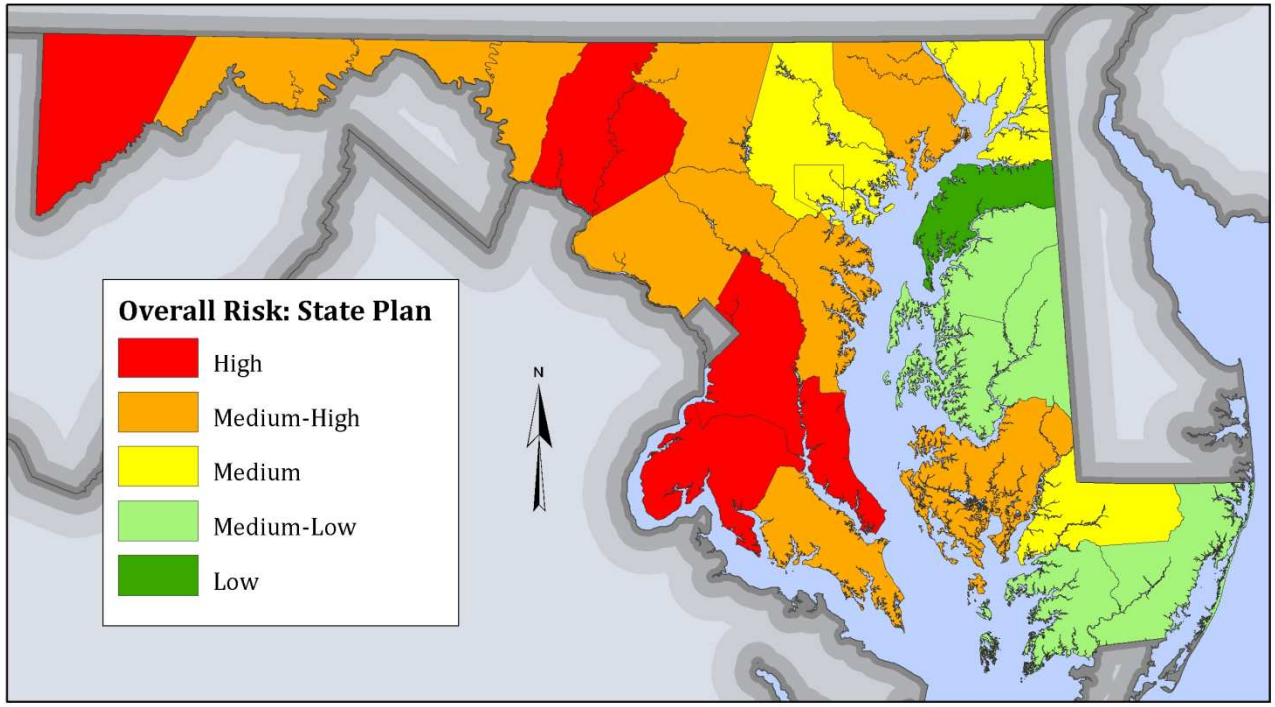

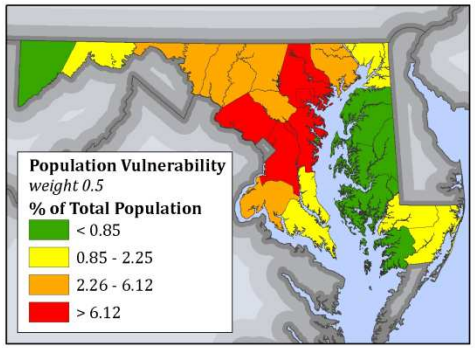

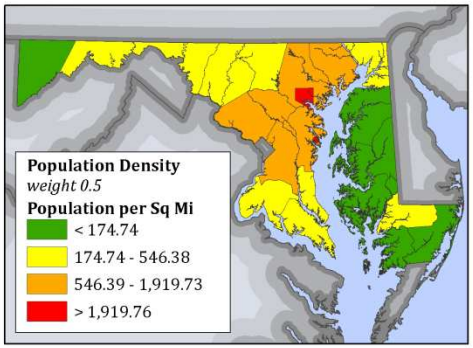

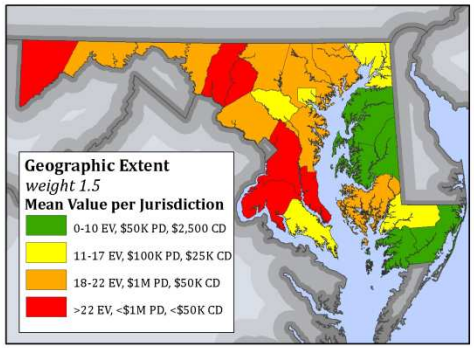

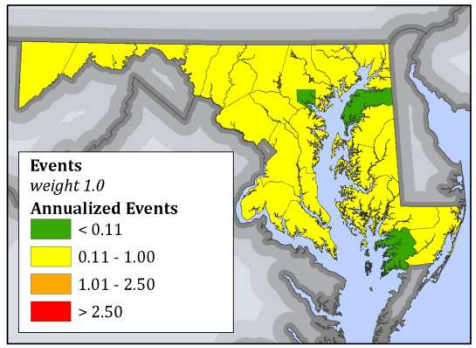

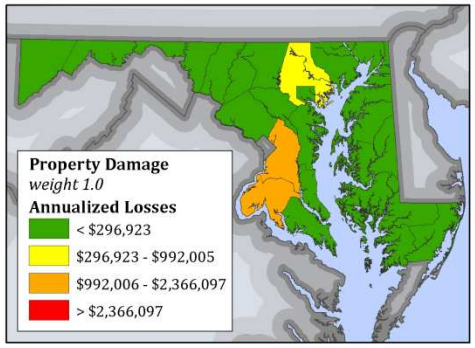

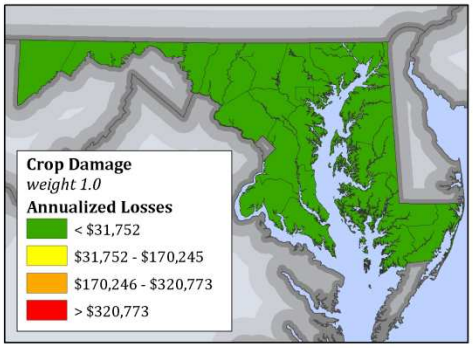

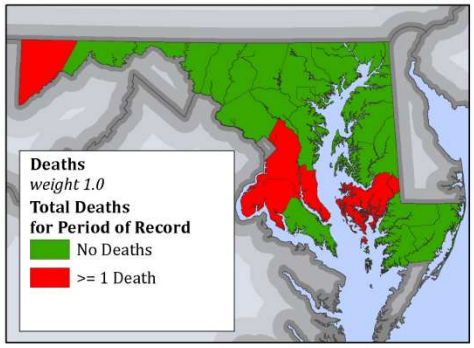

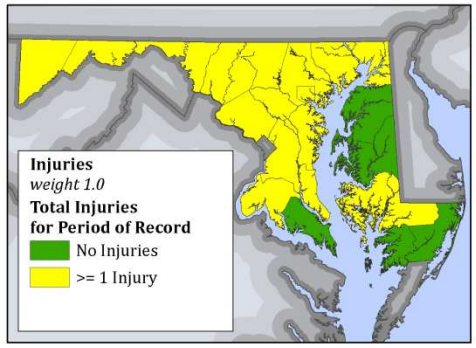

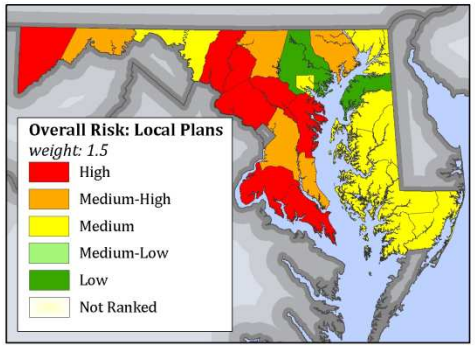

Tornado Hazard Ranking & Risk Map

State of Maryland
Hazard Mitigation Plan 2011

Hazard Identification & Risk Assessment

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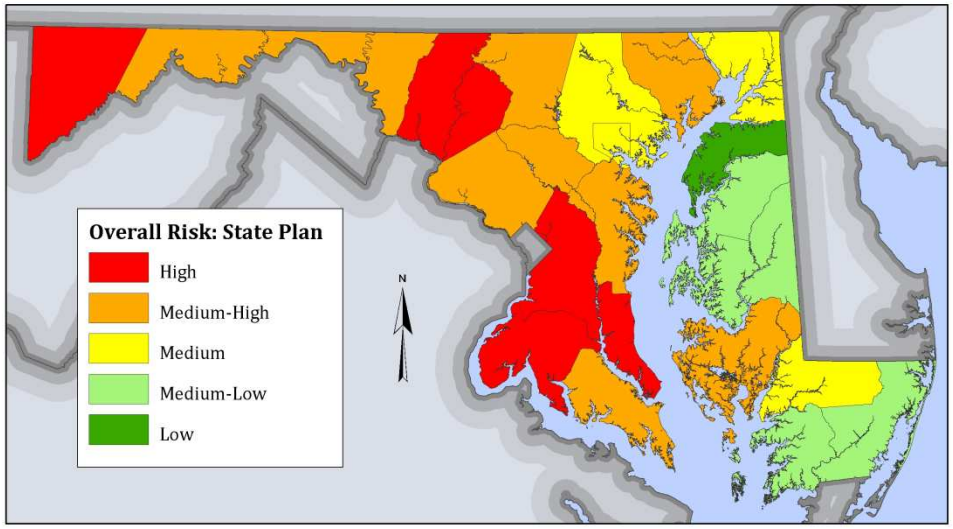

Data Sources
Maryland Emergency Management Agency
Federal Emergency Management Agency
Maryland Local Hazard Mitigation Plans
NOAA NCDC Storm Events (1950-2010)
MSHA State & County Boundaries
ESRI State Boundaries

Dewberry

Wildfire Hazard Ranking & Risk Map

State of Maryland
Hazard Mitigation Plan 2011

Hazard Identification & Risk Assessment

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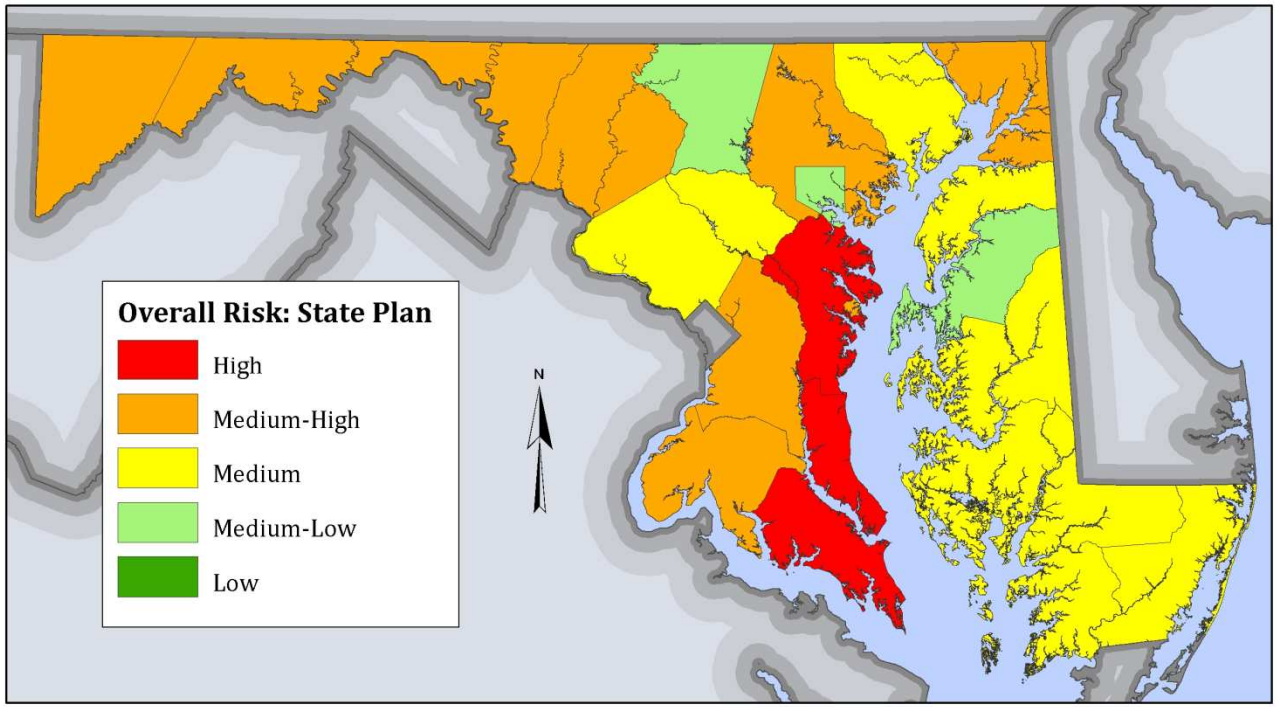

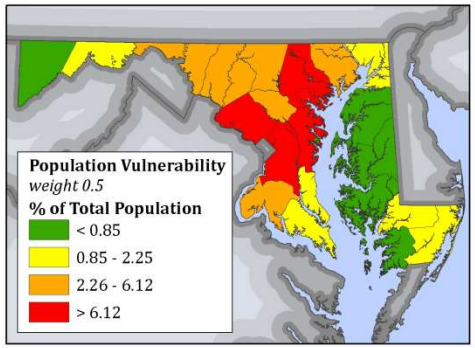

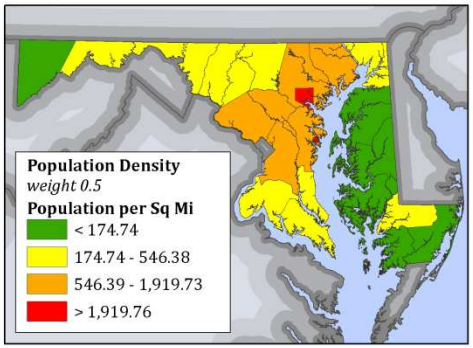

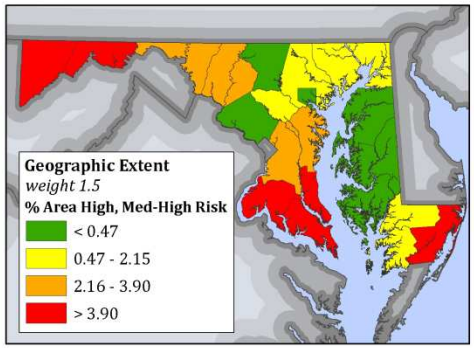

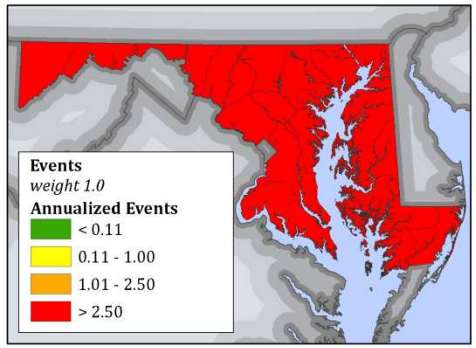

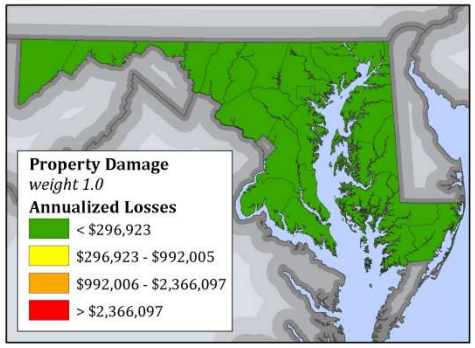

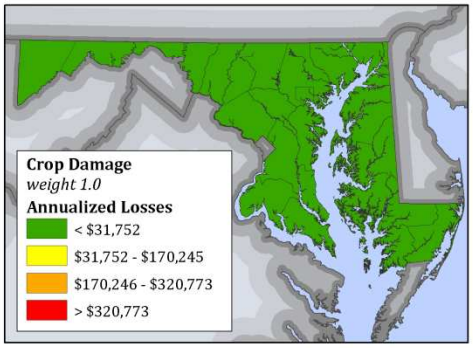

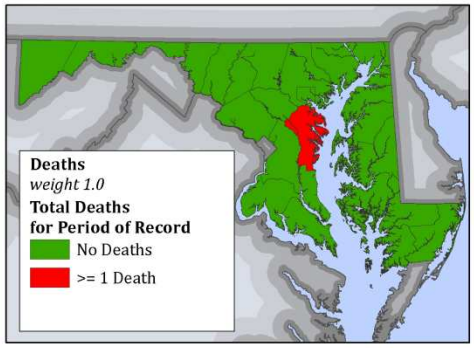

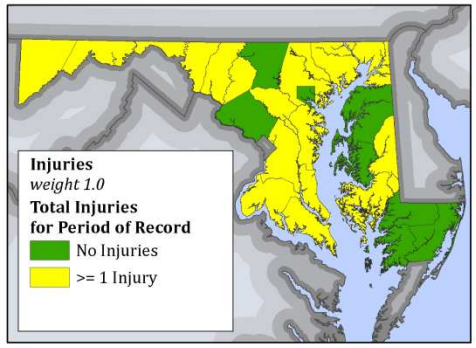

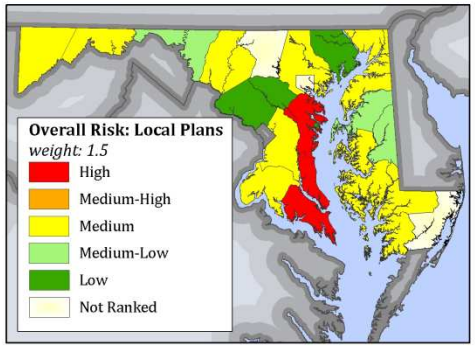

Wildfire Hazard Ranking & Risk Map

State of Maryland
Hazard Mitigation Plan 2011

Hazard Identification & Risk Assessment

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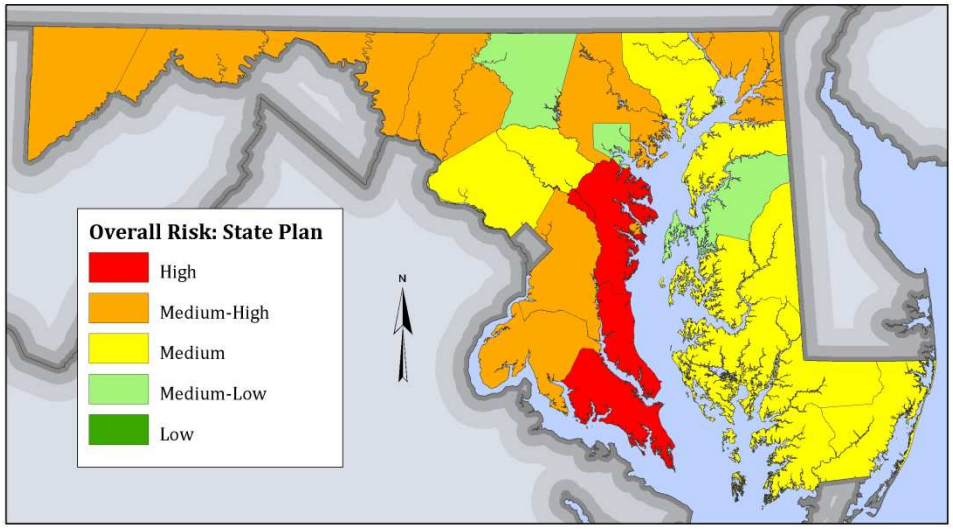

Data Sources
Maryland Emergency Management Agency
Federal Emergency Management Agency
Maryland Local Hazard Mitigation Plans
NOAA NCDC Storm Events (2001-2006)
Maryland Department of Natural Resources – Forest Service (1998-2010)
MSHA State & County Boundaries
ESRI State Boundaries

Dewberry

Wind Hazard Ranking & Risk Map

State of Maryland
Hazard Mitigation Plan 2011

Hazard Identification & Risk Assessment

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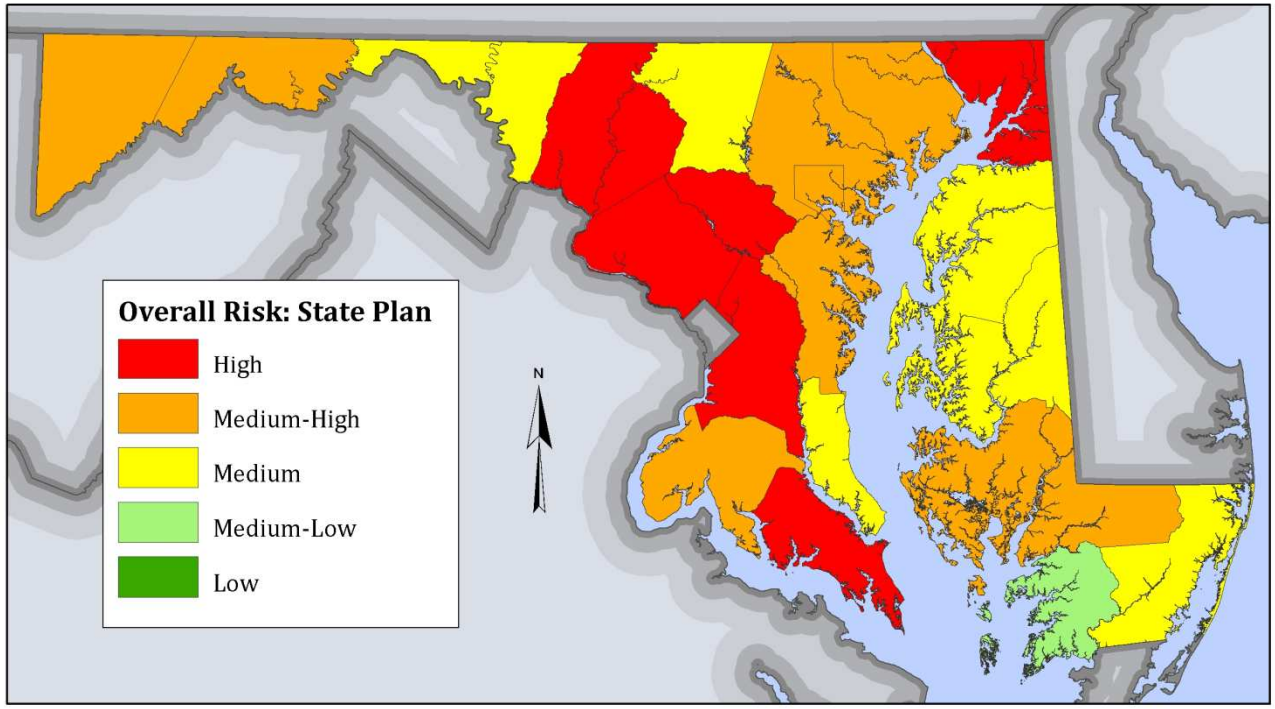
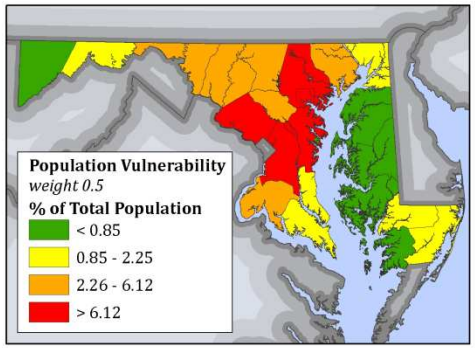
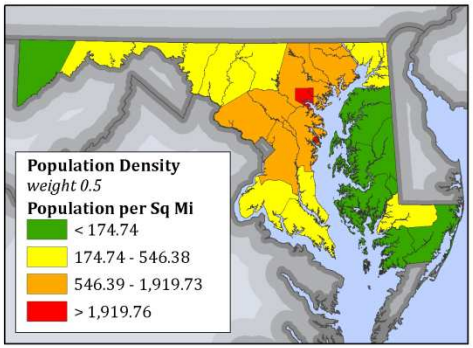
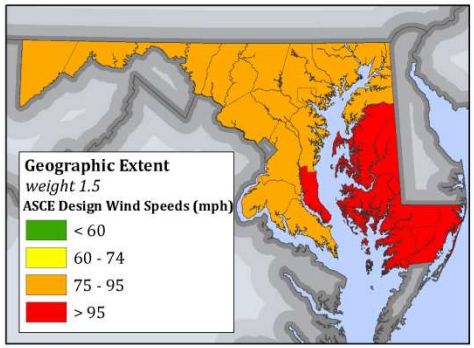
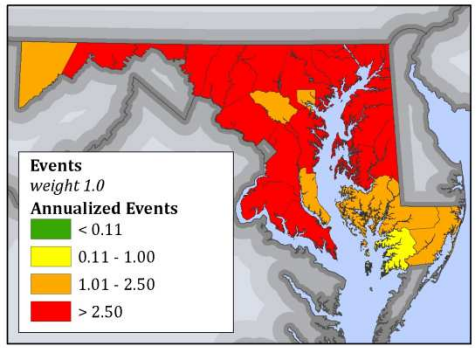
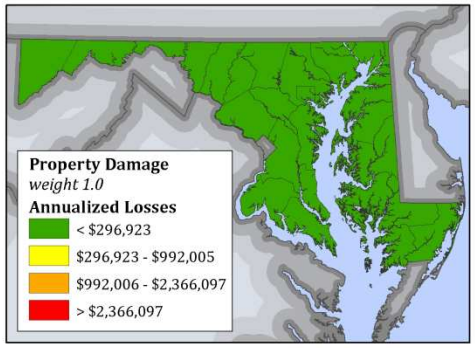


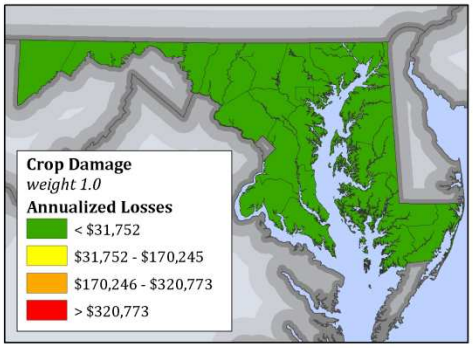


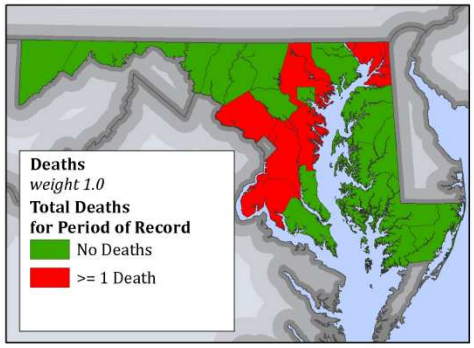


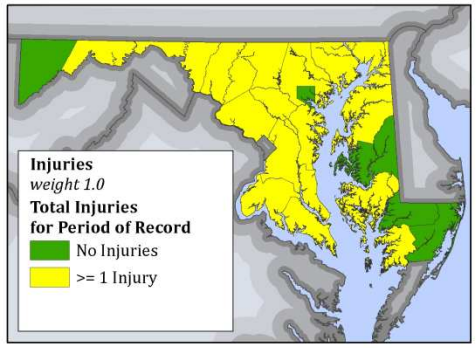


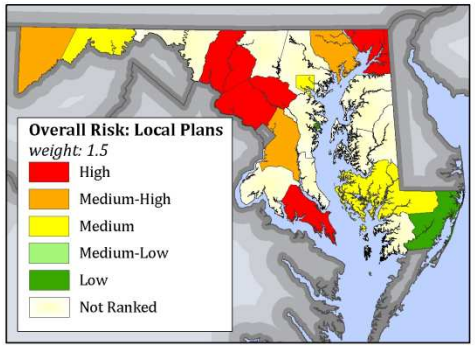












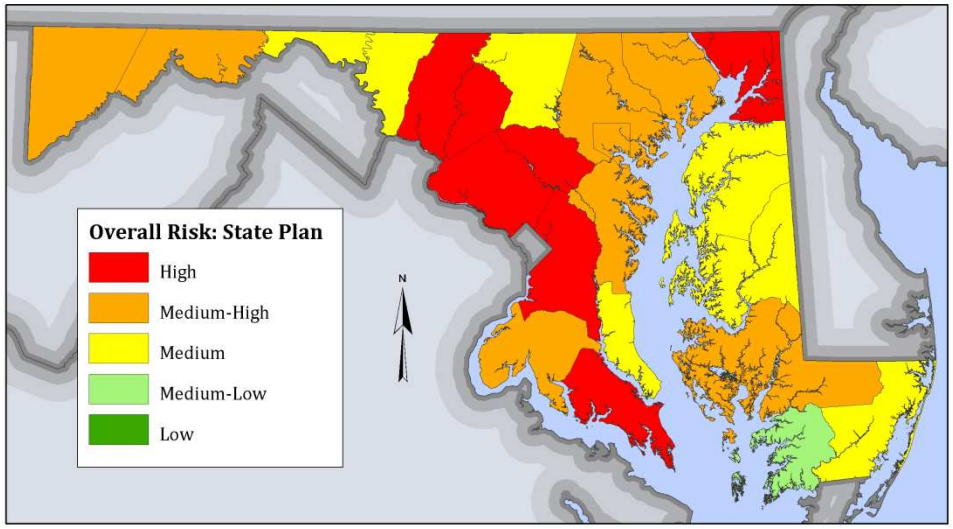
Wind Hazard Ranking & Risk Map

State of Maryland
Hazard Mitigation Plan 2011

Hazard Identification & Risk Assessment

A number of factors have been considered in this risk assessment to be able to compare between jurisdictions and hazards. The factors have been added together to calculate the overall total ranking for each hazard.

*Risk= PV*0.5+PN*0.5+GE*1.5+EV*1.0+ PD*1.0+CD*1.0+DT*1.0+IN*1.0+LP*1.5*
where
PV=Population Vulnerability
PN=Population Density
GE=Geographic Extent
EV=Events
PD=Property Damage
CD=Crop Damage
DT=Deaths
IN=Injuries
LP=Local Plan Risk Assessment



Data Sources
Maryland Emergency Management Agency
Federal Emergency Management Agency
Maryland Local Hazard Mitigation Plans
NOAA NCDC Storm Events (1956-2010)
ASCE Design Wind Speeds
MSHA State & County Boundaries
ESRI State Boundaries

Dewberry

Winter Storm
Hazard Ranking & Risk Map

State of Maryland
Hazard Mitigation Plan 2011

Hazard Identification & Risk Assessment

A number of factors have been considered in this risk assessment to be able to compare between jurisdictions and hazards. The factors have been added together to calculate the overall total ranking for each hazard.

*Risk= PV*0.5+PN*0.5+GE*1.5+EV*1.0+ PD*1.0+CD*1.0+DT*1.0+IN*1.0+LP*1.5*
where
PV=Population Vulnerability
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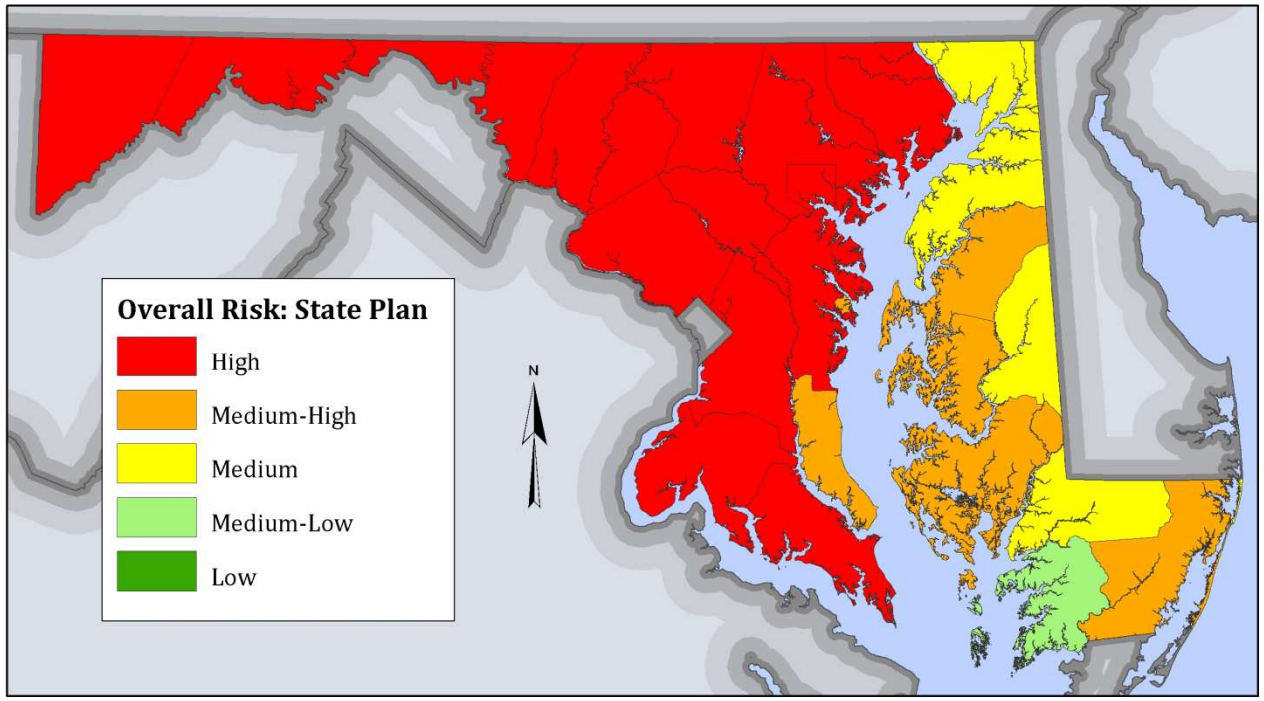
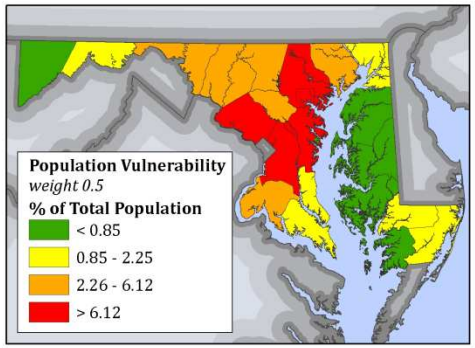
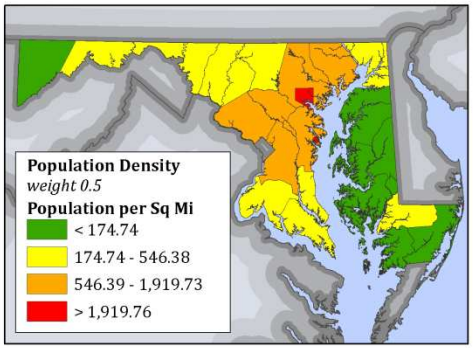
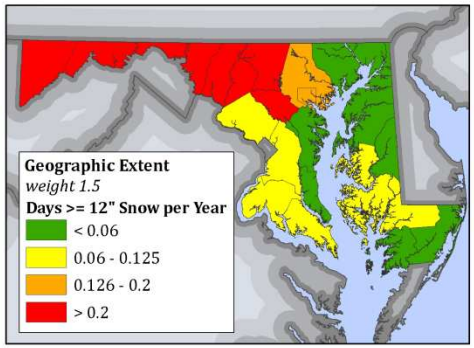
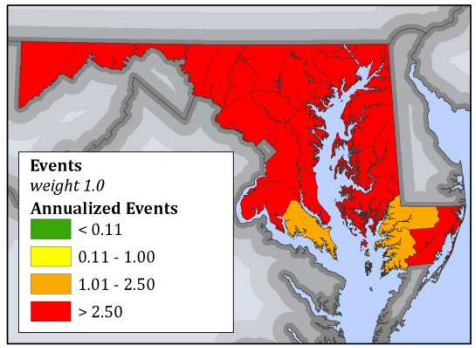
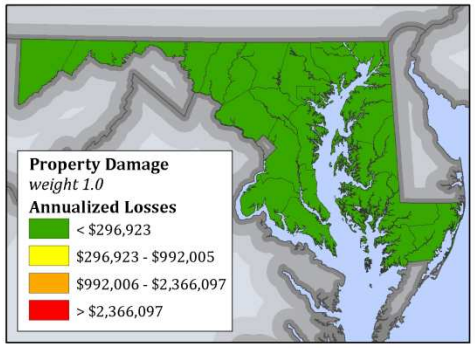


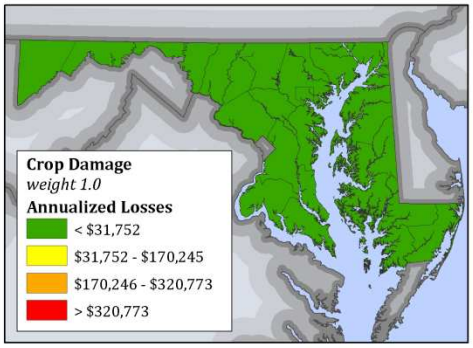


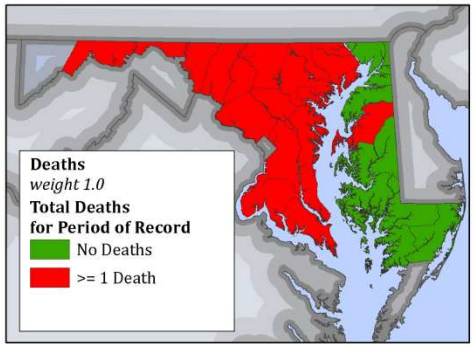


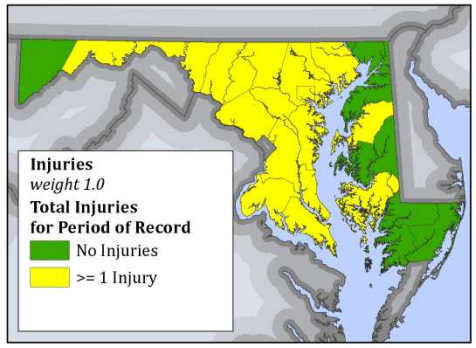


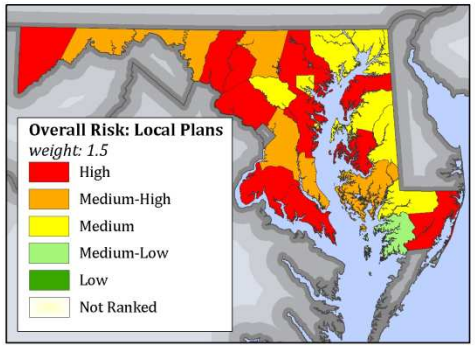












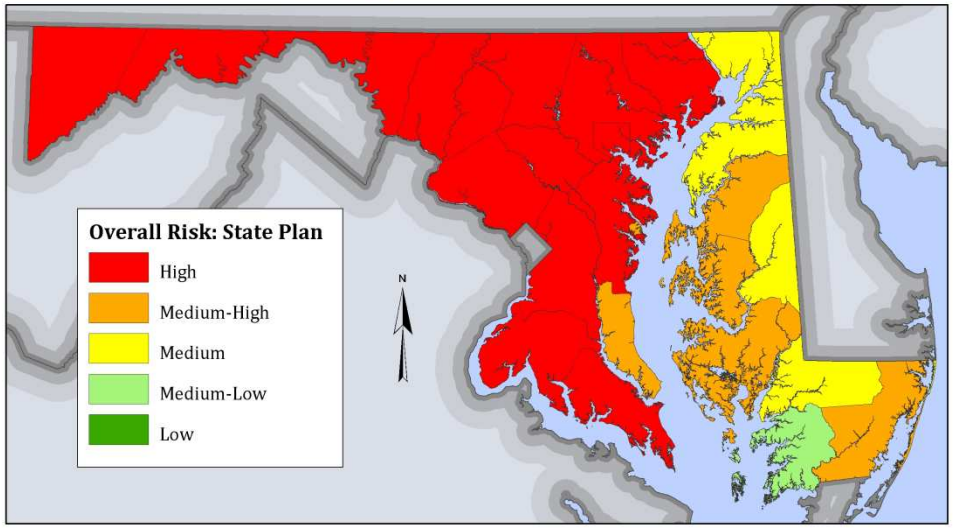
Winter Storm Hazard Ranking & Risk Map

State of Maryland
Hazard Mitigation Plan 2011

Hazard Identification & Risk Assessment

A number of factors have been considered in this risk assessment to be able to compare between jurisdictions and hazards. The factors have been added together to calculate the overall total ranking for each hazard.

*Risk= PV*0.5+PN*0.5+GE*1.5+EV*1.0+ PD*1.0+CD*1.0+DT*1.0+IN*1.0+LP*1.5*
where
PV=Population Vulnerability
PN=Population Density
GE=Geographic Extent
EV=Events
PD=Property Damage
CD=Crop Damage
DT=Deaths
IN=Injuries
LP=Local Plan Risk Assessment



Data Sources
Maryland Emergency Management Agency
Federal Emergency Management Agency
Maryland Local Hazard Mitigation Plans
NOAA NCDC Storm Events (1993-2010)
MSHA State & County Boundaries
ESRI State Boundaries

Dewberry

Thank You.

For taking this time to contribute to the 2011 Maryland State Hazard Mitigation Plan Update. go on to take the survey that we have prepared in order to receive your input on what YOU think are your greatest hazards. If, at that point you would like to seek more information, on the plan or on what your state is doing to reduce the threat of those hazards, please review the actual *2011 Maryland State Hazard Mitigation Plan Update*. That document can be found back on the main page. You are also welcome to attend our "Regional Open Houses". Details on where and when those will be taking place can also be found on the main page.

For questions specific to the Vulnerability Analysis and how these hazards were ranked, please email rtowell@dewberry.com.
For questions or comments in general, email dmills@dewberry.com.

If you would like information on what you can do to prepare for these hazards, please visit Ready.gov

Thank you for your time.

Sincerely,

The *2011 Maryland State Hazard Mitigation Plan Update* Team

Risk

***1. What jurisdiction do you live in?**

2. How likely is your neighborhood or home to be impacted by a disaster?

- Very likely
- Somewhat likely
- Not very likely

3. Have you been impacted by a disaster in your current residence?

- Yes
- No

4. If yes, what type of disasters have you have been impacted by? (select all that apply) If no, skip to the next page.

- Coastal Storm (with or without flooding)
- Dam Failure
- Drought
- Earthquake
- Extreme Heat
- Extreme Cold
- Flood
- Karst/Sinkhole
- Landslide
- Other (please specify)
- Mining/Marcellus Shale
- Sea Level Rise
- Shoreline Erosion
- Thunderstorm
- Tornado
- Wildfire
- Wind
- Winter Storm
- I have not been impacted a by a disaster

5. Which of the following hazards pose the most risk to you and your family? Please select the top three.

- ☐ Coastal Storm (with or without flooding)
- ☐ Dam Failure
- ☐ Drought
- ☐ Earthquake
- ☐ Extreme Heat
- ☐ Extreme Cold
- ☐ Flood
- ☐ Karst/Sinkhole
- ☐ Landslide
- ☐ Mining/Marcellus Shale
- ☐ Sea Level Rise
- ☐ Shoreline Erosion
- ☐ Thunderstorm
- ☐ Tornado
- ☐ Wildfire
- ☐ Wind
- ☐ Winter Storm

Other (please specify)

6. Are there specific areas in your community that are subject to the hazards listed above? If so please list them with as much detail as possible; include addresses, instersections, building names, etc.

Readiness

7. If a severe hazard event occurred today such that all services were cut off from your home (power, gas, water, sewer) and you were unable to leave or access a store for 72 hours, which of these items do you have readily available?

- ☐ 3 Gallons Potable Water (1 gallon per person per day)
- ☐ Cooking and eating utensils
- ☐ Can Opener
- ☐ Canned / Non-perishable Foods (ready to eat)
- ☐ Gas grill / Camping stove
- ☐ Extra Medications
- ☐ First Aid Kit/Supplies
- ☐ Portable AM/FM Radio (solar powered, hand crank,or batteries)
- ☐ Handheld "Walkie-Talkie" Radios (with batteries)
- ☐ Important Family Photos/Documentation in a water and fire proof container
- ☐ Extra Clothes and Shoes
- ☐ Blanket(s)/ Sleeping Bag(s)
- ☐ Cash
- ☐ Flashlight (with batteries)
- ☐ Gasoline
- ☐ Telephone (with batteries)
- ☐ Pet Supplies

What else do you have in your emergency kit?

8. Have you taken any actions within your home or on your property to prevent damage from any of the the above hazards?

- ○ Yes
- ○ No

9. If yes, what kind of actions have you taken? If no, skip to the next question.

- ☐ Installed backflow prevention device(s)
- ☐ Defensible space landscaping (clear vegetation around house to reduce wildfire risk)
- ☐ Roof retrofit using fire resistant material
- ☐ Installation of fire sprinklers
- ☐ Installation of fire hydrant or above ground water storage tank
- ☐ Strengthened openings (Doors, windows, and/or garage door to reduce high-hazard wind risk)
- ☐ Constructed a tornado safe room
- ☐ I have not taken any actions to protect my property

Other (please specify)

10. If you are a homeowner, do you have adequate basic homeowners insurance to cover the hazards that may impact your home?

- ○ Yes, my insurance coverage should be adequate
- ○ No, I don't believe my insurance coverage would be adequate for a major disaster
- ○ I do not have an insurance policy
- ○ Unsure
- ○ Not applicable, I rent my current residence

11. If you rent your current residence, do you have renter's insurance?

- ○ Yes
- ○ No
- ○ Not Applicable, I own my residence

12. Do you have flood insurance?

- ○ Yes, I own my home and have flood insurance
- ○ Yes, I rent my home and have flood insurance
- ○ No

13. Please note any additional insurance you have on your home, such as wind insurance.

Response

14. What are the most important things your state government can do to help your community be more prepared for a disaster? (check all that apply)

- [ ] Provide effective emergency notifications and communication
- [ ] Train and educate residents and business owners
- [ ] Distribute emergency preparedness materials to schools and other public locations
- [ ] Conduct emergency planning for vulnerable populations
- [ ] Enact and enforce regulations on land use and building codes (i.e. new construction in floodplains)
- [ ] Build infrastructure to protect the community (i.e. more storm sewers, or seawalls)

Other (please specify)

15. What recomendations do you have for the Maryland State Emergency Management Agency to improve its response to disasters?

16. Please provide any additional comments, questions or concerns related to Maryland's disaster readiness.

Thank you for taking the time to contribute to this project. Your input is valuable.

Additional Information

Keep this information.

For information on how to prepare for a disaster, visit:
http://www.ready.gov/

For information on flood insurance options, visit:
http://www.floodsmart.gov/floodsmart/

For information on what your state is doing to prepare for a disaster, visit:
http://www.MEMA.state.md.us/

Appendix P – Supplementary HIRA Documents and Data

Portions of this appendix not included in this section are available for electronic review by contacting the Maryland State Hazard Mitigation Officer:

Mark D James
Acting State Hazard Mitigation Officer
Maryland Emergency Management Agency
Camp Fretterd, 5401 Rue Saint Lo Drive,
Reisterstown, MD 21136
410 517 3649
mjames@mema.state.md.us

Contents:

- Hazard Ranking and Vulnerability Analysis Methodology
- HIRA Data Sources
- State and Critical Facility Databases
- HAZUS Analysis
- Maps

Federally Declared Disasters and NCDC Hazard Category Grouping

Hazard Type Compilation. Federally Declared Disaster data from the previous hazard mitigation plans was used to initiate disaster record update. Once the data from the new sources was compiled and all available missing data was added, the data was ready to be processed into the hazard categories used in this HIRA. Descriptions of the disasters can vary quite dramatically and as a result they needed to be grouped into broad hazard type categories for comparison. Appendix P shows how the declared disaster categories were grouped into the HIRA hazard categories.

It should also be noted that since many of these disaster declarations include multiple hazards and cover large areas, there is the possibility that a municipality has received funding for a hazard that did not occur in that particular municipality. For example, an event that included severe storms, flooding and tornadoes may have only produced a tornado in one county, while disaster assistance was provided to multiple counties. Without examining disaster data for each specific local government, there is no simple method to separate these events. To visualize the number of different disaster types that have impacted Maryland, the maps showing individual federally declared disasters have been double counted (or more) when different hazards have occurred during a single event. Section 3.7 includes discussion of mitigation funding and projects completed.

For example, the storm from June 22 – July 12, 2006 (DR1652MD) was classified by FEMA as "Flooding, Tornado and Wind". To depict these as separate events, each designated county was given a score of one for each of the event types for this specific declared disaster. Each declared disaster is represented from the assigned FEMA categories. This may result in some types of categories not being fully represented. The total number of declared disasters does not double count disaster declaration. The sum of total number of individual hazard events per county exceeds the total number of declared disasters for Maryland for the reasons discussed above.

Table P-1. Hazard type compilation for comparison of declared disasters and HIRA hazard categories.

HIRA Categories	Federal Disaster Categories Included
Coastal	Hurricane Floyd Hurricane Fran Hurricane Isabel Tropical Storm Agnes Severe Storms, High Tides, Flooding
Flood	Flooding Heavy Rains, Flooding Severe Storms, Flooding Severe Storms, Flooding and Tornadoes Severe Storms, High Tides and Flooding Hurricane Floyd Hurricane Fran Hurricane Isabel Tropical Storm Agnes
Tornado	Tornado Severe Storms, Flooding and Tornadoes
Wind	Severe Storms, Flooding Severe Storms, Flooding, Tornadoes Severe Storms, High Tides, flooding Severe Storms, High Winds Severe Storms, Tornadoes and Flooding
Winter Storm	Blizzard Ice Conditions Ice Storms, Severe Storm, Winter Storm Severe Snowfall and Winter Storm Snowstorm Winter Storm

NCDC

The NWS does not guarantee the accuracy or validity of the information. Although the historical records in the database often vary widely in their level of detail, the NWS does have a set of guidelines for use in the preparation of event descriptions which were followed in preparation of this hazard analysis.[1]

Processing of the NCDC data was necessary to be able to use the data for analysis. Below is a summary of the processing completed on the NCDC storm events data.

[1] National Water Service Instruction 10-1605. Operations and Services Performance: Storm Data Preparation Guide. August 17, 2007. Available at: http://www.nws.noaa.gov/directives/sym/pd01016005curr.pdf

Normalizing NCDC Data. To accurately count the number of events occurring in a single county, the zonal data records were expanded into a set of individual city/county records, based on NCDC zone definitions. For example, if there were three political jurisdictions in a given zone, a record in the database for a winter storm covering that zone were replaced with three records for that storm, corresponding to each of the political jurisdictions. During this process, the damages, deaths and injuries associated with a storm event in a certain zone were divided evenly among the political jurisdictions in that zone. The amount of effort to properly assign the zonal events with damages, deaths and injuries was beyond the scope of this project.

Table P-2 shows the normalized sum of all the counties, by hazard, for the NCDC fields of interest. Each event in this table represents a storm event affecting a single county. For the hazards of interest, this database includes 7,006 events, close to $779 million in property damage, $17.3 million in crop damage, 944 injuries and 55 fatalities.

Inflation of Crop and Property Damages. Damages entered into the NCDC Storm Events database portray how much damage was incurred in the year of the event. Due to inflation and the changing value of money, the values of damages incurred have been adjusted to 2011 dollars. This was accomplished using the U.S. Bureau of Labor Statistics annual index of Consumer Prices. Each value was multiplied by the index of its year of occurrence and subsequently divided by the index value in 2011, the target year.

Table P-2. NCDC storm events normalized for zonal events and inflated.

Hazard Type	Period of Record	Number of Events	Property Damage (2011 $)	Crop Damage (2011 $)	Injuries	Deaths
Coastal	1993-2010	66	$109,050,194	$193,215	201	1
Drought	1995-2010	75	$0	$13,903,863	0	0
Flood	1993-2010	1,179	$121,538,808	$1,400,983	64	16
Thunderstorm (hail & lightning)	1956-2010	1,216	$33,461,165	$821,890	73	13
Tornado	1950-2010	339	$463,257,911	$719,906	314	7
Wildfire	2001-2006	10	$0	$0	2	0
Wind	1956-2010	3,462	$47,362,158	$306,871	122	8
Winter Storm	1993-2010	659	$4,307,752	$13,620	168	10

Annualizing NCDC Data. After the data was normalized, inflation accounted for, and summary statistics calculated, the data was annualized so that results were comparable using a common system (i.e. ranking the hazards). The parameter or value of interest was divided by the length of record for each hazard. The annualized value should only be used to estimate what can be expected annually. Property and crop damage and events were annualized for each county using this method.

Hazard Type Compilation. The NCDC Storm Events database uses very detailed event categories. The reported storm events were grouped into the major hazard types addressed by this

plan. Table P-3 shows the NCDC categories as reported in the database and the hazard categories used for the HIRA. Section 3.5 on ranking methodologies also explains how the NCDC data was used in ranking the hazards against each other. Several events did not have a county name or location associated with the record. As a result, these events were omitted from the analysis.

Table P-3. Assignment of NCDC Event Categories to Hazard Categories Addressed in the HIRA.

HIRA Categories	NCDC Categories Included
COASTAL	COASTAL FLOOD
	COASTAL FLOODING
	HIGH WINDS/COASTAL FLOOD
	HURRICANE
	STORM SURGE
	STORM SURGE/TIDE
	TIDAL FLOODING
	TROPICAL STORM
DROUGHT	DROUGHT
	DROUGHT/EXCESSIVE HEAT
FLOOD	FLASH FLOOD
	FLASH FLOODING
	FLOOD
	FLOOD/FLASH FLOOD
	FLOODING
	HEAVY RAIN
	Heavy Rain and Wind
	HEAVY RAIN/WIND
	RIVER FLOODING
	URBAN/SML STREAM FLD
	URBAN/SML STREAM FLDG
THUNDERSTORM	HAIL
	LIGHTNING
TORNADO	FUNNEL CLOUD
	LANDSPOUT
	TORNADO
	TORNADO DEBRIS
	WATERSPOUT
WILDFIRE	WILD/FOREST FIRE

HIRA Categories	NCDC Categories Included
	WILDFIRE
WIND	GUSTY WIND
	GUSTY WINDs
	HIGH WIND
	HIGH WINDS
	STRONG WIND
	THUNDERSTORM WIND
	THUNDERSTORM WINDS
	THUNDERSTORM WINDS HAIL
	TSTM WIND
	TSTM WIND/HAIL
	WIND
	WINDS
WINTER STORM	BLIZZARD
	FREEZING RAIN
	FREEZING RAIN AND SLEET
	HEAVY SNOW
	HEAVY SNOW/SLEET
	ICE STORM
	LIGHT SNOW AND SLEET
	SLEET/FREEZING RAIN
	SNOW
	WINTER STORM
	WINTER WEATHER
	WINTER WEATHER/MIX
	WINTRY MIX

Several NCDC hazard types were not considered as part of the ranking as they were not associated with the hazards the MAC agreed to be part of the analysis. These events results in 559 injuries and 104 deaths. Almost all of the injuries and deaths were attributed to excessive heat and are discussed in the narrative of Section 3.16.

Hazards not included in the ranking analysis:

- Agricultural Freeze
- Astronomical Low Tide
- Black Ice
- Cold
- Cold/Wind Chill
- Dense Fog

- Dry Pattern
- Dust Devil
- Excessive Heat or Cold
- First Snow
- Fog
- Freezing Fog
- Frost/Freeze
- Heat, Heat Wave or Heat Spell
- Prolonged Rain
- Rain
- Rip Current
- Smoke
- Snow/Rain
- Unseasonably Cold or Warm
- Unusually Cold or Warm
- Wet Month/Year

Unlike the federally declared disasters, the individual hazard maps do not double count events. To be consistent with the NCDC data, only the dominate hazard type is shown, as is described in the above sections and Table P-2. Most of the events are not associated with a Federal Emergency or Disaster. If the event did occur at the same time as an event that was later determined to be a Federal Emergency or Disaster, it is included with the NCDC data even if it occurred in a county not included with the federal declaration.

State and Critical Facility Analysis

All data is in Maryland State Plane NAD 1983 Meters coordinates.

State Owned Facilities

State facility data was derived from the Maryland State Treasurer's Office February 2011 database. A 2007 version of this database was used for analysis in the 2008 Plan. The updated dataset used in this Plan includes a list of all Maryland State owned property.

For this Plan, the number of State owned facilities in the dataset was reduced to 6,866 from 7,777. Facilities that were located outside the State of Maryland or that did not include an address and latitude and longitude coordinates were deleted from the database. These facilities were saved in a separate Excel spreadsheet within this Appendix so that they may be updated by the State for future updates to this Plan.

For many of the facilities in the dataset, 2010 building and content values were already designated by the State Treasurer's Office. However, if a building value but no content value was included,

the building value was divided by three to produce an estimated content value. If a content value but no building value was included, the content value was multiplied by three to produce an estimated building value. This estimation process was also conducted in the 2008 Plan.

In the GIS database, two fields, "BV_combo" and "CV_combo", were used to sum potential losses. These fields include both the original and estimated building and content values. In some cases, many facilities located on 1 property were assigned the same building and content value. In order to reduce this duplication, only one facility on the entire property was used when summing potential losses. The "comments" field in the GIS database designates if a facility's values include other facilities on the same property.

For the 2008 Plan and for this Plan update, facilities are categorized based on the State agency that owns the facility using the following facility types: Administrative, Airport, Correctional, Department of Natural Resources, Educational, Environmental, Fire and Police Departments, Health Related, Historic, Judicial/Legal, Military, Social Services, Transportation, and Utility/Infrastructure.

The table below lists the State agencies that own property in Maryland, the type of facility, examples of facilities, the number of facilities mapped and analyzed in the GIS database, and the source of the data.

Table P-4. State-Owned facility data used for 2011 hazard analysis and vulnerability.

State Agency Owner	Facility Type	Examples of Facilities	Number of Facilities included in Analysis	Source
Dept of Natural Resources	Dept of Natural Resources	State Parks and Facilities, Manning Hatchery, Carroll Forestry Project	1,918	State Treasurer's Database 2011
MD Dept of Ed HQ	Educational	University of MD Medical Centers, University of MD Systems, MD School for the Deaf	1,256	State Treasurer's Database 2011
Dept of Public Safety and Correctional Services	Correctional	Sudbrook Station, MD Correction Institute Jessup, Metropolitan Transition Center	512	State Treasurer's Database 2011
Department of Mental Health and Hygiene	Health Related	Office of the Secretary, Regulatory Services, Community and Public Health, Family Health Admin, Office of Preparedness and Response, Thomas Finan Hospital Center	492	State Treasurer's Database 2011
Dept of Transportation	Transportation	Radio Tower, Storage, Rest Area, Sheds	460	State Treasurer's Database 2011
MD Institute for Emergency Medical Services	Health Related	Dorchester 911, Harford Memorial, Anne Arundel Fire HQ, MEMA	220	State Treasurer's Database 2011
Dept of Juvenile Services	Correctional	Victor Cullen School, Hickey School	218	State Treasurer's Database 2011
Dept of Human Resources	Administrative	Baltimore City Child Protective Services, Ann Arundel County EOC, Cecil County Homeless Intake Center	176	State Treasurer's Database 2011
Military Department	Military	Military Reservations and Armories	168	State Treasurer's Database 2011
Judiciary	Judicial/Legal	Courthouses, State Attorney Offices	137	State Treasurer's Database 2011
Interagency Comm for Public School Construction	Educational	Loch Raven Academy, Green Valley E., Bowie H.	102	State Treasurer's Database 2011
MD Transportation Authority	Transportation	Point Breeze Maritime Center, Francis Scott Key Bridge	99	State Treasurer's Database 2011

State Agency Owner	Facility Type	Examples of Facilities	Number of Facilities included in Analysis	Source
Saint Mary's City Comm	Historic	Admin Office, Chancellor's Point House, Brown House Garage	97	State Treasurer's Database 2011
Department of General Services	Administrative	Old Treasury Bldg, State House, Annapolis Data Center, Saratoga State Center, Woodstock Center	96	State Treasurer's Database 2011
MD State Police and State Fire Marshalls Office	Police Department/Fire Department	Hagerstown Barracks, Frederick Aviation Hangar, Garages	91	State Treasurer's Database 2011
MD Port Admin	Transportation	Dundalk Terminal, North Locust Point, Clinton St Marine Terminal	81	State Treasurer's Database 2011
Motor Vehicle Admin	Transportation	MVA Locations, VEIP Locations	65	State Treasurer's Database 2011
MD Aviation Admin	Transportation	BWI Main Terminal Area, Martin State Airport	64	State Treasurer's Database 2011
MD Environmental Services	Environmental Related	Sewage Treatment Plant, Landfill, WWTP	61	State Treasurer's Database 2011
Mass Transit Admin	Transportation	Light Rail Facility, Police Substation and Daycare, Kirk Bus Division	60	State Treasurer's Database 2011
MD Dept of Housing and Community Development	Social Services	Foreclosed Properties, Offices	58	State Treasurer's Database 2011
Labor, Licensing, and Regulation	Administrative		49	State Treasurer's Database 2011
MD Dept of Planning	Utility/Infrastructure	Offices, Jefferson Patterson Park and Museum,	47	State Treasurer's Database 2011
Department of Agriculture	Administrative	Mosquito Control, Plant Protection	46	State Treasurer's Database 2011
Office of Public Defender	Judicial/Legal		36	State Treasurer's Database 2011
MD Veterans Commission	Military	Cheltenham Chapel, Easter Shore Garage, MD Vietnam Memorial	36	State Treasurer's Database 2011

State Agency Owner	Facility Type	Examples of Facilities	Number of Facilities included in Analysis	Source
State Board of Elections	Administrative	Local Boards of Election	26	State Treasurer's Database 2011
Department of Assessment and Taxation	Administrative		25	State Treasurer's Database 2011
MD Dept of Environment	Environmental Related	Offices	23	State Treasurer's Database 2011
Comptroller of the Treasury	Administrative		15	State Treasurer's Database 2011
Board of Public Works	Utility/Infrastructure	Conservation Center, Warehouse, Archeology Bldg	12	State Treasurer's Database 2011
Department of Business and Economic Development	Administrative	State Welcome Centers, Offices, MD Arts Council	11	State Treasurer's Database 2011
Department of Legislative Service	Judicial/Legal	Senate Office Bldg, State House	10	State Treasurer's Database 2011
Canal Place Preservation	Historic	Footer Dye Works Bldg, Building D, Boat Replica	8	State Treasurer's Database 2011
MD State Archives Hall of Records	Administrative	MD State Records, UMBC, Candlewood Road Warehouse	7	State Treasurer's Database 2011
Office of Attorney General	Judicial/Legal	Consumer Protection Offices	6	State Treasurer's Database 2011
Workers Comp Commission	Judicial/Legal	Hearing Sites	6	State Treasurer's Database 2011
Property Tax Assessment Appeals Board	Administrative		6	State Treasurer's Database 2011
Office of the Governor	Administrative	State House, Shawn House, Schaefer Tower	5	State Treasurer's Database 2011
MD Commission on Human Relation	Social Services	Easton Office, Eliz. Hager Center	5	State Treasurer's Database 2011

State Agency Owner	Facility Type	Examples of Facilities	Number of Facilities included in Analysis	Source
Stadium Authority	Administrative	Oriole Park, M and T Bank Stadium	5	State Treasurer's Database 2011
MD Food Center Authority	Administrative	MD Wholesale Produce Market, Rock Hall Seafood Processing Plant	5	State Treasurer's Database 2011
Office of Admin Hearings	Administrative		4	State Treasurer's Database 2011
MD Economic Development Corp	Administrative	Offices	3	State Treasurer's Database 2011
Department of Budget and Management	Administrative		3	State Treasurer's Database 2011
Department of IT	Administrative		3	State Treasurer's Database 2011
MD State Lottery	Administrative	Montgomery Park Business Center, Warehouse	2	State Treasurer's Database 2011
Office for Individuals with Disabilities	Administrative	MD Rehabilitation	2	State Treasurer's Database 2011
Office of State Prosecutor	Judicial/Legal		1	State Treasurer's Database 2011
MD Tax Court	Judicial/Legal		1	State Treasurer's Database 2011
Public Service Commission	Judicial/Legal		1	State Treasurer's Database 2011
Office of Peoples Council	Judicial/Legal		1	State Treasurer's Database 2011
Subsequent Injury Fund	Judicial/Legal		1	State Treasurer's Database 2011
Uninsured Red Employers Fund	Judicial/Legal		1	State Treasurer's Database 2011

State Agency Owner	Facility Type	Examples of Facilities	Number of Facilities included in Analysis	Source
Office of Deaf and Hard of Hearing	Administrative	East Redwood	1	State Treasurer's Database 2011
MD Energy Admin	Administrative		1	State Treasurer's Database 2011
Office of Minority Affairs	Administrative	Sheafer Tower	1	State Treasurer's Database 2011
Office of Service and Volunteerism	Administrative		1	State Treasurer's Database 2011
State Ethics Commission	Administrative		1	State Treasurer's Database 2011
Health Claims Arbitration Office	Administrative		1	State Treasurer's Database 2011
Office of Crime Control and Prevention	Administrative	Hampton Plaza	1	State Treasurer's Database 2011
Volunteer MD	Administrative	DHCD Bldg	1	State Treasurer's Database 2011
State Coalition on Criminal Sentencing Policy	Administrative		1	State Treasurer's Database 2011
Grants Office	Administrative	Shaw House	1	State Treasurer's Database 2011
State Labor Relations Board	Administrative		1	State Treasurer's Database 2011
State Commission and Offices	Administrative	Bannneker Douglass Museum	1	State Treasurer's Database 2011
Secretary of State Office	Administrative	Jeffery Bldg	1	State Treasurer's Database 2011
Governor's Office for Children	Administrative		1	State Treasurer's Database 2011

State Agency Owner	Facility Type	Examples of Facilities	Number of Facilities included in Analysis	Source
MD Dept of Aging	Social Services	State Office Complex	1	State Treasurer's Database 2011
State Board of Contract Appeals	Administrative		1	State Treasurer's Database 2011
MAIF	Administrative		1	State Treasurer's Database 2011
MD Health Insurance Plan	Administrative		1	State Treasurer's Database 2011
MD Insurance Admin	Administrative		1	State Treasurer's Database 2011
State Treasurer's Office	Administrative		1	State Treasurer's Database 2011
MD State Retirement Agency	Social Services	Sun Trust Bank Bldg	1	State Treasurer's Database 2011
MD Teachers and State Employees Supplemental Retirement Plan	Social Services	Shaefer Tower	1	State Treasurer's Database 2011
Injured Workers Insurance Fund	Social Services		1	State Treasurer's Database 2011
MD African American Museum Corp	Educational	Reginald Lewis Museum of Maryland African American History and Culture	1	State Treasurer's Database 2011

Critical Facilities

The following critical facilities, which were outlined and used in the 2008 Plan, were also found to be the most up to date and available datasets, and were therefore also used in this Plan update:

- Above Ground Storage Tanks: The locations of above ground storage tanks throughout the State of Maryland are contained in the shapefile entitled AST_9_8_03.shp. The data for this file was acquired from a database provided by the Maryland Department of the Environment Oil Control Program. A point shapefile was created based on the longitude and latitude coordinates contained in the database. Twenty-six of the facilities could not be located due to incorrect coordinates.
- Underground Storage Tanks: The locations of underground storage tanks throughout the State of Maryland are contained in the shapefile entitled ust97_83m.shp. This data was provided in shapefile format by the Maryland Department of the Environment Oil Control Program. Each point in this shapefile represents one underground storage tank. Therefore, multiple tanks belonging to the same facility have been stacked upon each other. 12,241 underground storage tanks could not be located due to incorrect coordinates.
- Bridges and Overpasses: The shapefile entitled MdBridges.shp contains the locations of bridges and overpasses throughout the State. The file was provided to MEMA in shapfile format by the Maryland State Highway Administration.
- Emergency Operations Centers (EOC): A total of 26 EOC's have been included in the GIS database. This includes one for each of the State's 23 counties and Baltimore City, one for Ocean City, and an additional location for Charles County, which has two EOC locations.
- Hospitals and Nursing Homes: A database consisting of 311 acute, general, special, and comprehensive care facilities was geocoded from information provided by the Maryland Department of Health and Mental Hygiene.
- Nuclear Power Plants: Three points in the MD Property View shapefile represent nuclear power plants. One point is for the locationg of the Peach Bottom Nuclear Power Plant in York County, PA. The other two points are for the Calvert Cliffs Nuclear Power Plant in Calvert County, MD. The two Calvert County points represent each of the plant's two cooling towers.
- Consolidated Waste Management Information System Dataset: The shapefile cwmis2000.shp contains the locations of hazardous waste generators throughout the State of Maryland. The file was provided in shapefile format by the Maryland Department of the Environment Hazardous Waste Program. Each point in the shapefile represents individual facilities that are known to house or generate hazardous materials.
- Environmental Permit Service Center Dataset: The shapefile epsc.shp contains the locations of facilities that are registered environmental permit holders in MD. These types of facilities includes, but are not limited to, permitted landfills and sewage/sludge incinerating, composting, pellitizing, storage and distribution sites. This data was provided in Excel format by the Maryland Department of the Environment Environmental Permits Service Center. A shapefile was created from this data by using the longitude and latitude

coordinates contained in the database. Twenty-six facilities could not be located due to incorrect coordinates.

- Department of Juvenile Services Facilities: The shapefile DJS_Offices_Facilities.shp contains the locations of Department of Juvenile Services offices and facilities throughout the State of Maryland. The file was provided to MEMA in Excel format by the Maryland Department of Juvenile Services Office of Research and Planning. A point shapefile was created by geocoding the facilities in this database based on their address. Five facilities could not be located due to inadequate address information.
- Gas Chlorine Plants: The shapefile gas_cl_plants.shp contains the locations of gas chlorine plants in MD. The file was provided in shapefile format to MEMA by the Maryland Department of the Environment Water Management Program.
- Large System Water Sources: The shapefile large_system_sources.shp contains the locations of large system water sources serving populations greater than 10,000 in MD. The file was provided in shapefile format by the Maryland Department of the Environment Water Management Program.
- 2007 Maryland Department of Planning's Property View Dataset: The following types of features were extracted from the Maryland Property View Database: Police Stations, Fire Departments, Schools, Airports, Docks/Wharfs, Waste Water Pumping Stations, and Fresh Water Pumping Stations. These facilities were extracted based on the following Exemption Class Codes:
  - Police, Fire, and Educational Facilities
    - Exclass Code 430 – JUR- Police Station
    - Exclass Code 620 – MUN – Police Station
    - Exclass Code 490 – JUR – Fire Department
    - Exclass Code 640 – MUN – Fire Department
    - Exclass Code 940 – NPF – Volunteer Fire Department
    - Exclass Code 140 – PUB – School
    - Exclass Code 440 – JUR – Public School including Junior College
  - Airports and Transportation/Terminal Facilities
    - Exclass Code 150 – PUB – Non-Military Airport
    - Exclass Code 450 – JUR – Airport
    - Exclass Code 550 – JUR – Dock or Wharf
  - Fresh and Wastewater Pumping Facilities
    - Exclass Code 507 – JUR Waste Water Pumping Station
    - Exclass Code 508 – JUR Fresh Water Pumping Station

Two updates were made to the critical facilities dataset for this Plan. First, the locations of high, significant, and low hazard dams were updated based on new information from the MDE Dam Safety Division. Data was provided in Excel format and was converted to a point shapefile using latitude and longitude coordinates. FEMA and MD DEP Levee data sets were also incorporated.

Second, selected HAZUS (version MR5) layers from the essential facility, transportation systems and utility systems databases were used to supplement the property view dataset. Listed below are the HAZUS datasets[2] that were used to supplement the critical facility data gathered from the 2008 plan:

- Airports: Airport runways and facilities datasets were developed from 1999 data obtained from the Bureau of Transportation Statistics, Federal Aviation Administration.
- EOCs: The EOC database is a combination of data provided by InfoUSA Inc. and geocoded data provided by FEMA. The InfoUSA Inc data is based on the SIC for the entire US.
- Ferry: The ferry facilities dataset was developed from the Port and Waterway Facilities database (see below).
- Fire Stations: Developed from geocoded data from 2001 based on the SIC for the entire US provided by InfoUSA, Inc.
- Hospitals and Health Facilities: The care facility dataset was developed from American Hospital Association data from 2000. AHA provided information on hospitals for the entire US.
- Police Stations: Developed from geocoded data from 2001 based on the SIC for the entire US provided by InfoUSA Inc.
- Ports/Docks: The port facilities dataset was developed from the 2000 dataset of Port and Waterway Facilities obtained from the US Army Corps of Engineers/CEIWR, Navigation Data Center, Ports and Waterways Division.
- Potable Pumping Stations: Developed from 2001 data obtained through the EPA Envirofacts Data Warehouse Location Reference Tables tool based on SIC.
- Public and Private Schools: Developed from the 2000 Public Elementary/Secondary School Universe Survey Data and the Private School Universe Survey Data maintained by the National Center for Education Statistics, US Department of Education. A propriety geocoding application was used to assign geographical coordinates to each school based on its address.
- Waste Water Pumping Stations: see Potable Pumping Stations above.

[2] FEMA, Summary of Databases in HAZUS-MH, http://www.fema.gov/plan/prevent/hazus/hz_database.shtm (August 2010)

Using the HAZUS layers mentioned above and their corresponding types within the property view dataset comparisons were made to ensure that duplicate facilities would be not be analyzed. For an example, HAZUS layer called "Airport Flty" was compared to Exclass Codes: 450 - Airport and 150 – Non-Military Airport within property view. In situations where a facility was in the HAZUS layer but not property view it was extracted to supplement the Maryland critical facilities list. Conversely, any facilities that were not in the HAZUS database but in property view were extracted from the property view and inserted into the HAZUS. Where a facility was in the HAZUS database and had a corresponding match in the property view dataset, the HAZUS point was spatially moved (latitude and longitude coordinates updated) to its match within the property view dataset. The HAZUS ID was then added as an attribute to its match within the property view dataset. The end results in a complete one to one match between the HAZUS and property view datasets, with each point in the property view having a HAZUS ID associated with it.

There were additional HAZUS layers that could have been compared to the property view dataset but due to time limitations they were not completed and the stock HAZUS information was used for the HAZUS runs. HAZUS Dam information was completely wiped out and replaced with the MDE dam information.

Building and Content Values were only available from the Maryland Property View dataset. Therefore, while the count results of the hazard intersections include all critical facility datasets listed above, the building and content value includes only the values listed in the Property View dataset. As with the state facilities above, if a building value but no content value was included, the building value was divided by three to produce an estimated content value. If a content value but no building value was included, the content value was multiplied by three to produce an estimated building value.

The table below includes the type of critical facility, the number of facilities used in this Plan's analysis, examples of facilities in the dataset, and the source of the data.

Table P-5. Critical facility data used for 2011 hazard analysis and vulnerability.

Facility Type	Example of Facility	Number of Critical Facilities	Source
Nuclear Power Plants	Calvert Cliffs	3	MEMA 2008 Plan
Dams (High, Significant and Low Hazard)	Liberty Dam	470	MDE
Large System Water Sources		242	MDE
Above Ground Storage Tanks (oil)		818	MDE
Underground Storage Tanks (oil)		31,658	MDE
Hazardous Waste Generators		12,190	MDE
Environmental Permit Holders		3,153	MDE
Correctional Facilities	Western MD Detention Center	75	Planning Office - Property View Dataset 2007, MD Dept. of Juv. Services
Gas Chlorine Plants		208	MDE
Bridges and Overpasses		3,853	SHA
Hospitals, Emergency Operating Centers and Nursing Homes	Frederick Memorial	867	Planning Office - Property View Dataset 2007, HAZUS
Waste Water Pumping Stations	Church Hill Waste Water Treatment Plant	212	Planning Office - Property View Dataset 2007, HAZUS
Fresh Water Pumping Stations	Mystic Harbor Water Treatment Plant	27	Planning Office - Property View Dataset 2007, HAZUS
Dock/Wharf	Public Landing Wharf, Seagirt Marine Terminal	178	Planning Office - Property View Dataset 2007, HAZUS
Airport (Public, Private, Non-Military, No state owned)	Potomac Airfield, St. Mary's County Airport	70	Planning Office - Property View Dataset 2007, HAZUS
Fire Departments (Volunteer, municipal, jurisdictional and state)	City of Salisbury Fire Department	689	Planning Office - Property View Dataset 2007, HAZUS
Police Departments (Volunteer, municipal, jurisdictional, sheriff locations)	Easton Police Department	186	Planning Office - Property View Dataset 2007, HAZUS
School (Public, Private, Junior Colleges and Colleges. No school administration buildings)	Largo High School	2,420	Planning Office - Property View Dataset 2007, HAZUS

Vulnerability Analysis

Facility Buffers. Sixty-five foot buffers were generated in ArcGIS to take into consideration the entire building/facility when running hazard intersections. This number was determined by taking the square footage of the state and critical facilities, dividing this number by the number of building stories when available, and then taking the average of the resulting number. The average square footage was determined to be 13,000 SQFT. Another equation was used to determine the radius of the buffer. The equation can be seen below:

Area of a Circle = 3.14 (Pi) * r2

Therefore, for a 13,000 SQFT building:
13,000/3.14159 = 4,140
Sqrt (4,140) = 64.34

Analysis. To determine potential losses due to coastal storm, flood, wildfire, karst/sinkhole, landslide, dam failure, and shoreline erosion, intersections were completed in ArcGIS to determine which state and critical facilities are located in a hazard area. The total number of facilities located in the different hazard areas and their associated total building and content values can be found under each hazard's vulnerability section.

To determine potential losses due to thunderstorm, tornado, wind, and winter storm, the number of state and critical facilities and total building and content values were calculated for the highest ranked, or most vulnerable, counties.

Updates from 2008 Analysis. Exposure Analysis that was completed in the 2008 Plan:

Coastal Storm: Includes tropical cyclones-tropical depression, tropical storm, hurricane

Facilities at Risk for Flooding: Value estimations for critical and state-owned facilities within inundations zones are based on building values and content values. Building values are extracted from the Maryland Department of Planning Maryland Property View dataset and the Maryland State Treasurer's Office dataset. Unknown building values were estimated for facilities with a content value. In addition, building values in the State Treasurer's database with no building or content value were estimated based on the building occupancy and type of facility.

Flood: Includes flash and riverine
Facilities at Risk for Flooding: Critical and State Owned Facilities were overlayed with only the 100-year floodplain and not the 500-year or flooding caused by storm surge. Value estimations for critical and state-owned facilities within floodplain are based on building values and content values. Building values are extracted from the Maryland Department of Planning Maryland

Property View dataset and the Maryland State Treasurer's Office dataset. Unknown building values were estimated for facilities with a content value.

Thunderstorm: Do not see any critical/state facility analysis from 2004/2008 plan

Tornado: (Anne Arundel, Charles, Frederick, Price George's)
Facilities at Risk: Methodology- To obtain the best picture possible for the tornado assessment, a hexagon map was created for each county that divides the county into one-square mile hexagon shapes. The hexagons illustrate where state-owned and critical facilities are most concentrated, and there illustrate facility vulnerability to tornados across the county. For example, a hexagon that contains no facilities has a lower vulnerability to tornados than a hexagon that contains three facilities.

Wildfire
Facilities at Extreme Risk of Wildfires: Valuations for facilities at extreme or high risk of wildfire is based on building values extracted from the Treasurer's database and the Property View database. Building values were estimated for facilities where content values but no building values were available.

Wind
Facilities at Risk for High Wind: High wind risk areas for both Category 1 and Category 3 (based on NOAA's Inland High Wind Model) hurricanes cover the entire state; therefore, all facilities within Maryland are at risk. Valuations for facilities within each wind zone are based on the building values extracted from the Treasurer's and Property View datasets.

Winter Storm
Facilities at Risk: Two methods:
- Allegany and Garrett Counties: Only facilities in the Property View and Treasurer's databases that had building value were used to calculate total building value for each county. If a facility did not have a building value, but had a content value, the facility's building value was estimated based on the facility's content value. An "exposure value" was used, which consisted of aspect and elevation. See formula below:

The formula devised to determine facility exposure value is:

Exposure Value (X) = ((2A) + E)/2, where A = aspect class and E = elevation class. The assigned aspect class for facilities located on north- or west- facing slopes is "3". For facilities located on south- or east-facing slopes, the assigned aspect class is "2". Elevation classes are assigned to facilities based on the following scale:

Elevation Range	Elevation Class
< 1000'	1
1001-1500'	2
1501-2000'	3
> 2000'	4

Based on exposure value, facilities are assigned to one of the following heavy snow risk categories:

Heavy Snow Risk	Exposure Value
Moderate	2.5 – 3.0
High	3.1 – 4.0
Severe	4.1 – 5.0

-Anne Arundel, Baltimore, Howard, Montgomery, and Prince George's Counties and Baltimore City: Same in terms of facilities and values used above. Same methodology used in tornado risk assessment.

Karst/Sinkhole
Facilities at Risk for Sinkholes: Valuations based on building values from Property View and Treasurer's database. Building values were estimated based on the facility's known content value, if one existed. Facilities are compared with Sinkhole Susceptibility shapefile- high, moderate, moderately low, low.

Earthquake: Do not see any critical/state facility analysis in 2004/2008 plan

Shoreline Erosion
Facilities at Risk: MD Property View and Treasurer's Office database facilities that are located in 100-foot risk zone.

Sea Level Rise: Do not see any critical/state facility analysis in 2004/2008 plan

Extreme Heat: Do not see any critical/state facility analysis in 2004/2008 plan

Extreme Cold: Do not see any critical/state facility analysis in 2004/2008 plan

Dam Failure: Do not see any critical/state facility analysis in 2004/2008 plan

Exposure Analysis that was completed in 2011 Update:

Coastal Storm- Intersection between facilities and SLOSH
Drought- NO ANALYSIS
Flood- Intersection between facilities and flood zones
Landslide- Intersection between USGS susceptibility zones and facilities
Thunderstorm- Number of facilities and exposure values for highest ranked counties
Tornado- Number of facilities and exposure values for highest ranked counties
Wildfire- Intersection between facilities and wildfire zones
Wind- Number of facilities and exposure values for highest ranked counties
Winter Storm- Number of facilities and exposure values for highest ranked counties
Karst/Sinkhole- Intersection between facilities and subsidence zones
Earthquake- HAZUS
Sea Level Rise- Intersections will be done
Extreme Heat- NO ANALYSIS
Extreme Cold- NO ANALYSIS
Dam Failure- Intersection between facilities and dam failure inundation zones
Shoreline Erosion- Intersections with facilities and shoreline erosion data

Appendix Q – Social Vulnerability Index

This appendix is available for electronic review by contacting the Maryland State Hazard Mitigation Officer:

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