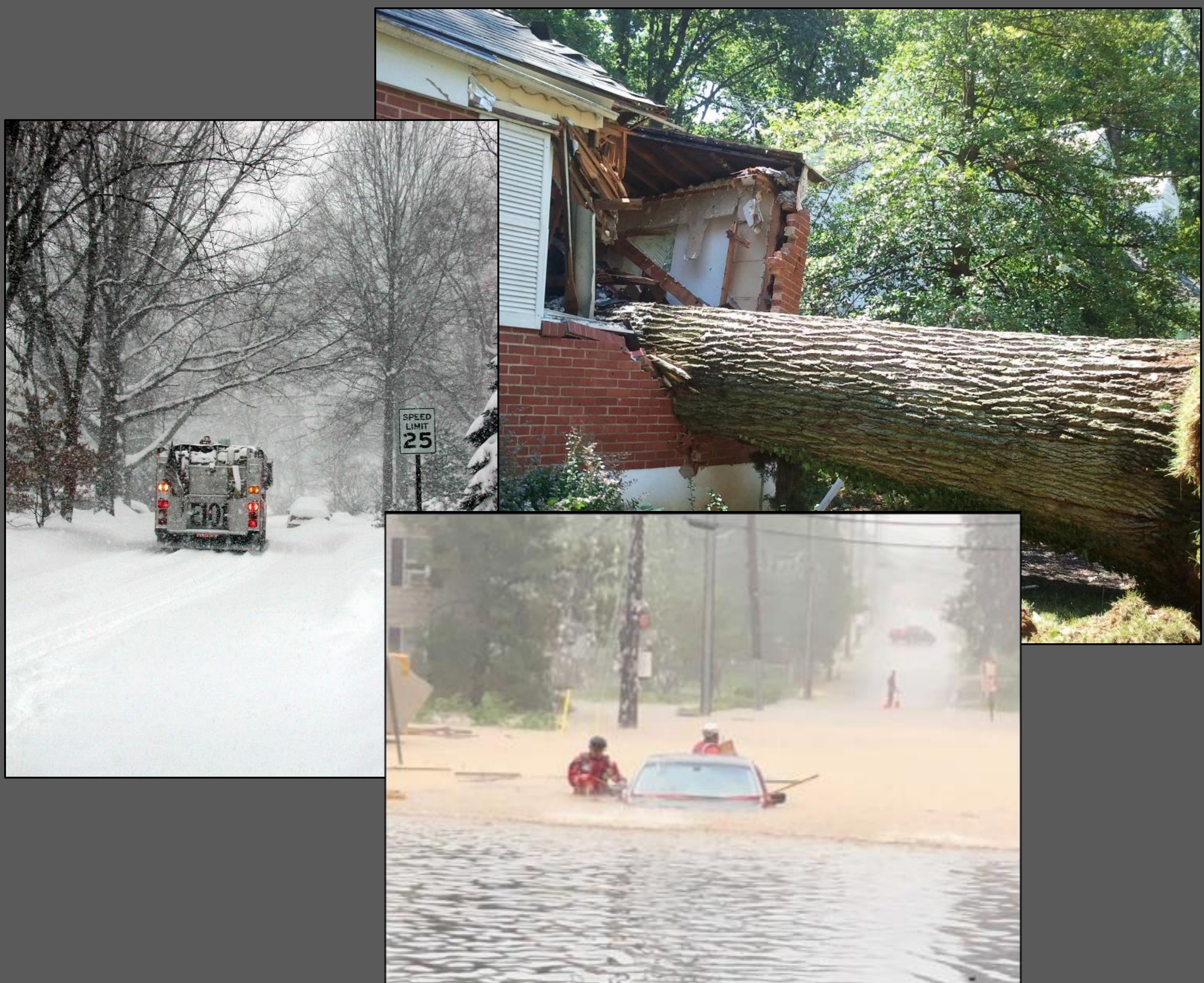
Baltimore County Hazard Mitigation Plan Update



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700 East Joppa Road
Towson, MD 21286

2021

Public Version

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CHAPTER 1:
PLAN INTRODUCTION

UPDATES

During the 2021 Plan Update process, **Chapter 1: Plan Introduction** was updated with the most recently available data.

Updates to this chapter include:

1. Thematic and visual update
2. Minor text updates to the following sections:
    - *1.1 2021 Plan Update*
    - *1.3 Plan Requirements*
    - *1.4 Plan Organization*
3. Section *1.5.1 Organizing Resources* – updated to reflect new and current HMPC members (Table 1-1). Also updated to discuss the development of a capability assessment (Appendix C).
4. *Section 1.5.2 Hazard Identification and Risk Assessment* – updated with new HIRA results for each hazard and describes the first and second HMPC meetings.
5. *Section 1.5.4 Mitigation Strategies* – updated to reflect the third HMPC meeting.
6. **New sections**, *1.6.1 Public Outreach* and *1.6.2 Public Survey*, have been added to highlight steps taken to involve the public in the plan update process as well as important results of the public survey, which was a major component of public outreach.
7. *Section 1.7 Plan Maintenance and Adoption* was updated to reflect public meeting dates hosted by Baltimore County as well as plan update adoption meeting dates.

1.1 2021 PLAN UPDATE

The 2021 Baltimore County Hazard Mitigation Plan Update was completed by the Baltimore County Office of Homeland Security and Emergency Management and their stakeholders. The Plan was adopted and approved by the Federal Emergency Management Agency (FEMA). To maintain compliance under the Disaster Mitigation Act of 2000, the Plan must be updated every five years. To that end, Baltimore County Homeland Security and Emergency Management applied for and received hazard mitigation grant funding through MEMA. The Plan Update process began in late 2020 with the hiring of Smith Planning and Design consulting firm, and the formation of the 2021 Hazard Mitigation Planning Committee (HMPC). The HMPC consists of a cross-section of disciplines and has served as a guide during the Plan Update development process. HMPC members and their agency/department are listed on Table 1-1.

1.2 THE IMPORTANCE OF HAZARD MITIGATION

The primary goal of any hazard mitigation planning effort is to determine which means are most effective in reducing and/or eliminating loss of life and property damage caused by natural disasters. Creating and maintaining a Hazard Mitigation Plan represents a proactive approach resulting in mitigation steps to be undertaken before a disaster occurs. Hazard mitigation planning provides Baltimore County with practical knowledge and strategies, empowering citizens, first responders, and government officials to prepare for and respond to natural disasters.

1.3 PLAN REQUIREMENTS

The Disaster Mitigation Act of 2000 encourages and rewards hazard mitigation planning efforts by state and local governments. These efforts are strongly encouraged for two primary reasons. First, the goal of these plans is to prevent and/or reduce the loss of life and injury as well as limiting future damage costs by developing methods to mitigate or eliminate damage from various hazards. Second, hazard mitigation is most effective when state and local jurisdictions are participating in the process and working together. As more local municipalities become involved in the hazard mitigation planning process, the state can fund more effective mitigation actions, which in turn benefit local jurisdictions.

Local governments are required to create and maintain a hazard mitigation plan to receive federal funding for hazard mitigation projects. This requirement reinforces the importance of proactive mitigation planning and emphasizes planning for disasters before they occur. Additionally, the plan improves the County's eligibility for funding from federal and state agencies for hazard mitigation and disaster relief. This includes the Stafford Disaster Relief and Emergency Act, the Disaster Mitigation Act of 2000, the Flood Mitigation Assistance Program created under the National Flood Insurance Reform Act, the Hazard Mitigation Grant Program (HMGP), the Pre-Disaster Mitigation Grant Program, and the Maryland Comprehensive Flood Management Grant Program.

According to the Federal Emergency Management Agency, the Hazard Mitigation Grant Program provides grants to states and local governments so that they can implement long-term hazard mitigation plans. The purpose of the HMGP is to reduce the loss of life and property due to natural disasters and to enable mitigation measures to be implemented during the immediate recovery from a disaster.

The 2015 *Hazard Mitigation Assistance Guidance,* produced by FEMA, states that mitigation plans are the foundation for effective hazard mitigation. [1] As such, local jurisdictions must have a FEMA-approved local hazard mitigation plan at the time of obligation of grant funds to be eligible for grant funding under the unified Hazard Mitigation Assistance (HMA) programs.

Plan Update

The local jurisdiction is required by 44 CFR §201.6(d)(3) to review and revise its plan and resubmit it for approval within 5 years in order to continue to be eligible for mitigation project grant funding.

In keeping with the Disaster Mitigation Act, hazard mitigation plans are required to be updated every five years from the date of their initial FEMA approval. As such, Baltimore County has updated their previous hazard mitigation plan with the *2021 Baltimore County Hazard Mitigation Plan Update*. Regular plan updates allow for the determination of program and project effectiveness and ensures the plan utilizes the most up-to- date data available. For example – as of May 22, 2019 it became required that local hazard mitigation plans include all dam risk in accordance with the requirements set forth in the High Hazard Potential Dams (HHPD) Grant Program Notice of Funding Opportunity. While Baltimore County had previously included a profile of all dams within *Chapter 15: Technological and Man-Made Hazards*, the update process proved integral in updating this existing information while also maintaining plan requirements.

Hazard mitigation plans are required to have ongoing participation from their municipalities throughout the planning process, especially if the municipalities wish to formally adopt the plan. However, Baltimore County has no municipalities as all areas in the county are unincorporated. Therefore, Baltimore County has sole authority over governance.

1.4 PLAN ORGANIZATION

The 2021 Hazard Mitigation Plan Update is primarily driven by all-inclusive hazard specific chapters. Each chapter begins with an introductory paragraph explaining how the chapter has been updated from the previous version of the plan. Then a profile of the hazard is provided, focused on answering the question; “how is this hazard a threat to Baltimore County?” Factors that create risk for each hazard are then explained, followed by a history of major hazard events within the county. Using the most recent and available data, each chapter contains a vulnerability assessment tailored for that hazard. When possible, these assessments include mapping products. Additionally, hazard chapters with a well-defined geographic extent (e.g., flood, coastal storm and flooding, and wildfire) discuss social vulnerability in relation to the hazard via a social vulnerability index score.

Appropriate chapters, Flood, Coastal Storm and Flooding, Earthquake, and High Winds include a HAZUS Level 2 Analysis (explained in *1.5.3 Vulnerability Assessment*). Finally, each chapter ends with a section regarding current mitigation activities and a section regarding future goals, their objectives, and actions items utilized to complete said goals and objectives. In some cases, larger datasets and results of vulnerability assessments are included in appendices, rather than in the parent chapter. However, it is the goal of the Plan Update to keep most of the hazard-specific information within its related chapter.

1.5 PLANNING PROCESS

The requirements of a local hazard mitigation plan include: (1) inventorying essential facilities and other at-risk structures, (2) conducting risk assessments for the identified hazards, (3) providing mitigation strategies for high-risk hazards, (4) preparing a method to maintain and update the Plan, and (5) ensuring public involvement throughout the process.

To meet these requirements, the Baltimore County Hazard Mitigation Plan Update process followed these four basic steps:

1.5.1 Organizing Resources

Baltimore County's first step in the Plan Update process was the creation of a Hazard Mitigation Planning Committee in November of 2020. The HMPC was composed of representatives from various county agencies, including the Fire Department, Budget Office, Department of Planning, Department of Public Works, Permits, Approvals and Inspections, Preservation Services, Department of Health, Baltimore County Public

Schools, Department of Environmental Protection and Sustainability, and the Office of Homeland Security and Emergency Management. Additionally, Smith Planning and Design was contracted to provide technical support to the lead agency, the Baltimore County Fire Department in the Plan Update Process. HMPC members are listed in Table 1-1, below.

Table 1-1. Hazard Mitigation Planning Committee Members

Name	Department/Office
Brady Locher	Department of Environmental Protection and Sustainability
Kritty Udhin	Department of Environmental Protection and Sustainability
Terry Sapp	Department of Health
Matt Gawel	Department of Permits, Approvals and Inspections
Bill Skibinski	Department of Planning
Caitlin Merritt	Department of Planning (Landmarks Preservation)
Doug Adams	Department of Public Works and Transportation
Terry Curtis	Department of Public Works and Transportation (Floodplain Manager)
Paul Lurz	Baltimore County Fire Department
Thomas Ramey	Fire Department
Matt Carpenter	Office of Budget and Finance
Debra Shindle	Office of Budget and Finance/Property Management
David Bycoffe	Office of Homeland Security and Emergency Management
Kathy Suter	Office of Homeland Security and Emergency Management
Ashley Morris	Office of Homeland Security and Emergency Management
Irene Debye	Office of Homeland Security and Emergency Management/Fire Department
Richard Muth	Public Schools

Additional resources needed to complete the 2021 Plan Update process centered on the collection of the most recently available data specific to Baltimore County. The types of data collected included GIS data, demographic data, a variety of local planning documents, and data collected from local government agencies. Data sources are included as footnotes in each chapter and methodology of data usage is included within each hazard-specific chapter.

Capability Assessment

An in-depth capability assessment was created for Baltimore County as part of the organizing resources process.

The purpose of conducting a capability assessment is to determine the ability of a jurisdiction to implement a comprehensive hazard mitigation strategy, and to identify potential opportunities for establishing or enhancing specific mitigation policies, programs, or projects. The capability assessment provides an opportunity to highlight the positive hazard mitigation measures already in place or being implemented throughout the county and which should continue to be supported and enhanced via future mitigation efforts.

The capability assessment is comprised of four sections that detail specific capabilities that are relevant to hazard mitigation, including: (1) Planning and Regulatory, (2) Administrative and Technical, (3) Financial, and (4) Education and Outreach. Full results of the Capability Assessment, including recommendations, are contained in *Appendix C* of this plan update. Additionally, *Chapter 16: Mitigation Strategies* includes those recommendations for strengthening capabilities in the following areas: planning and regulatory, administrative and technical, financial, and education and outreach.

Plan Integration

The Federal Emergency Management Agency (FEMA) considers plan integration the process by which communities look critically at their existing planning framework and align efforts with the goal of building a safer, smarter community. There are two primary ways to effectively accomplish plan integration:

1. Integrate natural hazard information and mitigation policies and principles into local planning mechanisms and vice versa by:
    a. Including information on natural hazards (past events, potential impacts, and vulnerabilities).
    b. Identifying hazard-prone areas throughout the community.
    c. Developing appropriate goals, objectives, policies, and projects.

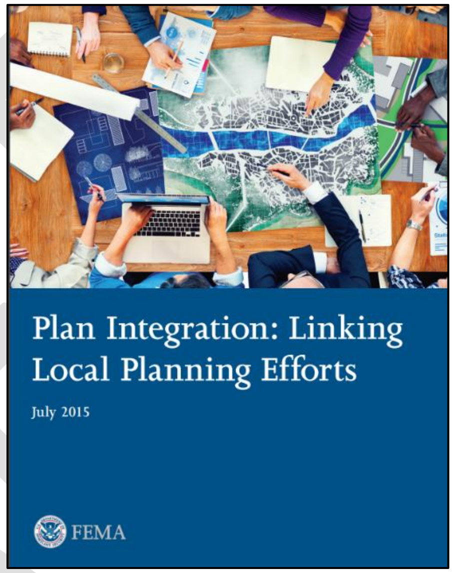
2. Encourage collaborative planning and implementation and inter-agency coordination in the following ways:
    a. Involving key community officials with the authority to execute policies and programs to reduce risk.
    b. Collaborating across departments and agencies with key staff to help share knowledge and build relationships that are important to the successful implementation of mitigation activities.

Baltimore County's hazard mitigation plan provides the necessary natural hazard information to incorporate into existing planning documents. The data, tables, analyses, assessments, mapping, and action items within this plan are easily applicable when updating or modifying existing planning documents. Local planning documents that would benefit from integrating components from this hazard mitigation plan include the County's:

- Comprehensive Plan/Master Plan
- Capital Improvement Plan
- Emergency Operations Plan
- Regional Transit Plan
- Stormwater Management Plan
- Land Preservation, Parks and Recreation Plan

As detailed in the Capability Assessment (*Appendix C*), Baltimore County's current planning and regulatory documents recognize and prioritize hazard mitigation efforts. To further increase plan integration, the county should consider the following basic steps to integrate hazard mitigation principles into other local planning mechanisms:

1. Collect Documents
   - Make a list of all relevant and most recent plans and ordinances for the county to review for plan integration purposes.
2. Review Questions
   - Questions should be geared towards identifying inconsistencies, gaps, and recommendations in current planning and regulatory documents in relation to, at minimum, land use, transportation and infrastructure, emergency management, environment and open space, and plan implementation,
3. Review Examples and Best Practices
   - Review examples of current local plans and regulatory documents wherein natural hazard mitigation concepts were successfully integrated. These documents provide planner with acceptable language and best practices for integration.



For a complete guide to plan integration, FEMA has created a step-by-step guidebook to aid local communities. The guide is called “Plan Integration: Linking Local Planning Efforts” and was published in July 2015. The guide is available at fema.gov.

1.5.2 Hazard Identification and Risk Assessment

The initial step in preparing new hazard mitigation strategies for Baltimore County involved the identification of various hazards and their associated risk. In 2016, the Maryland Emergency Management Agency published the *State of Maryland Hazard Mitigation Plan,* which is designed to identify natural hazards common to the State as well as propose mitigation strategies to lessen the negative effects of major natural disasters and events. Part of this process, represented in Table 1-2, involved determining the level of risk for each hazard. The State of Maryland ranked coastal flood, drought, flood, thunderstorm, tornado, and winter storm as ‘high’ risk for Baltimore

Table 1-2. Maryland State Hazard Assessment for Baltimore County, 2016

Hazard	Ranking
Coastal	High
Drought	High
Flood	High
Thunderstorm	High
Tornado	High
Wildfire	Medium-high
High Winds	Medium-high
Winter Storm	High

County. As part of the plan update process, a Hazard Identification Risk Assessment

(HIRA) was completed for Baltimore County. During the first stakeholder meeting (November 24, 2020) of Baltimore County's Hazard Mitigation Plan Update, members of the HMPC were asked to participate in an online survey as part of hazard identification and risk assessment process. Committee members were also able to add, remove, and/or modify any of the existing hazards.

Hazard: a source of danger

Vulnerability: open to attack or damage

Risk: possibility of loss or injury

The committee chose to keep all existing hazards, add one new hazard (Pandemic and Emerging Infectious Diseases), and modify the ratings of several hazards identified in the 2014 Plan. The basis for these decisions came from individual expertise brought by each member of the HMPC. Results from the Hazard Risk Survey completed by Stakeholders have been integrated into the updated HIRA (see *Appendix A*).

Results of the risk assessment are represented in Table 1-3. Like the State of Maryland, the Baltimore County HMPC rated flood and thunderstorm as 'high' risk yet differed in every other rating except for high wind, which both determined to be 'medium-high'.

Table 1-3. Baltimore County Hazard Risk Assessment, 2021

Hazard	2014 Ranking	2021 Ranking
Flood	High	High
Drought	Medium	Medium
Tornado	Medium	Medium
Thunderstorm	Medium-High	High
High Wind	Medium	Medium-High
Wildfire	Medium	Medium
Earthquake	Medium-Low	Medium-Low
Sinkhole	Medium-Low	Medium-Low
Winter Weather	Medium-High	Medium-High
Coastal Storm and Flooding	High	Medium-High
Pandemic and Emerging Infectious Disease*	No 2014 Ranking	High

** Indicates a new hazard added by the HMPC*

The 2021 Hazard Mitigation Plan also includes technological and "man-made" hazards, which are listed in Table 1-4. The 2021 Plan Update profiles and discusses these hazards in a single chapter called *Technological and Man-made Hazards*. Epidemic, which was previously defined as a "man-made" hazard, has been reclassified as a natural hazard and is included within the *Pandemic and Emerging Infectious Diseases* chapter.

Table 1-4. Technological and Man-Made Hazard Risk Assessment, 2021

Hazard	Risk
Transportation Accident	High
Hazardous Material Incident	High
Dam Failure	Medium
Fire & Explosion	Medium-high
Mass Power Outage	Medium-high

The first meeting also provided an opportunity for the HMPC to identify goals and objectives for county-wide mitigation efforts. These goals and objectives represent the County and communities' vision for disaster resistance. The HMPC was asked to provide status updates for each highly ranked 2014 mitigation action.

The second HMPC meeting took place on February 23, 2021 and provided the committee members an opportunity to review and comment on the HIRA results. This meeting also focused on the major updates to the plan, including: (1) new chapter *Pandemic and Emerging Infectious Disease*, (2) social vulnerability analysis for hazards with a well-defined geographic extent, (3) a HAZUS Level 2 analysis on historic and cultural resources within the 1% annual chance floodplain, and (4) the Capability Assessment conducted for Baltimore County. (see *Appendix C*).

1.5.3 Vulnerability Assessment

A vulnerability assessment works to model and estimate potential damages to populations and property during a storm event. Each hazard-specific chapter in the 2021 Plan Update includes a vulnerability assessment which gathers available data relevant to each hazard to provide reasonable estimates of expected damages during a storm event.

Each assessment first identifies and briefly discusses those areas, populations, and/or infrastructure that are especially vulnerable to the hazard. Then, the 'Data Utilization' section lists the data, and their sources, utilized to perform the assessment. Assessments typically include affected infrastructure, such as buildings, roadways, and bridges, as well as impacts to essential facilities, land uses, transportation networks, future development, hazardous material storage facilities, and vulnerable populations. In most cases, these vulnerability assessments result in mapping products that depict the intersection between hazard area and vulnerable infrastructure, resources, and people.

Flood, Coastal Storm and Flooding, Earthquake, and High Winds, utilized a HAZUS Level 2 Analysis. Results of this type of analysis include essential facility and general building stock damages, debris generation, shelter requirements, and associated economic losses. This level of analysis is more accurate than a Level 1 Analysis because the data used for the analysis is derived from user-supplied sources as well as data available in the Hazus database. According to the FEMA website:

> "Hazus is a nationally applicable standardized methodology that contains models for estimating potential losses from earthquakes, floods, and hurricanes. Hazus uses Geographic Information Systems (GIS) technology to estimate physical, economic, and social impacts of disasters. It graphically illustrates the limits of identified high-risk locations due to earthquake, hurricane, and floods."

1.5.4 Mitigation Strategies

Existing goals, objectives, and action items were updated during the final meeting. Overall goals and objectives are in *Chapter 3: Overall Hazard Mitigation Goals, Objectives, and Action Items*, while hazard-specific goals and objectives are located at the end of each hazard-specific chapter.

The final meeting was held on March 31, 2021. Utilizing an action item matrix, HMPC members were asked to review hazard-specific mitigation action items and determine if they were to be included within the 2021 Plan Update. Recommended projects, agencies responsible for their implementation, and other important information was gathered during this process.

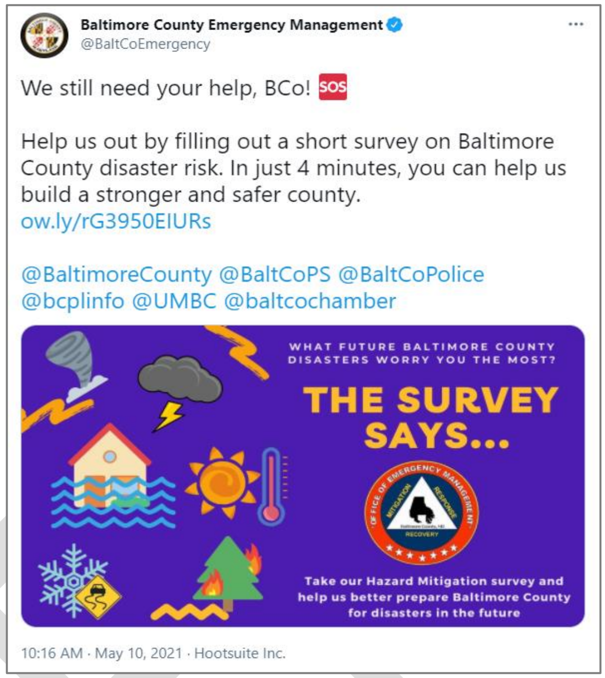
Mitigation strategies include goals, objectives, action items, and mitigation projects. Goals provide a general guideline as to what Baltimore County hopes to achieve within the next 5-year planning cycle. Objectives are not as broad as goals or defined as action items but serve to provide a measurable connection between goals and action items. Action items consist of real-world steps that can be taken to fulfill the mitigation goals set by the County. Mitigation projects, which are derived from high priority action items (see section 16.1.1 of *Chapter 16*) are the final step to making action items come to life. Refer to *Chapter 16: Mitigation Strategies* to learn more about high priority action items and their associated mitigation projects.

1.6 PUBLIC OUTREACH

1.6.1 Public Outreach

Public outreach is critical in the hazard mitigation planning process in the following ways: (1) describe issues of concern, (2) narrate hazard history, (3) prioritize proposed mitigation actions, and (4) provide ideas for ongoing public involvement.
More than simply informing the public of the plan's development, a good public outreach strategy seeks to educate the public as well as motivate them to act. During this Plan Update cycle Baltimore County created a project website, baltimorecohazardplan.org, that allowed the public to learn about hazard mitigation, view the previous plan, stay up to date with the planning process, and provide their feedback via a survey. In addition, the website created an opportunity for citizens to provide their contact information and be added to a mailing list, as well as an area to submit questions and/or feedback, The project website proved to be critical for gathering feedback as the plan update cycle occurred during the COVID-19 global pandemic, thus severely limiting face-to-face interaction.

In addition to the project website, Baltimore County initiated a social media campaign to inform the public of the plan update process and to maximize the feedback gathered via the public survey on the project website. Regular posts were made to county-operated social media accounts that promoted the plan update process, the public survey, general hazard mitigation knowledge, and public meeting dates and times.



Baltimore County advertised and recruited for virtual public meetings on multiple dates for the 2021 Hazard Mitigation Plan Update, including:

- 5/12 at 6:30 PM - 8:00 PM
- 5/18 at 6:30 PM - 8:00 PM
- 5/22 at 6:30 PM - 8:00 PM

The following message was sent by Baltimore County to members of the public, including workers and business-owners, to advertise the availability of three virtual public meetings.

> "Good Afternoon,
>
> An important part of disaster readiness and community resilience is hazard mitigation. Our county hazard mitigation plan identifies potential threats to Baltimore County and lists future projects that may reduce or eliminate damage before a disaster strikes. We are working to update our hazard mitigation plan to better represent our threats and add more projects that allow us to enhance resilience.
>
> Mitigation not only saves lives, but also reduces disaster costs. For every $1 spent on mitigation, more than $6 are saved that would have been used responding to or recovering from disaster.
>
> Input from residents, community members, workers, and business owners will help ensure the success of the County's hazard mitigation plan and projects. There are a couple of ways community members can participate:
>
> 1). Take our four-minute survey on disaster risk: https://www.baltimorecohazardplan.org/engage-in-the-planning-process
> 2). Participate in a virtual community meeting this month:
>
> -5/12 at 6:30 PM - 8:00 PM [Link to register: https://www.eventbrite.com/e/151231029079]
> -5/18 at 6:30 PM - 8:00 PM [Link to register https://www.eventbrite.com/e/152520710551]
> -5/22 at 6:30 PM - 8:00 PM [Link to register https://www.eventbrite.com/e/152522542029]"

A full record of important meeting, training, and public outreach efforts is included in Table 1-5 (included at the end of this chapter). This table includes dates, intended audience, type of outreach, and other important information.

1.6.2 Public Survey

As described in section *1.6.1 Public Outreach*, a public survey was developed and placed on the project's website (<u>www.baltimorecohazardplan.org</u>) to make it easily accessible to interested members of the public as well as stakeholders. The public survey was regularly promoted throughout the Plan Update process on Baltimore County's social media platforms.

In total, 194 members of the public responded to the public survey. Most of the responses were from Baltimore County residents (93.3%) with representation from 21 of the County's unincorporated communities. The top five communities with the most responses were Timonium, Cockeysville, Lutherville, Catonsville, and Towson. Further highlights from the public survey are included below.

Figure 1-1.

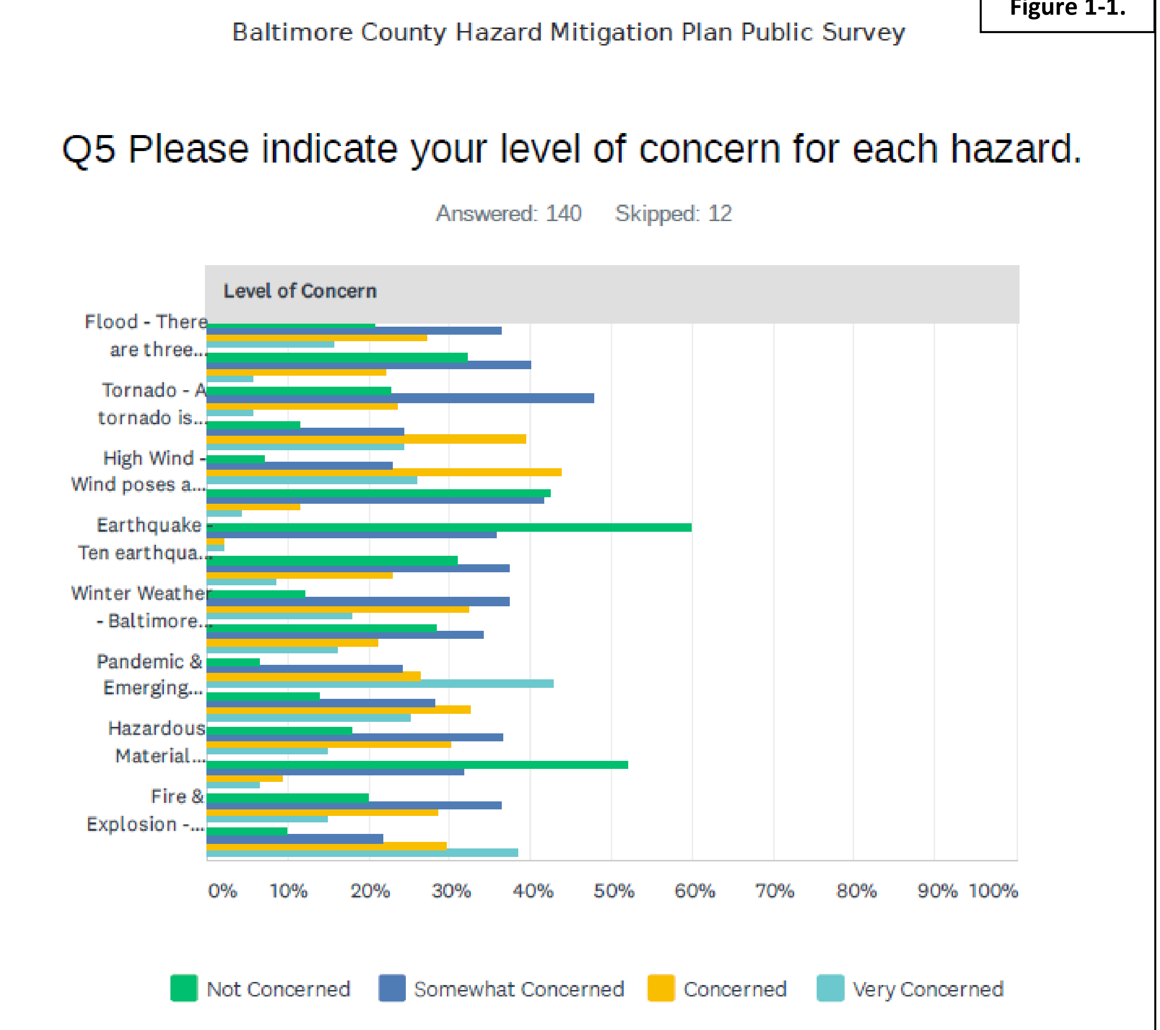
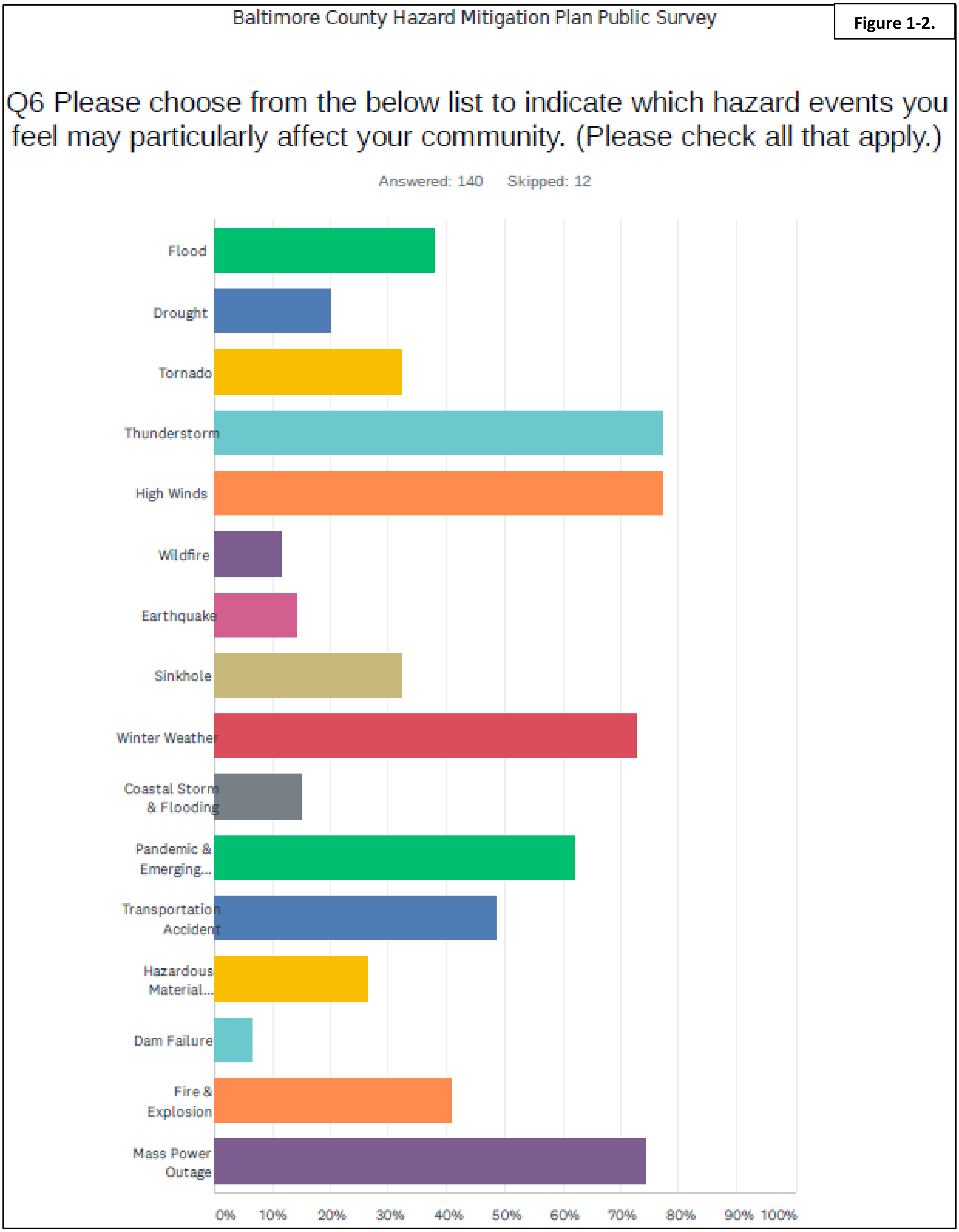


Figure 1-2.


Baltimore County Hazard Mitigation Plan Public Survey
Q6 Please choose from the below list to indicate which hazard events you feel may particularly affect your community. (Please check all that apply.)
Answered: 140 Skipped: 12
Flood
Drought
Tornado
Thunderstorm
High Winds
Wildfire
Earthquake
Sinkhole
Winter Weather
Coastal Storm & Flooding
Pandemic & Emerging...
Transportation Accident
Hazardous Material...
Dam Failure
Fire & Explosion
Mass Power Outage
0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

Of the 11 natural hazards respondents could select (Figure 1-1), the top five natural hazards that Baltimore County residents indicated they are “very concerned” with were: (1) Pandemic and Emerging Infectious Diseases, (2) High Wind, (3) Thunderstorm, (4) Winter Weather, and (5) Coastal Storm and Flooding. The level of concern shown by the public for these hazards is reflected in the HIRA results represented in table 1-3. All the hazards that the public is “very concerned” about are ranked as either Medium-High (Coastal Storm and Flooding, High Wind, and Winter Weather) or High (Pandemic and Emerging Infectious Diseases and Thunderstorm).

Results of another survey question (Figure 1-2) were similar, indicating that most Baltimore County residents are concerned with: High Winds, Thunderstorms, and Winter Weather. Mass Power Outage was also indicated as a major concern for the community, which makes sense alongside concern for hazards that produce strong winds or put additional pressure on the power grid.

Full results of the Public Survey are included in *Appendix F* on this Plan Update.

1.7 PLAN ADOPTION AND MAINTENANCE

1.7.1 Plan Adoption

The Disaster Mitigation Act of 2000 requires that local Hazard Mitigation Plans and any updates be formally adopted by the County Council following review by MEMA and FEMA. The Plan and any Plan Updates are also subject to a public hearing prior to adoption by the Council. The public was provided numerous opportunities to review and comment on the Plan. Comments made by the public have been included and integrated into the Plan prior to final adoption by Baltimore County.

Public meetings were advertised for the following dates for the 2021 Hazard Mitigation Plan Update: May 12, 2021, May 18, 2021, and May 22, 2021. All meetings were to be conducted for a public audience via video conference.

Plan adoption meetings were held on ______ for the 2021 Hazard Mitigation Plan Update.

During the plan adoption period, the Draft Plan was available for review and comment on the project website, here: www.baltimorecohazardplan.org/. The public was able to download the Plan Update or review it online.

1.7.2 Plan Maintenance

The Baltimore County Office of Homeland Security and Emergency Management will implement the Plan and continue to perform periodic reviews and revisions to the Plan through on-going Hazard Mitigation Planning Committee meetings. The Committee will be entrusted with the responsibility to meet, at a minimum, annually to review the Plan and hold public meetings to solicit citizen input. A mitigation status update tool will be utilized to gather information throughout the 5-year planning cycle.

Table 1-5. Baltimore County Hazard Mitigation Planning, Training, and Outreach Initiatives				
Date	**Meeting, Training, or Outreach Activity**	**Target Audience**	**Materials Provided**	**Comments/Input**
10/2/2020	Project Kick-Off Mtg.	Core Planning Team	WebEx Meeting- 2014 HMP Committee Listing and HIRA	Discussed outreach strategy and development of project website.
11/4/2020	Coordination Mtg.	Core Planning Team	WebEx Meeting- Project Website and Stakeholder Listing, Meeting Date, & Agenda	Previewed plan logo and social media post. Picked from listing of project website domain names. Established stakeholder meeting #1 date and agenda items.
11/24/2020	HMPC Stakeholder Meeting #1	HMPC Stakeholders	WebEx Meeting- Agenda & Meeting Packet (PDF)	Meeting Notes, Fillable PDF Mitigation Status, Community Perspective Survey & Project Website Preview
12/8/2020	Climate Action Plan	Project Committee	Draft Plan	Discussion related to integrating action items from CAP into the HMP Update.
12/10/2020	Project Website	HMPC Stakeholders	Draft Website	Draft project website link distributed for review and comment.
12/11/2020	Historic Preservation Small Group Mtg.	Key Staff	Review of 2015 HMP	Discussed incorporation of historic resources into plan update. National Register of Historic Places and flood vulnerability.
12/15/2020	Resource-Data Mtg.	Doug Adams, GIS	Data layers, Geodatabase	Identified data needed and various sources. Identified new contact for real property values for loss estimations.
1/25/2021	Coordination Mtg.	Project Manager & EM Planner	Status Update, HIRA & Mitigation Actions Status Report	Confirm Meeting with Communications Engagement Director and next Committee Mtg. Date
1/25/2021	New Website Content	HMPC Stakeholders	2021 HIRA Results	In addition, 2015-Present finalized Mitigation Status Report provided to stakeholders.
2/8/2021	Project Website and Public Survey	Public	Project website link added to Baltimore Co. EM website page.	In addition to website, social media post(s) directing public to project website.
2/16/2021	Social Media Post	Public	Project website link provided with logo.	Increase traffic to the project website.
2/18/2021	Social Media Post	Public	Provide public online survey link.	Increase participation in online public survey.
2/19/2021	Press Release	Public	Brief summation of the plan, project website, and online survey.	Increase participation in online public survey and traffic to project website.
2/22/2021	Historic Preservation Small Group Mtg.	Key Staff	Hazus Level 2 Analysis Results- Flood Loss Estimations and New Mapping	New attribute table including depth of flooding, category 1 storm surge, and SRL risk for historic buildings provided.
2/23/2021	HMPC Stakeholder Meeting #2	HMPC Stakeholders	WebEx Meeting- Agenda & Meeting Packet (PDF)	Meeting Notes, Fillable PDF Capability Survey, Vulnerability Assessment Update- NEW Historic Properties.
2/23/2021	New Website Content	Public & HMPC Stakeholders	Meeting #2 HMPC Notes	Added Button w/ PDF
2/23/2021	Social Media Post	Public	Facebook and Twitter post linking to public online survey.	Increase participation in online public survey and traffic to project website.
2/26/2021	News Release	Public	News Release article with helpful links.	Increase participation: www.baltimorecountymd.gov/county-news/2021/02/26/baltimore-county-seeking-public-input-regarding-hazard-mitigation-plan
3/1/2021	Social Media Post	Public	Facebook and Twitter post linking to public online survey.	Increase participation in public survey and to project website (https://twitter.com/BaltCoEmergency/status/1366486921359351811)

Table 1-5. Baltimore County Hazard Mitigation Planning, Training, and Outreach Initiatives				
Date	**Meeting, Training, or Outreach Activity**	**Target Audience**	**Materials Provided**	**Comments/Input**
3/5/2021	New Website Content	Public & HMPC Stakeholders	Under Risk & Vulnerability Tab added Social Vulnerability.	New text and maps.
3/5/2021	New Website Content	Public & HMPC Stakeholders	Under Risk & Vulnerability Tab added flood prone historic properties mapping.	New text and maps.
3/9/2021	Social Media Post	Public	Twitter Post with new graphic and survey link.	https://twitter.com/BaltCoEmergency/status/1369400350034255890
3/11/2021	Social Media Post	Public	Retweet	https://twitter.com/BaltCoEmergency/status/1369400350034255890
3/27/2021	Social Media Post	Public	Twitter Post with new graphic and survey link.	https://twitter.com/BaltCoEmergency/status/1369400350034255890
3/31/2021	HMPC Stakeholder Meeting #3	HMPC Stakeholders	WebEx Meeting- Agenda & Mitigation Action Workshop Packet (PDF)	Meeting Notes & New Mitigation Action Items & Prioritization Tool for Stakeholder Completion.
4/1/2021	New Website Content	Public & HMPC Stakeholders	Meeting #3 HMPC Notes	Added Button w/ PDF
4/4/2021	Social Media Post	Public	Twitter Post with new graphic and website link.	https://twitter.com/BaltCoEmergency/status/1380179563897094144
4/14/2021	Public Meeting Schedule	Core Planning Team	Public Meeting Topics	EM Planner, Ashley Morris, followed-up with meeting dates and time slots. Planned evening meeting(s) and one morning meeting.
5/3/2021	Social Media Post	Public	Twitter Thread	https://twitter.com/BaltCoEmergency/status/1389227659025080322
5/3/2021	Social Media Post	Public	Meeting 6:30-8:00PM	https://www.eventbrite.com/e/152520710551
5/3/2021	Social Media Post	Public	Meeting 6:30-8:00PM	https://www.eventbrite.com/e/152522542029
5/7/2021	Email- Community Outreach	Non-Profits & Community Groups	Community Resilience-Hazard Mitigation provided ways to engage.	Provided survey link and invite link to all three \community meetings
5/12/2021	Virtual Community Meeting	Public	Meeting, 6:30-8:00PM	www.eventbrite.com/e/151231029079
5/12/2021	Public Outreach Event	Public	Presentation, Survey Link, & Meeting upload to YouTube	A virtual public meeting was advertised for the HMP Update, to be conducted in the evening from 6:30-8:00PM (1 of 3 advertised virtual meetings).
5/14/2021	Volunteer Email Push	Volunteers	Survey Link	The survey link was pushed out to volunteers in Baltimore County, roughly 2600 people.
5/18/2021	Public Outreach Event	Public	Presentation, Survey Link, & Meeting upload to YouTube	A virtual public meeting was advertised for the HMP Update, to be conducted in the evening from 6:30-8:00PM (2 of 3 advertised virtual meetings).
5/20/2021	Social Media Post	Public	Twitter and Facebook poots.	Social media posts targeted the public to gather increased hazard mitigation survey responses.
5/22/2021	Public Outreach Event	Public	Presentation, Survey Link, & Meeting upload to YouTube	A virtual public meeting was advertised for the HMP Update, to be conducted in the morning from 10:0-11:30AM (3 of 3 advertised virtual meetings).
6/2/2021	Informational Session	Core Planning Team & Interested Stakeholders	Virtual Presentation	An informational session hosted by MEMA, part of their Mitigation Series. Focused on info related to FY21 FMA and BRIC. (Presentation Link: https://mema.maryland.gov/community/Documents/FY21-FMA-and-BRIC-Overview.pdf)
6/5/2021	Safety Day Event	Public	Discussion/Presentation	Baltimore County met with Baltimore Chapter of Delta Sigma Thea Sorority (20 members) and touched on mitigation and how the county works to prevent disasters.

Table 1-5. Baltimore County Hazard Mitigation Planning, Training, and Outreach Initiatives				
Date	Meeting, Training, or Outreach Activity	Target Audience	Materials Provided	Comments/Input
6/8/2021	Social Media Post	Public	Facebook post, Survey Link	White Marsh Volunteer Fire Company makes a post advocating for emergency preparedness and hazard mitigation; the post also asked members of the public to take the online survey. (link: https://www.facebook.com/wmvfc/posts/10157707682742234)
6/9/2021	Informational Session	Core Planning Team & Interested Stakeholders	Virtual Presentation	An informational session hosted by MEMA as part of their Mitigation Series, focused on "Mitigation in Action."
6/11/2021	Newsletter	Public	Survey Link	The Department of Aging is set to send out their latest newsletter (10k subscribers) in July 2021, including the link to the Hazard Mitigation Survey on the project website.

[1] Federal Emergency Management Agency. Hazard Mitigation Assistance Guidance. Updated February 27, 2015. www.fema.gov/sites/default/files/2020-07/fy15_HMA_Guidance.pdf.

CHAPTER 2:

BALTIMORE COUNTY PROFILE

UPDATES

During the 2021 Plan Update process, **Chapter 2: Baltimore County Profile** was updated with the most recently available data.

Updates to this chapter include:

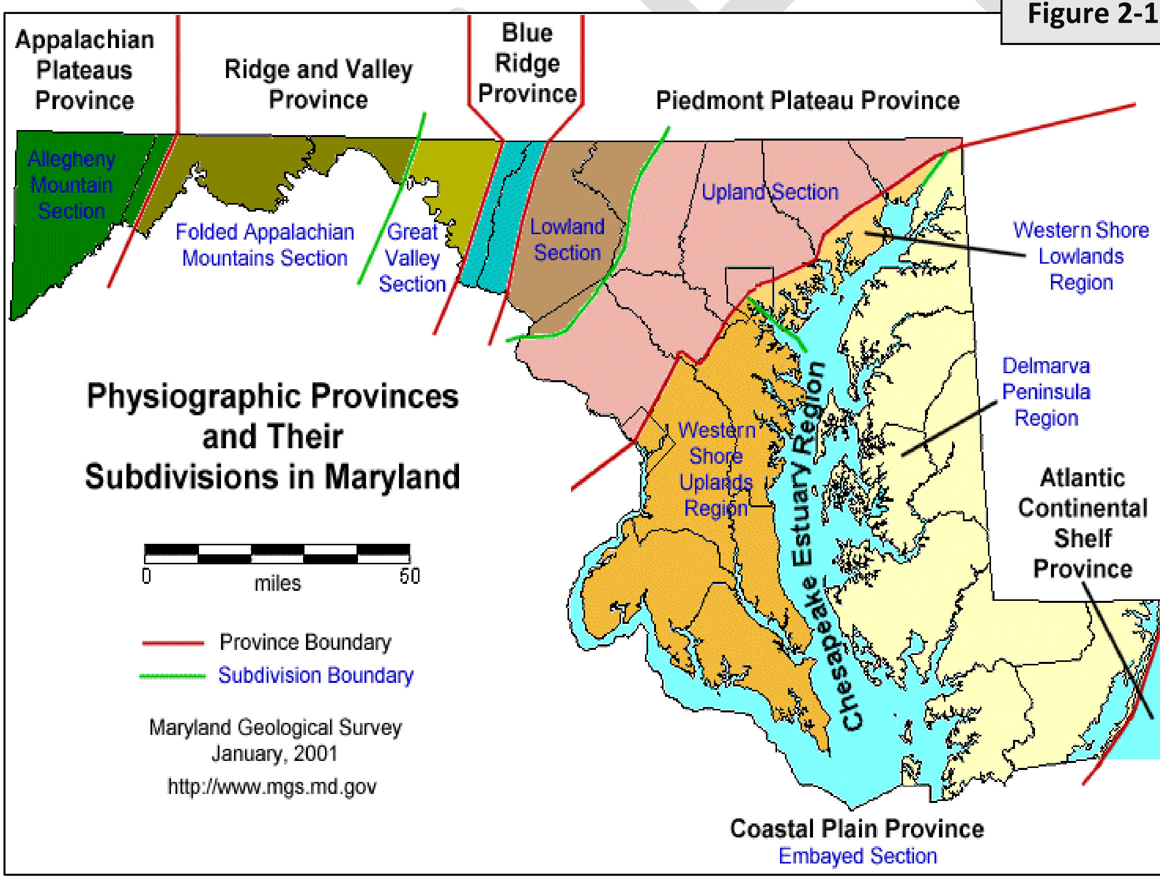
1. **Thematic and visual update**
2. Relevant **text and data updates** to the following sections and tables:
3. *Section 2.2 Demographic Trends and Characteristics*
    a. Table 2-2 Age Structure Estimates, 2019
    b. Table 2-3 Racial Composition Estimates, 2019
4. *Section 2.4 Housing and Community Development*
    a. **Updated** population and household data with Census ACS estimates.
    b. Added MDP projections
5. *Section 2.5 Employment and Industry*
    a. Table 2-4, updated employment statistics, 2018
    b. Table 2-5, updated percentage of total employment by industry, 2018

2.1 GEOGRAPHY AND THE ENVIRONMENT

Baltimore County is in Central Maryland, bordering York County, Pennsylvania to the north, Harford County, MD to the east, the Chesapeake Bay to the southeast, Anne Arundel County to the south, Howard County to the southwest and Carroll County, MD to the west. Baltimore County also surrounds the City of Baltimore and its harbors but are entirely separate political units. Map 2-1, on the following page, provides a visual overview of the region.

The County's geography, depicted in Figure 2-1, below, is characterized by the Atlantic Coastal Plain and the Piedmont Plateau Province. The Atlantic Coastal Plain, which stretches from New Jersey to Florida, around the Gulf of Mexico, south to Mexico and to the Yucatan Peninsula, comprises the southeastern portion of the County and is flat and low rising to around 400 feet. The Piedmont runs from New Jersey, southwest, to Alabama and is marked by low rolling landscapes and fertile valleys.[1] The County's elevation runs from sea level at the Chesapeake Bay to 966 feet at Middletown Road on the Mason-Dixon Line near Stiltz, PA.[2] On average, elevations in the County range from 200 to 700 feet.[3]

Figure 2-1.



Map 2-1. Regional Map

Source: Baltimore County - Office of Information Technology

2.1.1 Water Resources

The County includes more than 2,100 miles of streams and rivers. About 46 percent of the land area drains to three reservoirs: Loch Raven, Prettyboy and Liberty. Loch Raven and Prettyboy Reservoirs are located within the County, while Liberty reservoir is located on the western boundary with Carroll County. These three reservoirs are owned and managed by the City of Baltimore as the drinking water source for over 2.8 million citizens in the metropolitan region, including the City, about 90 percent of Baltimore County, and small portions of three other counties.[4]

Baltimore County's streams and rivers ultimately drain to the Chesapeake Bay, the nation's largest estuary, where salt water from the ocean meets fresh water from the rivers.[5] The County has approximately 175 miles of shoreline along the Patapsco, Back, Middle, and Gunpowder Rivers and other smaller creeks which are sub-estuaries of the Bay.[6] Those streams along the coastal plain are tidal estuaries. The streams of the Piedmont Plateau portion of the county are rapidly flowing, fluctuating streams. The principal Piedmont streams are the Gunpowder River and its branches, Stemmers Run, Herring Run, Jones Falls, Gwynns Falls, and the Patapsco River. All are part of the Chesapeake Bay drainage system and reach the Bay through the broad estuaries of the Gunpowder, Middle, Back, and Patapsco Rivers.

2.1.2 Climate

Baltimore County lies in a region about midway between the rigorous climates of the North and the mild climates of the South, and adjacent to the modifying influences of the Chesapeake Bay and Atlantic Ocean to the east and the Appalachian Mountains to the west. Since this region is near the average path of the low-pressure systems which move across the country, changes in wind direction are frequent and contribute to the changeable character of the weather. The net effect of the mountains to the west and the bay and ocean to the east is to produce a more equable climate compared with other continental locations inland at the same Latitude. Table 2-1 depicts annual precipitation and temperature averages for Baltimore County.

Table 2-1. Annual Averages
• Precipitation: 45.6" • Snowfall: 21.9" • Summer Temp: 73.1 F • Winter Temp: 33.2 F • Days Below Freezing: 102.0 days
Note: Temperature and precipitation data based on 30-year averages. National Oceanic and Atmospheric Administration (1981-2010 normals)

Rainfall distribution throughout the year is rather uniform, however the greatest intensities are confined to the summer and early fall months. The average date for the last occurrence in spring of temperatures as low as 32 degrees is mid-April. The average date for the first occurrence in fall of temperatures as low as 32 degrees is late October. The days below freezing is approximately 102 days. January is the coldest month, and July the warmest. Snowfall occurs on about three days per year on the average, however, an average of only about six days annually produces snowfalls of one inch or greater. Snow is frequently mixed with rain, sleet and ice, and snow seldom remains on the ground more than a few days. The annual prevailing wind direction is from the west. Winter and spring months have the highest average wind speed.[7] Several hazard chapters in the plan discuss climate in the form of storm events, including Flood, Drought, Thunderstorm, High Wind, and Winter Weather. *Chapter 13: Coastal Storm and Flooding* provides an in depth look at the history of coastal storms and sea level rise in Baltimore County.

2.1.3 Geology: Minerals and Soils

Baltimore County is part of two distinct physiographic provinces: The Coastal Plain Province and the Piedmont Plateau Province. The Coastal Plain Province is underlain by a wedge of unconsolidated sediments including gravel, sand, silt, and clay, which overlaps the rocks of the Eastern Piedmont along an irregular line of contact known as the Fall Zone. The sediments of the Coastal Plain dip eastward at a low angle, generally less than one degree, and range in age from Triassic to Quaternary. Mineral resources of the Coastal Plain are chiefly sand and gravel and are used as aggregate materials by the construction industry. Clay for brick and other ceramic uses is also important.

Small deposits of iron ore are of historical interest. Plentiful supplies of ground water are available from several aquifers throughout much of this region. The Piedmont Plateau Province is composed of hard, crystalline igneous and metamorphic rocks and extends from the inner edge of the Coastal Plain westward. Bedrock in the eastern part of the Piedmont consists of schist, gneiss, gabbro, and other highly metamorphosed sedimentary and igneous rocks of probable volcanic origin. In several places these rocks have been intruded by granitic plutons and pegmatites. Deep drilling has revealed that similar metamorphic and igneous rocks underlie the sedimentary rocks of the Coastal Plain. Several domal uplifts of Precambrian gneiss mantled with quartzite, marble, and schist are present in Baltimore County and in parts of adjacent counties. Differential erosion of these contrasting rock types has produced a distinctive topography in this part of the Piedmont.

The Piedmont Plateau Province contains a variety of mineral resources. Formerly, building stone, slate, and small deposits of nonmetallic minerals, base-metal sulfides, gold, chromite, and iron ore were mined. Currently, crushed stone is important for aggregate, cement, and lime. Small to moderate supplies of ground water are available throughout the region, but favorable geological conditions locally may provide larger amounts.[8]

2.2 DEMOGRAPHIC TRENDS AND CHARACTERISTICS

The basic demographics of Baltimore County has changed from predominantly rural to an urban-rural mix. According to the 2010 Census, about 90 percent of the County's population lives within the Urban Rural Demarcation Line (URDL) while the remaining 10 percent resides in the rural areas. According to the U.S. Census, Baltimore County's population is 827,370 (Table 2-2). The County's population has been growing significantly since 1950 (population of 270,273), increasing by 557,097 in roughly 70 years.

Within Baltimore County, the 2010 Census designated places with the greatest populations are: Dundalk, Towson, Catonsville, Essex, Woodlawn, Parkville, Randallstown, Pikesville, and Carney. New population growth in Baltimore County is being directed toward two areas – Perry Hall-White Marsh and Owings Mills, which are the county's designated growth areas. Both town centers are adjacent to major transportation networks and regional shopping centers.[9]

The increased amount of people living in Baltimore County creates more community exposure and changes how agencies prepare for and respond to hazards. Furthermore, increased density can affect risk. For example, narrow, congested streets are more difficult for emergency service vehicles to navigate, a higher ratio of residents to emergency responders affects response times, and homes located closer together increase the chances of fires spreading.[10]

As the County continues to experience population growth, other aspects of population, such as age structure (Table 2-2), racial composition, household and family type, employment status, and income level are changing. The median age of the population continued to grow from 38.8 in 2008 to 39.5 in 2018. This represents a growing number in the elderly 65 years old or over, which increased its percent share in the County's total population from 14.4 percent in 2008 to 17.5 percent in 2019. According to the 2019 Census population estimates, population distribution according to age shows 31.2 percent of the population is aged 55 or older. Persons below the age of 19 make up 24.4 percent of the total population. Baltimore County's total population is projected to be 862,200 in 2030 and 892,150 in 2045.[11]

Table 2-2. Age Structure in Baltimore County, Population Estimates 2019

Age Group	Total	Percent
Under 5 years	48,874	5.9
5 to 9 years	46,270	5.6
10 to 14 years	53,986	6.5
15 to 19 years	52,708	6.4
20 to 24 years	49,555	6.0
25 to 29 years	55,739	6.7
30 to 34 years	55,675	6.9
35 to 39 years	54,733	6.6
40 to 44 years	47,781	5.8
45 to 49 years	50,172	6.1
50 to 54 years	52,191	6.3
55 to 59 years	49,780	6.0
60 to 64 years	63,947	7.7
65 to 69 years	46,456	5.6
70 to 74 years	35,393	4.3
75 to 79 years	24,134	2.9
80 to 84 years	18,086	2.2
85 years and over	20,890	2.5
Total population	827,370	(X)

Source: U.S. Census Bureau, 2019 American Community Survey 1-Year Estimates

Along with its population increase, Baltimore County has undergone a change in racial composition, which is depicted in Table 2-3. According to the U.S. Census Bureau, 2019 American Community Survey 1-Year Estimates, approximately 58.4 percent of the County's population is White compared to 65 percent in 2010. Approximately 30 percent of the minority population is African American with the remaining 11.9 percent primarily comprised of Hispanic and Asian populations. Specifically, the largest Hispanic populations are in Cockeysville, Reisterstown-Owings Mills, Catonsville-west of Rolling Road, east Lansdowne, and Perry Hall-north of White Marsh Boulevard. The largest Asian populations are in Cockeysville-Timonium, Carney, Perry Hall-north of White Marsh Boulevard, Catonsville-west of Rolling Road, and Catonsville-Arbutus near University of Maryland Baltimore County. This ethnic diversity suggests a need to address multi-cultural needs and services.

Table 2-3. Racial Composition in Baltimore County, Demographic Estimates, 2019		
Race/Ethnicity	**Total**	**Percent**
White	483,230	58.4
Black or African American	248,401	30.0
American Indian and Alaska Native	2,305	0.3
Asian	50,514	6.1
Asian Indian	9,117	1.1
Chinese	5,811	0.7
Filipino	7,280	0.9
Japanese	562	0.1
Korean	4,524	0.5
Vietnamese	5,848	0.7
Other Asian	7,392	0.9
Native Hawaiian and Other Pacific Islander	429	0.1
Hispanic or Latino (of any race)	48,074	5.8
Mexican	9,595	1.2
Puerto Rican	6,898	0.8
Cuban	2,482	0.3
Other Hispanic or Latino	29,099	3.5
Some Other Race	2,146	0.3
Two or More Races	20,314	2.5
Total population	805,029	(X)

Source: U.S. Census Bureau, 2019 American Community Survey 1-Year Estimates

Population and demographic characteristics are a critical component to preparing and responding to hazard events. Items to be considered include:

- Multi-cultural needs and services – Communication and cultural norm (belief) are critical to preparing and responding to a hazard event, including the ability to communicate with non-English speaking individuals and communities;
- Vulnerable populations – Vulnerable populations include seniors, disabled citizens, children and low-income households;
- Involvement of citizen groups – Citizen groups include: neighborhood watch programs and other local community groups, non-profit and religious groups who assist with recovery efforts;
- Mass Care Shelters – Should be accessible to vulnerable and special needs populations and be able to accommodate large populations in the event of a hazard event;
- Insurance Companies – Insurance companies should prioritize the education of their staff relevant to policies covering hazard events. This education will allow insurance agents to better explain and answer questions about specific policy issues with citizens and business owners.

2.3 LAND AND DEVELOPMENT

Central to the way that the County has developed is the concept of delineating two distinct land management areas – the urban area and the rural area. This concept manages growth in a manner that preserves important natural and agricultural resources and maximizes the efficiency of County revenues spent on transportation improvements, utilities, and other capital projects. In 1967, Baltimore County took the first significant step toward creating a sustainable policy framework for growth and development when it established an urban growth boundary, the Urban Rural Demarcation Line (URDL). The URDL divides the County into urban and rural land management areas. The division allows infrastructure investments and most land development to be focused in the urban areas, while natural and agricultural resources in the rural areas are preserved. Subsequently, Resource Conservation (RC) zones were adopted to restrict the number, configuration, size and location of new building lots in order to preserve agriculture and protect natural resources, while permitting limited growth. The protection of agriculture has been a key component of the rural growth management of the County for over 40 years.[12]

2.3.1 Master Plan Land-Use Visions

Baltimore County Comprehensive Plan, 1975 & Baltimore County Master Plan, 1980

These Plans reorganized land use and development planning into a comprehensive growth management program, creating the current land use framework. These plans modified the County's land use policy to reduce inefficient low-density suburban development and establish urban and rural zoning. Two growth areas – Owings Mills and Perry Hall-White Marsh – were created. Future development was to be directed in these areas, preserving agriculture and watershed land in other areas of the county.[13]

Master Plan 1990

This Plan balanced County efforts between growth areas and community conservation areas in the urban areas with the philosophy of enhancing the quality of development. In the rural areas, policies reaffirmed the county's commitment to agricultural and natural resource protection, while providing some areas for low density rural residential growth.[14]

Master Plan 2000

The 2000 Plan focused on maintaining flexibility to respond to opportunities and problems as they arose. The Plan created land management areas for urban and rural portions of the county. The intent was to achieve a balanced development in designated growth and community conservation areas and preserve agricultural activities and natural resources outside the URDL.[15]

Master Plan 2010

This Plan recognized the interdependence of traditional land use issues with nontraditional master plan topics such as education, public safety, social services, economic development, and community stewardship. Master Plan 2010 recognized that Baltimore County's sustained prosperity will require continued significant reinvestment in its urban areas. Buildings, facilities, and infrastructure in most of the communities adjacent to the Baltimore County-Baltimore City Line are 50 years old. The infrastructure is reaching the end of its life expectancy and needs repair and replacement.[16]

Master Plan 2020

This latest Plan seeks to continue the success of growth management, improve the built environment, and strengthen resource conservation and protection within Baltimore County. The plan will build on the successful concepts and strategies of previous plans and will strengthen these long-term goals using a framework of sustainability. The present and future needs of citizens within Baltimore County with respect to the economy, community, and the environment will be protected and enhanced by actions proposed in this plan, with the intention of achieving a sustainable community.[17]

2.3.2 Growth Areas

Baltimore County has more than a twenty-year history of implementing multiple smart growth principles. As the size and amount of undeveloped land parcels within the URDL diminishes, the redevelopment of ailing or underused property at greater density and with a mix of land uses provides significant environmental and economic benefits.[18] Owings Mills is the designated growth area within the County. This location is targeted as a self-sustaining planned community with employment-intensive business and residential development. It is a preferred location for industrial and office development with established, concentrated retail areas. At its fullest development potential, Owings Mills would be home to 44,000 residents and provide jobs for approximately 32,000 employees.

In addition to existing growth areas, Master Plan 2020 proposes the Middle River Redevelopment Area. The proposed Middle River Redevelopment Area is currently employment-oriented with some residential development. It is among the largest employment centers in the Baltimore region and presents great potential for future growth. This area is diverse in land use and has been divided into nine sub-areas.[19]

Directing land development in the County's employment centers includes preserving industrially zoned land for future growth in employment. The County's employment centers include the Southwest Industrial Corridor, UMBC, Woodlawn–Security, Hunt Valley-Timonium, Loveton, Towson/Loch Raven, Middle River, Philadelphia-Pulaski, North Point, and White Marsh. The urban center of Towson has the County's largest concentration of diverse uses including office and retail businesses, government facilities, nonprofit institutions, and restaurants. The future of Towson is focused on maintaining and improving upon the economic vitality of businesses, providing open space, and continuing the viability of residential neighborhoods. The area encompassing GBMC, Towson University, St. Joseph's Hospital, and Sheppard Pratt Health System are being evaluated for growth opportunities.

2.3.3 Waterfront Development

The County's waterfront has a variety of residential, industrial, and protected land uses. It has been the County's policy to limit growth and control density along the waterfront to protect water quality and biological integrity. It is also the County's policy to ensure that any surplus sewerage capacity that may exist is not used to support unplanned growth along the waterfront. Areas along the Bird River are targeted as agricultural preservation areas and surplus property owned by Lockheed-Martin at Dark Head Creek is being studied for the development of a commercial waterfront destination. The underused and abandoned industrial land along the waterfront is also targeted for redevelopment to support port-related uses.

2.3.4 Critical Areas Act

The Chesapeake Bay Critical Areas law helps to protect water quality and sensitive waterfront areas by regulating development within 1000 feet of tidal water. The County, as part of the State of Maryland's commitment to save the Chesapeake Bay from further environmental degradation, enforces this legislation. Although sites available for new development are limited, the Chesapeake Bay Critical Areas regulation includes a mechanism called "growth allocation" that allows for density increases on a limited amount of Chesapeake Bay Critical Areas land. To implement growth allocation, Baltimore County has established a committee consisting of representatives from various county departments to evaluate petitions for site design excellence and environmental sensitivity.[20]

2.3.5 Rural Development

Baltimore County's rural areas continue to face development pressure. While approximately 37,000 acres of land have been preserved for agricultural use, the goal of preserving 80,000 acres by 2020 is still being threatened by traditional suburban development. Tools for directing development in rural areas of the county include agricultural preservation districts, land preservation easements, land trusts, purchase of development rights, transfer of development rights and the rural legacy program. Designated agricultural preservation areas include Caves, Upperco/Worthington/Sparks, Parkton, Monkton/White Hall, Bird River, Greenspring, Patapsco/Granite, Freeland/Maryland Line, and Long Green. It is the County's policy to preserve lands for agricultural and avoid conflicts with incompatible uses.

Areas intended as resource preservation areas for the protection of historic, cultural, recreational, and environmental resources include Patapsco/Granite, Gunpowder, Chesapeake Bay, Soldiers Delight, Prettyboy Reservoir, Liberty Reservoir and Loch Raven reservoir. The focus for these areas is limiting residential development and acquiring available land for public benefit.

The bulk of residential development in rural areas have occurred in the Freeland, Patapsco/Granite, Kingsville, Chestnut Ridge, Hereford and Jacksonville land management areas. The County continues to face challenges in limiting new residential growth and maintaining these areas' rural character. The only two designated rural commercial centers, Hereford and Jacksonville, are to remain geographically small, rural in character, and be regulated through a master plan process.

2.4 HOUSING AND COMMUNITY DEVELOPMENT

The U.S. Census Bureau, 2019 American Community Survey 1-Year Estimates indicates that the total number of housing units within the County is 338,286. Of these, 312,466 (92.4 percent) are occupied, and 25,820 (7.6 percent) are vacant. The Maryland Department of Planning (MDP) provides household projections up until 2040. The MDP predicts a positive trend in households, indicating the number of households increasing to 338,500 by 2020, and increasing to 351,900 by 2040. Household size is expected to slowly decline in the coming decades. As of 2019, the average household size was 2.64 (owner-occupied unit). The MDP expects this size to decrease to 2.44 by 2020, and to 2.39 by 2040.

A major component to the increasing household population in Baltimore County is due to large amounts of in-migration from residents leaving Baltimore City between 2011 and 2015; thirty percent of all in-migration within the state comes from Baltimore City.[21] This shift to the suburbs is likely being driven by quality-of-life issues related to schools, taxes, and crime.

New housing will need to be constructed to keep pace with the expected future demand. Within the last five years (2014-2019), 9,070 total housing units were authorized for construction. Of these, 1,758 were single family units and 654 were multi-family units. This means that on average, 804 housing units are being constructed per year.

2.4.1 Community Programs

The overall objective of Baltimore County's Housing Opportunities Program is to improve housing stock and preserve neighborhoods by working with community based organizations, creating home ownership opportunities, assisting homeowners to bring their residences up to Baltimore County codes and standards, and to stimulate the development and redevelopment of high quality multi-family housing for County renters.[22]

The CDBG Grants Administration provides for the appropriation of entitlement funds awarded to Baltimore County from Federal and State housing and community development programs, such as the Community Development Block Grant (CDBG) Program, the HOME Investment Partnerships (HOME) Program, and the Stewart B. McKinney Emergency Shelter Grant (ESG) Program funded under the U.S. Department of Housing and Urban Development (HUD), and the Maryland State Department of Housing and Community Development (DHCD). These grant programs are primarily designed to benefit low and moderate-income households and individuals through various activities carried out by public agencies and non-profit organizations, such as housing rehabilitation, home ownership assistance, drug and alcohol counseling, fair housing, education and counseling services to the homeless and at-risk, capital improvements for community-based facilities and public infrastructure, and programs which benefit the disabled. Baltimore County has been designated by the U. S. Department of Housing and Urban Development as an entitlement jurisdiction for the Community Development Block Grant (CDBG) Program and the Stewart B. McKinney Emergency Shelter Grant (ESG) Program, and a participating jurisdiction for the Home Investment Partnerships (HOME) Program.[23]

2.5 EMPLOYMENT AND INDUSTRY

Baltimore County has a diverse corporate presence within the region with over 21,000 businesses reported in 2018, including headquarters for companies such as Stanley Black & Decker Global Tools & Storage, Textron Systems, and McCormick & Company. The business community is balanced among industry sectors, including major operations for T. Rowe Price, Lockheed Martin, BD Diagnostics, Middle River Aerostructure Systems, and Bank of America. Woodlawn is home to the headquarters of the Social Security Administration and Centers for Medicare and Medicaid Services, and contains an Enterprise Zone. Table 2-5 details the total employment by industry within Baltimore County.

Table 2-4. Employment Statistics, 2018
• Number of Businesses: 21,000+ • Total Civilian Labor Force: 450,336 • Employment: 432,164 • Unemployment: 18,202 • Unemployment Rate: 4.0%

Source: U.S. Department of Commerce – Brief Economic Facts – Baltimore County, Maryland

Economic highlights of the region include:

- The Eastern business corridor includes some of the region's largest manufacturers, is accessible by interstate, rail, air, and public and private port facilities and is a revitalization area of underutilized business and industry.
- The White Marsh business community is a fast-growing area in the County, seeing more than 3.8 million square feet of businesses development in the past decade. It includes retail and entertainment centers, clusters of financial, insurance and health care operations, light manufacturing, and technology distribution.
- The Hunt Valley corridor provides a diverse business community with a substantial number of technology companies including bioscience, software, defense/aerospace, and high-tech machinery/instrument firms.
- Owings Mills provides a core of commercial office and industrial development in one of the fastest growing communities in the County. Businesses include retail, health care, financial, and bioscience firms.
- Woodlawn is a center for federal government headquarters, government contractors and business services and offers a mix of office, flex, and manufacturing sites.

Table 2-5. Percentage of Total Employment by Industry, 2018	
Federal Government	3.7%
State Government	3.0%
Local Government	7.9%
Private Sector	85.4%
Natural Resources & Mining	0.2%
Construction	6.4%
Manufacturing	4.1%
Trade, Transportation & Utilities	17.5%
Information	1.3%
Financial Activities	7.9%
Professional & Business Services	16.0%
Education & Health Services	19.4%
Leisure & Hospitality	9.3%
Other Services	3.3%

Source: U.S. Department of Commerce – Brief Economic Facts – Baltimore County, Maryland 2018

Mitigation activities are needed at the business level to ensure the safety and welfare of workers and limit damage to industrial infrastructure. Employees are highly mobile, commuting from a surrounding area to industrial and business centers. This creates a greater dependency on roads, communications, accessibility, and emergency plans to reunite people with their families. Before a natural hazard event, large and small businesses can develop strategies to prepare for natural hazards, respond efficiently, and prevent loss of life and property.

2.6 TRANSPORTATION AND COMMUTING PATTERNS

One of the major challenges facing Baltimore County's transportation system is accommodating the increased demands placed on its radial roadway network, which no longer matches predominant commuting patterns. Land use decisions in the past have not adequately addressed growing transportation needs, and therefore permitted a considerable increase in vehicle miles traveled, consumption of green-fields, and water and air quality degradation.[24] Other roadway transportation challenges include: heavy weekday commuter traffic near Baltimore, heavy vacation traffic on the weekends, substantial truck traffic, and suburban land use patterns and sprawl nearby that tends to promote auto travel. Preventing congestion can be accomplished through a combination of highway capacity improvements, management of existing services and facilities, and implementation of Transit-Oriented Development (TOD).

Ninety percent of all travel in the county is made in private automobiles. More than 2,700 miles of state and county roads provide the infrastructure to serve the mobility needs of residents, but roadway capacity has not kept pace with demand. Roadway improvements recommended in Master Plan 2020 support growth management and land use policies by reinforcing the County's commitment to focus growth inside the URDL. Additionally, policy will seek to continue support for regional rail transit services, actively support Transit-Oriented Development, continue to plan and implement improvements to the County's physical infrastructure, assure adequate roads for rural areas, provide appropriate pedestrian facilities, and expand those facilities to meet the needs of current and future residents.[25]

2.6.1 Roadways

Table 2-6. Major Transportation Corridors	
• I-70 • I-83 • I-95 • I-195 • I-695	• I-795 • I-895 • U.S. 1 • U.S. 40

Baltimore City's transportation infrastructure, developed in the classic radial "star" pattern, laid the framework for the development of Baltimore County. Radial arterial highways – such as Baltimore National Pike, Liberty Road, Reisterstown Road, York Road, Belair Road, and Pulaski Highway – provide radial access to the County. The Baltimore Beltway (I-695), the County's circumferential connector, is designed to carry large volumes of traffic. The arterial highways provide the spokes of the beltway wheel and allow for through trips to Baltimore City. Collector roads provide the link between the arterial network and local streets. I-83 and I-95 provide access to the north and south while I-70 provides access to the west. In April 2018, the Maryland Transportation Authority (MDTA) began construction on I-895 to replace the bridge north of the Baltimore Harbor tunnel. The MDTA will limit part of the expressway to one lane in each direction for the $189-million project to replace the 60-year-old bridge. The expected completion date is summer 2021.

2.6.2 Mass Transit

The transportation system also consists of transit services provided by the state, county, and the private sector. Transit services consist of:

1. Subway connects Owings Mills to Baltimore City and the Johns Hopkins medical campus;
2. BaltimoreLink bus service;
3. Light rail from Hunt Valley to downtown Baltimore, Penn Station and BWI Marshall Airport; and
4. MARC Commuter Rail links county with Washington D.C., and fort Meade to the south and Aberdeen Proving Ground to the north.

2.6.3 Freight Rail

CSX Transportation (CSXT) and Norfolk Southern provide rail freight transportation service for business and industry throughout the Baltimore region and connects with systems throughout North America. Major freight facilities include the Dundalk Marine Terminal. The Maryland Midland Rail road (MMID) is a small regional railroad serving Carroll, Frederick and western Baltimore County and serves customers who need coal and other raw materials. MMID has an interchange point with CSXT in Glyndon. The Canton Railroad serves businesses in Baltimore City's Canton area and operates in the eastern part of Baltimore City to Eastpoint in Baltimore County. The Patapsco and Back Rivers Railroad transports raw materials to and from Sparrows Point (formerly Bethlehem Steel).

2.6.4 Truck

The County's public roads are used extensively for freight movement by the trucking industry and for access to major freight movement and industrial facilities in the region. Roadways providing internal access between port facilities include Broening Highway and Dundalk Avenue. Direct regional highway access to BWI Airport is provided from I-95 and I-695 via I-195 and MD 295. More than 200 local and long-distance trucking establishments serve the County.

2.6.5 Water

The County's 219 miles of tidal shoreline provides water access for business and recreation use. Although most of the port facilities are in the City of Baltimore, the International Steel Group complex (formerly Bethlehem Steel), Dundalk Marine Terminal, and storage warehouses are located within the County. The County's transportation infrastructure is instrumental in moving goods shipped through the port.

2.6.6 Air

Baltimore County is served by Baltimore Washington International Thurgood Marshall Airport (BWI) in neighboring Anne Arundel County, Ronald Reagan National (DCA), and Washington Dulles Airport (IAD). Martin State Airport, in Middle River, is a major facility with approximately 120,000 flight operations per year. Many area businesses use the airport for corporate travel needs. The Baltimore County marine police, Baltimore City Police, Air National Guard, Medevac, television news stations and over 200 privately owned aircraft are based at the airport. Baltimore County also has privately-owned Baltimore Air Park and Essex Skypark serving small airplanes. There are also several private airstrips serving mainly agricultural needs in the County.

[1] www.netstate.com/states/geography/md_geography.htm
[2] www.mgs.md.gov/esic/fs/fs1.html
[3] www.mgs.md.gov/geology/
[4] water.epa.gov/type/watersheds/
[5] www.chesapeakebay.net/discover/bay101/facts
[6] water.epa.gov/type/watersheds/
[7] weatherspark.com/y/21918/Average-Weather-in-Baltimore-Maryland-United-States-Year-Round#:~:text=The%20predominant%20average%20hourly%20wind,of%2032%25%20on%20March%209.
[8] www.bcplonline.org/info/comm/
[9] Master Plan 2020
[10] Clackamas County, page 2-6
[11] planning.maryland.gov/MSDC/pages/s3_projection.aspx
[12] Master Plan 2020
[13] Comprehensive Plan 1975 and Master Plan 1980
[14] Master Plan 1990
[15] Baltimore County Department of Planning
[16] Master Plan 2010
[17] Master Plan 2020
[18] Master Plan 2020
[19] Master Plan 2020
[20] Master Plan 2020
[21] planning.maryland.gov/MSDC/Documents/American_Community_Survey/2011-2015/migration/flows/baco.pdf
[22] www.baltimorecountymd.gov/departments/planning/housingopportunities/
[23] www.baltimorecountymd.gov/departments/planning/grants/index.html
[24] Master Plan 2020
[25] Master Plan 2020

CHAPTER 3: Overall Hazard Mitigation Goals, Objectives, and Action Items

UPDATES

During the 2021 Plan Update process, **Chapter 3: Overall Hazard Mitigation Goals, Objectives, and Actions Items** was updated with the most recently available data.

Updates to this chapter include:

1. Thematic and visual update
2. Relevant text and data updates
3. Updates (addition, removal, modification) to mitigation Objectives and Action Items based on stakeholder feedback.

3.1 HAZARD MITIGATION STRATEGIES

The purpose of hazard mitigation strategies is to reduce or eliminate long-term risk to people and property from hazards and their effects using mitigation measures that promote environmental and fiscally responsible objectives and strategies.

Mitigation strategies include goals, objectives, and action items. Goals provide a general guideline as to what Baltimore County hopes to achieve within the next 5-year planning cycle. Objectives are not as broad as goals or as defined as action items but serve to provide a measurable connection between goals and action items. Action items consist of real-world steps that can be taken to fulfill the mitigation goals set by the County. The flow chart below represents this relationship.

To promote consistency with State mitigation efforts, the 2021 Plan utilized general goals and objectives provided by MEMA, which are to be used as guidelines for state and local governments. The goals and objectives detailed on the following pages provide a framework for implementing mitigation strategies in Baltimore County. Objectives and action items are based on successful mitigation projects implemented throughout the United States where those projects are aligned with the needs of Baltimore County.

The goals and objectives provided in this chapter are not always specific to a certain hazard, but general to hazard mitigation planning. Hazard specific goals and objectives are located at the end of each hazard's chapter. The 2021 HMPC provided status updates to the goals and objectives in this chapter wherever necessary. Those goals, objectives, and action items that were kept and/or modified by the 2021 HMPC have been included.

GOAL 1: Eliminate or reduce human, environmental, social, and economic loss from natural and technological hazards	
OBJECTIVE	**ACTION ITEM(S)**
1. Direct new development away from hazard areas	1. Regulate the location, type, and intensity of new development in hazard areas which can include flood-zone regulations, steep slopes, and coastal erosion areas.
	2. Evaluate the Resource Conservation zones to determine if an overlay zoning district is needed that applies additional development standards for sensitive lands, such as wetlands, coastal areas, and hillsides.
2. Reduce the number of repetitive loss properties	1. Assess repetitive damages.
	2. Purchase or relocate repetitive loss properties with public funds.
3. Reduce the number of properties within the 1% annual chance floodplain	1. Determine feasibility of acquiring undeveloped lands in hazard-prone areas.
	2. Place use restrictions on deeds of vacant land to prevent future residential or commercial development where appropriate.
4. Identify and protect historic structures that are at risk from hazards	1. Develop action plan to protect or relocate identified historic structures.
5. Develop and improve upon hazard data using GIS as the technical foundation for floodplain management planning	1. Evaluate and broaden inventory of infrastructure, demographic, and property statistics.
	2. Coordinate with FEMA to ensure that data created through future Flood Insurance Studies are compatible with existing systems and models.
	3. Equip emergency response vehicles with computers containing GIS data of properties in the community, including homes and businesses located in the floodplain and those with special assistance needs.
	4. Use GIS as an education and marketing tool to illustrate acquisition plans and benefits and to assist with relocation planning.
6. Facilitate accurate insurance ratings	1. Apply for the Community Rating System program. CRS is a voluntary incentive program that recognizes and encourages community floodplain management activities that exceed the minimum NFIP requirements. As a result, flood insurance premium rates are discounted to reflect the reduced flood risk resulting from the community actions meeting the three goals of the CRS. (1) reduce flood losses; (2) facilitate accurate insurance rating; and (3) promote the awareness of flood insurance.

GOAL 2: Support mitigation measures that show potential for environmental enhancement and cost-effectiveness	
OBJECTIVE	**ACTION ITEM(S)**
1. Develop a Green Infrastructure Plan that would redevelop areas as open spaces that create amenities and services to benefit the overall community	1. Identify hub areas for appropriate activities and links with connectors or greenway segments.
	2. Determine appropriate activities that include heritage tourism, passive recreation, and active recreation.
	3. Utilize the most vulnerable part of the floodplain as a greenway, park, or wildlife habitat.
2. Ensure adequacy of stormwater management facilities and infrastructure	1. Use structural mitigation measures and techniques as appropriate to minimize future flood damages.

OBJECTIVE	ACTION ITEM(S)
3. Ensure public water and wastewater facilities and infrastructure failure is minimized to reduce adverse impacts to communities and the environment	1. Evaluate back-up power at facilities to determine if further actions are required (many critical sites now have back-up power).
	2. Determine if submersible pumps are needed at pumping stations to ensure operation during hazard events.

GOAL 3: Promote hazard mitigation as the cornerstone of emergency management in Maryland	
OBJECTIVE	**ACTION ITEM(S)**
1. Educate the public about natural hazard risks, preparedness, and mitigation	1. Develop an outreach program to increase awareness in the community.
	2. Enroll people to help get the message out.
	3. Provide educational materials to the construction industry, homeowners, tenants, and businesses.
	4. Establish a web site that provides notices of when businesses reopen after a hazard event.
	5. Increase risk awareness and encourage adequate business insurance.
	6. Work with the real estate industry to develop hazard disclosure requirements.
	7. Hold briefings or training at disaster recovery centers after a hazard event.
2. Target owners of properties within hazard areas for outreach regarding mitigation and preparedness	1. Develop and outreach program to increase property owner participation in the National Flood Insurance Program.
	2. Create a public awareness campaign on the many benefits of floodplain preservation and restoration.
3. Develop public/private partnerships toward the protection of private properties	1. Educate business owners about losses due to natural hazards such as safety for employees and customers, reduced down-time in production, reduced damages to inventory and supplies, protected information systems, reduced damages to facilities and nonstructural components (have held numerous business continuity seminars and performed many community presentations that include points concerning emergency and continuity planning).
	2. Develop a recovery planning task force composed of community leaders, representatives of local government, and citizens to structure long-term recovery planning.
	3. Coordinate with electricity providers to develop a feasible and phased approach to putting electrical lines underground in high hazard areas. Over time, this will reduce the number of power disruptions during severe storms, high winds, winter weather events, and hurricanes/tropical storms.
4. Improve communication and coordination between County agencies	1. Form a Hazards and Emergency Management Council to promote communication and coordination between various departments with a focus on hazards and emergency related concerns. The Council should be inclusive of emergency management, emergency response, planning, information services (GIS), public works, social services, and environmental resource management agencies.

CHAPTER 4: FLOOD

UPDATES

During the 2021 Plan Update process, **Chapter 4: Flood** was updated with the most recently available data.

Major updates to this chapter include:

1. Thematic and visual updates were made throughout the entire chapter.
2. **Sections Updated**:
   1. 4.2 Contributing Factors to Flood Risk - Results of the HIRA were added to this section. Flood risk is ranked as "High." See Appendix A for full results.
   - 4.2.2 Development - updated statistics with new damage estimates from FEMA, updated endnote.
   - 4.4 National Flood Insurance Program – NFIP data was updated and compared between 2013 and 2021.
   - 4.6.2 County Overview – adjusted population data.
   - 4.6.6 Social Impact - adjusted household and population numbers.
   - 4.7.4 Assessment Results - added Essential Facility section to the analysis.
   - 4.7.5 Assessment Analysis - updated Transportation Impact section to reflect impacted roadways.
     - Updated Middle River and Pulaski Highway Redevelopment Areas section to reflect newly added impacted roadways.
3. **Tables Updated:**
   - 4-1, added 4 new declarations.
   - 4-2, added June 2012 Derecho.
   - **New** Table 4-3. CRS Credit Points, Classes, and Premium Discounts.
   - 4-4, updated with latest RLP data.
   - **New** Table 4-5. Severe Repetitive Loss Properties
   - 4-11, updated dollar estimates to represent 2021 dollars.
4. **New Sections:**
   - **4.8 Social Vulnerability**
   - **4.9 HAZUS Analysis of Historic Resources**
   - **Added** Tables 4-14 and 4-15.
5. **New Mapping**
   - **Map 4-4** FEMA 1% Annual Chance Floodplain
   - **Map 4-5** Roadways within the 100-year Floodplain
   - **Map 4-6** Bridges within the 100-year Floodplain
   - **Map 4-7** Culverts within the 100-year Floodplain
   - **Map 4-8** Social Vulnerability and 100-year Floodplain
   - **Map 4-9** Historic Resources within the 1% Annual Chance Flood Zone
6. **Figures Updated:**
   - 4-1, updated with latest NFIP flood insurance data for the County,
   - 4-2, changed to show percentage of bridges within the 100-year floodplain.

4.1 HOW ARE FLOODS A THREAT TO BALTIMORE COUNTY?

As discussed in *Chapter 2: County Profile,* there are three primary factors that contribute to flooding in Baltimore County: geography, climate, and soils. Baltimore County's geographic location in the mid-Atlantic region, with its coastal presence on the Chesapeake Bay, and its inland terrain, make the County susceptible to coastal, riverine, and flash flooding.

Events such as Hurricane Isabel produced both coastal and riverine flooding. As Isabel moved inland, the storm produced more extensive flooding from storm surge and coastal still-water flooding than from riverine flooding from heavy rains. Excessive damage was witnessed in many communities along the Chesapeake Bay and coastlines on inland waterways. Many structures were destroyed because of the storm surge[1]. The devastation inflicted by Isabel created a renewed interest in mitigation measures to protect life and property within the County.

Table 4-1. Presidential Declarations

Event	Date
Severe storms and flooding	August 17, 1971
Tropical Storm Agnes	June 23, 1972
Heavy rains and flooding	October 4, 1975
Severe storms, tornadoes, and flooding	September 14, 1979
Blizzard of '96	January 11, 1996
Severe winter storm	April 10, 2000
Severe snowfall	March 14, 2003
Hurricane Isabel	September 19, 2003
Blizzard	December 19, 2009
Blizzard	January 31, 2010
Blizzard	February 5, 2010
Hurricane Irene	August 25, 2011
Tropical Storm Lee	September 2, 2011
Derecho	June 29, 2012
Hurricane Sandy	October 26, 2012
Snowstorm	February 12, 2014
Severe winter storm and snowstorm	January 22, 2016
COVID-19	January 20, 2020
Tropical Storm Isaias	August 3, 2020

Isabel is not the only event in Baltimore County's history that has raised concern regarding the County's vulnerability to flooding. Presidential declarations have been made in past years allowing for Federal assistance to supplement State and local efforts and capabilities to save lives and to protect property and public health and safety, or to lessen or avert the threat of a catastrophe. These declarations, listed in Table 4-1 and outlined in section 4.3, are a result of severe storms, hurricane/tropical storms, large snow events, and pandemics.

4.2 CONTRIBUTING FACTORS TO FLOOD RISK

As part of this plan update, a Hazard Identification and Risk Assessment (HIRA) was conducted for the flood hazard. A composite scoring method was utilized to rank natural hazards, which included five (5) key components: historical impacts (in terms of human lives and property), geographic extent, historical occurrences, future probability, and community perspective.

Based on this method, flood was assigned a risk ranking of "**High**" during this plan update. This is consistent with flood's ranking during the previous planning cycle. The future probability of a flood event is considered “likely”, as determined by the HIRA. Full results of the HIRA, including method, are included within *Appendix A* of this plan.

4.2.1 Weather

Most flash floods are caused by intense, localized, convective thunderstorms. These storms, which are most frequent in summer, occur in late afternoon and sometimes last well into the evening. A persistent, active frontal system lingering in the area can also gradually saturate the ground with slight to moderate rainfall for several days. Then, a single, intense storm moving along the frontal system can induce floods because of the saturated ground conditions. Hurricanes and other convective tropical storms inundate large areas with intense rainfall, commonly six inches or more in less than 24 hours. Flooding can be either local and sudden, or regional and prolonged. While sometimes overlooked, rapid snow melt also contributes to flooding. According to NOAA, flooding because of snowmelt occurs every year in the northern U.S., but most events are relatively minor and localized. However, eight of the most significant floods of the 20th century (in terms of area affected, property damage, and deaths) were related to snowmelt.[2]

4.2.2 Development

According to the Federal Emergency Management Agency (FEMA), the cost of flood related damage between 2010 and 2018 was approximately $17 billion annually.[3] In Baltimore County, the rapid growth and development since the 1950’s has created highly urbanized watersheds with runoff characteristics that lead to fast-rising, dangerous riverine floodplain areas. Recognizing this risk factor, the County’s development policies have prohibited construction of dwellings in the riverine floodplain area since as early as the 1955 Department of Public Works Design Manual. To address the urbanization of watersheds, the County’s floodplain criteria require the delineation of the area of hazard to be based on the design assumption of fully developed, not existing, watershed areas. In this way, the area of hazard does not increase with build-out of the developing area.

> In the last 20 years, but especially since tropical storm Isabel, substantial residential development of a much larger scale occurred, presenting the following issues: increased impervious surface area, diminished viewsheds, reduction in public access to the water, and excessive permitting issues due to regulations that fail to consider current residential trends.

Source: Baltimore County Master Plan 2020

Encroachment on floodplains, such as structures and fill, reduces flood-carrying capacity, increases flood heights and velocities, and increases flood hazards in areas beyond the encroachment itself. These factors affect the function and capacity of the watershed and drastically increase the risk of flooding.[4] One aspect of floodplain management involves balancing the economic gain from floodplain development against the resulting increase in flood hazard.

4.2.3 Hydraulic Structures

Depending upon design and size, bridges over streams can sometimes act as significant constrictive hydraulic structures. Even during small floods, upstream ponding occurs until floodwaters can flow through small bridge openings or over the top of high roadways. Examples include: Old Court Road Bridge over Gwynns Falls, the B&O Railroad Bridge over Herbert Run, and the downstream bridge at Interchange 33 over Stemmers Run.[5]

4.3 HISTORY OF FLOODING

Baltimore County's history of flood events primarily are the result of three weather-related conditions: tropical storms and hurricanes, snowmelt from winter weather events, and severe thunderstorms. The following are brief descriptions of some of the most significant weather events that have affected Baltimore County. Additionally, Table 4-2 provides a chronological listing of these significant storm events.

Table 4-2. Significant Tropical Storms/Hurricanes Affecting Baltimore County	
• Chesapeake-Potomac, 1933	• Dennis, 1999
• Hazel, 1954	• Floyd, 1999
• Agnes, 1972	• Isabel, 2003
• David, 1979	• Irene, 2011
• Gloria 1985	• Lee, 2011
• Bertha 1996	• Sandy, 2012
• Fran, 1996	• June Derecho, 2012

4.3.1 Tropical Storms/Hurricanes

Sandy – October 2012

Compared to many locations in the Northeast, Baltimore County avoided disaster in terms of damage from Sandy. Except for flooding on the Eastern Shore that destroyed parts of the Ocean City boardwalk, and heavy snowfall in Western Maryland that shutdown I-68, most of central Maryland was left relatively unscathed. In total, about 300,000 BGE customers lost power starting on October 28; a rather light number compared to the June Derecho and Hurricane Irene, which each had about 750,000 reported power outages.[6]

Tropical Storm Lee – September 2011

On the heels of Hurricane Irene, Tropical Storm Lee set up in a north/south orientation across Maryland from Charles County into Baltimore County on September 7. Rainfall rates of 2 to 3 inches per hour occurred for several hours within this region, causing numerous high-water rescues, road closures, and flooded homes. Of note was a rain gauge in Bowie, MD, that observed 4.57 inches of rain in 3 hours, which is an amount that only has a 0.5 percent chance of occurring each year. Across much of the

Baltimore region, the storm dumped more rain than Hurricane Irene did, but lighter winds meant that far fewer people lost electrical service. About 66,000 BGE customers lost service for a time; and almost 6,000 were still in the dark into the following morning.[7]

Irene – August 2011

Hurricane Irene tracked up the Mid-Atlantic Coast during the evening hours of August 27th through the early morning hours of the 28th. Irene passed by just to the east of Ocean City, Maryland during the early morning hours of the 28th. The minimum central pressure was 958 millibars and maximum sustained winds were 80 mph, making Irene a category one hurricane. Irene produced tropical storm conditions across portions Maryland near and east of the Interstate 95 Corridor. The worst conditions were near the Chesapeake Bay. As with most of the state, Baltimore County did not receive the amount of damage and flooding that had been predicted. However, high winds did lead to downed trees and power lines, which caused some 130,000 reported power outages throughout the county.[8]

Isabel – September 2003

Areas adjacent to the Chesapeake Bay and its tributaries were particularly hard hit, with storm surge exceeding the previous record levels set by the Chesapeake-Potomac Hurricane of 1933. In Baltimore County alone, $3 million in damage is estimated to have occurred from erosion of the shoreline. Residential areas of Millers Island, Edgemere, North Point, Bowley's Quarters and Turners Station were hard hit with more than 400 people being rescued from their homes and over 300 buildings destroyed. Marinas were also destroyed or severely damaged. Baltimore County was estimating 3189 tons of debris to be hauled from the storm. While most people had their power back in a week, some locations took up to two weeks. Many injuries and three fatalities occurred from carbon monoxide poisoning from people improperly running generators in their houses. Other injuries were related to chain saws and the clean-up of debris. Heavy rains, several days after Isabel, added to localized and flash flooding throughout the County. The State was declared a Federal Disaster Area on September 19, 2003. 4,113 Baltimore County residents have registered with the federal government for disaster relief. For the entire State of Maryland, the number of claims reported to the National Flood Insurance program totaled approximately $122 million.

Floyd – September 1999

The highest rainfall reports ranged from 5 – 6 inches throughout the County. Across Baltimore County, 57,000 customers lost power. Winds gusted to 69 MPH at Martin State Airport, and hundreds of trees fell in Gunpowder State Park. Countywide, fallen trees damaged homes, sheds, fences, and cars, and closed 125 roads. Officials reported 6 rapid water rescues and 350 flooded basements. A 10-year-old boy was swept into a storm drain and carried 300 feet in a buried pipe before fire fighters opened a manhole cover and rescued him uninjured. The impact of Floyd was compounded by the effects of Hurricane Dennis which had produced rainfall on the Atlantic coast one week prior to Floyd's arrival. This resulted in already saturated conditions in the region.

Hurricane David – September 1979

Hurricane David, which at the time was classified as a tropical storm, directly hit Baltimore County on the night of September 5, 1979. Heavy rain caused flooding in multiple locations, including Ellicott City, Oella, and Mount Washington. A tornado in Kingsville was recorded as having done damage to an uncompleted home. The tropical storm caused one recorded death and several injuries in Jones Falls Valley. President Jimmy Carter declared a disaster area shortly after the event. News outlets reported that Baltimore sustained $40 million of the total $66 million of damage in the state.[9]

Agnes – June 1972

Agnes is a reminder that we cannot assume that the size and category of hurricane tells the whole picture. Agnes evolved from a weak Category 1 hurricane at landfall on the Gulf of Mexico, to a tropical depression as it moved eastward. Total storm damage in the United States from Agnes was estimated at just under $3.5 billion with a death toll of 122 lives. Total storm damage in Maryland and the District of Columbia was estimated at $110 million. In Maryland heavy rains in less than 24 hours resulted in severe flooding. Just west of Baltimore County, the highest total rainfall was 14.68 inches at Westminster and 13.85 inches at Woodstock. The heavy rains caused disastrous flash flooding of creeks and streams. Flooding along the Patapsco River broke all existing records, inundating the chronically flooded Ellicott City and Oella regions of Baltimore and Howard Counties with flood waters cresting almost 15 feet above Main Street in Ellicott City.

The American Red Cross in Maryland reported 103 houses destroyed and 1,930 damaged, 17 farm buildings destroyed and 44 damaged, and 82 small businesses destroyed. Damage to residential, farm, and business structures was estimated at $48.5 million.[10] Damage to State roads and bridges in Maryland was estimated to be $6.5 million and to county roads and bridges, $25 million.[11] Flooding along the larger streams and rivers severely damaged or destroyed crops through erosion or silt deposition. Excessive runoff into the Chesapeake Bay decreased salinity levels and severely affected the shellfish industry.[12]

Hurricane of 1933

Prior to Agnes, this storm was the storm of record in terms of flooding. The storm caused 13 deaths statewide and $12.3 million in damages.

4.3.2 Winter Storms

“Snowmageddon” – February 2010

Baltimore County was paralyzed by back-to-back blizzard events that led to significant accumulations of snow across the region. According to NOAA, total snow accumulation by the end of February at BWI Airport was 50 inches.

Severe Winter Storm – February 2003

Baltimore set a new snowfall record with the President's Day storm (15-18, 2003). A total of 28.2 inches of snow fell making this storm the top snowstorm on record.

Blizzard – January 1996

Baltimore recorded over 22 inches of snow. The entire state was paralyzed, and the Federal Government remained shut down after a month-long furlough. As road crews worked to clear the snow, another storm moved through on Tuesday, January 9 dumping an additional 3 to 5 inches from Washington northeast through Baltimore. Plows that would have been working on secondary roads and residential areas were sent back to the primary roads. The government remained closed for 4 days that week and many schools and businesses announced their closure for the entire week. A third storm struck on Friday, January 12 dumping another 4 to 6 inches over the metro areas. By the week's end approximately 3 to 4 feet of snow had fallen in the region.

4.3.3 Significant Severe Thunderstorms

Derecho – June 2012

A long-lived line of severe thunderstorms struck Baltimore County on the evening of June 29, 2012, with prolific lightening and wind gusts that exceeded 75 miles per hour. Numerous trees and limbs were knocked down onto homes, power lines, and parked vehicles. It took over a week to fully restore power to all Baltimore County residents.

Storm – August 1971

The thunderstorm of August 1-2, 1971 was one of the most damaging in the Baltimore metropolitan area during the past 50 years. A "bucket" survey indicated an unofficial rainfall total of 11 inches in less than 10 hours, with a total of 12.61 inches near White Marsh. The National Weather Service gage in Baltimore recorded 5.5 inches in 3 hours. Floods at stations along the Gunpowder and Back River basins had recurrence intervals equivalent to or more than 100 years. Fourteen people died because of the flooding. Bridge and roadway washouts were widespread. Total damage attributable to the flood was estimated at $6.5 million.[13]

Storms – July 1968

The effects of these storms killed approximately 50 people with an estimated $2 million in damages.

Storm – March 1936

This storm was significant, because it was preceded by a cold spell that formed thick ice in local rivers and streams. In addition, entire basins were covered with snow averaging 15 inches in depth. Rain and snowmelt caused by mild temperatures in early March saturated the ground and caused moderate rises in stream flow.

More Flood History?

Please visit the following links to learn about significant flooding events not listed in this section:

www.weather.gov/lwx/FloodTimeline
www.ncdc.noaa.gov/stormevents/

4.4 NATIONAL FLOOD INSURANCE PROGRAM

The National Flood Insurance Program (NFIP) was enacted by the Federal government in 1968 to facilitate citizens' access to affordable flood insurance and shift the burden of private property flood losses from taxpayers to floodplain property owners. The program is also designed to guide development away from flood hazard areas and requires new design and construction to be carried out in a way that minimizes or prevents flood damage.[14]

Baltimore County NFIP Policy and Claim Information (as of 10/31/2013)

Number of policies in force: 4,654
Total coverage value: $1,091,896,600
Number of claims: 2,970
Total claim value: $64,186,927

Source: bsa.nfipstat.fema.gov, 2013

Baltimore County NFIP Policy and Claim Information (as of 03/31/2021)

Number of policies in force: 3,421
Total coverage value: $926,965,500
Number of claims: 3,208
Total claim value: $66,924,935

Source: https://nfipservices.floodsmart.gov//reports-flood-insurance-data, 2021

Presently, Baltimore County has fewer policies in force than it did in 2013; total policies have decreased by 1,233. The total value of flood insurance coverage has also decreased by $164,931,000.

The fewer policies in force as compared to 2013 may be due to changes between the previous effective FIRM (8/2/2011) and the current effective FIRM (5/5/2014). The Special Flood Hazard Area (SFHA) boundaries within the coastal regions of Baltimore County were updated due to new engineering analysis performed within the Flood Risk Project. The updated modeling produced new flood zone areas and new base flood elevations.

Both the SFHA and non-SFHA areas decreased in total area (mi^2). The SFHA decreased by 2.8 mi^2 and the non-SFHA area decreased by 3.3 mi^2. The decrease in total land area for these zones may translate into less structures within the zones, which could explain the decrease in total NFIP policies in force.

4.4.1 Flood Mapping

A Flood Insurance Rate Map (FIRM), created for floodplain management insurance purposes, is an official map of a community on which FEMA has delineated both the special hazard areas and the risk premium zones applicable to the community. Digital versions of these maps are called DFIRMS, which are compatible with Geographic Information Systems (GIS). The improvements in spatial accuracy provided by the new base map, and the availability of electronic floodplain information should greatly enhance the ability to use the maps for planning, permitting, and insurance applications.[15]

The State of Maryland in conjunction with the Federal Emergency Management Agency (FEMA) has been systematically updating Flood Insurance Rate Maps (FIRMs) for communities over the past several years. As of May 1, 2021, Baltimore County's Preliminary Map release date for riverine floodplain mapping was August 2020. The current effective FIRM for riverine floodplain mapping date is May 2008. Updated effective riverine floodplain mapping is slated for release in September of 2022. Baltimore County utilizes the May 2014 coastal mapping for insurance rates only; for building purposes in coastal areas, property owners must build in accordance with the 2008 FIRM, which follows the most current Baltimore County Code.

4.4.2 Community Rating System

The NFIP's Community Rating System (CRS) is a voluntary incentive program that recognizes communities for implementing floodplain management practices that exceed the Federal minimum requirements of the NFIP to provide protection from flooding.

In exchange for a community's proactive efforts to reduce flood risk, policyholders can receive reduced flood insurance premiums for buildings in the community. These reduced premiums reflect the reduced flood risk resulting from community efforts toward achieving the three CRS goals:

1. Reduce flood damage to insurable property;
2. Strengthen and support the insurance aspects of the NFIP;
3. Encourage a comprehensive approach to floodplain management.

CRS Credit Opportunities

According to a 2020 report conducted by the Chesapeake Conservancy, Baltimore County is eligible for up to 578 Open Space Preservation (OSP) credits, qualifying for a 5% discount to flood insurance. This is possibly due to the considerable headway Baltimore has made in preserving open space within their floodplains. Of the almost 18,000 acres of floodplain, 7,151 acres (or about 40%) of it is preserved open space. To reach the 10% discount, the County would have to preserve another 5,206 acres of its floodplain.

Source: "Land Conservation and the Community Rating System: Mapping Open Space Preservation Opportunities in Maryland Communities." Chesapeake Conservation Partnership, July 2020.

Participation in the Community Rating System (CRS) is voluntary. By participating, communities earn credit points that determine classifications. There are 10 CRS Classes: Class 1 requires the most credit points and provides the largest flood insurance premium reduction (45 percent), while Class 10 means the community does not participate in the CRS or has not earned the minimum required credit points, and residents receive no premium reduction. The CRS Classes are based on completion of 19 creditable activities organized into four categories:

1. Public Information
2. Mapping and Regulations
3. Flood Damage Reduction
4. Warning and Response

Table 4-3. CRS Credit Points, Classes, and Premium Discounts

Credit Points	Class	Premium Reduction SFHA*	Premium Reduction Non-SFHA**
4,500+	1	45%	10%
4,000 – 4,499	2	40%	10%
3,500 – 3,999	3	35%	10%
3,000 – 3,499	4	30%	10%
2,500 – 2,999	5	25%	10%
2,000 – 2,499	6	20%	10%
1,500 – 1,999	7	15%	5%
1,000 – 1,499	8	10%	5%
500 – 999	9	5%	5%
0 – 499	10	0	0

*Special Flood Hazard Area
**Preferred Risk Policies are available only in B, C and X Zones for properties that are shown to have a minimal risk of flood damage. The Preferred Risk Policy does not receive premium rate credits under the Community Rating System because it already has a lower premium than other policies. The Community Rating System credit for AR and A99 Zones are based on non-Special Flood Hazard Areas (non-SFHAs) (B, C and X Zones).

4.5 REPETITIVE LOSS PROPERTIES

Repetitive loss properties are the biggest drain on this country's Flood Insurance Fund. According to the NFIP, a property is considered a repetitive loss property when there are two or more losses reported and $1,000 or more was paid on each loss. The two losses must be within ten years of each other and be at least ten days apart; only losses proceeding January 1, 1978 are considered. Additionally, a property may be considered a 'severe repetitive loss property' if it meets the following criteria:

- Has at least four NFIP claim payments (including building and contents) over $5,000 each, and the cumulative amount of such claims payments exceeds $20,000; or
- For which at least two separate claims payments (building payments only) have been made with the cumulative amount of the building portion of such claims exceeding the market value of the building.

- For both (a) and (b) above, at least two of the referenced claims must have occurred within any ten-year period and must be greater than 10 days apart.

As of April 27, 2021, Baltimore County has 177 total repetitive loss properties (Table 4-4) Of these, 13 are severe repetitive loss properties. Most of these properties are residential (139 total). Communities with repetitive loss properties are listed in Table 4-4, below. Figure 4-1 depicts the percentage of RLPs that have NFIP flood insurance versus those that do not.

Figure 4-1.

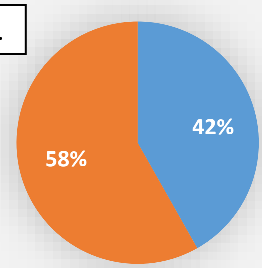


Table 4-4. Communities with the Greatest Amount of RLP in the County

Community	# of Properties	% of total RLP (out of 177)
Baltimore*	93	52.54
Cockeysville	20	11.3
Middle River	12	6.78
Sparrows Point	7	3.95
Dundalk	5	2.82
Edgemere	5	2.82
Lutherville	5	2.82
Catonsville	3	1.69
Lutherville Timonium	3	1.69
Pikesville	3	1.69
Brooklandville	2	1.13
Essex	2	1.13
Monkton	2	1.13
Owings Mills	2	1.13
Ruxton	2	1.13
White Marsh	2	1.13
Ellicott City	1	0.56
Fort Howard	1	0.56
Fuxton	1	0.56
Glencoe	1	0.56
Halethorpe	1	0.56
Randallstown	1	0.56
Reisterstown	1	0.56
Stevenson	1	0.56
Townson	1	0.56
Total:	**177**	**100%**

**Indicates a rural RLP or one that is not within a designated community.*
Repetitive Loss Data Source: Terry Curtis, Baltimore County.

The repetitive loss data contained in Tables 4-5 and 4-6 has been redacted due to issues of privacy. This data is available for official use in *Appendix I: Repetitive Loss Data (Official Use Only).*

Table 4-5. NFIP Repetitive Loss Properties			
Street Name	**Total Properties**	**Street Name**	**Total Properties**
[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]
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[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]		
[redacted]	[redacted]		

Table 4-6. NFIP Severe Repetitive Loss Properties

Street Name	Total Properties
[redacted]	

4.6 HAZUS LEVEL 2 FLOOD ANALYSIS

A HAZUS Level 2 Analysis was conducted for *Chapter 4 Flood* in 2014. As part of the 2021 Plan Update this analysis was modified to reflect current estimates provided by the American Community Survey (5-year). Full results from the 2020 U.S. Census are not yet available and are slated for release in late summer of 2021.

Results of this type of analysis include essential facility and general building stock damages, debris generation, shelter requirements, and associated economic losses. This level of analysis is more accurate than a Level 1 Analysis because the data used for the analysis is derived from user-supplied sources, including best-available data specific to Baltimore County, as well as data available in the Hazus database. Examples of user-supplied data utilized for this analysis include:

- Building stories
- Year built
- Structure value
- Square Footage

<u>U.S. Census Bureau Data Utilization</u>

The HAZUS analysis conducted during the 2014 Plan Update utilized the most recent version of the software (version 2.1), which was released in October of 2013. At the time of this HAZUS Level 2 Analysis for Flood, FEMA had not yet integrated 2010 Census data into the Hazus version 2.1 software. As such, household numbers and other demographic data had been increased by 5.6% to better represent the total number of households (316,716) in Baltimore County per the 2010 U.S. Census. This percentage increase was derived by determining the percent change in demographic data from 2000 to 2010. For example, the total number of households in Baltimore County had changed from 299,000 in 2000 to 316,715 in 2010, which represents an increase of 17,715 households. This change was calculated as a percentage (5.6%) and related household values were increased by this amount where necessary. In the case of population estimates, a 6.3% change was calculated and added to necessary population values.

Results from the 2014 HAZUS analysis within this section have been modified with estimated values for the 2021 Plan Update. This is because 2020 Census data is not currently available. Certain demographic data, such as household size and total population, is provided by ACS 5-year data estimates.

Population results have been increased by 2.775% to better represent the estimated number of people (827,370) in Baltimore County per the 2019 ACS 5-year estimates. This percentage increase was derived by determining the percent change in population data from 2013 to 2020. For example, the total population in Baltimore County has changed from 805,029 in 2010 to 827,370 in 2020, which represents an increase of 22,341 people. This change was calculated as a percentage (2.775%) and related population values were increased by this amount where necessary. In the case of household size estimates, a -1.009% change was calculated and added to necessary household size values.

4.6.1 Introduction

The HAZUS Flood Model analyzes both 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. Depth, duration, and velocity of water in the floodplain are the primary factors contributing to flood losses. The flood model does not estimate the losses due to high velocity flash floods currently.

Note: The full report of the HAZUS Level 2 Analysis for Flood is included in Appendix E.

4.6.2 County Overview

Baltimore County is roughly 607 square miles and contains 7,879 census blocks. The region contains 313,519 households and has a total population of 827,370 people (ACS 5-year estimate). There are an estimated 269,655 buildings in the region with a total building replacement value (excluding contents) of $77.5 billion (2021 dollars). Approximately 93% of the buildings (and 76% of the building value) are associated with residential housing.

HAZUS Riverine Flood Parameters

Study Region: Baltimore County
Scenario: 100-year flood
Return Period Analyzed: 100

Table 4-7, below, provides building exposure values by occupancy type for the 100-year flood event scenario. The information contained in this table represents only building stock that was determined by HAZUS to have been affected ("exposed") by the 100-year flood event.

Table 4-7. Building Exposure by Occupancy Type for the Scenario		
Occupancy	**Exposure ($) ***	**Percent of Total**
Residential	9,563,749,000	72.0%
Commercial	2,623,484,927	19.7%
Industrial	696,050,143	5.2%
Agricultural	56,176,796	0.4%
Religion	200,089,544	1.5%
Government	55,873,212	0.4%
Education	89,873,551	0.7%
Total	13,285,297,173	**100.00%**

Note: Dollar exposure values are produced from the square footage values derived from U.S. Census data, Maryland Property View, and Dun & Bradstreet, by applying the RS Means replacement values for typical building square foot factors and construction for each occupancy type.
* 2021 dollars, adjusted for inflation.

Critical Facility Inventory

Critical facilities were broken down into two groups: essential facilities and high potential loss facilities (HPL). Essential facilities include hospitals, medical clinics, schools, fire stations, police stations and emergency operations facilities. High potential loss facilities include dams, levees, military installations, nuclear power plants, and hazardous material sites.

For essential facilities, there are 25 hospitals in the region with a total bed capacity of 1,800 beds. There are 375 schools, 65 fire stations, 20 police stations and 1 emergency operation center. With respect to high potential loss facilities (HPL), there are 11 dams identified within the region. Of these, 4 of the dams are classified as 'high hazard'. The inventory also includes 66 hazardous material sites, 0 military installations and 0 nuclear power plants.

4.6.3 Damage Estimates

General Building Stock Damage

Hazus estimates that about 1,595 buildings will be at least moderately damaged. This is over 72% of the total number of buildings in the scenario. There are an estimated 309 buildings that will be destroyed. Table 4-8, below, summarizes the expected damage by general occupancy for the buildings in the scenario.

Table 4-8. Expected General Building Stock Damage by Occupancy	
Occupancy	**Count**
Residential	1,585
Commercial	9
Industrial	1
Agricultural	0
Religion	0
Government	0
Education	0
Total	**1,595**

Essential Facility Damage

Before the flood event analyzed in this scenario, Baltimore County had 1,800 hospital beds available for use. On the day of the scenario flood event, the model estimates that all these hospital beds will remain available for use. Table 4-9, below, summarizes the expected damage to essential facilities in Baltimore County due to the proposed flood event. Except for three schools (listed below), HAZUS results indicate that essential facilities are not expected to receive damage.

Table 4-9. Expected Damage to Essential Facilities

Classification	Total	At Least Moderate Damage	At Least Substantial Damage	Loss of Use
Fire Station	65	0	0	0
Hospital	25	0	0	0
Police Station	20	0	0	0
School	375	3	0	3

Affected Schools:

- Ashland Preschool Center, Cockeysville, MD
- Options Celebrating Education One on One Tutorial, Woodlawn, MD
- CCBC & MD Department of Health and Mental Hygiene, Nottingham, MD

4.6.4 Induced Flood Damage

Debris Generation

Hazus estimates the number of debris that will be generated by the flood. The model breaks debris into three general categories: 1) Finishes (dry wall, insulation, etc.), 2) Structural (wood, brick, etc.) and 3) Foundations (concrete slab, concrete block, rebar, etc.). This distinction is made because of the different types of material handling equipment required to handle the debris.

The model estimates that a total of 97,511 tons of debris will be generated. Of the total amount, Finishes comprises 29% of the total, and Structure comprises 38% of the total. If the debris tonnage is converted into an estimated number of truckloads, it will require 3,900 truckloads (@25 tons/truck) to remove the debris generated by the flood.
The total economic loss estimated for the flood is $851.77 million (2021 dollars), which represents 6.4 % of the total replacement value of the scenario buildings.

4.6.5 Economic Loss

Building-Related Losses

Building losses are broken into two categories: direct building losses and business interruption losses. The direct building losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the flood. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the flood.

The total building-related losses were $847.71 million (2021 dollars). Less than 1% of the estimated losses were related to the business interruption of the region. The residential occupancies made up 45% of the total loss. Table 4-10, below, provides a summary of the losses associated with the building damage.

Table 4-10. Building-Related Economic Loss Estimates (2021 Dollars)

Type	Residential	Commercial	Industrial	Others	Total
Building	$236,159,261	$102,559,294	$28,880,333	$7,390,636	$374,989,524
Content	$143,605,752	$207,847,438	$71,404,919	$30,472,163	$453,330,271
Inventory	$0	$5,571,403	$13,303,146	$454,808	$19,329,357
Total	$379,765,013	$315,978,135	$113,588,398	$38,317,607	$847,649,152

4.6.6 Social Impact

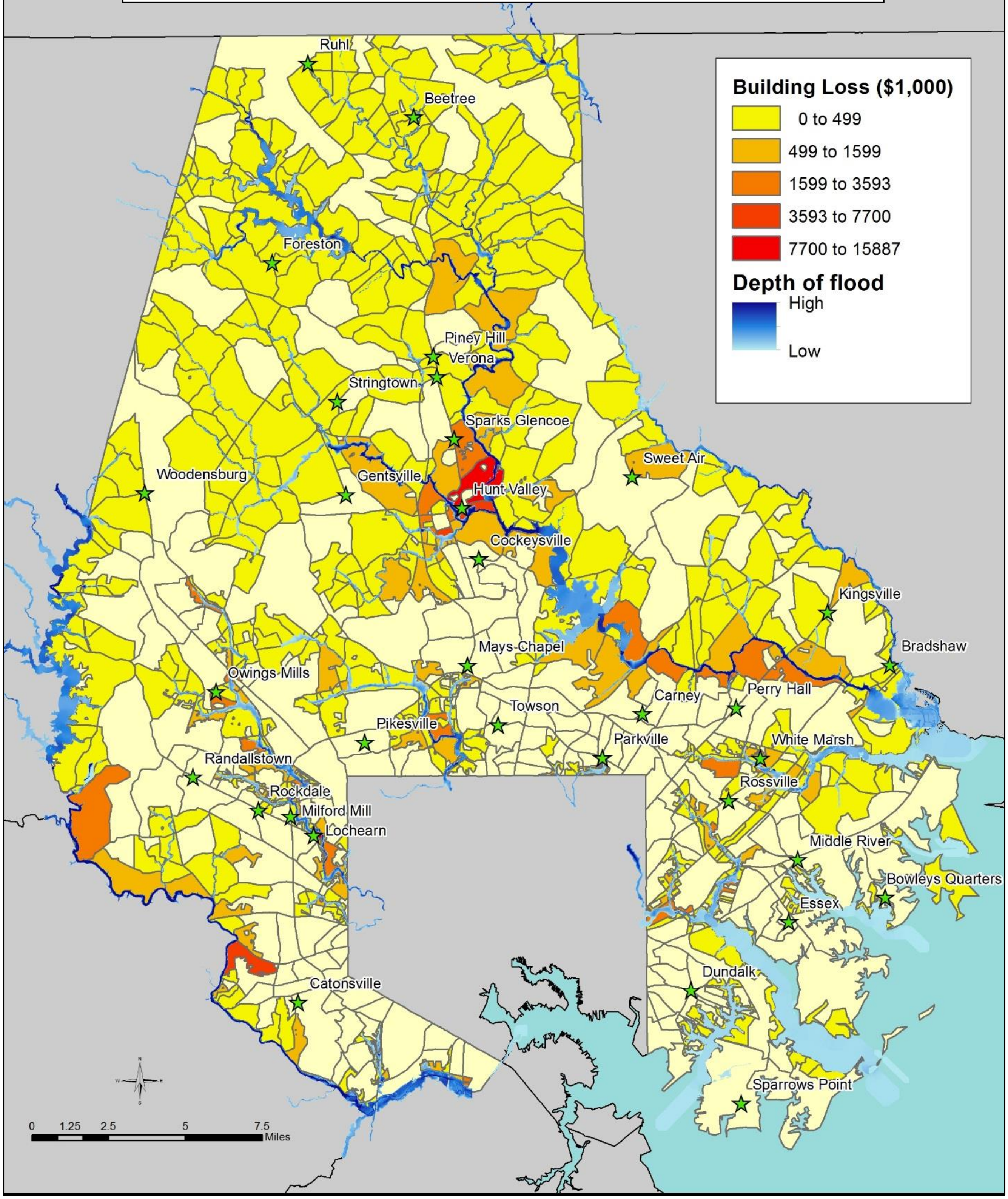
Shelter Requirements

Hazus estimates the number of households that are expected to be displaced from their homes due to the flood and the associated potential evacuation. Hazus also estimates those displaced people that will require accommodations in temporary public shelters. The model estimates 3,969 (2021 adjusted) households will be displaced due to the flood. Displacement includes households evacuated from within or near to the inundated area. Of these, 9,080 people (out of a total population of 827,370) will seek temporary shelter in public shelters.

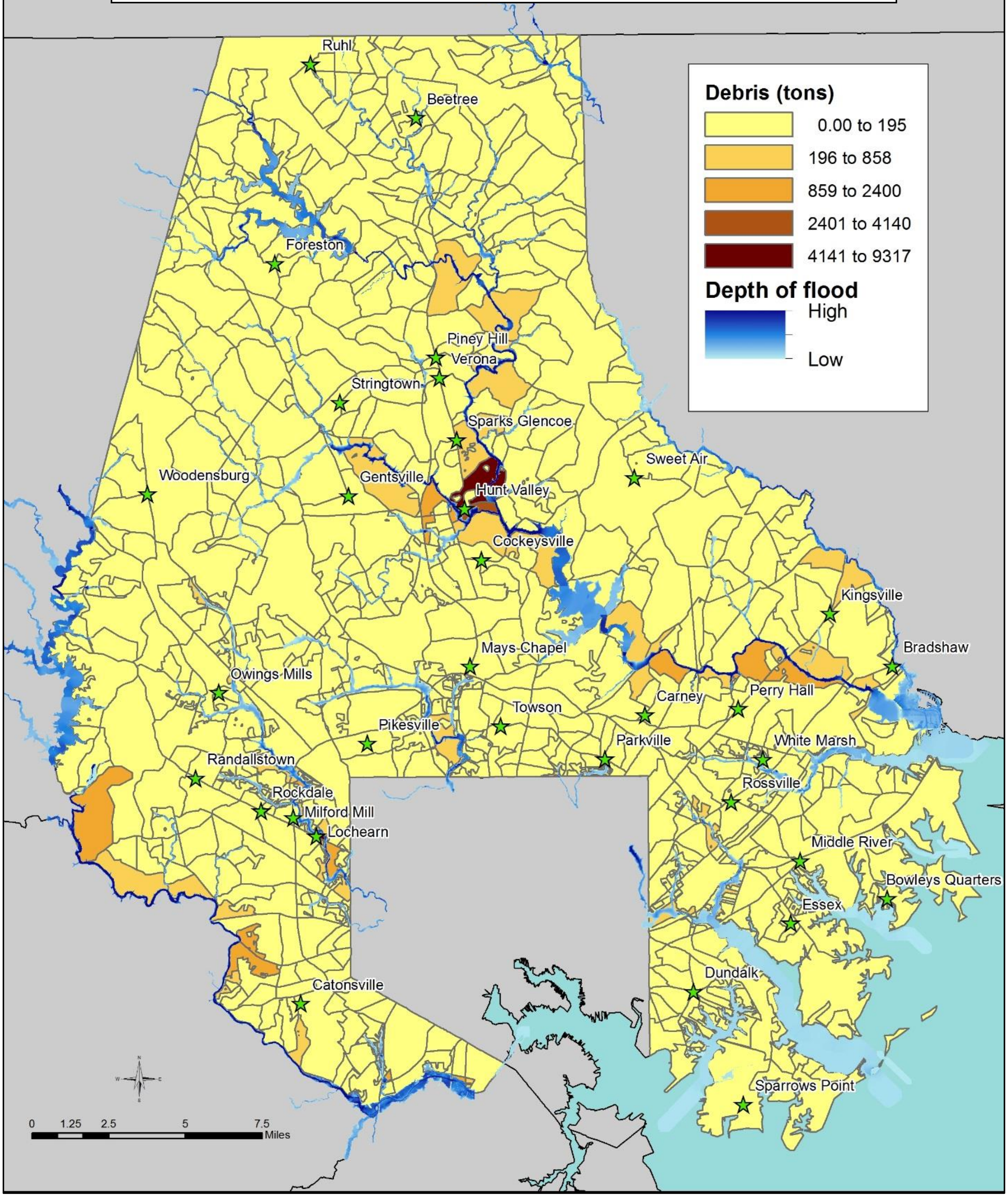
These short-term shelter needs are depicted by census block on Map 4-3. Areas with the greatest short term shelter needs tend to follow major waterways. Based on the results, the Cockeysville, Hunt Valley, and Phoenix areas will have the highest demand for short term sheltering.

Source: Baltimore County. Heavy flooding at Ingleside Ave & Fern Valley Circle (Catonsville) on 5/27/18.

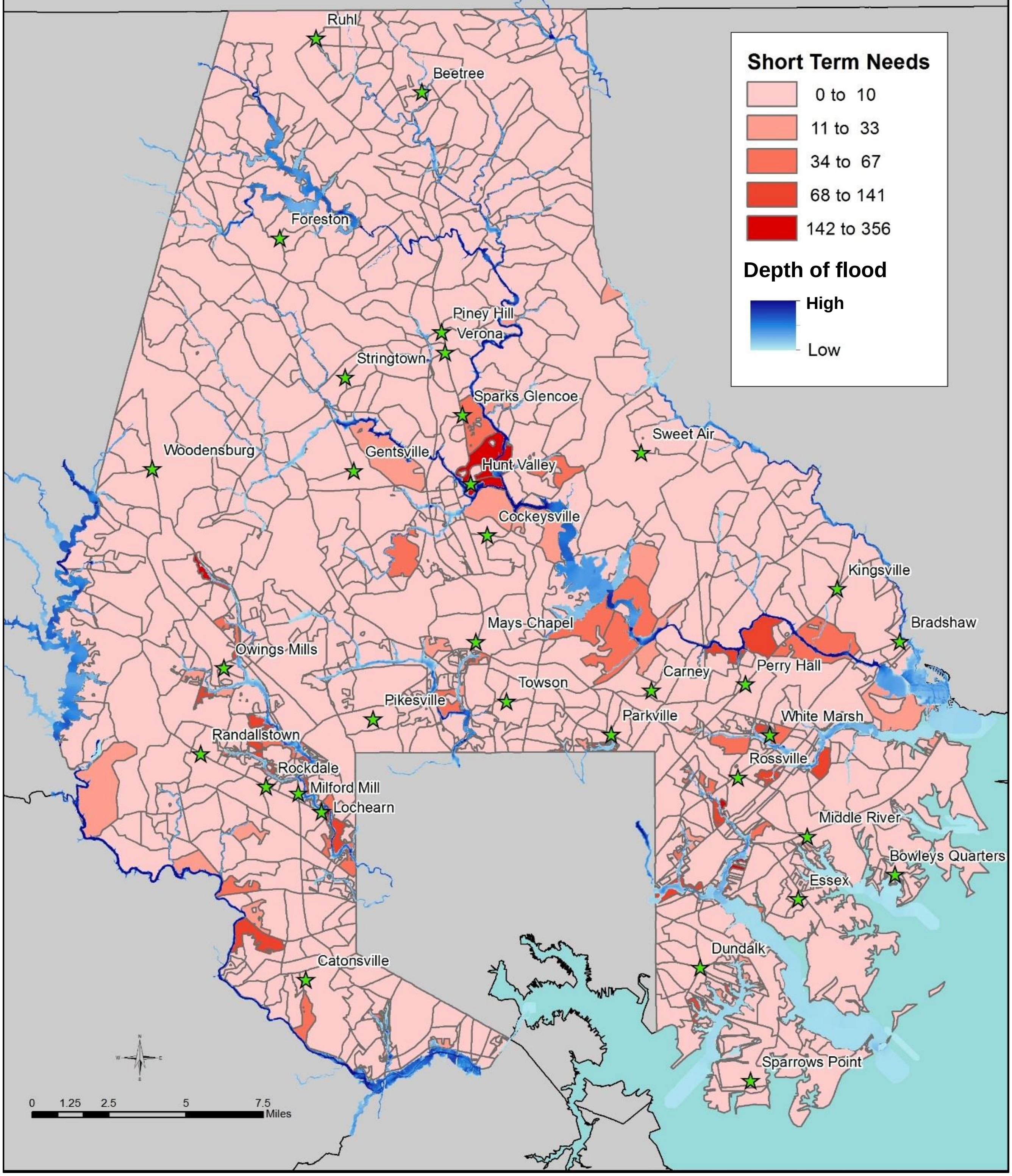
Map 4-1. Riverine Flood Building Loss



Map 4-2. Riverine Total Tons of Debris



Map 4-3. Riverine Flood Sheltering – Short Term Needs



4.7 FLOOD HAZARD ASSESSMENT – INFRASTRUCTURE

4.7.1 Introduction

In the Baltimore County 2014 Hazard Mitigation Plan, infrastructure within the FEMA mapped 100-year floodplain were identified. Identified infrastructure included: roadways, bridges, culverts, and communication towers.

The HAZUS Level 2 Analysis for Flood primarily considered impacts to residential, commercial, and industrial structures, and essential and critical facilities. Impacts to infrastructure were not included in the HAZUS Level 2 Analysis.

Therefore, to complete the 2021 Plan Update, infrastructure within the 100-year floodplain (based upon the new preliminary FEMA 2020 DFIRM) were identified. For this assessment, infrastructure includes roadways, bridges, culverts, and communication towers. Essential facilities were also included in this analysis to factor in the updated DFIRMs. All bridges and culverts included within the analysis are county owned.

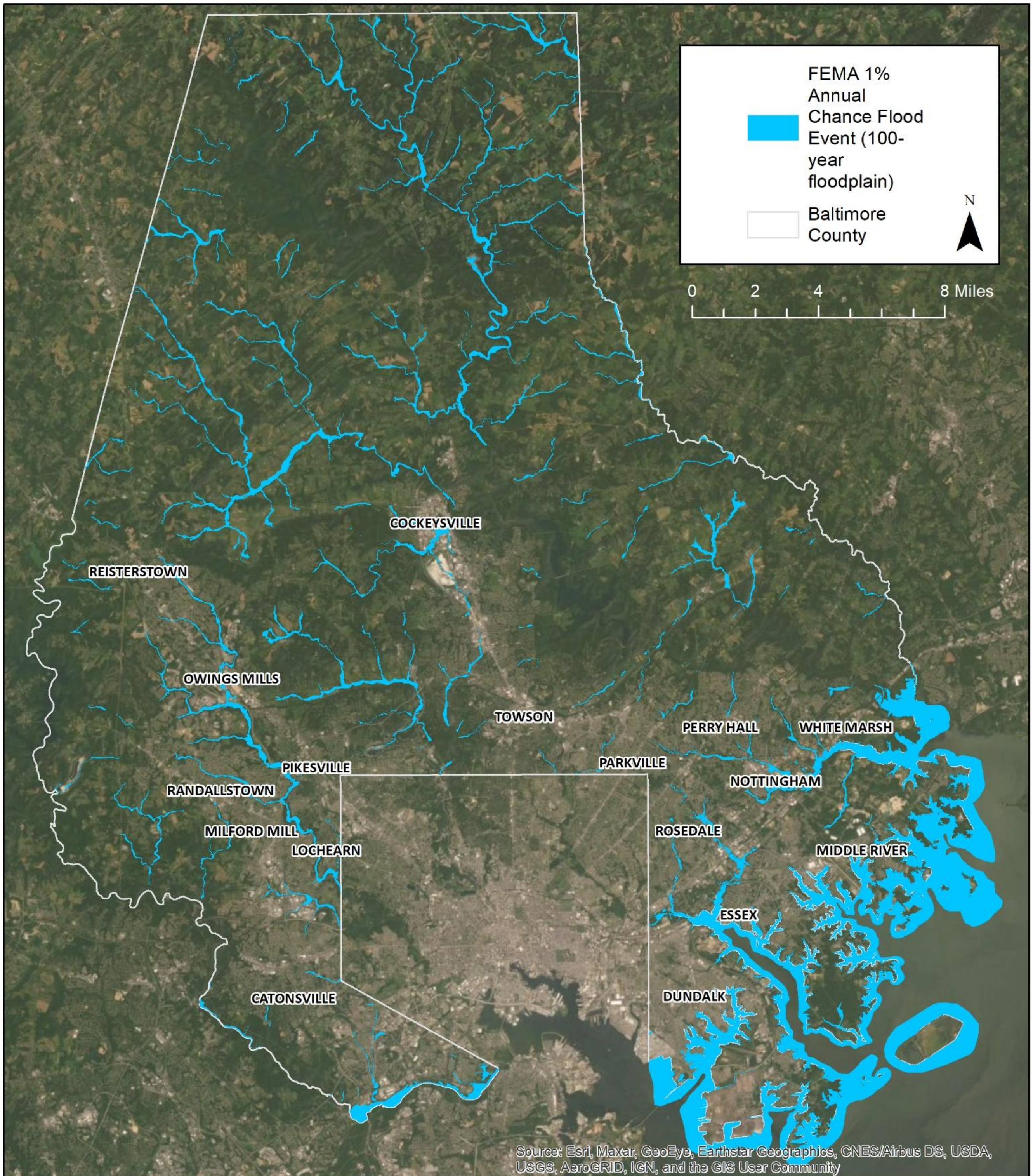
4.7.2 Data Utilization

The following shapefiles (sources included) were utilized to determine hazard areas and affected infrastructure:

- 100-year floodplain – FEMA Preliminary DFIRM (Effective Date: 8/12/2020)
- Bridges (county owned) – Baltimore County Office of Information Technology (2020)
- Culverts (county-owned) – FEMA DFIRM Database (8/2/2011)
- Street Centerlines – Baltimore County Office of Information Technology (June 2020)
- Essential Facilities (Fire Stations, Police Stations, Schools, Hospitals/Health Centers, EOCs) – Baltimore County Office of Information Technology (2020)
- Commercial Transmission Towers – Federal Communications Commission (2021)

4.7.3 Method

Data listed in section 4.7.2 was analyzed using ArcMap 10.4.1, a geographic information system (GIS). This program allows various data layers, such as shapefiles, to be overlaid and spatially compared. To determine vulnerable infrastructure within the County, each infrastructure shapefile (bridges, roadways, etc.) was intersected with the 100-year floodplain. Infrastructure was deemed to be vulnerable to flood if it was within (intersects) the 100-year floodplain. Map 4-4, on the following page, depicts the 100-year floodplain.



SP&D
Smith Planning and Design

Map 4-4. FEMA 1% Annual Chance Floodplain (100-year floodplain)

Source: FEMA preliminary DFIRM 2020

4.7.4 Assessment Results

Based on the assessment, the following structures were determined to be within the FEMA defined 100-year floodplain:

Bridges within FEMA 100-year floodplain

In total, there are about 681 bridges within Baltimore County. Of these, 328 are within the 100-year floodplain. Figure 4-2 further highlights this relationship. Additionally, Table 4-11 lists total bridges within the 100-year floodplain by their location. Map 4-6 illustrates bridges in the county within the 100-year floodplain.

Figure 4-2.

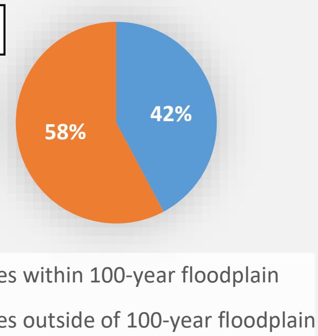


Table 4-11. Impacted Bridges (>20 Feet) by Location

Road/River Name	Total Bridges	Road/River Name	Total Bridges
Avondale Road	1	Joppa Road	1
Bacon Road	1	Keeney Mill Road	1
Beaconsfield Drive	1	Kelso Drive	1
Beaver Dam Road	1	Lakeside Twin Sppa	1
Beaverdam Road (Box)	1	Linden Avenue	1
Beetree Road	1	Little Ck Drive	1
Belfast Road	1	Long Green Pike	1
Bellbeck Twin Sppa	1	Long Green Road	1
Belmont Avenue	1	Longnecker Road	1
Benson Mill Road	1	Lord Balto Drive Triple Mppa	1
Bentley Road	1	Malvern Avenue	1
Big Falls Road	2	Mantua Mill Road	3
Blue Mount Road	2	Marriottsville Road	1
Bond Road	1	Mccormick Road	1
Brenbrook Drive	1	Mcdonogh Road	2
Buckingham Road	1	Mcdonogh Road (From Sha)	1
Business Park Drive	2	Millford Mill Road	1
Carroll Island Road	1	Monkton Road	1
Carroll Road	1	Monkton Road (To Sha)	1
Caves Road	1	Mt Gilead Road	1
Cherry Hill Road	1	Mt Vista Road	1
Circle Road	1	Mt Zion Road	2
Cockeysville Road	1	New Forge Twin Box	1
Cold Bottom Road	1	Northwind Road	1
Colonial Road	1	Oakleigh Road	1
Corbett Road	4	Offutt Road	1
Cowpens Avenue	1	Old Court Road	2
Cromwell Valley Park Entr	1	Old Valley Road	1
Cub Hill Road	1	Orems Road	1
Cuba Road	1	Owings Mills Boulevard	3
Dairy Road	3	Padonia Road	1

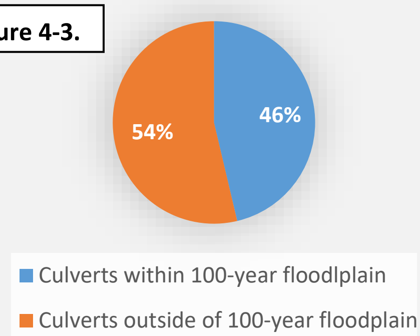
Table 4-11. Impacted Bridges (>20 Feet) by Location			
Road/River Name	**Total Bridges**	**Road/River Name**	**Total Bridges**
Dance Mill Road	1	Painters Mill Road	2
Dark Hollow Road	1	Patterson Avenue	1
Dogwood Road	2	Perry Hall Boulevard	2
Dolfield Boulevard	2	Pinedale Drive Triple Mppa	1
Dulaney Valley Road	1	Piney Hill Road	1
Dunk Freeland Road	1	Pleasant Grove Road	1
Eagle Mill Road	1	Pocock Road	1
East Homberg Avenue	1	Race Road	1
Ebenezer Road	2	Red Run Boulevard	2
Ebony Road Twin Sppa	1	Regester Avenue	1
Elm Road	1	Resh Mill Road	1
Ensor Mill Road	1	Ridge Road	2
Ensor Road	1	River Road	1
Essex Farm Road	1	Roland Avenue	1
Essex Road	1	Rolling Road	2
Falls Road	2	Ruxton Road	1
Forest Park Avenue N	1	S Dolfield Road	1
Francis Avenue	2	Seiling Avenue	1
Franklin Boulevard	1	Seminary Avenue	1
Freeland Road	1	Shawan Road	1
Gilroy Road	1	Shelbourne Road	1
Glen Arm Road East	1	Silver Spring Road	1
Glenarm Road East	1	Southern Cross Drive	1
Glencoe Road	1	Sparks Road	1
Golden Ring Road	1	Stablers Church Road	2
Gores Mill Road	2	Stablersville Road	1
Gorsuch Mill Road	1	Stringtown Road	1
Graves Run Road	1	Sulphur Spring Road	1
Green Road	1	Summit Avenue	1
Greenspring Avenue	3	Sussex Avenue	1
Gunpowder Road	2	Thornton Road	1
Gunview Twin Mppa	1	Tom Day Boulevard	1
Gwynn Oak Avenue	2	Towsontowne Boulevard	1
Gwynnbrook Avenue	2	Trenton Road	2
Gwynndale Avenue	1	Tufton Avenue	1
Hammershire Road	1	Tulsmere Road	1
Harris Mill Road	3	Upper Beckleysvill	1
Hartley Mill Road	2	Valley Mill Road	1
Hazelwood Avenue	1	Vernon Road	1
Heathcote Road	1	Vernon Twin Box	1
Hess Road	1	Walker Road	1
Hicks Road	1	Waltham Woods Twin Sppa	1
High Falcon Road	1	Walther Boulevard Triple Sppa	1
Hillrise Avenue	1	Wards Chapel Road	1
Homeland Avenue	1	Warren Road (From Sha)	1
Honeygo Boulevard	1	Weisburg Road	1
Honeygo Boulevard - Pipe Arch	1	West Liberty Road	1
Houcks Mill Road	1	Western Run Road	2

Table 4-11. Impacted Bridges (>20 Feet) by Location			
Road/River Name	**Total Bridges**	**Road/River Name**	**Total Bridges**
Hunter Mill Road	2	Weyburn Road	1
Hutchins Mill Road	1	Windemere Pkwy	1
Hydes Road	1	Wise Avenue	1
Ilchester Road	1	Wiseburg Road	1
India Avenue	1	Woodlawn Drive	1
Ingleside Avenue (Old)	1	Wrights Mill Road	2
Jerome Jay Drive	1		

Culverts within FEMA 100-year floodplain

In total, there are roughly 13,566 culverts within Baltimore County. Of these, 6,211 are within the 100-year floodplain. Figure 4-3 further highlights this relationship. Map 4-7 illustrates culverts in the county within the 100-year floodplain.

Figure 4-3.



Roadways within FEMA 100-year floodplain

In total, there are roughly 9,875 roadways within Baltimore County. Of these, portions of 697 roadways are within the 100-year floodplain. This translates to just over 98 miles (2% of total road miles) of roadway within the 100-year floodplain. Tables 4-12 and 4-13 list the most impacted roads by total miles, and communities by number of affected roadways, respectively. Map 4-5 illustrates roadways in the county within the 100-year floodplain.

Table 4-12. Most Impacted Roadways by Total Miles Within 100-year Floodplain	
Road Name	**Total Miles**
I-695	4.17
Ramp	3.67
I-83	2.19
Carroll Island Road	2.09
I-895	1.91
Pulaski Hwy	1.53
I-95 North	1.36
I-95 South	1.29
Falls Road	1.20
Bay Drive	0.97
River Road	0.96
Burke Road	0.95

Table 4-13. Communities by Number of Affected Roadways			
Community	**Affected Roadways**	**Community**	**Affected Roadways**
Middle River	88	Freeland	16
Dundalk	72	Phoenix	14
Essex	57	White Marsh	14
Sparrows Point	56	Glen Arm	12
Gwynn Oak	41	Perry Hall	11
Halethorpe	41	Upperco	11
Baltimore	33	Randallstown	9
Reisterstown	31	Fort Howard	8
Parkton	28	Hampstead	7
Pikesville	27	Baldwin	6
Rosedale	27	Linthicum Heights	6
Lutherville Timonium	25	Ellicott City	5
Nottingham	24	Hydes	5
Parkville	23	Kingsville	5
Catonsville	22	Woodstock	5
Cockeysville	22	Hunt Valley	3
Owings Mills	22	Manchester	3
Sparks Glencoe	21	Brooklyn	2
Towson	20	Marriottsville	2
Monkton	19	Elkridge	1
Windsor Mill	18	Joppa	1
White Hall	17		

Commercial Transmission Towers within FEMA 100-year floodplain

1 Communication
- WPWR Nextel Communications of the Mid-Atlantic, Inc. (Cockeysville)

Essential Facilities within the FEMA 100-year floodplain

The County has one essential facility identified as being within the 1% annual chance floodplain:
- Baltimore County Police Department, Marine Unit (3033 Strawberry Point Road)

4.7.5 Assessment Analysis

Transportation Impacts

While many roadways within the 100-year floodplain are at risk, there are several regions in the County with high densities of roadways within the floodplain. These areas include: Middle River, Dundalk, Essex, Sparrows Point, Gwynn Oak, and Halethorpe. Roadways within the 100-year floodplain in these regions make up 40% of all the impacted roadways in the County.

Development Impacts

According to Baltimore County’s Master Plan 2020, Owings Mills is the County’s designated Growth Area, Middle River is a Redevelopment Area, and Pulaski Highway is also a Redevelopment Area.

Owings Mills Growth Area

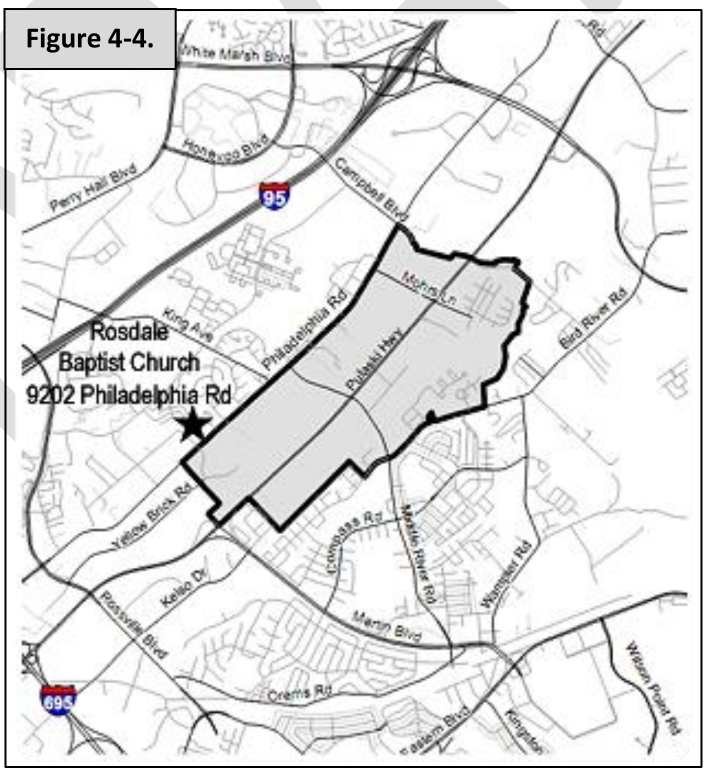
Based on both the HAZUS Level 2 Analysis and the Infrastructure Analysis, the Owings Mills area can expect to face minimal impacts from a 100-year flood event.

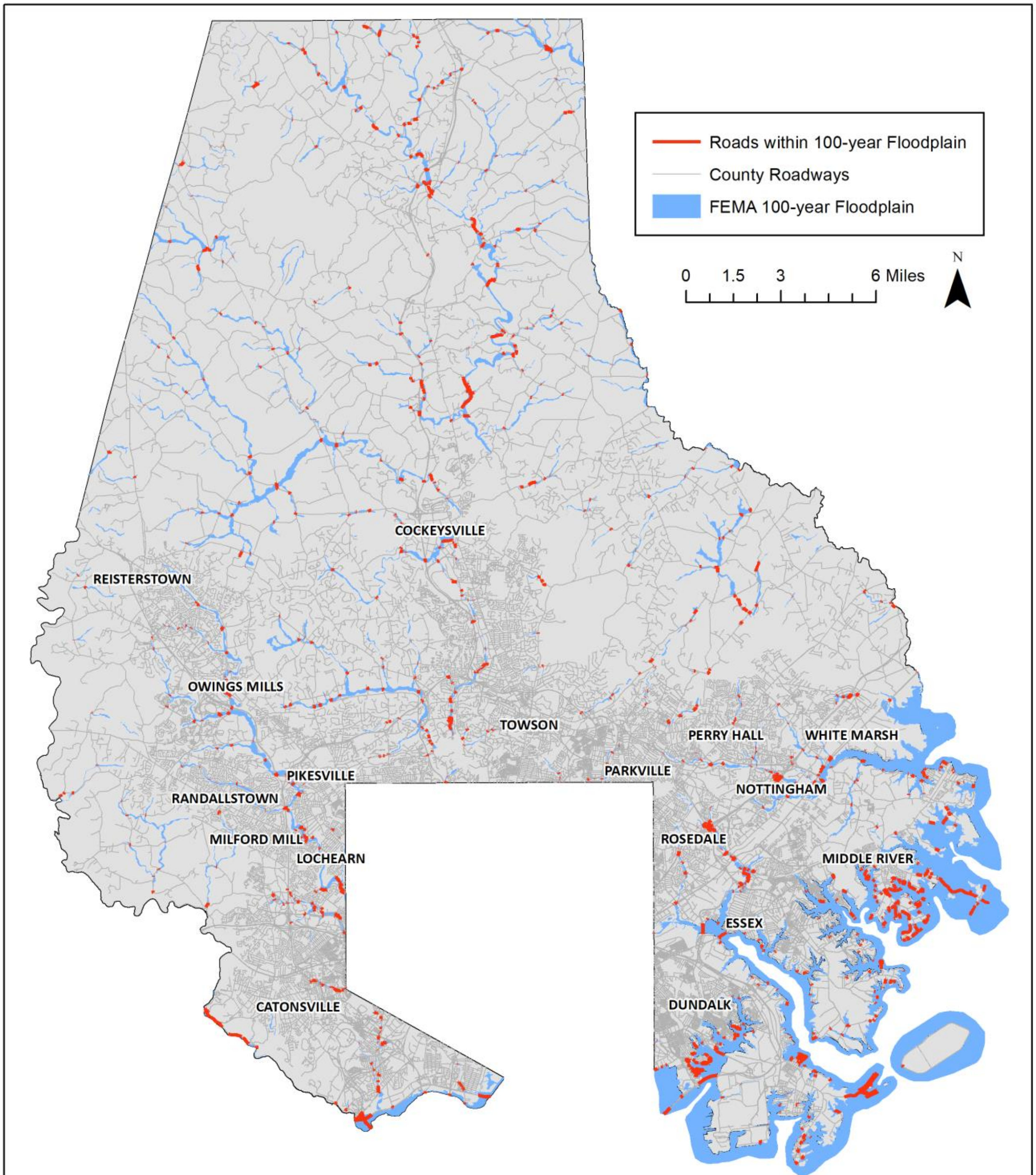
Middle River & Pulaski Highway Redevelopment Areas

Baltimore County’s *Master Plan 2020* identifies a 920-acre district along a five-mile segment of Pulaski Highway U.S.40 in the Middle River community as a potential target area for community-scaled redevelopment. Figure 4-3, below, highlights this location.

The largest problem the Middle River area may face is related to the number of roadways within the 100-year floodplain. Middle River ranks as the number one community in terms of impacted roadways within the floodplain, with a total of 88 affected roadways. Pulaski Highway, within Middle River, also faces floodplain problems. Just over 1.5 miles of the highway is within the 100-year floodplain.

Figure 4-4.





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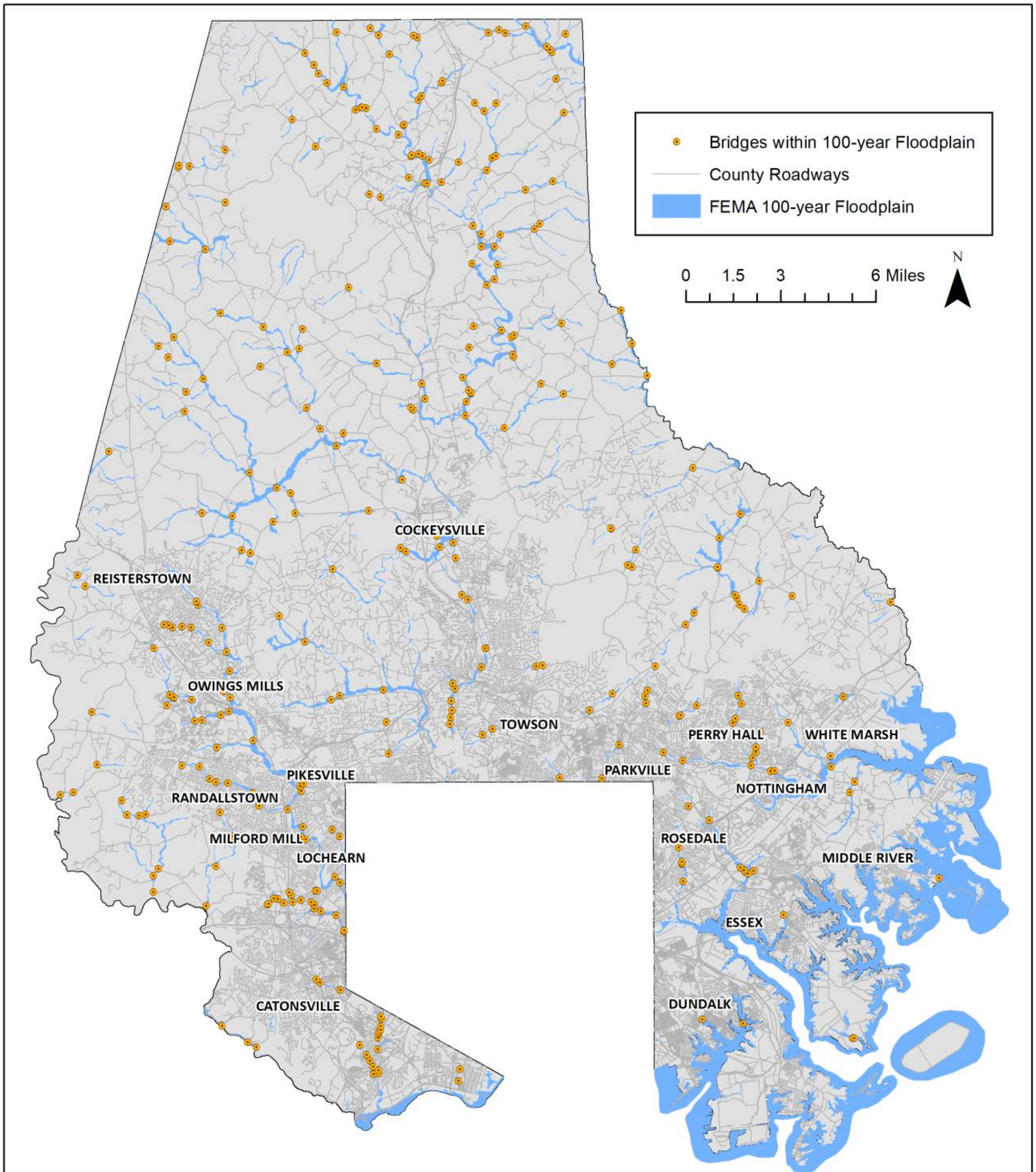
Smith Planning and Design

Map 4-5. Roadways within the 100-year Floodplain

Source: Baltimore County Office of Information Technology, FEMA prelim DFIRM 2020



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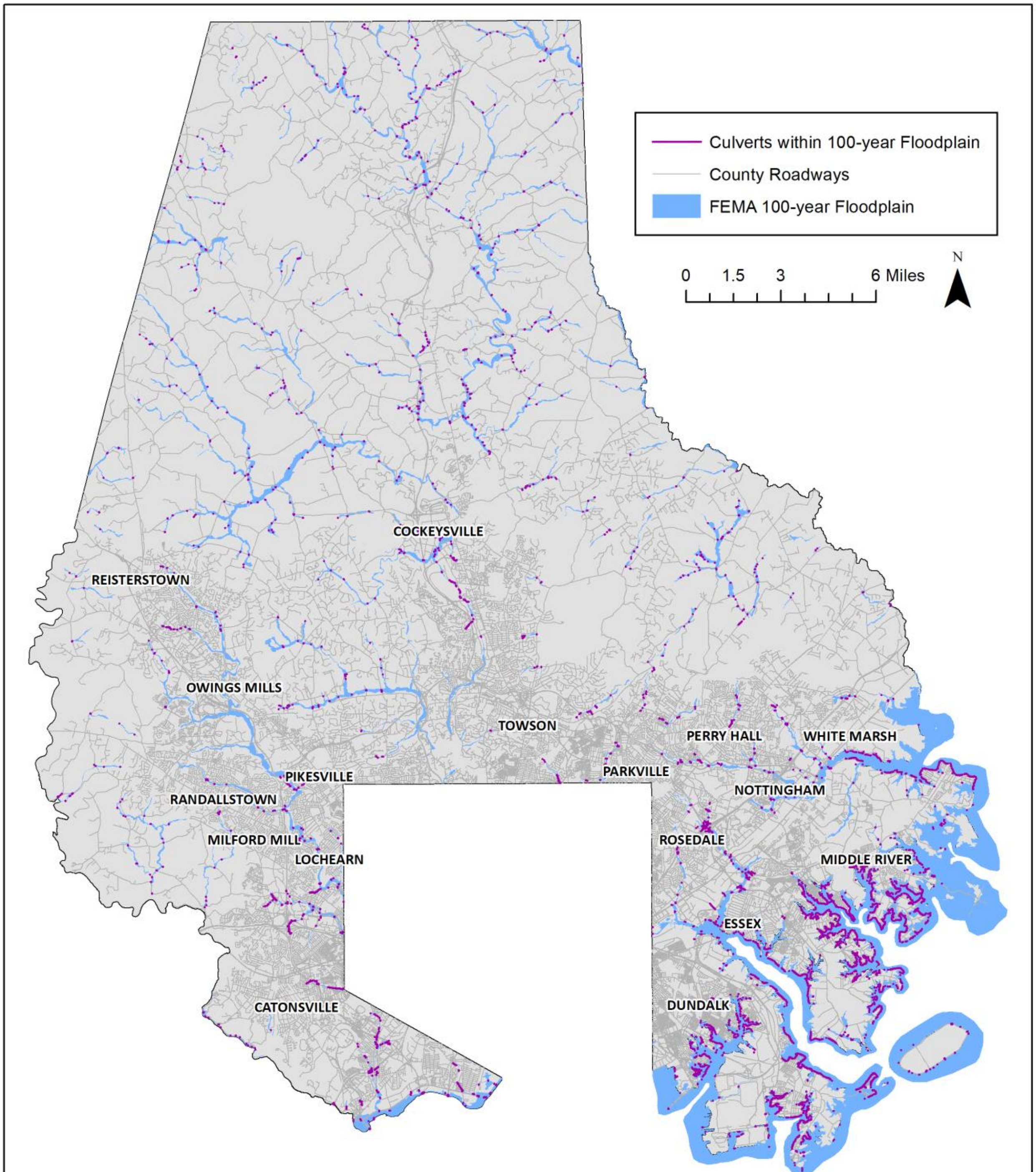
Map 4-6. Bridges within the 100-year Floodplain

Source: Baltimore County Office of Information Technology, FEMA prelim DFIRM 2020



Map 4-7. Culverts within the 100-year Floodplain

Source: Baltimore County Office of Information Technology, FEMA prelim DFIRM 2020

4.8 SOCIAL VULNERABILITY

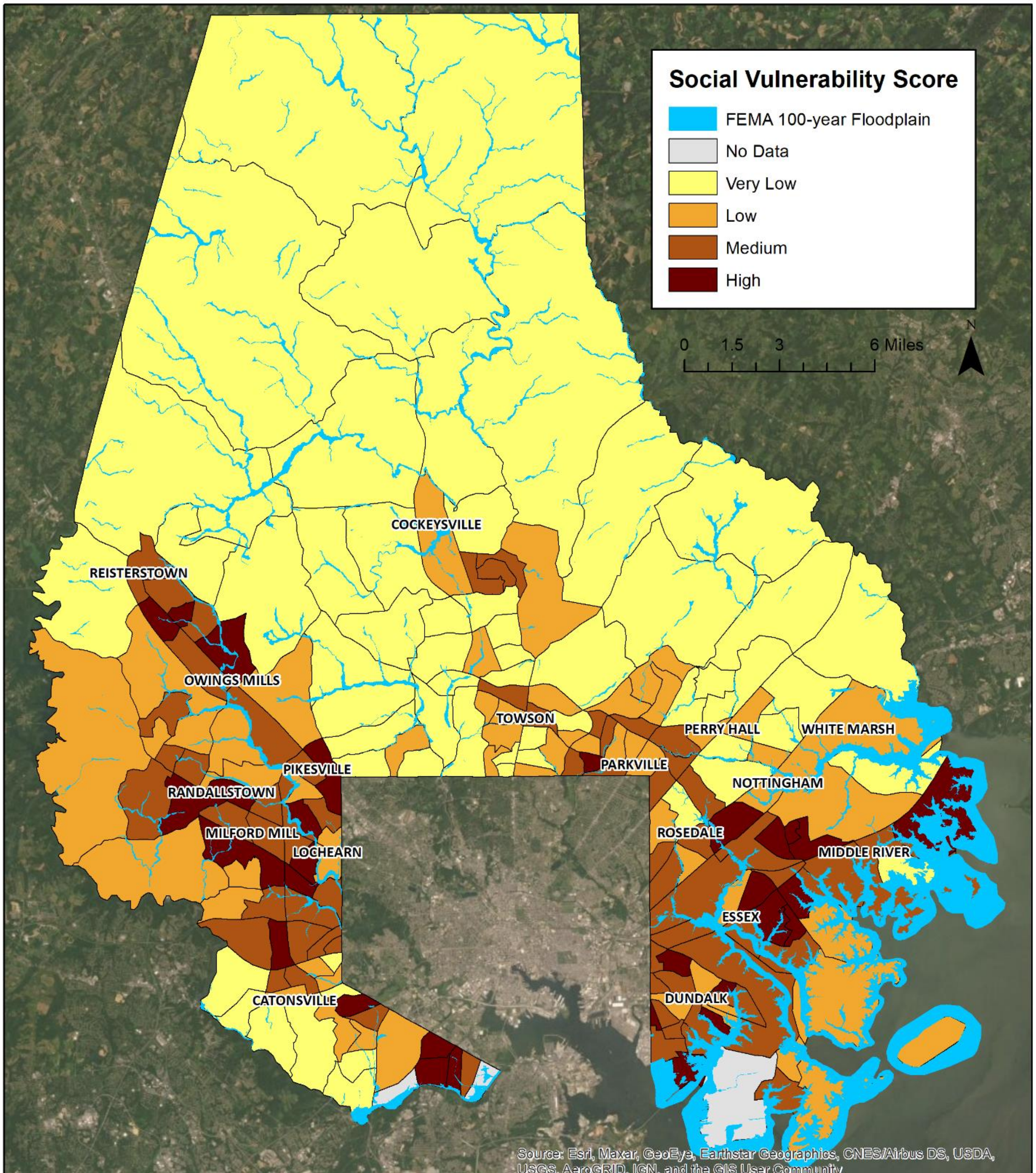
According to the Center for Disease Control and Prevention (CDC), social vulnerability refers to "the negative effects on communities caused by external stresses on human health. Such stresses include natural or human-caused disasters, or disease outbreak." Reducing social vulnerability can decrease both human suffering and economic loss.[16]

The CDC developed a Social Vulnerability Index (SVI) to help local jurisdictions determine their level of vulnerability based on fifteen (15) indicators that are routinely utilized to measure social vulnerability. These indicators are as follows:

- **Socioeconomic Status**
    1. Below Poverty
    2. Unemployed
    3. Income
    4. No High School Diploma
- **Household Composition & Disability**
    1. Aged 65 or Older
    2. Aged 17 or Younger
    3. Civilian with a Disability
    4. Single-Parent Households
- **Minority Status & Language**
    1. Minority
    2. Speaks English "Less than Well"
- **Housing Type & Transportation**
    1. Multi-Unit Structures
    2. Mobile Homes
    3. Crowding
    4. No Vehicle
    5. Group Quarters

The SVI has been conducted for Baltimore County at the census tract level and is mapped on the follow page. The SVI utilizes ACS 5-year estimates. The darker census tracts indicate areas of higher social vulnerability while the lightest tracts indicate relatively low social vulnerability. The SVI results have been mapped alongside the FEMA 1% Annual Chance Flood Zone to aid in determining areas of concern where flood mitigation activities might make the most sense due to increased vulnerability. Areas of concern are locations where high social vulnerability and extensive 100-year floodplain overlap. These areas (Map 4-8, next page) are as follows:

- Southeast Baltimore County
    - Dundalk
    - Essex
    - Middle River
    - Rosedale
- Southeast Baltimore County
    - Owings Mills
    - Randallstown
    - Milford Mill



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Smith Planning and Design

Map 4-8. Social Vulnerability and 100-year Floodplain

Source: CDC/ATSDR SVI 2018, ACS 5-year Estimates.
FEMA prelim DFIRM 2020

4.9 HAZUS ANALYSIS OF HISTORIC RESOURCES

As part of this plan update, Smith Planning and Design worked closely with staff from Baltimore's Department of Planning to determine how historic and cultural resources within the county might be impacted by the FEMA defined 1% annual chance flood zone (100-year floodplain).

A HAZUS Level 2 analysis was conducted for historic resources in Baltimore County to determine which resources are within the FEMA defined 100-year floodplain. Preliminary DFIRM data was utilized to complete the analysis. The results of this analysis are depicted on Map 4-9. The analysis determined that 29 historic resources (i.e., structures) are within the 100-year floodplain. Most historic resources that are within the 100-year floodplain are in Parkton, followed by Catonsville and Sparks Glencoe. Table 4-14, below, lists total historic resources by community.

Table 4-14. Historic Resources Within 1% Annual Chance Flood Zone by Community

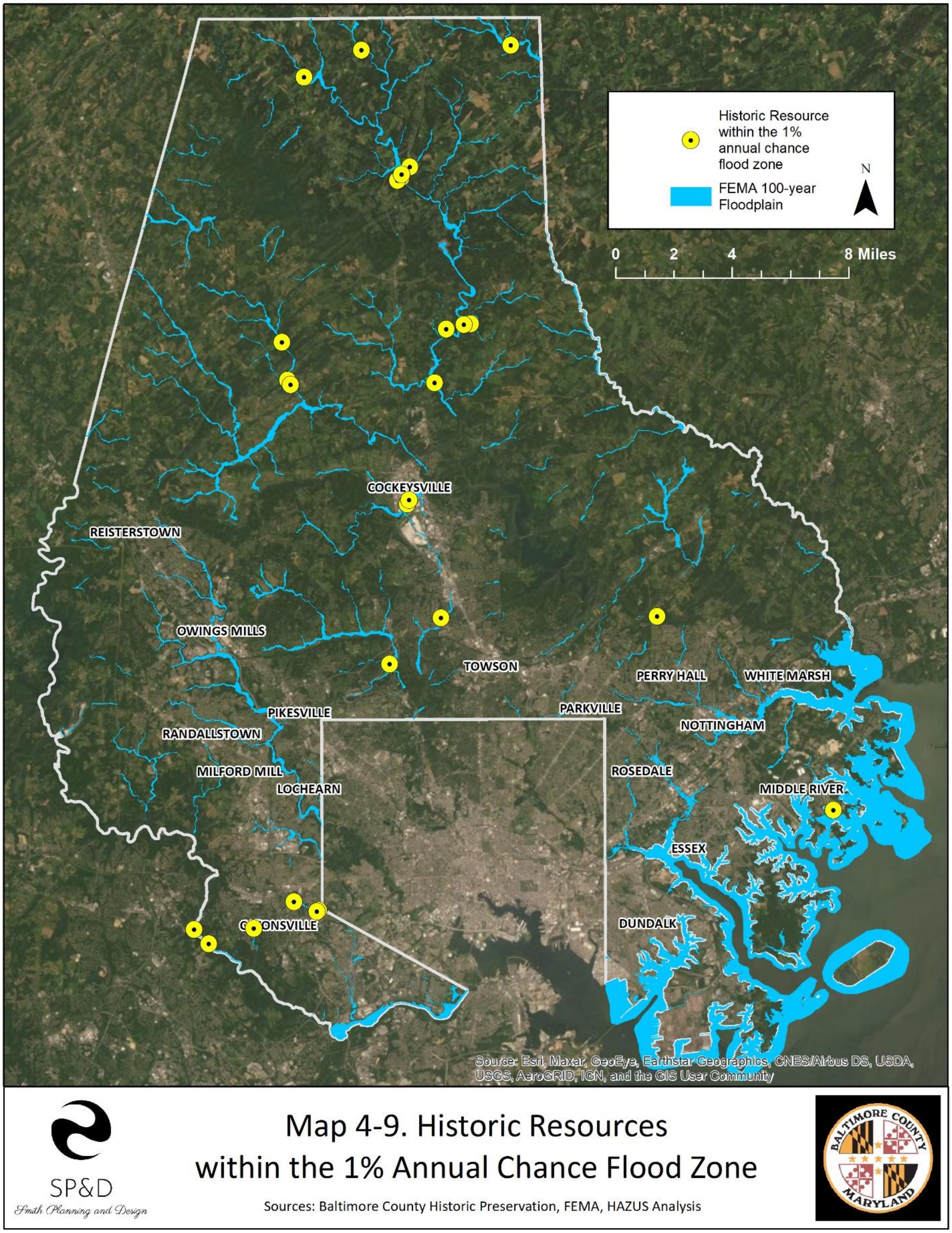
Community	# of Historic Resources
Catonsville	4
Cockeysville	2
Ellicott City	2
Freeland	2
Glen Arm	1
Lutherville Timonium	1
Middle River	1
Monkton	3
Parkton	8
Sparks Glencoe	4
Woodstock	1

Most of the historic resources are classified as residential (21 total), six (6) are commercial, and the remaining two (2) are classified as "other'. In terms of building materials, 17 are masonry, 11 are wood, and 1 is metal. A more detailed list, including address, year built, flood depth, building/content cost, and building/content loss are included within Table 4-15, below.

Table 4-15. Historic Resources Within 1% Annual Chance Flood Zone

Resource	Year Built	Flood Depth	Building Cost*	Content Cost*	Building Loss*	Content Loss*
Fisher House (Christian's Chance)	1853	3.1	42200	21100	6077	4093
6222 Frederick Road	1923	N/A	132000	66000	0	0
6300-6330 Frederick Road	1930	N/A	105300	52650	0	0
Beall House	1877	5.0	66100	33050	31067	17186
Beaver Dam Quarries Building	1900	2.9	200000	300000	91200	173700

Table 4-15. Historic Resources Within 1% Annual Chance Flood Zone						
Resource	Year Built	Flood Depth	Building Cost*	Content Cost*	Building Loss*	Content Loss*
Beaver Dam Swimming Club	1950	1.9	475100	475100	45610	228048
Charity Lodge No. 134	1900	6.2	163000	163000	33578	128770
First National Bank, Parkton And Setting	1912	7.7	150400	75200	63318	36472
Gorsuch Chapel	1900	2.3	27400	27400	2822	15892
Gunpowder Copper Works	1814	5.0	0	0	0	0
Hartley House	1902	1.7	114600	57300	13408	5787
J.M. Price House	1910	2.3	128300	64150	16166	8596
John Bollinger House	1801	2.3	147900	73950	18635	9909
Johns Mill Workers House No. 2	1849	5.1	128500	64250	25957	18311
Kensey John's Grist Mill	1897	3.5	227600	113800	0	0
Lutherville Colored Schoolhouse	1900	2.1	127000	63500	0	0
Mace-Luthardt House	1987	0.5	127100	63550	10168	6355
Maisel, Ed - House	1850	0.7	112600	56300	4504	1971
Marble Hill Hotel	1900	1.5	147500	147500	0	0
Mclaughlin House-Tavern	1870	N/A	331200	331200	0	0
Norris House (South)	1897	0.4	136700	68350	6015	2187
Parkton Hotel	1852	5.7	115900	57950	35234	23064
Patapsco Factory Gray's Mill Ruins	1937	N/A	0	0	0	0
River Bend Farm	1852	1.1	321100	160550	35642	13326
Robert Townsend House	1941	3.3	418600	209300	63627	42279
Rockland Mill	1813	6.3	533100	533100	94892	149268
St. James Lutheran Sparks State Bank	1900	20.4	39800	39800	26586	28019
Turner-Alimony Dwelling	1901	8.8	60400	30200	14254	11416
Williams Store Apartments	1896	0.3	105300	52650	4739	1895
* Estimated via HAZUS Level 2 Flood Analysis						



Map 4-9. Historic Resources within the 1% Annual Chance Flood Zone

Sources: Baltimore County Historic Preservation, FEMA, HAZUS Analysis

4.10 2021 MITIGATION GOALS AND ACTION ITEMS

During the 2021 Plan Update, new mitigation goals and action were added. Additionally, previous mitigation goals and action items from the 2014 Plan were reviewed, and those that were determined to be still in progress or relevant were included.

GOAL 1: Promote hazard mitigation as the cornerstone of emergency management in Baltimore County.			
OBJECTIVE	**ACTION ITEM(S)**	**RESPONSIBLE ENTITY**	**RANKING (HIGH, MEDIUM, OR LOW)**
1. Educate the public about natural hazards risks, preparedness, and mitigation.	a. Continue to provide information on the County's social media about flood risk and vulnerability.	County	Medium
	b. Develop an educational plan for updates on emergency preparedness, including communications, evacuation, traffic, area closures, visitor controls, damage assessment, clean up etc.	County	High
2. Provide technical assistance for homeowners regarding flooding.	a. Develop a technical assistance information program for homeowners to teach them how to strengthen their homes against flooding. The program could include providing local government building departments with copies of existing strengthening and repair information for distribution to homeowners. Other potential distribution sources include insurance companies, realtors, homeowner associations, and libraries.	County	Medium
	b. Increase community awareness regarding opportunities for restoration, flood proofing, etc. non-acquisition mitigation measures for homeowners in RLP that do not wish to move.	County, Department of Public Works and Transportation	Medium
	c. Encourage homeowners within the SFHA (1-percent annual chance floodplain) to purchase a flood insurance policy by educating them on the likelihood and dangers of flooding.	County, Department of Public Works and Transportation	Medium
3. Utilize the most up-to-date and available data and information.	a. Request new FEMA Risk MAP product be produced for coastal/riverine using new DFIRM. The previous FEMA Risk MAP product for Baltimore County was completed in 2014 for coastal only. (In Progress)	Department of Public Works and Transportation	High

GOAL 2: Eliminate or reduce human, environmental, social, and economic loss from natural and technological hazards.			
OBJECTIVE	**ACTION ITEM(S)**	**RESPONSIBLE ENTITY**	**RANKING (HIGH, MEDIUM, OR LOW)**
1. Identify potential contributing factors to flood risk within the floodplain.	a. Conduct stream corridor assessments to determine the status of bridges, culverts, pipes, failing channelization, debris blockages, and other issues that may increase the severity of flood events.	County	Medium
	b. Develop and adopt a Flood Mitigation Plan following planning guidance or mitigation and NFIP CRS standards and suggestions.	Department of Public Works and Transportation, Department of Planning	Medium
	c. Earn potential CRS credits by continuing to preserve the county's floodplains as open space. More opportunities for CRS credits are outlined in the report "*Land Conservation and the Community Rating System: Mapping Open Space Preservation Opportunities in Maryland Communities*".	Department of Public Works and Transportation	High
2. Enforce current building standards.	a. Continue to perform building inspections to ensure compliance with current building standards as they relate to flooding.	County	Medium
3. Identify flood prone properties and infrastructure for mitigation efforts.	a. Focus flood mitigation efforts in the communities identified as having the greatest amount of Repetitive Loss Properties: Cockeysville, Middle River, and Sparrows Point (Table 4-4).	Department of Public Works	Medium
	b. Elevate or acquire repetitive loss and severe repetitive loss properties affected by flooding when funding from State and Federal sources is available.	County	Medium
	c. Identify pre-FIRM structures located within the 100-year floodplain and determine the mitigation measures that are needed to reduce flooding.	County	Medium
	d. Conduct surveys for flood prone historic resources to verify several facts regarding them, including: if and where they currently exist in space. Targeted surveys for a small group of sites could be conducted for particularly important resources, or for resources that have a lot of unknowns. Develop an action plan to protect or relocate identified historic structures within the 100-year floodplain.	County, Department of Planning, Preservation Services	Medium
	e. Review Fire Department flood mapping for comparison with roadway prioritization and select roads to be scheduled for resiliency upgrades (CAP project).	Fire Department	Medium
	f. Consider flood-proofing measures for the County's 60 pump stations identified as having medium to high flood vulnerability (Climate Adaptation Plan). It is	Department of Public Works and Transportation	High

GOAL 2: Eliminate or reduce human, environmental, social, and economic loss from natural and technological hazards.			
OBJECTIVE	**ACTION ITEM(S)**	**RESPONSIBLE ENTITY**	**RANKING (HIGH, MEDIUM, OR LOW)**
	recommended that a recurring CIP budget be established for the flood-proofing of pump stations.	Department of Planning	

4.11 EXISTING FLOOD MITIGATION ACTIVITIES

Baltimore County's current capabilities provide a framework for future mitigation action items.

- National Flood Insurance Program (NFIP)
    - Enforce floodplain management regulations in identified flood hazard areas
    - Bill 173-93 Floodplain Management Ordinance adopted in 1993 which complies with Section 60.3 (D) of the regulations for the National Flood Insurance Program as revised on October 1, 1986
    - Citizens are eligible to purchase flood insurance that is not normally available through private insurance companies
    - Utilization of FEMA's flood mapping program called Risk Mapping, Assessment, and Planning, or Risk MAP.
    - As of March 2021, the Effective Map date for floodplain mapping (riverine and coastal) was May 5, 2014, and the preliminary date was August 12, 2020.
- Building Codes
    - The Codes allow new construction in tidal flood plains but do not allow new development by right in riverine flood plains. Anyone rebuilding within the state's official floodplains must elevate their first floor above the 100-year flood level.
        - Rebuilt homes will have no basements. Owners sign non-conversion agreement promising not to convert ground level floor space to a living area. This agreement becomes part of the deed.
    - Ground floor may be used for storage or garage but must include flood venting.
    - Any outbuildings larger than 100 square feet must meet the same flood codes as the house.
    - Newly constructed homes in 100-year tidal floodplain to be elevated a minimum of 2 feet above flood elevation.
- Participation in the national "Turn Around, Don't Drown" program.
- Utilization of social media (Facebook, Twitter, Instagram) to disperse warnings and information prior to and during a severe weather and/or flood event.
- Continue to consider possibly entertaining the idea of continual and steady continuation of considerable material and partial reconstitution of possible

techniques to consider when pondering possible outcomes leading to potential scenarios of flooding whereas possible scenarios also lead to potential outcomes, therefore preventing possible outcomes negatively impacting perceived events.

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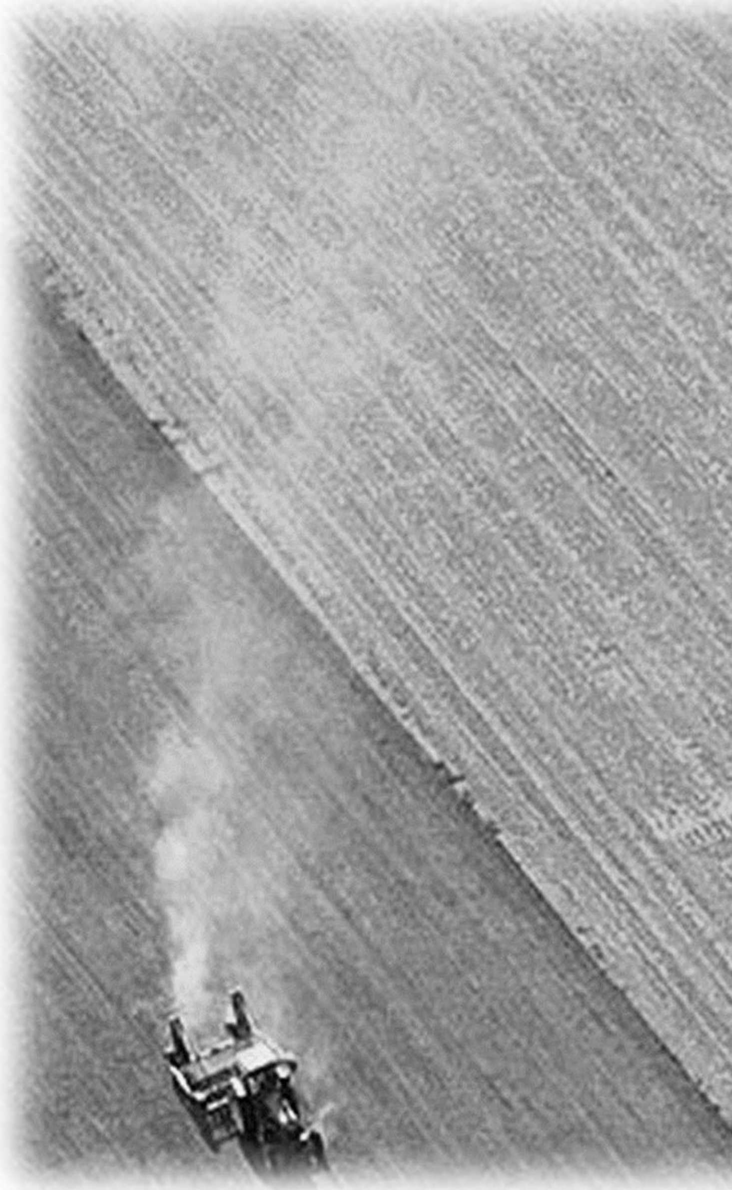
[1] Hurricane Isabel Rapid Response Coastal High Water Mark (CHWM) Collection, p. 7
[2] www.weather.gov/safety/flood-hazards
[3] science.house.gov/imo/media/doc/Grimm%20Testimony.pdf
[4] Rebuilding for a More Sustainable Future: An Operational Framework, 4-4
[5] Flood Insurance Study, Baltimore County, MD (Unincorporated Areas). May 5, 2014
[6] The Baltimore Sun, October 30, 2012
[7] The Baltimore Sun, September 8, 2011
[8] The Baltimore Sun, August 28, 2011
[9] The Baltimore Sun, September 9, 2019
[10] National Oceanic and Atmospheric Administration, 1972, v. 76, no. 6, p. 63
[11] National Oceanic and Atmospheric Administration, 1972, v. 76, no. 6, p.63
[12] md.water.usgs.gov/publications/wsp-2375/md-dc
[13] R.W. James, Jr., U.S. Geological Survey; "General Climatology" section by W.J. Moyer, Maryland State Climatologist, and A.J. Wagner, National Oceanic and Atmospheric Administration; "Water Management" section by G.T. Setzer, Maryland Department of Natural Resources
[14] www.fema.gov/pdf/floodplain/is_9_complete.pdf
[15] www.mdfloodmaps.net
[16] www.atsdr.cdc.gov/placeandhealth/svi/index.html



CHAPTER 5: DROUGHT

UPDATES

During the 2021 Plan Update process, **Chapter 5: Drought** was updated with the most recently available data.

Updates to this chapter include:

1. Thematic and visual update
2. **Data updates** (including tables, text, and figures as needed) throughout the chapter.
3. Results of the HIRA were added to *Section 5.2 Contributing Factors to Drought Risk*. Drought risk is ranked as "Medium." See Appendix A for full results.
4. **Updated section** *5.4 Vulnerability Assessment*, utilizing the latest land cover, structure, and parcel data to complete a new assessment.
    a. Section 5.4.4 updated to include results of the new analysis.
    b. **Updated** *Table 5-1. Land Uses Affected by Drought* and *Table 5-2. Schools Outside of the Urban Rural Demarcation Line* with assessment results.
    c. **Updated Map 5-1, "**Agricultural Parcels Without Access to Public Water"
5. *Section 5.5* and *5.6,* added new mitigation action items and updated current mitigation activities.

5.1 HOW ARE DROUGHTS A THREAT TO BALTIMORE COUNTY?

Drought has the potential to affect the environmental, economic, and social systems within Baltimore County. Residents, farms, and businesses need a constant, reliable supply of water, and a reduction in that supply will have physical and economic impacts. As the population in Baltimore County continues to grow, the demand for water will increase as more and more is consumed for residential, commercial, agricultural, and industrial uses. Conversely, the water supply will remain relatively static, which makes reducing the impact of drought a critical component to the responsible management of the water supply.

The State of Maryland uses the U.S. Army Corp 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 human and environmental uses because of natural shortfalls in precipitation or stream flow."[1]

Predicting drought has proven difficult if not impossible, as so many variables come together to affect the extended weather patterns relative to a region. Adding to the complexity, drought rarely has a well-defined beginning or end and generally affects a large area.

Maryland Department of the Environment (MDE) uses four main indicators based on the amount and effect of precipitation in the hydrologic system to monitor potential drought conditions.[2] The indicators are evaluated by comparing the current conditions to natural conditions within the period of record. The indicators are: (1) precipitation levels, (2) stream flows, (3) ground water levels, and (4) reservoir storage.

Other indicators used by MDE to determine drought include the Palmer Drought Severity Index and the condition of the water system as monitored by water suppliers. The Palmer Drought Severity Index uses temperature and rainfall to determine dryness of a region. The index is slow to change and is not useful for short term monitoring of the water supply. However, the index is useful in long term planning as it reflects the status of the water supply in reservoirs, aquifers, and streams. The condition of the water supply is specific to a particular system and is the responsibility of those monitoring the supply. One supply system may suffer negative impacts sooner than another, indicating the potential for more wide-spread problems.

5.2 CONTRIBUTING FACTORS TO DROUGHT RISK

As part of this plan update, a Hazard Identification and Risk Assessment (HIRA) was conducted for the drought hazard. A composite scoring method was utilized to rank natural hazards, which included five (5) key components: historical impacts (in terms of human lives and property), geographic extent, historical occurrences, future probability, and community perspective.

Based on this method, drought was assigned a ranking of "**Medium**" during this plan update. This is consistent with drought's ranking during the previous planning cycle. The future probability of a drought event is considered "unlikely", as determined by the HIRA Full results of the HIRA, including method, are included within *Appendix A* of this plan.

5.2.1 Climate and Weather

"Climate is what you expect, weather is what you get."[3] Drought is a natural part of every climate, describing the relative departure from normal precipitation for a particular region. Weather, however, plays the more integral role in determining the likelihood of a drought. Persistent high-pressure systems over the Southeastern U.S. can keep moisture producing low pressure systems to the north of the Baltimore Metropolitan region. These high-pressure systems can occur at any point within the seasonal year—a lack of winter snowfall can be as detrimental as a lack of summer rainfall when considering the groundwater supply for the region.

5.2.2 Water Resource Allocation

The water supply for Baltimore County is static even though the population continues to grow at a fast pace. This growing population creates an increased competition for the available water supply from several groups of consumers—residential, industrial, commercial, agricultural, and recreational. Within the Urban Rural Demarcation Line (URDL), which designates the extent of the public utility network, suburban communities rely on urban infrastructure which can lead to inefficient distribution of public water due to age or failures. Outside of the URDL, sprawling residential development relies on individual wells to supply homeowners and businesses with water.

Rural Water Supply

Roughly 10% of the County's population currently resides in the rural areas outside the URDL and relies on some 30,000 domestic wells as their primary source of drinking water. These include 9 community well supplies and approximately 270 transient and non-transient non-community water supplies.

Source: Baltimore County Water Resources Element, Master Plan 2020

5.3 HISTORY OF DROUGHT

The following is a brief description of significant drought events that have affected Baltimore County.

- **1930-1931** – The 13-month period from January 1930 to January, 1931 was the driest on record, with precipitation totaling 15-26 inches below normal for weather stations throughout Maryland.[4] The weather station in Woodstock, MD at the Baltimore-Howard County line, recorded the precipitation as -25.10 inches below normal.

- **1963-1966** – The longest drought to grip Maryland lasted from 1963 to 1966. For the 4-year period between January 1963 and December, 1966, precipitation was between 26 and 38 inches below normal.[5] The Division 6 station, which includes Baltimore County, registered a departure from normal of -38.23 inches, which was the worst in the state.

- **1998-1999** – The 13-month period from July 1998 to July, 1999 was extremely dry throughout Maryland, with precipitation totaling 10-21 inches below normal.[6] The weather station in Woodstock, MD at the Baltimore-Howard County line, recorded the precipitation as –11.46 inches below normal. While this drought was not as long as the one in the 1960s nor as severe as the one in the 1930s, it caused a number of problems for residents and businesses in Maryland. This was the first time in its history that Maryland declared a statewide drought emergency and implemented mandatory water restrictions.[7]

- **2001-2002** – By the end of 2001, rainfall totals across Maryland were 30 percent below normal, putting the state in an emergency category. By mid-February 2002, nearly all of Maryland was in a state of severe drought, which is a very unusual classification for the middle of winter.[8] The period of September 2001 to August, 2002 was the second driest 12 month period in Maryland history, when record keeping began 108 years prior.[9] Reservoir levels fell to 49 percent capacity in August 2002, levels not seen since the severe drought of the 1960s.[10]

- **October 2007** – Severe Drought conditions persisted through October. In early October, rainfall deficits totaled nearly 10 inches. However, a series of low-pressure systems late in the month brought between 3 and 6 inches of rainfall to slightly reduce those deficits. Many counties and cities posted both voluntary and mandatory water restrictions throughout the month.[11]

- **June-August 2012** – During this period, much of Maryland, particularly the Eastern Shore and Southern Maryland, entered what the U.S. Drought Monitor considers to be "severe" drought. By the end of July, 29% of the State would be under a “severe” drought status; the week prior only 20% of the State was considered to meet these criteria. Many central Maryland counties, such as Anne Arundel, were in a “moderate” drought, while southern Baltimore County experienced “abnormally dry” conditions.[12]

5.4 VULNERABILITY ASSESSMENT

5.4.1 Introduction

All of Baltimore County is vulnerable during a drought, but farmers (via crop damage) and those residents living and working outside the URDL, where the public water supply ends, are at greatest risk. While those residents utilizing the public water supply will not be exempt from the risks, public officials will be monitoring the water supply and imposing restrictions as necessary to manage the supply until precipitation returns to normal in the area.

The URDL represents the geographic area within which public water and sewer services are provided. Properties that are adjacent to the line but outside it may petition to be included. During a drought, properties experiencing well failure have the best chance of accessing public water when they are relatively close to this boundary.

5.4.2 Data Utilization

The following data sources and shapefiles were utilized to determine land uses and essential facilities especially vulnerable to drought:

- Urban Rural Demarcation Line (URDL) - Baltimore County Office of Information Technology (2020)
- Structures/Parcels – Baltimore County Office of Information Technology (2014/2020)
- Essential Facilities – Baltimore County Office of Information Technology (2020)
    - Fire Stations, Police Stations, Schools/Colleges, Hospitals/Health Centers, EOCs.
- U.S. Census Bureau (2020)

5.4.3 Method

Data listed in section 5.4.2 was analyzed using ArcMap 10.4.1, a geographic information system (GIS). This program allows various data layers, such as shapefiles, to be overlaid and spatially compared. Land uses and essential facilities within the County were determined to be especially vulnerable to drought if they were outside of (did not intersect) the URDL, which is the extent of the public water and sewer supply.

Estimated economic losses to land uses within the County due to drought are based on the Maryland State Department of Assessments and Taxation (SDAT) database for all affected parcels. Tax Exempt properties include but are not limited to Public, County, State, or Federal owned Hospitals, Schools, Museums, Airports, Police Stations, and/or Fire Departments. Also included are church properties and other non-profit or charitable organizations. Economic losses are based on assessed value of property, and do not include contents value or indirect costs related to drought.

5.4.4 Assessment Results

Based on the 2021 assessment the following land uses and essential facilities were determined to be vulnerable to drought:

Table 5-1. Land Uses Affected by Drought

Land Use	Buildings Affected	Parcels	Value of Parcels
Residential	31,308	29,456	$11,688,908,500
Commercial/Residential	-	54	$13,545,000
Institutional	940	-	-
Agricultural	-	3,575	$1,035,047,900

Table 5-1. Land Uses Affected by Drought			
Land Use	Buildings Affected	Parcels	Value of Parcels
Commercial	1,916	434	$347,721,600
Exempt Commercial	-	298	$424,675,200
Exempt	-	1,207	$212,894,100
Garage	5,820	-	-
Industrial	-	500	$37,149,800
Apartment	-	3	$12,067,100
Country Club	-	25	$42,349,000
Storage Tank	129	-	-
Water Tower	24	-	-
Silo	494	-	-
Miscellaneous Structure	25,529	-	-
Total	66,160	35,552	$13,814,358,200
Note: Land uses located outside of public water service area.			

Essential Facilities

10 Fire Stations

- Baltimore County Fire Department Station 38 – Long Green
- Baltimore County Fire Department Station 44 – Hereford
- Baltimore County Fire Department Station 45 – Maryland Line
- Baltimore County Fire Department Station 47 – Jacksonville
- Baltimore County Fire Department Station 48 – Kingsville
- Baltimore County Fire Department Station 49 – Butler
- Baltimore County Fire Department Station 50 – Chestnut Ridge
- Baltimore County Fire Department Station 53 – Hereford Ambulance
- Baltimore County Fire Department Station 60 – Parkton
- Baltimore County Fire Department Station 85 – Upperco

9 Public Schools

Table 5-2. Public Schools Outside of the Urban Rural Demarcation Line	
School	Location
Carroll Manor Elementary School	Baldwin
Fifth District Elementary School	Upperco
Hereford High School	Parkton
Hereford Middle School	Monkton
Jacksonville Elementary School	Phoenix
Kingsville Elementary School	Kingsville
Prettyboy Elementary School	Freeland
Seventh District Elementary School	Parkton
Sparks Elementary School	Sparks Glencoe

1 College

- Stevenson University (Lutherville)

5.4.5 Assessment Analysis

Agricultural Impacts

In total, 3,575 agricultural parcels are especially vulnerable (rural parcels outside the metropolitan area) during a drought event. The total land value for these parcels is over $314 million dollars. The total value for all agricultural parcels is nearly 1.1 billion dollars. These at-risk agricultural parcels are depicted on Map 5-1, below. Potential crop damage to these agricultural parcels is more difficult to determine. The length and intensity of the drought period will determine the extent of damage to crops. Currently, the NCEI reports major damages associated with various natural disasters from 1996 to the present. According to this database, ten drought events occurred during this time, the majority being between 1997 and 1999. Of these, two of the events caused major crop damages, totaling an estimated 4.2 million dollars.

Vulnerable Populations

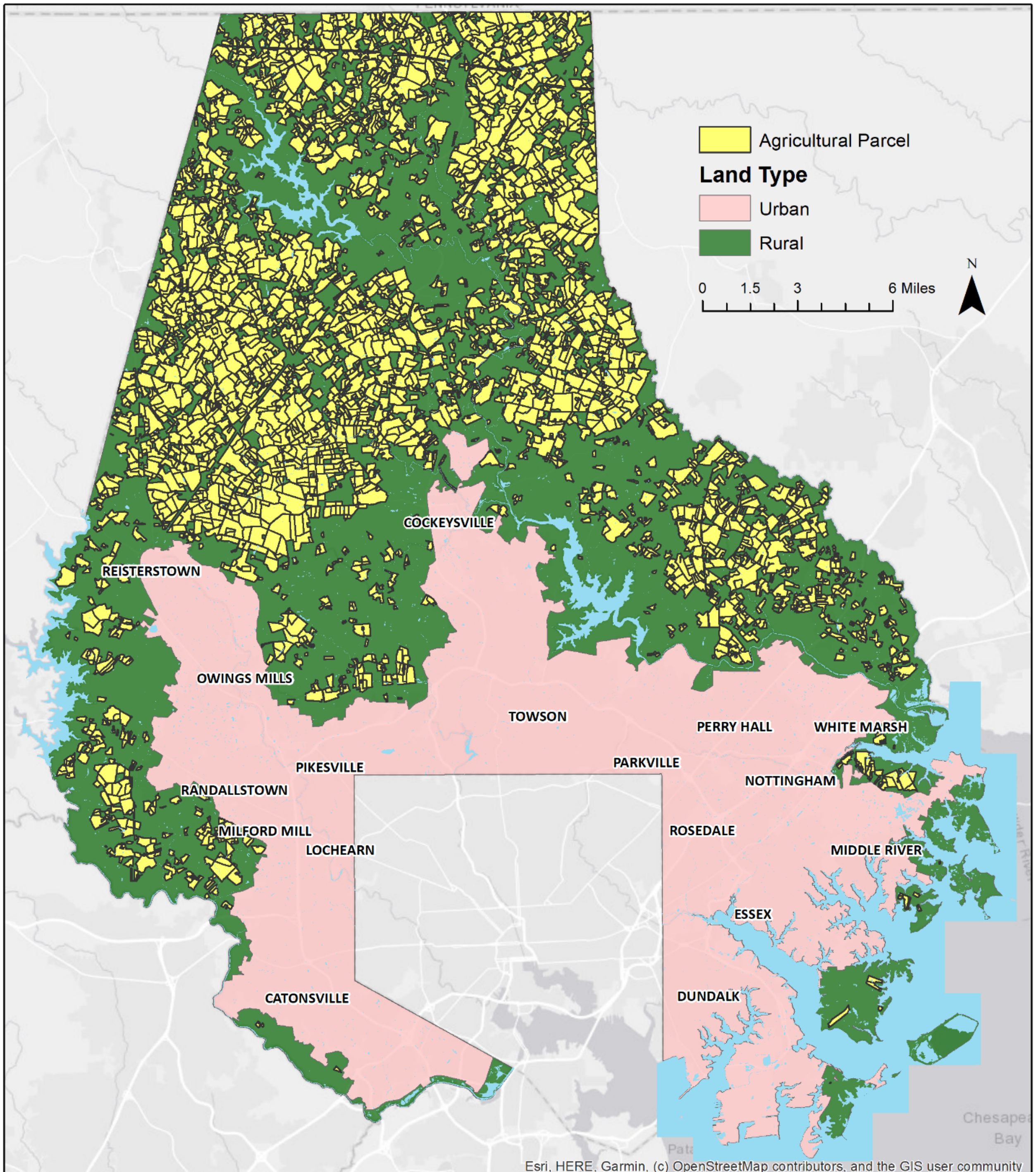
The two most vulnerable populations within Baltimore County during a drought are farmers and residents relying on a well as their primary water supply.

Human Impacts

In total, 31,308 residential structures were found to be outside the extent of the public water supply. According to ACS 5-year estimates, the average household size in 2019 was 2.58. Given this information, it can be estimated that a population of around 80,775 people could be adversely affected in the event of a drought. Due to their reliance on outside water sources, these households would be more at risk for running out of water due to a drought event.

Development Impacts

Baltimore County's designated growth area, Owings Mills, is within the URDL, which means the area is served by public water. Communities, and their residents, within the extent of public water service are less likely to be negatively affected by drought because public officials will be able to set restrictions and manage the water supply if necessary.



SP&D
Smith Planning and Design

Map 5-1. Agricultural Parcels Without Access to Public Water

Source: Baltimore County Office of Information Technology

5.5 2021 MITIGATION GOALS AND ACTION ITEMS

During the 2021 Plan Update, new mitigation goals and action were added. Additionally, previous mitigation goals and action items from the 2014 Plan were reviewed, and those that were determined to be still in progress or relevant were included.

GOAL 1: Eliminate or reduce human, environmental, social, and economic loss from natural and technological hazards.

OBJECTIVE	ACTION ITEM(S)	RESPONSIBLE ENTITY	RANKING (HIGH, MEDIUM, OR LOW)
1. Direct new development away from hazard areas.	a. Consistently track residential and commercial well failures within the County to determine if a geographic pattern of failures exists.	County	MEDIUM

GOAL 2: Support mitigation measures that show potential for environmental enhancement and cost-effectiveness.

OBJECTIVE	ACTION ITEM(S)	RESPONSIBLE ENTITY	RANKING (HIGH, MEDIUM, OR LOW)
2. Implement water conservation efforts at County facilities.	a. Conduct audits of County facilities to determine whether infrastructure upgrades would improve efficient water use.	County	MEDIUM
	b. Implement a program to upgrade County facilities.	County	MEDIUM

GOAL 3: Promote hazard mitigation as the cornerstone of emergency management in Baltimore County.

OBJECTIVE	ACTION ITEM(S)	RESPONSIBLE ENTITY	RANKING (HIGH, MEDIUM, OR LOW)
3. Educate the public about natural hazards risks, preparedness, and mitigation.	a. Continue to participate in the Green School Program.	County	MEDIUM
	b. Continue to promote water saving tips for homeowners and businesses throughout the year.	County	MEDIUM

5.6 EXISTING DROUGHT MITIGATION ACTIVITIES

- Promotion of water saving tips for homeowners and businesses on the County's website and social media platforms.
- Participation in the Green School award program which promotes water conservation as one of its many goals.
- Enacted and enforce fire hydrant connection permit regulations.
- Continue to implement the 1993 Ground Water Management and Protection Strategy as directed by the Master Plan 2020.
- Established the Well Program, responsible for the enforcement of the Maryland Department of the Environment Well Construction Regulations 26.04.02, which includes the issuance of well drilling permits and surveillance of well construction activities.

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[1] mde.maryland.gov/programs/water/droughtinformation/Pages/droughtinfoandindicators.aspx
[2] mde.maryland.gov/programs/water/droughtinformation/Pages/droughtinfoandindicators.aspx
[3] www.weather.gov/media/owlie/2011_Weather_Climate_General_Public.pdf
[4] www.atmos.umd.edu/~climate/drought.html
[5] www.atmos.umd.edu/~climate/drought.html
[6] www.atmos.umd.edu/~climate/drought.html
[7] www.mde.state.md.us/programs/PressRoom/Pages/280.aspx
[8] www.atmos.umd.edu/~climate/drought.html
[9] Baltimore Sun reporting, August 21, 2002
[10] Baltimore Sun reporting, August 21, 2002
[11] NOAA, NCDC Storm Events Database
[12] Baltimore Sun reporting, August 2, 2012

CHAPTER 6: TORNADO

UPDATES

During the 2021 Plan Update process, **Chapter 6: Tornado** was updated with the most recently available data.

Updates to this chapter include:

1. Thematic and visual update
2. **Data updates** (including tables, text, and figures as needed) to the following sections: *6.3 History of Tornadoes, 6.4 Vulnerability Assessment, 6.4.3 Assessment Results*
3. Results of the HIRA were added to *Section 6.2 Contributing Factors to Tornado Risk*. Tornado risk is ranked as "Medium." See Appendix A for full results.
4. Table 6-2 was updated with the most recently available data.
5. New data (parcels and structures) from the County's Office of Information Technology was utilized for the vulnerability assessment.
6. **New vulnerability assessment results** added for structures vulnerable to tornado events, including: mobile homes, multi-family residences, and structures built 1950 or prior.
7. **Updated 2021 Mitigation Action Items**

6.1 HOW ARE TORNADOES A THREAT TO BALTIMORE COUNTY?

Due to the unpredictability of tornado occurrences, it is impossible to categorize geographic areas as high or low risk areas based on the physical attributes of the landscape. A tornado can occur anywhere given the proper conditions. The only way to mitigate for this hazard event is to evaluate the existing property on the land.

There are several types of areas that are particularly susceptible to high loss in the event of a tornado touchdown: mobile homes, high density housing, and structures built prior to 1940.

Mobile homes, due to their lack of foundation and weak structural integrity, are at the highest risk to damage and property loss. Even the weakest of tornadoes can do considerable damage to a mobile home. In mobile home parks, this potential loss is compounded greatly.

High density residential areas are also at risk for loss. These relatively small geographic areas contain dense housing and other properties, which means these areas have a greater potential for personal injury and death due to the high population densities. For example, a tornado that touches down on a farm in Hereford is less likely to do as much damage as one of the same severity that touches down in a townhouse subdivision in Towson.

In addition to mobile home and high-density areas, structures built prior to 1940 are also at significant high risk to tornado damage. Building codes and construction practices, since 1940, have vastly changed and improved the structural integrity of residential and commercial buildings. Generally, it has been determined that buildings built before 1940 are more susceptible to damage than those built after 1940.

6.1.1 Enhanced Fujita Scale for Tornado Damage

Since 2007, tornadoes are rated by the National Weather Service according to the Enhanced Fujita Scale (EF Scale). Ratings vary from EF0, for light damage, to EF5, for total destruction of a building. A tornado's rating is determined by a combination of wind speed (Table 6-1) and damage estimates to structures. Figure 6-1, below, provides basic FEMA definitions for each category.

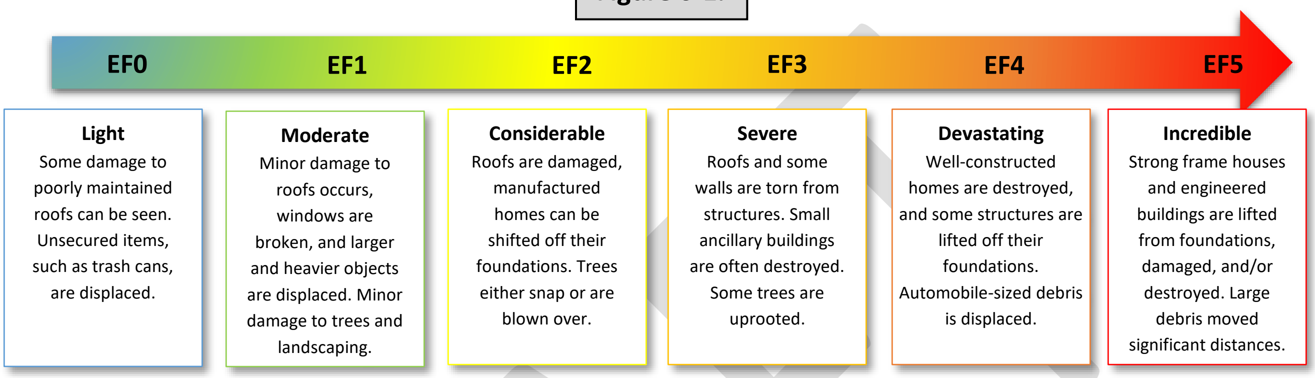
Table 6-1: Enhanced Fujita (EF) Wind Scale

Fujita Scale			Derived EF Scale		Operational EF Scale	
F Scale	Fastest 1/4-mile (mph)	3 Second Gust (mph)	EF Number	3 Second Gust (mph)	EF Number	3 Second Gust (mph)
F0	40-72	45-78	0	65-85	0	65-85
F1	73-112	79-117	1	86-109	1	86-110
F2	113-157	118-161	2	110-137	2	111-135

Table 6-1: Enhanced Fujita (EF) Wind Scale						
Fujita Scale			Derived EF Scale		Operational EF Scale	
F3	158-207	162-209	3	138-167	3	136-165
F4	208-260	210-261	4	168-199	4	166-200
F5	261-318	262-317	5	200-234	5	Over 200

Source: www.spc.noaa.gov/faq/tornado/ef-scale.html

Figure 6-1.



6.2 CONTRIBUTING FACTORS TO TORNADO RISK

As part of this plan update, a Hazard Identification and Risk Assessment (HIRA) was conducted for the tornado hazard. A composite scoring method was utilized to rank natural hazards, which included five (5) key components: historical impacts (in terms of human lives and property), geographic extent, historical occurrences, future probability, and community perspective.

Based on this method, tornado was assigned a risk ranking of "**Medium**" during this plan update. This is consistent with tornado's ranking during the previous planning cycle. The future probability of a tornado event is considered "unlikely", as determined by the HIRA Full results of the HIRA, including method, are included within *Appendix A* of this plan.

6.2.1 Climate

Tornadoes are byproducts of cold air moving quickly over a warm air mass. As warm moist air moves upward and the cold air downward, thunderstorms form from the condensation and, depending on the wind speed and rotation, tornadoes are spawned. Tornadoes have also been known to form off fast-moving winds generated by hurricanes and large wildfires. Tornadoes are extremely unpredictable and can occur almost anywhere. They are most

Tornado Quick-Facts

- ✓ Tornadoes are most likely to occur in the mid-afternoon, between 3:00 p.m. and 6:00 p.m.
- ✓ Tornadoes predominantly move from the southwest to the northeast.
- ✓ The average tornado path-length is 5 miles, but some tornado paths have exceeded 100 miles.
- ✓ The average tornado path-width is 300 to 400 yards but may reach up to 1 mile.
- ✓ Tornadoes travel at an average of 25 to 40 miles per hour (mph), but speeds from 5 to 60 mph have been recorded.

Source: FEMA, 2009

prevalent in the American mid-west and plains states, due to warm moist air from the Gulf of Mexico and cold air from the Rocky Mountains constantly colliding during the spring and summer months. The traditional tornado season is from March through August, and while most events occur within these months, tornadoes can strike anytime.

6.2.2 Damaging Winds

According to FEMA, two primary forms of damaging winds occur during a tornado event: rotating vortex winds and straight-line winds. Rotating vortex winds, which define a tornado and create its distinctive shape, are responsible for specific types of damage. These vortex winds are known to rip structures apart, uproot trees, and lift vehicles off the ground. Tornadoes also produce straight-line wind, a force typically associated with thunderstorms. The forces from a tornado's straight-line, high velocity winds exert significant pressure, or loads, on structures in their path.[1] These winds are known to tear off all, or part, of a roof, break windows, damage siding, or cause complete structural collapse.

6.2.3 Development

Predicting and mitigating for tornado damage is difficult. NOAA maintains a record of reported tornadoes and damage reports. Looking at past tornado events in terms of severity and destructiveness at the state and local level can help determine the probability and likelihood of a tornado striking in any given area. However, future frequency, occurrences and/or severity cannot be predicted to any level of accuracy.

6.3 HISTORY OF TORNADOES

From 2010 to 2020, Maryland has experienced a total of 393 tornado events (mostly EF0), which averages to 9.5 tornado events per year.[2] From 1990 to 2010, Maryland averaged 9.9 tornadoes per 10,000 square miles each year, trailing only Florida's 12.2, and Kansas' 11.7 in the 50 states.[3] According to the Weather Channel, Maryland has such a high tornado density because: "It's just east of the Appalachians. The air sinks down off the Appalachians and there is a little bit of low-pressure trough that sets up and trigger thunderstorms. It's also close to the Delaware Bay and Atlantic Ocean so there are some local winds the thunderstorms can tap to create tornadoes."

Table 6-2, below, contains NOAA's listing of all verified and recorded tornadoes that have occurred within Baltimore County that also have recorded damages.

Table 6-2. Historic Tornadoes with Recorded Damages

Date	Scale	Location	Homes Damaged	Injuries	Damage Amount
April 29, 1807	F2	Gunpowder Falls	17	-	-
October 21, 1939	F2	West of Hereford	1+	1	$75,000
August 26, 1946	F0	Eastern Baltimore Co	-	-	$1,000

Table 6-2. Historic Tornadoes with Recorded Damages					
Date	**Scale**	**Location**	**Homes Damaged**	**Injuries**	**Damage Amount**
June 16, 1973	F2	Towson Area	1	4	$25,000
August 11, 1978	F1	Loch Raven Area	-	0	$4,000
September 5, 1979	F2	Kingsville	2	0	$130,000
June 8, 1990	F0	Monkton	0	0	$3,000
October 18, 1990	F2	Reisterstown	53	59	$25,000,000
July 6, 1995	F0	Monkton	1	0	$5,000
July 6, 1995	F1	Hereford	2	0	$100,000
July 19, 1996	F1	Tyler	2+	0	$50,000
November 8, 1996	F1	Dundalk	-	1	$750,000
July 30, 1999	F0	Beckleysville	2+	0	$1,000
May 13, 2000	F1	Overlea Area	-	0	$250,000
November 17, 2010	EF1	Parkville	6	0	$50,000
April 28, 2011	EF0	Trenton (Boring)	0	0	$5,000
April 28, 2011	EF0	Evna (West of Hereford)	0	0	$1,000
June 10, 2013	EF0	Fork	0	0	$1,000
June 10, 2013	EF0	Sparrows Point	0	0	$10,000
November 2, 2018	EF1	St. Helena	0	1	$15,000
June 3, 2021	EF1	Jacksonville	2	0	-
Total	-	-	89+	66	$26,476,000

** (-) Indicates None Reported*
Source: NOAA, National Centers for Environmental Information (NCEI) – July 2020

6.4 VULNERABILITY ASSESSMENT

6.4.1 Introduction

It can be difficult to predict monetary damages to structures caused by tornadoes because damages can vary significantly. Depending on wind speed, damages can range from cosmetic to complete structural failure, or anywhere in between. As such, only structures which are most at-risk to damages from tornadoes are included in this assessment; mobile homes and mobile home parks, multi-family residential structures, and structures built prior to 1950. According to MEMA, these types of structures are more susceptible due to their building materials, lack of bolted-down foundations, and less stringent building codes at the time of their construction (in the case of structures built prior to 1950).

6.4.2 Data Utilization

Areas within Baltimore County at high risk in the event of a tornado were identified using the following sources:

- Structures – Baltimore County Office of Information Technology (2020)
- Parcels – Baltimore County Office of Information Technology (2020)

The estimated economic losses to properties within the County are based on the Maryland State Department of Assessments and Taxation Real Property (SDAT) Database for all affected parcels. Economic losses are based on assessed value of property, and do not include contents value or indirect costs related to the damage (economic losses due to business closings).

6.4.3 Assessment Results

Mobile Homes

Number of Structures – 3,321
Value of Structures – $56,564,600
Structure Extent – 71.89 acres

Multi-Family Residential Buildings

Number of Parcels – 19,539
Number of Structures – 5,111
Value of Structures – $6,281,287,500
Structure Extent – 908.03 acres

Buildings Constructed Prior to 1950

Number of Parcels with Primary Structure Constructed 1950 or Prior– 65,341
Value of Structures – $6,616,891,500
Structure Extent – 2362.59 acres

6.5 2021 MITIGATION GOALS AND ACTION ITEMS

During the 2021 Plan Update, new mitigation goals and action were added. Additionally, previous mitigation goals and action items from the 2014 Plan were reviewed, and those that were determined to be still in progress or relevant were included.

GOAL 1: Promote hazard mitigation as the cornerstone of emergency management in Baltimore County.			
OBJECTIVE	**ACTION ITEM(S)**	**RESPONSIBLE ENTITY**	**RANKING (HIGH, MEDIUM, OR LOW)**
1. Educate the public about natural hazards risks, preparedness and mitigation.	a. Continue to promote tornado education on the County's social media for homeowners and businesses.	County	Medium
	b. Develop targeted public education materials for mobile home residents.	County	Medium
2. Continued education for emergency responders and personnel.	a. Continue to provide staff training in the form of damage assessment courses so that emergency personnel are up to date on the latest techniques for assessing tornado damage, as well as any other major natural disaster. This course, and those like it, would be beneficial to new staff members, and provide a refresher for current staff.	County	Medium
	b. Investigate damage assessment applications to streamline data collection efforts.	County	Medium

6.6 EXISTING TORNADO MITIGATION ACTIVITIES

- Promote tornado education on the County website for homeowners and businesses.
- As of 2012, minimum design wind loads for buildings are more stringent. They have been changed to 90 mph for Risk Categories I and II, and 101 mph for Risk Categories III and IV.
- The County's Emergency Notification System (ENS) is an opt-in system which can notify citizens and businesses of emergency or disaster management situations that may require time-sensitive actions. This system sends a recorded message and/or e-mail to homes and businesses within the County, which provides safety information and instructions. This system does not send weather watches or warnings at the present time.
- The public may receive Wireless Emergency Alerts (WEA) of tornados on their cellphones via the Integrated Public Alert & Warning System (IPAWS).
- Baltimore County schools have NOAA weather radios for warning; a service which is promoted to residents to receive weather warnings quickly.
- Utilization of social media (Facebook, Twitter, Instagram) to disperse warnings and information prior to and during a severe weather event, such as a tornado.

[1] www.fema.gov
[2] data.delmarvanow.com
[3] www.washingtonpost.com/blogs/capital-weather-gang/post/shock-stat-maryland-has-third-highest-tornado-density-in-us/2012/03/26/gIQAReMmgS_blog.html

CHAPTER 7: THUNDERSTORM

UPDATES

During the 2021 Plan Update process, **Chapter 7: Thunderstorm** was updated with the most recently available data.

Updates to this chapter include:

1. Thematic and visual update
2. **Data updates** (including tables, text, and figures as needed) to the following sections:
   a. *7.1 How are Thunderstorms a Threat to Baltimore County,* updated text and data source.
   b. Results of the HIRA were added to *Section 7.2 Contributing Factors to Thunderstorm Risk*. Thunderstorm risk is ranked as "High." See Appendix A for full results.
   c. *7.2.2 Moisture,* added and updated text.
   d. *7.3 History of Thunderstorms,* updated text and added new events to Table 7-1.
   e. *7.3.2 Hail Events,* updated text, added new events to Table 7-2.
3. **Updated** Lightning Quick-Facts and Hail Quick-Facts text boxes.
4. **Updated Section 7.4** *Vulnerability Assessment* with the best available data.
5. **Goals and Action Items** have been updated in section 7.5.
6. **Existing Mitigation Activities** have been revised in section 7.6.

7.1 HOW ARE THUNDERSTORMS A THREAT TO BALTIMORE COUNTY?

Thunderstorms are always accompanied by lightning and have the potential to cause damage via flooding, hail, strong winds, and tornadoes. Thunderstorms pose a threat to Baltimore County because they are always accompanied by some combination of the aforementioned. As such, the threats associated with these individual hazards are very real possibilities during a thunderstorm event. The same populations that are threatened by hazards such as tornadoes and flooding are also potentially at risk during a thunderstorm.

According to the National Severe Storms Laboratory (NSSL), it is estimated that 100,000 thunderstorms occur in the U.S. per year; of which ten percent are considered severe.[1] The National Weather Service considers a thunderstorm severe if it produces hail of at least one inch in diameter, generates winds of 58 miles per hour or stronger, a tornado, or some combination of these events. This chapter will focus only on hail and lightning, as thunderstorm winds, flooding, and tornadoes are explained in more detail in other hazard-specific chapters.

7.2 CONTRIBUTING FACTORS TO THUNDERSTORM RISK

As part of this plan update, a Hazard Identification and Risk Assessment (HIRA) was conducted for the thunderstorm hazard. A composite scoring method was utilized to rank natural hazards, which included five (5) key components: historical impacts (in terms of human lives and property), geographic extent, historical occurrences, future probability, and community perspective.

Based on this method, thunderstorm was assigned a ranking of "**High**" during this plan update. This represents an increase in thunderstorm's risk ranking compared to the previous planning cycle. The future probability of a thunderstorm event is considered "highly likely", as determined by the HIRA Full results of the HIRA, including method, are included within *Appendix A* of this plan.

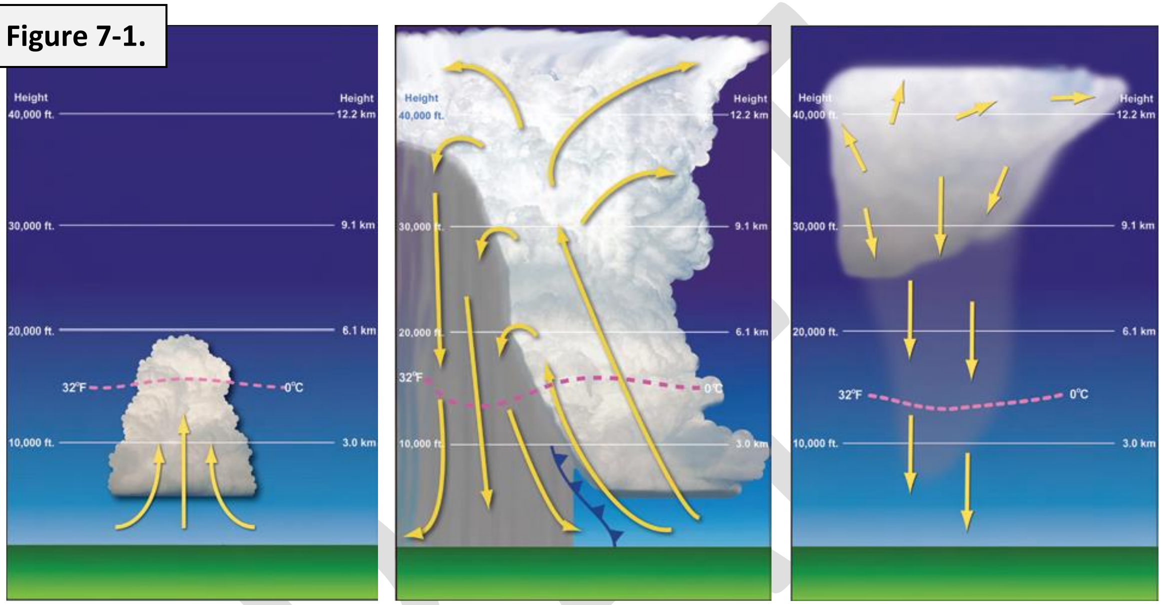
7.2.1 Temperature

Thunderstorms most commonly occur in the afternoon after daytime heating of the land by the sun has caused the lower portion of the troposphere (the lowest layer of the Earth's atmosphere) to become unstable from the higher temperatures. Conversely, thunderstorms can form because of the upper atmosphere becoming unusually cool due to the approach of an upper air disturbance. Under these circumstances, thunderstorms can form at any time of the day, even when heating of the lower atmosphere has not occurred during the day.[2]

7.2.2 Moisture

Three basic ingredients are needed to form a thunderstorm: moisture, rising unstable air, and a lifting mechanism.[3] For a thunderstorm to form, there must be sufficient moisture since clouds and precipitation originate as water vapor. This water vapor acts as fuel for the thunderstorm and as the storm uses this fuel it is converted into rainfall. Eventually, the thunderstorm uses the excess water vapor, which causes the atmosphere to stabilize as the lower atmosphere cools and the upper atmosphere warms.[4] The full thunderstorm lifecycle is represented in Figure 7-1, following.

Figure 7-1.



Developing Stage
- Towering cumulus cloud indicates rising air
- Usually little if any rain during this stage
- Lasts about 10 minutes
- Occasional lightning

Mature Stage
- Most likely time for hail, heavy rain, frequent lightning, strong winds, and tornadoes
- Storm occasionally has a black or dark green appearance
- Lasts an average of 10 to 20 minutes but some storms may last much longer

Dissipating Stage
- Downdrafts, downward flowing air, dominate the storm
- Rainfall decreases in intensity
- Can still produce a burst of strong winds
- Lightning remains a danger

Source: NOAA, NWS

7.3 HISTORY OF THUNDERSTORMS

7.3.1 Lightning Events

According to the National Weather Service (NWS), lightning causes an average of 49 fatalities and hundreds of injuries per year.[5] Additionally, lightning occurs with all thunderstorms and damages caused by lightning strikes cost more than $1 billion in insured losses per year. June, July, and August are

Lightning Quick-Facts

- ✓ There is no safe place outdoors when a thunderstorm is nearby.
- ✓ Lightning fatalities are most common during summer afternoons and evenings.
- ✓ Many wildfires in the western U.S. and Alaska are ignited by lightning (see *Chapter 9* for more information regarding wildfires).

Source: NOAA, NWS

the peak months for lightning activity across the United States and the peak months for outdoor activities. This results in more than 70% of all lightning fatalities occurring in the summer months, particularly on weekends. Table 7-1 contains the severe lightning events recorded by the National Centers for Environmental Information (NCEI) that occurred between 2000 and 2020 in Baltimore County. In total, 9 severe events were recorded during the twenty-year period; one included a reported injury, and two reported significant property damages.

Table 7-1. Severe Lightning Events, 2000-2020

Location	Date	Injuries	Property Damage
Countywide	6/12/2001	0	$0
Catonsville Manor	6/20/2001	0	$0
Towson	7/1/2001	0	$1,000,000
Baldwin/Towson	8/27/2003	0	$0
Cockeysville	5/17/2004	0	$0
Brooklandville	5/21/2004	0	$0
Reisterstown	7/7/2004	0	$0
Daniels	4/20/2008	0	$15,000
Belltown	8/8/2018	1	$0
Totals:		1	$1,015,000

Source: NOAA, National Centers for Environmental Information (NCEI)

7.3.2 Hail Events

Hail Quick-Facts

- ✓ Hail can be larger than a softball (5 inches in diameter).
- ✓ Large hailstones can fall at speeds greater than 100 mph.
- ✓ The largest hailstone ever recorded in the U.S. was 8 inches in diameter.
- ✓ Hail causes more than $1 billion in crop and property damage per year.

Source: NOAA, NWS

Hail is created when strong updrafts lift water droplets to such an altitude that freezing occurs. These frozen droplets are held by the updraft until they increase to such as size where the wind is no longer able to keep them suspended, at which point they fall to the ground. In general, hail is larger than sleet and only forms during a thunderstorm. According to the NWS, the severity of hail events is determined by the size of the hailstone; hail equal to or greater than one inch is severe.

Table 7-2 contains the severe hail events recorded by the National Centers for Environmental Information (NCEI) that occurred between 2000 and 2020 in Baltimore County. In total, 72 events were recorded during the twenty-year period; there was one reported event with significant property damages.

Table 7-2. Severe Hail Events (1-Inch or greater), 2000-2020

Location	Date	Magnitude	Injuries	Property Damage
Cockeysville	5/13/2000	1.00 in.	0	$0
Rosedale	7/14/2000	1.75 in.	0	$0
White Marsh	5/13/2002	1.75 in.	0	$0
South Portion	8/3/2002	1.00 in.	0	$0

Table 7-2. Severe Hail Events (1-Inch or greater), 2000-2020				
Location	**Date**	**Magnitude**	**Injuries**	**Property Damage**
Towson	8/22/2003	1.75 in.	0	$0
Towson	5/17/2004	1.00 in.	0	$0
Essex	7/1/2004	2.75 in.	0	$0
Towson	6/6/2005	1.00 in.	0	$0
Perry Hall	4/3/2006	1.00 in.	0	$0
Dundalk	4/3/2006	1.00 in.	0	$0
Perry Hall	7/2/2006	1.00 in.	0	$0
Catonsville Manor	7/4/2007	1.00 in.	0	$0
Lutherville	6/10/2008	1.00 in.	0	$0
Timonium	6/10/2008	1.75 in.	0	$5,000
Dundalk	7/22/2008	1.75 in.	0	$0
White Marsh	8/2/2008	1.00 in.	0	$0
Baltimore Martin St	8/2/2008	1.00 in.	0	$0
Poplar	6/20/2009	1.25 in.	0	$0
Harewood Park	4/25/2010	1.00 in.	0	$0
Maryland Line	5/14/2010	1.75 in.	0	$0
Rogers Forge	5/14/2010	1.00 in.	0	$0
Halethorpe	5/14/2010	1.00 in.	0	$0
Essex	7/7/2011	1.00 in.	0	$0
Dundalk	7/7/2011	1.00 in.	0	$0
Pleasant Grove	8/18/2011	1.00 in.	0	$0
Middle River	8/19/2011	1.00 in.	0	$0
Carney	8/19/2011	1.00 in.	0	$0
Dundalk	8/21/2011	1.00 in.	0	$0
Dundalk	8/21/2011	1.25 in.	0	$0
Edgemere	8/21/2011	1.00 in.	0	$0
Sunnybrook	6/29/2012	1.00 in.	0	$0
Kenwood	6/29/2012	1.00 in.	0	$0
Parkville	8/14/2012	1.50 in.	0	$0
Carney	8/14/2012	1.00 in.	0	$0
Parkville	8/14/2012	1.00 in.	0	$0
Poplar	8/14/2012	1.00 in.	0	$0
Halethorpe	6/18/2014	1.00 in.	0	$0
Fullerton	7/10/2014	1.00 in.	0	$0
McDonogh	8/3/2014	1.00 in.	0	$0
Padonia	6/23/2015	1.00 in.	0	$0
Ashland	6/23/2015	1.50 in.	0	$0
Ashland	6/23/2015	3.00 in.	0	$0
Cockeyville	6/23/2015	1.75 in.	0	$0
Padonia	6/23/2015	1.75 in.	0	$0
Padonia	6/23/2015	4.00 in.	0	$0
Harrisonville	6/23/2015	1.25 in.	0	$0
Texas	6/23/2015	1.75 in.	0	$0
Texas	6/23/2015	1.75 in.	0	$0
Middle River	7/16/2016	1.00 in.	0	$0
(MTN) Martin Airport Bal	7/16/2016	1.00 in.	0	$0
Fullerton	2/25/2017	1.00 in.	0	$0

Table 7-2. Severe Hail Events (1-Inch or greater), 2000-2020				
Location	**Date**	**Magnitude**	**Injuries**	**Property Damage**
Fullerton	2/25/2017	1.00 in.	0	$0
Poplar	2/25/2017	1.00 in.	0	$0
Linhigh	2/25/2017	1.25 in.	0	$0
Owings Mills	5/25/2017	1.00 in.	0	$0
Chase	8/2/2017	1.00 in.	0	$0
Pikesville	8/3/2017	1.00 in.	0	$0
Essex	8/21/2017	1.00 in.	0	$0
Edgemere	8/21/2017	1.00 in.	0	$0
Oella	5/12/2018	1.75 in.	0	$0
Baltimore Highlands	5/12/2018	1.00 in.	0	$0
Halethorpe	5/12/2018	1.00 in.	0	$0
Sparrows Pt	5/12/2018	1.00 in.	0	$0
Bentley Spgs	5/15/2018	1.00 in.	0	$0
Perry Hall	8/13/2018	1.00 in.	0	$0
Baltimore Martin St	5/29/2019	1.50 in.	0	$0
Bowleys Quarters	6/29/2019	1.75 in.	0	$0
Sparrows Pt	8/6/2019	1.00 in.	0	$0
Essex	4/13/2020	1.00 in.	0	$0
Bowleys Quarters	7/5/2020	1.25 in.	0	$0
Baltimore Martin St	7/6/2020	1.00 in.	0	$0
Lutz Hill	8/23/2020	1.00 in.	0	$0
Totals:	-	-	0	$5,000

Source: NOAA, National Centers for Environmental Information (NCEI)

7.4 VULNERABILITY ASSESSMENT

Thunderstorms have the potential to impact all of Baltimore County, therefore specific thunderstorm prone areas were not identified. Instead, general safety guidelines, specifically as they relate to hail and lightning, have been outlined. Please see *Chapter 6: Tornado* for more information regarding tornadoes as they relate to thunderstorms.

Severe Thunderstorm Profile: Derecho

On the evening of June 29, 2012, a long-lived line of severe thunderstorms struck Baltimore County with prolific lightning and wind gusts that exceeded 75 miles per hour. Numerous trees and limbs were knocked down onto homes, power lines, and parked vehicles. Most of the damages observed were in the Towson area. It took over a week to fully restore power to all Baltimore County residents.

According to a 2019 analysis[6], men are the most common victims of lightning strikes – by a large margin. During the 14-year period of the study, men accounted for 79% of the total fatalities. Furthermore, two thirds of the deaths were attributed to people who had been enjoying "outdoor leisure activities", most commonly including fishing, beach, camping, farming or ranching, riding a bike, motorcycle or ATV, and boating.

Those who are outside during a thunderstorm event are most at risk for injury or death caused by lightning strikes or sufficiently large hail stones. In fact, there is no safe place outside during a thunderstorm, regardless of geographic location or time of day. The

single most effective strategy for avoiding injury caused by thunderstorms is to stay inside or seek indoor shelter immediately; most lightning victims were going to a safe place but waited too long before seeking safe shelter[7].
If you are unable to reach a sturdy shelter during a thunderstorm event, remember these tips to minimize your risk of being struck by lightning:

1. Avoid open areas and stay away from isolated tall trees or other structures that may act as a lightning rod;
2. Stay away from metal conductors such as wires or fences.

All structures are at risk of being damaged from lighting or hail during a thunderstorm event, but some are particularly vulnerable depending on several factors. Structures most at risk to a lightning strike are those that are taller, elevated on a hill, have large protrusions (such as a steeple) that may act as a lightning rod, or are near trees. A structure would be more vulnerable to hail strikes depending upon the construction materials used for the structure. Buildings that are tall and have large amounts of glass-facing are particularly at risk.

7.5 2021 MITIGATION GOALS AND ACTION ITEMS

During the 2021 Plan Update, new mitigation goals and action were added. Additionally, previous mitigation goals and action items from the 2014 Plan were reviewed, and those that were determined to be still in progress or relevant were included.

GOAL 1: Promote hazard mitigation as the cornerstone of emergency management in Baltimore County.			
OBJECTIVE	**ACTION ITEM(S)**	**RESPONSIBLE ENTITY**	**RANKING (HIGH, MEDIUM, OR LOW)**
1. Educate the public about natural hazards risks, preparedness and mitigation.	a. Continue to promote thunderstorm education via social media for homeowners and businesses.	County	Medium
	b. Target educational material to residents and businesses that meet the criteria for structures which are particularly vulnerable to lightning and hail.	County	Medium
2. Continued education for emergency responders and personnel.	a. Provide staff training in the form of a damage assessment course so that emergency personnel are up to date on the latest techniques for assessing thunderstorm related damage, as well as any other major natural disaster. This course, and those like it, would be beneficial to new staff members, and provide a refresher for current staff.	County	Medium

GOAL 2: Eliminate or reduce human, environmental, social, and economic loss from natural and technological hazards.			
OBJECTIVE	**ACTION ITEM(S)**	**RESPONSIBLE ENTITY**	**RANKING (HIGH, MEDIUM, OR LOW)**
3. Enforce current building standards.	a. Continue to perform building inspections to ensure compliance with current building standards as they relate to maximum wind loads.	Department of Permits, Approvals and Inspections	Medium

7.6 EXISTING THUNDERSTORM MITIGATION ACTIVITIES

- The County's Emergency Notification System (ENS) is an opt-in system which can notify citizens and businesses of emergency or disaster management situations that may require time-sensitive actions. This system sends a recorded message and/or e-mail to homes and businesses within the County, which provides safety information and instructions. This system does not send weather watches or warnings at the present time.
- Utilization of social media (e.g., Facebook, Twitter, Instagram) to disperse warnings and information prior to and during a severe weather event.

[1] National Severe Storms Laboratory, "Severe Weather 101 – Thunderstorms"
[2] NOAA, NWS
[3] www.nssl.noaa.gov/education/svrwx101/thunderstorms/
[4] NOAA, NWS
[5] www.weather.gov/media/safety/Analysis06-19.pdf
[6] Jensenius, John S. "A Detailed Analysis of Lightning Deaths in the United States from 2006 through 2019." Weather.gov, Feb. 2020, www.weather.gov/media/safety/Analysis06-19.pdf.
[7] www.weather.gov/media/owlie/ttl6-10.pdf

UPDATES

During the 2021 Plan Update process, **Chapter 8: High Winds** was updated with the most recently available data.

Updates to this chapter include:

1. Thematic and visual update
2. **Data updates** (including tables, text, and figures as needed) to the following sections:
   a. Results of the HIRA were added to *Section 8.2 Contributing Factors to High Wind Risk*. High Wind risk is ranked as “Medium-High.” See Appendix A for full results
   b. 8.2 added “Downbursts v. Tornadoes”.
   c. 8.3 *History of High Winds in Baltimore County,* tables 8-1 and 8-2.
   d. Updated text in section 8.4.1 to explain estimated data within the vulnerability assessment.
3. Vulnerability assessment results adjusted with latest available data from U.S. Census.
   a. Results from the previous HAZUS analysis were updated to reflect values more representative of demographic estimates in 2020.

CHAPTER 8: HIGH WINDS

8.1 HOW ARE HIGH WINDS A THREAT TO BALTIMORE COUNTY?

High wind poses a threat to Baltimore County in many forms, including winds produced by severe thunderstorms and tropical weather systems, such as hurricanes. The damaging effects of high wind can include blowing debris from trees and structures, interruptions to above ground power and communication systems, and intensified effects of winter weather. Harm may occur to both people and animals, and damage often occurs to property and infrastructure.

8.2 CONTRIBUTING FACTORS TO HIGH WIND RISK

As part of this plan update, a Hazard Identification and Risk Assessment (HIRA) was conducted for the high wind hazard. A composite scoring method was utilized to rank natural hazards, which included five (5) key components: historical impacts (in terms of human lives and property), geographic extent, historical occurrences, future probability, and community perspective.

Based on this method, high wind was assigned a ranking of “**Medium-High**” during this plan update. This represents an increase in high wind’s risk ranking compared to the previous planning cycle. The future probability of a high wind event is considered “unlikely”, as determined by the HIRA. Full results of the HIRA, including method, are included within *Appendix A* of this plan.

Source: Baltimore County Department of Emergency Management

Aside from tropical cyclones, which are discussed in *Chapter 13 Coastal Storm and Flooding*, Baltimore County is most affected by thunderstorm winds. The most prevalent type of wind event associated with thunderstorms are downbursts, also known as straight-line wind, which are responsible for most thunderstorm wind damage. Downbursts are produced by the downward momentum in the downdraft region of a thunderstorm. They earn their nickname from the fact that, unlike a tornado, which spreads debris in multiple directions, straight-line winds push debris in the same direction that the wind is blowing. These winds can exceed speeds of 165 mph and can cause destruction equal to that of a tornado.[1]

In severe cases, thunderstorms may produce a derecho, which is a type of straight-line windstorm that is widespread, long-lived, and fast-moving. Winds in a derecho can be enhanced by downburst clusters embedded inside the storm. These straight-line winds may exceed 100 miles per hour (mph) and have been known to reach 130 mph; the derecho event that affected Baltimore County in June of 2012 had recorded wind speeds that exceeded 75 mph. Tornadoes sometimes form within derecho events, although such events are often difficult to confirm due to the additional damage caused by straight-line winds in the immediate area.

Downbursts v. Tornadoes

Downbursts are often mistaken for tornadoes for three reasons:

1. Both can have very damaging winds causing significant or extensive damage.
   - Tornado winds range from 40 to over 300 MPH and downburst winds can exceed 165 MPH.
2. A loud "roaring" sound
   - Wind speeds greater than 75 MPH often sound loud, leading some to believe they heard a tornado when in fact they heard straight-line wind.
3. Trees are damaged in such a way (i.e., "twisted") that it appears to be tornado damage.
   - Due to the asymmetrical nature of tree growth, certain sides of a tree are more wind resistant than others. If wind speeds are high enough the tree will begin to tear apart in a twisting motion – even though the winds are relatively straight.

Source: www.weather.gov/iwx/2013_straight-line_winds_vs_tornado

8.3 HISTORY OF HIGH WIND

Between January 1, 2010, and December 31, 2020, there were 15 severe thunderstorm events (60 kts. or stronger and with property damage) recorded in the National Centers for Environmental Information (NCEI) database for Baltimore County. Severe thunderstorm wind events occur at a rate of roughly 1.4 events per year. In total, these high winds from thunderstorms have caused an estimated $369,500 in damages. Table 8-1 further details these severe thunderstorm wind events, including approximate location, wind speed, and reported property damages.

Table 8-1. Severe Thunderstorm Wind Events, 2010-2020

Location(s)	Date	Wind Speed	Property Damage ($)
Hydes	9/22/2010	65 kts. EG	5,000
Long Green	9/22/2010	70 kts. EG	5,000
Parkville	11/17/2010	70 kts. EG	15,000
Parkville	11/17/2010	78 kts. EG	10,000
Dundalk	7/7/2011	66 kts. EG	100,000
Baltimore Highlands	7/7/2011	61 kts. EG	75,000
Dundalk	8/13/2011	61 kts. EG	5,000
Rogers Forge	6/1/2012	61 kts. EG	7,500
Padonia	6/1/2012	61 kts. EG	5,000
Oella	6/29/2012	66 kts. EG	1,000
Owings Mills, Kenwood	6/29/2012	61 kts. EG	6,000
Ashland	6/23/2015	61 kts. EG	5,000
Baltimore Martin St	7/6/2020	65 kts. EG	50,000
(MTN) Martin Airport Bal, Stemmers Run	7/6/2020	60 kts. EG	30,000
Stemmers Run	9/3/2020	60 kts. EG	50,000
Totals:	-	-	$369,500
Note: Only includes those wind events stronger than 60 kts with reported property damage. Note: EG – Estimated Gust			

Source: National Centers for Environmental Information, July 2020

Between January 1, 2010, and December 31, 2020, there were three (3) severe high wind events recorded in the NCEI storm database for Baltimore County. This translates to an average of 0.3 severe high wind events per year within the County. In total, severe high wind events caused an estimated $8,601,000 in damages during this time. This number is likely higher, as the NCEI database is only able to provide estimates of damages from sources such as news and property owner reports. Table 8-2 further details these severe high wind events, including wind speed, and reported property damages.

Table 8-2. Severe High Wind Events, 2010-2020

Location(s)	Date	Wind Speed	Deaths	Injuries	Property Damage ($)
Southern Baltimore County	2/19/2011	52 kts. EG	0	0	1,000
Baltimore County	10/29/2012	59 kts. EG	0	2	8,600,000
Southern Baltimore County	3/2/2018	50 kts. EG	1	0	0
Totals:	-	-	1	2	8,601,000

Note: Only includes those high wind events stronger than 60 kts or with reported property damage or reported casualties.
Note: EG – Estimated Gust

8.4 HAZUS LEVEL 2 HURRICANE WIND ANALYSIS

8.4.1 Plan Update

A HAZUS Level 2 Analysis was conducted for *Chapter 8 High Winds* in 2014. As part of the 2021 Plan Update this analysis was modified to reflect current estimates provided by the American Community Survey (5-year). Full results from the 2020 U.S. Census are not yet available and are slated for release in late summer of 2021.

Results of this type of analysis include essential facility and general building stock damages, debris generation, shelter requirements, and associated economic losses. This level of analysis is more accurate than a Level 1 Analysis because the data used for the analysis is derived from user-supplied sources, including best-available data specific to Baltimore County, as well as data available in the Hazus database. Examples of user-supplied data utilized for this analysis include:

1. Building stories
2. Year built
3. Structure value
4. Square Footage

U.S. Census Bureau Data Utilization

The HAZUS analysis conducted during the 2014 Plan Update utilized the most recent version of the software (version 2.1), which was released in October of 2013. At the time of this HAZUS Level 2 Analysis for Hurricane Wind, FEMA had not yet integrated 2010 Census data into the Hazus version 2.1 software. This data will be made available with the next release. As such, household numbers and other demographic data was increased by 5.6% to better represent the total number of households (316,716) in Baltimore County per the 2010 U.S. Census. This percentage increase was derived by determining the percent change in demographic data from 2000 to 2010. For example, the total number of households in Baltimore County has changed from 299,000 in 2000 to 316,715 in 2010, which represents an increase of 17,715 households. This change was calculated as a percentage (5.6%) and related household values were increased by this amount where necessary. In the case of population estimates, a 6.3% change was calculated and added to necessary population values.

Results from the 2014 HAZUS analysis within this section have been modified with estimated values for the 2021 Plan Update. This is because 2020 Census data is not currently available. Certain demographic data, such as household size, is provided by ACS 5-year data estimates.

Population results have been increased by 2.775% to better represent the estimated number of people (827,370) in Baltimore County per the 2019 ACS 5-year estimates. This percentage increase was derived by determining the percent change in population data from 2013 to 2020. For example, the total population in Baltimore County has changed from 805,029 in 2010 to 827,370 in 2020, which represents an increase of 22,341 people. This change was calculated as a percentage (2.775%) and related population values were increased by this amount where necessary. In the case of household size estimates, a -1.009% change was calculated and added to necessary household size values.

8.4.2 Introduction

The Hurricane Model allows practitioners to estimate the economic and social losses from hurricane winds. Although the software offers users the opportunity to prepare comprehensive loss estimates, it should be recognized that, even with state-of-the-art techniques, uncertainties are inherent in any such estimation methodology. The next major hurricane to affect your area will likely be quite different than any "scenario hurricane" anticipated as part of a hurricane loss estimation study. Hence, the results of a scenario analysis should not be looked upon as a prediction but rather as an indication of what the future may hold.

Note: The full report of the HAZUS Level 2 Analysis for Hurricane Wind is included in Appendix E.

8.4.3 County Overview

HAZUS Hurricane Wind Parameters

Study Region: Baltimore County
Scenario: Probabilistic (worst-case)
Return Period Analyzed: 1000

Baltimore County is roughly 607 square miles and contains 204 census tracts. The region contains 313,519 households and has a total population of 827,370 people (ACS 5-year estimate). There are an estimated 269,655 buildings in the region with a total building replacement value (excluding contents) of 77.549 billion dollars (2021 dollars). Approximately

93% of the buildings (and 76% of the building value) are associated with residential housing.

The hurricane event selected for this analysis of Baltimore County was the 1000-year event, which represents a worst-case scenario. The chosen storm path, higlighted on Map 8.1 below, represents a storm path that could conceivably cause the highest amount of damage via high winds.

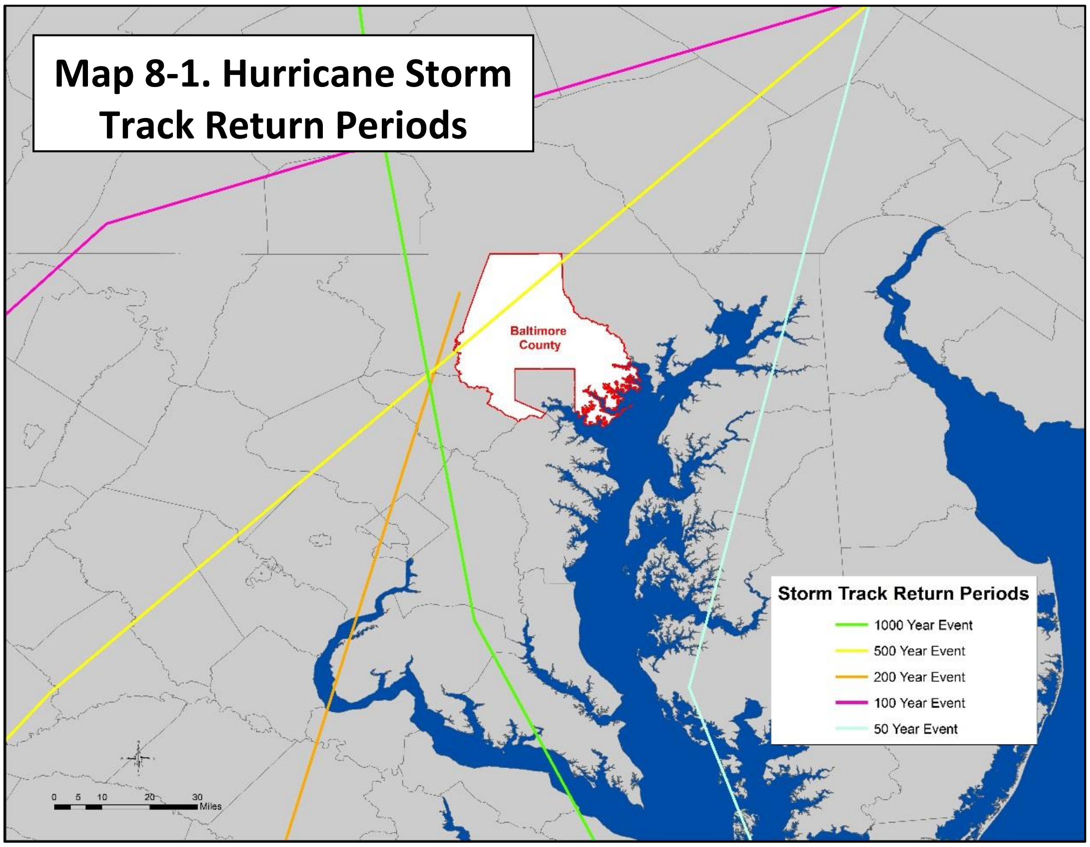


Table 8-3, below, provides building exposure values by occupancy type for the hurricane wind event scenario. The information contained in this table represents only building stock that was determined by HAZUS to have been affected ("exposed") by the hurricane wind event.

Table 8-3. Building Exposure by Occupancy Type for the Scenario		
Occupancy	**Exposure ($) ***	**Percent of Total**
Residential	$51,070,973,154	75.5%
Commercial	$11,809,888,698	17.5%
Industrial	$2,284,432,962	3.4%
Agricultural	$180,781,500	0.3%

Table 8-3. Building Exposure by Occupancy Type for the Scenario		
Occupancy	Exposure ($) *	Percent of Total
Religion	$1,117,029,120	1.7%
Government	$383,464,206	0.6%
Education	$793,853,682	1.2%
Total	$67,640,423,322	100.00%
Note: Dollar exposure values are produced from the square footage values derived from U.S. Census data, Maryland Property View, and Dun & Bradstreet, by applying the RS Means replacement values for typical building square foot factors and construction for each occupancy type. *2021 Dollars		

Critical Facility Inventory

Critical facilities were broken down into two groups: essential facilities and high potential loss facilities (HPL). Essential facilities include hospitals, medical clinics, schools, fire stations, police stations and emergency operations facilities. High potential loss facilities include dams, levees, military installations, nuclear power plants, and hazardous material sites.

For essential facilities, there are 25 hospitals in the region with a total bed capacity of 1,800 beds. There are 375 schools, 65 fire stations, 20 police stations and 1 emergency operation facilities. With respect to high potential loss facilities (HPL), there are 11 dams identified within the region. Of these, 4 of the dams are classified as 'high hazard'. The inventory also includes 66 hazardous material sites, 0 military installations and 0 nuclear power plants.

8.4.4 Damage Estimates

General Building Stock Damage

Hazus estimates that about 4,067 buildings will be at least moderately damaged. This is over 2% of the total number of buildings in the region. There are an estimated 123 buildings that will be destroyed. Table 8-4, below, summarizes the expected damage by general occupancy for the buildings in the scenario.

Table 8-4. Expected General Building Stock Damage by Occupancy										
	None		Minor		Moderate		Severe		Destruction	
Occupancy	Count	%	Count	%	Count	%	Count	%	Count	%
Agriculture	701	89.39	63	8.06	14	1.73	6	0.75	1	0.07
Commercial	12,382	91.63	939	6.95	175	1.30	18	0.13	0	0.00
Education	446	92.47	32	6.61	4	0.88	0	0.03	0	0.00
Government	331	92.09	24	6.75	4	1.10	0	0.06	0	0.00
Industrial	3,348	91.48	257	7.02	47	1.30	7	0.19	0	0.01
Religion	1,051	92.29	79	6.95	8	0.74	0	0.02	0	0.00

Table 8-4. Expected General Building Stock Damage by Occupancy										
	None		Minor		Moderate		Severe		Destruction	
Occupancy	Count	%	Count	%	Count	%	Count	%	Count	%
Residential	217,017	86.91	28,918	11.58	3,590	1.44	70	0.03	122	0.05
Total	**235,276**		**30,312**		**3,843**		**101**		**123**	

Most of the damage from hurricane winds is expected to be minor, representing 11.2% of the total building stock within the County. Residential buildings are expected to make up the largest percentage of buildings with minor damage – 11.6%. Map 8-2 depicts regions where minor residential damage is expected to occur, by percentage affected. Minor residential damage is uniform throughout the County, with notable exceptions along the coastline.

Critical Facility Damage

Before the hurricane, Baltimore County had 1,800 hospital beds available for use. On the day of the hurricane, the model estimates that 1,228 will be unavailable for use. After one week, all the beds are expected to be in service. Table 8-5, below, summarizes the expected damage to essential facilities in Baltimore County due to the proposed hurricane event.

Table 8-5. Expected Damage to Essential Facilities				
Classification	Total	Probability of at Least Moderate Damage > 50%	Probability of Complete Damage > 50%	Loss of Use (< 1 day)
EOCs	1	0	0	1
Fire Station	65	0	0	65
Hospital	25	8	0	13
Police Station	20	0	0	20
School	375	0	0	150

8.4.5 Induced Hurricane Wind Damage

Debris Generation

Map 8-3 represents hurricane wind speed by peak gust. Peak gust is the maximum sustained wind speed for a three second period. Baltimore County can expect the highest wind speeds near its coastal region, with speeds near 100 miles per hour. The map clearly depicts that wind speeds are expected to drop as one moves westward across the county. The most western portion of the county can expect wind speeds between 85 and 88 miles per hour, which are still significant and dangerous. The wind speeds depicted on Map 8-3 are not a result of the linear path of the hurricane, which is shown on Map 8-1 to be outside of Baltimore County, but rather due to the clockwise rotation of hurricane winds. The most damaging winds from a hurricane typically occur within its northeast quadrant. The 1000-year storm track chosen for this analysis places the northeast quadrant directly over the County, which explains the peak gust patterns depicted on Map 8-3.

Hazus estimates the number of debris that will be generated by the hurricane. The model breaks the debris into four general categories: a) Brick/Wood, b) Reinforced Concrete/Steel, c) Eligible Tree Debris, and d) Other Tree Debris. This distinction is made because of the different types of material handling equipment required to handle the debris.

The model estimates that a total of 314,170 tons of debris will be generated. Of the total amount, 153,219 tons (49%) is Other Tree Debris. Of the remaining 160,951 tons, Brick/Wood comprises 49% of the total, Reinforced Concrete/Steel comprises of 0% of the total, with the remainder being Eligible Tree Debris.

If the building debris tonnage is converted to an estimated number of truckloads, it will require 3,139 truckloads (@25 tons/truck) to remove the building debris generated by the hurricane. The number of Eligible Tree Debris truckloads will depend on how the 82,487 tons of Eligible Tree Debris are collected and processed. The volume of tree debris generally ranges from about 4 cubic yards per ton for chipped or compacted tree debris to about 10 cubic yards per ton for bulkier, un-compacted debris.

Map 8-4 depicts the total tonnage of tree debris expected to be generated by location. Areas expected to have the most tree debris include Middle River, areas surrounding Loch Raven Reservoir, and areas around Liberty Reservoir.

8.4.6 Economic Loss

The total economic loss estimated for the hurricane is 543.6 million dollars ($618.1 million as of 2021), which represents 0.92 % of the total replacement value of the region’s buildings.

<u>Building-Related Losses</u>

Building related losses are broken into two categories: direct property damage losses and business interruption losses. The direct property damage losses are the estimated costs to repair or replace the damage caused to the building and its contents.

The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the hurricane. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the hurricane.

The total property damage losses were 544 million dollars ($618.5 million as of 2021). Two percent of the estimated losses were related to the business interruption of the region. By far, the largest loss was sustained by the residential occupancies which made up over 90% of the total loss. Table 8-6, below, provides a summary of the losses associated with building property damage, and Table 8-7 provides a summary of business interruption loss estimates.

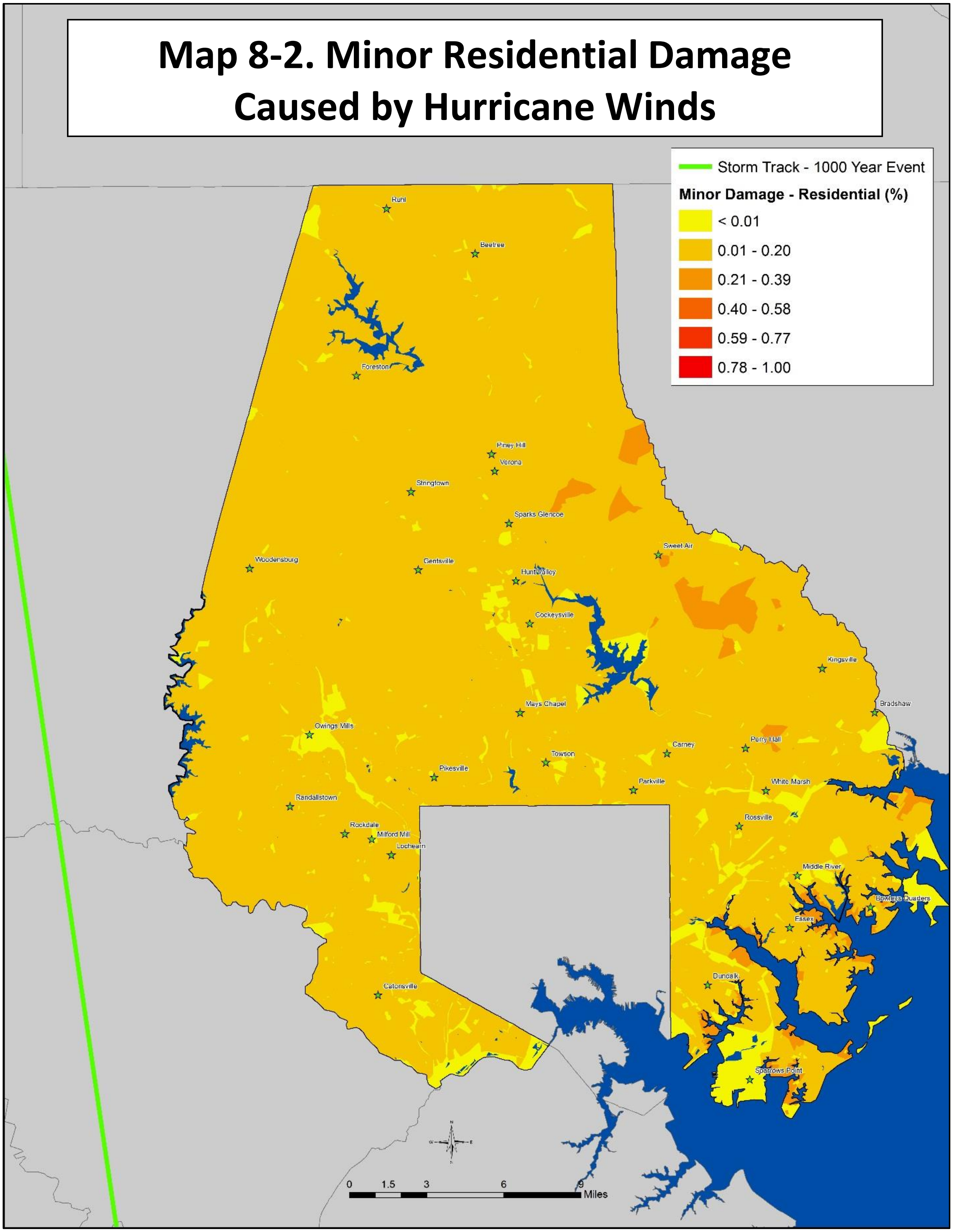
Table 8-6. Building-Related Property Damage					
Type	**Residential**	**Commercial**	**Industrial**	**Others**	**Total**
Building	393,025	19,506	5,336	4,175	422,042
Content	65,474	3,910	2,933	930	73,246
Inventory	0.0	116	660	53	830
Total	**458,499**	**23,531**	**8,930**	**5,158**	**496,117**
Note: 2021 Dollars.					

Table 8-7. Business Interruption Loss Estimates					
Type	**Residential**	**Commercial**	**Industrial**	**Others**	**Total**
Income	$0	$3,484,986	$72,198	$500,802	$4,057,986
Relocation	$25,373,586	$4,006,416	$350,676	$717,396	$30,448,074
Rental	$12,293	$1,992,894	$59,592	$59,592	$14,415,534
Wage	$0	$2,836,350	$120,330	$2,596,836	$5,553,516
Total	$37,666,728	$12,319,500	$603,942	$3,875,772	$54,465,942
Note: 2021 Dollars.					

8.4.7 Social Vulnerability

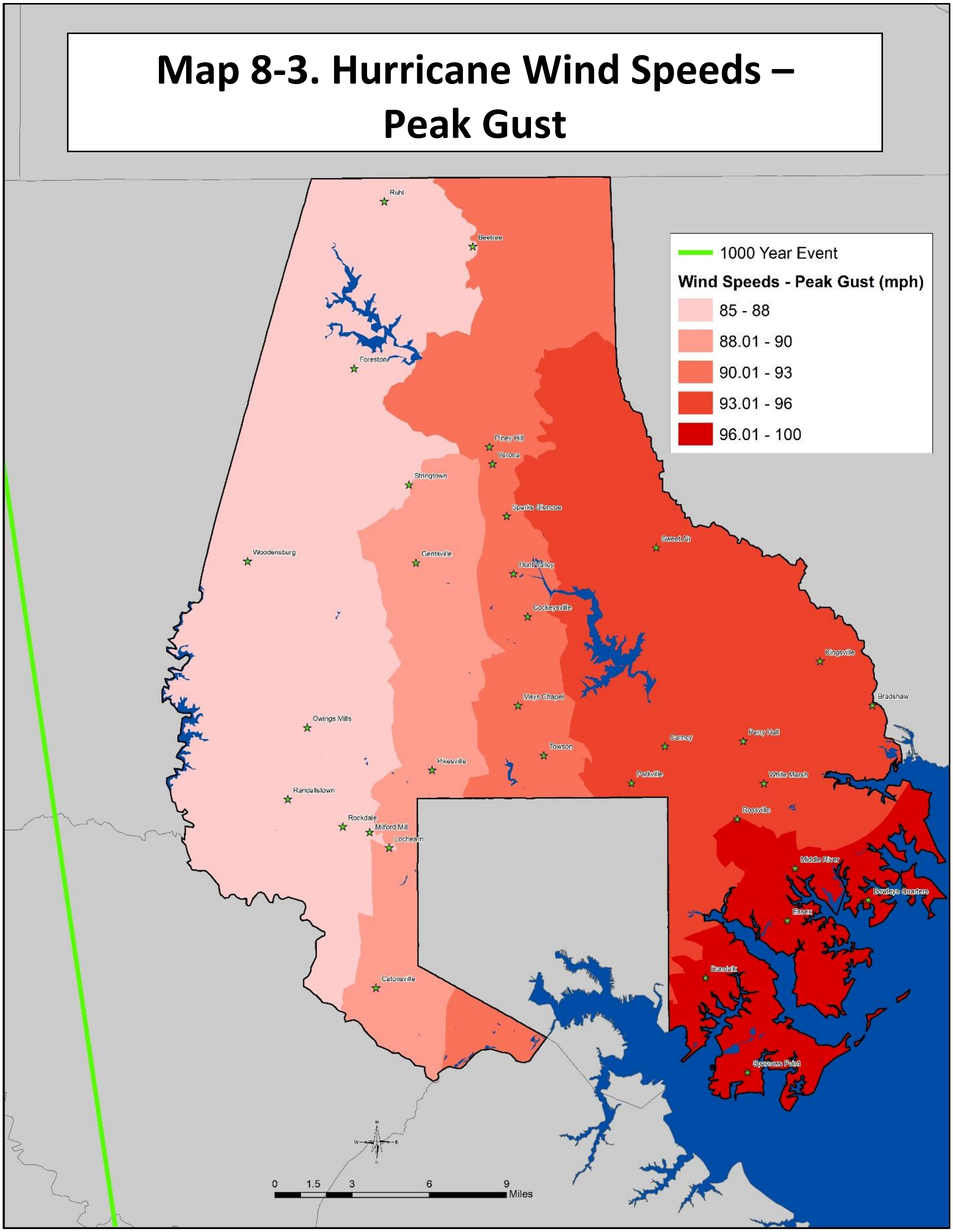
Shelter Requirements

Hazus estimates the number of households that are expected to be displaced from their homes due to the hurricane and the number of displaced people that will require accommodations in temporary public shelters. The model estimates 8 households to be displaced due to the hurricane. Of these, one (1) person (out of a total population of 827,370) will seek temporary shelter in public shelters.

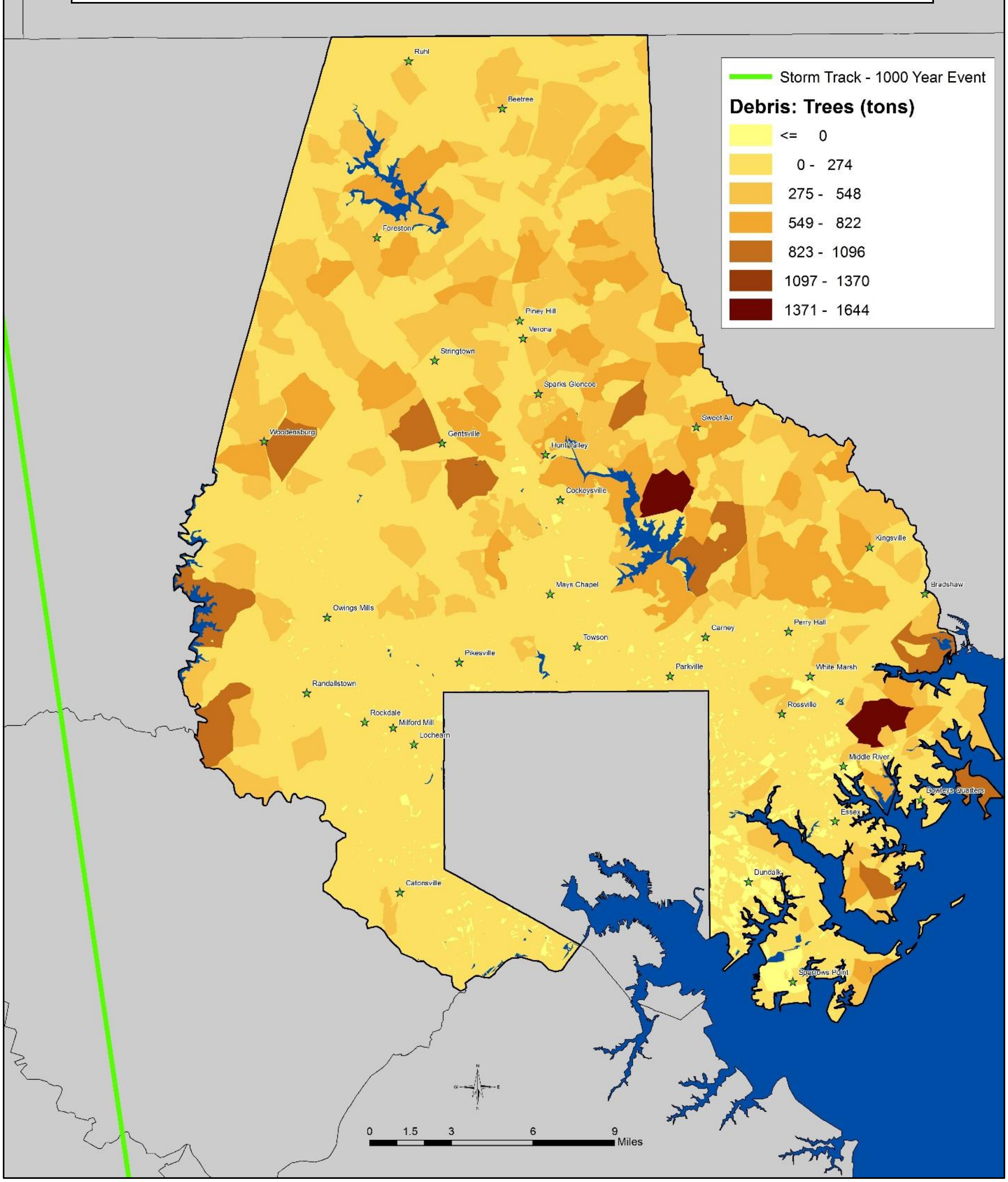


Map 8-2. Minor Residential Damage Caused by Hurricane Winds

Map 8-3. Hurricane Wind Speeds – Peak Gust



Map 8-4. Total Tons of Tree Debris



8.5 2021 MITIGATION GOALS AND ACTION ITEMS

GOAL 1: Promote hazard mitigation as the cornerstone of emergency management in Baltimore County.			
OBJECTIVE	ACTION ITEM(S)	RESPONSIBLE ENTITY	RANKING (HIGH, MEDIUM, OR LOW)
1. Educate the public about natural hazards risks, preparedness, and mitigation.	a. Promote educational material on social media website relating to the dangers of, and differences between, Derechos and Tornadoes.	Department of Health, Office of Homeland Security and Emergency Management, Office of Information Technology	High
2. Provide technical assistance for homeowners regarding high winds.	a. Provide information to builders and owners of manufactured and mobile homes regarding tie-downs with ground anchors.	County	Medium

8.6 EXISTING HIGH WIND MITIGATION ACTIVITIES

- As of 2012, minimum design wind speeds for buildings are 90 mph for Risk Categories I and II, and 101 mph for Risk Categories III and IV.
- The *2012 International Residential Code* for Maryland has significantly improved roof uplift provisions, relating to roof tie-down.
- The County's Emergency Notification System (ENS) is an opt-in system which can notify citizens and businesses of emergency or disaster management situations that may require time-sensitive actions. This system sends a recorded message and/or e-mail to homes and businesses within the County, which provides safety information and instructions. This system does not send weather watches or warnings at the present time.
- Utilization of social media (Facebook, Instagram, and Twitter) to disperse warnings and information prior to and during a severe weather event, such as a tornado.

[1] www.weather.gov/iwx/2013_straight-line_winds_vs_tornado

CHAPTER 9: WILDFIRE

UPDATES

During the 2021 Plan Update process, **Chapter 9: Wildfire** was updated with the most recently available data.

Updates to this chapter include:

1. Thematic and visual update
2. **Data updates** (including tables, text, and figures as needed) to the following sections:
    a. Table 9-1. updated to represent prescribed burns, 2010-2020.
    b. "Fire Department Facts" text box updated with latest available information.
    c. Table 9-3. updated with data from 2010-2020 as well as 10-year averages.
3. Results of the HIRA were added to *Section 9.2 Contributing Factors to Wildfire Risk*. Wildfire risk is ranked as "Medium." See Appendix A for full results.
4. **Updated Section 9.4** Vulnerability Assessment utilizing the latest land cover, digital elevation model, and parcel data.
    a. Map 9-1. *Wildfire Prone Areas* has been updated.
5. **New Section** *9.4.5 Social Vulnerability*
    a. **New Map 9-2** *Social and Wildfire Vulnerability*
6. Section 9.6 Added new mitigation action items and updated current mitigation activities.

9.1 HOW ARE WILDFIRES A THREAT TO BALTIMORE COUNTY?

Wildfires are a threat to Baltimore County for two primary reasons: first, the amount of development, particularly residential, that has taken place within wooded areas has increased the number of structures that are along the Wildland-Urban Interface (WUI) and within the Wildland-Urban Intermix. Second, wildfires can interact with other natural hazards, especially drought.

The WUI interface is defined by the National Fire Protection Association (NFPA) as "an area where development and wildland fuels meet at a well-defined boundary." Characteristics of the interface involve structures built adjacent to wildland vegetation. Another term, wildland-urban intermix, refers to "an area where development and wildland fuels meet with no clearly defined boundary." The wildland-urban intermix areas are where individual homes or pockets of structures are surrounded by wildland fuels. This situation is quite common in Northern Baltimore County, which increases the number of people that are living in or near forested areas.

As many as 90 percent of wildland fires in the United States are caused by humans. Some human-caused fires result from campfires left unattended, the burning of debris, negligently discarded cigarettes and intentional acts of arson. The remaining 10 percent are started by lightning or lava.[1] The number of wildfires can increase dramatically in the presence of other natural hazards, especially extreme heat and drought. Excessive heat and drying can facilitate the start of a fire, and then intensify its behavior depending upon local topography and the types of fuel available.

Prescribed burns make up a portion of the 90 percent of wildfires that are caused by humans. Prescribed burns are ignited to reduce hazardous fuel loads near developed areas, manage landscapes, restore natural woodlands, and for research purposes. These types of burns are carefully controlled, professionally administered, and only performed under acceptable conditions.[2] Table 9-1, below, details these burns in the county from 2010 to 2020.

Table 9-1. Prescribed Burns in Baltimore County, 2010-2020

Date	Fuel Type	Total Acres	# Of Burns
April, 2016	Grass/Shrub	5.0	1
November, 2016	Grass	20.0	2
November, 2015	Grass	14.0	1
November, 2015	Grass	10.0	1
April, 2014	Marsh	30.0	1
April, 2014	Marsh	30.0	1
May, 2014	Understory	14.0	1
April, 2013	Grass	3.0	1
May, 2013	Grass	5.0	1
November, 2013	Grass	15.0	2
March, 2012	Grass	15.0	1
May, 2012	Grass/Brush	14.0	3

Source: Maryland Department of Natural Resources, Maryland Forest Service, Wildland Fire Program Annual Fire Reports, 2010-2020

9.2 CONTRIBUTING FACTORS TO WILDFIRE RISK

As part of this plan update, a Hazard Identification and Risk Assessment (HIRA) was conducted for the wildfire hazard. A composite scoring method was utilized to rank natural hazards, which included five (5) key components: historical impacts (in terms of human lives and property), geographic extent, historical occurrences, future probability, and community perspective.

Based on this method, wildfire was assigned a ranking of "**Medium**" during this plan update. This is consistent with wildfire's ranking during the previous planning cycle. The future probability of a wildfire event is considered "highly likely", as determined by the HIRA. Full results of the HIRA, including method, are included within *Appendix A* of this plan.

9.2.1 Type of Fuel

The type and amount of fuel available will affect wildfire potential and behavior. Fuels are classified based on the type of vegetation in a given area, and consist of: ground fuels, surface fuels, and crown fuels. The moisture level within the fuel will also play a role in how it will burn. Large, more continuous areas where fuel is present will increase the potential for larger wildfires. Of the wildfires that have occurred in Baltimore County (Table 9-2), the majority (85%) occurred in woodland environments and utilized hardwood litter as a primary fuel source. The remaining 15% occurred in marshland and utilized tall grass as a primary fuel source. In all cases, these would be considered surface fuels.

Table 9-2. Description of Fuel Types

Fuel Type	Description	Example
Ground fuel	This vegetation is close to the ground or lying on the ground. Ground fuels include dead grass and leaves; needles, dead branches, twigs, and logs.	
Surface fuel	These plants and trees are closer to the ground but are not actually lying on the ground. They are usually made up of shrubs, grasses, low-hanging branches and anything not located in the high branches of the trees that may burn. They can also be referred to as "ladder fuels," because fire can move from ground fuels to surface fuels, then on to crown fuels.	

Table 9-2. Description of Fuel Types

Fuel Type	Description	Example
Crown/Aerial fuel	Crown fuels are only in the "crowns" or tops, of the trees. They do not touch the ground and are usually the high branches of trees. When a wildfire burns in the tops of the trees, firefighters call it a "crown fire."	

Source: www.fs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb5042664.html

9.2.2 Topography

Topography affects the movement of the fire over the ground. Steeper slopes and the general shape of the terrain affect the speed the fire will travel. The topography will also affect the ability for fire fighters and firefighting equipment to access wildfires. In Baltimore County, steeper slopes were identified as slopes 15% and greater. Utilizing ArcGIS and spatial analyst software, it was determined that steep slopes (≥15%) comprise 18.1% of the land in Baltimore County. This equates to roughly 79,045 acres of land.

9.2.3 Weather

Weather plays a role in the development of wildfires in the form of temperature, humidity, and wind. At any immediate moment, hot, dry, and windy conditions will directly affect the severity and duration of a fire. For example, Maryland can often have very dry airmasses follow cold front passages in the spring and fall months. The dry, windy conditions often lead to an elevated fire risk where sparks can cause outdoor fires more easily.

9.2.4 Development

Just as with flooding hazards (see *Chapter 4 Flood*), land development patterns over the past several decades have emphasized sprawling suburban communities and homes constructed with little or no attention paid to protection against natural hazards. Building is often permitted in high hazard areas because it satisfies an economic need or locational preference. This increases the potential for property damage due to wildfire as sprawl continues and development increases near the WUI and intermix.

Residential Sprinkler Systems

Under Maryland law, all new single-family homes and duplexes must be equipped with automatic sprinkler systems.

The regulation, approved in 2011, is part of the latest edition of the International Residential Code (IRC), adopted by the Baltimore County Council as part of the Building Code of Baltimore County. The code has required sprinklers in town homes and multi-family dwellings since the early 1990s.

Source: baltimorecountymd.gov

9.2.5 People

Most wildfires are caused by human interaction, whether it be from smoking, campfires, burning debris, or arson. Development, both high and low density, introduces higher levels of human interaction with the forest, increasing the opportunities for accidental and intentional fire.

Fire Department Facts

- FY 2020 operating budget: $110.7 million
- More than 1,000 paid emergency response personnel
- 25 career stations & 29 volunteer fire companies
- Facilities:
  - Fire Department headquarters: 700 East Joppa Road, Towson
  - Fire-Rescue Academy, 1545 Sparrows Point Boulevard, Sparrows Point
  - Logistics, Glen Arm
- An estimated 3,000 citizens volunteer with the 29 fire companies as active responders, fundraisers, and support personnel.

Source: baltimorecountymd.gov

9.3 HISTORY OF WILDFIRES

Baltimore County does not have an extensive history of high impact wildfires. Most fires to date have been caused by human actions and were quickly brought under control by local emergency response crews.

9.3.1 Time of Year

Maryland, as well as Baltimore County, is more vulnerable to wildfires during certain months of the year. As demonstrated on Table 9-3 below, March and April have the highest 10-year average for fire starts and are the months where wildfire risk is greatest because of the dry debris covering the ground, the increasing daytime temperatures, and lower relative humidity. Once the tree canopy is established in May, the risk is reduced because the canopy holds in the moisture that would otherwise evaporate during the spring months.

Table 9-3. Maryland Wildfire Starts, 2010-2020

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	Total	10-year AVG
Jan	5	4	5	4	3	3	1	2	8	1	3	**39**	3.5
Feb	0	53	11	3	10	7	4	29	1	9	15	**142**	12.9
Mar	15	12	29	18	29	28	35	30	6	12	19	**233**	21.2
Apr	21	5	39	36	29	45	32	13	44	17	17	**298**	27.1
May	12	2	3	7	8	21	0	3	12	2	4	**74**	6.7
Jun	15	11	12	6	8	0	5	5	1	1	5	**69**	6.3
Jul	30	19	28	2	5	4	3	3	2	5	4	**105**	9.5
Aug	8	10	8	1	2	5	2	1	1	8	0	**46**	4.2
Sep	42	1	4	13	4	22	1	1	0	30	1	**119**	10.8
Oct	11	0	3	4	5	6	3	5	0	33	4	**74**	6.7
Nov	5	5	14	25	12	14	31	9	1	15	3	**134**	12.2
Dec	6	3	3	3	3	3	4	6	1	5	1	**38**	3.5
Total	**170**	**125**	**159**	**122**	**118**	**158**	**121**	**107**	**77**	**138**	**76**	**1371**	**124.6**

Source: Maryland Department of Natural Resources, Maryland Forest Service Database, 2010-2020

Table 9-4. Baltimore Wildfire Starts, 2010-2020		
Year	**# of Fire Starts**	**Acres Burned**
2010	4	6.2
2011	4	61.3
2012	8	14.8
2013	6	3.6
2014	4	14.8
2015	1	3
2016	4	12.3
2017	6	29.2
2018	2	1.9
2019	1	11
2020	6	22.2
Total:	**46**	**180.3**

Source: Maryland Department of Natural Resources, Maryland Forest Service Database, 2010-2020

9.3.2 Cause

The only natural cause of wildfires is lightning, and this accounts for only 4% of the wildfire ignitions in Maryland. The remaining 96% of wildfires are caused by humans. Maryland's leading cause of wildfires is improper debris or outdoor burning that ignites an average of 28% of the fires each year. Arson, the second leading cause, accounts for around 23% of ignitions. Other causes include equipment use, children playing with fire, smoking, campfires, railroads, and other miscellaneous ignitions from sources such as downed power lines, discarded ashes, and fireworks.[3]

9.3.3 Drought

During the years with documented drought, 2001-2002, the number of wildfires drastically increased in Baltimore County, illustrating the influence one hazard can have on another. Refer to *Chapter 5: Drought* for information regarding this hazard.

9.4 VULNERABILITY ASSESSMENT

9.4.1 Introduction

This vulnerability assessment is directed at properties with the following characteristics: contain structures that are less than 30 feet[4] from continuous vegetation tracts greater than or equal to 20 acres and within areas delineated as being relatively steeper slopes (15% and greater). Generally, these areas follow stream and ridge lines and are more likely to be underdeveloped due to their steeper slopes.

9.4.2 Data Utilization

The following data sources and shapefiles were utilized to determine affected land uses, critical facilities, and infrastructure within the wildfire hazard area:

- Continuous forested tracts greater than 20 acres, derived from USGS National Land Cover Database (2016)
- Slopes greater than 15%, derived from Maryland LiDAR – 1 Meter DEM (2019)
- Structures/Parcels – Baltimore County Office of Information Technology (2014/2020)
- Street Centerlines – Baltimore County Office of Information Technology (June 2020)
- Metropolitan District Line – Baltimore County Office of Information Technology (2020)
- Essential Facilities (Fire Stations, Police Stations, Schools, Hospitals/Health Centers, EOCs) – Baltimore County Office of Information Technology (2020)
- Commercial Transmission Towers – Federal Communications Commission (2021)
- Underground Storage Tanks (2021) – Maryland Department of the Environment (MDE)

9.4.3 Method

Data listed in section 9.4.2 was analyzed using ArcMap 10.4.1, a geographic information system (GIS). This program allows various data layers, such as shapefiles, to be overlaid and spatially compared.

To determine vulnerable land uses, essential facilities, and infrastructure within the County, each shapefile (bridges, roadways, etc.) was intersected with the hazard area shapefile as previously described. Essential facilities, structures, and infrastructure were deemed to be vulnerable to wildfire if they were within (intersected) this hazard area.

The estimated structure values for buildings within the wildfire hazard area are derived from the Maryland State Department of Assessments and Taxation (SDAT) database for all affected parcels. Structure values are based on assessed value of property (improvement value), and do not include contents value or indirect costs related to wildfires (economic losses due to business closings).

9.4.4 Assessment Results

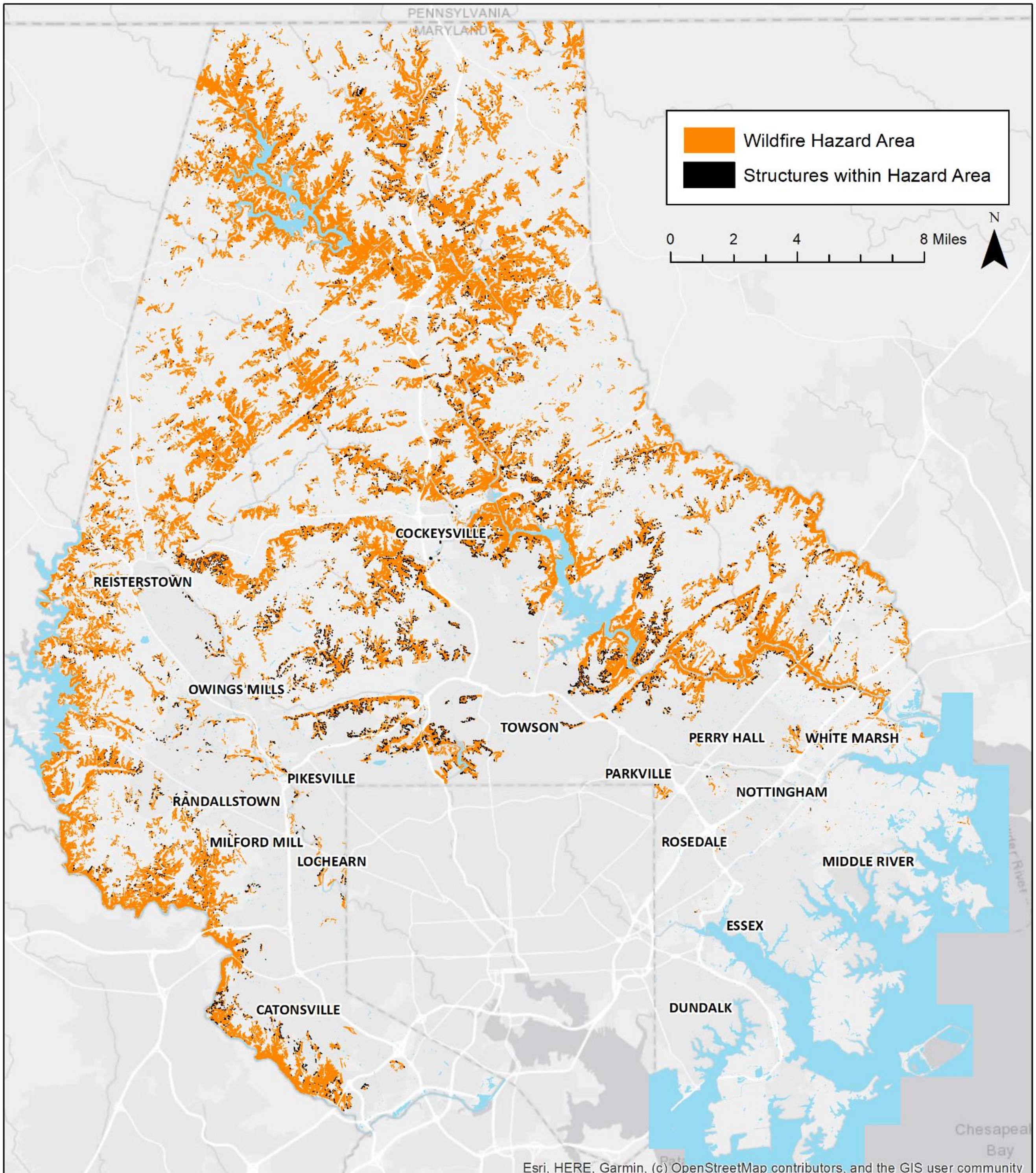
In total, 66,551.3 acres of land in Baltimore County are prone to wildfire. This means that these areas are on continuous tracts of vegetation greater than 20 acres in size, and that they are on land with a 15% or greater slope. Map 9-1, located on the next page, depicts these wildfire hazard areas as well as affected structures.

<u>Buildings/Structures</u>

Table 9-5, next page, lists the structures that are in these wildfire prone areas and their associated estimated damages.

Table 9-5. Structures Within Wildfire Hazard Area		
Structure Description	**Total Structures Affected**	**Value of Structures***
Residential	7,166	$2,255,152,200
Institutional	170	$109,520,900
Commercial	101	$104,901,400
Garage	780	$189,339,100
Storage Tank	8	$9,000,600
Silo	1	$360,300
Miscellaneous Structure	3,492	$568,307,600
Total	**11,718**	$3,236,582,100

*Note: These are approximate values. Values are derived from SDAT parcel data. Each parcel's "improvement value" was utilized for estimating structure values. It is possible that values are higher or lower depending upon how many structures exist on any given parcel.



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Map 9-1. Wildfire Prone Areas

Source: Baltimore County Office of Information Technology, USGS NLCD (2016)

Major Bridges

There are about 681 bridges within Baltimore County. Of these, only 6 major bridges are within the wildfire hazard area. Table 9-6, below, lists bridges within the hazard area, including their name/location and approximate length.

Table 9-6. Total Impacted Bridges by Location

Location	Approx. Length (feet)
Westchester Avenue @ Trolley Line #9	>20
Offutt Road near Chapman Road	>20
Hartley Mill Road @ Long Green Creek	>20
Hicks Road @ Little Falls	>20
Corbett Road near Falls Road	>20
Gore Mill Road @ Little Falls	>20

Roadways

In total, there are roughly 9,875 roadways (i.e., centerlines) within Baltimore County. Of these, 528 are within the wildfire hazard area. This translates to over 465 miles (7.4% of total road miles) of roadway within the hazard area. Tables 9-7 and 9-8, below, list the most impacted roads by total miles, and communities by number of affected roadways, respectively. For the most part, the greatest amount of impacted roadway miles includes driveways, "roads" (unnamed roads primarily consisting of alleys and local streets), I-83, and Falls Road.

Table 9-7. Most Impacted Roadways by Total Miles Within the Wildfire Hazard Area

Road Name	Total Miles
Driveway	73.14
Road	14.15
I-83	11.89
Falls Road	10.73
Gunpowder Road	5.89
Spooks Hill	4.81
Harford Road	4.45
Butler Road	4.32
York Road	4.28
Bottom Road	4.17
Hillside Road	3.21
Wards Chapel Road	3.20
Harris Mill Road	3.10
Cromwell Bridge Road	3.10
Hunter Mill Road	3.06
Loch Raven Drive	3.04
Paper Mill Road	3.00

Table 9-8. Communities by Number of Affected Roadways			
Community	**Affected Roadways**	**Community**	**Affected Roadways**
Owings Mills	57	Ellicott City	12
Reisterstown	47	Woodstock	12
Towson	43	Randallstown	11
Parkton	42	Perry Hall	10
Phoenix	42	Manchester	8
Sparks Glencoe	34	Upperco	8
Cockeysville	32	Baldwin	7
Lutherville Timonium	31	Gwynn Oak	7
Glen Arm	29	Hydes	7
Pikesville	22	Halethorpe	6
Catonsville	21	Hampstead	6
Monkton	20	Middle River	5
Freeland	18	Marriottsville	4
White Hall	18	Nottingham	4
Kingsville	17	White Marsh	3
Baltimore	16	Rosedale	2
Parkville	16	Upper Falls	1
Windsor Mill	14		

Commercial Transmission Towers

7 Towers

- KNRT (Glyndon)
- WNUT (Towson)
- WPLA (Halethorpe)
- WPWR (Cockeysville)
- WPWR (Glen Arm)
- WPXH (Baltimore)
- WPXV (Sparks Glencoe)

Essential Facilities

6 Private Schools

- Garrison Forest School (Elizabeth White Building)
- Maryvale Preparatory School (Lutherville/Timonium)
- Oldfields School (Sparks Glencoe)
- St. Timothy’s School (Lutherville/Timonium)
- The Jemicy School (Owings Mills)
- Woodstock Job Corps (Woodstock)

Hazardous Materials Storage

10 Active Underground Storage Tanks (locations)

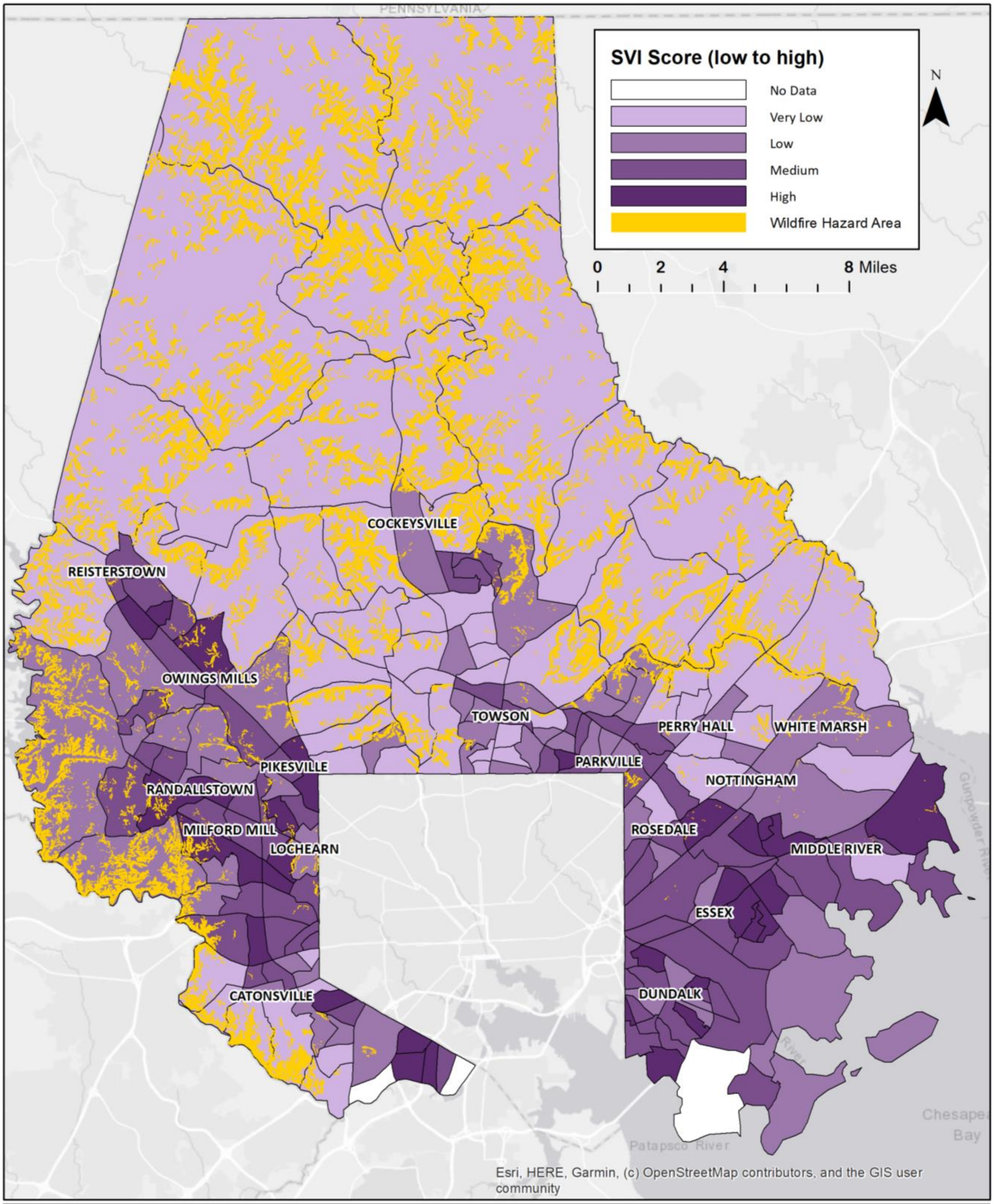
- 1 Arbutus
- 1 Cockeysville
- 1 Glen Arm
- 2 Owings Mills
- 1 Parkton
- 1 Pikesville
- 2 Reisterstown
- 1 Woodstock

Development Impacts

Wildfire events are largely unpredictable, which means all development within the hazard area has the potential to experience damage caused by a wildfire. In terms of future growth and development, Owings Mills is the designated Growth Area in the County. Parts of Owings Mills are within the wildfire hazard area and it is the most impacted community in terms of roadways within the hazard area, followed by Reisterstown and Towson.

9.4.5 Social Vulnerability

Most of the wildfire prone areas in Baltimore County are within rural areas which largely have lower social vulnerability scores (depicted on Map 9-2). Areas where high social vulnerability and wildfire risk intersect are mostly in the southwestern region of the county, including near the communities of Milford Mill, Randallstown, and Owings Mills.



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Map 9-2. Social and Wildfire Vulnerability

Source: CDC/ATSDR SVI 2018, ACS 5-year Estimates

9.5 2021 MITIGATION GOALS AND ACTION ITEMS

During the 2021 Plan Update, new mitigation goals and action were added. Additionally, previous mitigation goals and action items from the 2014 Plan were reviewed, and those that were determined to be still in progress or relevant were included.

GOAL 1: Promote hazard mitigation as the cornerstone of emergency management in Baltimore County.

OBJECTIVE	ACTION ITEM(S)	RESPONSIBLE ENTITY	RANKING (HIGH, MEDIUM, OR LOW)
1. Educate the public about natural hazards risks, preparedness, and mitigation	a. Develop and execute targeted fire prevention and safety efforts for elderly residents.	County, Fire Department	Medium
	b. Distribute information regarding fire-resistant landscape materials, targeted to residents within the WUI.	County, Fire Department, Residents within WUI	Medium

GOAL 2: Continue to support both career and volunteer fire departments via training, funding, and technological upgrades.

OBJECTIVE	ACTION ITEM(S)	RESPONSIBLE ENTITY	RANKING (HIGH, MEDIUM, OR LOW)
2. Strengthen Volunteer Fire Service.	a. Continue to support volunteer fire companies through financial contributions, training, and technical assistance. Work cooperatively with residents of established communities to locate or improve firefighting water sources.	County	Medium
	b. Assist volunteer fire companies with outreach and fundraising.	County	Medium

9.6 EXISTING WILDFIRE MITIGATION ACTIVITIES

- Life Safety Code: 2015 National Fire Protection Association (NFPA) 101, adopted and amended by Baltimore County Bill 3-17 (Effective date: March 19, 2017)
- Fire Prevention Code: 2015 Edition NFPA 1, adopted and amended by Baltimore County Bill 3-17 (Effective date: March 19, 2017)
- Other NFPA Codes and Standards: adopted and amended by Baltimore County Bills 3-17 (Effective date: March 19, 2017)
- Effective January 1, 2011, all single-family homes and duplexes must be equipped with automatic sprinkler systems.
- Baltimore County has installed numerous 30,000 gallon underground rural water supply tanks for rural fire fighting. These tanks are listed in Appendix D.
- Observance of and activities for the annual Fire Prevention Week including the Fire Expo focusing on fire safety awareness and education.
- Continual public education efforts focusing on fire safety and injury prevention

- The Baltimore County Volunteer Firemen's Association has established a regularly active Water Resource Committee dealing with rural water sources, and tanker strike teams for rural fire fighting. They have identified and established water sources and installed drafting connections.
- Baltimore County was evaluated by the Insurances Service Office (ISO) for Municipal Grading in their rural communities. As a result, Baltimore County went from an ISO Class 9 public protection classification in their rural areas to an ISO Class 6; subject to being within five road miles of a fire station.

[1] Insurance information Institute, Facts + Statistics: Wildfire, 2020 www.iii.org/
[2] Wildland Fire: What is a Prescribed fire? (U.S. National PARK SERVICE). (n.d.). Retrieved March 06, 2021, from www.nps.gov/articles/what-is-a-prescribed-fire.htm
[3] dnr.maryland.gov/forests/pages/wfm.aspx
[4] National Wildfire Coordinating Group, www.firewise.org

CHAPTER 10: EARTHQUAKE

UPDATES

During the 2021 Plan Update process, **Chapter 10: Earthquake** was updated with the most recently available data.

Updates to this chapter include:

1. Thematic and visual update
2. **Data updates** (including tables, text, and figures as needed) to the following sections:
   a. Results of the HIRA were added to *Section 10.2 Contributing Factors to Earthquake Risk*. Earthquake risk is ranked as "Medium-Low." See Appendix A for full results.
   b. *10.3 History of Earthquakes*, table 10-2 updated.
   c. Table 10-7 updated with estimated data.
3. *Section 10.4* Vulnerability assessment results adjusted with latest available data from U.S. Census.
   a. Results from the previous HAZUS earthquake analysis were updated to reflect values more representative of demographic estimates in 2020.
4. *Section 10.5 and 10.6,* added new mitigation action items and updated current mitigation activities.

10.1 HOW ARE EARTHQUAKES A THREAT TO BALTIMORE COUNTY?

The USGS estimates that several million earthquakes occur in the world each year. Many are not felt by humans or are not detected because of their small magnitude. Baltimore County is not in a geographic location that is prone to powerful or severe earthquakes, however earthquakes do affect the County. Ten earthquakes with epicenters in Baltimore County have been recorded starting in 1906. These were considered minor earthquakes and caused minimal property damage. Buildings and infrastructure most vulnerable to earthquake damage in Baltimore County are older structures built prior to the adoption of modern building codes. Additionally, older structures may suffer from seismic activity resulting in cracking and crumbling of aged building material. Falling debris from these structures could result in both property damage and life safety of residents and/or pedestrians.

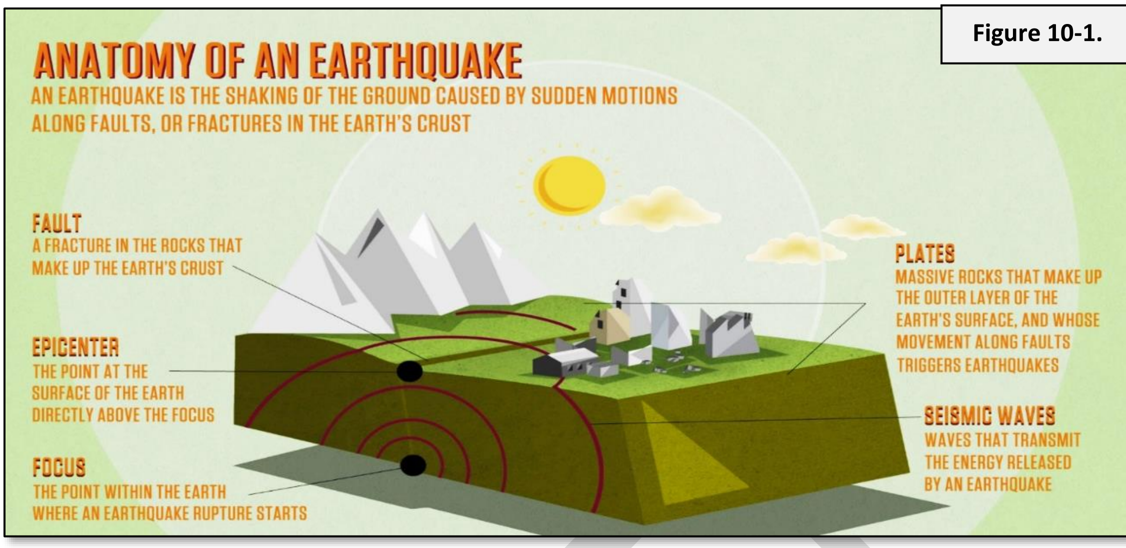
10.2 CONTRIBUTING FACTORS TO EARTHQUAKE RISK

As part of this plan update, a Hazard Identification and Risk Assessment (HIRA) was conducted for the earthquake hazard. A composite scoring method was utilized to rank natural hazards, which included five (5) key components: historical impacts (in terms of human lives and property), geographic extent, historical occurrences, future probability, and community perspective.

Based on this method, earthquake was assigned a ranking of "**Medium-Low**" during this plan update. This is consistent with earthquake's ranking during the previous planning cycle. The future probability of an earthquake event is considered "unlikely", as determined by the HIRA. Full results of the HIRA, including method, are included within *Appendix A* of this plan.

Earthquakes are caused by the release of stress and tension on the Earth's tectonic plates. This release is usually in the form of a crack or a break in the rock plates underground. The magnitude of the released energy and the proximity to the surface determines how strong the earthquake is felt on the surface and how much damage is incurred. The area directly over the stress release is called the epicenter, which receives the most direct damage and dissipates the further away from this location. The released energy travels in the form of waves which result in ground motion at the Earth's surface. These processes are depicted on Figure 10-1. There are several different ways of measuring an earthquakes destructive force: a Richter Magnitude, a Modified Mercalli Intensity (MMI), and Peak Ground Acceleration (PGA). Each of these measuring techniques is further described in the sections to come.

Figure 10-1.



Source: science.kqed.org

10.2.1 Richter Magnitude

The Richter Scale is used to measure the magnitude of earthquakes and is not used to express damage incurred by an earthquake. The Richter Scale is the result of a mathematical formula that determines magnitude through the logarithm of the amplitude of waves, recorded by seismographs. Seismographs record the seismic waves (or vibrations) that pass through the Earth from an earthquake. On the Richter Scale, magnitude is expressed in whole numbers and decimal fractions. For example, a magnitude of 5.3 might be computed for a moderate earthquake, and a strong earthquake might be rated as magnitude 6.3.[1]

10.2.2 Modified Mercalli Intensity Scale

The Modified Mercalli Intensity Scale describes the severity of earthquake effects. It is a ranking based on observed effects that people will experience and find relatable. The lower numbers of the intensity scale generally deal with the way the earthquake is felt by people. 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.[2] Table 10-1, below, describes the Modified Mercalli Intensity Scale values.

Table 10-1. Mercalli Intensity Scale Value Descriptions

Intensity	Richter Magnitude	Shaking	Description/Damage	Average Estimated Annual Frequency
I	<2.0 – 2.9	Not Felt	Not felt except by a very few under especially favorable conditions.	Continual/several million per year
II		Weak	Felt only by a few persons at rest, especially on upper floors of buildings.	Over one million per year
III	3.0 – 3.9	Weak	Felt quite noticeably by persons indoors, especially on upper floors of buildings. Many	Over 100,000 per year

Table 10-1. Mercalli Intensity Scale Value Descriptions

Intensity	Richter Magnitude	Shaking	Description/Damage	Average Estimated Annual Frequency
			people do not recognize it as an earthquake. Standing motor cars may rock slightly. Vibrations similar to the passing of a truck.	
IV		Light	Felt indoors by many, outdoors by a few during the day. At night, some will be awakened. Dishes, windows, and doors disturbed; walls may make cracking sound. Sensation like a heavy truck striking a building. Standing motor cars rocked noticeably.	
V	4.0 – 4.9	Moderate	Felt by nearly everyone; many awakened. Some dishes/windows broken. Unstable objects overturned. Pedulum clocks may stop.	10,000 to 15,000 per year
VI		Strong	Felt by all, many frightened. Some heavy furniture moved; a few instances of fallen plaster. Damage is slight.	
VII	5.0 – 6.9	Very Strong	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.	1,000 to 1,500 per year
VIII		Severe	Damage slight in specially designed structures; considerable damage in ordinary substantial buildsings with partial collapse. Damage great in poorly built structures. Fall of chimneys, factory stacks, columns, monuments, walls. Heavy furniture overturned.	
IX		Violent	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.	100 to 150 per year
X	7.0 – 9.0 and greater	Extreme	Some well-built wooden structures destroyed; most masonry and frame structures destroyed with foundations. Rails bent.	One per year

Source: U.S. Geological Survey (USGS)

10.2.3 Peak Ground Acceleration

Baltimore County is in 'Peak Ground Acceleration Zone 3' as identified by the United States Geological Survey. This means that in a 50-year period there is a 10% chance that Baltimore County will experience an earthquake with a PGA of .03.

Source: USGS, 2008

Peak Ground Acceleration (PGA) is a method that measures the horizontal ground velocity compared to normal gravity. The back-and-forth movement of the ground during an earthquake does the most damage to structures, but it is the acceleration stoppage and reversal of this movement that determines how much damage is actually incurred. Depending on the PGA zone, building codes require the structure to account for this PGA force to withstand. PGA is expressed as a decimal and represents the areas strongest earthquake most likely to occur within the next 50 years. If you live in a PGA zone 4, that areas PGA rating is 0.04 which means within the next 50 years there is a 1 in 10 chance of an earthquake with 4/10ths the PGA of gravity. Conversely, if you live in zone 1, with a PGA rating of 0.01, you have a 1 in 10 chance of an earthquake with 1/10th the acceleration of gravity. This force must be considered when designing the structural integrity of a building. The 2012 International Building Code, which have been adopted by the County, takes this force into consideration by including seismic building zone maps.

10.3 HISTORY OF EARTHQUAKES

While the impacts to person and property have been minimal, Baltimore County does have a noteworthy history of earthquakes. In the last hundred years, the County has experienced ten earthquake events with the epicenter located in the County. This history, as recorded by the Maryland Geological Survey, is presented in Table 10-2, below.

Table 10-2. Recorded Earthquakes with Epicenters in Baltimore County

Date	Location	Modified Mercalli Intensity	Richter Scale Reading
10/13/1906	Catonsville, MD	III	2.7
4/24/1910	Catonsville, MD	III	2.7
6/22/1939	Phoenix, MD	III	2.7
11/18/1939	Phoenix, MD	IV	3.1
11/26/1939	Phoenix, MD	V	3.5 - 3.7
1/13/1990	Randallstown, MD	III-V	2.5 – 2.6
4/4/1990	Randallstown, MD	III	1.7
9/28/1991	Randallstown, MD	II	2.4
2/23/2005	Dundalk, MD	II-III	2.0-2.1
9/29/2009	Catonsville, MD	I	1.6
7/16/2010	Germantown, MD	III	3.6
*6/25/2021	Woodlawn, MD	III	2.6

*Epicenter occurred in adjacent Baltimore City.

Source: www.mgs.md.gov/geology/geohazards/earthquakes_and_maryland.html

10.4 HAZUS LEVEL 2 EARTHQUAKE ANALYSIS

A HAZUS Level 2 Analysis was conducted for *Chapter 10 Earthquake* in 2014. As part of the 2021 Plan Update this analysis was modified to reflect current estimates provided by the American Community Survey (5-year). Full results from the 2020 U.S. Census are not yet available and are slated for release in late summer of 2021.

Results of this type of analysis include essential facility and general building stock damages, debris generation, shelter requirements, and associated economic losses. This level of analysis is more accurate than a Level 1 Analysis because the data used for the analysis is derived from user-supplied sources, including best-available data specific to Baltimore County, as well as data available in the Hazus database. Examples of user-supplied data utilized for this analysis include:

- Building stories
- Year built
- Structure value
- Square Footage

U.S. Census Bureau Data Utilization

The HAZUS analysis conducted during the 2014 Plan Update utilized the most recent version of the software (version 2.1), which was released in October of 2013. At the time of this HAZUS Level 2 Analysis for Earthquake, FEMA had not yet integrated 2010 Census data into the Hazus version 2.1 software. This data will be made available with the next release. As such, household numbers and other demographic data has been increased by 5.6% to better represent the total number of households (316,716) in Baltimore County per the 2010 U.S. Census. This percentage increase was derived by determining the percent change in demographic data from 2000 to 2010. For example, the total number of households in Baltimore County has changed from 299,000 in 2000 to 316,715 in 2010, which represents an increase of 17,715 households. This change was calculated as a percentage (5.6%) and related household values were increased by this amount where necessary (see Table 10-7). In the case of population estimates, a 6.3% change was calculated and added to necessary population values.

Results from the 2014 HAZUS analysis within this section have been modified with estimated values for the 2021 Plan Update. This is because 2020 Census data is not currently available. Certain demographic data, such as household size and total population, is provided by ACS 5-year data estimates.

Population results have been increased by 2.775% to better represent the estimated number of people (827,370) in Baltimore County per the 2019 ACS 5-year estimates. This percentage increase was derived by determining the percent change in population data from 2013 to 2020. For example, the total population in Baltimore County has changed from 805,029 in 2010 to 827,370 in 2020, which represents an increase of 22,341 people. This change was calculated as a percentage (2.775%) and related population values were increased by this amount where necessary (see Table 10-6). In the case of household size estimates, a -1.009% change was calculated and added to necessary household size values.

10.4.1 Introduction

The earthquake-related hazards considered by the methodology in evaluating casualties, damage, and resultant losses are collectively referred to as potential earth science hazards (PESH). Most damage and loss caused by an earthquake is directly or indirectly the result of ground shaking. Thus, it evaluates the geographic distribution of ground shaking resulting from the specified scenario earthquake and expresses ground shaking using several quantitative parameters, ex. peak ground acceleration and spectral acceleration.

Uncertainties are inherent in any loss estimation methodology, which arise from several factors, some of which include:

- Incomplete scientific knowledge concerning earthquakes and their effects upon buildings and facilities;
- The approximations and simplifications that are necessary for comprehensive analyses;
- Incomplete or inaccurate inventories of the built environment, demographics, and economic parameters.

These factors can result in a range of uncertainty in loss estimates produced by the HAZUS Earthquake Model, possibly by, at best, a factor of two or more.

Note: The full report of the HAZUS Level 2 Analysis for Earthquake is included in Appendix E.

10.4.2 County Overview

Baltimore County is roughly 682 square miles (land and water) and has 313,519 households in the region which have a total population of 827,370 people (ACS 5-year estimate). There are an estimated 269,000 buildings in the county with a total building replacement value (excluding contents) of 77.549 billion dollars (2021 dollars). Approximately 93% of the buildings (and 76% of the building value) are associated with residential housing. The replacement value of the transportation and utility lifeline systems is estimated to be \$5.3 and \$6.4 billion (2021 dollars), respectively.

HAZUS Earthquake Parameters

Longitude of Epicenter:	-76.80
Latitude of Epicenter:	39.36
Earthquake Magnitude:	5.0
Depth (Km):	10.0
Attenuation Function:	Central & East US (CEUS 2008)

<u>Critical Facility Inventory</u>

Critical facilities were broken down into two groups: essential facilities and high potential loss facilities (HPL). Essential facilities include hospitals, medical clinics, schools, fire stations, police stations and emergency operations facilities. High potential loss facilities include dams, levees, military installations, nuclear power plants, and hazardous material sites.

For essential facilities, there are 25 hospitals in the region with a total bed capacity of 1,800 beds. There are 375 schools, 65 fire stations, 20 police stations and 1 emergency operation facilities.

With respect to high potential loss facilities, there are 11 dams identified within the region. Of these, 4 of the dams are classified as 'high hazard'. The inventory also includes 66 hazardous material sites.

Transportation and Utility Lifeline Inventory

The lifeline inventory is divided between transportation and utility lifeline systems. There are seven (7) transportation systems that include highways, railways, light rail, bus, ports, ferry, and airports. There are six (6) utility systems that include potable water, wastewater, natural gas, crude & refined oil, electric power, and communications.

The total value of the lifeline inventory is over $11.7 billion (2021 dollars). This inventory includes over 507 kilometers of highways, 449 bridges, and 11,839 kilometers of pipes.

Epicenter

As depicted on Map 10-1, the chosen epicenter and magnitude was based upon an historical earthquake which occurred near Randallstown on 9/28/91 and was of magnitude 2.4. For this analysis, the magnitude of the earthquake was doubled to five (5) to provide a worst-case scenario.

10.4.3 Damage Estimates

Building Damage

Hazus estimates that about 22,754 buildings will be at least moderately damaged. This is over 8% of the buildings in Baltimore County. There are an estimated 843 buildings that will be damaged beyond repair. Table 10-4, below, summarizes the expected damage by general occupancy for the buildings in the county.

Table 10-3. Expected Building Damage by Occupancy Type

Occupancy	None		Minor		Moderate		Extensive		Complete	
	Count	%	Count	%	Count	%	Count	%	Count	%
Agricultural	601	0.29	99	0.27	63	0.36	17	0.42	3	0.35
Commercial	9,866	4.69	1,782	4.91	1,374	7.75	417	9.97	75	8.92
Education	344	0.16	66	0.18	54	0.30	15	0.37	3	0.35
Governmen t	246	0.12	50	0.14	46	0.26	14	0.35	3	0.32
Industrial	2,769	1.31	419	1.15	348	1.96	106	2.53	19	2.22
Other Residential	19,106	9.07	3,344	9.21	1,805	10.18	439	10.50	76	8.97
Religion	830	0.39	162	0.45	108	0.61	32	0.77	6	0.73

Single Family	176,824	83.97	30,392	83.69	13,932	78.58	3,140	75.10	659	78.14
Total	210,586	100	36,314	100	17,731	100	4,180	100	843	100

Essential Facility Damage

Before the earthquake, the region had 1,800 hospital beds available for use. On the day of the earthquake, the model estimates that only 993 hospital beds (55%) will be available for use by patients already in the hospital and those injured by the earthquake. After one week, 74% of the beds will be back in service. By thirty days, 90% will be operational.

Table 10-4. Expected Damage to Essential Facilities

Classification	Total	Number of Facilities		
		At Least Moderate Damage > 60%	Complete Damage > 50%	With Functionality > 50% on Day 1
Hospitals	25	4	0	17
Schools	375	53	0	215
EOC	1	0	0	0
Police Stations	20	2	0	13
Fire Stations	65	3	0	48

Transportation and Utility Lifeline Damage

The following table provides information on expected damage to transportation systems. Hazus indicates that damage to transportation systems will be minimal, and nearly all the systems are expected to have greater than 50% functionality a day after the disaster.

Table 10-5. Expected Damage to Transportation Systems

System	Component	Number of Locations				
		Locations/ Segments	With at Least Moderate Damage	With Complete Damage	With Functionality > 50%	
					After Day 1	After Day 7
Highway	Segments	331	0	0	331	331

Table 10-5. Expected Damage to Transportation Systems

	Bridges	449	14	1	435	445
	Tunnels	0	0	0	0	0
Railway	Segments	160	0	0	160	160
	Bridges	2	0	0	2	2
	Tunnels	0	0	0	0	0
	Facilities	6	0	0	6	6
Light Rail	Segments	23	0	0	23	23
	Bridges	0	0	0	0	0
	Tunnels	0	0	0	0	0
	Facilities	17	3	0	17	17
Bus	Facilities	1	0	0	1	1
Ferry	Facilities	0	0	0	0	0
Port	Facilities	13	0	0	13	13
Airport	Facilities	1	0	0	1	1
	Runways	1	0	0	1	1

Note: Roadway segments, railroad tracks and light rail tracks are assumed to be damaged by ground failure only.

Table 10-7, below, represents the number of households expected to be without electric power and/or potable water service. Hazus indicates that potable water will be available to all households, while nearly 25% of all households will be without electric power at day one of the earthquake event. However, after seven days this figure is expected to drop dramatically and only 5% of households will be without electric power.

Table 10-6. Number of Households without Service

	At Day 1	At Day 3	At Day 7	At Day 30	At Day 90	Total # of Households
Potable Water	0	0	0	0	0	313,519
Electric Power	76,846	45,970	16,512	2,593	2,593	

10.4.4 Induced Earthquake Damages

How It Works…
The Monte Carlo simulation performs risk analysis by building models of possible results by substituting a range of values—a probability distribution—for any factor that has inherent uncertainty. It then calculates results repeatedly, each time using a different set of random values from the probability functions. Depending upon the number of uncertainties and the ranges specified for them, a Monte Carlo simulation could involve thousands or tens of thousands of recalculations before it is complete.

Source: www.palisade.com

Fire Following Earthquake

Fires often occur after an earthquake. Because of the number of fires and the potential lack of water to fight the fires, they can often burn out of control. Hazus uses a Monte Carlo simulation model to estimate the number of ignitions and the amount of burnt area. For this scenario, the model estimates that there will be one (1) ignition that will burn about 0.18 sq. mi (0.03% of the county's total area.) The model also estimates that the fires will displace about 298 people and burn about $29.5 million (2021 dollars) of building value.

Debris Generation

Hazus estimates the amount of debris that will be generated by the earthquake. The model breaks the debris into two general categories: a) Brick/Wood and b) Reinforced Concrete/Steel. This distinction is made because of the different types of material handling equipment required to handle the debris. The model estimates that a total of 0.81 million tons of debris will be generated. Of the total amount, Brick/Wood comprises 60% of the total, with the remainder being Reinforced Concrete/Steel. If the debris tonnage is converted to an estimated number of truckloads, it will require 32,400 truckloads (@25 tons/truck) to remove the debris generated by the earthquake.

Total tons of debris are depicted by census block on Map 10-2. Areas with the greatest debris generation tend to be closest to the epicenter. Based on the results, the Owings Mills area would have the greatest amount of debris generation.

10.4.5 Economic Losses

The total economic loss estimated for the earthquake is $2.95 billion (2021 dollars) which includes building and lifeline related losses based on the county's available inventory. The following sections provide more detailed information about these losses.

Building-Related Losses

The building losses are broken into two categories: direct building losses and business interruption losses. The direct building losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the earthquake. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the earthquake.

The total building-related losses were $2.72 billion (2021 dollars); 20% of the estimated losses were related to the business interruption of the region. By far, the largest loss was sustained by the residential occupancies which made up over 63% of the total loss.

10.4.6 Social Impacts

Shelter Requirement

Hazus estimates the number of households that are expected to be displaced from their homes due to the earthquake and the number of displaced people that will require accommodations in temporary public shelters. The model estimates 2,576 (2021 adjusted) households to be displaced due to the earthquake. Of these, 1,591 people (out of a total population of 827,370) will seek temporary shelter in public shelters.

These short-term shelter needs are depicted by census block on Map 10-3. Areas with the greatest short term shelter needs tend to be closest to the epicenter.

Casualties

Hazus estimates the number of people that will be injured and killed by the earthquake. The casualties are broken down into four (4) severity levels that describe the extent of the injuries. The levels are described as follows:

- Severity Level 1: Injuries will require medical attention, but hospitalization is not needed.
- Severity Level 2: Injuries will require hospitalization but are not considered life-threatening.
- Severity Level 3: Injuries will require hospitalization and can become life threatening if not promptly treated.
- Severity Level 4: Victims are killed by the earthquake.

The casualty estimates (Table 10-7) are provided for three (3) times of day: 2:00 AM, 2:00 PM and 5:00 PM. These times represent the periods of the day that different sectors of the community are at their peak occupancy loads. The 2:00 AM estimate considers that the residential occupancy load is at maximum, the 2:00 PM estimate considers that the educational, commercial, and industrial sector loads are at maximum and 5:00 PM represents peak commute time.

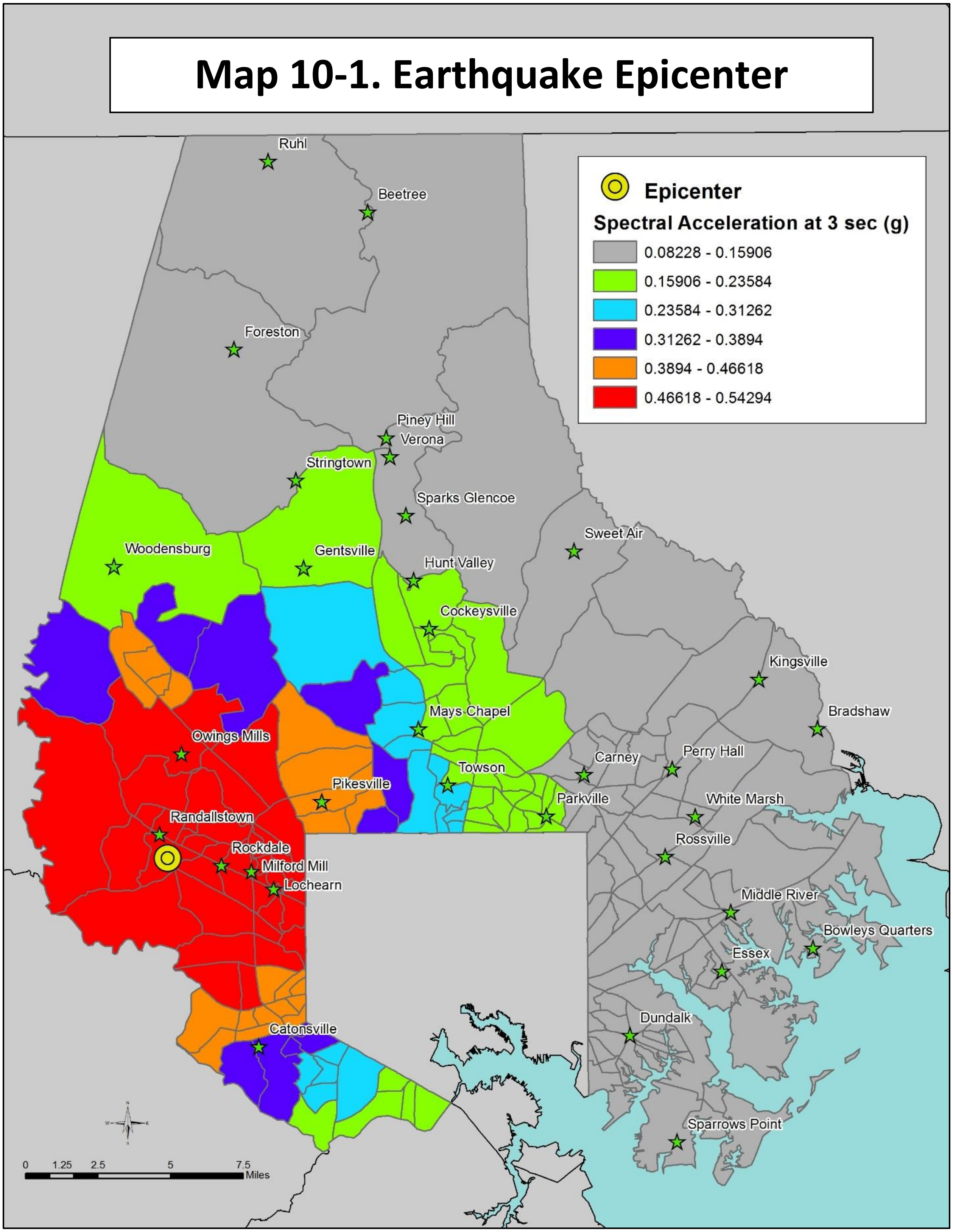
Table 10-7. Casualty Estimates

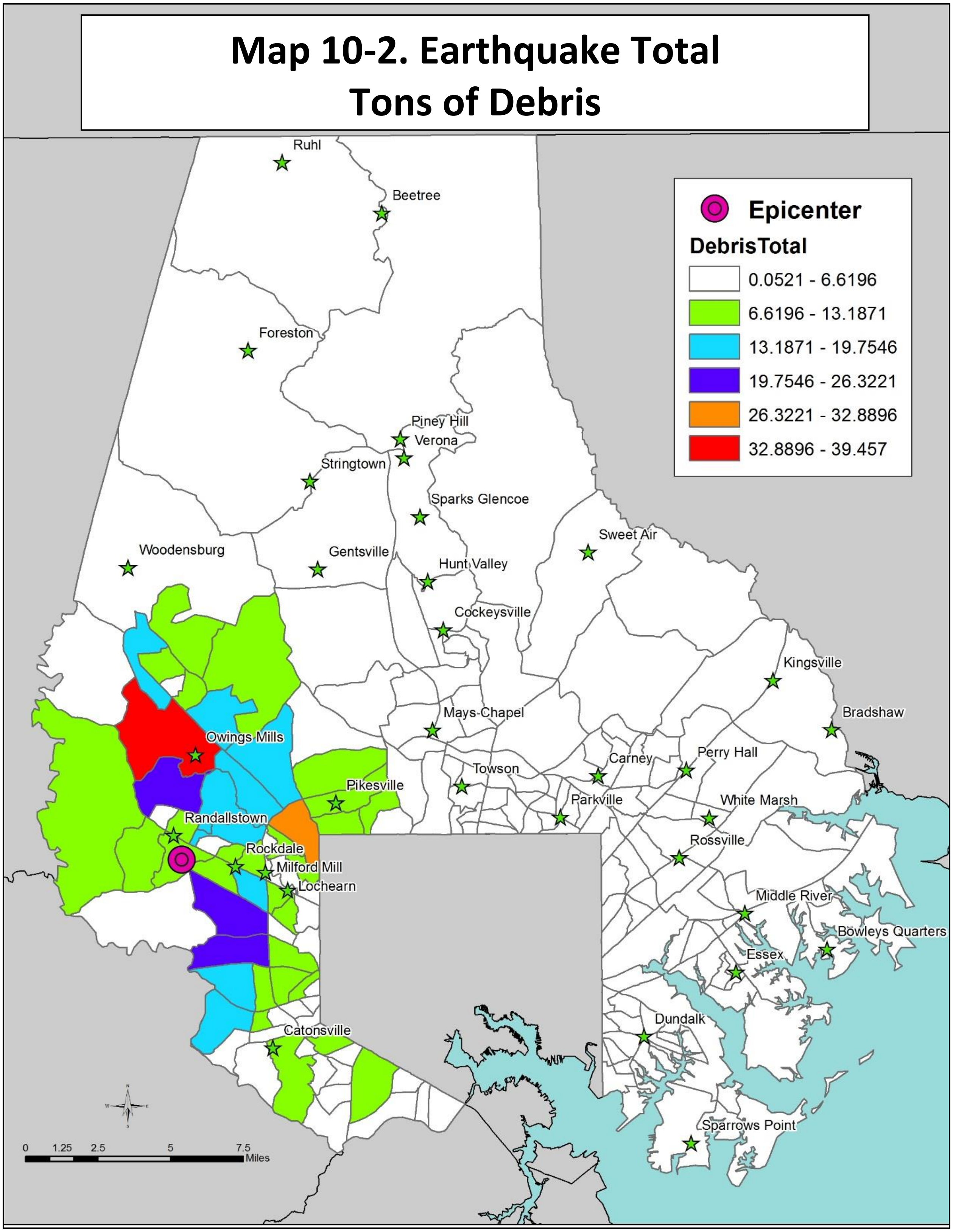
		Level 1	Level 2	Level 3	Level 4
2 AM	Commercial	6	1	0	0
	Commuting	0	0	0	0
	Educational	0	0	0	0
	Hotels	1	0	0	0

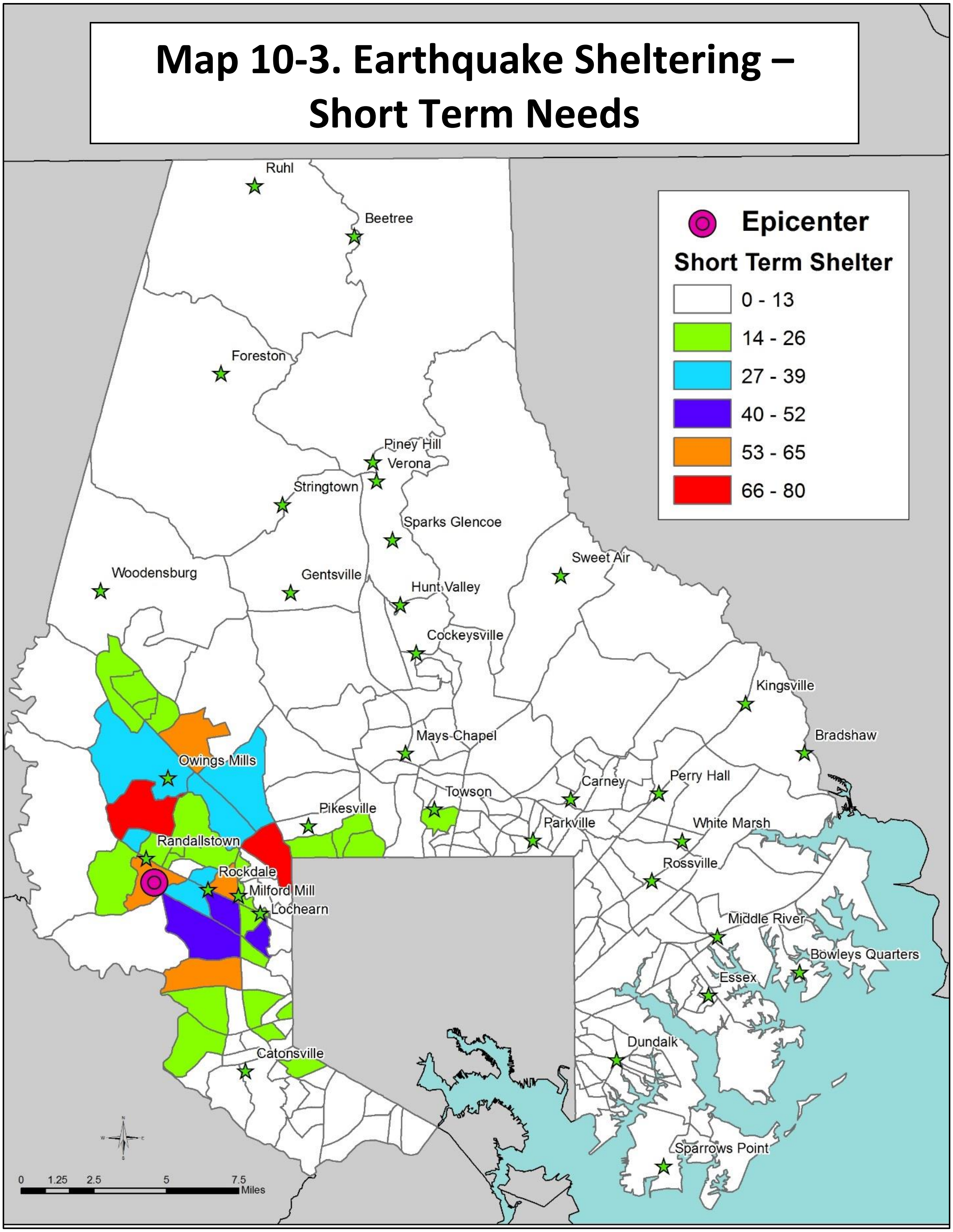
Table 10-7. Casualty Estimates

		Level 1	Level 2	Level 3	Level 4
	Industrial	5	1	0	0
	Other-Residential	152	30	4	7
	Single Family	524	103	12	24
	Total	**689**	**135**	**17**	**32**
2 PM	Commercial	352	70	8	16
	Commuting	1	1	2	0
	Educational	88	18	2	5
	Hotels	0	0	0	0
	Industrial	39	7	1	2
	Other-Residential	27	5	1	1
	Single Family	90	18	2	4
	Total	**596**	**120**	**17**	**28**
5 PM	Commercial	263	53	6	12
	Commuting	31	37	68	13
	Educational	14	3	0	1
	Hotels	0	0	0	0
	Industrial	24	5	1	1
	Other-Residential	60	12	2	3
	Single Family	209	42	5	10
	Total	**602**	**152**	**83**	**40**

Map 10-1. Earthquake Epicenter




Map 10-2. Earthquake Total
Tons of Debris
Epicenter
DebrisTotal
0.0521 - 6.6196
6.6196 - 13.1871
13.1871 - 19.7546
19.7546 - 26.3221
26.3221 - 32.8896
32.8896 - 39.457
Ruhl
Beetree
Foreston
Piney Hill
Verona
Stringtown
Sparks Glencoe
Woodensburg
Gentsville
Hunt Valley
Sweet Air
Cockeysville
Kingsville
Bradshaw
Mays Chapel
Owings Mills
Carney
Perry Hall
Towson
Pikesville
Parkville
White Marsh
Randallstown
Rossville
Rockdale
Milford Mill
Lochearn
Middle River
Bowleys Quarters
Essex
Dundalk
Catonsville
Sparrows Point
0 1.25 2.5 5 7.5
Miles


Map 10-3. Earthquake Sheltering – Short Term Needs
Epicenter
Short Term Shelter
0 - 13
14 - 26
27 - 39
40 - 52
53 - 65
66 - 80
Ruhl
Beetree
Foreston
Piney Hill
Verona
Stringtown
Sparks Glencoe
Sweet Air
Woodensburg
Gentsville
Hunt Valley
Cockeysville
Kingsville
Bradshaw
Mays Chapel
Owings Mills
Carney
Perry Hall
Towson
Pikesville
Parkville
White Marsh
Randallstown
Rossville
Rockdale
Milford Mill
Lochearn
Middle River
Bowleys Quarters
Essex
Dundalk
Catonsville
Sparrows Point
0 1.25 2.5 5 7.5 Miles

10.5 2021 MITIGATION GOALS AND ACTION ITEMS

During the 2021 Plan Update, new mitigation goals and action were added. Additionally, previous mitigation goals and action items from the 2014 Plan were reviewed, and those that were determined to be still in progress or relevant were included.

GOAL 1: Promote hazard mitigation as the cornerstone of emergency management in Baltimore County.

OBJECTIVE	ACTION ITEM(S)	RESPONSIBLE ENTITY	RANKING (HIGH, MEDIUM, OR LOW)
1. Educate the public about natural hazards risks, preparedness, and mitigation.	a. Provide information on the County's social media about earthquake risk and vulnerability.	County	Low
	b. Continue to participate in the annual "Great ShakeOut" event/drill by Maryland Emergency Management Agency (MEMA).	Office of Homeland Security and Emergency Management, BCPS	Low
2. Provide technical assistance for homeowners regarding earthquakes.	a. Develop a technical assistance information program for homeowners to teach them how to seismically strengthen their homes. The program could include providing local government building departments with copies of existing strengthening and repair information for distribution to homeowners. Other potential distribution sources include insurance companies, realtors, homeowner associations, and libraries.	County	Low

GOAL 2: Eliminate or reduce human, environmental, social, and economic loss from natural and technological hazards.

OBJECTIVE	ACTION ITEM(S)	RESPONSIBLE ENTITY	RANKING (HIGH, MEDIUM, OR LOW)
3. Enforce current building standards.	a. Strengthen Seismic Design from Category A to Category B.	County, Department of Permits, Approvals and Inspections	Medium
4. Take steps to "harden" infrastructure.	a. Identification and hardening of critical lifeline systems, i.e., critical public services such as utilities and roads, to meet "Seismic Design Guidelines and Standards for Lifelines," or equivalent standards, may distinguish a manageable earthquake from a social and economic catastrophe.	County, Department of Permits, Approvals and Inspections	Medium

10.6 EXISTING EARTHQUAKE MITIGATION ACTIVITIES

- Building Code: 2015 International Building Code, adopted and amended by Baltimore County, Bill 40-15 (Effective date: July 1, 2015)

[1] pubs.usgs.gov/gip/earthq4/severitygip.html#
[2] www.usgs.gov/natural-hazards/earthquake-hazards/science/modified-mercalli-intensity-scale

CHAPTER 11: SINKHOLE

UPDATES

During the 2021 Plan Update process, **Chapter 11: Sinkhole** was updated with the most recently available data.

Updates to this chapter include:

1. Thematic and visual update
2. **Data updates** (including tables, text, and figures as needed) to the following sections:
   a) *11.2.2 Human Factors*, updated text with new information.
   b) *11.3 History of Sinkholes*, updated with new data.
   c) *11.5 2021 Mitigation Goals and Action Items, action items were updated for 2021.*
   d) *11.6 Existing Sinkhole Mitigation Activities, updated to reflect present activities.*
3. Results of the HIRA were added to *Section 11.2 Contributing Factors to Sinkhole Risk*. Sinkhole risk is ranked as "Medium-Low." See Appendix A for full results.
4. **Updated Section 11.4** *Vulnerability Assessment* with the latest and best available data, including: centerlines, structures, parcels, bridges, towers, storage tanks, and essential facilities.
   a) Updated Tables 11-1, 11-2, 11-3, 11-4, and 11-5 with assessment results.
5. **Map 11-2 Sinkhole Hazard Area,** visual update (hazard area remained the same).
6. **11.4.5 Social Vulnerability** section added, discussing the intersection of the sinkhole hazard area and socially vulnerable populations. Includes new mapping, Map 11-3.

11.1 HOW ARE SINKHOLES A THREAT TO BALTIMORE COUNTY?

Sinkholes, like landslides, are a form of ground movement that occur with little warning and can cause major damage. Sinkholes are common in karst terrain, where the rock below the land surface is limestone, carbonate rock, salt beds, or rocks that can naturally be dissolved by ground water circulating through them. As the rock dissolves, spaces and caverns develop underground. Sinkholes are dramatic because the land usually stays intact for a while until the underground spaces become too big, then a collapse occurs. These collapses can be small and have little impact on people, or they can be huge and can occur where a house, road, or other structure is on top.[1]

Baltimore County is well known for its Cockeysville Marble geologic formation, a carbonate rock, characterized by its disrupted surface drainage due to loss of surface water to the subsurface. Areas that are underlain by this carbonate rock and others like it make Baltimore County susceptible to collapse sinkholes. These Cockeysville Marble formations are depicted in light blue on Map 11-1.

11.2 CONTRIBUTING FACTORS TO SINKHOLE RISK

As part of this plan update, a Hazard Identification and Risk Assessment (HIRA) was conducted for the sinkhole hazard. A composite scoring method was utilized to rank natural hazards, which included five (5) key components: historical impacts (in terms of human lives and property), geographic extent, historical occurrences, future probability, and community perspective.

Based on this method, sinkhole was assigned a ranking of "**Medium-Low**" during this plan update. This is consistent with sinkhole's ranking during the previous planning cycle. The future probability of a sinkhole event is considered "unlikely", as determined by the HIRA. Full results of the HIRA, including method, are included within *Appendix A* of this plan.

11.2.1 Groundwater Erosion

The formation of sinkholes involves the natural processes of erosion, or gradual removal of slightly soluble bedrock (limestone, carbonate rock, salt beds, etc.) by percolating water, the collapse of a cave roof, or a lowering of the water table. Sinkholes often form through the process of suffosion. For example, groundwater may dissolve the carbonate cement holding sandstone particles together and then carry away the soft particles, gradually forming a void.[2] Figure 11-1, on the following page, provides a visual aid for better understanding the formation of sinkholes.

11.2.2 Human Factors

New sinkholes have been correlated to land-use practices, especially from groundwater pumping and from construction and development practices. Sinkholes can also form when natural water-drainage patterns are changed, and new water-diversion systems are developed. Some sinkholes form when the land surface is changed, such as when industrial and runoff-storage ponds are created. The substantial weight of the new material can trigger an underground collapse of supporting material, thus causing a sinkhole.

The overburden sediments that cover buried cavities in the aquifer systems are delicately balanced by ground-water fluid pressure. The water below ground is helping to keep the surface soil in place. Groundwater pumping for urban water supply and for irrigation can produce new sinkholes in sinkhole-prone areas. If pumping results in a lowering of groundwater levels, then underground structural failure, and thus, sinkholes, can occur.[3]

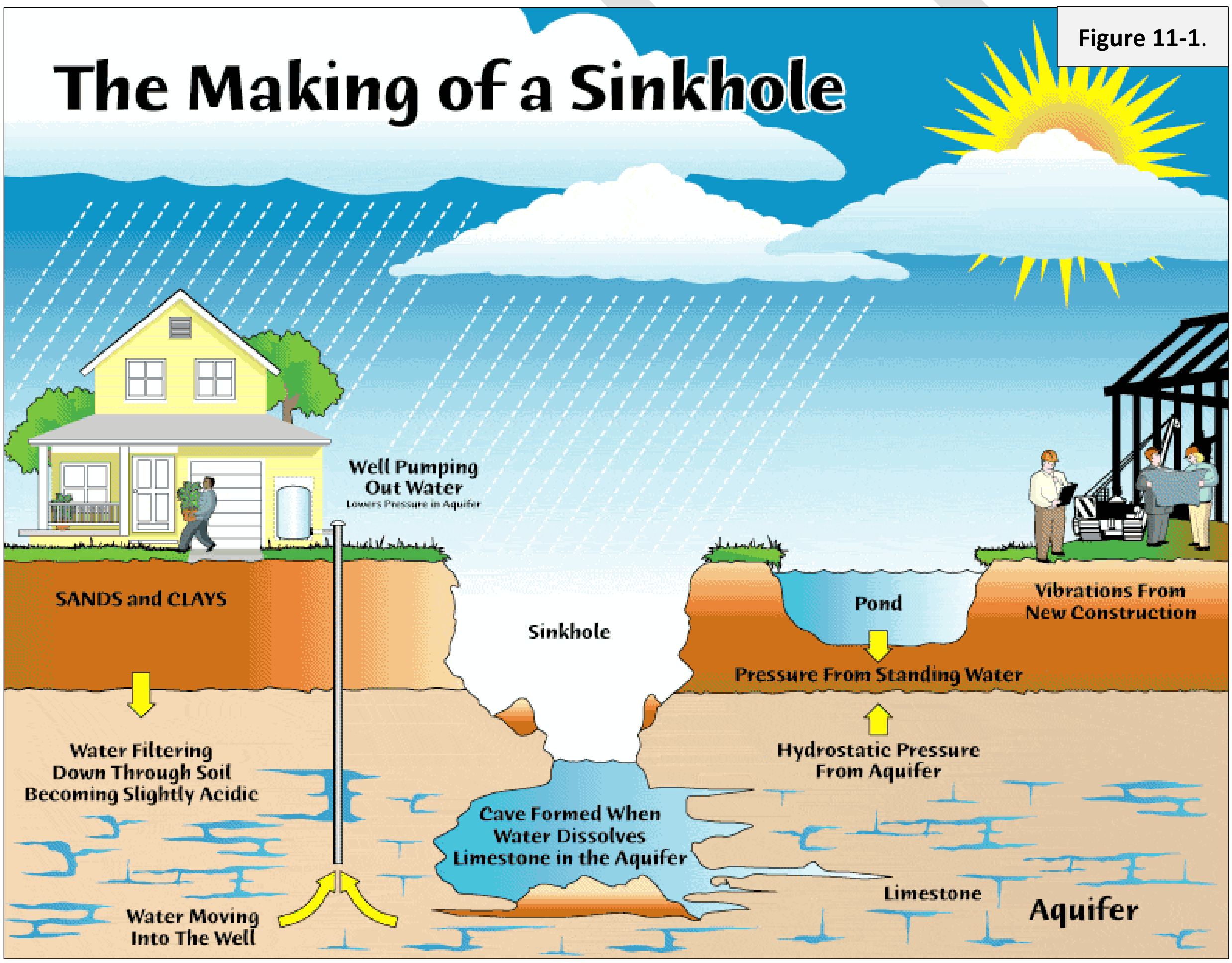
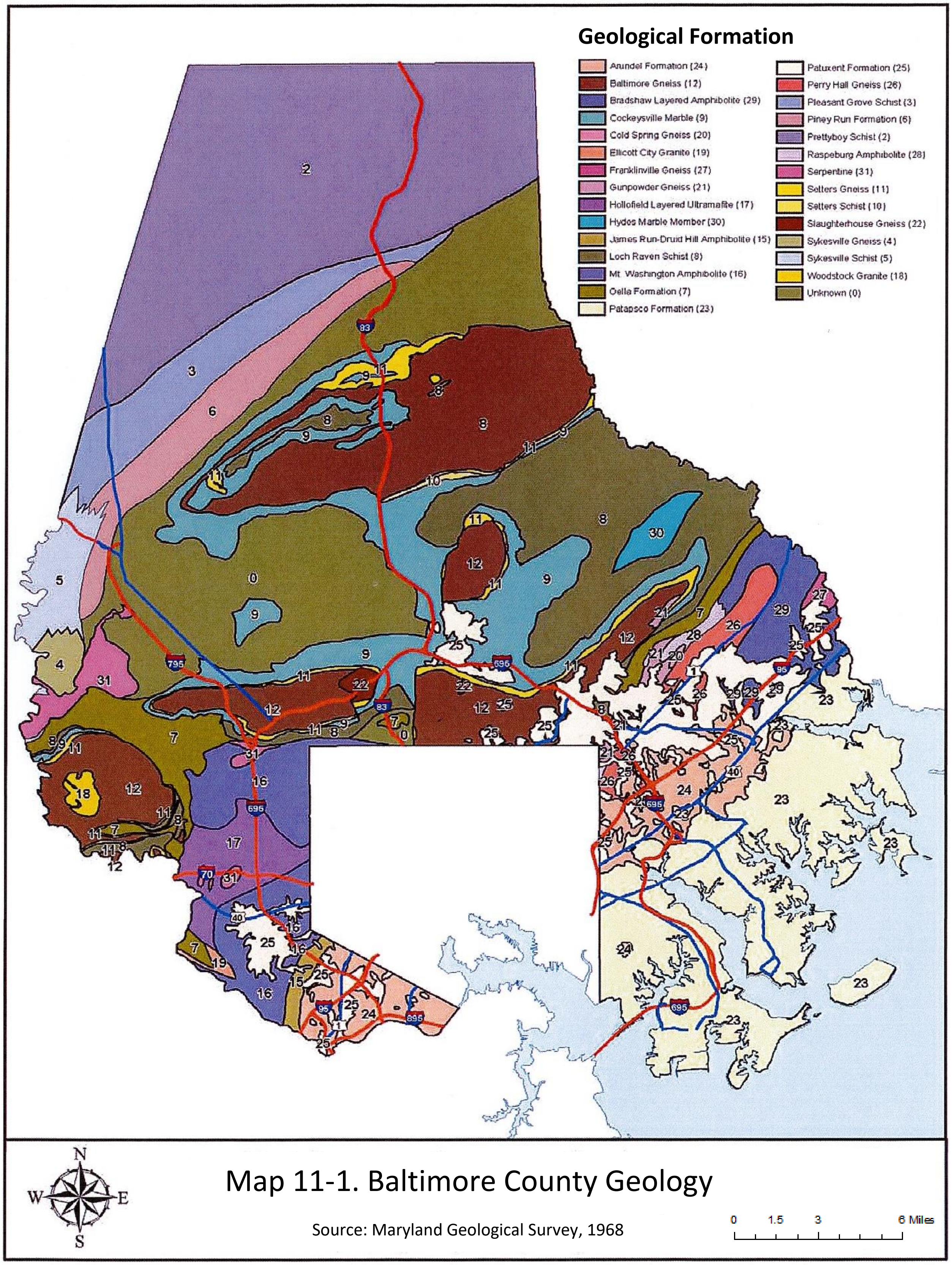


Figure 11-1.

Source: www.lakecountyfl.gov



Map 11-1. Baltimore County Geology

Source: Maryland Geological Survey, 1968

According to the Maryland Geological Survey (MGS), if a sinkhole is within a mile of a quarry operation, it may fall within the Zone of Influence (ZOI), established by the Maryland Department of the Environment. The zone of influence is typically a legal definition that refers to a specific area around a quarry operation in which the operation is responsible for any sinkholes that occur within a defined distance and depth. If it affects a Maryland state road, contact the State Highways Administration Engineers Office.[4]

11.3 HISTORY OF SINKHOLES

There is no authoritative source for sinkhole locations and causes in Baltimore County. The Maryland State Highway Administration (SHA) maintains some records of sinkhole locations on state-owned properties and right of ways within the County, but it is not an all-inclusive history of sinkhole occurrences. The 14 sinkhole locations identified by the SHA are consistent with locations of carbonate rock.

Baltimore County's Property Management Division (PM) keeps track of verified sinkholes in the county. There were 52 sinkholes verified between January 1, 2020 and January 12, 2021. The sinkholes are primarily associated with sewer/utilities in the roadways and are backfilled or repaired.

11.4 VULNERABILITY ASSESSMENT

11.4.1 Introduction

Areas in Baltimore County identified as moderate for land subsidence in the 2011 Maryland State Hazard Mitigation Plan Update were considered as hazard areas for this vulnerability assessment. These areas are entirely underlain by Cockeysville Marble, which makes them susceptible to collapse sinkholes, and are represented on map 11-2. Note: land subsidence and sinkholes were not assessed within the 2016 State Hazard Mitigation Plan.

11.4.2 Data Utilization

The following data sources and shapefiles were utilized to determine affected land uses, essential facilities, and infrastructure within the hazard area:

- Sinkhole Hazard Area – based upon Maryland Geological Survey data, Cockeysville Marble Formation (2019)
- Bridges – Baltimore County Office of Information Technology (2020)
- Street Centerlines – Baltimore County Office of Information Technology (June 2020)
- Sewer Lines – Baltimore County Department of Public Works (2014)
- Commercial Transmission Towers – Federal Communications Commission (2021)
- Structures/Parcels – Baltimore County Office of Information Technology (2014/2020)
- Above Ground Storage Tanks – Maryland Department of the Environment (2020)
- Underground Storage Tanks – Maryland Department of the Environment (2021)

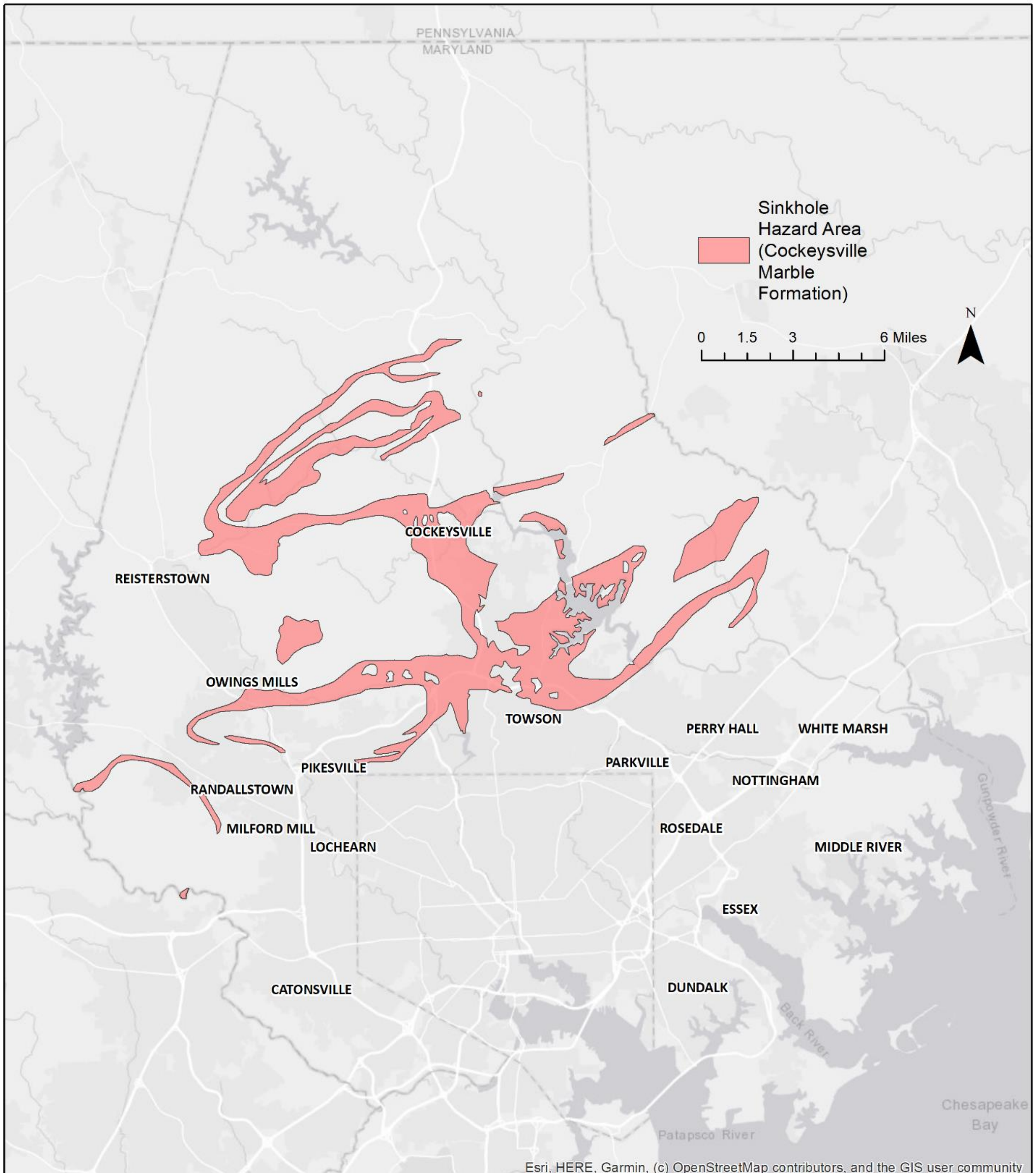
- Essential Facilities (Fire Stations, Police Stations, Schools, Hospitals/Health Centers, EOCs) – Baltimore County Office of Information Technology (2020)

11.4.3 Method

Data listed in section 11.4.2 was analyzed using ArcMap 10.4.1, a geographic information system (GIS). This program allows various data layers, such as shapefiles, to be overlaid and spatially compared. The hazard layer for this assessment was based upon areas determined to have moderate risk for land subsidence in the 2011 Maryland State Hazard Mitigation Plan Update. These areas coincide with instances of Cockeysville Marble formations.

To determine vulnerable land uses, essential facilities, and infrastructure within the County, each shapefile (bridges, roadways, etc.) was intersected with the hazard area shapefile as previously described. Essential facilities, structures, and infrastructure were deemed to be vulnerable to sinkholes if they were within (intersected) this hazard area.

The estimated values for structures within the sinkhole hazard area are derived from the Maryland State Department of Assessments and Taxation (SDAT) database for all affected parcels. Tax Exempt properties include but are not limited to Public, County, State, or Federal owned Hospitals, Schools, Museums, Airports, Police Stations, and/or Fire Departments. Also included are church properties and other non-profit or charitable organizations. Structure values are based on assessed value of property (improvement value), and do not include contents value or indirect costs related to sinkholes (e.g., economic losses due to business closings).



SP&D
Smith Planning and Design

Map 11-2. Sinkhole Hazard Area

Source: Mayland Geological Survey, Geological Formations

11.4.4 Assessment Results

Based on the 2021 assessment, the following structures, essential facilities, and infrastructure were determined to be within the sinkhole hazard area:

Extent of Sinkhole Hazard Area

54,644 Acres

Major Bridges

In total, there are about 681 bridges within Baltimore County. Of these, 98 major bridges are within the sinkhole hazard area. Table 11-1, below, lists total bridges within the hazard area and their location. Locations with the greatest number of impacted bridges include Glen Arm Road, Beaver Dam Road, and Marriottsville Road.

Table 11-1. Total Impacted Bridges by Location

Bridge Location (Road)	Total Bridges	Bridge Location (Road)	Total Bridges
Glen Arm Road	5	Greenside Drive	1
Beaver Dam Road	4	Hydes Road	1
Marriottsville Road	4	Jeffers Road	1
Joppa Road	3	L'hirondelle Club Road	1
Painters Mill Road	3	Long Green Pike	1
Shawan Road	3	Longnecker Road	1
Tufton Avenue	3	Mantua Mill Road	1
Belfast Road	2	Mccormick Road	1
Business Park Drive	2	Merrick Access Road	1
Cromwell Valley Park	2	Metfield Road	1
Greenspring Avenue	2	Morris Avenue	1
Kellogg Road	2	Notchcliff Road	1
Merrymans Mill Road	2	Old Valley Road	1
Padonia Road	2	Owings Mills Boulevard	1
Pot Spring Road	2	Patterson Road	1
Ruxton Road	2	Pine Valley Drive	1
Seminary Avenue	2	Powells Run Road	1
Western Run Road	2	Priceville Road	1
Worthington Avenue	2	Quaker Bottom Road	1
Bellclare Circle	1	Red Run Boulevard	1
Bonita Avenue	1	Ridgefield Road	1
Caves Road	1	Roland Avenue	1
Charmuth Road	1	Scott Adam Road	1
Cinder Road	1	Shetland Hills Drive	1
Circle Road	1	St Francis Road	1
Cockeysville Road	1	Stevenson Road	1
Cold Bottom Road	1	Tenbury Road	1
Cranbrook	1	Thornton Road	1

Cuba Road	1	Timonium Road	1
Dance Mill Road	1	Wards Chapel	1
Eastridge Road	1	Warren Road	1
Ensor Mill Road	1	Weil Mandel Way	1
Essex Farm Road	1	Windemere Pkwy	1
Garrison Forest	1		
Gilroy Road	1		

Roadways

In total, there are roughly 9,875 roadways within Baltimore County. Of these, 903 are within the sinkhole hazard area. This translates to 589 miles (9.4% of total road miles) of roadway within the hazard area. Tables 11-2 and 11-3, below, list the most impacted roads by total miles, and communities by number of affected roadways, respectively. For the most part, the greatest amount of impacted roadway miles includes driveways, ramps, and miscellaneous “roads”, which make up around 70 miles of roadway, or about an eighth (12%) of the total impacted roadway miles within the sinkhole hazard area.

Table 11-2. Most Impacted Roadways by Total Miles Within the Sinkhole Hazard Area

Road Name	Total Miles
I-83	32.79
Driveway	30.85
Ramp	21.87
Road	18.32
I-695	18.17
Parking	12.60
Dulaney Valley Rd.	10.23
Butler Rd.	8.45
Falls Rd.	7.71
York Rd.	7.22
Greenspring Valley Rd.	6.10
Belfast Rd.	5.98
Beaver Dam Rd.	5.32
Tufton Ave.	4.99
Shawan Rd.	4.75
Paper Mill Rd.	4.49
I-795	4.46
Western Run Rd.	4.32
Marriottsville Rd.	4.17
Glen Arm Rd.	3.71
Cold Bottom Rd.	3.65
Bellona Ave.	3.31
W Seminary Ave.	3.27
Worthington Ave.	3.06

Table 11-3. Communities by Number of Affected Roadways			
Community	Affected Roadways	Community	Affected Roadways
Lutherville Timonium	329	Phoenix	14
Towson	190	Hunt Valley	5
Cockeysville	152	Baldwin	5
Owings Mills	65	Hydes	4
Randallstown	36	Monkton	4
Baltimore	25	Marriottsville	2
Glen Arm	21	Windsor Mill	2
Sparks Glencoe	19	Parkville	1
Pikeville	15		
Reisterstown	14		

Sewer System

Including active gravity main lines and active pressurized main lines, the sewer system in Baltimore County consists of roughly 2,099 miles of sewer line. Of this amount, a total of 187 miles (9%) is within the sinkhole hazard area. These affected sewer lines are further detailed below. Additionally, five sewer pump stations were determined to be within the hazard area.

5,236 Active Gravity Main Lines = 178 miles total
Number of Pipes @ Pipe Diameter:

- 1 @ 4.0”
- 16 @ 6.0”
- 4,231 @ 8.0”
- 162 @ 10.0”
- 227 @ 12.0”
- 186 @ 15.0”
- 42 @ 16.0”
- 131 @ 18.0”
- 35 @ 21.0”
- 92 @ 24.0”
- 55 @ 27.0”
- 91 @ 30.0”
- 1 @ 32.0”
- 7 @ 33.0”
- 48 @ 36.0”
- 11 @ 39.0”
- 22 @ 42.0”
- 14 @ 48.0”
- 8 @ 54.0”
- 4 @ 60.0”
- 9 @ 66.0”
- 1 @ 72.0”

79 Active Pressurized Main Lines = 9.0 miles total
Number of Pipes @ Pipe Diameter:

- 4 @ 1.25”
- 22 @ 1.5”
- 25 @ 2.0”
- 2 @ 4.0”
- 2 @ 6.0”
- 1 @ 8.0”
- 1 @ 12.0”
- 2 @ 24.0”
- 5 @ 30.0”
- 1 @ 33.0”
- 13 @ 36.0”
- 1 @ 42.0”

5 Active Sewer Pump Stations
- Campus Hills
- Cockeysville
- Longquarter
- Montrose Ave.
- Texas

Commercial Transmission Towers

4 Towers
- WPWR (Lutherville Timonium)
- WQHX (Lutherville Timonium)
- WPPS (Timonium)
- WPKW (Cockeysville)

Buildings/Structures

Table 11-4. Land Uses Within the Sinkhole Hazard Area

Land Use	Buildings Affected	Value of Structures*	Value of Parcels
Residential	10,946	$2,951,312,700	$1,727,564,100
Residential Condo	-	$283,322,100	$139,974,800
Industrial	-	$384,821,400	$334,398,300
Institutional	383	-	-
Agricultural	-	$119,396,500	$47,379,800
Commercial	1,184	$1,405,924,200	$847,703,500
Exempt Commercial	-	$356,924,500	$195,406,000
Exempt	-	$13,574,800	$39,739,600
Country Club	-	$28,875,300	$10,697,00
Apartment	-	$616,085,100	$157,531,500
Garage	1,030	-	-
Water Tower	1	-	-
Storage Tank	62	-	-
Silo	40	-	-
Miscellaneous	3,646	-	-
Total	**17,292**	**$6,160,236,600**	**$$3,489,697,600**

*Note: These are approximate values. Values are derived from SDAT parcel data. Each parcel's "improvement value" was utilized for estimating structure values. It is possible that values are higher or lower depending upon how many structures exist on any given parcel.

Essential Facilities

1 Backup EOC
- 11112 Gilroy Road – Hunt Valley

4 Fire Stations
- Fire Dept. Station 14 – Brooklandville

- Fire Dept. Station 19 – Garrison
- Fire Dept. Station 17 – Texas
- Fire Dept. Station 49 – Butler

1 Police Stations

- Police Precinct 7 – Cockeysville

12 Public Schools

Table 11-5. Public Schools Within the Sinkhole Hazard Area	
School	**Location**
Cockeysville Middle School	Cockeysville
Cromwell Valley Magnet Elementary School	Towson
George Washington Carver Center for Arts and Technology	Towson
Hampton Elementary School	Lutherville
Lutherville Laboratory Elementary School	Lutherville
Padonia International Elementary School	Cockeysville
Pikesville Middle School	Pikesville
Pinewood Elementary School	Lutherville
Riderwood Elementary School	Towson
Ridgely Middle School	Lutherville
Sparks Elementary School	Sparks-Glencoe
Timonium Elementary School	Lutherville

4 Colleges

- Community College of Baltimore County Hunt Valley Extension
- Community College of Baltimore County Owings Mills Extension
- Goucher College (Towson)
- Stevenson University (Lutherville)

<u>Hazardous Materials Storage</u>

7 Locations with Above Ground Storage Tanks

- 10519 York Rd, Cockeysville, 21030
- 11411 Marriottsville Rd, Marriottsville, 21104
- 2300 Dulaney Valley Rd, Lutherville Timonium, 21093
- 1001 Providence Rd, Towson, 21286
- 160 Church Ln, Cockeysville, 21030
- 4405 Painters Mill Rd, Owings Mills, 21117
- 10615 Beaver Dam Rd, Cockeysville, 21030

61 Underground Storage Tanks, by Community

- Baldwin – 1
- Cockeysville – 11
- Hunt Valley – 4
- Hydes – 2
- “Baltimore” – 5
- Lutherville – 5
- Lutherville Timonium – 16
- Owings Mills – 6

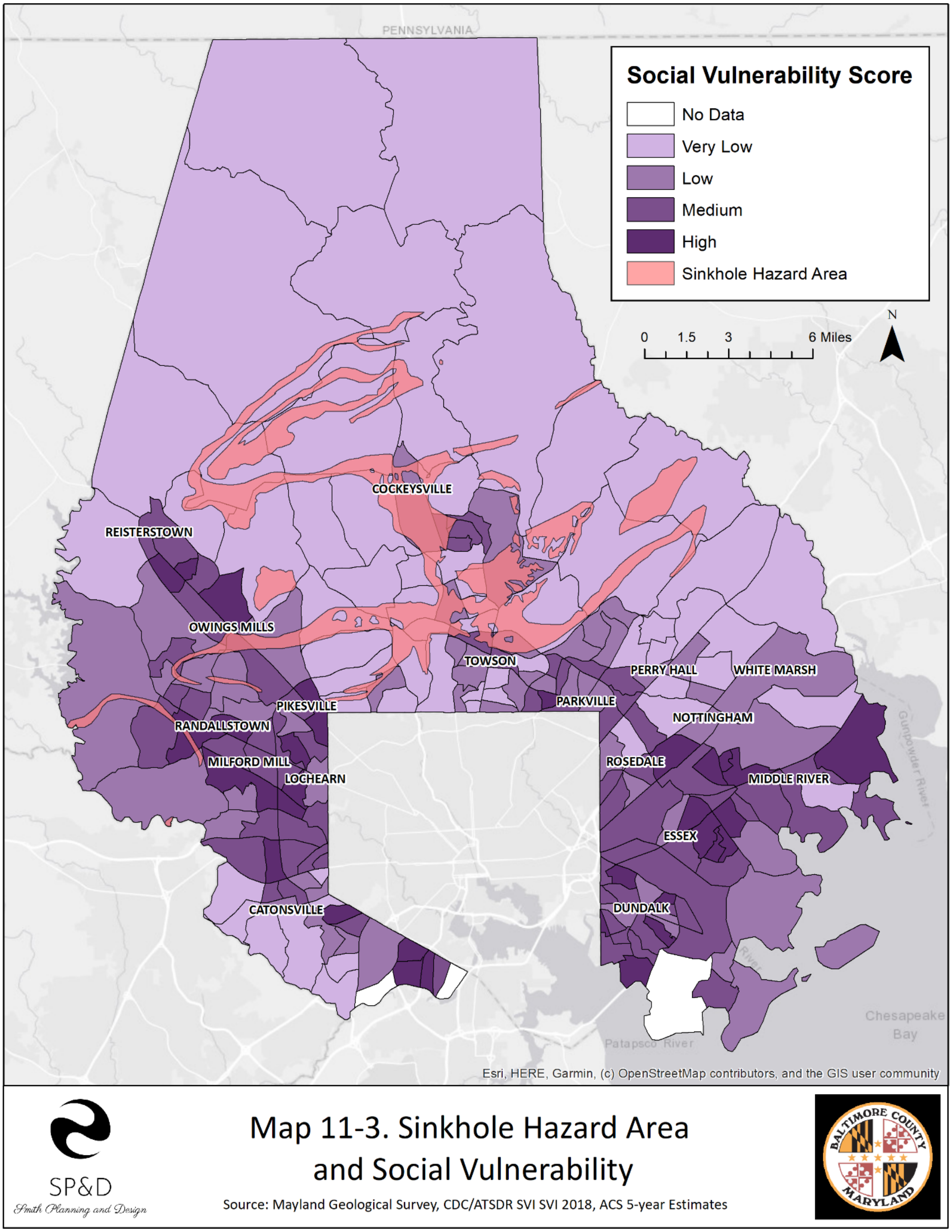
- Reisterstown – 1
- Sparks Glencoe – 2
- Stevenson – 3
- Timonium – 4
- Towson – 1

Development Impacts

Given the unpredictable nature of a sinkhole event, all development within the hazard area has the potential to experience damage caused by a sinkhole. In terms of future growth and development, Owings Mills is the designated Growth Area in the County. Parts of Owings Mills are within the sinkhole hazard area, and it is the fourth most impacted community in terms of roadways within the hazard area.

11.4.5 Social Vulnerability

While the presence of karst topography or cockeysville marble increase the risk of sinkholes, they can still occur in most locations; therefore, any person or group of people can be considered vulnerable to sinkholes to some degree. However, a sinkhole occurring in a developed or urban area with a high social vulnerability index score is potentially more devastating and costly. Map 11-3, following, illustrates the intersection between social vulnerability and the sinkhole hazard area. Most areas within the hazard area have low social vulnerability. Notable exceptions include areas around Owings Mills, Towson, and Randallstown, which include census tracts with high social vulnerability.



Map 11-3. Sinkhole Hazard Area and Social Vulnerability

Source: Mayland Geological Survey, CDC/ATSDR SVI SVI 2018, ACS 5-year Estimates

11.5 2021 MITIGATION GOALS AND ACTION ITEMS

During the 2021 Plan Update, new mitigation goals and action were added. Additionally, previous mitigation goals and action items from the 2014 Plan were reviewed, and those that were determined to be still in progress or relevant were included.

GOAL 1: Eliminate or reduce human, environmental, social, and economic loss from natural and technological hazards.			
OBJECTIVE	ACTION ITEM(S)	RESPONSIBLE ENTITY	RANKING (HIGH, MEDIUM, OR LOW)
1. Direct new development away from hazard areas.	a. Regulate the location, type, and intensity of new development in areas most susceptible to sinkhole formation. Areas with the greatest amount of infrastructure within the sinkhole hazard area include: Lutherville, Cockeysville, Towson, Loch Raven, and Owings Mills.	Lutherville, Cockeysville, Towson, Loch Raven, Owings Mills	Low
2. Develop and improve upon hazard data using GIS as the technical foundation for sinkhole hazard planning.	a. Evaluate and broaden inventory of infrastructure, demographic, and property statistics in areas susceptible to sinkhole formation.	County	Medium

11.6 EXISTING SINKHOLE MITIGATION ACTIVITIES

The Maryland Geological Survey, supported by the Baltimore County Department of Environmental Protection and the Department of Public Works, as needed, performs current sinkhole mitigation and investigation activities.

- The Maryland Geological Survey (MGS), located nearby in Baltimore City, offers immediate investigative services anytime a sinkhole has been identified in Baltimore County.
- Corrective measures are immediately performed anytime a sinkhole is located as to prevent it from impacting nearby structures, roads, bridges, and other essential infrastructure.

[1] nationalatlas.gov/articles/geology/a_geohazards.html#four
[2] www.mgs.md.gov/geology/geohazards/engineering_problems_in_karst.html
[3] www.usgs.gov/special-topic/water-science-school/science/sinkholes
[4] www.mgs.md.gov/geology/geohazards/sinkhole_resources.html

CHAPTER 12: WINTER WEATHER

UPDATES

During the 2021 Plan Update process, **Chapter 12: Winter Weather** was updated with the most recently available data.

Updates to this chapter include:

1. Thematic and visual update
2. **Data updates** (including tables, text, and figures as needed) to the following sections: *12.3 History of Winter Weather, 12.5 2021 Mitigation Goals and Action Items, and 12.6 Existing Winter Weather Mitigation Activities.*
3. **Updated** "Baltimore County Snow Removal" with latest available data.
4. Results of the HIRA were added to *Section 12.2 Contributing Factors to Winter Weather Risk*. Winter Weather risk is ranked as "Medium-High." See Appendix A for full results.
5. **Updated** "vulnerable populations" section and created section *12.4.1 Social Vulnerability.*
6. **Updated** sections 12.5 and 12.6 with the latest mitigation goals, action items, and current activities.

12.1 HOW IS WINTER WEATHER A THREAT TO BALTIMORE COUNTY?

According to the Maryland's 2016 Hazard Mitigation Plan, Baltimore County had the highest number of deaths attributed to the winter storm hazard in Maryland at the time of the plan update.[1] Baltimore County has a long history of winter weather events that have caused property loss, personal injury, and in some cases, fatalities. Winter weather most commonly takes the form of snowfall, but it can also take the form of freezing rain, sleet, or extreme cold. These conditions, which are further explained below, may occur individually or simultaneously in any combination. Such events create dangerous travel conditions, power outages, property damage, and other hazardous conditions.

12.1.1 Freezing Rain and Sleet

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.

Even small accumulations of ice can be hazardous to pedestrians and motorists. Significant accumulations of ice can fell trees and power lines, resulting in loss of power and communication. To produce this amount of ice, freezing rain usually must fall for several hours.[2]

Baltimore County Snow Removal Facts: 2019-2020

Roadways
There are 8,823 roadways within the County. Of these roadways, 164 are snow emergency routes, and each route has 50 to 60 roads.

Snow Removal
In total, there are 411 snow removal trucks with 491 personnel working from 11 locations. Drivers follow specific routes with no special lists or preferred customers. Roads are cleared in this order: collector, arterials, and development subdivisions.

Cost
$8,422,032 has been budgeted for snow removal in 2019-2020. Salting costs about $48.95 per ton and takes 4-6 hours.

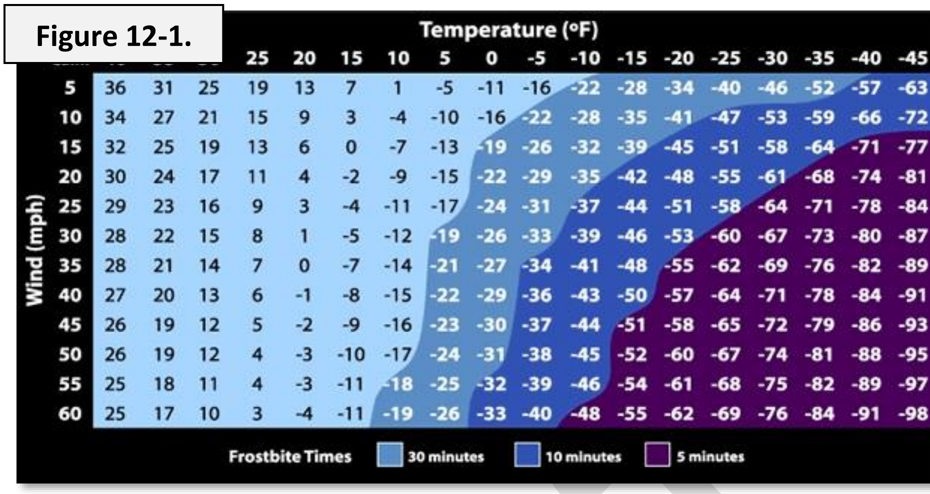
Source: Baltimore County Department of Public Works

12.1.2 Extreme Cold and Wind Chill

Exposure to extreme cold, even for short periods of time, can result in hypothermia, frostbite, or even death. Wind greatly increases the dangers of frostbite and hypothermia by drawing heat away from the body.[3]

Wind chill describes the rate of heat loss on the human body resulting from the combined effect of low temperature and wind. As winds increase, heat is carried away from the body at a faster rate, driving down both the skin temperature and eventually the internal body temperature. Exposure to low wind chills can be life threatening to both humans and animals alike.[4] Figure 12-1, created by the National Weather Service (NWS), demonstrates the relationship between temperature, wind speed, and frostbite.

Figure 12-1.



Wind (mph)				Temperature (°F) 25	20	15	10	5	0	-5	-10	-15	-20	-25	-30	-35	-40	-45
5	36	31	25	19	13	7	1	-5	-11	-16	-22	-28	-34	-40	-46	-52	-57	-63
10	34	27	21	15	9	3	-4	-10	-16	-22	-28	-35	-41	-47	-53	-59	-66	-72
15	32	25	19	13	6	0	-7	-13	-19	-26	-32	-39	-45	-51	-58	-64	-71	-77
20	30	24	17	11	4	-2	-9	-15	-22	-29	-35	-42	-48	-55	-61	-68	-74	-81
25	29	23	16	9	3	-4	-11	-17	-24	-31	-37	-44	-51	-58	-64	-71	-78	-84
30	28	22	15	8	1	-5	-12	-19	-26	-33	-39	-46	-53	-60	-67	-73	-80	-87
35	28	21	14	7	0	-7	-14	-21	-27	-34	-41	-48	-55	-62	-69	-76	-82	-89
40	27	20	13	6	-1	-8	-15	-22	-29	-36	-43	-50	-57	-64	-71	-78	-84	-91
45	26	19	12	5	-2	-9	-16	-23	-30	-37	-44	-51	-58	-65	-72	-79	-86	-93
50	26	19	12	4	-3	-10	-17	-24	-31	-38	-45	-52	-60	-67	-74	-81	-88	-95
55	25	18	11	4	-3	-11	-18	-25	-32	-39	-46	-54	-61	-68	-75	-82	-89	-97
60	25	17	10	3	-4	-11	-19	-26	-33	-40	-48	-55	-62	-69	-76	-84	-91	-98

Frostbite Times: 30 minutes; 10 minutes; 5 minutes

Source: National Weather Service

12.2 CONTRIBUTING FACTORS TO WINTER WEATHER RISK

As part of this plan update, a Hazard Identification and Risk Assessment (HIRA) was conducted for the winter weather hazard. A composite scoring method was utilized to rank natural hazards, which included five (5) key components: historical impacts (in terms of human lives and property), geographic extent, historical occurrences, future probability, and community perspective.

Based on this method, winter weather was assigned a ranking of "**Medium-High**" during this plan update. This is consistent with winter weather's ranking during the previous planning cycle. The future probability of a winter weather event is considered "highly likely", as determined by the HIRA. Full results of the HIRA, including method, are included within *Appendix A* of this plan.

12.2.1 Weather Patterns

The climate and weather patterns of the Mid-Atlantic region makes for often unpredictable weather conditions during the late fall, winter, and early spring months in Baltimore County. There are several common weather patterns that can occur that bring winter weather to the area, but the results of those patterns are variable, and therefore sometimes unpredictable. The following describes weather patterns that have resulted in winter weather events in Baltimore County:[5]

- Areas of low pressure that track across the region from the west;
- Upper-level jet stream interacting with a cold dome of arctic air;
- Combination of low pressure over the southern Ohio Valley, a cold high-pressure ridge extending over the region from south-central Canada, and warm air aloft;
- Low and mid-level lift ahead of an Alberta Clipper;
- An Alberta Clipper, moving southeast from the upper Midwest into the Deep South, can link up with subtropical moisture along the southeast US coast to develop a classic nor'easter. As the area of low pressure intensifies, it wraps

Atlantic moisture well to the west, where modified arctic air is pouring in from southern Canada; and

- Strong surface high pressure over New England can push a shallow layer of subfreezing air into Maryland.

12.2.2 Temperature

Slight variations in temperature can be the difference between a rain, snow, mixed precipitation, or ice event. In some cases, a rain event can become extremely dangerous if ground temperatures are below freezing causing rain to freeze on contact with the ground resulting in "black ice" conditions. In contrast, the dangers of mixed precipitation weather events that occur during busy travel times, in some cases, can minimize the amount of ice accretion damage. This occurs because the contact of tires to pavement helps to keep the roadway temperature elevated to not form additional ice accumulations. It should be noted that traveling during these mixed precipitation events is not encouraged, and the warming of the roadway is a benefit of conditions where the roadways are already being heavily traveled during the event, such as peak hour travel.

12.2.3 Physical Terrain

The physical terrain can put certain areas at risk to winter weather events. Areas of high terrain, such as the northern and western parts of the County, can result in colder temperatures and more frequent icy conditions. Valleys are also vulnerable because temperatures cool faster than in the more urbanized areas of the County, which can lead to increased ice on the roads as pooled water freezes more rapidly.

12.3 HISTORY OF WINTER WEATHER

Baltimore County's history of winter weather events is diverse, but winter storm and heavy snow events comprise most weather events during the winter season. Table 12-1, below, identifies the winter storm and heavy snow events that have led to the greatest snow accumulations within the County. Table 12-2 identifies presidential declarations related to winter weather.

Table 12-1. Significant Winter Weather Events in Baltimore County

Date	Total Snowfall
Feb. 15-18, 2003	28.2 inches
Jan. 22-24, 2016	27.0 inches
Jan. 27-29, 1922	26.5 inches
Feb. 12-14, 2014	26.0 inches
Feb. 5-6, 2010	24.8 inches
Feb. 11, 1983	22.8 inches
Jan. 7-8, 1996	22.5 inches
Mar. 29-30, 1942	22.0 inches
Feb. 11-14, 1899	21.4 inches
Dec. 18-19, 2009	21.1 inches
Feb. 18-19, 1979	20.0 inches

Feb. 9-10, 2010	19.5 inches
February 12-14, 2014	15.0 inches

The following are brief descriptions of some of the most significant winter weather events that have affected Baltimore County in recent years.

Blizzard – January 2016

An historic snowstorm created treacherous conditions in Baltimore and throughout Maryland. Governor Larry Hogan issued a State of Emergency in Maryland. According to NOAA, total snow accumulation were 27 inches in the southern part of the county and 30 inches in the northern part of the county.

Valentine's Day Snowstorm – February 2014

Heavy snow fell across most parts of the Mid Atlantic with the highest amounts near the Mason Dixon line where mid-level forcing led to a heavy band. According to NOAA, total snow accumulation of 15 inches in the White Marsh and Townson Areas.

"Snowmageddon" – February 2010

Baltimore County was paralyzed by back-to-back blizzard events that led to significant accumulations of snow across the region. According to NOAA, total snow accumulation by the end of February at BWI Airport was 50 inches.

Table 12-2. Presidential Declarations (Winter Weather)

Event	Date
Blizzard of '96	January 11, 1996
Severe winter storm	April 10, 2000
Severe snowfall	March 14, 2003
Blizzard	December 19, 2009
Blizzard	January 31, 2010
Blizzard	February 5, 2010
Snowstorm	February 12, 2014
Severe winter storm and snowstorm	January 22, 2016

Source: NOAA, NCEI Storm Events Database

President's Day Storm – February 2003

A total of 28.2 inches of snow fell during this storm, which made it the top snowstorm on record. A dozen structures including car ports, a factory, and an office building collapsed due to the excessive snowfall. Additionally, a man in his twenties died from carbon monoxide poisoning while trapped in a snowbound car.

Blizzard – January 1996

Baltimore County recorded over 22 inches of snow, the entire state was paralyzed, and the Federal Government remained shut down after a month-long furlough. As road crews worked to clear the snow, another storm moved through on Tuesday, January 9 dumping an additional 3 to 5 inches from Washington northeast through Baltimore. Plows that would have been working on secondary roads and residential areas were sent back to the primary roads. The government remained closed for 4 days that week and many schools and businesses announced their closure for the entire week. A third storm struck on Friday, January 12 dumping another 4 to 6 inches over the metro areas. By the week's end approximately 3 to 4 feet of snow had fallen in the region.

12.4 VULNERABILITY ASSESSMENT

Winter weather hazards can affect all parts of Baltimore County. The northern and western parts of the County have a history of slightly cooler temperatures than other parts of the County, mainly due to the increase in elevation, and less urbanized development.

Infrastructure

All public infrastructure is vulnerable to winter weather events. Transportation systems including roadways, bus service, light rail, Metro, heavy rail, and airports can be adversely impacted during snow, mixed precipitation, and ice events. Particularly, bridges and overpasses become vulnerable because they freeze before roadways due to the materials from which they are constructed.

Extreme cold also has adverse impacts on the public utility infrastructure. Utility line and valve breaks are known to occur when temperatures are extremely low and then warming temperatures cause soil movement that result in the shifting of utility lines. This results in breaks mainly to water lines but can also affect stormwater and sewer utilities.

Power outages are also a common result of ice storms and heavy snow. Heavy snow can form on tree limbs which results in breaks and downed power lines. However, with ice accumulations, power lines can be downed without the intervention of trees, due to the heavy burden of ice accumulations on the lines. When these outages occur, many residents turn to their gas-powered generators to power their homes. This creates a new risk of carbon monoxide poisoning if not used properly or without proper ventilation.

Building Stock

Structures are also vulnerable to heavy snow events. Older housing is generally not able to support large amounts of snow, and roof collapses are known to occur to these structures. Structures with flat roofs are particularly vulnerable because the melting snow can form pools on rooftops with minimal ability for the water to drain effectively. This is not only the case for residential properties, but businesses and other manufacturing facilities as well. For all structures, gutters can be torn off from homes because of “ice dams”, which can also cause interior leaks in the structure.

12.4.1 Social Vulnerability

Winter weather places a heavy toll on residents throughout the County. The elderly and other special needs populations are particularly vulnerable because of their need to have access to medications and other medical necessities, public transportation, meal delivery, and home care support. Because of the weather conditions, emergency responders are not able to reach these populations in an emergency as quickly as they would during normal conditions.

Livestock and pets are also at risk during extreme cold. Many residents do not account for the needs of their pets during winter weather events and leave pets outside for inappropriate amounts of time. In contrast, the farming community tends to be more attentive to the needs of livestock during extreme cold.

12.5 2021 MITIGATION GOALS AND ACTION ITEMS

During the 2021 Plan Update, new mitigation goals and action were added. Additionally, previous mitigation goals and action items from the 2014 Plan were reviewed, and those that were determined to be still in progress or relevant were included.

GOAL 1: Eliminate or reduce human, environmental, social, and economic loss from natural and technological hazards.

OBJECTIVE	ACTION ITEM(S)	RESPONSIBLE ENTITY	RANKING (HIGH, MEDIUM, OR LOW)
1. Provide those residents in need with shelter during cold weather.	a. Continue to provide, and possibly increase, warming center locations within Baltimore County.	County, Department of Health	Medium

GOAL 2: Reduce vulnerabilities to future natural hazards; guide and facilitate post-storm recovery.

OBJECTIVE	ACTION ITEM(S)	RESPONSIBLE ENTITY	RANKING (HIGH, MEDIUM, OR LOW)
2. Enforce current winter weather policy and procedure.	a. Develop a winter response plan and continue to enforce the State's snow emergency plan for Baltimore County.	County	Medium

GOAL 3: Promote hazard mitigation as the cornerstone of emergency management in Baltimore County.

OBJECTIVE	ACTION ITEM(S)	RESPONSIBLE ENTITY	RANKING (HIGH, MEDIUM, OR LOW)
3. Educate the public about natural hazards risks, preparedness, and mitigation.	a. Continue to promote winter weather survival tips to citizens throughout the fall and winter seasons on the County website.	County, Department of Health	Medium
	b. Make FEMA's "Emergency Supply List" available on the County's website.	County	Medium
	c. Make SHA's "The Three P's of Safe Winter Driving" available on the County's website.	County	Medium

12.6 EXISTING WINTER WEATHER MITIGATION ACTIVITIES

- The 2015 Baltimore County Building Code mandates: Ground Snow Load – 30 PSF; Roof Snow Load- 30 PSF.
- The Bureau of Highways Snow Center is manned 24-hours a day during storms. The Snow Center coordinates between plow crews, emergency services and the community.
- The Property Management (PM) Division of the Office of Budget and Finance provides snow-removal services to county-owned properties during snow events and winter weather.
  - PM provides a hotline for agencies to contact in the event they need service to their site or have specific concerns.
  - PM has installed snow breaks and other devices to rooftops with a high risk of damage from snow weight.
- "Stormfighter" is an online resource, available on the County website, which provides timely updates regarding the status of salting, plowing, and general road conditions within Baltimore County.
- Every year the Baltimore County Department of Public Works conducts a winter weather emergency coordination meeting to bring together all the participants in winter weather emergency response.
- The County stores 91,600 tons of salt in 17 salt barns around the County and replenishes those supplies throughout the winter as needed.
- The County, via Public Works, is equipped with 481 trucks and 571 personnel working from 11 highways shops. The County has budgeted $7.7 million for storm response for the 2020-2021 season.

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[1] State of Maryland 2016 Hazard Mitigation Plan
[2] 2011 Maryland State Hazard Mitigation Plan Update
[3] 2011 Maryland State Hazard Mitigation Plan Update
[4] www.weather.gov/mfl/about_cold
[5] www.ncdc.noaa.gov/stormevents/

CHAPTER 13: COASTAL STORM AND FLOODING

UPDATES

During the 2021 Plan Update process, **Chapter 13: Coastal Storm and Flooding** was updated with the most recently available data.

Major updates to this chapter include:

1. Thematic and visual updates were made throughout the entire chapter.
2. Sections Updated:
   - 13.1, updated total tidal coastline miles
   - 13.2, Results of the HIRA were added to this section. Coastal Storm and Flooding risk is ranked as "Medium-High." See Appendix A for full results.
   - 13.4, updated NFIP text boxes comparing insurance policies in force between 2013 and 2021.
     - Added text discussing decline in policies in force due to changes from old effective FIRM to new effective FIRM.
   - 13.4.1 Updated text box with CRS Credit opportunities,
   - 13.4.1 Updated effective and prelim FIRM text.
   - 13.5 HAZUS Coastal Flood Analysis, modified text to describe estimation method.
   - 13.7.4 Assessment Results
     - Updated results for bridges within 100-year VE zone and storm surge cat 3.
     - Updated results for culverts within 100-year VE flood zone and storm surge cat 3.
     - Updated results for roadways within 100-year VE flood zone and storm surge cat 3.
     - Created a section for essential facilities within cat 3 storm surge and VE zones.
   - 13.7.5 Assessment Analysis
     - Transportation Impacts – updated results.
     - River Drive Road – updated RLP total.
3. Tables Updated:
   - New Table 13-2, with latest SLR projections
   - New Table 13-3 with projection from the Climate Action Plan.
   - 13-6, updated with newest RLP data.
   - New Table 13-7, RLP by street.
   - 13-10, adjusted amounts to 2021 dollars.
   - 13-11, Updated results of bridges impacted by storm surge.
   - 13-12, updated roadways within 100-year coastal flood zone (VE).
   - 13-13, updated communities by affected roadway within 100-year coastal flood zone.
   - 13-14, updated roadways by miles (> 1 mile).
   - 13-15, updated communities by roadways impacted by cat 3 storm surge.
4. New Sections:
   - 13.8 Social Vulnerability
5. New Mapping:
   - Maps 13-4, 13-5, 13-6 have been updated with latest vulnerability assessment results.
   - New: Map 13-7 Social Vulnerability and Cat 3 Storm Surge.
6. Figures Updated:
   - Figure 13-1, new coastal RLP with NFIP insurance percentages
   - Figure 13-2, recommendations for Police Marine Unit (CAP project).
   - Figure 13-3, updated with the latest RLP on River Drive Road.

13.1 HOW ARE COASTAL STORMS AND FLOODING A THREAT TO BALTIMORE COUNTY?

Tropical cyclones are rotating weather systems (counterclockwise in the northern hemisphere) over tropical or subtropical waters. They bring with them powerful winds, rain, flooding, and tornadoes. The three most common types of tropical cyclones are: tropical depressions, tropical storms, and hurricanes. The Atlantic hurricane season begins in June and continues through November, with most hurricane activity occurring in late summer and early fall.[1]

Tropical Depression - An organized system of clouds and thunderstorms with a defined circulation and maximum sustained winds of 38 mph (33 knots) or less.

Tropical Storm - An organized system of strong thunderstorms with a defined circulation and maximum sustained winds of 39 to 73 mph (34-63 knots).

Hurricane - An intense tropical weather system with a well-defined circulation and maximum sustained winds of 74 mph (64 knots) or higher. In the western Pacific, hurricanes are called "typhoons," and similar storms in the Indian Ocean are called "cyclones."

Source: National Weather Service (NWS)

Hurricanes are products of warm tropical oceans and the atmosphere. Powered by heat from the sea, they are steered by the easterly trade winds and the temperate westerlies, as well as by their own ferocious energy. Around their core, winds grow with great velocity, generating violent seas. Moving ashore, they sweep the ocean inward, often spawning tornadoes and producing torrential rains and floods. They begin to die once they move over land and lose the moisture from the ocean.[2]

Baltimore County has approximately 219 miles of tidal shoreline along the Patapsco, Back, Middle, and Gunpowder Rivers. This eastern coastal shoreline has been vulnerable to hurricanes and tropical systems as their recorded histories in section 13.3 indicates. These storms have caused intense coastal flooding and shoreline erosion resulting in extensive loss of property, injuries, and even loss of life.

13.2 CONTRIBUTING FACTORS TO COASTAL STORM AND FLOODING RISK

As part of this plan update, a Hazard Identification and Risk Assessment (HIRA) was conducted for the coastal storm and flooding hazard. A composite scoring method was utilized to rank natural hazards, which included five (5) key components: historical impacts (in terms of human lives and property), geographic extent, historical occurrences, future probability, and community perspective.

Based on this method, coastal storm and flooding was assigned a ranking of "**Medium-High**" during this plan update. This represents a slight change in coastal storm and flooding's risk ranking compared to the previous planning cycle. The future probability of a coastal storm and flooding event is considered "unlikely", as determined by the HIRA. Full results of the HIRA, including method, are included within *Appendix A* of this plan.

13.2.1 High Winds

The Saffir-Simpson Hurricane Wind Scale is a 1 to 5 rating based on a hurricane's sustained wind speed. This scale estimates potential property damage. Hurricanes reaching Category 3 and higher are considered major hurricanes because of their potential for significant loss of life and damage. Category 1 and 2 storms are still dangerous, however, and require preventative measures. In the western North Pacific, the term "super typhoon" is used for tropical cyclones with sustained winds exceeding 150 mph.[3]

Table 13-1. Saffir-Simpson Hurricane Wind Scale

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

Source: National Hurricane Center, NWS

While hurricanes are ranked according to the strength of their winds, a hurricane does not need to be a Category 4 or 5 to cause serious damage. A tropical system's heavy rains and flooding usually cause the most damage and loss of life.

In 1972, Hurricane Agnes was a weak Category 1 when it came ashore, but its heavy rains caused flooding that resulted in billions of dollars in damage and killed 129 people.[4]

13.2.2 Heavy Rainfall

Tropical cyclones often produce widespread, torrential rains in excess of 6 inches, which may result in deadly and destructive floods. In fact, flooding is the major threat from tropical cyclones for people living inland. Flash flooding, defined as a rapid rise in water levels, can occur quickly due to intense rainfall. Longer term flooding on rivers and streams can persist for several days after the storm.

Rainfall amounts are not related to the strength of tropical cyclones but rather to the speed and size of the storm, as well as the geography of the area. Slower moving and larger storms produce more rainfall. In addition, mountainous terrain enhances rainfall from a tropical cyclone.

13.2.3 Storm Surge and Storm Tide

Isabel was the worst hurricane to affect the Chesapeake Bay region since 1933. Storm surge values of more than 8 feet flooded rivers that flowed into the bay across Virginia, Maryland, Delaware, and Washington, D.C.

Source: NWS, NOAA

Storm surge and large waves produced by hurricanes pose the greatest threat to life and property along the coast. Storm surge is an abnormal rise of water generated by a storm's winds. Storm surge can reach heights well over 20 feet, span hundreds of miles of coastline, and penetrate several miles inland. Storm tide is the water level rise during a storm due to the combination of storm surge and the astronomical tide.

The destructive power of storm surge and large battering waves can result in loss of life, destruction of property, beach and dune erosion, and road and bridge damage along the coast. In estuaries and bayous, saltwater intrusion endangers public health and the environment.[5]

13.2.4 Sea Level Rise and Shoreline Erosion

Within the Chesapeake Bay, shorelines have been continuously eroding since the formation of the Bay roughly 10,000 years ago. Over the long term, sea-level rise is one of the primary causes of this shoreline erosion. In the short term, waves and storm events are the primary cause of changes in the shoreline. While localized human activities, such as coastal development, have played a part in shoreline erosion, global climate change is also an important factor. Warmer global temperatures mean two events occur: 1) loss of land-based ice, such as glaciers and polar ice caps, and 2) thermal expansion, which simply means that water expands and takes up more space as it warms. These two factors are major causes of sea-level rise, which in turn causes shoreline erosion.[6]

Currently, sea-level rise averages about 3-4 mm a year in Maryland, or one foot per century[7]. According to NOAA, this is a “significantly larger rate than the sea-level rise averaged over the last several thousand years.”

The State of Maryland has not adopted an “official” projection to be used for SLR assessments in the state. The Maryland Department of Transportation Climate Change Vulnerability Viewer uses the 1% probability from the UMCES projections. In the 2018 report, *Sea-Level Rise Projections for Maryland 2018,*[8] sea-level rise estimates for Maryland are determined based on the Baltimore tide-gauge station. These projections are included in Table 13-2, below.

Table 13-2. Projected Sea-Level Rise Estimates Above 2000 Levels, Maryland

Year	Emissions Pathway	Central Estimate 50% probability SLR meets or exceeds	Likely Range 67% probability SLR is between:	1 in 20 Chance 5% probability SLR meets or exceeds:	1 in 100 Chance 1% Probability SLR meets or exceeds:
2030		0.6 ft	0.4-0.9 ft	1.1 ft	1.3 ft
2050		1.2 ft	0.8-1.6 ft	2.0 ft	2.3 ft
2080	Growing	2.3 ft	1.6-3.1 ft	3.7 ft	4.7 ft
	Stabilized	1.9 ft	1.3-2.6 ft	3.2 ft	4.1 ft
	Paris Agreement	1.7 ft	1.1-2.4 ft	3.0 ft	3.2 ft
2100	Growing	3.0 ft	2.0-4.2 ft	5.2 ft	6.9 ft
	Stabilized	2.4 ft	1.6-3.4 ft	4.2 ft	5.6 ft
	Paris Agreement	2.0 ft	1.2-3.0 ft	3.7 ft	5.4 ft
2150	Growing	4.8 ft	3.4-6.6 ft	8.5 ft	12.4 ft
	Stabilized	3.5 ft	2.1-5.3 ft	7.1 ft	10.6 ft
	Paris Agreement	2.9 ft	1.8-4.2 ft	5.9 ft	9.4 ft

Source: Sea-level Rise Projections for Maryland 2018

Additional sea-level rise projections, produced within the *Baltimore County Climate Action Plan* (2021), are displayed in Table 13-3, below.

The *Baltimore County Climate Action Plan* includes many recommended mitigation projects, some of which have been integrated as action items into this Plan Update (see section 13.9). The CAP Plan seeks to identify the range of future climate change for Baltimore County, assess potential impacts, and recommend adaptation options for improving County resilience for planning horizons of 2050 and 2080.

Table 13-3. Maryland 2018 Projections for Sea-Level Rise in 2050 and 2080

Year	Central Estimate 50% probability SLR meets or exceeds:	Likely Range 67% probability lower range:	Likely Range 67% probability upper range:	1 in 20 Chance 5% probability SLR meets or exceeds:	1 in 100 Chance 1% probability SLR meets or exceeds:
2050	1.2 ft	0.8 ft	1.6 ft	2.0 ft	2.3 ft
2080	1.9 ft	1.3 ft	2.6 ft	3.2 ft	4.1 ft

Source: Baltimore County Climate Action Plan, Resilience Assessment for General County Government Assets, 2021

Living shoreline projects utilize a variety of structural and organic materials, such as wetland plants, submerged aquatic vegetation, oyster reefs, coir fiber logs, sand fill, and stone. The benefits of living shorelines include:

- Stabilization of the shoreline.
- Protection of surrounding riparian and intertidal environment.
- Improvement of water quality via filtration of upland run-off.
- Creation of habitat for aquatic and terrestrial species.

Source: NOAA

Including tidal shoreline and low-lying rural and urban lands, Maryland has 3,100 miles of shoreline,[9] 219 miles of which are in Baltimore County. Efforts to protect these coastlines are ongoing and consist of multiple erosion control methods, the preferred method being living shorelines. In fact, The Living Shorelines Act of 2008 requires that living shorelines be considered for erosion control unless the Maryland Department of the Environment (MDE) grants a waiver.[10]

In Baltimore County, living shoreline stabilization projects have occurred in Essex Skypark and Watersedge Park.[11] The Essex Skypark project, which began in June of 2011, included enhancements to 2,610 linear feet of severely eroded shoreline.

The shoreline of Watersedge Park **before** construction of the shoreline stabilization project.

The shoreline of Watersedge Park **after** construction of the shoreline stabilization project.

Shoreline protection measures are critical for another reason: the relationship between sea-level rise and storm surge. As a result of global warming, highly intense storms are projected to become more common in higher latitudes along the Mid-Atlantic during the 21st century. Add to this that sea-level rise will cause a general deepening of the Bay, one is presented with higher and more intense storm surges along coastlines.

13.3 HISTORY OF COASTAL STORMS AND FLOODING

Baltimore County has a broad history of coastal storms resulting in coastal flooding events. Table 13-4 provides a list of the most significant tropical storms that have occurred during the last 100 years. Descriptions of these storms are provided to show the intensity and devastation caused by coastal storms and their resultant flooding.

Table 13-4. Significant Tropical Storms/Hurricanes Affecting Baltimore County	
• Chesapeake-Potomac, 1933	• Fran, 1996
• Hazel, 1954	• Dennis, 1999
• Agnes, 1972	• Floyd, 1999
• Gloria, 1985	• Isabel, 2003
• Bertha, 1996	• Irene, 2011
	• Sandy, 2012

Sandy – October 2012

Compared to many locations in the Northeast, Baltimore County avoided disaster in terms of damage from Sandy. Except for flooding on the Eastern Shore that destroyed parts of the Ocean City boardwalk, and heavy snowfall in Western Maryland that shutdown I-68, most of central Maryland was left relatively unscathed. In total, about 300,000 BGE customers lost power starting on October 28; a rather light number compared to the June Derecho and Hurricane Irene, which each had about 750,000 reported power outages.[12]

Tropical Storm Lee – September 2011

On the heels of Hurricane Irene, Tropical Storm Lee set up in a north/south orientation across Maryland from Charles County into Baltimore County on September 7. Rainfall rates of 2 to 3 inches per hour occurred for several hours within this region, causing numerous high-water rescues, road closures, and flooded homes. Of note was a rain gauge in Bowie, MD, that observed 4.57 inches of rain in 3 hours, which is an amount that only has a 0.5 percent chance of occurring each year. Across much of the Baltimore region, the storm dumped more rain than Hurricane Irene did, but lighter winds meant that far fewer people lost electrical service. About 66,000 BGE customers lost service for a time; and almost 6,000 were still in the dark into the following morning.[13]

Irene – August 2011

Presidential Declarations (Coastal Storms)
Tropical Storm Agnes – June 23, 1972
Hurricane Isabel – September 19, 2003
Hurricane Irene – August 25, 2011
Tropical Storm Lee – September 2, 2011
Hurricane Sandy – October 26, 2012
Tropical Storm Isaias – August 3, 2020

Hurricane Irene tracked up the Mid-Atlantic Coast during the evening hours of August 27th through the early morning hours of the 28th. Irene passed by just to the east of Ocean City, Maryland during the early morning hours of the 28th. The minimum central pressure was 958 millibars and maximum sustained winds were 80 mph, making Irene a category one hurricane. Irene produced tropical storm conditions across portions Maryland near and east of the I-95 Corridor. The worst conditions were near the Chesapeake Bay. As with most of the state, Baltimore County did not receive the amount of damage and flooding that had been predicted. However, high winds did lead to downed trees and power lines, which caused some 130,000 reported power outages throughout the county.[14]

Isabel – September 2003

Areas adjacent to the Chesapeake Bay and its tributaries were particularly hard hit, with storm surge exceeding the previous record levels set by the Chesapeake-Potomac Hurricane of 1933. In Baltimore County alone, $3 million in damage is estimated to have occurred from erosion of the shoreline. Residential areas of Millers Island, Edgemere, North Point, Bowley's Quarters and Turners Station were hard hit with more than 400 people being rescued from their homes and over 300 buildings destroyed. Marinas were also destroyed or severely damaged. Baltimore County was estimating 3,189 tons of debris to be hauled from the storm. While most people had their power back in a week, some locations took up to two weeks. Many injuries and three fatalities occurred from carbon monoxide poisoning from people improperly running generators in their houses. Other injuries were related to chain saws and the clean-up of debris. Heavy rains, several days after Isabel, added to localized and flash flooding throughout the County. The State was declared a Federal Disaster Area on September 19, 2003. 4,113 Baltimore County residents have registered with the federal government for disaster relief. For the entire State of Maryland, the number of claims reported to the National Flood Insurance program totaled approximately $122 million.

Floyd – September 1999

The highest rainfall reports ranged from 5 – 6 inches throughout the County. Across Baltimore County, 57,000 customers lost power. Winds gusted to 69 MPH at Martin State Airport, and hundreds of trees fell in Gunpowder State Park. Countywide, fallen trees damaged homes, sheds, fences, and cars, and closed 125 roads. Officials reported 6 rapid water rescues and 350 flooded basements. A 10-year-old boy was swept into a storm drain and carried 300 feet in a buried pipe before fire fighters opened a manhole cover and rescued him uninjured. The impact of Floyd was compounded by the effects of Hurricane Dennis which had produced rainfall on the Atlantic coast one week prior to Floyd's arrival. This resulted in already saturated conditions in the region.

Agnes – June 1972

Agnes is perhaps a reminder that we cannot assume that the size and category of a hurricane tells the whole picture. Agnes evolved from a weak Category 1 hurricane at landfall on the Gulf of Mexico, to a tropical depression as it moved eastward. Total storm damage in the United States from Agnes was estimated at just under $3.5 billion with a death toll of 122 lives. Total storm damage in Maryland and the District of Columbia was estimated at $110 million. In Maryland heavy rains in less than 24 hours resulted in severe flooding. Just west of Baltimore County, the highest total rainfall was 14.68 inches at Westminster and 13.85 inches at Woodstock. The heavy rains caused disastrous flash flooding of creeks and streams. Flooding along the Patapsco River broke all existing records, inundating the chronically flooded Ellicott City and Oella regions of Baltimore and Howard Counties with flood waters cresting almost 15 feet above Main Street in Ellicott City.

The American Red Cross in Maryland reported 103 houses destroyed and 1,930 damaged, 17 farm buildings destroyed and 44 damaged, and 82 small businesses destroyed. Damage to residential, farm, and business structures was estimated at $48.5 million.[15] Damage to State roads and bridges in Maryland was estimated to be $6.5 million and to county roads and bridges, $25 million.[16] Flooding along the larger streams and rivers severely damaged or destroyed crops through erosion or silt deposition. Excessive runoff into the Chesapeake Bay decreased salinity levels and severely affected the shellfish industry.[17]

Hurricane of 1933

Prior to Agnes, this storm was the storm of record in terms of flooding. The storm caused 13 deaths statewide and $12.3 million in damages.

13.4 NATIONAL FLOOD INSURANCE PROGRAM

The National Flood Insurance Program (NFIP) was enacted by the Federal government in 1968 to facilitate citizens' access to affordable flood insurance and shift the burden of private property flood losses from taxpayers to floodplain property owners. The program is also designed to guide development away from flood hazard areas and requires new design and construction to be carried out in a way that minimizes or prevents flood damage.[18]

Baltimore County NFIP Policy and Claim Information (as of 10/31/2013)

Number of policies in force: 4,654
Total coverage value: $1,091,896,600
Number of claims: 2,970
Total claim value: $64,186,927

Source: bsa.nfipstat.fema.gov, 2013

Baltimore County NFIP Policy and Claim Information (as of 03/31/2021)

Number of policies in force: 3,421
Total coverage value: $926,965,500
Number of claims: 3,208
Total claim value: $66,924,935

Source: https://nfipservices.floodsmart.gov//reports-flood-insurance-data, 2021

Presently, Baltimore County has fewer policies in force than it did in 2013; total policies have decreased by 1,233. The total value of flood insurance coverage has also decreased by $164,931,000.

The fewer policies in force as compared to 2013 may be due to changes between the previous effective FIRM (8/2/2011) and the current effective FIRM (5/5/2014). The Special Flood Hazard Area (SFHA) boundaries within the coastal regions of Baltimore County were updated due to new engineering analysis performed within the Flood Risk Project. The updated modeling produced new flood zone areas and new base flood elevations.

Both the SFHA and non-SFHA areas decreased in total area (mi^2). The SFHA decreased by 2.8 mi^2 and the non-SFHA area decreased by 3.3 mi^2. The decrease in total land area for these zones may translate into less structures within the zones, which could explain the decrease in total NFIP policies in force.

13.4.1 Coastal Flood Mapping

A Flood Insurance Rate Map (FIRM), created for floodplain management insurance purposes, is an official map of a community on which FEMA has delineated both the special hazard areas and the risk premium zones applicable to the community. Digital versions of these maps are called DFIRMS, which are compatible with Geographic Information Systems (GIS). The improvements in spatial accuracy provided by the new base map, and the availability of electronic floodplain information should greatly enhance the ability to use the maps for planning, permitting, and insurance applications.[19]

The State of Maryland in conjunction with the Federal Emergency Management Agency (FEMA) has been systematically updating Flood Insurance Rate Maps (FIRMs) for communities over the past several years. As of May 1, 2021, Baltimore County's Preliminary Map release date for coastal flood mapping was August 2020 and the Effective Map date is May 2014[20]. Updated effective floodplain mapping is slated for release in September of 2022. Baltimore County utilizes the May 2014 coastal mapping for insurance rates only; for building purposes in coastal areas, property owners must build in accordance with the 2008 FIRM, which follows the most current Baltimore County Code.

13.4.2 Community Rating System

The NFIP's Community Rating System (CRS) is a voluntary incentive program that recognizes communities for implementing floodplain management practices that exceed the Federal minimum requirements of the NFIP to provide protection from flooding.

In exchange for a community's proactive efforts to reduce flood risk, policyholders can receive reduced flood insurance premiums for buildings in the community. These reduced premiums reflect the reduced flood risk resulting from community efforts toward achieving the three CRS goals:

1. Reduce flood damage to insurable property;
2. Strengthen and support the insurance aspects of the NFIP;
3. Encourage a comprehensive approach to floodplain management.

CRS Credit Opportunities

According to a 2020 report conducted by the Chesapeake Conservancy, Baltimore County is eligible for up to 578 Open Space Preservation (OSP) credits, qualifying for a 5% discount to flood insurance. This is possible due to the considerable headway Baltimore has made in preserving open space within their floodplains. Of the almost 18,000 acres of floodplain, 7,151 acres (or about 40%) of it is preserved open space. To reach the 10% discount, the County would have to preserve another 5,206 acres of its floodplain.

Source: "Land Conservation and the Community Rating System: Mapping Open Space Preservation Opportunities in Maryland Communities." Chesapeake Conservation Partnership, July 2020

Participation in the Community Rating System (CRS) is voluntary. By participating, communities earn credit points that determine classifications. There are 10 CRS Classes: Class 1 requires the most credit points and provides the largest flood insurance premium reduction (45 percent), while Class 10 means the community does not participate in the CRS or has not earned the minimum required credit points, and residents receive no premium reduction. The CRS Classes are based on completion of 19 creditable activities organized into four categories:

1. Public Information
2. Mapping and Regulations
3. Flood Damage Reduction
4. Warning and Response

Table 13-5. CRS Credit Points, Classes, and Premium Discounts

Credit Points	Class	Premium Reduction SFHA*	Premium Reduction Non-SFHA**
4,500+	1	45%	10%
4,000 – 4,499	2	40%	10%
3,500 – 3,999	3	35%	10%
3,000 – 3,499	4	30%	10%
2,500 – 2,999	5	25%	10%
2,000 – 2,499	6	20%	10%
1,500 – 1,999	7	15%	5%
1,000 – 1,499	8	10%	5%
500 – 999	9	5%	5%
0 – 499	10	0	0

*Special Flood Hazard Area
**Preferred Risk Policies are available only in B, C and X Zones for properties that are shown to have a minimal risk of flood damage. The Preferred Risk Policy does not receive premium rate credits under the Community Rating System because it already has a lower premium than other policies. The Community Rating System credit for AR and A99 Zones are based on non-Special Flood Hazard Areas (non-SFHAs) (B, C and X Zones).

13.5 REPETITIVE LOSS PROPERTIES

Repetitive loss properties are the biggest drain on this country's Flood Insurance Fund. According to the NFIP, a property is considered a repetitive loss property (RLP) when there are two or more losses reported and $1,000 or more was paid on each loss. The two losses must be within ten years of each other and be at least ten days apart; only losses proceeding January 1, 1978, are considered. Additionally, a property may be considered a 'severe repetitive loss property' if it meets the following criteria:

- Has at least four NFIP claim payments (including building and contents) over $5,000 each, and the cumulative amount of such claims payments exceeds $20,000; or
- For which at least two separate claims payments (building payments only) have been made with the cumulative amount of the building portion of such claims exceeding the market value of the building.

- For both (a) and (b) above, at least two of the referenced claims must have occurred within any ten-year period and must be greater than 10 days apart.

As of April 27, 2021, Baltimore County has 177 total repetitive loss properties; 102 of which are coastal properties (which is 58% of the total RLPs). Of these 102 coastal RLPs, one is a severe repetitive loss property. Coastal communities with repetitive loss properties are listed in Table 13-6, below. Figure 13-1 depicts the percentage of coastal RLPs that have NFIP flood insurance versus those that do not.

Figure 13-1.

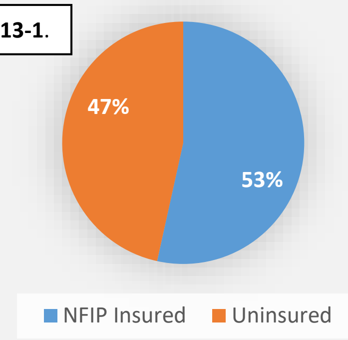


Table 13-6. Coastal Communities with the Greatest Amount of RLP in the County

Community	# of Properties	% of total RLP (out of 102)
Dundalk	10	9.80%
Essex	3	2.94%
Fort Howard	1	0.98%
Middle River	44	43.14%
Sparrows Point	43	42.16%
White Marsh	1	0.98%
Total:	**102**	**100%**

Repetitive Loss Data Source: Terry Curtis, Baltimore County.

The repetitive loss data contained in Table 13-7 has been redacted due to issues of privacy. This data is available for official use in *Appendix I: Repetitive Loss Data (Official Use Only).*

Table 13-7. Coastal NFIP Repetitive Loss Properties

Street Name	Total Properties	Street Name	Total Properties
[redacted]			

[redacted]

13.6 HAZUS LEVEL 2 COASTAL FLOOD ANALYSIS

A HAZUS Level 2 Analysis was conducted for *Chapter 13: Coastal Storm and Flooding* in 2014. As part of the 2021 Plan Update this analysis was modified to reflect current estimates provided by the American Community Survey (5-year). Full results from the 2020 U.S. Census are not yet available and are slated for release in late summer of 2021.

Results of this type of analysis include essential facility and general building stock damages, debris generation, shelter requirements, and associated economic losses. This level of analysis is more accurate than a Level 1 Analysis because the data used for the analysis is derived from user-supplied sources, including best-available data specific to Baltimore County, as well as data available in the Hazus database. Examples of user-supplied data utilized for this analysis include:

- Building stories
- Year built
- Structure value
- Square Footage

<u>U.S. Census Bureau Data Utilization</u>

The HAZUS analysis conducted during the 2014 Plan Update utilized the most recent version of the software (version 2.1), which was released in October of 2013. At the time of this HAZUS Level 2 Analysis for Coastal Flood, FEMA had not yet integrated 2010 Census data into the Hazus version 2.1 software. As such, household numbers and other demographic data had been increased by 5.6% to better represent the total number of households (316,716) in Baltimore County per the 2010 U.S. Census. This percentage increase was derived by determining the percent change in demographic data from 2000 to 2010. For example, the total number of households in Baltimore County had changed from 299,000 in 2000 to 316,715 in 2010, which represented an increase of 17,715 households. This change was calculated as a percentage (5.6%) and related household values were increased by this amount where necessary (see

Table 10-6). In the case of population estimates, a 6.3% change was calculated and added to necessary population values.

Results from the 2014 HAZUS analysis within this section have been modified with estimated values for the 2021 Plan Update. This is because 2020 Census data is not currently available. Certain demographic data, such as household size and total population, is provided by ACS 5-year data estimates.
Population results have been increased by 2.775% to better represent the estimated number of people (827,370) in Baltimore County per the 2019 ACS 5-year estimates. This percentage increase was derived by determining the percent change in population data from 2013 to 2020. For example, the total population in Baltimore County has changed from 805,029 in 2010 to 827,370 in 2020, which represents an increase of 22,341 people. This change was calculated as a percentage (2.775%) and related population values were increased by this amount where necessary. In the case of household size estimates, a -1.009% change was calculated and added to necessary household size values.

13.6.1 Introduction

The HAZUS Flood Model analyzes both 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. Depth, duration, and velocity of water in the floodplain are the primary factors contributing to flood losses. The coastal flood model does not estimate the losses due to storm surge currently.

Note: The full report of the HAZUS Level 2 Analysis for Coastal Flood is included in *Appendix E*.

13.6.2 County Overview

Baltimore County is roughly 682 square miles (land and water) and contains 7,879 census blocks. The region contains 313,519 households and has a total population of 827,370 people (ACS 5-year estimate). There are an estimated 269,655 buildings in the region with a total building replacement value (excluding contents) of $77.5 billion (2021 dollars). Approximately 93% of the buildings (and 76% of the building value) are associated with residential housing.

HAZUS Coastal Flood Parameters

Study Region: Baltimore County
Scenario: Coastal Flood
Return Period: 100

Table 13-8, below, provides building exposure values by occupancy type for the coastal flood event scenario. The information contained in this table represents only building stock that was determined by HAZUS to have been affected ("exposed") by the coastal flood event.

Table 13-8. Building Exposure by Occupancy Type for the Scenario		
Occupancy	**Exposure ($) ***	**Percent of Total**
Residential	1,693,618	80.7%
Commercial	275,103	13.1%
Industrial	68,420	3.3%
Agricultural	3,843	0.2%
Religion	16,794	0.8%
Government	20,601	1.0%
Education	20,433	1.0%
Total	**2,098,812**	**100.00%**
Note: Dollar exposure values are produced from the square footage values derived from U.S. Census data, Maryland Property View, and Dun & Bradstreet, by applying the RS Means replacement values for typical building square foot factors and construction for each occupancy type. * 2021 dollars, adjusted for inflation.		

Essential Facility Inventory

Critical facilities were broken down into two groups: essential facilities and high potential loss facilities (HPL). Essential facilities include hospitals, medical clinics, schools, fire stations, police stations and emergency operations facilities. High potential loss facilities include dams, levees, military installations, nuclear power plants, and hazardous material sites.

For essential facilities, there are 25 hospitals in the region with a total bed capacity of 1,800 beds. There are 375 schools, 65 fire stations, 20 police stations and 1 emergency operation center. With respect to high potential loss facilities (HPL), there are 11 dams identified within the region. Of these, 4 of the dams are classified as 'high hazard'. The inventory also includes 66 hazardous material sites, 0 military installations and 0 nuclear power plants.

13.6.3 Damage Estimates

General Building Stock Damage

Hazus estimates that about 89 buildings will be at least moderately damaged, which is defined as damage to the interior of structures from water and some physical damage to building components. This is over 27% of the total number of buildings in the scenario. It is estimated that no buildings will be destroyed during this event. Table 13-7, below, summarizes the expected damage by general occupancy for the buildings in the scenario.

Essential Facility Damage

Before the flood event analyzed in this scenario, Baltimore County had 1,800 hospital beds available for use. On the day of the scenario flood event, the model estimates that all these hospital beds will remain available for use. There is no expected damage to essential facilities.

13.6.4 Induced Flood Damage

Debris Generation

Hazus estimates the amount of debris that will be generated by the flood. The model breaks debris into three general categories: 1) Finishes (dry wall, insulation, etc.), 2) Structural (wood, brick, etc.) and 3) Foundations (concrete slab, concrete block, rebar, etc.). This distinction is made because of the different types of material handling equipment required to handle the debris.

The model estimates that a total of 1,145 tons of debris will be generated. Of the total amount, Finishes comprises 97% of the total, and Structure comprises 1% of the total. If the debris tonnage is converted into an estimated number of truckloads, it will require 46 truckloads (@25 tons/truck) to remove the debris generated by the flood.

Total tons of debris, by census block, generated by the coastal storm event is depicted on Map 13-1. Based on the results, the Essex, Dundalk, Middle River, and Bowleys Quarter areas will have the greatest amount of debris.

The total economic loss estimated for the flood is $16.54 million (2021 dollars), which represents 0.79 % of the total replacement value of the scenario buildings.

13.6.5 Economic Loss

Building-Related Losses

Building losses are broken into two categories: direct building losses and business interruption losses. The direct building losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the flood. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the flood.

The total building-related losses were $16.36 million (2021 dollars). Less than 1% of the estimated losses were related to the business interruption of the region. The residential occupancies made up 62% of the total loss. Table 13-9, below, provides a summary of the losses associated with the building damage.

Table 13-9. Building-Related Economic Loss Estimates (2021 Dollars)

Type	Residential	Commercial	Industrial	Others	Total
Building	$6,623,880	$1,180,380	$194,820	$148,980	$8,136,600
Content	$3,632,820	$3,357,780	$217,740	$928,260	$8,148,060
Inventory	$0	$22,920	$45,840	$0	$68,760
Total	$10,256,700	$4,561,080	$458,400	$1,077,240	$16,353,420

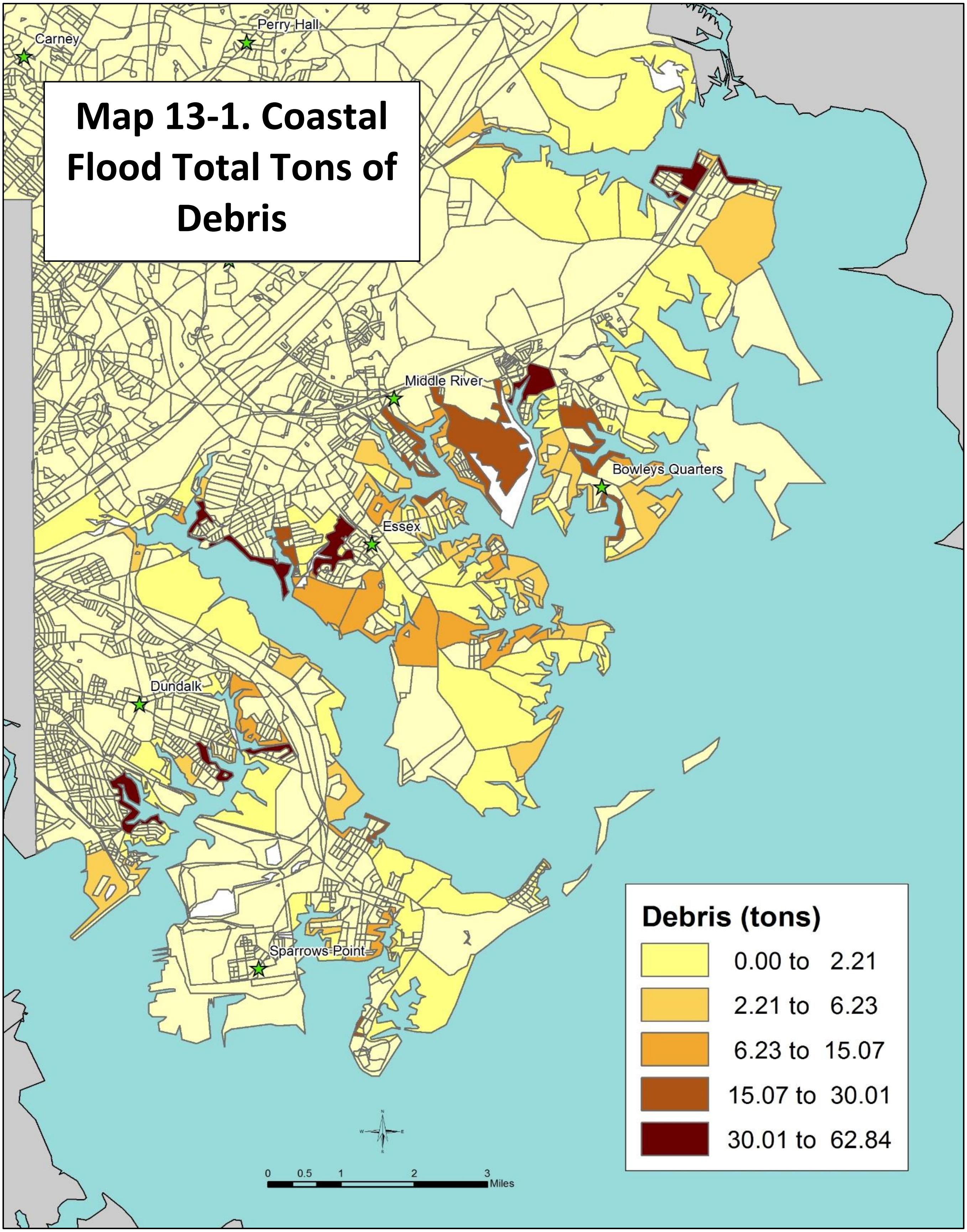
Building-related economic losses are depicted on Map 13-2. Based on the results, the Essex, Dundalk, Middle River, and Bowleys Quarter areas will have the greatest amount of building loss.

13.6.6 Social Impact

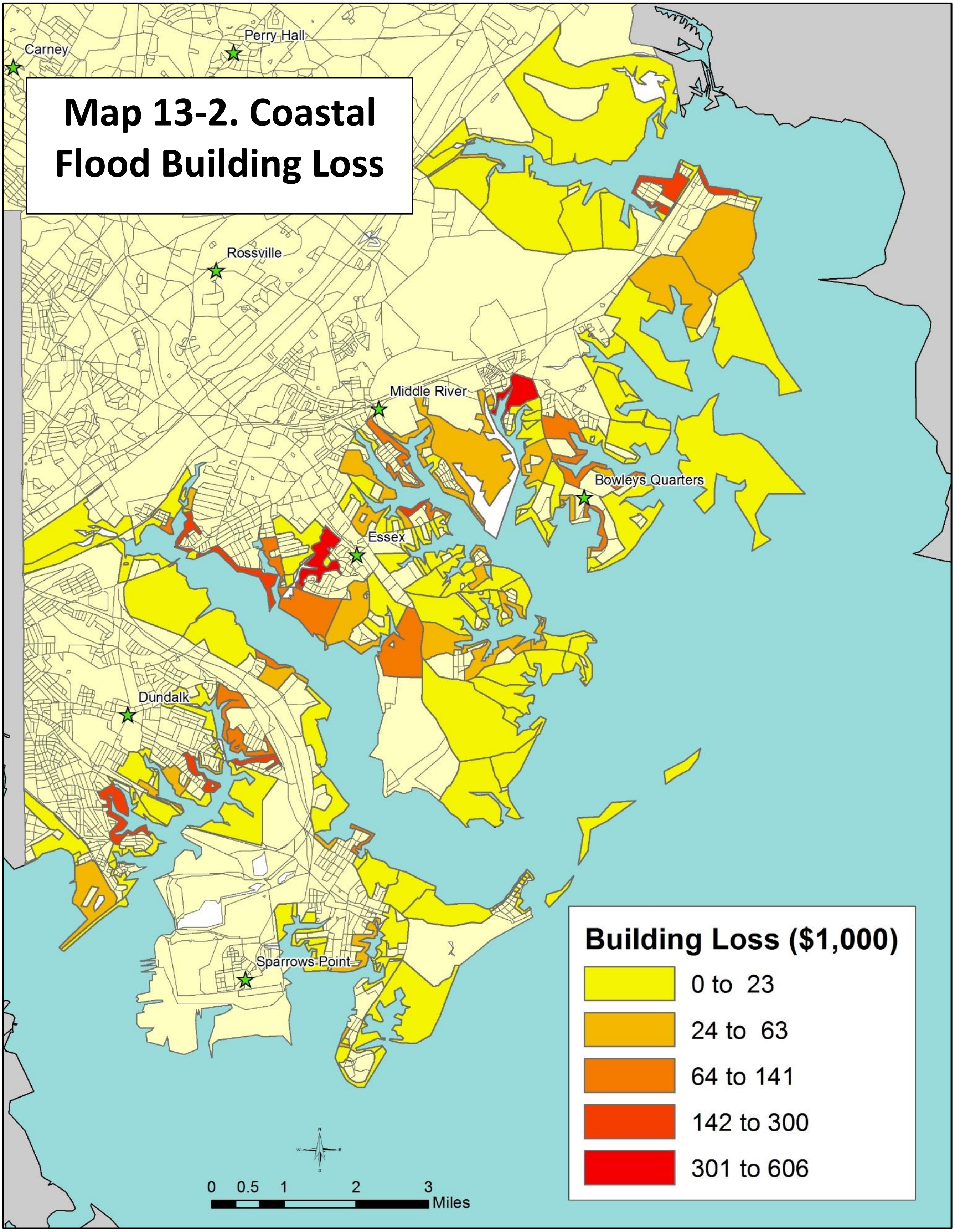
Shelter Requirements

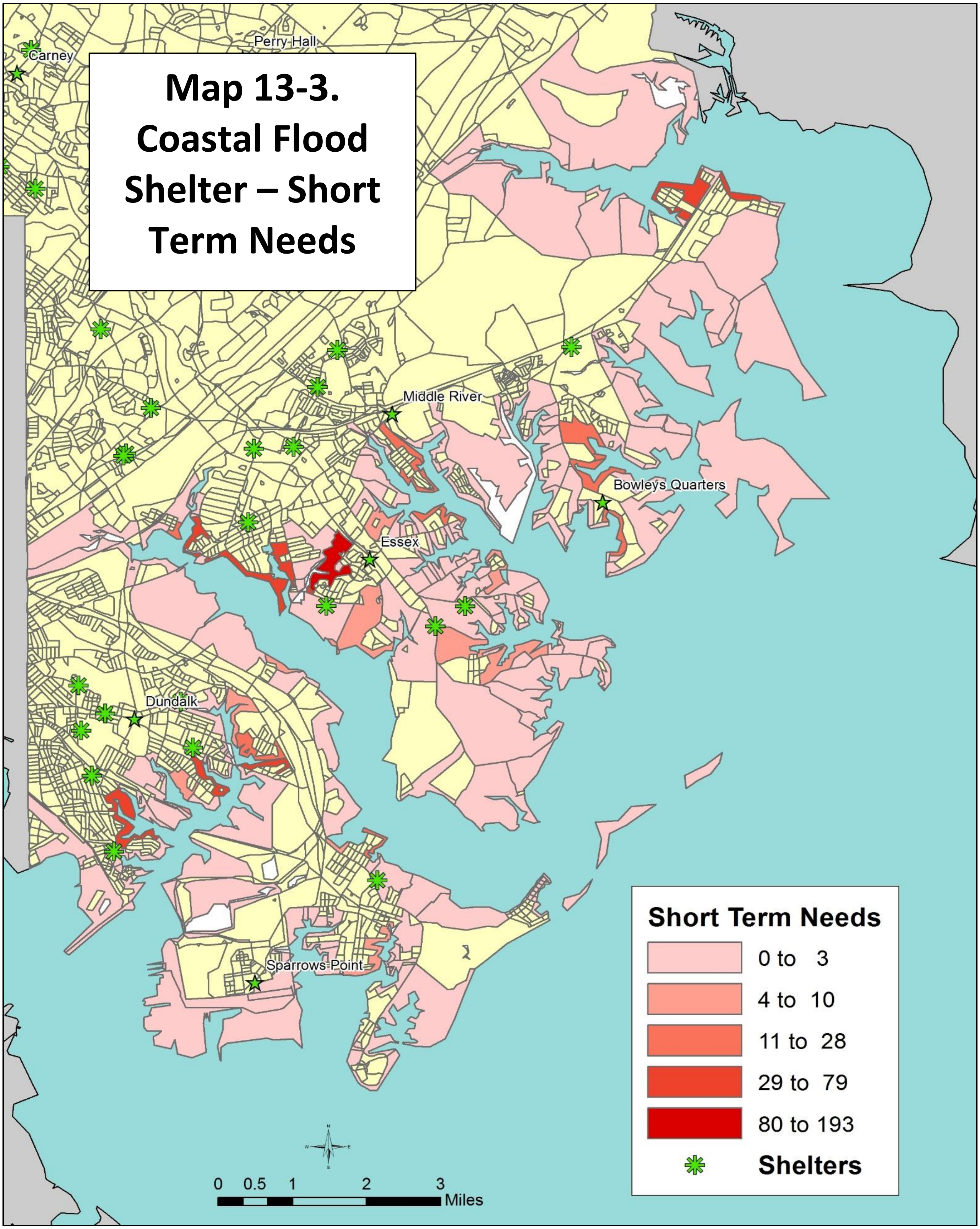
Hazus estimates the number of households that are expected to be displaced from their homes due to the flood and the associated potential evacuation. Hazus also estimates those displaced people that will require accommodations in temporary public shelters. The model estimates 605 households will be displaced due to the flood. Displacement includes households evacuated from within or extremely near to the inundated area. Of these, 1,099 people (out of a total population of 827,370) will seek temporary shelter in public shelters.

These short-term shelter needs are depicted by census block on Map 13-3. Based on the results, the Essex, Dundalk, Middle River, and Bowleys Quarters areas will have the highest demand for short term sheltering.



Map 13-1. Coastal Flood Total Tons of Debris
Carney
Perry Hall
Middle River
Bowleys Quarters
Essex
Dundalk
Sparrows Point
Debris (tons)
0.00 to 2.21
2.21 to 6.23
6.23 to 15.07
15.07 to 30.01
30.01 to 62.84
0 0.5 1 2 3 Miles


Map 13-2. Coastal Flood Building Loss
Carney
Perry Hall
Rossville
Middle River
Bowleys Quarters
Essex
Dundalk
Sparrows Point
Building Loss ($1,000)
0 to 23
24 to 63
64 to 141
142 to 300
301 to 606
0 0.5 1 2 3
Miles


Map 13-3. Coastal Flood Shelter – Short Term Needs
Carney
Perry Hall
Middle River
Bowleys Quarters
Essex
Dundalk
Sparrows Point
Short Term Needs
0 to 3
4 to 10
11 to 28
29 to 79
80 to 193
Shelters
0 0.5 1 2 3 Miles

13.7 COASTAL FLOOD HAZARD ASSESSMENT – INFRASTRUCTURE

13.7.1 Introduction

In the Baltimore County 2014 Hazard Mitigation Plan, infrastructure within the FEMA mapped 100-year coastal floodplain were identified. Identified infrastructure included: roadways, bridges, culverts, and communication towers.

The HAZUS Level 2 Analysis for Coastal Flood primarily considered impacts to residential, commercial, and industrial structures, and essential and critical facilities. Impacts to infrastructure were not included in the HAZUS Level 2 Analysis.

Therefore, to complete the 2021 Plan Update, infrastructure within the 100-year coastal flood zone (based upon the new preliminary FEMA 2020 DFIRM), as well as infrastructure impacted by a Category 3 Hurricane, were identified. Essential facilities were also included in this analysis to factor in the updated DFIRMs. All bridges and culverts included within the analysis are county owned.

A Category 3 hurricane scenario was selected for this assessment. According to the Maryland State Archives hurricanes rarely directly hit the State (only twice since recording began in 1851), and a major hurricane (category 3 or higher) has never directly hit.[21] Presumably, this means that Maryland has only ever been struck by Category 1 and 2 hurricane events. However, to provide a realistic "worst case" scenario, a Category 3 hurricane event was selected.

13.7.2 Data Utilization

The following shapefiles (sources included) were utilized to determine hazard areas and affected infrastructure:

- Storm Surge Category 3 Hurricane – National Weather Service SLOSH Model (2016)
- 100-year floodplain – FEMA Preliminary DFIRM (Effective Date: 8/12/2020)
- Bridges (county-owned) – Baltimore County Office of Information Technology (2020)
- Culverts (county-owned) – FEMA DFIRM Database (8/2/2011)
- Street Centerlines – Baltimore County Office of Information Technology (June 2020)
- Essential Facilities (Fire Stations, Police Stations, Schools, Hospitals/Health Centers, EOCs) – Baltimore County Office of Information Technology (2020)
- Commercial Transmission Towers – Federal Communications Commission (2021)

13.7.3 Method

Data listed in section 13.7.2 was analyzed using ArcMap 10.4.1, a geographic information system (GIS). This program allows various data layers, such as shapefiles, to be overlaid and spatially compared. To determine vulnerable infrastructure within the County, each infrastructure shapefile (bridges, roadways, etc.) was intersected with the 100-year coastal floodplain and the Category 3 hurricane storm surge shapefile. Infrastructure was deemed to be vulnerable to coastal flood if it was within (intersects) either of these layers.

13.7.4 Assessment Results

Based on the 2021 assessment, the following structures were determined to be within the FEMA defined 100-year coastal flood zone and/or the Category 3 hurricane storm surge area:

Bridges within FEMA 100-year coastal flood zone (VE)

In total, there are about 681 bridges within Baltimore County. Of these, none (0) were determined to be within the 100-year coastal flood zone.

Bridges Affected by Category 3 Hurricane

It is estimated that 13 bridges will be impacted by storm surge from a Category 3 Hurricane. Table 13-10, below, details these bridges. Map 13-4 depicts these bridges.

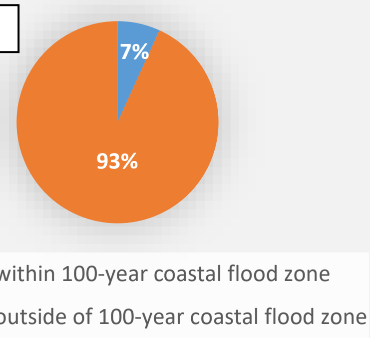
Table 13-10. Bridges Impacted by Storm Surge from Category 3 Hurricane

Bridge/Roadway	River Crossing
Bird River Road	Windlass Run
Church Road	Lynch Cove
E. Homberg Avenue	Deep Creek
Ebenezer Road	Windlass Run
Ebenezer Road	Whitemarsh Run
Golden Ring Road	Northeast Creek
Grange Footbridge	Lynch Cove
Kelso Drive	Stemmers Run
Loreley Beach Road	-
Race Road	Stemmers Run
Red Lion Road	Bird River
Seaside Road	Bullneck Creek
Trappe Road	Bear Creek

Culverts within FEMA 100-year coastal flood zone (VE)

In total, there are about 13,566 culverts within Baltimore County. Of these, 921 are within the 100-year coastal flood zone. Figure 13-1 further highlights this relationship. Map 13-5 illustrates culverts in the county within the 100-year coastal flood zone.

Figure 13-1.



Culverts Affected by Category 3 Hurricane

Of the 13,566 culverts within Baltimore County, only 1,633 will be impacted by storm surge from a Category 3 hurricane. Map 13-5 illustrates these culverts.

Roadways within FEMA 100-year coastal flood zone (VE)

In total, there are about 9,875 roadways within Baltimore County. Of these, 15 are within the 100-year coastal flood zone. This translates to about 8 miles (<1% of total road miles) of roadway within the 100-year coastal flood zone. Tables 13-11 and 13-12 list the roadways by total miles impacted, and communities by number of affected roadways, respectively. Map 13-6 illustrates roadways in the county within the 100-year coastal flood zone.

Table 13-11. Roadways by Total Miles Impacted Within 100-year Coastal Flood Zone (VE)

Road Name	Total Miles
11th Street	0.04
13th Street	0.21
14th Street	0.19
I-695	1.66
Baltimore Yacht Club Road	0.32
Carroll Island Road	1.43
Chesapeake Avenue	0.08
G Street	0.16
Hart Miller Island Dike	1.02
Phillips Road	0.33
"Road"	0.86
Sandy Beach Drive	0.69
Service Road	0.38
Slater Road	0.46
Wharf Road	0.14

Table 13-12. Communities by Number of Affected Roadways Within 100-year Coastal Flood Zone (VE)	
Community	**Affected Roadways**
Dundalk	7
Sparrows Point	4
Middle River	2
Essex	2

Roadways Affected by Category 3 Hurricane

In total, there are about 9,875 roadways within Baltimore County. Of these, 742 are within the category 3 hurricane storm surge area. This translates to over 283 miles (6.3% of total road miles) of roadway within the category 3 storm surge area. Tables 13-13 and 13-14 list roadways most impacted by storm urge by total miles, and communities by number of affected roadways, respectively. Map 13-6 illustrates these roadways.

Table 13-13. Roadways Most Impacted by Storm Surge from Category 3 Hurricane*			
Road Name	**Total Miles**	**Road Name**	**Total Miles**
I-695	9.16	Barrison Point Rd	1.37
Pulaski Hwy	5.20	Ebenezer Rd	1.32
Carroll Island Rd	4.51	Chesapeake Park Plz	1.31
Ramp	4.47	Keeners Rd	1.31
Hart Miller Isl Dike	4.17	Holly Neck Rd	1.31
Bowleys Quarters Rd	3.60	Marshy Point Rd	1.30
North Point Rd	3.32	Burke Rd	1.24
Peninsula Expy	3.28	Baltimore Washington Pkwy	1.22
Wilson Point Rd	3.09	Bird River Grove Rd	1.19
Eastern Ave	2.94	Chesapeake Ave	1.18
Dundalk Ave	2.22	Seneca Park Rd	1.18
Southeast Blvd	2.20	Bay Dr	1.16
Riverside Dr	2.16	Eastern Blvd	1.14
North Point Blvd	2.10	Entrance Rd	1.12
Shore Rd	1.84	Cold Mill Rd	1.11
Wharf Rd	1.72	River Drive Rd	1.09
Bethlehem Blvd	1.64	Evergreen Ln	1.09
Bay Shore Rd	1.60	Shipyard Rd	1.06
Finishing Mill Rd	1.57	Wildwood Beach Rd	1.02
White Marsh Blvd	1.55	Warehouse Rd	1.01
Sparrows Point Blvd	1.52		
Broening Hwy	1.48		
Back River Neck Rd	1.45		
Millers Island Rd	1.40		
*Note: only includes roadways with 1 or more miles of roadway within the category 3 storm surge hazard area.			

Table 13-14. Communities by Number of Roadways Impacted by Storm Surge from Category 3 Hurricane	
Community	**Affected Roadways**
Middle River	216
Dundalk	177
Sparrows Point	159
Essex	150
Fort Howard	13
White Marsh	8
Rosedale	7
Linthicum Heights	5
Halethorpe	3
Kingsville	1

<u>Commercial Transmission Towers within FEMA 100-year coastal flood zone (VE)</u>
None

<u>Commercial Transmission Towers Inundated by Category 3 Hurricane</u>

2 Towers
- WPJM (Sparrows Point)
- WPXZ (Baltimore)

<u>Essential Facilities within the FEMA 100-year coastal flood zone (VE)</u>
None

<u>Essential Facilities Inundated by Category 3 Hurricane</u>

The following essential facilities were found to be within the category 3 storm surge inundation area:

Public Schools
- Battle Monument School, Charlesmont Elementary School, Sandy Plains Elementary School, Seneca Elementary School

Fire Stations
- Bowleys Quarter (Station 21), Sparrows Point (Station 57)

Police
- Baltimore County Police Department Marine Unit

The *Baltimore County Climate Action Plan* (CAP) assessed facilities vulnerable to coastal storm surge. Of the seven (7) essential facilities identified above, only one (i.e., Police Marine Unit) was identified within the CAP as being vulnerable to storm surge. Their risk and vulnerability scores, as well as their recommendations for adaptation are included in Figure 13-2 below.

Figure 13-2.

Police Marine Unit

Risk Rank = 30
- Vulnerability Score = 4
  - Within current SFHA
- Criticality = 5
  - Essential Service
- Weighting Factor = 1.5
  - Asset occupancy required

Adaptation Recommendation
- Raise facility
- Est $120,000 to $180,000
- This property and building are owned by the State of Maryland and leased to Baltimore County.
- Review with the State options for improving resilience.
- Pier is County-owned and important to police operations
- Implement pier upgrades to improve resiliency to SLR and storm surge

Source: Baltimore County Climate Action Plan, Resilience Assessment for General County Government Assets, 2021

13.7.5 Assessment Analysis

<u>Transportation Impacts</u>

The analysis indicates that only 15 roadways are within the 100-year coastal flood zone. Most of these roadways, over half, are in the Dundalk and Sparrows Point communities. The number of roadways within the category 3 hurricane storm surge area is much higher, with 742 roads being affected. Communities with the greatest density of roadways within the category 3 storm surge area are: Middle River, Dundalk, Sparrows Point, and Essex. Roadways in these four regions comprise 95% of all the impacted roadways in the coastal communities of Baltimore County.

<u>River Drive Road</u>

Coastal repetitive loss properties were identified in section 13.5 of this chapter. The roadway with the greatest amount of repetitive loss properties, 20, was River Drive Road. This roadway has been identified as one of the most impacted roadways from storm surge associated with a category 3 hurricane. It would be prudent for Baltimore County to focus coastal flood mitigation efforts in this location.

<u>Development Impacts</u>

According to Baltimore County’s Master Plan 2020, Owings Mills is the County’s designated Growth Area, Middle River is a Redevelopment Area, and Pulaski Highway is also a Redevelopment Area.

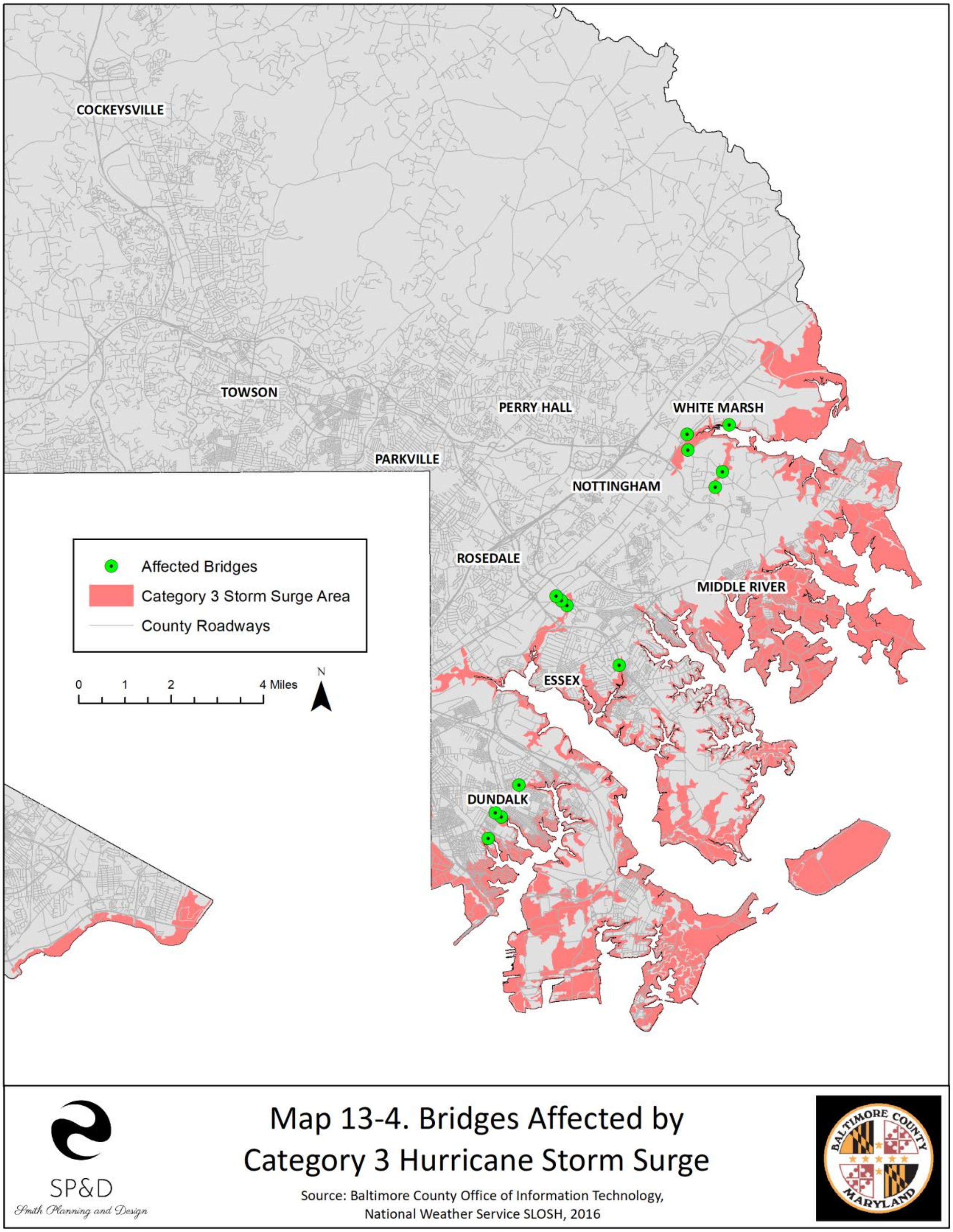
Owings Mills Growth Area

Based on both the HAZUS Level 2 Analysis and the Infrastructure Analysis, the Owings Mills area can expect to face virtually zero impacts from a 100-year coastal flood event due to its inland location.

Middle River & Pulaski Highway Redevelopment Areas

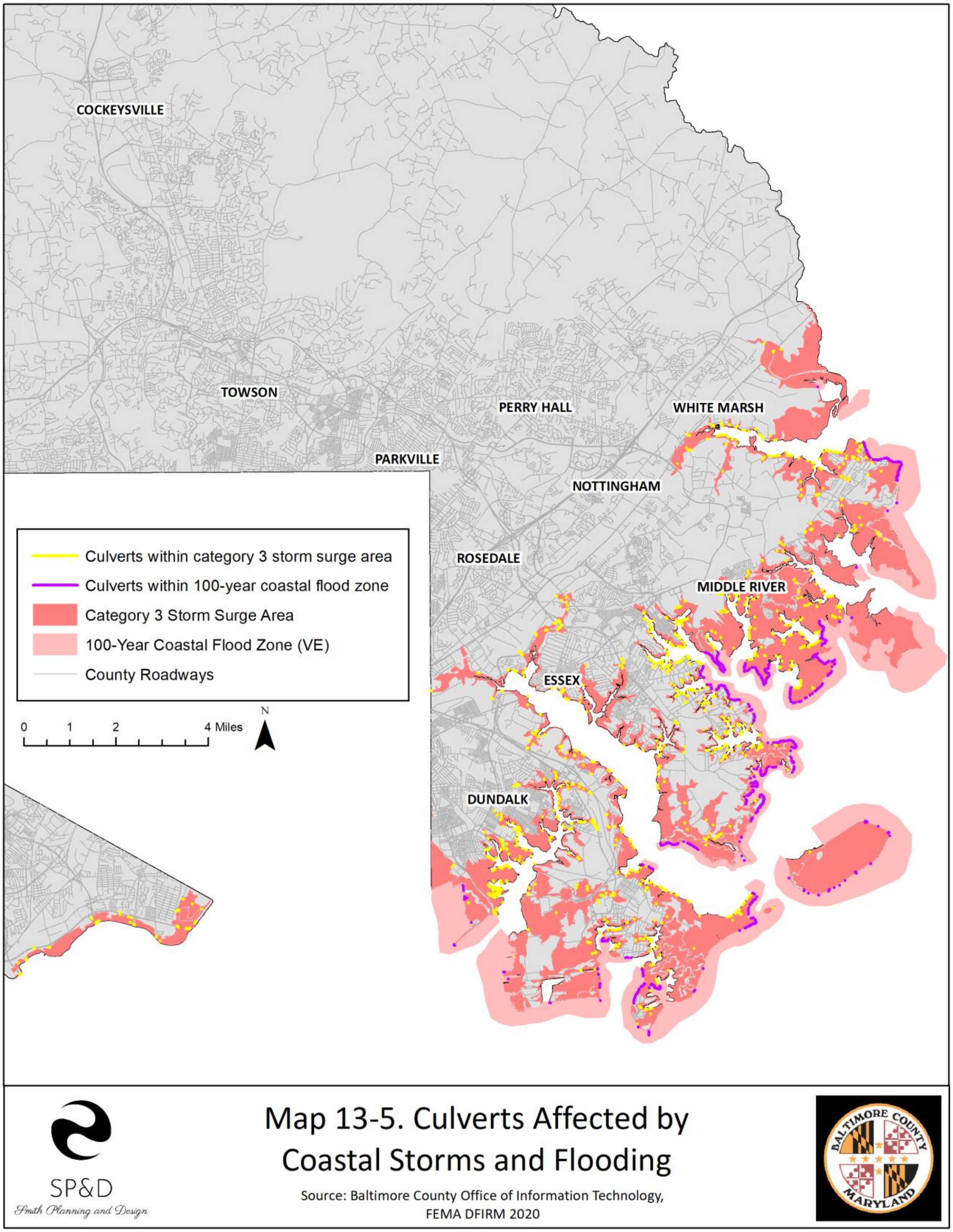
Baltimore County's *Master Plan 2020* identifies a 920-acre district along a five-mile segment of Pulaski Highway U.S.40 in the Middle River community as a potential target area for community-scaled redevelopment.

The largest problem the Middle River area may face is related to the number of roadways within the category 3 storm surge area. Combined with roadways within the 100-year coastal flood zone, Middle River has a total of 218 effected roadways. Pulaski Highway, within Middle River, also faces floodplain problems. Just over 2.5 miles of the highway is within the category 3 hurricane storm surge area.



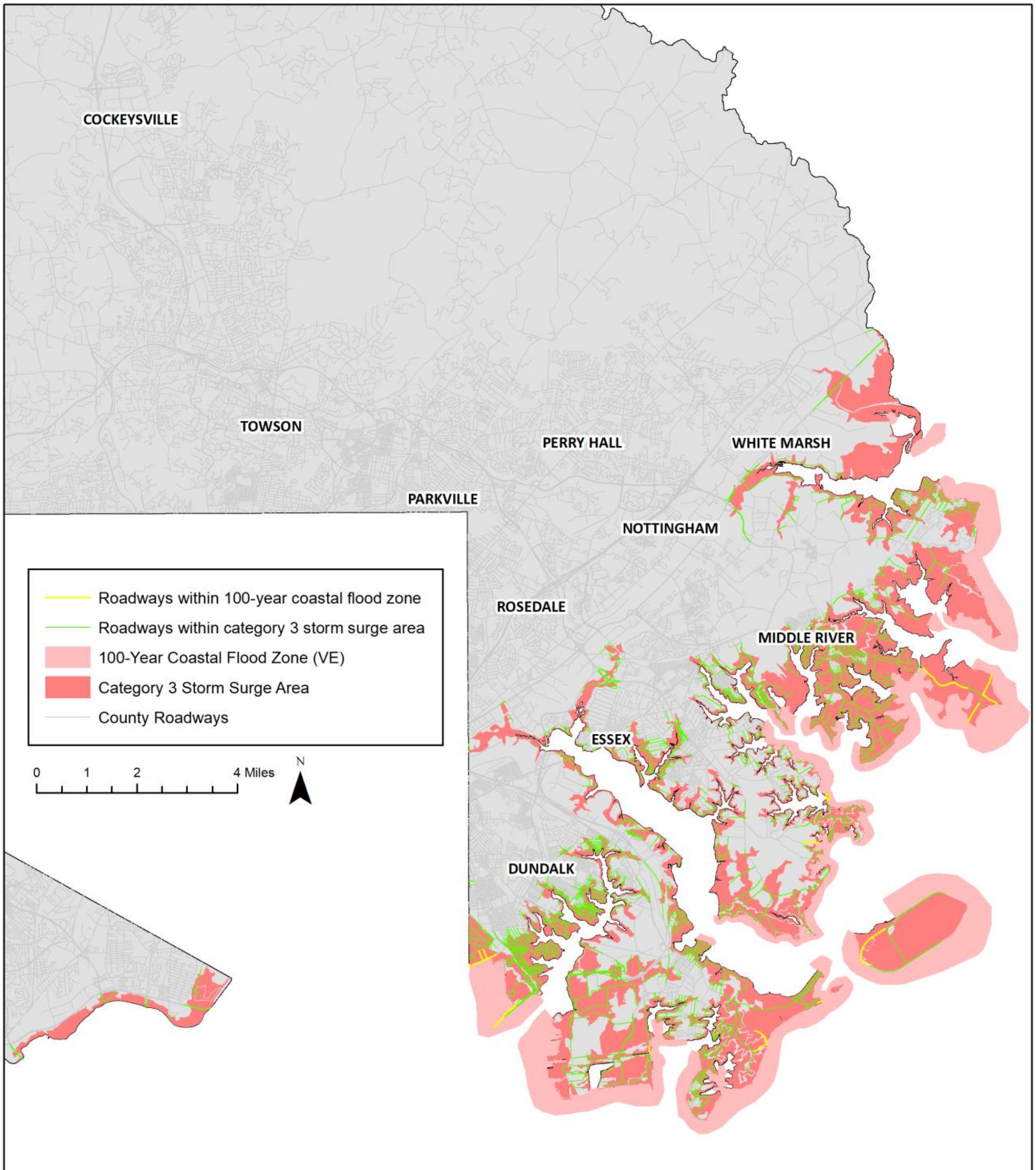
Map 13-4. Bridges Affected by Category 3 Hurricane Storm Surge

Source: Baltimore County Office of Information Technology, National Weather Service SLOSH, 2016



Map 13-5. Culverts Affected by Coastal Storms and Flooding

Source: Baltimore County Office of Information Technology, FEMA DFIRM 2020



Map 13-6. Roadways Affected by Coastal Storms and Flooding

Source: Baltimore County Office of Information Technology, FEMA DFIRM 2020, National Weather SLOSH, 2016

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Smith Planning and Design

13.8 SOCIAL VULNERABILITY

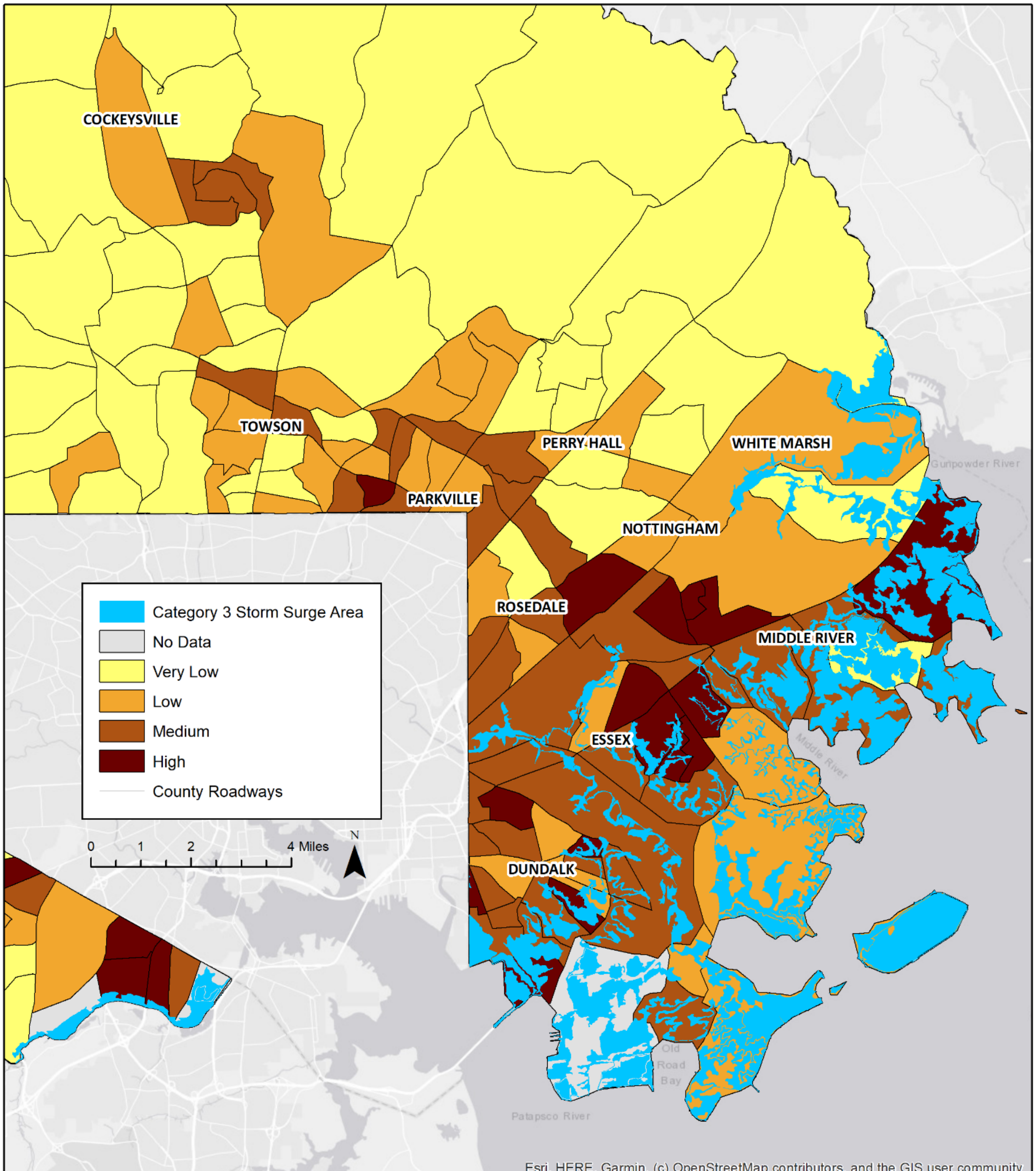
According to the Center for Disease Control and Prevention (CDC), social vulnerability refers to “the negative effects on communities caused by external stresses on human health. Such stresses include natural or human-caused disasters, or disease outbreak.” Reducing social vulnerability can decrease both human suffering and economic loss.[22]

The CDC developed a Social Vulnerability Index (SVI) to help local jurisdictions determine their level of vulnerability based on fifteen (15) indicators that are routinely utilized to measure social vulnerability. These indicators are as follows:

- **Socioeconomic Status**
    1. Below Poverty
    2. Unemployed
    3. Income
    4. No High School Diploma
- **Household Composition & Disability**
    1. Aged 65 or Older
    2. Aged 17 or Younger
    3. Civilian with a Disability
    4. Single-Parent Households
- **Minority Status & Language**
    1. Minority
    2. Speaks English “Less than Well”
- **Housing Type & Transportation**
    1. Multi-Unit Structures
    2. Mobile Homes
    3. Crowding
    4. No Vehicle
    5. Group Quarters

The SVI has been conducted for Baltimore County at the census tract level and is mapped on the follow page. The SVI utilizes ACS 5-year estimates. The darker census tracts indicate areas of higher social vulnerability while the lightest tracts indicate relatively low social vulnerability. The SVI results have been mapped alongside category 3 storm surge to aid in determining areas of concern where coastal flood mitigation activities might make the most sense due to increased vulnerability. Areas of concern are locations where high social vulnerability and extensive category 3 storm surge overlap. These areas (Map 13-7, next page) are as follows:

- Southeast Baltimore County
    - Dundalk
    - Essex
    - Middle River



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Map 13-7. Social Vulnerability and Category 3 Storm Surge

Source: CDC/ATSDR SVI 2018, ACS 5-year Estimates, National Weather SLOSH, 2016

13.9 2021 MITIGATION GOALS AND ACTION ITEMS

During the 2021 Plan Update, new mitigation goals and action were added. Additionally, previous mitigation goals and action items from the 2014 Plan were reviewed, and those that were determined to be still in progress or relevant were included.

GOAL 1: Promote hazard mitigation as the cornerstone of emergency management in Baltimore County.

OBJECTIVE	ACTION ITEM(S)	RESPONSIBLE ENTITY	RANKING (HIGH, MEDIUM, OR LOW)
1. Public awareness and planning are crucial for safety and minimizing stress during weather events that affect the waterfront.	a. Continue to provide information on the County's social media about coastal storm risk and vulnerability.	County	Medium
2. Provide technical assistance for homeowners regarding coastal storms and flooding.	a. Develop a technical assistance information program for homeowners to teach them how to strengthen their homes against coastal storms. The program could include providing local government building departments with copies of existing strengthening and repair information for distribution to homeowners. Other potential distribution sources include insurance companies, realtors, homeowner associations, and libraries.	County	Medium
3. Continue to build CRS credit by participating in qualifying CRS activities.	a. Conduct NFIP Workshop targeting insurance and real estate agents as well as loan officers working in Baltimore County. Offer continuing education credit and request a FEMA provided instructor.	County, Department of Public Works and Transportation	High
	b. Conduct a Flood Ordinance and FEMA Mapping Workshop targeting surveyors, engineering firms, and developers that conduct business in Baltimore County.	County	Medium

GOAL 2: Eliminate or reduce human, environmental, social, and economic loss from natural and technological hazards.

OBJECTIVE	ACTION ITEM(S)	RESPONSIBLE ENTITY	RANKING (HIGH, MEDIUM, OR LOW)
4. Continue to adapt to and mitigate impacts of climate change on the environment.	a. Implement the recommendations of the County's Sustainability Network for County operations, energy conservation, protection of natural resources, and communities to reduce emissions of greenhouse gases and energy consumption.	County	Medium

GOAL 2: Eliminate or reduce human, environmental, social, and economic loss from natural and technological hazards.			
OBJECTIVE	**ACTION ITEM(S)**	**RESPONSIBLE ENTITY**	**RANKING (HIGH, MEDIUM, OR LOW)**
5. Enforce current building standards.	a. Continue to perform building inspections to ensure compliance with current building standards as they relate to coastal flooding.	County	Medium
6. Identify flood prone properties and communities/areas for mitigation efforts.	a. Focus flood mitigation efforts in the coastal communities identified as having the greatest amount of Repetitive Loss Properties: Middle River, Sparrows Point, and Dundalk (Table 13-6).	Middle River, Sparrows Point, Dundalk	Medium
	b. Elevate or acquire repetitive loss and severe repetitive loss properties affected by coastal flooding when funding from State and Federal sources is available.	County, Department of Public Works and Transportation	Medium
	c. Acquired properties that are adjacent should be considered for open space projects. Prime examples include RLP properties on River Drive Road (see 13.7.5).	County, River Drive Road	Medium
	d. Identify pre-FIRM structures located within the coastal high hazard area and determine the mitigation measures that are needed to reduce flooding.	County	Medium
	e. Obtain additional information on properties within identified high hazard areas. Ex. Lowest floor elevation.	County	Medium
	f. During the next review and/or update to the Master Plan, evaluate the Middle River and Pulaski Highway Redevelopment areas in terms of flood hazard inundation areas. Prioritize projects within the mapped redevelopment areas that are located outside of flood hazard areas.	Middle River, Pulaski Highway Areas	Medium
	g. Adopt and integrate recommendations for coastal flood mitigation measures as outlined in the Climate Action Plan.	County	Medium

13.10 EXISTING COASTAL STORMS AND FLOODING MITIGATION ACTIVITIES

Baltimore County's current capabilities provide a framework for future mitigation action items.

- National Flood Insurance Program (NFIP)
    - Enforce floodplain management regulations in identified flood hazard areas
    - Bill 173-93 Floodplain Management Ordinance adopted in 1993 which complies with Section 60.3 (D) of the regulations for the National Flood Insurance Program as revised on October 1, 1986
    - Citizens are eligible to purchase flood insurance that is not normally available through private insurance companies

- Utilization of FEMA's flood mapping program called Risk Mapping, Assessment, and Planning, or Risk MAP.
- Building Codes
  - New buildings and substantially improved structures within areas subject to tidal flooding must not have their lowest floor lower than one foot above flood protection elevation.
  - New buildings, additions, substantial improvements, and repetitive loss properties are not allowed to have basements.
  - Ground floor may be used for storage or garage but must include flood venting.
  - Any accessory structures larger than 300 square feet should be outside the floodplain when feasible. When not feasible, structures must meet the same flood codes as the house.
- Participation in the national "Turn Around, Don't Drown" program.
- Utilization of social media (Facebook, Twitter, Instagram) to disperse warnings and information prior to and during a severe weather and/or flood event.

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CHAPTER 14: Pandemic and Emerging Infectious Diseases

UPDATES

During the 2021 Plan Update process the stakeholder group identified a new hazard to be included as a chapter in the Hazard Mitigation Plan. The Chapter, **Pandemic and Emerging Infectious Diseases,** was added to the Plan with the most recently available data.

Chapter Highlights

1. How are Pandemics and Emerging Infectious Diseases a Threat to Baltimore County?
   - Overview of Epidemics and Pandemics
   - The difference between pandemic, epidemic, and emerging infectious disease
2. Contributing factors to pandemic and emerging infectious disease risk
   - Results of the HIRA were added to *Section 14.2.* Pandemic and Emerging Infectious Diseases risk is ranked as "High." See Appendix A for full results.
3. History of notable pandemics and epidemics
4. Vulnerability Assessment
   - COVID-19
   - Social Vulnerability
5. Capability Assessment and Mitigation Strategies
6. 2021 Mitigation Goals and Action Items

14.1 HOW ARE PANDEMICS AND EMERGING INFECTIOUS DISEASES A THREAT TO BALTIMORE COUNTY?

We live in an ever-connected world and the benefits seem limitless. At present, the average U.S. citizen can travel coast-to-coast in less than six hours. A round trip flight out of BWI airport to Los Angeles can be purchased for just about $200. When we travel, however, there are additional costs than the ticket price – this has been made devastatingly clear in the face of a yearlong global pandemic. As demonstrated by the COVID-19 pandemic, not only has human health been jeopardized, but also the social and economic well-being of the world.

Pandemic refers to an epidemic that has spread over several countries or continents, usually affecting a large number of people. **Epidemics** occur when an agent and susceptible hosts are present in adequate numbers, and the agent can be effectively conveyed from a source to the susceptible hosts.

Centers for Disease Control and Prevention CDC.gov

14.1.1 Epidemic

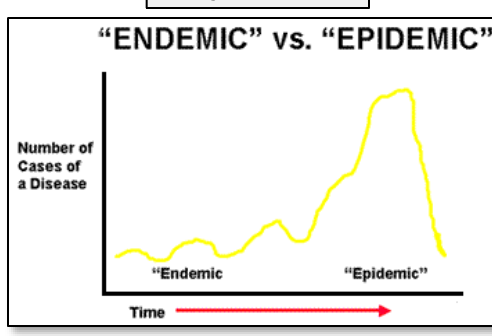
The amount of a particular disease that is usually present in a community is referred to as the baseline or endemic level of the disease. This term refers to the constant presence and/or usual prevalence of a disease or infectious agent in a population within a geographic area, such as Baltimore County.

Sometimes the amount of disease in a community rises above the expected level; this is known as an epidemic. Epidemics are characterized by an increase, often sudden, in the number of cases of a disease above what is normally expected in that population in that area. While some diseases are so rare in each population that a single case warrants an epidemiologic investigation (e.g., rabies, plague, polio), other diseases occur more commonly so that only deviations from the norm warrant investigation.[1] Figure 14-1 provides a visual representation of the difference between endemic and epidemic.

According to the Center for Disease Control (CDC), epidemics may commonly result from:

- A recent increase in amount or virulence of the agent;
- The recent introduction of the agent into a setting where it has not been before;
- An enhanced mode of transmission so that more susceptible persons are exposed;
- A change in the susceptibility of the host response to the agent, and/or;
- Factors that increase host exposure or involve introduction through new portals of entry.

Figure 14-1.



Source: Health.mo.gov

Epidemics may also take the form of large-scale incidents of food or water contamination, infestations of disease bearing insects or rodents, or extended periods without adequate water or sewer service. An epidemic may also be a secondary effect from other disasters such as flooding, tornadoes, hurricanes, or hazmat incidents.

14.1.2 Pandemic

The CDC defines a pandemic as "an epidemic that has spread over several countries or continents, usually affecting a large number of people." Similarly, according to the World Health Organization (WHO) a pandemic is defined as "the worldwide spread of a new disease." A pandemic occurs when a new strain of a virus appears for which people have little or no immunity. As a result, it spreads easily from person to person around the world, causing widespread illness and death. Individuals, families, caregivers, healthcare workers, and teachers can all take steps to prepare for a pandemic before it happens.

14.1.3 Emerging Infectious Diseases

According to the CDC, emerging infectious diseases are those whose incidence in humans has increased in the past two decades or threaten to increase in the near future. These diseases, which respect no national boundaries, can challenge efforts to protect workers as prevention and control recommendations may not be immediately available. These diseases include:

- New infections resulting from changes or evolution of existing organisms
- Known infections spreading to new geographic areas or populations
- Previously unrecognized infections appearing in areas undergoing ecologic transformation
- Old infections reemerging as a result of antimicrobial resistance in known agents or breakdowns in public health measures

14.2 CONTRIBUTING FACTORS TO PANDEMIC AND EMERGING INFECTIOUS DISEASE RISK

As part of this plan update, a Hazard Identification and Risk Assessment (HIRA) was conducted for the pandemic and emerging infectious diseases hazard. A composite scoring method was utilized to rank natural hazards, which included five (5) key components: historical impacts (in terms of human lives and property), geographic extent, historical occurrences, future probability, and community perspective.

Based on this method, pandemic and emerging infectious diseases was assigned a ranking of "**High**" during this plan update. The future probability of a pandemic and emerging infectious diseases event is considered "highly likely", as determined by the HIRA. Full results of the HIRA, including method, are included within *Appendix A* of this plan.

Evidence suggests that the likelihood of pandemics has increased over the past century because of increased global travel and integration, urbanization, changes in land use, and greater exploitation of the natural environment.[2] These trends likely will continue and will intensify. Significant policy attention has focused on the need to identify and limit emerging outbreaks that might lead to pandemics and to expand and sustain investment to build preparedness and health capacity.[3]
The most common risk factors related to pandemics and infectious diseases include the following:

- Pandemics have occurred throughout history and appear to be increasing in frequency, particularly because of the increasing emergence of viral disease from animals.
- Pandemic risk is driven by the combined effects of spark risk (where a pandemic is likely to arise) and spread risk (how likely it is to diffuse broadly through human populations).
- Some geographic regions with high spark risk, including Central and West Africa, lag behind the rest of the globe in pandemic preparedness.
- Probabilistic modeling and analytical tools such as exceedance probability (EP) curves are valuable for assessing pandemic risk and estimating the potential burden of pandemics.
- Influenza is the most likely pathogen to cause a severe pandemic. EP analysis indicates that in any given year, a 1 percent probability exists of an influenza pandemic that causes nearly 6 million pneumonia and influenza deaths or more globally.

14.3 HISTORY OF PANDEMIC AND EMERGING INFECTIOUS DISEASES

The following section provides historical context and narrative to some of the worst epidemics, disease outbreaks, and pandemics to ever occur within the United States. This section discusses the following: smallpox pandemic, yellow fever epidemic, cholera pandemic, scarlet fever epidemic, typhoid fever epidemic, H1N1 pandemic, diphtheria epidemic, and the COVID-19 pandemic. Note: this is not an all-inclusive historical account of pandemics, epidemics, and emerging infectious diseases that have occurred in the United States.

Smallpox: 1633-1634

Smallpox came to North America in the 1600s. Symptoms included high fever, chills, severe back pain, and rashes. It began in the Northeast and the Native American population was ravaged by it as it spread to the west.

In 1721, more than 6,000 cases were reported out of a Boston population of 11,000. Around 850 people died from the disease.[4] In 1770, a vaccine was developed by Edward Jenner from cow pox.

Yellow Fever: 1793

During the summer of 1793, refugees fleeing a yellow fever epidemic in the Caribbean carried the virus with them to Philadelphia.

Yellow fever causes yellowing of the skin, fever, and bloody vomiting. During the 1793 outbreak, it is estimated that ten percent of Philadelphia's population died, and many others fled the city to avoid it.[5]

A vaccine was developed and licensed in 1953. One vaccine is enough for life and it is mostly recommended for those nine months and older, particularly if one lives or travels to high-risk areas.

The Centers for Disease Control and Prevention (CDC) provides a list of countries where the vaccine is recommended for travel on their website.[6]

Present: Mosquitoes are key to how this disease spreads, particularly in areas such as Central America, South America, and Africa. Eliminating mosquitoes has been successful in controlling yellow fever. While yellow fever has no cure, someone who does recover from the illness becomes immune for the rest of their life.

Cholera (three waves): 1832-1866

The United States had three serious waves of cholera, an infection of the intestines, between 1832 and 1866. The pandemic began in India and swiftly spread across the globe through trade routes.

New York City was the first U.S. city to feel the impact. Between five and ten percent[7] of the total population died in large cities. While it is not clear how the pandemic ended, it was likely due to the combination of climate change and the use of quarantine measures; by the early 1900s, outbreaks of cholera had ended.

Present: Cholera is responsible for nearly 95,000 deaths a year worldwide[8], according to the CDC. Modern sewage and water treatment have helped eradicate cholera in some countries, but the virus is still present elsewhere. Vaccinations for cholera are available for those planning to travel to high-risk areas. The most effective way to prevent cholera is regular hand washing with soap and water and avoiding consumption of contaminated water.

Scarlet Fever: 1858

Scarlet fever is a bacterial infection that can occur after strep throat. Like cholera, scarlet fever epidemics came in waves. Scarlet fever most commonly affects children ages five to fifteen.[9] Adults who are in contact with sick children have an increased risk.

Studies once indicated that scarlet fever declined due to improved nutrition, but new research suggests that improvements in public health were more likely the cause.

Present: There is no vaccine to prevent strep throat or scarlet fever. It is important for those with strep throat symptoms to seek treatment quickly. Scarlet fever is typically treated with antibiotics.

“Typhoid Mary”: 1906-1907

One of the largest typhoid fever epidemics of all time occurred between 1906 and 1907 in New York. Mary Mallon, often referred to as “Typhoid Mary,” spread the virus to about 122 New Yorkers during her time as a cook on an estate and in a hospital unit. About five of the 122 New Yorkers who contracted the virus by Mary Mallon died.[10] The CDC cites a total of 13,160 deaths in 1906 and 12,670 deaths in 1907. Typhoid fever can cause sickness and red spots to form on the chest and abdomen. A vaccine was developed in 1911, and an antibiotic treatment for typhoid fever became available in 1948.

Present: It is rare to contract typhoid fever today, but it can spread through direct contact with people who have the virus, as well as consumption of contaminated food or water.

H1N1 Flu: 1918

H1N1 is a strain of flu that still circulates the globe annually. In 1918, it was the type of flu behind the influenza pandemic, sometimes referred to as the “Spanish flu” (though it did not actually originate from Spain). After World War I, cases of the flu slowly declined. None of the suggestions provided at the time (wearing masks, drinking coal oil) were effective cures. Today’s treatments include bed rest, fluids, and antiviral medications.

Present: Influenza strains mutate every year, meaning it is important to get receive an annual vaccination to decrease personal risk for the flu.

Diphtheria Epidemic: 1921-1925

Diphtheria peaked in 1921, with 206,000 cases.[11] It causes swelling of the mucous membranes, including within the throat, that can obstruct breathing and swallowing. Sometimes a bacterial toxin can enter the bloodstream and cause fatal heart and nerve damage. A vaccine was produced by researchers in the mid-1920s, which led to a sharp decline in infection rates in the United States.

Present: According to the CDC, more than 80 percent of children in the United States are vaccinated today.[12] Those who contract the disease are treated with antibiotics.

Novel COVID-19: 2019-Present

The Novel COVID-19 pandemic has exploded since cases were first reported in Wuhan, Hubei Province, China in December 2019. As of January,15 2021, the CDC estimates that 83.1 million total infections occurred between February and December of 2020. Of those cases, 70.4 million are estimated to have been symptomatic, and an estimated 4.1 million led to hospitalizations.

Individuals of all ages are at risk for infection and severe disease. The probability of fatal disease is highest in people aged ≥65 years and those living in a nursing home or long-term care facility. Others at highest risk for COVID-19 are people of any age with certain underlying conditions, especially when not well-controlled. In addition, COVID-19 can spread between people who are in close contact with one another (within about 6 feet), via respiratory droplets produced when an infected person coughs, sneezes or talks, and by persons who are asymptomatic. Symptoms, or a combination of symptoms, can appear 2-14 day after exposure. Note: COVID-19 is an evolving pandemic. As such, symptoms are best practices to manage the spread of the virus are still being updated and adjusted by health professionals.

14.4 VULNERABILITY ASSESSMENT

14.4.1 COVID-19 Pandemic Vulnerability Assessment

The National Institute for Environmental Health Services (NIEHS) provides a COVID-19 Pandemic Vulnerability Index (PVI) to be utilized in assessing vulnerability at the county-level for the entire country.

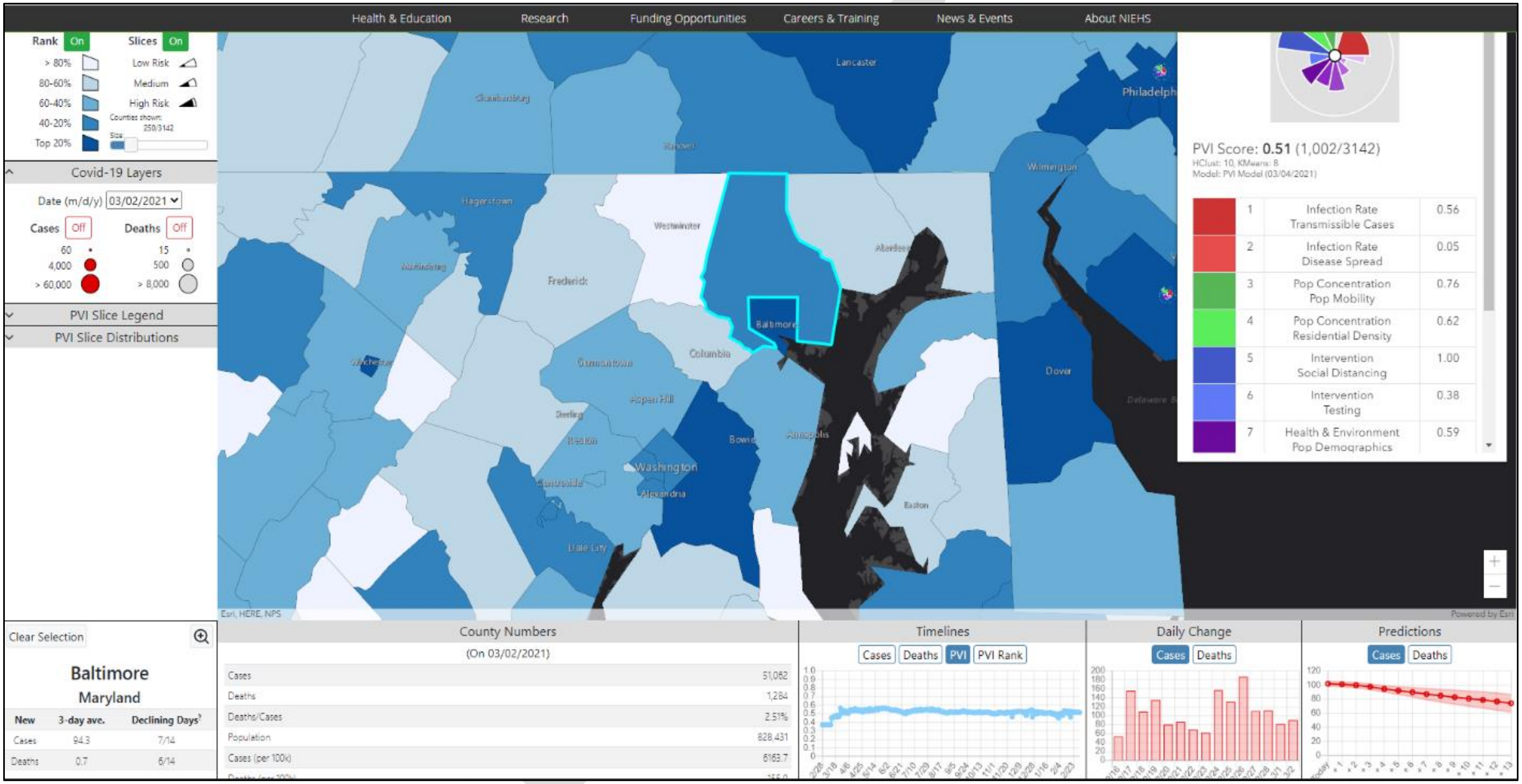
According to the source, the dashboard creates risk profiles, called PVI scorecards, for every county in the United States. It is continuously updated with the latest data. The PVI summarizes and visualizes overall risk in a special version of a pie chart, called a radar chart, where different data sources make up pieces of the pie. Infection rates, depicted in red slices, are labeled 1 and 2. Intervention rates, noted in blue slices 5 and 6, are highly variable and are updated daily. Population concentration and density are fixed values describing general demographic information, and these are shown in green slices 3 and 4. Health and Environmental variables are shown in the purple slices 7-12.

As of March 4, 2021, Baltimore County has an overall PVI score of 0.51. This score has remained relatively stable, having only momentary highs and lows, since data synthesis began a year prior. Compared to other counties in Maryland and the U.S., Baltimore County is in the 40-20% percentile. This indicates that, in the worst-case scenario, less than 20% of all U.S. counties have a higher PVI. As of March 2, 2021, the following table depicts the state of Baltimore County in relation to COVID-19 cases.

Table 14-1. Baltimore County COVID-19 Numbers (as of 03/02/2021)

Cases	51,062
Deaths	1,284
Deaths/Cases	2.51%
Population	828,431
Cases (per 100k)	6163.7
Deaths (per 100k)	155.0

Source: https://covid19pvi.niehs.nih.gov/



Source: https://covid19pvi.niehs.nih.gov

14.4.2 Social Vulnerability Assessment

In the sphere of social science and public health science, policy, and practice, the terms *vulnerable*, *at risk,* and *special* are used in different contexts to describe overlapping segments of the U.S. population. In social science literature, vulnerability has been defined as "the potential for loss"; county-level socioeconomic and demographic data can be used to construct an index of social vulnerability to environmental hazards to guide research and interventions.

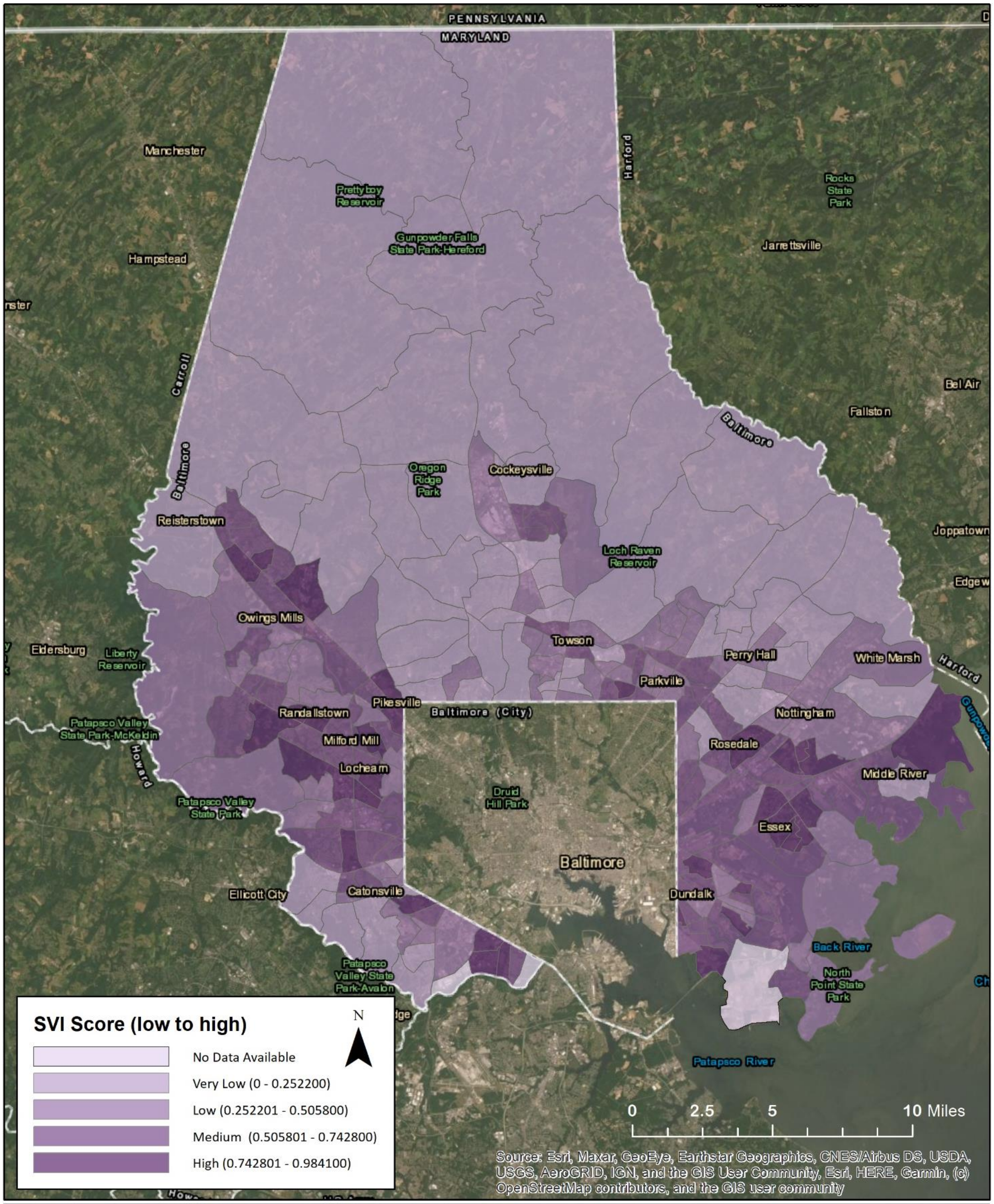
[13] Other researchers have published comprehensive models of vulnerability that are based on likely inequities in health and health care for use in health services research and public health practice.[14]

When discussing vulnerability in terms of public health, vulnerability may be defined as "increased exposure to infection; increased susceptibility to severe disease, including complications, hospitalizations, and death; and lack of access to health care."[15]

With these definitions in mind, Baltimore County should consider the following four questions – developed by the CDC – when addressing the needs of vulnerable populations during a pandemic, epidemic, or disease outbreak:

1. Why is the population considered vulnerable?
2. What are the unique issues, concerns, and needs of each vulnerable population?
3. What strategies can protect these populations?
4. What specific approaches are needed for vulnerable populations, their families, and their health care and service providers to ensure their protection?

A vulnerability assessment method (social vulnerability index – SVI) developed by the CDC and the Agency for Toxic Substances and Disease Registry (ATSDR) addresses the first question by identifying vulnerable populations at a census tract level for all counties in the United States. The method utilizes multiple sets of census data in the form of ACS 5-year estimates. The SVI includes fifteen demographic variables categorized by four "indicator groups" that are commonly used to characterize social vulnerability. The SVI was conducted utilizing 2018 data and the results of the analysis for Baltimore County are depicted on Map 14-1 on the next page. The indicator groups and the data they comprise include **(1) Socioeconomic Status:** Below Poverty, Unemployed, Income, No High School Diploma**; (2) Household Composition & Disability:** Aged 65 or Older, Aged 17 or Younger, Civilian with a Disability, Single-Parent Households; **(3) Minority Status & Language:** Minority, Speaks English "Less than Well"; and **(4) Housing Type &Transportation:** Multi-Unit Structures, Mobile Homes, Crowding, No Vehicle, Group Quarters.



SP&D
Smith Planning and Design

Map 14-1. Social Vulnerability Index - 2018

Source: CDC/ATSDR SVI 2018, ACS 5-year Estimates

The results of the SVI highlight census tracts in Baltimore County with high social vulnerability (dark purple). These tracts, which largely surround Baltimore City, are ideal locations for further examination of vulnerability and indicate locations where increased services and extra care may be necessary for vulnerable populations during a pandemic, epidemic, or disease outbreak.

14.5 CAPABILITY ASSESSMENT AND MITIGATION STRATEGIES

14.5.1 Capability Assessment

Amidst the rising number of COVID-19 cases in early 2020, local governments had to quickly provide information to as many residents as possible in an effective and safe (i.e., socially distanced) manner. Having a robust website and online technical capabilities is a key element in dispersing information and creating a safe and informed population. Baltimore County currently has the following services available to the public:

- Vaccine Registration
- Testing Appointments
- COVID-19 Case Data
- Food Distribution
- Resource Guide
- County Employee Guide

Mass Care Events

In the event of a mass-casualty incident that involved significant health hazards, the Health Officer, as appropriate, would carry out the following activities:

- Initiate epidemic control measures, such as quarantines and mass immunization.
- Identify contaminated and exposed individuals and provide guidance for the treatment and care of these individuals.
- Assist in the identification of areas to which access should be restricted.

Source: Baltimore County Emergency Operations Plan, 2019

The online vaccine hub includes relevant information about the vaccine(s), statistics, how the vaccine is allocated, priority groups, and vaccine registration. There is also an option to schedule an appointment for free testing.

Source: https://coronavirusvaccineoutreach-bc-gis.hub.arcgis.com/

14.5.2 Mitigation Strategies

The CDC recommends the following "guiding principles" to consider when developing and implementing mitigation strategies:

1. Community mitigation efforts aim to reduce the rate at which someone infected comes in contact with someone not infected or reduce the probability of infection if there is contact. The more a person interacts with different people, and the longer and closer the interaction, the higher the risk of COVID-19 spread.
2. Each community is unique. Appropriate mitigation strategies should be based on the best available data. Decision making will vary based on the level of community transmission and local circumstances. Refer to Table 14-2.
3. The characteristics of the community and its population, health system and public health capacity, and the local capacity to implement strategies are important when determining community mitigation strategies.
4. As communities adjust mitigation strategies, they should ensure that the healthcare system capacity will not be exceeded. Precautions should be taken to protect health care professionals and other critical infrastructure workers. Communities need to assure healthcare systems have adequate staffing, a surplus of inpatient and Intensive Care Unit (ICU) beds, and critical medical equipment and supplies such as Personal Protective Equipment (PPE).
5. As communities adjust mitigation strategies, they should ensure public health capacity will not be exceeded. Public health system capacity relies on detecting, testing, contact tracing, and isolating those who are or might be sick, or have been exposed to known or suspected COVID-19 cases; it is important to stop broader community transmission and prevent communities from having to implement or strengthen further community mitigation efforts.
6. Attention should be given to people who are at higher risk for severe illness when determining and adjusting community mitigation strategies.
7. Certain settings and vulnerable populations in a community are at particularly high risk for transmission. This includes but is not limited to congregate settings such as nursing homes and other long-term care facilities, correctional facilities, and the homeless population.
8. Mitigation strategies can be scaled up or down, depending on the evolving local situation, and what is feasible, practical, and legal in a jurisdiction. Any signs of a cluster of new cases or a reemergence of broader community transmission should result in a re-evaluation of community mitigation strategies and a decision on whether and how mitigation might need to change.
9. Cross-cutting community mitigation strategies can be organized into the following categories: promoting behaviors that prevent spread; maintaining healthy environments; maintaining healthy operations; and preparing for when someone gets sick. Presuming a community is not sheltering-in-place, cross-cutting strategies under each rubric are outlined below and should be implemented to the extent possible, and in accordance with the amount of ongoing community transmission. Refer to Table 14-2.
10. Community mitigation strategies should be layered upon one another and used at the same time—with several layers of safeguards to reduce the spread of

disease and lower the risk of another spike in cases and deaths. No one strategy is sufficient.

11. There are range of implementation choices when setting or adjusting community mitigation plans. These choices offer different levels of protection from the risk of community transmission.
12. Communities need to decide the level of risk that is acceptable and make informed choices about implementing mitigation plans accordingly.
13. Individuals make choices about following the behavioral practices that are recommended. Compliance to community mitigation decisions will also impact the spread of COVID-19.
14. CDC offers setting-specific strategies for a variety of sectors that include businesses, schools, institutes of higher education, parks and recreational facilities, and other places.
15. Travel patterns within and between jurisdictions will impact efforts to reduce community transmission. Coordination across state and local jurisdictions is critical – especially between jurisdictions with different levels of community transmission.

Table 14-2. Level of Mitigation Needed by Community Transmission and Community Characteristics

Level of Community Transmission	Community Characteristics and Description	Level of mitigation
Substantial, uncontrolled transmission	Large scale, uncontrolled community transmission, including communal settings (e.g., schools, workplaces)	Shelter in place
Substantial, controlled transmission	Large scale, controlled community transmission, including communal settings (e.g., schools, workplaces)	Significant mitigation
Minimal to moderate community transmission	Sustained transmission with high likelihood or confirmed exposure within communal settings and potential for rapid increase in cases	Moderate mitigation
No to minimal community transmission	Evidence of isolated cases or limited community transmission, case investigations underway; no evidence of exposure in large communal setting	Low mitigation

Source: www.cdc.gov/coronavirus/2019-ncov/community/community-mitigation.html

The following table includes mitigation strategies that Baltimore County could adopt in the future if they are not already in place. These strategies are divided into four groups that: (1) promote behaviors that prevent spread, (2) maintain healthy environments, (3) maintain healthy operations, and (4) preparation for when someone gets sick. Not all strategies will be relevant for every community or setting within Baltimore County, but an important component of mitigation is preparedness via foreknowledge of multiple strategies in the face of an uncertain future.

Table 14-3. Overview of Possible Mitigation Strategies to Consider in Communities with Local COVID-19 Transmission Across Settings and Sectors	
Promote Behaviors that Prevent Spread	• Educate people to stay home when sick or when they have been in close contact with someone with COVID-19 • Teach and reinforce practicing hand hygiene and respiratory etiquette • Teach and reinforce the use of cloth face coverings to protect others (if appropriate) • Ensure you have accessible sinks and enough supplies that are easily available for people to clean their hands (e.g., soap, hand sanitizer with at least 60% alcohol, and a way to dry hands, such as paper towels or a hand dryer). • Post signs or posters and promote messaging about behaviors that prevent spread
Maintain Healthy Environments	• Intensify cleaning and disinfection of frequently touched surfaces • Ensure ventilation systems operate properly and increase circulation of outdoor air • Ensure all water systems are safe to use • Modify layouts to promote social distance of at least 6 feet between people – especially for persons who do not live together • Install physical barriers and guides to support social distancing if appropriate • Close communal spaces, or stagger use and clean and disinfect between use • Limit sharing of objects, or clean and disinfect between use
Maintain Healthy Operations	• Protect people at higher risk for severe illness from COVID-19 • To cope with stress, encourage people to take breaks from the news, take care of their bodies, take time to unwind and connect with others, particularly when they have concerns • Maintain awareness of local or state regulations • Stagger or rotate scheduling • Create static groups or "cohorts" of individuals and avoid mixing between groups • Pursue virtual events. Maintain social distancing at any in-person events, and limit group size as much as possible • Limit non-essential visitors, volunteers, and activities involving external groups or organizations, especially with those who are not from the local area • Encourage telework and virtual meetings if possible • Consider options for non-essential travel in accordance with state and local regulations • Designate a COVID-19 point of contact • Implement flexible and non-punitive leave policies • Monitor absenteeism and create a back-up staffing plan • Train staff on all safety protocols • Consider conducting daily health checks such as temperature screening or symptom checking • Encourage those who share the facilities to also adhere to mitigation strategies

Table 14-3. Overview of Possible Mitigation Strategies to Consider in Communities with Local COVID-19 Transmission Across Settings and Sectors	
	• Put in place communication systems for: • Individuals to self-report COVID-19 symptoms, a positive test for COVID-19, or exposure to someone with COVID-19 • Notifying local health authorities of COVID-19 cases • Notifying individuals (employees, customers, students, etc.) of any COVID-19 exposures while maintaining confidentiality in accordance with privacy laws • Notifying individuals (e.g., employees, customers, students) of any facility closures
Prepare for When Someone Gets Sick	• Prepare to isolate and safely transport those who are sick to their home or to a healthcare facility • Encourage individuals who are sick to follow CDC guidance for caring for oneself and others who are sick • Notify local health officials of any case of COVID-19 while maintaining confidentiality in accordance with the Americans with Disabilities Act (ADA). • Notify those who have had close contact with a person diagnosed with COVID-19 and advise them to stay home and self-monitor for symptoms, and follow CDC guidance if symptoms develop • Advise individuals who are sick when it would be safe for them to return based on CDC's criteria to discontinue home isolation • Close off areas used by someone who is sick. Wait >24 hours before cleaning and disinfecting. Ensure safe and correct use and storage of EPA-approved List N disinfectants, including storing products securely away from children.

14.6 2021 MITIGATION GOALS AND ACTION ITEMS

GOAL 1: Promote hazard mitigation as the cornerstone of emergency management in Baltimore County.

OBJECTIVE	ACTION ITEM(S)	RESPONSIBLE ENTITY	RANKING (HIGH, MEDIUM, OR LOW)
1. Educate the public about natural hazards risks, preparedness, and mitigation.	a. Develop a "community preparedness toolkit" that provides step-by-step directions along with useful resources for making the community safer, more resilient, and better prepared in the event of a public health crisis where social distancing and quarantining are necessary.	County	Medium
	b. Continue to provide information on the County's social media about pandemic and emerging infectious diseases risk and vulnerability.	Department of Health, Office of Homeland Security and Emergency Management, Office of	High

		Information Technology	
2. Continued education for emergency responders and medical personnel.	a. Host and promote training courses such as DHS and FEMA certified courses, specifically related to pandemic/emerging infectious disease.	County	Low
	b. Emergency and medical first responders should be educated on the unique needs of socially vulnerable populations. Develop a training course that introduces the concept of vulnerable populations, how disasters impact these groups, and ways these populations can be assisted in before, during, and after a hazard event.	County, Fire Department, EMS Personnel, Department of Health	Medium

GOAL 2: Eliminate or reduce human, environmental, social, and economic loss from natural and technological hazards.

OBJECTIVE	ACTION ITEM(S)	RESPONSIBLE ENTITY	RANKING (HIGH, MEDIUM, OR LOW)
3. Maintain healthy environments at county-owned and operated locations, beyond the global pandemic.	a. Where possible, maintain social distance practices by modifying site/office layouts and promote/enforce proper mask wearing (and other personal protective equipment as necessary) in public settings.	County	Low
	b. Employ a thorough cleaning routine of high traffic public areas as well as the disinfection of frequently touched surfaces by multiple persons.	County	Low
4. Identify vulnerable populations and provide resources to these groups based on their unique needs.	a. Utilize results of the Social Vulnerability Index (SVI) mapping to identify potentially under-served and/or under-represented communities. Including pandemic and emerging infectious diseases, these areas are likely to be impacted by multiple hazards. Targeted outreach efforts should be attempted to “bridge the gap” in access to information and services as it relates to natural hazards.	County	Medium
	b. Ensure that all health-related announcements, information, and materials are accessible to all socially vulnerable groups, including but not limited to those: over the age of 65, under the age of 5, with limited English-speaking proficiency, with disability, and those at or below the poverty line.	Department of Health	High

GOAL 3: Provide outreach to agencies and organizations within Baltimore County regarding hazard mitigation.			
OBJECTIVE	**ACTION ITEM(S)**	**RESPONSIBLE ENTITY**	**RANKING (HIGH, MEDIUM, OR LOW)**
5. Maintain awareness of local or state regulations in relation to pandemic and emerging infectious diseases planning and best practices.	a. Circulate the most up-to-date guidance from trusted health sources (Centers for Disease Control and Prevention, World Health Organization, National Institute of Environmental Health Services, etc.) to all departments and organizations within Baltimore County.	County	Medium
	b. Develop an After-Action Report and Improvement Plan for the COVID-19 pandemic. These documents are intended to capture observations of an exercise or event and make recommendations for post-exercise/event improvements.	County, Office of Homeland Security and Emergency Management, Planning, Department of Health	Medium
	c. Coordinate with the Department of Economic and Workforce Development and the Chamber of Commerce to distribute information to local businesses.	County, DEWD, Chamber of Commerce	Medium

[1] www.cdc.gov/osels/scientific_edu/ss1978/lesson1/section11.html
[2] Jones K E, Patel N G, Levy M A, Storeygard A, Balk D., and others. 2008. "Global Trends in Emerging Infectious Diseases." Nature 451 (7181): 990–93.
[3] www.ncbi.nlm.nih.gov/books/NBK525302/
[4] sitn.hms.harvard.edu/flash/special-edition-on-infectious-disease/2014/the-fight-over-inoculation-during-the-1721-boston-smallpox-epidemic/
[5] www.historyofvaccines.org/content/yellow-fever-decimates-philadelphia
[6] wwwnc.cdc.gov/travel/diseases/yellow-fever
[7] www.ncbi.nlm.nih.gov/pmc/articles/PMC2394684/
[8] www.cdc.gov/cholera/general/index.html
[9] www.cdc.gov/groupastrep/diseases-public/scarlet-fever.html#increased-risk
[10] www.ncbi.nlm.nih.gov/pmc/articles/PMC3959940/
[11] www.cdc.gov/diphtheria/clinicians.html
[12] www.cdc.gov/nchs/fastats/immunize.htm
[13] Cutter S, Boruff B J, Shirley WL. Social vulnerability to environmental hazards. Soc Sci Q. 2003;84:242–261. Available at: www.colorado.edu/hazards/resources/socy4037/Cutter%20%20%20Social%20vulnerability%20to%20environmental%20hazards.pdf. Accessed August 5, 2009.
[14] www.ncbi.nlm.nih.gov/pmc/articles/PMC4504371/
[15] www.ncbi.nlm.nih.gov/pmc/articles/PMC4504371/

CHAPTER 15: Technological and Man-Made Hazards

UPDATES

During the 2021 Plan Update process, **Chapter 15: Technological and Man-Made Hazards** was updated with the most recently available data. This chapter includes the following hazard profiles: transportation accident, hazardous material incident, fire and explosion, mass power outage, and dam failure.

Updates to this chapter include:

1. Thematic and visual update
2. Removal of "Epidemic" as a sub-hazard within this chapter due to the development of *Chapter 14: Pandemic and Emerging Infectious Diseases*
3. **Data updates** (including tables, text, and figures as needed) to the following sections:
   a. 15.2 Transportation Accident (incident data from LEPC & SHA), 15.3 Hazardous Materials, 15.4 Fire and Explosion, 15.5 Mass Power Outage, and 15.6 Dam Failure
4. **Map updates**: 15.1 Average Annual Daily Traffic
5. **New section**: *15.5.2 Social Vulnerability and Mass Power Outage*
6. **New section:** *15.6.2 High Hazard Dam Failure Assessment*

15.1 INTRODUCTION

Table 15-1. Technological and Man-Made Hazard Risk Assessment	
Hazard	**Risk**
Transportation Accident	High
Hazardous Material Incident	High
Fire and Explosion	Medium-High
Mass Power Outage	Medium-High
Dam Failure	Medium

During the 2020 kick-off meeting for the Plan Update, stakeholders decided to remove "epidemic" as a sub-hazard within this chapter and combine it with the new *Pandemic and Emerging Infectious Diseases* chapter. Hazards within this chapter were ranked by the Hazard Mitigation Planning Committee (HMPC). The results of this ranking are displayed in the accompanying table, 15-1. Each hazard, including transportation accident, hazardous material incident, fire and explosion, mass power outage, and dam failure have been profiled in this chapter.

In the event of a major technological or man-made hazard event, emergency responders and appropriate agencies would follow response guidelines as set forth in the County's Emergency Operations Plan (EOP). This Plan covers a broad range of topics, some of which include: mitigation, preparedness, response, and recovery operations. The EOP consists of a Basic Plan, attachments to the basic plan, functional annexes, and hazard-specific appendices.[1] Additionally, Baltimore County utilizes an Emergency Notification System which sends out a recorded message and/or email in the event of a disaster.

15.2 TRANSPORTATION ACCIDENT

Baltimore County consists of a highly sophisticated transportation system that includes nearby Baltimore-Washington Thurgood Marshall International Airport, Martin State Airport, local airports/helicopter pads, Amtrak passenger rail service, CONRAIL, CSX, MARC commuter trains; Interstates 95, 70, and 83; U.S. Routes 1 and 40; and numerous State routes. There is also considerable boat and barge traffic proximate to Baltimore County on the Patapsco River and the Chesapeake Bay. This section will primarily focus on accidents as they relate to roadways and railways.

Baltimore County's Local Emergency Planning Committee (LEPC) keeps track of transportation incidents that occur within the County. These events include roadway, railway, marine, and air incidents. Table 15-2 and Table 15-3, below, detail the events recorded by the LEPC. This list is not exhaustive and does not include all events of this type in Baltimore County.

Table 15-2. Transportation Incidents for Baltimore County, 2018-2020		
Date	**Location**	**Type**
1/14/2018	Wilson Point Marina	Boat Fire
4/25/2018	Reisterstown Rd., Owings Mills	Tractor Trailer Fire
10/3/2018	I-695 and I-70	Tractor Trailer Fire
10/21/2018	Contractors Rd, Rosedale	Train v. Tractor Trailer Accident
12/3/2018	Black Rock Rd - Hampstead	Propane truck Accident – No Leaks
2/18/2019	I-83 and Shawan Rd	Tractor Trailer Fire
7/16/2019	Cove Rd., Dundalk	Boat Fire on Land

Table 15-2. Transportation Incidents for Baltimore County, 2018-2020		
Date	**Location**	**Type**
10/2/2019	I-83 and Shawan Rd	Tractor Trailer accident – No Fuel leak
11/8/2019	Cove Rd., Dundalk	Tractor Trailer Fire
11/11/2019	I-695 and Charles Street	Boat Fire On Land
11/30/2019	I-95 BTW 64-67	Boat Fire On Land
12/10/2019	Seneca Park Rd, Middle River	Tractor Trailer Fire
4/1/2020	I-83 and Ruxton Rd	Tractor Trailer Fire
06/03/2020	I-95 and Southwestern Blvd	Tractor Trailer Fire with Rescue
6/7/2020	I-695 and Harford Rd	Tractor Trailer Fire
7/23/2020	Quad Ave. Dundalk	Tractor Trailer Fire
8/6/2020	I-95 and Pulaski Hwy	Tractor Trailer Fire
8/9/2020	Philadelphia Rd. Middle River	Dump Truck Fire
8/17/2020	Eastern Blvd. Essex	Boat Fire on Land

15.2.1 Roadway

The State Highway Administration (SHA) maintains numerous traffic monitoring locations throughout Maryland, including 1,290 in Baltimore County. These monitoring locations keep track of public roadway traffic on 1,535 segments of roadway throughout the County. One of the most popular measures of traffic volume is Annual Average Daily Traffic (AADT). This measure represents the total volume of vehicle traffic of a highway or road for a year, divided by 365 days.

Based on the most recent (2018) AADT data for Baltimore County, provided by the SHA, the top five busiest road segments within the county are:

1. I-70 to MD 122 (AADT: 220,142)
2. I-83/I-695 Ramp 7 to I-695 Ramps (AADT: 205,270)
3. I-83 (north) to MD 139 (AADT: 204,055)
4. MD 122 to MD 26 (AADT: 202,851)
5. Edmonson Avenue to US 40 (AADT: 199,312)

Maryland Highway Accident Quick Facts

- ✓ Property damage crashes comprise 70.7% of total crashes; fatal crashes make up less than 1% of the total.
- ✓ The overall fatality rate has been consistently lower than the national average.
- ✓ Most crashes occur in October (9.2%), least crashes occur in February (7.3%).
- ✓ Most crashes occur on Friday (16.0%), least crashes occur on Sunday (12.1%).
- ✓ Most crashes occur at 5 pm (7.4%), least occur at 4 am (1.3%).
- ✓ Male drivers are statistically more likely to get into an accident than female drivers.
- ✓ Injury rates between male and female drivers are very similar, but male drivers comprise 77.4% of total driver fatalities.

*All figures represent averages from 2015-2019.

Source: Maryland Department of Transportation, Maryland MVA, Maryland Highway Safety Office – Statewide Crash Summary, 2015-2019

These roads comprise the Baltimore Beltway which is known for its extremely heavy traffic. Aside from these top five roads, there are many other roadways within the County that experience heavy traffic daily. Heavy traffic on any roadway increases the chance of major traffic accidents occurring simply because there are more drivers on the road. Map 15-1, at the end of this section, highlights the busiest road segments in Baltimore County based on 2018 AADT counts. Red indicates roadways with very high AADT, while dark green indicates roadways with (comparatively) very low AADT.

The Maryland Motor Vehicle Administration provides an annual "statewide crash summary" which reports highway transportation accidents within the state. Table 15-3 details these accidents from 2015 to 2019. Recorded accidents consist of fatal crashes, injury crashes, and property damage crashes. The most common type of transportation accident in Baltimore County is property damage, with a 5-year average of 15,832 per year, or 75.7% of the total accidents recorded in the County. The statewide crash summary has also been included for comparative purposes (Table 15-4). Baltimore County tends to have more crashes resulting in property damage compared to statewide data but has less crashes resulting in injuries on average.

Table 15-3. Highway Transportation Accidents in Baltimore County, 2015-2019

	2015	2016	2017	2018	2019	5-year AVG.	% of Total
Fatal Crashes	65	53	65	78	57	64	0.3
Injury Crashes	4,738	5,004	5,048	5,247	5,040	5,015	24.0
Property Damage Crashes	14,034	15,518	15,711	17,298	16,596	15,831	75.7
Total Crashes (County)	18,837	20,575	20,824	22,623	21,693	20,910	100.0
Total of all Fatalities	68	53	73	85	60	68	
Total Number Injured	6,834	7,347	7,265	7,570	7,264	7,256	

Source: Maryland Motor Vehicle Administration, Maryland Highway Safety Office, August 11, 2020

Table 15-4. Highway Transportation Accidents in Maryland, 2015-2019

	2015	2016	2017	2018	2019	5-year AVG.	% of Total
Fatal Crashes	480	483	518	485	496	492	0.4
Injury Crashes	30,721	34,720	34,664	33,930	32,919	33,391	28.9
Property Damage Crashes	76,917	85,075	80,247	83,611	82,511	81,672	70.7
Total Crashes (Maryland)	108,118	120,278	115,429	118,026	115,926	115,555	100.0
Total of all Fatalities	521	522	558	512	535	530	
Total Number Injured	44,929	50,921	51,391	50,003	48,658	49,180	

Source: Maryland Motor Vehicle Administration, Maryland Highway Safety Office, August 11, 2020

15.2.2 Railway

Major railway systems in Baltimore County include Amtrak passenger rail service, CONRAIL, CSX Transportation, and MARC commuter trains. Rail travel is one of the safest methods of moving both passengers and hazardous materials, but as unlikely as it is, accidents do occur. In May of 2013, a train carrying hazardous materials used to make plastic derailed in Rosedale.[2] While there was initial confusion at first regarding the materials carried by the train, the response from emergency officials was rapid and competent.

Incidents such as the one in Rosedale are unfortunate, but uncommon, and according to the Federal Railroad Administration (FRA), the number of derailments in Baltimore County has dropped from 7 in 2011 to 3 in 2019. The number of hazmat derailments over the same period declined from 3 to no reported hazmat derailments. In Baltimore

County, there were a total of 403 recorded railway accidents from 2011 to 2020, which averages to about 40 per year. Table 15-5, below, further details these accidents.

Table 15-5. Railway Accidents in Baltimore County, 2011-2020
(Ten Year Accident/Incident Overview by calendar year (January-December)

Category	CY 2011	CY 2012	CY 2013	CY 2014	CY 2015	CY 2016	CY 2017	CY 2018	CY 2019	CY 2020	Total For CY2011 TO CY 2020
TRAIN ACCIDENTS (NOT A GRADE CROSSINGS)	**10**	**3**	**3**	**-**	**1**	**3**	**4**	**2**	**5**	**-**	**31**
Train accident injuries	-	-	-	-	-	-	1	-	-	-	1
HIGHWAY-RAIL INCIDENTS	**4**	**4**	**2**	**1**	**4**	**1**	**3**	**3**	**2**	**2**	**26**
Highway-rail incidents deaths	-	-	-	-	-	-	-	-	-	-	-
Highway-rail incidents injuries	-	1	8	1	-	-	1	2	1	-	14
Incidents at public crossings	4	2	1	-	-	-	3	1	1	1	13
OTHER ACCIDENTS/ INCIDENTS	**63**	**53**	**60**	**46**	**20**	**21**	**20**	**29**	**21**	**13**	**346**
Other incidents deaths	3	1	2	4	2	1	2	1	2	2	20
Other incidents injuries	61	52	61	42	18	20	18	28	19	11	330
TOTAL ACCIDENTS/ INCIDENTS	**77**	**60**	**65**	**47**	**25**	**25**	**27**	**34**	**28**	**15**	**403**
Total fatalities	3	1	2	4	2	1	2	1	2	2	20
Total nonfatal conditions	61	53	69	43	18	20	20	30	20	11	345

Source: Federal Railroad Administration Office of Safety Analysis. March 12,2021
https://safetydata.fra.dot.gov/OfficeofSafety/publicsite/query/TenYearAccidentIncidentOverview.aspx
Total Accidents/Incidents is the sum of train accidents, highway-rail incidents, and other accidents/incidents.
Other Accidents/Incidents are events other than Train Accidents or Crossing Incidents that cause physical harm to persons

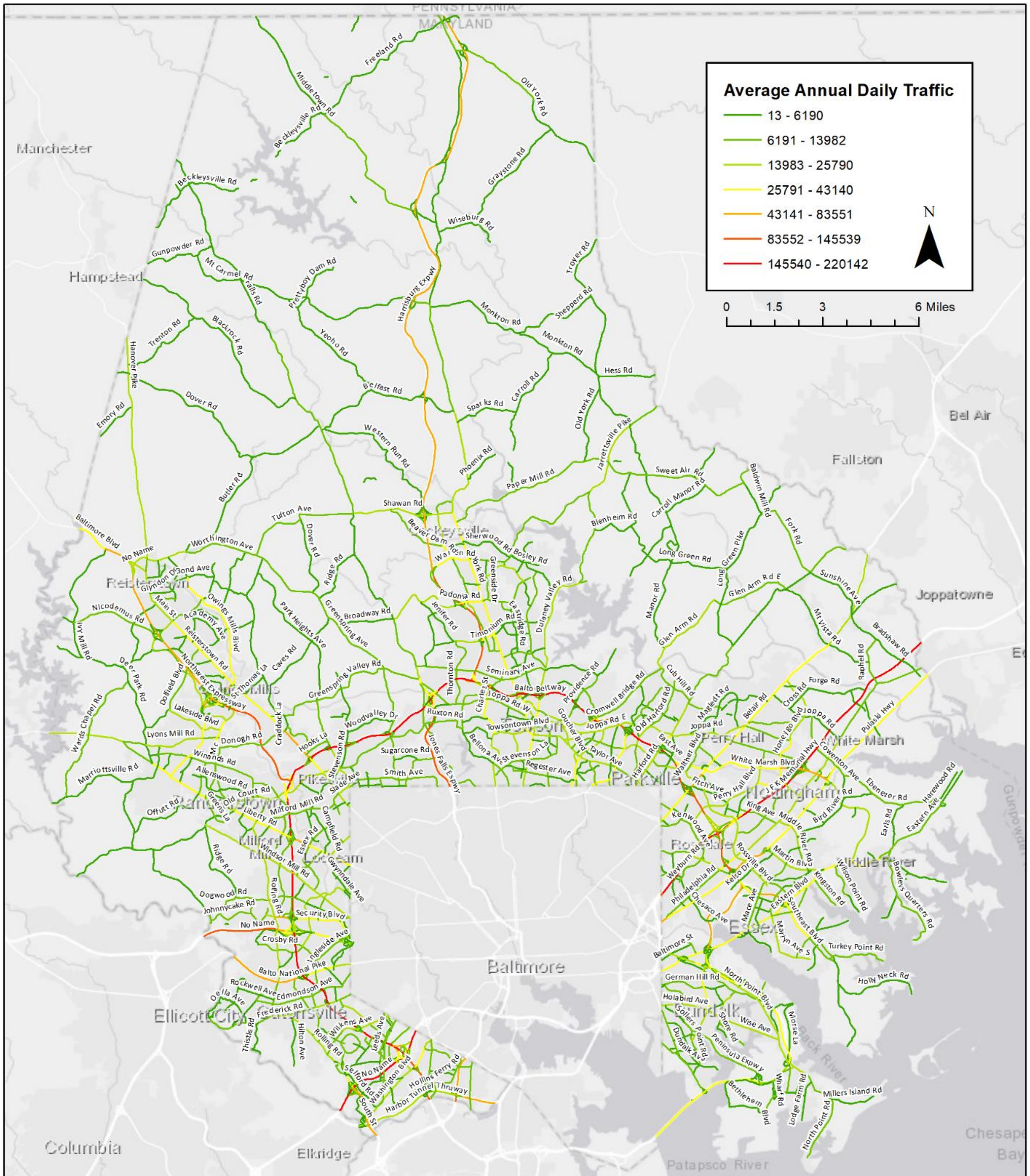
The FRA also records railway accidents by company for counties within Maryland. According to the FRA, between 2010 and March 12, 2021, there were 422 recorded accidents/incidents in Baltimore County involving railways. The greatest number of accidents during this period were reported by Amtrak, followed by MARC, and then CSX. Table 15-6, below, further details these accidents.

Table 15-6. Railway Accidents by Railroad Company, 2010-2020
(Ten Year Accident/Incident Overview by calendar year (January-December)

Railroad	Total Accident/ Incident Records	% Of Total	Form 57*	Form 54*	Form 55a*
Amtrak (National Railroad Passenger Corporation) (ATK)	154	36.493	-	6	148
MARC Train Service (MACZ)	132	31.20	1	-	131

Table 15-6. Railway Accidents by Railroad Company, 2010-2020 (Ten Year Accident/Incident Overview by calendar year (January-December)					
Railroad	**Total Accident/ Incident Records**	**% Of Total**	**Form 57***	**Form 54***	**Form 55a***
CSX Transportation (CSX)	98	23.223	21	8	69
Norfolk Southern Railway Company (NS)	21	4.976	3	13	5
Canton Railroad Company (CTN)	9	2.133	1	-	8
Patapsco & Back Rivers Railroad Company (PBR)	7	1.659	-	4	3
Baltimore Industrial Railroad (BDR)	1	0.237	-	-	1
Total	**422**	**100.00**	**26**	**31**	**365**

Source: Federal Railroad Administration Office of Safety Analysis. March 12, 2021
https://safetydata.fra.dot.gov/OfficeofSafety/publicsite/query/TenYearAccidentIncidentOverview.aspx
**Form 55a Used for Reporting Deaths and Injuries. Form 54 For Train Accidents, And Form 57 For Highway-Rail Crossing Incidents*



SP&D
Smith Planning and Design

Map 15-1. Average Annual Daily Traffic for Baltimore County Roadways in 2018

Source: State Highway Administration

15.3 HAZARDOUS MATERIAL INCIDENT

Hazardous materials are defined as any items or agents (biological, chemical, physical) which have the potential to cause harm to humans, animals, or the environment, either by themselves or through interaction with other factors.[3]

A hazardous material incident may occur via spilling, leaking, emission of toxic vapors, or any other process that enables the material to escape its container, enter the environment, and create a potential hazard. For this hazard profile, the term 'incident' applies to hazardous material spills that require an emergency response.

Many hazardous materials are stored and used at fixed sites, but these materials are typically produced elsewhere and shipped to the fixed facility by rail, truck, or freight. Hazardous materials are constantly on the move in Baltimore County, and the possibility of accidental release may occur at any time. As such, vehicles carrying hazardous materials are marked with placards (Figure 15-1) specific to the materials being carried. These placards are detailed in the *2020 Emergency Response Guidebook* – a useful tool for emergency responders because it outlines containment and clean-up procedures per hazardous material.

FIGURE 15-1.

15.3.1 Historical Occurrences of Hazardous Material Incidents

HazMat Quick Facts

- ✓ HazMat Unit 114 Responded to **270** incidents in 2019.
- ✓ HazMat Unit 114 Responded to **460** incidents in 2020.
- ✓ Due to the COVID19 pandemic, Baltimore County's LEPC has been unable to meet in person due to safety concerns and social distancing guidelines. The LEPC is hosting virtual meetings via Zoom and/or WebEx.

Baltimore County's LEPC, comprised of community and business leaders, and local fire, police, EMS and emergency management responders, meets regularly to develop and review contingency and evacuation plans for emergencies involving hazardous materials. These may include weather disasters, industrial/transportation accidents, and terrorist attacks.[4]

A portion of these meetings involves reporting hazardous material incidents and spills. The following three tables (15-7, 15-8, and 15-9) provide information regarding these types of incidents in Baltimore County from January 2018 to December 2020.

Table 15-7. Annual Hazardous Material Incidents for Baltimore County, 2018

Date	Location	Incident Description
1/5/2018	Beechwood Road, Dundalk	Anhydrous ammonia tank leaking
2/4/2018	I-95 at MM 63	Tractor trailer accident w/fuel leak
2/20/2018	Bucks Schoolhouse Road, Perry hall	2800-gallon tanker rolled over
2/21/2020	Yeoho Road, Hereford	Crane overturned with fluids leaking

Table 15-7. Annual Hazardous Material Incidents for Baltimore County, 2018		
Date	**Location**	**Incident Description**
2/24/2018	I-695 and I-95 Rosedale	Tractor trailer accident with leaking fuel
2/28/2018	I-695 and Liberty Road, Woodlawn	Tractor trailer fire involving gasoline tanker
3/21/2018	Nicodemus Road	300-gallon delivery truck traffic accident
3/24/2018	Baltimore National Pike, Catonsville	Freon leak in a restaurant w/sick patrons
3/31/2018	York Road, Cockeysville	Dumpster fire containing paint and chemicals
4/11/2018	Carriage Hill Circle, Randallstown	Apartment explosion due to gas leak
4/13/2018	Beaver Dam Road, Cockeysville	Lg stone quarry vehicle fire
4/17/2018	Reisterstown Road, Pikesville	Fuel delivery truck spilled 50 gallons gasoline
4/20/2018	Leeds Ave, Arbutus	Malicious act – acid thrown on a vehicle
4/29/2018	Warren Road, Cockeysville	15 gallons gasoline spilled at gas station
5/2/2018	Curtis Bay	Mutual aid to Anne Arundel County – nitrogen oxide leak
5/9/2018	Old Court Road, Woodstock Job Corps	1500-gallon propane tank leaking
5/20/2018	Redwood Circle, Catonsville	Fatality due to carbon monoxide leak
5/22/2018	I-83 and Shawan	Tractor trailer accident with fuel leak
5/29/2018	Perry hall Blvd, Nottingham	Chemical suicide in a vehicle
6/1/2018	Marston Road, Woodlawn	Freon leak in a residence
6/21/2018	I-695 and Stevenson Ave	Tractor trailer accident with fuel leak
6/26/2018	Windsor Road, Parkville	Sulfuric acid spill due to exploded battery
7/2/2018	I-95 and Mountain Road	Tractor trailer accident with fuel leak
8/13/2018	Dover Road, Upperco	Dump truck overturned with fuel leak
9/4/2018	Dundalk Ave, Dundalk	Fire in a body shop/paint shop
9/4/2018	Tolson Ave, Dundalk	Clandestine drug lab
9/11/2018	North Point Blvd, Edgemere	Underground propane tank leaking
9/24/2018	Joppa Road, Towson	Suspicious package, MD public safety and correctional
10/5/2018	St. Mary's St., Woodlawn	Multiple household chemicals leaking in basement
10/14/2018	Chester Road, Middle River	15-gallon fuel spilled during refueling
10/30/2018	I-795 and Owings Mills Blvd	Tractor trailer accident with fuel leak
11/17/2018	Roxy Dr, Windsor Mill	Confined space rescue
11/29/2018	Waltham Woods Road, Parkville	Motor vehicle accident - van with leaking fuel tank
12/7/2018	Satyr Hill Road, Parkville	Clandestine drug lab
12/7/2018	Edmondson Ave., Catonsville	Chemical odor in a school with 20 sick children
12/17/2018	Park Heights Ave., Pikesville	Domestic terrorism – suspicious package at synagogue
12/24/2018	Park Dr., Cockeysville	Chemical suicide in a vehicle
12/25/2018	I-695 and I-95 Halethorpe	Tractor trailer accident with leaking fuel

Table 15-8. Annual Hazardous Material Incidents for Baltimore County, 2019		
Date	**Location**	**Incident Description**
1/4/2019	Dulaney valley Road, Towson	Lithium battery fire inside Towson Town Mall
1/22/2019	Susquehanna Ave., Towson	Body/paint shop fire
1/24/2019	I-83 and Old York Road, Hereford	Tractor trailer rollover with fuel leak
2/5/2019	Fenor Ave., Halethorpe	Gasoline dumped in sewer drain
3/6/2019	Old Harford Road, Parkville	15 gallons of gasoline spilled from gas station
3/6/2019	McCormick Road, Hunt Valley	Dumpster fire containing lithium batteries
3/8/2019	Pennsylvania Ave., Towson	High carbon monoxide levels in a hookah lounge
3/12/2019	Church Lane, Pikesville	Transformer fire with leak
3/14/2019	Sudbrook Lane, Pikesville	Confined space rescue

Table 15-8. Annual Hazardous Material Incidents for Baltimore County, 2019		
Date	**Location**	**Incident Description**
3/17/2019	Old Court Road, Pikesville	Suspicious package at a synagogue
3/29/2019	Transverse Ave., Middle River	Chemical odor in a house from overcharged battery
4/9/2019	Philadelphia Road, White Marsh	Clandestine drug lab
4/11/2019	Kavanaugh Road, Dundalk	Household chemicals mixed in a house
4/12/2019	I-83 and Padonia Road	Tractor trailer accident with fuel leak
4/16/2019	I-695 and Park Heights Ave	Tractor trailer accident with leaking fuel
4/24/2019	Glen Arm Road, Glen Arm	Overturned car into a stream with fluids leaking
4/25/2019	I-83 and Padonia	Overturned van with flammable liquids and acetylene tanks leaking
5/2/2019	Baltimore National Pike, Catonsville	Leaking 20 lb. propane tank
5/15/2019	Reisterstown Road, Owings Mills	Transformer leaking
5/22/2019	York Road, Towson	Domestic terrorism – white powder thrown during college graduation ceremony
6/1/2019	Cromwell Br Road, Parkville	Motor vehicle accident with fuel leak
6/11/2019	Sheppard Road, Monkton	Tractor trailer accident with fuel leak
6/13/2019	Cub Hill Road, Parkville	Vehicle rollover into a stream with fluids leaking
6/14/2019	Blair Hill La., Brooklandville	Chemical spill with fire at eyeglass lab
6/21/2019	Leiden Road, Rosedale	Pill mill involving fentanyl
6/23/2019	Philadelphia Road, Rosedale	Truck fire involving pool chemicals
6/25/2019	Fischer Road, Edgemere	Fire in a building involving lithium batteries
6/28/2019	Washington Blvd., Halethorpe	Ammonia spill in a storage facility
7/21/2019	Taylor Ave., Parkville	Unconscious person in a vehicle due to 200lbs dry ice in the car and not properly ventilated.
7/26/2019	Falls Road, Cockeysville	Commercial vehicle rollover with fuel leak
7/30/2019	Spring Hill Road, Garrison	Tractor trailer accident with leaking fuel tank
7/31/2019	Long Green Pike, Glen Arm	Motor vehicle accent with fluids leaking into waterway
8/3/2019	I-695 and Security Blvd	Tractor trailer accident with leaking fuel tank
8/10/2019	Denbury Dr., Dundalk	Fatality due to manufacturing of narcotics
8/14/2019	Liberty Road and I-695	250-gallon diesel tank fell off truck and spilled
8/22/2019	Stockton Road, Hereford	Biosolid fertilizer on fire
8/28/2019	Texas Station Ct., Cockeysville	Tractor trailer accident with fuel leak
8/31/2019	Solar Ci., Parkville	Cleaning chemicals spilled in an apartment bldg.
9/4/2019	Cross Trails Road, Woodlawn	Fire in a pool house
9/6/2019	Bowleys Quarters Road, Middle River	Leaking 500-gallon propane tank
9/7/2019	Mary Ridge Dr., Randallstown	Freon leak in a residence
9/9/2019	Pulaski Hwy, White marsh	Theft of 300 gallons of diesel fuel from underground storage tanks into clandestine vehicle
9/18/2019	McDonough Road, Owings Mills	Boiler explosion and collapse of lg chimney at collage
9/18/2019	Beaver Dam Road, Cockeysville	Chemical spill at recycle facility
9/19/2019	Tradepoint Ave, Sparrows point	Cleaning chemical spill at Trade Point Atlantic
9/27/2019	York Road, Towson	Truck fire involving paint and cleaners
10/9/2019	Bird River Road, White Marsh	Assisted animal control with removal of 77 live cats and 8 deceased cats in a shed with strong ammonia odor.
10/21/2019	Ebenezer Road, Middle River	Truck rollover with fuel leak
10/23/2019	Kenilworth Dr., Towson	Vehicle leaking gasoline tank
11/5/2019	I-695 and Liberty Road	Box truck accident with fuel leak
11/16/2019	Russell Ct., Woodlawn	Cleaning chemicals spilled in an apartment building
12/14/2019	I-83 and Mt Carmel Road	Tractor trailer accident with fuel leak

Table 15-9. Annual Hazardous Material Incidents for Baltimore County, 2020		
Date	**Location**	**Incident Description**
1/11/2020	I-695 and Loch Raven Blvd	Tractor trailer rollover with fuel leak
1/14/2020	Ladywell St., Middle River	100lb propane tank leaking
1/16/2020	Joppa Road, Parkville	Tractor trailer leaking fuel
2/3/2020	Center St., Westminster	Mutual aid to Carroll County – suspicious package at County courthouse
2/9/2020	Quad Ave., Baltimore	Lithium batteries leaking at commercial bldg.
2/10/2020	Freeland Road, Parkton	Tractor trailer accident with fuel leak
2/21/2020	Pulaski Hwy., Rosedale	Leaking drum of avph-110 (ammonia, isopropanol, and water).
3/1/2020	Milford Mill Road, Pikesville	Narcotics identification and clean up at police pct 4
3/4/2020	I-83 and Warren Road	Box truck rollover with fuel leak
3/9/2020	I-83 and Belfast Road	Tractor trailer rollover with fuel leak
3/12/2020	I-695 and Harford Road	Tractor trailer accident with fuel leak
3/15/2020	I-70 and HoCo Line	Tractor trailer accident with fuel leak
3/16/2020	Seling Ave., Rosedale	Mobile home fire with fatality due to clandestine lab explosion
3/28/2020	Montrose Manor Ct, 21208	Lithium batteries leaking
4/3/2020	Willowcrest Ci., Lutherville	Gas appliance explosion in a home
4/17/2020	Dover Road, Butler	Dump truck rollover with fuel leak
4/17/2020	Pot Spring Road, Lutherville	Trench rescue
4/18/2020	Providence Road, Towson	Cleaning chemicals mixed w/sick persons
4/23/2020	Dulaney Valley Road, Glen Arm	Truck accident with fuel leak
4/28/2020	Daybrook Ci., Middle River	Cleaning chemicals mixed w/sick persons
5/5/2020	Stansbury Mill Road, Phoenix	Leaking acetylene tank
5/10/2020	Owings Gate Ct., Owings Mill	Leaking fuel tank from construction truck
5/20/2020	Beaver Dam Road, Cockeysville	Chemical spill at recycling plant
5/26/2020	I-83 and Mt Carmel	Tractor trailer accident with fuel leak
6/4/2020	I-695 and York Road, Towson	Overturned tractor trailer carrying polyurethanes
6/4/2020	I-695 and Eastern Ave	Tractor trailer accident with fuel leak
6/6/2020	I-695 and Dulaney valley	Truck accident with large oil spill
6/9/2020	Brandon St, Brooklyn	Mutual aid into aa county – fire at power plant
6/17/2020	Beaver Dam Road, Cockeysville	Overturned dump truck with fuel leak
6/24/2020	Glen Arm Road, Glen Arm	Building fire involving propane tanks
7/17/2020	I-95 and River Road	Truck accident with fuel leak
7/20/2020	Golden West Dr., Cockeysville	Building fire with battery storage
7/24/2020	Vero Road, Halethorpe	Refueling truck fire
7/31/2020	I-695 and I-83	Tractor trailer accident with fuel leak
8/6/2020	Joppa Road, Parkville	Freon leak in a grocery store
8/7/2020	Mt Carmel Road, Hereford	45 gallons gasoline spilled from malfunctioning gas pump
8/10/2020	Labyrinth Road, Baltimore	Mutual aid to City of Baltimore – multiple houses exploded with 2 fatalities due to gas leak
8/19/2020	Rossville Blvd., Rosedale	Tractor trailer accident with fuel leak
8/25/2020	Southwick Dr., Towson	Muriatic acid spill
8/31/2020	Owings Mills Blvd	Truck accident with large oil spill
9/1/2020	Sulphur Spring Road, Halethorpe	Commercial building fire containing hydrochloric acid
9/22/2020	Reisterstown Road, Owings Mill	Street sweeper accident – hydraulic fluid leak

Table 15-9. Annual Hazardous Material Incidents for Baltimore County, 2020		
Date	**Location**	**Incident Description**
9/28/2020	Mt. Carmel Road, Hereford	Dwelling fire involving propane tanks
10/1/2020	Arlington Ave., Arbutus	Clandestine drug lab
10/9/2020	Whitton Ave., Middle River	Cleaning chemicals mixed
10/14/2020	Wards Chapel Road, Woodstock	Cleaning chemicals mixed
10/30/2020	Lakeside Blvd., Owings Mills	20-gallons gasoline spilled from gas station
11/2/2020	Preston Ct., Catonsville	Cleaning chemicals mixed w/sick patients
11/11/2020	Susquehanna Ave., Towson	Suspicious package at police pct. 06
11/11/2020	I-695 and Loch Raven	Tractor trailer accident with fuel leak
11/17/2020	Edgewood Ave., Parkville	Dwelling fire with ruptured home heating oil tanks
11/21/2020	York Road, Cockeysville	Fire in an auto repair shop
12/2/2020	Warren Road, Cockeysville	Electrical fire on light rail train
12/22/2020	I-695 and Pulaski Hwy	Tractor trailer accident with fuel leak

The records indicate that between 2018-2020, fuel spills (diesel, gasoline, motor oil, heating fuel) were some of the most common hazardous materials incidents. In 2018, 11 fuel related events were recorded. In 2019, 13 fuel related events were recorded. In 2020, 18 fuel related events were recorded.

Furthermore, based on the data, the most impacted roadways for these three years are I-695 and I-83. Between these years, 16 hazardous material incidents were reported on I-695, and 9 were reported on I-83. As stated in section 15.2.1, these roadways have a high AADT, which means they are traveled very heavily. As such, accidents involving hazardous materials are more likely to occur on these roadways due to their larger volume of traffic.

15.4 FIRE AND EXPLOSION

Fire is defined as the state, process, or instance of combustion in which fuel material is ignited and combined with oxygen, giving off heat, light, and flame. An explosion is defined as an expansion, with violent force, of materials through a chemical change or decomposition. Explosive atmospheres can be caused by flammable gases, mists, or vapors or by combustible dusts. If there is enough of a substance, mixed with air, then all it needs is a source of ignition to cause an explosion.

Each year people are injured at home or work by flammable substances accidentally catching fire or exploding. In some cases, household hazards are caused by relatively harmless chemicals, such as ammonia and bleach, being mixed to create dangerous gases. In the workplace, activities which involve using or creating chemicals, vapors, liquids, gases, solids, or dusts that can readily burn or explode is hazardous.[5]

The effects of an explosion or a fire at home or in the workplace can be devastating in terms of lives lost, injuries, significant damage to property and the environment, and to the business community. Most fires are preventable and creating fire safety procedures is an important step for any community.

The Baltimore County Fire Prevention Code (effective March 19, 2017) promotes public health and welfare by regulating the hazards of fire and explosion. The county fire code closely parallels the Maryland Fire Prevention Code but is tailored to the specific needs of Baltimore County and its residents. The code regulates the storage, handling and use of various substances, materials, and devices, including fireworks, barbeque grills, commercial cooking equipment and machinery. The Code sets standards for fire protection systems including automatic sprinkler systems, residential rural water supplies for fire suppression and smoke detectors in day care homes. It also regulates conditions related to the occupancy of various types of buildings, including proper egress and requirements for fire drills. Finally, it includes specific physical and operational requirements for new and existing occupancies based on the type of use for each occupancy.[6]

15.4.1 Fire and Explosion Incidents in Baltimore County

During 2019, there were 58 fires that resulted in 65 deaths in Maryland. In Baltimore County, there were 14 deaths caused by 13 fires during 2019 which reflects a slight increase compared to the 12 fire deaths reported during 2018.[7] Table 15-10 furthers details fire death occurrences in the County between 2015 and 2019. Additionally, a brief synopsis of the deaths and fires reported in Baltimore County in 2019 are included below:

- A smoking related apartment fire claimed the life of a 59-year-old female who, at the time of the fire, reportedly ambulated with a walker and wheelchair. The investigation revealed the fire started in the living space of the home, with non-working smoke alarms found at the scene.
- A fire that started in the living space of a single-family dwelling was ruled undetermined, claiming the life of a 98-year-old physically challenged female who died at the scene. The presence of working smoke alarms during the blaze were confirmed by investigators.
- A fire deemed heating related resulted in the death of a 34-year-old male fugitive who was squatting in a vacant home. The victim apparently started a fire for warmth, but the fire was too close to a mattress which erupted and spread to the structure entrapping the victim.
- A 57-year-old male became entrapped in a landscape trailer fire following the victim's attempt to connect a fuel pump tank to a lawnmower battery, causing a spark which erupted the vapors into flames.
- A double-fatal vehicle crash and subsequent fire claimed the lives of 39-year-old male and a 24-year-old female.
- A cooking related apartment fire resulted in the demise of a 68-year-old male who was battling a serious illness at the time of the incident. The smoke alarm status at the time of the blaze was reported as undetermined.
- A 74-year-old deceased female was extricated by firefighters from a residential fire. Investigators determined the fire was cooking related, with no smoke alarms found at the scene.
- Firefighters conducted a search and rescue on the scene of a fully involved residential fire and located an unconscious 73-year-old female victim who was pronounced deceased at the scene. Investigators reported the fire started in the bedroom of the structure due to an electrical failure, with no evidence of smoke alarms found present at the scene.

- A 66-year-old male succumbed to his injuries at a local medical center after being rescued by firefighters from a cooking related residential fire. Fortunately, a female resident escaped the blaze even though no smoke alarms were found on the scene by investigators.
- An electrical space heater was found to be the cause of a residential fire that claimed the life of a 67-year-old male. The fire started in the living room of the structure, with the presence of smoke alarms reported as undetermined.
- A 77-year-old female incurred burn injuries to her face and hands after smoking and falling asleep while on home oxygen. The victim succumbed to her injuries at a local burn center.
- A cooking related apartment fire claimed the life of a 50-year-old male, with working smoke alarms found on the scene by investigators.
- A 93-year-old female with limited mobility perished in an undetermined dwelling fire that started in the living space of the home. Investigators were unable to confirm the presence of smoke alarms.

Table 15-10. Fire Deaths in Baltimore County, 2015-2019

	2015	2016	2017	2018	2019	5-Year Average	% of State Total	5YR Fire Death Rate*	% of Total Deaths 2019*
Baltimore County	7	6	12	12	14	10.2	15%	1.3	21.5%
*Death Rate: Number of civilian fire deaths per 100,000 population.									

Source: Maryland State Fire Marshal, 2019

In addition to incidents reported by the State Fire Marshall, Baltimore County's Fire Department also tracks fire incidents that occur within the County. Table 15-11, below, details structural fires recorded by the Fire Department between 2019 and 2020. This list is not exhaustive and may not include all events of this type in Baltimore County. Results from Table 15-11 indicate a future probability of at least one (1) structural fire occurring per day in Baltimore County, on average. Emergency response staff should consider this information in their fire training exercises and response documents.

Table 15-11. Fire Incidents in Baltimore County, 2019-2020

Fires in Structures by Fixed Property Use	Number of Fires	Civilian Deaths	Casualties/ Injuries	Property Damage ($)
Private Dwellings	437	14	60	12,871,557
Apartments	200	3	17	1,363,666
Hotels and Motels	5	0	0	12,600
All Other Residential	11	0	3	118,517
TOTAL RESIDENTIAL FIRES	**653**	**17**	**80**	**14,366,340**
Public Assembly	10	0	1	455,600
Schools and Colleges	4	0	0	0
Health Care/Penal	9	0	2	817,500
Stores and Offices	43	0	3	1,842,007
Industry/Utility	7	0	0	140,000
Storage in Structures	21	0	0	207,100
Other Structures	11	0	0	5,001
TOTAL STRUCTURE FIRES	**758**	**17**	**86**	**17,833,548**

Source: Baltimore County Fire Department, NFPA Fire Experience Survey

Finally, Baltimore County's Police Department keeps records of "hazardous devices team statistics", which covers explosions, destructive devices, incendiary devices, chemical reaction device incidents, and more. These incidents are classified by service calls, recoveries, and disposals and are included in Table 15-12, below.

Table 15-12. Explosive Device Incidents in Baltimore County, 2013

Type of Incident	Number of Incidents
Calls for Service	
Explosions (Accidental)	0
Improvised Destructive Device Incidents	5
Incendiary Device Incidents	5
Chemical Reaction Device Incidents	6
Hoax Device Incidents	0
Bomb Threats (BATS)	16
Suspicious Item Incidents (No hazards found)	12
Military Ordnance Incidents	8
Explosives-related Searches	11
VIP/DP Detail/Special Event	5
Assist other Units/Jurisdictions/Investigation	28
Instructional Presentations	20
Total	**116**
Recoveries	
Recovered Fireworks	10
Recovered Ammunition	6
Recovered Explosives	7
Recovered HAZMAT	17
Total	**40**
Disposals	
Improvised Destructive Devices (Intact)	5
Fireworks (Class 1.4)	10
Ammunition	6
Hazard Materials	17
Military Ordnance	7
Explosives	6
Total	**51**

Source: Baltimore County Police Department

15.5 MASS POWER OUTAGE

Power outages may last seconds, hours, or days depending upon the cause. The most common causes of power outages are natural causes, human error, and equipment failure. Natural causes, such as strong storms, can result in large amounts of debris generation, especially trees and branches, which may fall onto power lines. Additionally, lightning strikes, high winds, heavy rain, salt, and snow and ice can damage substations, power lines, and equipment.

Tips for Getting Along Without Power

- Along with water, flashlights with extra batteries are essential emergency supplies.
- Portable generators are invaluable during an outage, but safety precautions must be taken as generations produce carbon monoxide gas.
- Families with members who have power-dependent health needs (oxygen, dialysis, etc.) should always have an emergency plan in place.

Source: Baltimorecountymd.gov

Mass power outages occur over a widespread area and are often the result of a major disaster event, such as a hurricane. There may be significant risks to public health and safety depending upon the severity of the disaster event coupled with the mass power outage. These risks may prompt local emergency management to open shelters, distribute food and water, and provide other coordinated disaster responses.

According to the Baltimore County Office of Homeland Security and Emergency Management, households, businesses, and institutions need an emergency plan for handling power outages for up to three days. Three days is the length of time that most emergency management agencies across the U.S. feel it is reasonable to expect citizens to get along without water or power. After three days, Baltimore County's Office of Emergency Management may provide emergency shelter to affected residents.[8]

15.5.1 Electric Service and Tracking Power Outages

Baltimore County is serviced by the Baltimore Gas and Electric Company (BGE). Presently, BGE serves roughly 831,128 residents within the County. In classifying storms, the company uses four main categories based on the total number of outages reported. These categories are detailed on Table 15-13, below. In general, smaller power outages caused by adverse weather and minor storms are most likely to occur. However, major storms and severe-impact storms, such as Hurricane Isabel in 2003, are still a possibility and have a likelihood of occurring about once every year.

Table 15-13. BGE Storm Categories by Number of Outages[9]

Storm Type	Description
Adverse Weather	A weather-related event causing less than 12,000 customer outages. Normally associated with strong wings, heavy rain, or extended heat/cold waves. Customer power typically restored in one (1) day. Frequency is usually 10 to 20 per pear.
Minor Storms	A weather relayed event causing 12,000 or more customer outages. Normally associated with isolated gusty thunderstorms or strong winds. Customer power typically restored in 1-2 days. Frequency is usually 12 to 18 per year.

Major Storms	A weather-related event causing 100,000 or more customer outages. Normally associated with system wide severe thunderstorms, isolated tornadoes, and extended high wind conditions. Customer power typically restored in 2-3 days. Frequency is usually 1 to 2 per year.
Severe-Impact Storms	A weather-related event causing 200,000 or more customer outages within BGE's territory, or 25% within a region. Severe damage to the distribution system requires need for significant mutual assistance and logistical support.

BGE provides an "Outage Map" as a tool to track power outages in their service area in real-time. This tool is available online and allows the user to view power outages by region. Additionally, BGE reports the status of current power outages on their website. While the company does its best to keep track of all outages, they encourage residents to report outages whenever possible.

CAIDI Update

A 2018 report suggested that BGE demonstrated "stable" performance over a two-year period in relation to their SAIFI, or "System Average Interruption Frequency Index."

Based on the CAIDI measurement, it was determined that BGE, and others, demonstrated continuous improvement in the time needed to restore service to customers experiencing a service interruption.

Source: annual performance reports on electric service reliability (filed pursuant to COMAR 20.50.12.11). September 4, 2018

Additionally, during mass power outages, utility companies compile an average of interruption time. CAIDI, Customer Average Interruption Duration Index, is an index utilized by electric companies to compute the average time of an outage. This method is capable of measuring in units of minutes or hours by calculating the sum of all customer interruption durations then dividing by the total number of customer interruptions. The outcome would be the average time length that any given customer would experience a power outage. Table 15-14, below, provides general observations regarding BGE's CAIDI and includes its sister companies, ComEd and PECO.

Table 15-14. CAIDI Observations for BGE and Sister Companies

Measure	Observations
CAIDI Contribution by Outage CAIDI Group	Almost half of BGE's CAIDI contribution comes from outages whose CAIDI exceeds four hours, while outages longer than four hours account for less than a quarter of CAIDI at ComEd and PECO.
CAIDI Contribution by Outage Size	The CAIDI contribution from outages with larger numbers of customer interruptions is significantly higher at ComEd as compared to BGE, but only slightly higher at PECO as compared to BGE.
CAIDI Contribution by Weather Status	Storms contribute a slightly smaller fraction of CAIDI minutes at PECO as compared to BGE, while storms are a far less significant contributor to overall CAIDI at ComEd.
Distribution of CAIDI Ratios	System configuration and switching practices at ComEd and PECO contribute to their ability to achieve a lower CAIDI than BGE.
Distribution of Outage Durations	Long duration outages contribute more to CAIDI at BGE than at PECO and ComEd.

Source: 2013 CAIDI Study Findings Prepared for BGE By Davies Consulting. ***Note****: Data based on a 5-year study, 2007-2011.*

15.5.2 Social Vulnerability and Mass Power Outages

Mass power outage is the hazard within this chapter that most clearly impacts vulnerable populations. This hazard has a generally well-defined geographic extent (e.g., streets, blocks, city, metropolitan area, or region) and because access to energy and the ability to consume energy is such a cornerstone to the modern world, it is the type of disaster than can negatively impact large populations at once.

Studies centered around mass power outage and vulnerable populations have identified significant differences in service restoration rates between urban and rural populations as well as a noticeable relationship between the duration of a power outage and certain socioeconomic factors.

A study conducted in Florida shortly after Hurricane Irma found a positive spatial dependence between power outages (caused by hurricane high winds) and several social vulnerability indicators.[10] Three socioeconomic variables found to be statistically significant highlight three different aspects of vulnerability to power outages: (1) minority groups, (2) populations with sensory, physical, and mental disability, and (3) economic vulnerability expressed via unemployment rate. While everyone within the area of effect of a mass power outage will experience negative impacts, the aforementioned groups are more likely to suffer longer negative impacts on top of facing completely unique challenges.

A study conducted in New York City examined major power outages in relation to the concern and preparedness of vulnerable groups.[11] Vulnerable groups were defined as having members over the age of 65 and households with members who require assistance with daily activities or are dependent upon electric medical equipment. This study indicated that health concerns were greater among all vulnerable groups than the general population, levels of preparedness varied among vulnerable respondents, and awareness of power outage notification programs was lower among vulnerable groups. The study concluded a need to increase awareness and preparedness among at-risk groups.

To mitigate harm to vulnerable populations for any hazard, but especially for mass power outage, Baltimore County can implement mitigation actions that focus on disaster preparedness. Having key items, such as a working flashlight and at least three days' worth of food and water is one important component of a preparedness plan and can make it easier to cope during a power outage. It is important that the county consider which groups may not have a preparedness plan or emergency supply in place and then provide targeted outreach to these groups. Outreach efforts to vulnerable populations should consider the barriers preventing certain groups from developing a preparedness plan and then create ways to educate these groups in a meaningful way. For example, if a communication barrier is preventing a non-English speaking or limited-English speaking group from fully understanding the potential impacts of a mass power outage event, then a potential solution would be to include interpreters and/or properly translated materials at community outreach events.

15.6 DAM FAILURE

Dams present risks but they also provide many benefits, including irrigation, flood control, and recreation. Dams have been identified as a key resource of our national infrastructure that is vulnerable to terrorist attack.

States have the primary responsibility for protecting their populations from dam failure. Of the approximately 94,400 dams in the United States, State governments regulate about 70 percent. About 27,000 dams throughout the U.S. could incur damage or fail, resulting in significant property damage, lifeline disruption (utilities), business disruption, displacement of families from their homes, and environmental damage.[12]

Baltimore County may be affected by the failure of eleven high hazard dams, all of which are located within or on the border of Baltimore County. However, there is no record of a high hazard dam failure in Baltimore County. In addition to these eleven dams, there are six significant and six low risk dams located within the County. These dams, listed from highest hazard to lowest hazard, are identified in Table 15-15 on the following page.

Except for the UMBC Dam, Lake Roland Dam, Roland Run Levee, and Catonsville Community Park Regional SWM Pond Dam, all the high hazard dam structures that pose a risk to Baltimore County are owned and operated by the City of Baltimore. The high-risk dams were constructed to provide public water supply to residents in the Baltimore Metropolitan region, as well as to provide flood control and recreational opportunities.

In terms of significant updates to dams in Baltimore County, the removal of Bloede Dam (pictured below), which used to have a “significant” hazard rating, was complete in the summer of 2019. The removal has been described as one of the most important dam removal projects in mid-Atlantic history. The project took 18 months and was described by the Maryland Department of Natural Resources (DNR) as “serving no functional purpose for decades and posing a serious public safety hazard in Patapsco Valley State Park.”[13] In fact, according to the DNR, there had been several recorded injuries and deaths at the dam, with at least nine dam-related deaths since the 1980s and the most recent occurring in June 2015.

Source: Maryland Dam Safety Update, Issue 4, April 2019

Table 15-15. Dams Within or Bordering Baltimore County, Highest to Lowest Hazard Rating

Dam Name	Dam Type	Primary Purpose	Max Storage Capacity (acre-feet)	Emergency Action Plan	Nearby Communities
Fullerton Reservoir Tanks	Arch	Water Supply	61	No	Fullerton, Putty Hill, Nottingham
Catonsville Community Park Regional SWM Pond Dam	Earth	Flood Control	27	Yes	Catonsville, Westchester, Westerlee, Windwood
Lake Roland Dam	Gravity	Recreation	1,867	Yes	Mt. Washington, Roland Park, Levindale, Pimlico
*Liberty Dam	Gravity	Water Supply	177,000	Yes	Marriottsville
Loch Raven Dam	Gravity	Water Supply	145,000	Yes	Loch Raven, Perry Hall
Mays Chapel Reservoir	Earth	Water Supply	80	Yes	Mays Chapel, Westwind, Timonium
Pikesville Reservoir Storage Tanks	Other	Water Supply	77	Yes	Pikesville
Prettyboy Dam	Gravity	Water Supply	90,100	Yes	Cockeysville, Phoenix, Monkton, Hunt Valley, Sparks Glencoe
Roland Run Levee	Earth	Flood Control	0	Yes	Riderwood, Ruxton
Towson Reservoir Storage Tanks	Arch	Water Supply	80	Yes	Towson, Greenbrier, Donnybrook
UBMC Dam	Earth	Flood Control	185	Yes	UMBC, Arbutus
GBMC Pond	Earth	Recreation	5	Yes	
Greenspring Quarry Dam	Earth	Recreation	576	Yes	
Painters Mill Levee	Earth	Flood Control	0	Yes	
Queen Annes Village SWM No. 1	Earth	Flood Control	13	Yes	
UMBC Central Campus Dam	Other	Recreation	5	Yes	
Velvet Hill South SWM Dam	Earth	Flood Control	14	Yes	
Camp Fretterd Military Reservation Dam	Earth	Water Supply	108	Not Required	
Chenoweth Farm Pond	Earth	Recreation	52	Not Required	
Daniels Dam	Buttress	Recreation	1,500	Not Required	
Greenspring East SWM Pond No. 3 (Stream Crossing Road)	Earth	-	58	Not Required	
Old Loch Raven Dam	Masonry	Recreation	300	Not Required	
Pleasant Hill SWM Dam (Gentle Brook Road)	Earth	-	125	Not Required	

*Source: National Inventory of Dams nid.sec.usace.army.mil/ords/f?p=105:113:30322970220978 Note: These do not include dams within Baltimore City. *Dams adjacent but just outside of Baltimore County*

15.6.1 Contributing Factors to Dam Failure Risk

According to DamSafety.org, hundreds of dam failures have occurred throughout U.S. history. No one knows precisely how many dam failures have occurred in the U.S, but they have been documented in every state. From January 2005 through June 2013, state dam safety programs reported 173 dam failures and 587 “incidents” (episodes that would have likely resulted in dam failure had there not been human intervention).[14] Taking these numbers into account, nearly 22 dam failures and 73 dam “incidents” occur in the U.S. per year. Over the past 20 years there have been over 40 incidents at dams in Maryland that could have resulted in failure, with seven incidents in 2018 alone.[15] For Maryland, this indicates a probability of at least two (2) dam incidents occurring per year. Baltimore County specifically has no record of high hazard dam failure.

Dam Safety in Baltimore County

- ✓ The State of Maryland has been assuring the safety of dams since 1934 through a permit and inspection program. The laws governing dam safety are administered by MDE’s Dam Safety Division.
- ✓ Baltimore City participates the National Dam Safety Program as a source for grant assistance to improve dam safety, and to provide funds for research and training.
- ✓ Emergency Action Plans (EAP) are in place for nearly all High Hazard and Significant Hazard dams. These are available on MDE’s Dam Safety website.

According to FEMA, dams can fail for several reasons, including overtopping caused by floods, acts of sabotage, or structural failure of materials used in dam construction.[16] Besides overtopping caused by flooding, dam failure may be the result of structural failure due to outside forces such as earthquakes, or even the result of another dam failing upstream.

Flood

The occurrence of a Probable Maximum Flood (PMF), which is the most severe storm that can theoretically occur, is one scenario that could cause dam failure. This failure would result in a peak dam breach flow. In certain instances, a condition of uplift could occur at the heel of a dam which would not necessarily create a situation where overturning would occur.

Upstream Dam Failure

The failure of an upstream dam can, in some cases, put downstream dams at risk for failure depending on the amount of flood wave from the upstream dam and the downstream reservoir’s capacity to store that wave. This factor is relevant in Baltimore County, because Prettyboy Dam is upstream from Loch Raven dam. A failure of Prettyboy Dam would cause major impacts on downstream flood levels as it approaches Loch Raven Reservoir.

Earthquake

A severe earthquake, which is not a high risk in Baltimore County, could result in structural deformation or liquefaction. This can lead to the outcome of the sudden release of reservoir contents.

15.6.2 High Hazard Dam Failure Assessment

In the event of a high hazard dam failure, surrounding communities may be at risk for inundation. Baltimore County communities could potentially be impacted by the failure of eleven (11) high hazard dams. These include:

1. Fullerton Reservoir Tanks
2. Catonsville Community Park Regional SWM Pond Dam
3. Lake Roland Dam
4. Liberty Dam
5. Loch Raven Dam
6. Mays Chapel Reservoir
7. Pikesville Reservoir Storage Tanks
8. Prettyboy Dam
9. Roland Run Levee
10. Towson Reservoir Storage Tanks
11. UBMC Dam

Nearby communities that are downstream or in proximity to each of these high hazard dams are included in the Table 15-15. In the case of a high hazard dam failure, the dam's Emergency Action Plan (EAP) would be initiated by the dam owner, which is then utilized by emergency responders. The purpose of the EAP is to identify incidents that can lead to potential emergency conditions at the dam, identify the areas that can be affected by a dam failure, and identify pre-planned actions to be followed to minimize property damage, potential loss of infrastructure and water resources, and potential loss of life.

Inundation maps are another key component of an EAP; these maps show areas that may have to be evacuated in the event of a dam failure. The EAP further defines events that trigger emergency actions and include notification flowcharts with names and numbers of who will call whom and in what priority. It is important that communities identified as "at-risk" in the EAP are properly educated regarding the potential risk of dam failure. Many people may not be aware that they live near a high hazard dam, therefore action should be taken to increase public awareness of dam locations, dam inundation areas, and the EAP.

For members of the community and business owners, the National Inventory of Dams is an online resource that can aid in determining the location of high hazard dams. Important information is included for each dam, such location, owner, and EAP status. Those interested in obtaining a copy of an EAP should contact the dam's owner.

15.7 2021 MITIGATION GOALS AND ACTION ITEMS

15.7.1 Transportation Accident

GOAL 1: Eliminate or reduce human, environmental, social, and economic loss from natural and technological hazards.			
OBJECTIVE	**ACTION ITEM(S)**	**RESPONSIBLE ENTITY**	**RANKING (HIGH, MEDIUM, OR LOW)**
1. Strong enforcement of traffic laws in high hazard areas.	a. Increase traffic enforcement along transportation corridors that have a high Annual Average Daily Traffic (AADT) count. These areas are more prone to transportation accidents due to the large volume of vehicles on the road. Refer to Map 15-1 for heavily traveled roadways (shown in red).	Baltimore County Police Department, Maryland State Police	Medium
	b. In reviewing data specific to transportation roadway accidents, areas between exits 22 and 23 of I-695 have a higher occurrence of accidents. Explore and determine mitigation options for this section of roadway.	SHA	Medium
2. Gather additional data relating to railway accidents in Baltimore County.	a. Conduct/obtain additional data on railway accidents specific to Amtrak, which has the highest recorded accidents resulting in death and/or injury within the 10-year period detailed on Table 15-7.	County	Medium

15.7.2 Hazardous Materials Incident

GOAL 1: Eliminate or reduce human, environmental, social, and economic loss from natural and technological hazards.			
OBJECTIVE	**ACTION ITEM(S)**	**RESPONSIBLE ENTITY**	**RANKING (HIGH, MEDIUM, OR LOW)**
1. Determine the amount and types of hazardous materials being transported and stored throughout Baltimore County.	a. Conduct a Hazardous Materials Commodity Flow Study to identify all hazardous materials that are stored and/or traveling through the County. The study should monitor high-traffic transportation routes at location where hazmat vehicles enter and exit the county. Routes with a history of hazardous material transportation incidents include I-695 and I-83. This study should also seek to identify essential facilities and commercial centers with large populations that are within 1000 feet of street centerlines. Using the Hazardous Materials Survey results, develop a plan to mitigate any identified risks.	County	Medium
2. Enhance the capabilities of emergency service providers.	a. Based on data for transportation accidents, tailor training and exercise programs to include fuel related incidents.	County	Medium

GOAL 2: Promote hazard mitigation as the cornerstone of emergency management in Baltimore County.			
OBJECTIVE	**ACTION ITEM(S)**	**RESPONSIBLE ENTITY**	**RANKING (HIGH, MEDIUM, OR LOW)**
3. Educate the public about man-made and technical hazard risks, preparedness, and mitigation.	a. Distribute information concerning hazmat transportation to highly developed areas that are located nearby and/or along heavily traveled roadways. Refer to Map 15-1 for heavily traveled roadways (shown in red).	Local Emergency Planning Committee (LEPC), County	Medium

15.7.3 Fire and Explosion

GOAL 1: Eliminate or reduce human, environmental, social, and economic loss from natural and technological hazards.			
OBJECTIVE	**ACTION ITEM(S)**	**RESPONSIBLE ENTITY**	**RANKING (HIGH, MEDIUM, OR LOW)**
4. Increase the number of structures that are more resistant to fire and explosion.	a. Ensure compliance with all life safety codes through diligent inspections. Attempt to inspect all commercial uses annually.	County	Medium
5. Acquire information regarding potential fire and explosion threats.	a. Conduct an inventory of sites or facilities that may be prone or vulnerable to explosions.	County	Medium
	b. Conduct an inventory of buildings that do not meet current Building Code standards.	County	Medium

GOAL 2: Promote hazard mitigation as the cornerstone of emergency management in Baltimore County.			
OBJECTIVE	**ACTION ITEM(S)**	**RESPONSIBLE ENTITY**	**RANKING (HIGH, MEDIUM, OR LOW)**
6. Educate the public about man-made and technical hazard risks, preparedness, and mitigation.	a. Continue to enhance fire safety awareness information and make such information more available to local homeowners and businesses via the County's social media.	County	Medium

7. Enhance the capabilities of emergency service providers.	a. Encourage the training of Fire Department personnel through fire and explosion disaster drills and response planning.	County	Medium

15.7.4 Mass Power Outage

GOAL 1: Eliminate or reduce human, environmental, social, and economic loss from natural and technological hazards.			
OBJECTIVE	**ACTION ITEM(S)**	**RESPONSIBLE ENTITY**	**RANKING (HIGH, MEDIUM, OR LOW)**
8. Provide fuel for emergency response vehicles during a long-term power outage.	a. Determine the number and locations of fuel service stations with generator power, as well as the number of emergency vehicles that need fuel.	County	Medium
	b. Identify the fueling locations that do not have generators but are "generator ready". Then, identify the size and type of generators that are required for fueling.	County	Medium
9. Provide for the life safety of vulnerable populations during a long-term power outage.	a. Assess the number of vulnerable persons that may need assistance such as shelter, medication, medical equipment, and food and water during a mass power outage event; conduct outreach to vulnerable populations during the event.	County	High
	b. Consider developing a Vulnerable Populations Plan. This document would seek to identify vulnerable population within Baltimore County and provide a useful aid to emergency responders by filling resource gaps and increasing preparedness before a mass power outage.	County	High

15.7.5 Dam Failure

GOAL 1: Support mitigation measures that show potential for environmental enhancement and cost-effectiveness.			
OBJECTIVE	**ACTION ITEM(S)**	**RESPONSIBLE ENTITY**	**RANKING (HIGH, MEDIUM, OR LOW)**
10. Develop a Green Infrastructure Plan that would redevelop inundation areas as open spaces, thus creating amenities and services to benefit the overall community.	a. Analyze land in the inundation areas to assess its suitability for conservation or recreational uses.	County	Medium

GOAL 2: Promote hazard mitigation as the cornerstone of emergency management in Baltimore County.			
OBJECTIVE	**ACTION ITEM(S)**	**RESPONSIBLE ENTITY**	**RANKING (HIGH, MEDIUM, OR LOW)**
11. Educate the public about man-made and technical hazard risks, preparedness, and mitigation.	a. Develop a targeted outreach program to increase awareness of dam safety and emergency response procedures for residents and businesses located in dam inundation areas.	County	Medium
	b. Update and Maintain notification listing found in Emergency Action Plans (EAPs). Review information and provide to stakeholders.	Dam Owner, MDE Dam Safety Division	Medium
	c. Create an Emergency Action Plan (EAP) for the Fullerton Reservoir. This dam is ranked as "high hazard" but does not currently have an EAP.	Dam Owner, MDE Dam Safety Division	High

[1] Baltimore County Emergency Operations Plan, July 2019
[2] The Baltimore Sun, May 2013 www.baltimoresun.com/maryland/bs-md-rosedale-train-derailment-20130528-story.html
[3] Baltimore County Emergency Operations Plan, July 2019
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[12] www.fema.gov/sites/default/files/2020-08/fema_dam-safety_aware-community_fact-sheet_2016.pdf
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CHAPTER 16:
MITIGATION STRATEGIES

UPDATES

During the 2021 Plan Update process, **Chapter 16: Mitigation Strategies** was updated with the most recently available data.

Updates to this chapter include:

- Thematic and visual update
- An **Action item Prioritization Survey** was developed to gather feedback from planning committee members. The survey acted as a benefit-cost analysis and served to prioritize the action items. Action items were ranked via the survey results and those items ranked as “high priority” were further developed into mitigation projects.
- **New Projects** developed based on highly ranked Action Items
- **New Section: 16.3 Capability Assessment Recommendations** has been added to this chapter, highlighting recommendations to improve current authorities, policies, programs, and resources as described in *Appendix C: Capability Assessment*.

16.1 INTRODUCTION

As stated in *Chapter 3: Overall Hazard Mitigation Goals, Objectives, and Action Items*, the purpose of hazard mitigation strategies is to reduce or eliminate long-term risk to people and property from hazards and their effects using mitigation measures that promote environmental and fiscally responsible objectives and strategies.

During the 2021 Plan Update process, hazard-specific goals, objectives, and action items from the 2014 Plan were reviewed and updated as necessary by the Hazard Mitigation Planning Committee (HMPC). This review process also included adding new hazard-specific action items within each chapter for the Plan Update.

Mitigation strategies include goals, objectives, action items, and mitigation projects. Goals provide a general guideline as to what Baltimore County hopes to achieve within the next 5-year planning cycle. Objectives are not as broad as goals or defined as action items but serve to provide a measurable connection between goals and action items. Action items consist of real-world steps that can be taken to fulfill the mitigation goals set by the County. Mitigation projects, which are derived from high priority action items (refer to section 16.1.1) are the final step to making action items come to life. These mitigation projects are included in section *16.2 Mitigation Projects*.

Additionally, recommendations from the capability assessment performed for this plan update are included in *Section 16.3*, at the end of this chapter. The purpose of conducting a capability assessment is to determine Baltimore County's ability to implement a comprehensive hazard mitigation strategy, and to identify potential opportunities for establishing or enhancing specific mitigation policies, programs or projects. The capability assessment provides an opportunity to highlight the positive hazard mitigation measures already in place or being implemented throughout the county and which should continue to be supported and enhanced via future mitigation efforts.

16.1.1 Action Item Prioritization Survey & Benefit-Cost Analysis

Each identified hazard and associated hazard specific chapter within the Plan contains goals, objectives, and action items. To prioritize these action items an online survey was designed for stakeholders to complete. HMPC members were asked five questions for every action item. An example of the online survey is provided below. Questions for each action item were as follows:

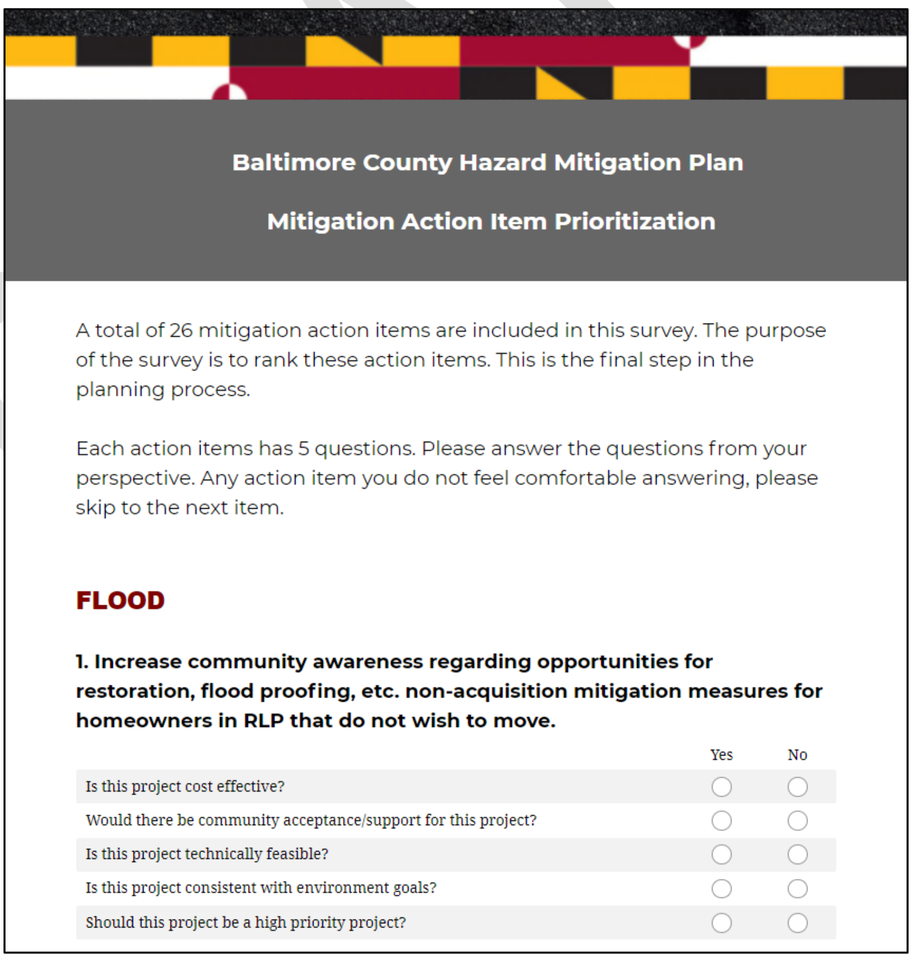
1. Is this project cost effective?
2. Would there be community acceptance/support for this project?
3. Is this project technically feasible?
4. Is this project consistent with environmental goals?
5. Should this project be a high priority project?

Planning committee members were asked to answer these survey questions to the best of their ability and were only asked to provide feedback on action items for which they had expertise or confidence in answering. In total, 26 action items were prioritized by planning committee members and eleven (11) action items were rated as high priority.

Action Items were ranked as High, Medium, or Low priority based on a total possible score of five (5) points for each item. Based on the feedback from HMPC members weighted averages were calculated for each action item and summed to create a final priority score. Criteria for ranking action items as “high priority” was as follows: action items with a combined weighted average of 4.25 or more out of 5 (≥ 85%) were determined to be of highest priority. In total, eleven (11) action items were deemed to be **high priority** by the HMPC, including:

- **4** action items from *Chapter 4: Flood*
- **3** action items from *Chapter 15: Technological and Man-Made Hazards* relating to Mass Power Outages and Dam Failure
- **2** action items from *Chapter 14: Pandemic and Emerging Infectious Diseases*
- **1** action items from *Chapter 13: Coastal Storm and Flooding*
- **1** action item from *Chapter 8: High Winds*

Note: action items prioritized as Medium or Low by HMPC members are not developed as mitigation projects but are included in their respective hazard-specific chapters.



Baltimore County Hazard Mitigation Plan

Mitigation Action Item Prioritization

A total of 26 mitigation action items are included in this survey. The purpose of the survey is to rank these action items. This is the final step in the planning process.

Each action items has 5 questions. Please answer the questions from your perspective. Any action item you do not feel comfortable answering, please skip to the next item.

FLOOD

1. Increase community awareness regarding opportunities for restoration, flood proofing, etc. non-acquisition mitigation measures for homeowners in RLP that do not wish to move.

	Yes	No
Is this project cost effective?	○	○
Would there be community acceptance/support for this project?	○	○
Is this project technically feasible?	○	○
Is this project consistent with environment goals?	○	○
Should this project be a high priority project?	○	○

Example of the Mitigation Action Item Prioritization Survey provided to HMPC members.

Action items ranked as **high priority** via the online survey by the planning committee are listed by hazard below. These high priority action items are consistent with the results of the hazard identification and risk assessment completed at the beginning of the Plan Update process. These results are fully discussed within *Chapter 1: Plan Introduction, Section 1.5.2* as well as *Appendix A.* Baltimore County ranked Flood and Pandemic and Emerging Infectious Disease as “high” risk and Coastal Storm and Flooding and High Winds as “medium-high” risk.

<u>FLOOD</u>

1. Develop an educational plan for updates on emergency preparedness, including communications, evacuation, traffic, area closures, visitor controls, damage assessment, clean up etc.
2. Earn potential CRS credits by continuing to preserve the county’s floodplains as open space. More opportunities for CRS credits are outlined in the report “Land Conservation and the Community Rating System: Mapping Open Space Preservation Opportunities in Maryland Communities”.
3. Consider flood-proofing measures for the County’s 60 pump stations identified as having medium to high flood vulnerability (see: Baltimore County Climate Adaptation Plan). It is recommended that a recurring CIP budget be established for the flood-proofing of pump stations.
4. Request new FEMA Risk MAP product be produced for coastal/riverine using new DFIRM. The previous FEMA Risk MAP product for Baltimore County was completed in 2014 for coastal only.

<u>COASTAL STORM & FLOODING</u>

5. Conduct an NFIP Workshop targeting insurance and real estate agents as well as loan officers working in Baltimore County. Offer continuing education credit and request a FEMA provided instructor.

<u>PANDEMIC AND EMERGING INFECTIOUS DISEASES</u>

6. Continue to provide information on the County’s social media about pandemic and emerging infectious diseases risk and vulnerability.
7. Ensure that all health-related announcements, information, and materials are accessible to all socially vulnerable groups, including but not limited to those: over the age of 65, under the age of 5, with limited English-speaking proficiency, with disability, and those at or below the poverty line.

<u>TECHNOLOGICAL AND MAN-MADE</u>

8. Assess the number of vulnerable persons that may need assistance such as shelter, medication, medical equipment, and food and water during a mass power outage event; conduct outreach to vulnerable populations during the event.

9. Create an Emergency Action Plan (EAP) for the Fullerton Reservoir. This dam is ranked as "high hazard" but does not currently have an EAP.
10. Consider developing a Vulnerable Populations Plan. This document would seek to identify vulnerable population within Baltimore County and provide a useful aid to emergency responders by filling resource gaps and increasing preparedness before a mass power outage.

HIGH WINDS

11. Promote educational material on social media relating to the dangers of, and differences between, Derechos and Tornadoes.

16.2 MITIGATION PROJECTS

The following six projects are the result of the Action item Prioritization Survey exercise completed by HMPC members. High Priority action items were combined into one project if they were similar. Each project table includes the following information, where applicable:

- Project Title
- Action Item(s)
- Related Hazard(s)
- Project Background
- Impacted Area
- Responsible Entity(ies)
- Partner(s)
- Potential Funding Sources
- Estimated Cost

Those actions pertaining to flooding that may be undertaken and documented for the National Flood Insurance Program (NFIP) – Community Rating System are denoted with the following: CRS. Projects included in this Plan Update are:

1. Public Outreach Strategy and Best Practices
2. Development of a Vulnerable Populations Plan
3. Open Space Preservation and the Community Rating System (CRS)
4. Flood Proofing of County Pump Stations
5. Dam Safety – Emergency Action Plan (EAP) Creation for Fullerton Reservoir
6. Requesting New FEMA Flood Risk MAP Products

Project Title:	**#1 – Public Outreach Strategy and Best Practices**
Action Item(s):	a. Continue to provide information on the County's social media about pandemic and emerging infectious diseases risk and vulnerability. b. Promote educational material on social media website relating to the dangers of, and differences between, Derechos and Tornadoes. c. Develop an educational plan for updates on emergency preparedness, including communications, evacuation, traffic, area closures, visitor controls, damage assessment, clean up etc.
Related Hazard(s):	Pandemic & Emerging Infectious Diseases, High Wind, Flood
Background:	 **<u>Social Media Best Practices</u>** According to FEMA, social media can be an effective tool that local governments can use to communicate and engage with the public. Recent studies have found that over 85 percent of local government agencies use social media platforms to get information to their constituents. Social media provides benefits of: • wide reach • greater accessibility of information • immediacy of information • ease of use • conversation starting Nationally, it is estimated by The Pew Research Center that 68% of US citizens have a Facebook profile and 21% utilize Twitter. Consider, in 2001 more than half of US citizens learned about the terrorist attacks from television, and only 1% from internet sources. However, in 2015, social media was successfully utilized by local and national authorities as an emergency response medium in handling the San Bernadino attack. Due to the widespread utilization of social media by citizens, these platforms can and do play a pivotal role in communicating with a variety of audiences about their risk from natural hazards and steps that can be taken to minimize these risks or their impact. To help ensure the most effective social media impact, public response, consider the following best practices: 1. ***Incorporate social media strategies into your emergency notification and public information plans*** for accountability. This includes identifying who is assigned to create, post, and update your information, along with the team that will monitor and oversee the channels. 2. Heavily monitor ***social media traffic***. The sharing of your official post(s) may cause more panic or serve as a complaint forum for naysayers. Pay attention to what is being discussed and respond appropriately. 3. Always ***note the date and time of your original post,*** as well as in any subsequent updates, to avoid outdated information from spreading after the fact. 4. ***Do not solely rely on social media***. Utilize every mode of communication to reach as many people as you can. Not everyone utilizes social media platforms or has 24×7 access, especially during critical situations.

The most important thing about an effective mass notification solution is leveraging all the right communication methods to circulate your message – especially when it is an emergency alert. Sending the right notification over all the appropriate platforms ensures your message reaches everyone regardless of whether they are using a particular social media platform at any given time, smart phone with text, mobile app, or IPAWS capabilities.

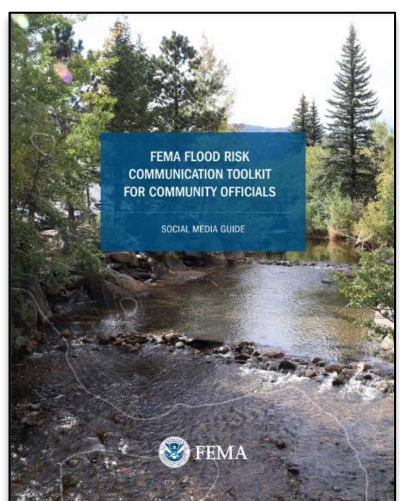
Some additional best practices, in the form of "do's and don'ts" from FEMA, include:

DO:

- Protect your community: Offensive, violent, or discriminatory comments regarding race, ethnicity, religion, gender, or sexual orientation will not be tolerated.
- Maintain a solicitation-free environment: State clearly that your page is not Craigslist. Promotions and business offers must align with the good of the community and not personal agendas.
- Embrace the diversity and struggles of your community: Their stories are what make community management a rich experience. Each fan/follower's experience is unique, and we should treat it as such in our response.

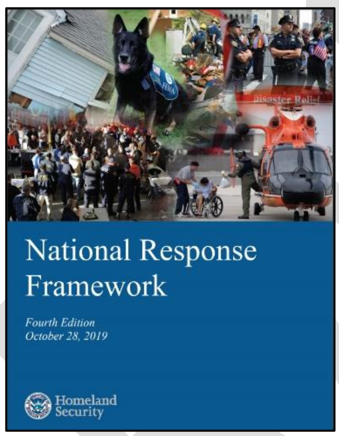
DON'T

- Delete anything: Deleting posts, tweets, or comments from your social content will be seen as a violation of FOIA. Please check your state's specific laws pertaining to FOIA and digital archiving practices (In Maryland, the Public Information Act includes all records "in any form" related to public business. By this definition, social media can be considered public records under the Act).
- Engage in organization bashing: Do not call out specific brands, groups, or organizations. Even if provoked, always take the high road.
- Engage in political discussion: Outside of delivering facts and information to your community, do not take a stance on issues deemed "political." If users comment with a political stance, do not engage/respond to those comments. Do not delete them unless they are cited as harmful or threatening. Before deletion, always refer to the FOIA laws for Maryland. If the state allows it, screenshot and log the comment internally. If a FOIA request surfaces in the future, you will have an internal source to share.



For more information about social media management and best practices, including the aforementioned information, please refer to FEMA's *Flood Risk Communication Toolkit for Community Officials*. In addition, for tools geared towards health professionals, the CDC has a multitude of social media tools at www.cdc.gov/socialmedia/tools/guidelines.

	The tools include social media policy, guides for specific platforms, security measures, and a tool kit. **<u>Key Components of Educational Outreach Plans</u>** • Informs and educates about hazards and risks • Invites interested parties to contribute their views and ideas for mitigation • Identifies conflicts and incorporates different perspectives and priorities early in the process • Provides data and information that improves overall quality and accuracy of the plan • Ensures transparency and builds trust • Development of a "5-Year Plan," including the identification of outreach events, target audience, method of delivery, and plan maintenance schedule. Working collectively with partners to share social media content at regular and coordinated intervals will maximize Baltimore County's outreach efforts, no matter what the topic may be. Public Information Officers, or equivalent, from each of the listed "Responsible Entities" and "Partners" should meet periodically to discuss outreach initiatives and coordinate efforts. This coordination effort should be included within the "5-Year Plan."
Impacted Area(s):	County-wide, with a special focus on property owners in flood prone areas and vulnerable populations.
Responsible Entity:	Department of Health, Office of Homeland Security and Emergency Management, Office of Information Technology
Partners:	Hazard Mitigation Planning Committee
Potential Funding:	Superfund Amendments and Reauthorization Act
Estimated Cost:	Minimal, can be built into staff-time.

Project Title:	**#2 – Development of a Vulnerable Populations Plan**
Action Item(s):	a. Ensure that all health-related announcements, information, and materials are accessible to all socially vulnerable groups, including but not limited to those: over the age of 65, under the age of 5, with limited English-speaking proficiency, with disability, and those at or below the poverty line. b. Assess the number of vulnerable persons that may need assistance such as shelter, medication, medical equipment, and food and water during a mass power outage event; conduct outreach to vulnerable populations during the event. c. Consider developing a Vulnerable Populations Plan. This document would seek to identify vulnerable population within Baltimore County and provide a useful aid to emergency responders by filling resource gaps and increasing preparedness before a mass power outage.
Related Hazard(s):	Pandemic & Emerging Infectious Diseases, Mass Power Outage
Background:	The National Response Framework defines vulnerable, or special needs, populations as follows:  "Populations whose members may have additional needs before, during and after an incident in functional areas, including but not limited to: maintaining independence, communication, transportation, supervision, and medical care. Individuals in need of additional response assistance may include those who have disabilities; who live in institutionalized settings; who are elderly; who are children; who are from diverse cultures; who have limited English proficiency or are non-English speaking; or who are transportation disadvantaged." A Vulnerable Populations Plan would seek to spatially identify vulnerable populations within Baltimore County. The plan would serve as a tool for emergency responders and health care providers to prepare and respond to both natural and man-made hazard events while addressing the unique needs of vulnerable populations. Further, the plan would identify resources gaps that may exist specifically relating to vulnerable populations. The plan development process of a Vulnerable Populations Plan consists of four main components: **1. Data Collection** **2. Development of Vulnerable Population Database** • Various data obtained should be reviewed and compiled to create a centralized database which will enable planners to query data for analysis and integrate into GIS software for mapping applications. **3. Creation of GIS Mapping Product(s) Identifying Vulnerable Populations** • Utilization of GIS software to analyze spatially referenced data to display the association between the locations of vulnerable populations, community resources, and the potential hazard(s). • This mapping product could be used during future emergency incident response and operations. Response planning personnel may use this mapping product, and an overlay of hazard impact area(s) could be incorporated,

Project Title:	#2 – Development of a Vulnerable Populations Plan
	thereby providing critical information to first responders and officials to promote better decision making specific to vulnerable populations. 4. **Development of Plan Document** • The plan document will include data analysis and results; scenario-based planning using hazard identification and risk assessment results; preparedness, response, and recovery information and resource gaps specific to special needs population; recommendations and suggested Best Practices including public outreach efforts. Baltimore County has developed various components necessary for the creation of a Vulnerable Populations Plan. The creation of a Vulnerable Populations Planning Committee will assist in the review and integration of necessary components into a cohesive working draft. The Vulnerable Populations Planning Committee will review the working draft and identify gaps and next step items.
Ideas for Integration:	- Integrate best practices from Project "#1 – Public Outreach Best Practices" when communicating with vulnerable populations. - Add vulnerable populations data, standard operating procedure, policies into County EOP.
Impacted Area(s):	Vulnerable populations, county-wide
Responsible Entity:	Department of Health
Partners:	Office of Information Technology Office of Homeland Security and Emergency Management
Estimated Cost:	$50,000

Project Title:	#3 – Open Space Preservation and the Community Rating System – CRS
Action Item(s):	a. Earn potential CRS credits by continuing to preserve the county's floodplains as open space. More opportunities for CRS credits are outlined in the report "Land Conservation and the Community Rating System: Mapping Open Space Preservation Opportunities in Maryland Communities". b. Conduct NFIP Workshop targeting insurance and real estate agents as well as loan officers working in Baltimore County. Offer continuing education credit and request a FEMA provided instructor.
Related Hazard(s):	Flood, Coastal Storm and Flooding
Background:	**Community Rating System & Open Space Preservation** Baltimore County's *2017 Land Preservation, Parks and Recreation Plan* characterizes flood plains preserved as open space as part of their "county-owned green spaces." These spaces are managed by the County's Department of Environmental Protection and Sustainability (EPS) and the Department of Public Works (DPW). These areas are very similar to parks and open spaces along stream valleys, with their primary role being to protect the natural environment. Public access is permissible, which allows nearby citizens to use these open spaces to "escape to nature." These green spaces do not include storm water management ponds or forest conservation, flood plain, steep slope, or drainage easements. The Community Rating System (CRS) is a voluntary incentive program that recognizes and encourages community floodplain management practices that exceed the minimum requirements of the National Flood Insurance Program (NFIP). Over 1,500 communities participate nationwide. In CRS communities, flood insurance premium rates are discounted to reflect the reduced flood risk resulting from the community's efforts that address the three goals of the program: 1. Reduce and avoid flood damage to insurable property 2. Strengthen and support the insurance aspects of the National Flood Insurance Program 3. Foster comprehensive floodplain management In total, 19 groups of activities qualify for CRS credit. Each activity has one or more elements. Elements are the basic credit level for the CRS. The element and activity scoring process are covered in depth within FEMA's Community Rating System Coordinator's Manual. The maximum number of points available to earn via open space preservation is 2,020. The table below depicts these activities and estimates average credit points earned based upon the number of applicants for each activity, as opposed to the total number of applicants for the CRS. Communities should note the average credits for these activities. They provide a better indication of what an applicant can expect for an activity than do the maximum points available. The CRS **"Quick Check"** is a tool that a community can use to assess its potential for receiving CRS credit for activities it is undertaking. The Quick Check can be found at www.CRSresources.org/200.

Project Title:	#3 – Open Space Preservation and the Community Rating System – CRS

The *Quick Check* does not estimate credit for a community. However, by reviewing each element and going through the steps explained in Section 220, a community can assess its potentially creditable activities.

Baltimore County may qualify for CRS credit for past and present open space preservation in flood plain areas. Open Space Preservation is one of the nineteen qualifying activities within the CRS. According to a 2020 report conducted by the Chesapeake Conservancy, Baltimore County is eligible for up to 578 Open Space Preservation (OSP) credits, qualifying for a 5% discount to flood insurance. This is possibly due to the considerable headway Baltimore has made in preserving open space within their floodplains. Of the almost 18,000 acres of floodplain, 7,151 acres (or about 40%) of it is preserved open space. To reach the 10% discount, the County would must preserve another 5,206 acres of its floodplain.

CRS Activity 420: "Open Space Preservation" Managing new development to minimize future damage, preserving open space.

Extra credit is provided for open space areas that are preserved in their natural state; have been restored to a condition approximating their pre-development natural state; or have been designated as worthy of preservation for their natural benefits, such as being designated in a habitat conservation plan.

Table 110-2. Credit points awarded for CRS activities.*

Activity	Maximum Possible Points	Maximum Points Earned	Average Points Earned	Percentage of Communities Credited
300 Public Information Activities				
310 Elevation Certificates	116	116	38	96%
320 Map Information Service	90	90	73	85%
330 Outreach Projects	350	350	87	93%
340 Hazard Disclosure	80	62	14	84%
350 Flood Protection Information	125	125	38	87%
360 Flood Protection Assistance	110	100	55	41%
370 Flood Insurance Promotion [5]	110	110	39	4%
400 Mapping and Regulations				
410 Flood Hazard Mapping	802	576	60	55%
420 Open Space Preservation	2,020	1,603	509	89%
430 Higher Regulatory Standards	2,042	1,335	270	100%
440 Flood Data Maintenance	222	249	115	95%
450 Stormwater Management	755	605	132	87%
500 Flood Damage Reduction Activities				
510 Floodplain Mgmt. Planning	622	514	175	64%
520 Acquisition and Relocation	2,250	1,999	195	28%
530 Flood Protection	1,600	541	73	13%
540 Drainage System Maintenance	570	454	218	43%
600 Warning and Response				
610 Flood Warning and Response	395	365	254	20%
620 Levees	235	207	157	0.5%
630 Dams	160	99	35	35%

* Figures are based on communities that have received verified credit under the 2013 *CRS Coordinator's Manual* (about 43% of CRS communities), as of October 2016. The maximum possible points are based on the 2013 *Coordinator's Manual*. Growth adjustments are not included.

Project Title:	**#3 – Open Space Preservation and the Community Rating System – CRS**
	<u>Training Opportunity - NFIP Flood Insurance Workshop</u> The National Flood Insurance Program (NFIP) was enacted by the Federal government in 1968 to facilitate citizens' access to affordable flood insurance and shift the burden of private property flood losses from taxpayers to floodplain property owners. The program is also designed to guide development away from flood hazard areas and requires new design and construction to be carried out in a way that minimizes or prevents flood damage. *Flood Insurance Promotion* is a qualifying activity under the CRS, which means hosting an NFIP Flood Insurance Workshop can provide two major benefits: 1. Increase training amongst targeted audiences, including real estate agents, insurance agents, and the public. 2. Contribute to potential CRS credit points for Baltimore County. NFIP Training courses are made available ***entirely online*** for insurance agents, claims adjusters, surveyors, and community officials via the FEMA Emergency Management Institute (EMI) Independent Study Program. Online training courses can be specialized for: agents, state agents, adjusters, surveyors, and public audiences. Courses related to NFIP Training are found for free at **nfipservices.floodsmart.gov**, or directly accessed at **training.fema.gov.**
Ideas for Integration:	- Land Preservation, Parks and Recreation Plan - Education and Outreach Plan discussed in Project #1 – Public Outreach Best Practices
Impacted Area(s):	Flood hazard areas, open space locations throughout the county.
Responsible Entity:	Department of Public Works and Transportation
Partners:	Office of Homeland Security and Emergency Management, Hazard Mitigation Planning Committee, PIO, Maryland Department of the Environment, Maryland Emergency Management Agency, Floodplain Manager
Potential Funding:	Community Assistance Program, State Support Services Element (CAP-SSSE)
Estimated Cost:	Staff Time + $5,000 for Outreach Efforts Coordination

Project Title:	#4 - Flood Proofing of County Pump Stations
Action Item(s):	a. Consider flood-proofing measures for the County's 55 pump stations identified as having medium to high flood vulnerability within the Climate Adaptation Plan. It is recommended that a recurring CIP budget be established for the flood-proofing of pump stations.
Related Hazard(s):	Flood, Coastal Storm and Flooding
Background:	Baltimore County owns and operates 121 sanitary sewer pump stations. A subset of these were evaluated in a recent report titled *Pumping Station Flood Resiliency Assessment & Evaluation Study (2019).* This study evaluated the flood risk to all the pump stations based on the criteria below. 1. Tier 4 (High) – Sites that are in most susceptible areas as defined by all three flood risk categories. (location relative to the FEMA SFHA, projected sea level rise, and projected storm surge areas) 2. (Medium) – Sites outside of the FEMA SFHA but in areas most susceptible to storm surge and sea level rise. 3. Tier 2 (Low) – Sites that are only affected by storm surges for Category 3 and 4 hurricanes. 4. Tier 1 (Unlikely) – Sites outside of all flood risk categories. Mitigation projects considered the most cost-effective by FEMA for pump stations: • Equipment or controls in a pump station that are subject to damage from 100-year flood can be elevated. Pump station buildings can be dry floodproofed. • Installation of camlocks, transfer switches, and electrical panels to facilitate the connection of portable emergency generators. • If pumps and their attached motors are damaged by storm water inundation, replace them with submersible or inline pumps as appropriate. • If pump station equipment is damaged because of inundation resulting from power failure, install switches, circuit isolation and quick connect capability to facilitate rapid connection of backup power. Pump stations should be prioritized for upgrades based on the rankings from the *Climate Action Plan (CAP)* and the *Pumping Station Flood Resiliency Assessment & Evaluation Study (2019).* The latter study provided detailed as-built plans for 24 stations but did not develop cost estimates for resiliency improvements. The *Climate Action Plan* includes risk rankings for each pump station. Cost estimates for flood-proofing pump station facilities were not included in the CAP because pump stations have building penetrations and equipment that are not typical of other buildings. It is therefore recommended that a cost-benefit analysis be conducted for flood mitigation alternatives for each pumping station along with detailed onsite investigations of the stations. A positive cost-benefit analysis is necessary for grant applications, especially FEMA grants.
Ideas for Integration:	Baltimore County Climate Action Plan (CAP)
Impacted Area(s):	County Pump Stations
Responsible Entities:	Public Works, Bureau of Utilities, Pumping and Treatment Division
Potential Funding:	Federal Emergency Management Agency, Hazard Mitigation Grant Program (HMGP), Pre-Disaster Mitigation, Flood Mitigation Assistance, Community Development Block Grants,

Project Title:	**#4 - Flood Proofing of County Pump Stations**
	U.S. Army Corp of Engineers (for elevating), Building Resilient Infrastructure and Communities (BRIC).
Estimated Cost:	Variable; dependent upon the needs of each pump station and any existing flood-proofing measures.

Project Title:	**#5 – Dam Safety – Emergency Action Plan (EAP) Creation for Fullerton Reservoir**
Action Item(s):	a. Create an Emergency Action Plan (EAP) for the Fullerton Reservoir. This dam is ranked as “high hazard” but does not currently have an EAP.
Related Hazard(s):	Dam Failure
Background:	The Federal Emergency Management Agency (FEMA) requires that “high hazard potential dams” be profiled within Hazard Mitigation Plans. A high hazard potential dam (HHPD) is defined as “any dam whose failure or mis-operation will cause loss of human life and significant property destruction.” Dams are eligible for federal HHPD funding only if they have an approved state Emergency Action Plan. The purpose of this grant funding is to aid with technical, planning, design, and construction activities related to repair, removal, and/or structural/non-structural rehabilitation of the dam. An Emergency Action Plan is defined as a “formal document that identifies potential emergency conditions at a dam and specifies pre-planned actions to be followed to minimize property damage and loss of life.” The EAP: 1. Specifies actions the dam owner should take to moderate or alleviate the problems at the dam, 2. Contains procedures and information to assist the dam owner in issuing early warning and notification messages to responsible downstream emergency management authorities of the emergency, 3. Contains inundation maps to show the emergency management authorities of the critical areas for action in case of an emergency. The dam owner is responsible for development, maintenance, and exercise of the EAP; however, there are guidelines, tools and assistance available to help owners. Local and state emergency management directors and state dam safety officials stand ready to partner with owners to create and exercise EAPs. An owner can tap into this technical and emergency management expertise and can get additional support by using state and national educational materials, EAP forms and examples, and step-by-step guidelines. When developing an EAP for a high-hazard dam, it is important to keep in mind the following key points: • An EAP must clearly specify the dam owner’s responsibilities to ensure timely and effective action. Responsibilities of dam owners include: surveillance (monitoring the condition of the dam) and notification (phoning local or state emergency management agency officials in charge of emergency response). • EAPs are developed by dam owners working with local emergency response managers, dam safety engineers, and state dam safety officials. • Inundation maps are a key component of the EAP. Inundation maps show areas that may have to be evacuated in a dam emergency. The maps facilitate notification by displaying flood areas and estimated travel times for the

	floodwaters. New, two-dimensional technologies are available to create inundation maps of areas below dams. • Dam owners and local emergency responders are primary users of EAPs. A Standard Operating Plan (SOP) is a related document that outlines the normal, non-emergency operation of a dam and is a document for the dam owner and his staff and not a public emergency document. • Public awareness is a critical component of emergency planning. Many people do not know they may live or work near a dam. Public awareness of an EAP will enhance its effective implementation. • The EAP defines events that trigger emergency actions. • An EAP includes a notification flowchart with names and numbers of who will call whom and in what priority. • Emergency events at dams are infrequent. Training and exercises of EAPs help maintain readiness. • EAPs should be updated at least once per year and following any changes or new information such as changes in downstream development or new contact information. EAPs should be exercised at least every five years. Primary Plan Components 1. Basic Dam Characteristics 2. EAP Plan Overview 3. Roles & Responsibilities 4. Event Detection 5. Emergency Level Determination 6. Notification & Communication Flowcharts 7. Expected Actions 8. Termination 9. EAP Maintenance Plan (Review, Exercise & Update) 10. Appendices including Inundation Maps for Evacuations For more information about Emergency Action Plans and Dam Safety, please visit damsafety.org.
Ideas for Integration:	- Baltimore County EOP - Baltimore County Hazard Mitigation Plan
Impacted Area(s):	Fullerton Reservoir and adjacent properties.
Responsible Entity:	Dam Owner, MDE Dam Safety Division
Partners:	Office of Homeland Security and Emergency Management, Department of Public Works
Potential Funding:	FEMA Dam Safety Grants, Rehabilitation of High Hazard Potential Dam Grant Program (eligible once EAP is created).

Project Title:	**#6 – Requesting New FEMA Flood Risk MAP Products**
Action Item(s):	a. Request new **FEMA Risk MAP** product be produced for coastal/riverine using new DFIRM. The previous **FEMA Risk MAP** product for Baltimore County was completed in 2014 for coastal only.
Related Hazard(s):	Coastal Storm and Flooding
Background:	Flood Risk Products, including Risk Mapping, Assessment and Planning (i.e., Risk MAP), help state, tribal, territories and local governments and community officials view and visualize their local flood risk, allowing communities to make informed decisions about reducing flood loss and mitigating potential damage from flood hazards. These individuals may include property owners, emergency management officials, community planners and developers, real estate and insurance specialists and other professionals and community decision-makers. An important distinction between the Flood Risk Products mentioned above (i.e., Flood Risk Maps or Flood Risk Reports) and regulatory flood hazard products (e.g., the FIRM, FIS, and FIRM Database) is that *regulatory flood hazard products* are mandated by law and are used by the National Flood Insurance Program (NFIP) for activities such as rating flood insurance policies or enforcing the federal mandatory insurance purchase requirements. *Flood Risk Products* are supplementary resources for understanding and communicating local flood risk to communities. Flood Risk Products should only be used for review and guidance purposes. The data and information displayed in these products are the latest Flood Risk Products produced by a FEMA Risk MAP study. The Flood Risk Products are not necessarily updated to match the regulatory flood maps. **Recent Updates:** Through its Risk MAP program, FEMA consistently releases new flood maps and data, giving communities across America access to helpful, authoritative data that they can use to make decisions about flood risk. The Biggert-Waters Flood Insurance Reform Act of 2012 (Biggert-Waters) as amended with the Homeowner Flood Insurance Affordability Act of 2014, directs FEMA to notify Members of Congress when constituents in their District are and will be affected by a flood mapping update. The most recent action taken by FEMA for Baltimore County was 8/12/2020; preliminary FIRM Panels, preliminary FIS Reports, and the preliminary FIRM Database was released. Additional Floodplain Information and Mapping is available on Baltimore County **Requesting an Update:** The first step in requesting new flood risk mapping is contacting FEMA via their website: www.fema.gov/flood-maps/change-your-flood-zone. This website provides general instructions on how to change your flood zone designation and answers frequently asked questions regarding “How to Submit a Letter of Map Change (LOMC) Request.” Typically, a LOMC is utilized to request small amendments or changes be made if there is believed to be an error in the mapping; these requests are typically for individual properties or neighborhoods.

Project Title:	#6 – Requesting New FEMA Flood Risk MAP Products

Data requests for existing Flood Insurance Studies (FIS) can also be initiated by completing an online form and mailing it to FEMA. There are seven (7) data request categories identified by FEMA, each category of request has an associated fee. The form, with instructions, is available here: https://www.fema.gov/sites/default/files/documents/fema_flood-insurance-study-data-request-form.pdf.

A "Compendium of Map Changes" is available online for users to review a list of all the changes made to National Flood Insurance Program (NFIP) maps in any given six-month period, including:

- Physical Map Revisions
- Letters of Map Revision
- Letters of Map Amendment
- Letter of Map Change batch files
- Product Availability catalog

The current available flood risk map product available from FEMA is depicted below.

Please note: Flood Risk Products have purposes that are different from regulatory flood hazard products (i.e., FIRM, FIS Report, and FIRM Database). Regulatory flood hazard products are mandated by law and used by the National Flood Insurance Program (NFIP) for rating flood insurance policies and enforcing the federal mandatory insurance purchase requirements. Flood Risk Products are supplementary resources for communicating flood risk to communities and may not entirely align with the regulatory flood maps. The information in these products reflect what was produced by the FEMA Risk MAP study in that area. Depending on the requirements of the study, the Flood Risk Products available for your community may consist of a Flood Risk Map, Flood Risk Report or Flood Risk Database.

Flood Risk Maps (1)

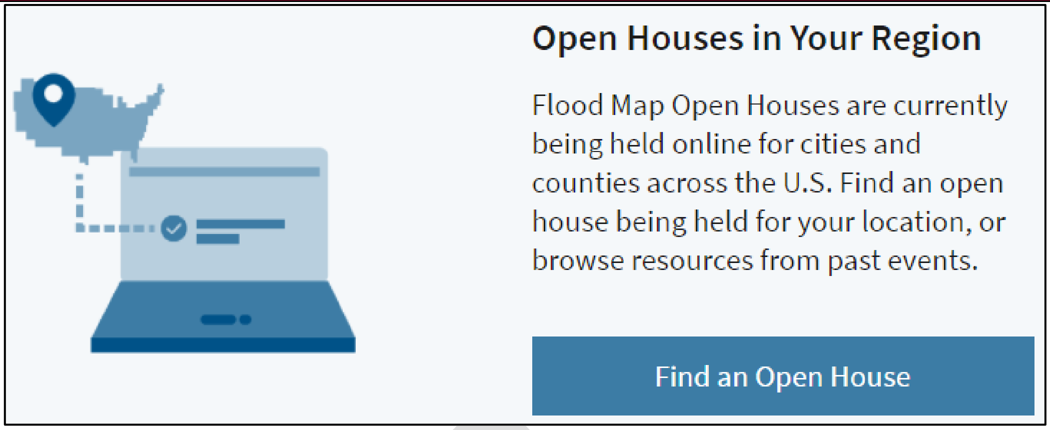
Product ID	MSC Posting Date	Size	Download
FRM_240010_Coastal	12/16/2014	79MB	DL

Flood Risk Reports (1)
Flood Risk Database (3)

Open Houses

If a person, organization, or community are interested in information regarding flood mapping, Open Houses are a great chance for community members to talk with FEMA and their local officials about flood risk. Community members can also learn how FEMA, their state and other partners can help them reduce risk.

A Flood Map Open House shows residents how the preliminary version of their updated flood map may affect their property and then connects them with available support resources.

Project Title:	**#6 – Requesting New FEMA Flood Risk MAP Products**
	 https://www.fema.gov/flood-maps/tools-resources/risk-map/open-houses
Ideas for Integration:	- Baltimore County Climate Action Plan - Baltimore County Hazard Mitigation Plan
Impacted Area(s):	Coastal areas, coastal flood hazard areas
Responsible Entity:	Department of Public Works and Transportation, Floodplain Manager
Partners:	Maryland Department of the Environment, NFIP coordinator’s Office, Maryland Emergency Management Agency
Potential Funding:	Grants made available by the FEMA Cooperating Technical Partners (CTP) Program.
Estimated Cost:	$35,000

16.3 CAPABILITY ASSESSMENT RECOMMENDATIONS

The following table includes recommendations created to increase Baltimore County's effectiveness in implementing hazard mitigation strategies, including the mitigation action items described in *Section 16.2* of this chapter. Baltimore County has robust hazard mitigation capabilities, and these recommendations are only meant to further strengthen these existing capabilities. The recommendations from the capability assessment are not action items, but rather suggested guidance to enhance current capabilities and eliminate potential resource gaps.

The capability assessment is comprised of four sections that detail specific capabilities that are relevant to hazard mitigation, including: (1) Planning and Regulatory, (2) Administrative and Technical, (3) Financial, and (4) Education and Outreach. Refer to *Appendix C* for full results of this assessment.

Figure 16-1.

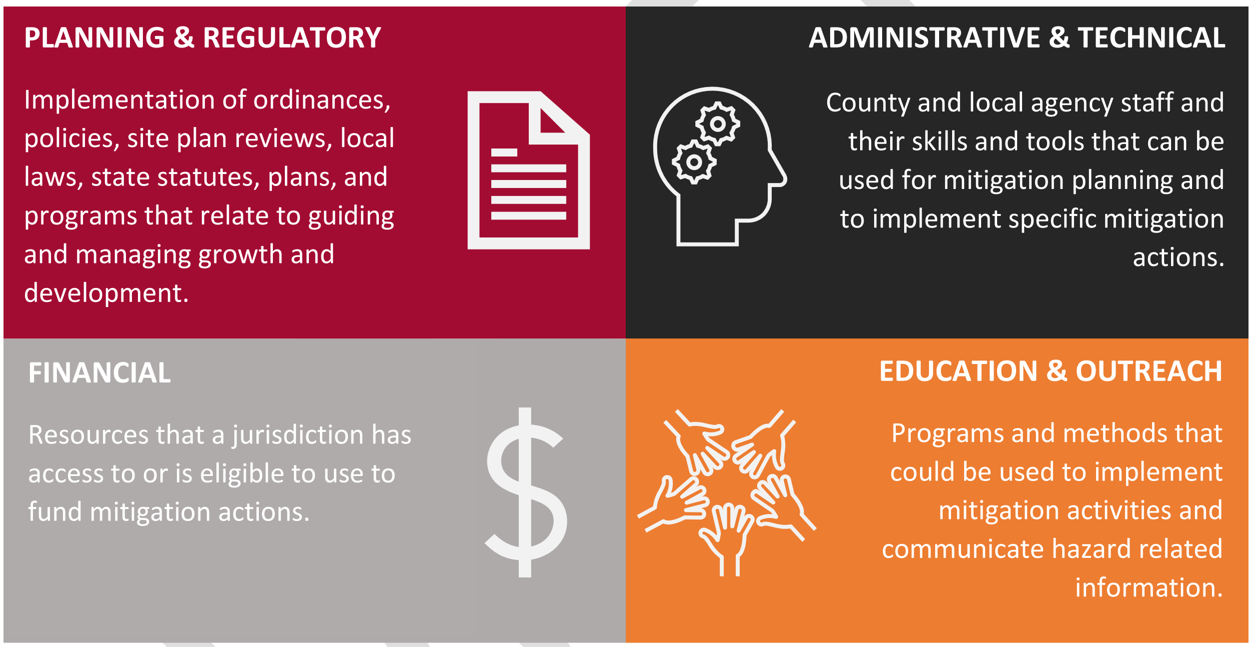


Table 16-1: Recommendations from the Capability Assessment

Planning & Regulatory Recommendations

1. "Plan Integration" could be added as a section within most planning documents. It would discuss the various planning tools in place specific to hazard mitigation, flood mitigation, climate adaption, etc.
2. Review future land-use map and growth areas for concurrence with their planning tools, such as plans, policies, and recommendations.
3. Prioritize areas for future acquisition and preservation that contain lands identified as "high hazard". Identify project(s) that provide co-benefits, both ecological and hazard mitigation/resilience.
4. Consider adopting an expanded floodplain (i.e., including the 0.2% chance "500-year" floodplain) or a "coastal resilience overlay zone" for greater protection from sea level rise and an increased margin of safety against errors in FEMA flood risk maps.
5. Include a "sensitive species locations" map in the *Biological Diversity and Sensitive Areas* element of the Master Plan. It would be a good idea to overlay this data with hazards with a geographic extent (e.g., flood) to demonstrate hazard vulnerability.
6. Add plan integration section discussing the various planning tools in-place specific to Climate Adaption. Review future land use map and growth areas for concurrence with their plan tools, such as plans, policies, and recommendations.
7. Benefits from stormwater management ponds include reduction of flooding and the retention on stormwater. Areas of current and future flood risk may be prioritized for stormwater conversion and retrofit projects.
8. Review Priority Funding Area(s) in relation to hazard areas. Extrapolate hazard areas from Priority Funding Area's and refine mapping product.
9. Consider floodplain policies that meet minimum federal and state requirements; adopting more stringent ordinances to further reduce risk; policies to prohibit development within, or filling of, wetlands, floodways, and floodplains.
10. Keeping in line with the *Community Services – Fire Safety* section of the Master Plan, encourage any departments, agencies, or organizations to create a COOP if they do not already have one.

Administrative & Technical Recommendations

1. The "Preparing for an Emergency" section of the county's website could be updated to include a direct link to the most up-to-date Hazard Mitigation Plan.
2. FEMA released an in-depth citizen's guide to preparedness in 2020 called "Are You Ready?"; this could be linked under the "Additional Resources" subsection of "Preparing for an Emergency."
3. FEMA produces hazard mitigation infographics periodically for ease of use by local jurisdictions; these infographics are an easy update for web content.

Financial Recommendations

1. Secure funding for hazard mitigation and climate adaptation projects and initiatives. Leverage special taxes and impact fees, as applicable.
2. Future capital improvement plans might consider budgeting for future infrastructure or new construction, rehabilitation, expansion, and/or improvements of facilities in high-hazard areas.

Education & Outreach Recommendations

1. Complete the application process to become Firewise certified.
2. Baltimore County is a StormReady Community and Towson University is a StormReady Supporter (as per weather.gov). It may be worthwhile to include a section about StormReady within the Emergency Preparedness section of the website – specifically highlighting what makes Baltimore County "StormReady."
3. Continue to promote volunteerism (volunteers.baltimorecountymd.gov) in Baltimore County via social media and the county website, particularly relating to pre-disaster mitigation efforts and post-disaster recovery.

Note: Refer to *Appendix C: Capability Assessment* for full results of this assessment.

APPENDIX A: HAZARD RISK METHODOLOGY, HAZARD RANKING RESULTS, & HAZARD DATA TABLES

Hazard Identification and Risk Assessment

As part of the plan update process, a Hazard Identification Risk Assessment (HIRA) has been completed for Baltimore County. Results from the Hazard Risk Survey completed by Stakeholders have been integrated into the updated HIRA.

A **risk** is the chance, high or low, that any hazard will occur and the severity or impact from that hazard.

Eleven (11) natural hazards have been identified and a hazard risk has been assigned to each. Only natural hazards are included in this assessment as they lend themselves better to data collection related to geographic extent than technological and man-made hazards.

Natural Hazard Identification and Risk Assessment Ranking Results

Hazards	Composite Score	2014 Ranking	2021 Hazard Ranking
Flood	25	High	High
Drought	16	Medium	Medium
Tornado	18.5	Medium	Medium
Thunderstorm	28.5	Medium-High	High
High Winds	22	Medium	Medium-High
Wildfire	17.5	Medium	Medium
Earthquake	10	Medium-Low	Medium-Low
Sinkhole	13	Medium-Low	Medium-Low
Winter Weather	20.5	Medium-High	Medium-High
Coastal Storm and Flooding	18.5	High*	Medium-High
Pandemic and Emerging infectious Diseases	28	No 2014 Ranking	High

*This hazard was identified as “Flooding (Tidal/Coastal)” in the 2014 Plan Update.

The methodology and data used to complete this HIRA has been included on the following pages, which will comprise Appendix A of the Plan Update.

Hazard Identification and Assessment (HIRA) Methodology

To assess the hazard risk for the eleven (11) natural hazards identified in this Plan Update a composite score method was undertaken. The composite score method was based on a blend of quantitative and qualitative factors extracted from the National Centers for Environmental Information (NCEI), Maryland Department of Health - Maryland's NEDSS And PRISM Databases, stakeholder survey, and other available data sources. These included:

- Historical impacts, in terms of human lives and property;
- Geographic extent;
- Historical occurrence;
- Future probability, and;
- Community perspective.

The following eight (8) ranking parameters were used to develop the composite risk score, which provide the hazard ranking results for the eleven (11) identified natural hazards. Each parameter was rated on a scale of one (1) to four (4).

Injuries and Death Ranking	
Death	4
N/A	3
Injury	2
None	1

Source: National Centers for Environmental Information

Property and Crop Damage Ranking	
> 2M	4
501K	3
50k	2
0	1

Source: National Centers for Environmental Information

Annualized Events Ranking	
2.51	4
1.01	3
0.11	2
0	1

Source: National Centers for Environmental Information, Maryland Dept. of Health – Maryland's NEDSS and PRISM Databases

Probability and Future Ranking	
Highly Likely	4
Likely	3
Occasional	2
Unlikely	1

Source: National Centers for Environmental Information, based upon annualized events

Community Perspective Ranking	
Very Concerned	4
Concerned	3
Somewhat Concerned	2
Not Concerned	1

Source: Baltimore County Hazard Mitigation Plan Update: Public Survey

Max Geographical Extent (Hazard Dependent) Ranking								
Ranking	**Coastal & Climate Change**	**Drought**	**Flood**	**Thunderstorm**	**Tornado & Earthquake**	**Wildfire**	**Wind**	**Winter Storm**
1	0.00	0	0.00	0-2 events	0-10 events	0	0.00	10”-19”
2	25.00	0.18	10.00	3-5 events	11-17 events	0.4674	60.00	20”-29”
3	50.00	0.3421	20.00	6-8 events	18-22 events	2.1545	74.00	30”-39”
4	75.00	0.49	30.00	>9 events	>23 event	3.9041	95.00	>40”
Source:	*COASTAL: Risk Area*	*DROUGHT: CDL MD*	*FLOOD: DFIRMS*	*THUNDERSTORM: NCDC*	*TORNADO: NCDC EARTHQUAKE: Maryland Geological Survey*	*WILDFIRE: MD DNR Forest Service*	*WIND: ASCE*	*WINTER STORM: National Weather Service*
Calculated Using:	% of Coastal Land Area	% Crop Area	% Area in 100-yr Floodplain	Average number based on: Number of events, 2"> hail and lightning events with Injuries/Deaths	Sum of all tornados weighted by F-scale (F1*1.5, F2*2, F3*3, F4*4); Number of Earthquake Events	Average annual acres burned (%)	ASCE Design Wind Speeds	Average Snowfall
Source: 2016 State of Maryland Hazard Mitigation Plan								

The following weighted risk factors were used in the equation below to determine the composite risk score for each identified hazard.

Weighted Risk Factors		
Injuries	IN	1
Deaths	DT	1
Property Damage	PD	1
Crop Damage	CD	1
Geographic Extent (Hazard Dependent)	GE	1.5
Events (Annualized)	EV	1
Future Probability	FP	1
Community Perspective	CP	1.5

Equation: Composite Score = IN + DT + PD + CD + (GE*1.5) + EV + FP + (CP*1.5)

Hazard Ranking Results: Using the data tables above to populate the parameters, the composite score was determined for each identified hazard. Hazard Rankings were assigned accordingly using the adjacent Composite Score chart.

Composite Score	
Score (>=)	**Hazard Ranking**
0	**Medium-Low**
15	**Medium**
20	**Medium-High**
25	**High**

The following table provides the hazard risk ranking update results. Flood, Thunderstorm, and Pandemic and Emerging Infectious Diseases were ranked as “High” risk hazards. High Winds and Winter Weather were ranked as “Medium-High” risk hazards. Drought, Tornado, Wildfire, and Coastal Storm and Flooding were ranked as “Medium” risk hazards. Finally, Earthquake and Sinkhole were ranked as “Medium-Low” risk hazards.

Composite Scores										
Hazard	**Injuries & Deaths**		**Property & Crop Damage**		**Geographic Extent**	**Total Events Annualized**	**Future Probability**	**Community Perspective**	**Composite Score**	**HAZARD RANKING**
Flood (flash flood, heavy rain)	32 = 2	2 = 4	12.567M = 4	0 = 1	8.06% = 1	2.49 = 4	Likely = 3	Concerned = 4	25	**High**
Drought	0 = 1	0 = 1	0 = 1	4.2M = 4	20% = 2	0.42 = 2	Unlikely = 1	Somewhat Concerned = 2	16	**Medium**
Tornado	67 = 2	0 = 1	31.827M = 4	8k = 1	22 = 3	0.46 = 2	Unlikely = 1	Somewhat Concerned = 2	18.5	**Medium**
Thunderstorm (thunderstorm wind)	13 = 2	2 = 4	1.389M = 3	10.25k = 1	234 = 4	3.71 = 4	Highly Likely = 4	Concerned = 3	28.5	**High**
High Winds	18 = 2	3 = 4	1.389M = 3	10.25k = 1	90 = 3	0.80 = 2	Unlikely = 12	Concerned = 3	22	**Medium-High**
Wildfire	2 = 2	0 = 1	<= 50k = 1	0 = 1	0.095% = 1	6.0 = 4	Highly Likely = 4	Somewhat Concerned = 2	17.5	**Medium**
Earthquake	0 = 1	0 = 1	0 = 1	0 = 1	6 = 1	0.3 = 2	Unlikely = 1	Not Concerned = 1	10	**Medium-Low**
Sinkhole	>= 1 = 2	>= 1 = 4	0 = 1	0 = 1	50.96 sq miles = 1	N/A = 1	Unlikely = 1	Not Concerned = 1	13	**Medium-Low**
Winter Weather (winter storm)	18 = 2	3 = 4	0 = 1	0 = 1	18.3” = 1	4.11 = 4	Highly Likely = 4	Somewhat Concerned = 2	20.5	**Medium-High**

Composite Scores										
Hazard	**Injuries & Deaths**		**Property & Crop Damage**		**Geographic Extent**	**Total Events Annualized**	**Future Probability**	**Community Perspective**	**Composite Score**	**HAZARD RANKING**
Coastal Storm and Flooding (tropical storm, coastal flood)	0 = 1	1 = 4	407.645M = 4	50k = 2	3.23% = 1	0.47 = 2	Unlikely = 1	Very Concerned = 4	21.5	**Medium-high**
Pandemic and Emerging Infectious Diseases	* 44,639 = 2	* 1,044 = 4	0 = 1	0 = 1	** 100% = 4	*** 8,137.2 cases annually = 4	Highly Likely = 4	Very Concerned = 4	28	**High**

*Injuries & Deaths were based on Coronavirus Disease 2019 (COVID-19) Outbreak data provided by Maryland Department of Health as of January 20, 2021
**Pandemic & Emerging Infectious Diseases' geographic extent is countywide (100%).
*** Total Events/Annualized based on Cases of Selected Notifiable Conditions Reported Baltimore County, Maryland 2014-2018. *Source: Maryland Department of Health - Maryland's NEDSS And PRISM Databases*

DATA TABLES

The following data tables were developed and used to populate five (5) of the eight (8) parameters: Injuries, Death, Property Damage, Crop Damage, and Annualized Events.

Flood (Tidal/Coastal)

Flood Hazard Data Table					
Injuries	**Deaths**	**Property Dmg**	**Crop Dmg**	**Geographic Extent % in 100-yr Flood Zone (A, AE, AO &VE)**	**Days with Events (2003-2020)**
0	0	35k	0k	8.06% (55 sq. miles)	Total = 58 Annual Avg = 3.22

Note: data collected for 1950-present, no data available for this event type prior to 2003.
Source: NOAA/NCEI

Flash Flood Hazard Data Table					
Injuries	**Deaths**	**Property Dmg**	**Crop Dmg**	**Geographic Extent % in 100-yr Flood Zone (A, AE, AO &VE)**	**Days with Events (1996-2020)**
0	*2	12.217M	0k	8.06% (55 sq. miles)	Total = 93 Annual Avg = 3.72

Source: NOAA/NCEI
** Deaths were directly caused by flash flood, male and female, on 06/19/1996, 25k property damage included.*
Note: data collected for 1950-present, no data available for this event type prior to 1996

Heavy Rain Hazard Data Table					
Injuries	**Deaths**	**Property Dmg**	**Crop Dmg**	**Geographic Extent % in 100-yr Flood Zone (A, AE, AO &VE)**	**Days with Events (1997-2020)**
*32	0	0	0k	8.06% (55 sq. miles)	Total = 13 Annual Avg = 0.54

**A long-distance public bus ran off a rain-slicked highway and flipped onto its side. Thirty-two people were taken to various local hospitals.*
Note: data collected for 1950-present, no data available for this event type prior to 1997.
Source: NOAA/NCEI

Drought

Drought Hazard Data Table					
Injuries	**Deaths**	**Property Dmg**	**Crop Dmg**	**Geographic Extent**	**Days with Events (1997-2020)**
0	0	0	4.2M	% Crop land cover from 2019 USDA CropLand Data = 20.0%	Total = 10 Annual Avg = 0.42

Note: data collected for 1950-present, no data available for this event type prior to 1997
Source: NOAA/NCEI

Tornado

Tornado Hazard Data Table					
Injuries	Deaths	Property Dmg	Crop Dmg	Geographic Extent	Days with Events (1973-2020)
67	0	31.827M	8k	Sum of all events = 22	Total = 22 Annual Avg = 0.46
Note: data collected for 1950-present, no data available for this event type prior to 1973. *Source: NOAA/NCEI*					

Thunderstorm

Thunderstorm Wind Hazard Data Table					
Injuries	Deaths	Property Dmg	Crop Dmg	Geographic Extent	Days with Events (1957-2020)
13	2	1.389M	10.25k	Sum of all events = 234	Total = 234 Annual Avg = 3.71
Note: data collected for 1950-present, no data available for this event type prior to 1957. *Source: NOAA/NCEI*					

High Winds

High Wind Hazard Data Table					
Injuries	Deaths	Property Dmg	Crop Dmg	Geographic Extent	Days with Events (1996-2020)
13	2	1.389M	10.25k	ASCE Wind Design Speed = 90	Total = 20 Annual Avg = 0.80
Note: data collected for 1950-present, no data available for this event type prior to 1996. *Source: NOAA/NCEI*					

Earthquake

Earthquake Hazard Data Table					
Injuries	Deaths	Property Dmg	Crop Dmg	Geographic Extent	Total Events (1990-Present)
0	0	0	0	Sum of all events = 6	Total = 6 Annual Avg = 0.30
Source: Maryland Geological Survey (MGS), 1990-2010					

Sinkhole

Sinkhole Hazard Data Table					
Injuries	Deaths	Property Dmg	Crop Dmg	Geographic Extent	Days with Events (1996-2020)
>= 1	>= 1	0	0	Total extent of Cockeysville Marble formation (karst topography) = 50.96 square miles or 7.48% of total land area	N/A
Source: USGS Soil Survey and Baltimore County Hazard Mitigation Plan 2014					

Winter Weather

Winter Weather Hazard Data Table					
Injuries	Deaths	Property Dmg	Crop Dmg	Geographic Extent	Days with Events (1997-2020)
18	3	0	0	Average snowfall total: 18.3” (1996-present NOAA/NWS)	Total = 142 Annual Avg = 5.92
**Icy roads on I-95 in 55-car accident, 12 injuries and 2 fatalities.* *Note: data collected for 1950-present, no data available for this event type prior to 1997.* *Source: NOAA/NCEI*					

Winter Storm Hazard Data Table					
Injuries	Deaths	Property Dmg	Crop Dmg	Geographic Extent	Days with Events (1998-2020)
*1	0	*1.510M	0	Average snowfall total: 18.3” (1996-present NOAA/NWS)	Total = 53 Annual Avg = 2.30
**President’s Weekend Snowstorm of 2003* *Note: data collected for 1950-present, no data available for this event type prior to 1998.* *Source: NOAA/NCEI*					

Coastal Storm and Flooding

Tropical Storm Hazard Data Table					
Injuries	Deaths	Property Dmg	Crop Dmg	Geographic Extent	Days with Events (1999-2020)
0	*1	407.600M	50k	% of County in the Coastal Rural Legacy area = 3.23%	Total = 3 Annual Avg = 0.14
**Hurricane Isabel, 09/18/2003; 155M prop dmg/50k crop dmg* *Note: data collected for 1950-present, no data available for this event type prior to 1999.* *Source: NOAA/NCEI*					

Coastal Flood Hazard Data Table					
Injuries	Deaths	Property Dmg	Crop Dmg	Geographic Extent	Days with Events (2006-2020)
0	0	45k	0k	% of County in the Coastal Rural Legacy area = 3.23%	Total = 12 Annual Avg = 0.80
Note: data collected for 1950-present, no data available for this event type prior to 2006. *Source: NOAA/NCEI*					

Pandemic and Emerging Infectious Diseases

Cases of Selected Notifiable Conditions Reported Baltimore County, Maryland					
Condition	2014	2015	2016	2017	2018
Amebiasis	1	2	9	3	6
Anaplasmosis	1	1	1	2	2
Animal Bites	1590	1662	1827	2037	1678
Babesiosis	0	0	1	0	2
Botulism	2	3	1	2	1
Brucellosis	0	0	0	0	1
Campylobacteriosis	109	109	114	109	110
Chikungunya	4	0	0	0	0
Chlamydia	3450	3614	4190	4479	4463
Cholera	0	0	2	0	0
Coccidioidomycosis	0	0	3	0	1
Creutzfeldt-Jakob Disease	2	0	0	0	0
Cryptosporidiosis	11	9	10	8	9
Cyclosporiasis	1	0	0	4	6
Dengue Fever	2	0	1	2	1
Ehrlichiosis	1	0	2	2	1
Encephalitis – non-Arboviral	3	3	1	4	8
Giardiasis	23	17	39	27	23
Gonorrhea	708	1017	1321	1549	1309
H. influenzae – invasive disease	12	15	19	20	24
Hemolytic Uremic Syndrome post-diarrhea	1	0	0	0	0
Hepatitis A (acute symptomatic)	2	1	0	2	5
Hepatitis B (acute symptomatic)	5	6	9	5	10
Hepatitis C (acute symptomatic)	3	0	4	4	0
Hepatitis C - Perinatal	0	0	0	0	1
Hepatitis D (acute symptomatic)	0	0	1	0	0
Hepatitis E (acute symptomatic)	0	1	0	0	0
Kawasaki Syndrome	0	1	2	1	0
Legionellosis	27	24	26	33	68
Leptospirosis	0	0	0	0	1
Listeriosis	3	6	5	4	5
Lyme Disease	199	219	193	212	176
Malaria	19	12	19	21	19
Meningitis, aseptic	86	96	57	85	61

Cases of Selected Notifiable Conditions Reported Baltimore County, Maryland					
Condition	**2014**	**2015**	**2016**	**2017**	**2018**
Meningitis, fungal	3	4	3	11	6
Meningococcal Invasive	0	0	1	0	0
Microsporidiosis	0	0	1	2	4
Mumps (infectious parotitis)	0	0	2	1	2
Mycobacteriosis, Other than TB & Leprosy	69	83	71	102	110
Pertussis	13	5	7	6	10
Pneumonia – hospitalized healthcare worker	2	1	0	1	1
Rubella (congenital syndrome)	0	0	1	0	0
Salmonellosis – other than typhoid fever	106	112	98	115	100
Shiga toxin producing E. coli (STEC)	13	21	19	15	29
Shigellosis	39	51	22	53	26
Spotted Fever Rickettsiosis	0	0	0	1	5
Strep Group A – Invasive Disease	43	37	41	60	68
Strep Group B – Invasive Disease	118	116	113	116	99
Strep pneumoniae - Invasive Disease	67	60	71	79	70
Syphilis – congenital	4	4	1	4	4
Syphilis – primary and secondary	46	79	78	74	103
Tuberculosis	31	28	22	28	26
Tularemia	0	0	0	1	0
Typhoid Fever - acute	2	4	3	3	2
Vibriosis (non-cholera)	2	3	4	7	18
West Nile Virus Symptomatic Infections	0	10	0	0	9
Yersiniosis	3	4	3	1	3
Zika virus disease, non-congenital	0	0	12	1	0
Zika virus infection, non-congenital	0	0	3	4	1
TOTALS:	6826	7440	8433	9300	8687

** Data sources: Maryland's NEDSS and PRISM databases. Data is current as of 6/19/2019. These are active databases and counts may vary slightly over time, as well as differ slightly from counts published by the Centers for Disease Control and Prevention (CDC). HIV/AIDS data are not included here but available at http://phpa.dhmh.maryland.gov/OIDEOR/CHSE/SitePages/statistics.aspx*.

APPENDIX B: MITIGATION PROJECTS STATUS REPORT UPDATE

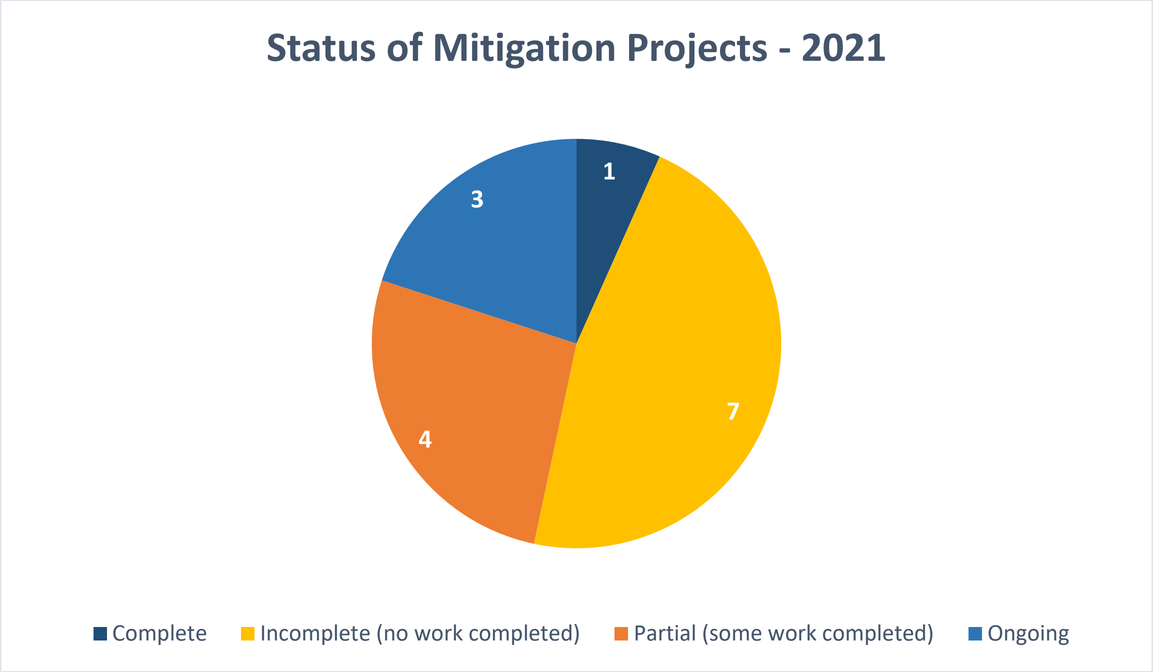
Mitigation Projects Status Report Update

The purpose of hazard mitigation action items and associated projects is to reduce or eliminate long-term risk to people and property from hazards and their effects. During the 2014 Plan Update process, hazard-specific action items and projects were developed. As part of this Plan Update, a mitigation status report was created to determine the present status of past projects.

The following mitigation projects are organized by project type and then further refined by hazard. Types of projects include: Public Outreach, Training, Data Distribution, Flood Mitigation, Studies, Continuation of Services, and Snow Emergency Plan Maintenance. All projects are presented with the responsible organization(s) for implementing the action.

A total of fifteen (15) highly ranked action items were evaluated as part of the plan update process. Members of the Hazard Mitigation Planning Committee provided important feedback regarding the progress of these projects. Based on this feedback, the following was determined: seven (7) projects are incomplete and have no work completed, four (4) projects are partially complete and have some work completed, three (3) projects are ongoing, and one (1) project is complete. The project identified as completed was project #1 under the "training" category, which consisted of a damage assessment refresher course for officers.

Roughly half (7) of all projects were identified as having received some amount of progress towards completion. The HMPC may determine that these projects are to be carried forward into the current Plan Update, in addition to the projects that were identified as being "incomplete (no work completed)".



Hazard/Mitigation Actions/Projects	Responsible Agency	Complete	Incomplete (No Work Completed)	Partial (Some Work Completed)	Ongoing
Public Outreach					
FLOOD Continue to provide information on the County's web site about flood risk and vulnerability. **COASTAL STORM AND FLOODING** Continue to provide information on the County's web site about coastal storm risk and vulnerability.					
Project 1: Add a section regarding flood insurance to both the "Flash Floods and Other Flooding" and "Hurricanes and Tropical Storms" webpages.	Office of Homeland Security and Emergency Management			X	
2021 Status Update: This information is present on the flash flooding website, but not the hurricane site.					
Project 2: Utilize these webpages to publicize outreach activities, such as workshops and public meetings.	Office of Homeland Security and Emergency Management		X		
2021 Status Update:					
Training					
THUNDERSTORM Provide staff training in the form of a damage assessment course so that emergency personnel are up to date on the latest techniques for assessing thunderstorm related damage, as well as any other major natural disaster. This course, and those like it, would be beneficial to new staff members, and provide a refresher for current staff. **TORNADO** Provide staff training in the form of a damage assessment course so that emergency personnel are up to date on the latest techniques for assessing tornado damage, as well as any other major natural disaster. This course, and those like it, would be beneficial to new staff members, and provide a refresher for current staff.					
Project 1: Schedule a damage assessment "refresher" course for appropriate staff members of responsible agencies and departments as defined in the Emergency Operations Plan 2011.	Office of Homeland Security and Emergency Management	X			
2021 Status Update: Officers have received initial damage assessment training.					
Project 2: Building upon staff training for damage assessments, consider the acquisition of, and staff training in the use of, tools such as GPS-enabled cameras, which could greatly aid in the damage assessment process.	Office of Homeland Security and Emergency Management				X
2021 Status Update: Currently installing upgraded technology in the fire apparatus that will enhance the ability of staff to receive training.					

Hazard/Mitigation Actions/Projects	Responsible Agency	Complete	Incomplete (No Work Completed)	Partial (Some Work Completed)	Ongoing
Data Distribution					
FLOOD Provide HAZUS flood data regarding shelter requirements to Emergency Preparedness for planning and mitigation purposes. **COASTAL STORM & FLOODING** Provide HAZUS coastal flood data to shelters nearby, but outside of the projected high hazard coastal flood zone within the County. Provide HAZUS coastal flood data regarding shelter requirements to Emergency Preparedness for planning and preparedness purposes.					
Project 1: Ensure that designated mass care shelters and reception centers within the County receive the HAZUS Level 2 Analysis results contained in this Plan as they relate to short-term shelter needs.	Office of Homeland Security and Emergency Management		X		
2021 Status Update:					
Project 2: Integrate the HAZUS Level 2 Analysis shelter results as an attachment to the Mass Care Annex (M) of the Emergency Operations Plan 2011.	Office of Homeland Security and Emergency Management		X		
2021 Status Update:					
Project 3: Utilize the GAP Lifecycle, designed by FEMA, to complete a review of current capabilities (incorporating HAZUS shelter requirements) to determine resource gaps that may exist within the following categories as they relate to short-term shelter needs: planning, organization, equipment, training, and exercises.	- Fire Department - Office of Homeland Security and Emergency Management			X	
2021 Status Update: The GAP Lifecycle has been incorporated into training within the Public Health Emergency Preparedness (PHEP) office.					

Hazard/Mitigation Actions/Projects	Responsible Agency	Complete	Incomplete (No Work Completed)	Partial (Some Work Completed)	Ongoing
Flood Mitigation					
FLOOD Focus flood mitigation efforts in the communities identified as having the greatest amount of Repetitive Loss Properties: Middle River, Sparrows Point, Cockeysville, Dundalk, and Pikesville. **COASTAL STORM & FLOODING** Focus flood mitigation efforts in the coastal communities identified as having the greatest amount of Repetitive Loss Properties: Middle River, Sparrows Point, and Dundalk.					
Project 1: Conduct an assessment of all the repetitive loss properties identified within Table 15-2 and obtain structural characteristics in order to determine the best flood protection measure(s).	- Budget and Finance - Office of Information Technology - Office of Homeland Security and Emergency Management			X	
2021 Status Update: There is an ongoing assessment via the Planning Department.					
Project 2: Conduct a detailed structural assessment of the twelve (12) repetitive loss properties on River Drive Road, identified in Figure 15-2, in order to determine appropriate mitigation measures to reduce damages caused by flooding and keep the character of the structure intact.	- Budget and Finance - Office of Information Technology - Office of Homeland Security and Emergency Management		X		
2021 Status Update:					
Project 3: Educate property owners about flood insurance and recommended property protection measures for their structures, including costs, and funding.	Office of Homeland Security and Emergency Management		X		
2021 Status Update:					

Hazard/Mitigation Actions/Projects	Responsible Agency	Complete	Incomplete (No Work Completed)	Partial (Some Work Completed)	Ongoing
Studies					
FLOOD Conduct stream corridor assessments to determine the status of bridges, culverts, pipes, failing channelization, debris blockages, and other issues that may increase the severity of flood events. **MASS POWER OUTAGES** Consider developing a Vulnerable Populations Plan. This document would seek to identify vulnerable population within Baltimore County and provide a useful aid to emergency responders by filling resource gaps and increasing preparedness before a mass power outage.					
Project 1: Prioritize those streams and stream sections which are to receive a stream corridor assessment.	- Environmental Protection and Sustainability – Watershed Management and Monitoring - Department of Public Works			X	
2021 Status Update: There is an ongoing assessment through the Planning Department. The Department of Public Works has information concerning often flooded areas but this data has not been prioritized or assessed. The DPW is prepared to do this in the future if it is continued to be recommended.					
Project 2: Develop a Vulnerable Populations Plan which would seek to spatially identify vulnerable and special needs populations within Baltimore County. The plan would serve as a tool for emergency responders and health care providers to prepare and respond to a mass power outage event by identifying and filling resource gaps that may exist specific to vulnerable populations.	- Department of Health - Office of Information Technology		X		
2021 Status Update:					
Continuation of Services					
WINTER WEATHER Continue to maintain the Baltimore County Snow Emergency Plan.					
Project 1: Utilizing a GIS mapping program, map the locations of current warming shelters within the County and make available on the County website.	- Department of Health - Office of Information Technology				X
2021 Status Update: Warming centers and freezing weather shelters are currently managed by the Department of Human Services.					

Hazard/Mitigation Actions/Projects	Responsible Agency	Complete	Incomplete (No Work Completed)	Partial (Some Work Completed)	Ongoing
Continuation of Services					
WINTER WEATHER Continue to maintain the Baltimore County Snow Emergency Plan.					
Project 2: After initial mapping of warming centers, determine potential ideal locations for new warming centers by comparing the location of current centers with population densities in Baltimore County.	- Department of Health - Office of Information Technology				X
2021 Status Update:					
Snow Emergency Plan Maintenance					
WINTER WEATHER Continue to provide, and possibly increase, warming center locations within Baltimore County.					
Project 1: Provide a personal/vehicle "recovery" service for those residents trapped on roadways during a snow emergency/winter storm event.	- Department of Public Works - Office of Homeland Security and Emergency Management - State Highway Administration		X		
2021 Status Update:					

APPENDIX C:
CAPABILITY ASSESSMENT

Capability Assessment

The purpose of conducting a capability assessment is to determine the ability of a jurisdiction, in this case Baltimore County, to implement a comprehensive hazard mitigation strategy, and to identify potential opportunities for establishing or enhancing specific mitigation policies, programs or projects. The capability assessment provides an opportunity to highlight the positive hazard mitigation measures already in place or being implemented throughout the county and which should continue to be supported and enhanced via future mitigation efforts.

The capability assessment is comprised of four sections that detail specific capabilities that are relevant to hazard mitigation, including: (1) Planning and Regulatory, (2) Administrative and Technical, (3) Financial, and (4) Education and Outreach.

PLANNING & REGULATORY

Implementation of ordinances, policies, site plan reviews, local laws, state statutes, plans, and programs that relate to guiding and managing growth and development.

ADMINISTRATIVE & TECHNICAL

County and local agency staff and their skills and tools that can be used for mitigation planning and to implement specific mitigation actions.

FINANCIAL

Resources that a jurisdiction has access to or is eligible to use to fund mitigation actions.

EDUCATION & OUTREACH

Programs and methods that could be used to implement mitigation activities and communicate hazard related information.

PLANNING AND REGULATORY

PLANNING AND REGULATORY

Baltimore County and its communities have identified capabilities for plans, policies, codes, and ordinances that prevent and reduce the impacts of hazards.

Planning and Regulatory Capabilities			
Plans	**Yes/No**	**Date**	**Comments**
Comprehensive/Master Plan	Yes	2021	• *Community Services – Fire Safety* – acknowledges that emergency response and management is the responsibility of virtually every county agency to varying degrees. • It is the policy of the County to "maintain a high level of preparedness for all types of emergencies, including natural disasters and terrorist acts." • It is the policy of the County to "continue to adapt to and mitigate impacts of climate change on the environment." • *Sustainable Environment – Streams and Non-Tidal Wetlands* – it is an action item to "Identify opportunities for the creation of wetlands as mitigation for County capital projects and other land development impacts." • Stormwater Management and Sediment Control is highlighted within the Plan. • *Biological Diversity and Sensitive Areas* – policy includes "Implement biological diversity protection measures for the County's diverse habitats and their dependent wildlife and the ecological processes that ensure healthy, productive, and sustainable ecosystems. Restore lost or degraded ecosystem functions and foster environmental stewardship" (pp. 175). Includes a sensitive area protection plan element into the Master Plan (pp. 173).
Capital Improvement Plan	Yes	2021 (fiscal year)	The capital budget is determined annually, and the most recent CIP includes funding for: • GIS data layer for storm drain infrastructure ($500,000) • Storm drain piping condition assessment ($1,000,000) • Development of 100-year flood zones for drainage areas less than one square mile ($736,562) • Land Use Regulatory Automation (LURA) Project ($1,410,000) • Increased Operational Funds for Volunteer Fire Companies ($360,063) • Multiple Stream restoration, repair, and stabilization projects ($11,375,000)
Emergency Operations Plan	Yes	July, 2019	Baltimore County Government maintains a high level of readiness to respond to natural and man-made disasters. Through a program of integrated emergency management, all departments, agencies, and private organizations plan for mitigation of hazards; prepare for future emergencies; and assist communities in returning to pre-disaster conditions • Hazard-specific appendices included in the EOP that are profiled in the HMP, include: severe weather (hurricane, tornado, extreme heat), hazardous materials, and dam failure.

			• Hazard-specific annexes included in the EOP that are profiled in the HMP, include: mass care shelter requirements and drought (short-term water shortage and long-term water shortage). • Recovery phase ***FEMA can provide 50/50 grant matching to the state or local government in the event of a disaster to prevent/mitigate future losses.
Continuity of Operations Plan	-	-	• According to the EOP's *Protective Response – Special Considerations* section: The Office of HS&EM encourages all facilities to develop and maintain emergency operations plans and continuity of operations plans. • COOP planning must address orders of succession, continuation of essential functions, emergency relocation, and backup of critical data. (EOP pp. 16-17)
Regional Transit Plan	Yes	October, 2020	• *Strategy:* utilize flood mitigation to "improve light rail speed and reliability" and "improve metro subway speed and reliability." • *Strategy: Include Environmental Sustainability in Transit Planning and Provision – (1)* maximize the use of green infrastructure to meet stormwater requirements (2) use sustainable and resilient design and construction practices to reduce the risk from extreme weather events." *Objective*: equitable approach to transportation planning removes barriers and ensures all residents, especially the most vulnerable, have access to a robust transit network.
Stormwater Management	Yes	2021	According to the County's SWM Plan, proper management of stormwater runoff will: • minimize damage to public and private property; • reduce the effects of development on land; • reduce stream channel erosion; • assist in the attainment and maintenance of water quality standards; • reduce local flooding, and • maintain after development, as nearly as possible, the predevelopment stormwater runoff characteristics.
Land Preservation, Parks and Recreation Plan	Yes	June, 2017	Climate resilience is touched upon in this plan and the county's HMP is mentioned. Goals from **Master Plan 2020:** (1) Prioritize infrastructure improvements via the Capital Improvement Program to endorse sustainable development, (2) Reduce pollutant loadings of runoff with enhanced stormwater management, (3) Protect health of the natural environment and maintain a valuable biodiversity. **State Goals:** (1) Manage watersheds in ways that protect, conserve, and restore stream corridors, riparian forest buffers, wetlands, floodplains and aquatic recharge areas and their associated hydrologic and water quality functions.

			The county (via EPS and DPW) administer substantial amounts of public land dedicated to preservation and conservation, including flood plain and drainage reservations (not including easements). *GOAL:* Improve implementation procedures of the Chesapeake and Atlantic Coastal Bays Program while maintaining the high level of water quality and habitat standards. *PROGRESS*: This effort is ongoing. Inventory of parkland and recreation facilities (p. 62); Growth Tiers (p. 180) Priority preservation and conservation areas & goals. (pp. 181-184). Zoning and land use recommendations reflects preservation and conservation ideas and goals consistent with climate adaptation and resilience. Coastal areas designated "resource conservation"; agricultural areas (per GI plan) designated "priority preservation"
Enterprise Strategic Plan	Yes	2019-2022	*Strategy: Build and enhance resiliency amongst all county infrastructure development.* (pp. 27) Key Success Factors (relating to hazard mitigation): Increased flood mitigation efforts (pp. 27)
Annual Report on Growth	Yes	2020	New residential and non-residential development, public facilities improvement, and new legislation and resolutions all compellingly proved that Baltimore County has been vigorous in maintaining its growth management policies to ensure quality and sensible development within the Priority Funding Area (PFA) and preserve resources outside the PFA.
Building Code, Permitting, and Inspections	**Yes/No**	**Date**	**Comments**
Building Code	Yes	July, 2015	2015 International Building Codes: • *Snow Loads:* ground snow load 30 psf • *Wind Loads:* minimum design wind loads a) Risk Categories I and II, 90 mph (3-second gust) nominal b) Risk Categories III and IV, 101 MPH (3-second gust) nominal • *Earthquake Loads: Minimum site class – site class B*
Land Use and Ordinances	**Yes/No**	**Date**	**Comments**
Code of Ordinances	Yes	July 2020 (most current version)	The Municipal Code Corporation (Municode) is the official publisher of the BCC and BCZR. BALTIMORE COUNTY CODE Codified through Bill. No. 50-20, effective June 8, 2020. (Supp. No. 15)
Floodplain Ordinance	Yes	November, 2014	Floodplain management guidelines are available in the County Code of Ordinance, Title 8 (32-8-101) Following applicable to new construction and substantial home

			improvements within the 100-year flood plain: • The lowest habitable floor must be at or above flood protection elevation. Flood protection elevation is one foot above the base flood elevation. New buildings constructed after July 15, 2007 must be at two feet above base flood elevation. • All mechanical, electrical, and plumbing devices shall not be installed below flood protection elevation
Land Acquisition and Planning – Program Open Space	Yes	2017	Guidelines for acquiring land for open space projects are within *Chapter Two: Recreation, Parks and Open Space* of the Land Preservation, Parks and Recreation Plan. Program Open Space (and Land and Water Conservation Fund State Program): POS funding, which derives from State of Maryland real estate transfer tax revenues, is shared between the Maryland Department of Natural Resources (DNR) and the counties, including Baltimore County.

How can these capabilities be expanded and improved to reduce risk?

1. “Plan Integration” could be added as a section within most planning documents. It would discuss the various planning tools in place specific to hazard mitigation, flood mitigation, climate adaption etc.
2. Review future land-use map and growth areas for concurrence with their planning tools, such as plans, policies, and recommendations.
3. Prioritize areas for future acquisition and preservation that contain lands identified as "high hazard". Identify project(s) that provide co-benefits, both ecological and hazard mitigation/resilience.
4. Consider adopting an expanded floodplain (i.e., including the 0.2% chance “500-year” floodplain) or a “coastal resilience overlay zone” for greater protection from sea level rise and an increased margin of safety against errors in FEMA flood risk maps.
5. Include a “sensitive species locations” map in the *Biological Diversity and Sensitive Areas* element of the Master Plan. It would be a good idea to overlay this data with hazards with a geographic extent (e.g., flood) to demonstrate hazard vulnerability.
6. Add plan integration section discussing the various planning tools in-place specific to Climate Adaption. Review future land use map and growth areas for concurrence with their plan tools, such as plans, policies, and recommendations.
7. Benefits from SWM ponds include reduction of flooding and the retention on stormwater. Areas of current and future flood risk may be prioritized for stormwater conversion and retrofit projects.
8. Review Priority Funding Area(s) in relation to hazard areas. Extrapolate hazard areas from Priority Funding Area's and refine mapping product.
9. Consider floodplain policies that meet minimum federal and state requirements; adopting more stringent ordinances to further reduce risk; policies to prohibit development within, or filling of, wetlands, floodways, and floodplains.
10. Keeping in line with the *Community Services – Fire Safety* section of the Master Plan, encourage any departments, agencies, or organizations to create a COOP if they do not already have one.

ADMINISTRATIVE AND TECHNICAL

ADMINISTRATIVE AND TECHNICAL

Baltimore County has identified the following administrative and technical capabilities. These include staff and their skills and tools that can be used for mitigation planning and to implement specific mitigation actions.

Government Department and Staff Resources		
Department/Resource	**Number of Staff**	**Responsibilities**
Budget and Finance		The Office of Budget and Finance provides public policy analysis and fiscal expertise in support of all agencies of Baltimore County government.
Communications		The office serves as a resource to Baltimore County Executive and county agencies in communicating with the public regarding county services, programs, initiatives, and issues of interest to the community.
Development Review and Land Use Planning		This department ensures compliance with Federal, State and County laws through the review of land use proposals and the development of plans, policies, and procedures to make recommendations to approving authorities.
Emergency Management	2 (as of 3/24/21)	The Office of Homeland Security and Emergency Management plans for and responds to all types of manmade and natural disasters.
Engineering and Construction		Engineering and Construction houses the following programs: Flood Insurance Map Information, Basic Services Maps, Master Plan Amendments, Administration, GIS, Design, Engineering Records, Land Surveys, and Construction Contracts Administration.
Environmental Protection and Sustainability	80 (as of 3/30/21)	The Department of Environmental Protection and Sustainability manages, protects, and enhances the natural resources of Baltimore County and the health of its citizens through the application of environmental and public health laws, principles, and practices.
Fire		The Fire Department provides fire protection, emergency medical services, fire prevention and safety education.
GIS		The County's enterprise GIS is managed in the Office of Information Technology's Business Application Unit. General GIS information and other data are available through the Office of Information Technology's GIS System.
Health and Human Services		The Department of Health and Human Services (HHS) promotes well-being among individuals and families by providing quality health, housing, and social services. Along with an administrative unit, HHS is comprised of the Departments of Health and Social Services.
Information Technology		The Office of Information Technology provides leadership, technical expertise, training, infrastructure, services, and technical support to County agencies.
Landmarks Preservation Commission		The Landmarks Preservation Commission reviews and advises Baltimore County on historic structures. The Department of Planning publishes the meeting dates and agendas for the commission online.
Permits, Approvals and Inspections	13 (as of 1/21/21)	The Department of Permits, Approvals and Inspections issues all building permits and enforces the rules and regulations of Baltimore County for development, building, electrical, plumbing, livability, and zoning codes. PAI is currently working on the Land Use Regulatory Automation Project – Phase 2 – Development Management Implementation.

Government Department and Staff Resources		
Department/Resource	**Number of Staff**	**Responsibilities**
Planning	56 (as of 2/19/21)	Working closely with citizens, elected officials and other government agencies, the Department of Planning formulates policies, plans and regulations to guide future growth and to preserve and enhance existing communities.
Planning Board		The County Charter gives the Planning Board a major role in recommending the content of the Capital Program and Budget. The Board's other advisory responsibilities are established in the County Code or by Executive Order. They include making recommendations or decisions on: Master Plan, Comprehensive Zoning Mapping, amends to zoning and related regulations, functional plans, and review and formulation of the Capital Improvement Program.
Police		The Police Department enforces the laws and ordinances of the state and county, safeguards life and property, prevents and detects crime, preserves the peace, and protects the rights of all citizens.
Property Management	258 (as of 4/7/2021	The Property Management Division of the Office of Budget and Finance coordinates grounds maintenance, design and construction, energy management, and building services to Baltimore County facilities and properties.
Public Works		The Department of Public Works provides and maintains the public infrastructure systems, including County roads and buildings.

Technical Capabilities		
Technical	**Yes/No**	**Comments**
911 Communications Center (calling, texting)	Yes	The 911 Center is one of the three largest Public Safety Answering Points (PSAP) in Maryland—receiving an average of 2,200 calls a day and employing nearly 200 dedicated civilian employees who serve the community.
Emergency Alert System (EAS)	Yes	The EAS is a national public warning system that requires radio and TV broadcasters, cable TV, wireless cable systems, satellite, and wireline operators to provide the President with capability to address the American people within 10 minutes during a national emergency.
Emergency Notification System (ENS)	Yes	Baltimore County's Emergency Notification System (ENS) is a notification tool designed to enhance emergency preparedness and notify residents and businesses in Baltimore County of emergency situations that may require time-sensitive actions.
Integrated Public Alert and Warning System (IPAWS)	Yes	IPAWS is FEMA's national system for local alerting that provides authenticated emergency and life-saving information to the public through mobile phones using Wireless Emergency Alerts, to radio and television via the Emergency Alert System, and on the National Oceanic and Atmospheric Administration's Weather Radio.
HAZUS Analysis	Yes	A HAZUS Level 2 Analysis is incorporated into the County's current Hazard Mitigation Plan for flood, earthquake, and high wind.
Generators at Essential Facilities	Yes	According to the EOP, some essential facilities already have this capability; could this be expanded to include all essential facilities?

Baltimorecountymd.gov	Yes	The Baltimore County Government (BCG) website receives more than 6 million visits and 15 million pageviews annually. As more and more services have moved online, for most constituents, the web has become their first and only interaction with their government. The website is currently in the process of receiving a major update, as of Spring 2021.
Geographic Information Systems (GIS)	Yes	Baltimore County operates an enterprise geographic information system (GIS) that is available to all County agencies and departments. The County's GIS is managed by the Office of Information Technology's Business Applications unit. Baltimore County has an award-winning IT/GIS department and makes much of their GIS data available to the online via a web portal.
How can these capabilities be expanded and improved to reduce risk?		
1. The "Preparing for an Emergency" section of the county's website could be updated to include a direct link to the most up-to-date Hazard Mitigation Plan. 2. FEMA released an in-depth citizen's guide to preparedness in 2020 called "Are You Ready?"; this could be linked under the "Additional Resources" subsection of "Preparing for an Emergency." 3. FEMA produces hazard mitigation infographics periodically for ease of use by local jurisdictions; these infographics are an easy update for web content.		

FINANCIAL

FINANCIAL

Baltimore County identified whether it has access to or is eligible to use the following funding resources for hazard mitigation purposes.

Financial Capabilities		
Funding Resources	**Access/Eligibility (Yes/No)**	**Comments**
Capital improvements project funding	Yes	Available via the County's Capital Improvement Plan
Authority to levy taxes for specific purposes	-	Property taxes provide 32 percent of the County's General Fund revenue and individual income taxes provide another 21 percent. Like other Maryland counties, Baltimore County cannot levy corporate income tax or a general sales tax and does not have access to lottery revenues.
Development Impact Fees	Yes	Fees are collected for apartment development, commercial and industrial development, single unit development, and townhome development.
Community Development Block Grant	Yes	The largest source of funds is derived from the federal Community Development Block Grant (CDBG) program. Baltimore's Department of Planning uses the CDBG guidelines to shape its applications and the use of grant funds. Additional funding comes from the federal Emergency Solutions Grant, the State of Maryland, and County General Funds.
Building Resilient Infrastructure and Communities (BRIC)	Yes	Supports states, local communities, tribes, and territories as they undertake hazard mitigation projects, reducing the risks they face from disasters and natural hazards. BRIC is a new FEMA pre-disaster hazard mitigation program that replaces the existing Pre-Disaster Mitigation (PDM) program.
Emergency Solutions Grant (ESG)	Yes	The purpose of the ESG program is to assist individuals and families quickly regain stability in permanent housing after experiencing a housing crisis or homelessness. ESG provides grants by formula to states, metropolitan cities, urban counties, and U.S. territories to support homelessness prevention, emergency shelter and related services.

How can these capabilities be expanded and improved to reduce risk?

1. Secure funding for hazard mitigation and climate adaptation projects and initiatives. Leverage special taxes and impact fees, as applicable.
2. Future capital improvement plans might consider budgeting for future infrastructure or new construction, rehabilitation, expansion, and/or improvements of facilities in high-hazard areas.

EDUCATION AND OUTREACH

EDUCATION AND OUTREACH

Baltimore County identified education and outreach programs and methods already in place that could be used to implement mitigation activities and communicate hazard-related information.

Education and Outreach Capabilities		
Program/Organization	**Yes/No**	**Comments**
Local citizen groups or non-profit organizations focused on environmental protection, emergency preparedness, access, and functional needs populations, etc.	Yes	Local Emergency Planning Committee (LEPC) – this committee meets regularly to develop and review contingency and evacuation plans for emergencies involving hazardous materials. These may include weather disasters, industrial or transportation accidents and terrorist attacks.
Ongoing public education or information program (e.g., responsible water use, fire safety, household preparedness, environmental education)	Yes	Social media posts for disaster preparedness, hazard mitigation, safety during a natural disaster, etc.
StormReady certification	Yes	StormReady uses a grassroots approach to help communities develop plans to handle all types of extreme weather—from tornadoes to winter storms. The program encourages communities to take a new, proactive approach to improving local hazardous weather operations by providing emergency managers with clear-cut guidelines on how to improve their hazardous weather operations. To be officially StormReady, a community must: ▪ Establish a 24-hour warning point and emergency operations center ▪ Have more than one way to receive severe weather warnings and forecasts and to alert the public ▪ Create a system that monitors weather conditions locally ▪ Promote the importance of public readiness through community seminars ▪ Develop a formal hazardous weather plan, which includes training severe weather spotters and holding emergency exercises.
Firewise USA certification	No	For a community to become Firewise certified they must: ▪ Form a board/committee made up of residents and wildfire stakeholders; ▪ Obtain a written wildfire risk assessment from a state forestry agency or fire department; ▪ The committee needs to develop an action plan, prioritizing a list of risk reduction projects/investments; ▪ Host an outreach event and work with locals on addressing items within the action plan, and;

Education and Outreach Capabilities		
Program/Organization	**Yes/No**	**Comments**
		▪ Complete an application at portal.firewise.org detailing the community's efforts.
How can these capabilities be expanded and improved to reduce risk?		

1. Complete the application process to become Firewise certified.
2. Baltimore County is a StormReady Community and Towson University is a StormReady Supporter (as per weather.gov). It may be worthwhile to include a section about StormReady within the Emergency Preparedness section of the website – specifically highlighting what makes Baltimore County "StormReady."
3. Continue to promote volunteerism (volunteers.baltimorecountymd.gov) in Baltimore County via social media and the county website, particularly relating to pre-disaster mitigation efforts and post-disaster recovery.

APPENDIX D:
RURAL WATER SUPPLY TANKS

Baltimore County Fire Department Rural Water Sources

	Box	ID #	Location	Type	Access	Capacity	ADC Grid	ADC Grid New Format	Latitude	Longitude	Elevation	Notes:
1	002-04	18050	Stevenson Road over Jones Falls	Dry Hydrant	Eng	1250 GPM	25H4	4577 F5	N39.41.196	W76.71.419	240'	
2	014-04	18051	Greenspring Valley Rd w/o Greenspring Ave adj to Henry Knott Hall	Cistern	Eng	10,000	25K2	4577 H3	N39.42.153	W76.70.007	213'	Stevenson University
3	017-01	18052	across 908 Crosshaven Rd	Dry Hydrant	Eng	1100 GPM			39.450532	-76.67652		Smyth Pond- Waterford Preserve
4	018-05	18053	Windsor Mill Rd	Cistern	Eng	12,000		4696 D4	N39.35.472	W76.79.458	400'	just east of Old Court Rd
5	018-08	18054	9700 Old Court Road	Dry Hydrant	Eng	1250 GPM	32B3	4695 J5	N39 20.872	W076 49.276	390'	Edrich Lumber, past main office
6	018-08	18109	Tallowtree Rd	Cistern	Eng	12,000	31K3	4695 H5	N39.34.427	W76.82.681	367'	just off Old Court Rd
7	018-08	19716	9700 Old Court Rd	Dry Hydrant	Eng	1250GPM	32C3	4695K5	N39.34.840	W76.81.358	299'	Edrich Farms pond, behind shed #15
8	018-09	18056	3124 Persimmon Tree Ct	Cistern	Eng	12,000	24A12		N39.36.724	W76.81.720	430'	Mardella Run
9	018-09	18058	2829 Offutt Rd	Dry Hydrant	Eng	1250GPM	24B2	4695K4	N39.35.373	W76.81.424	325'	Edrich Farms, near concrete bridge
10	026-08	18059	North Point Park, North Point Rd	Cistern	Eng	30,000	45J13	4942	N39.20.716	W76.42.598	49'	North Point Park
11	028-07	18060	Batavia Farms Rd	Cistern	Eng	10,000	36J8	4700 K9	N39.31.535	W76.49.541	157'	end of road at Lafarge
12	038-06	18061	12400 Manor Rd - Trinity Episcopal Church	Cistern	Eng	30,000		4462 F6	39.464111	-76.528091		Trinity Epsicopal Church
13	038-07	18062	Brighton View Ct	Cistern	Eng	12,000	20-B4	4462 C3	N39.48.687	W76.54.531	429'	Just off Dance Mill Rd
14	038-08A	18063	4434 Carroll Manor Rd	Cistern	Eng	30,000	20E2	4348 H10	N39.29.853	W076.31.363		Carroll Manor Elem School
15	038-08B	18064	4703 Three Sisters Ct	Cistern	Eng	12,000	20F1	4348 H10	N39.30.137	W076.30.897		
16	038-08C	18065	Long Green Fire Sta; 4506 Long Green Rd	Cistern	Eng	30,000	20F6	4462 G5	N39.28.380	W076.31.320		Station 38
17	038-10	18066	Hydes Park; Hydes Rd w/o Long Green Pike	Cistern	Eng	30,000	21B4	4463	N39.48.251	W76.48.357	226'	Hydes Park
18	038-12	18067	Pleasantville Rd & Baldwin Mill Rd	Cistern	Eng	30,000	21-D2	4463 E1	N39.30.949	W076.33.352	628'	State Park property-west side road
19	038-14	18068	Long Green Rd & Long Green Pike	Dry Hydrant	Eng	1250 GPM	20K7	4463 B5	N39.28.197	W076.29.477		
20	038-23	18660	13800 Manor Rd	Cistern	Eng	30,000			39.500444	-76.529839		at Animal Shelter
21	039-06	18070	Hunts Bluff Rd	Cistern	Eng	12,000	12F13	4346 E9	N39.50.968	W76.65.580	276'	
22	039-15	18071	Oregon Ridge Park Dr	Dry Hydrant	Eng	1250 GPM	18A2	4460 A2	N39.29.699	W076.41.253		
23	039-16	18072	909 Shawan Rd	Cistern	Eng	10,000	18-C2	4460 B1	N39.49.583	W76.67.855	262'	St. Mary's Orthodox Church

	Box	ID #	Location	Type	Access	Capacity	ADC Grid	ADC Grid New Format	Latitude	Longitude	Elevation	Notes:
24	039-18	18073	Ventry Farms Ct	Cistern	Eng	12,000	12-D11	4346 C8	N39.51.832	W76.66.915	318'	East side 500' off Thornton Mill
25	039-19	18069	Phoenix Rd off Carroll Rd	Dry Hydrant	Eng	1250 GPM	13A10	4347 B7	N39.31.187	W076.37.166		
26	039-19	18074	Hunting Way, 0.1 mi w/o Carroll Rd	Cistern	Eng	12,000	13B9	4347 B6	N39.52.768	W76.61.514	387'	
27	040-08	18075	Belmont Ave over Deleware Run	Dry Hydrant	Eng	800 GPM	16H2	4458 F1	N39.49.394	W76.77.707	282'	Stream - Belmont Farm
28	041-12	18076	13040 Old Hanover Rd	Dry Hydrant	Eng		16A4	4457 H4	N39.28.900	W076.49.694	700'	Reisterstown Lumber Company
29	044-01A	18087	Sparks Elem School; 601 W Belfast Rd, I-83	Cistern	Eng	30,000	12E6	4346 E4	N39.54.460	W76.66.033	266'	Sparks Elem School
30	044-02A	18088	Lower & Upper Glencoe Rd	Dry Hydrant	Eng	1250 GPM	12J5	4346 J3	N39.33.026	W076.38.214		
31	044-05	18089	Buedel Ct	Cistern	Eng	12,000	12F2	4234 E10	N39.56.538	W76.65.737	440'	
32	044-05D	18090	712 Corbett Rd, e/o York Rd	Cistern	Eng	30,000	12F1	4234 F9	N39.57.202	W76.65.247	436'	Hereford Middle School
33	044-09	18091	Castlebridge Ct.	Cistern	Eng	12,000	7G11	4234 F6	N39.58.892	W76.65.156	584'	
34	044-09A	18092	Hereford Fire Sta; 510 Monkton Rd	Cistern	Eng	20,000	7E11	4234 E6	N39.58.949	W76.66.221	587'	Station 44
35	044-15	18093	Hereford High School	Elevated	Eng	70,000	7E9	4234 E5	N39.56.896	W76.65.904	531'	Hereford High School(rear hydts.)
36	044-16	18094	Camp Puh Tok- Pool- 17433 Big Falls Rd	Pool	Eng	125,000	7H10		39.595969	-76.641024		Camp Puh Tok
37	044-26B	18095	Big Falls & Bernoudy Rd	Dry Hydrant	Eng	1100 GPM	7K6	4234 K2	N39.37.029	W076.37.791		
38	044-28	18096	River Bend Court	Cistern	Eng	12,000	8E5	4121 D10	N39.62.849	W76.59.548	289'	
39	045-04	18097	900 Zenith Drive	Cistern	Eng	12,000	3C8	4120 B2	N39.67.748	W76.67.881	600'	
40	045-04B	18098	Zenith Drive	Cistern	Eng	12,000	3C8	4120 B2	N39.68.067	W76.67.497	591'	
41	045-05	18101	Mikes Way off Kaufman Rd	Cistern	Eng	12,000	3F8	4120 F3	N39.67.447	W76.65.394	577'	
42	045-05A	18099	7th District Elem School; 20300 York Rd	Cistern	Eng	30,000	3G8	4120 G2	N39.68.204	W76.64.598	705'	7th District Elem School
43	045-05B	18100	Bentley Rd & NCR Trail	Dry Hydrant	Eng	1250 GPM	2C9	4120 C3	N39.40.523	W076.40.151		Little Falls
44	045-05E	18102	Quiet Valley Ct.	Cistern	Eng	12,000	3D10	4120 D3	N39.67.119	W76.66.764	535'	
45	045-11	18103	20701 Keeney Mill Rd	Dry Hydrant	Eng	1250 GPM	2G6	4007 D10	N39.41.537	W076.43.217		
46	045-20A	18105	3021 Rockdale Rd Tracey's Crossing	Cistern	Eng	12,000	2B6	4006K10	N39.68.878	W76.75.606	686'	

	Box	ID #	Location	Type	Access	Capacity	ADC Grid	ADC Grid New Format	Latitude	Longitude	Elevation	Notes:
47	045-27	18106	Maryland Line Fire Sta; 21631 York Rd	Cistern	Eng	40,000	3F1	4008 E6	N39.71.781	W76.65.538	754'	Station 45
48	045-32	18107	Harris Mill Road W of Stewartstown Rd	Dry Hyd Sw	Eng	1100 GPM	4D1	4009 D6	N39.71.804	W76.60.265	482'	Deer Creek, Bridge Swivel
49	046-06	18108	Harrison Grant Dr	Cistern	Eng	12,000	23J12	4695 F1	N39.36.906	W76.83.575	400'	
50	046-08	18110	Siena Way	Dry Hydrant	Eng	1250 GPM	31H7	4695 E8	N39.19.496	W076.50.870		Patapsco Ridge Development
51	046-08	18112	Park Vista Ct	Cistern	Eng	12,000		4695 C7	N39.33.148	W76.85.783	269'	
52	046-08A	18111	Davis Ave & Pine Hill Ct	Cistern	Eng	12,000	31H6	4695 E8	N39.33.137	W76.84.824	361'	
53	046-10	18113	Kimberly Ann Ct off Marriottsville Rd	Cistern	Eng	12,000			39.377085	-76.846752		
54	046-13	18115	Liberty Rd. & Falls Run Rd	Cistern	Eng	12,000	23J8	4575 F8	N39.38.944	W76.83.946	551'	
55	046-14	18116	4362 Chapeldale Dr	Cistern	Eng	12,000	23G8	4575 C8	N39.38.999	W76.85.665	420'	
56	047-01A	18117	3509 Houcks Mill Rd	Dry Hydrant	Eng	900 GPM	8K13	4236 C7	N39.35.077	W076.33.158		Andor Farms
57	047-03A	18118	15601 Hess Rd-- Manorview Farms	Dry Hydrant	Eng	1000 GPM	13K4	4348 H2	N39 33.136	W076 33.793	660'	4 Ponds Onsite
58	047-06A	18119	2515 Stockton Rd	Dry Hydrant	Eng	1250 GPM	13F9	4347 F6	N39.31.655	W076.35.429		Prices Pond
59	047-08	18120	Donerin Way	Cistern	Eng	12,000	14C9	4348 D6	N39.52.938	W76.53.854	453'	across from 3907
60	047-10	18121	Manor Shopping Center	Cistern	Eng	140,000	13K11	4348 A8	N39.29.855	W76.33.513		
61	047-10	18122	14330 Jarrettsville Pike-ShopRite	Cistern	Eng	10,000	13K11	4348 A7	N39.31.172	W076.33.714		D/C corner, sharp turn, on building
62	047-10	19395	3101 Paper Mill Rd	Cistern	Eng	30,000			39.517081	-76.570491		
63	047-10A	18123	3300 Paper Mill Rd	Cistern	Eng	50,000	13K11	4347 J8	N39.31.143	W076.33.650		Paper Mill Village Shop Ctr
64	047-10C	18124	Jacksonville Fire Sta; 3500 Sweet Air Rd	Cistern	Eng	30,000	14A11	4348 A8	N39.30.957	W076.33.349		Station 47
65	047-10E	18125	Meredith Ridge Rd	Cistern	Eng	12,000	13K10	4348 A7	N39.52.289	W76.56.104	515'	
66	047-13A	18126	Greene Rd & Harford Co. Line	Dry Hydrant	Eng	1250 GPM	14K8	4349 A7	N39.31.455	W076.29.862		
67	047-14A	18127	13509 Summerhill Dr	Cistern	Eng	30,000	19-F2	4461 F1	N39.30.949	W076.33.352		
68	047-16	18128	13700 Blenheim Rd	Cistern	Eng	40,000	20-B1	4462 C1	N39.49.784	W76.64.929	469'	Hillendale Country Club
69	047-16B	18129	Briar Knoll Ct opps. Hillendale CC	Cistern	Eng	12,000	20-B1	4348 C10	N39.30.086	W076.32.921		
70	047-17A	18130	Trail End Ct end of Manor Oaks	Cistern	Eng	12,000	20-C1	4348 D10	N39.30.130	W076.32.586		Off Manor Oaks Rd
71	048-04	18131	Fork Plaza-- Fork Rd & Harford Rd	Cistern	Eng	10,000	21G7	4463 K6	N39.46.842	W76.44.208	358'	Fork Rd. side

	Box	ID #	Location	Type	Access	Capacity	ADC Grid	ADC Grid New Format	Latitude	Longitude	Elevation	Notes:
72	048-10A	18132	Kingsville Elem School; 7300 Sunshine Ave	Cistern	Eng	30,000	22A9	4464 C8	N39.45.591	W76.41.922	315'	Kingsville Elem School
73	048-11	18134	Connor Ct off New Cut Road	Cistern	Eng	12,000	21-K7	4464 D6	N39.46.769	W76.41.127	354'	East side of Ct
74	048-12	18133	Kingsville Fire Sta; 11601 Bellvue Ave	Cistern	Eng	30,000	22B12	4464 D10	N39.44.276	W76.41.492	220'	Station 48
75	048-13	18135	Hammonds Glen Cir off Chapman Rd	Cistern	Eng	12,000	22C10		39.448601	-76.407372		
76	049-01	18136	Butler Fire Sta; 15019 Falls Rd	Cistern	Eng	30,000	11F8	4345 D5	N39.53.664	W76.72.796	230'	Station 49
77	049-02	18137	3426 Benson Mill Rd E. Black Rock Rd	Dry Hydrant	Eng	1,100 GPM	11A3	4344 G1	N39.33.574	W076.45.964		Pond
78	049-03	18138	Benson Mill Road East of Falls Rd.	Dry Hydrant	Eng	1300 GPM	11C2	4233 A10	N39.34.135	W076.44.669		
79	050-01	18139	Ridge Rd, 0.1 mi s/o Mansel Dr	Cistern	Eng	12,000	17G7	4459 E6	N39.46.535	W76.71.910	511'	
80	050-01	18140	Ridge Road over Beaverdam Run	Dry Hydrant	Eng	1000GPM	17G7	4459 F5	N39.46.929	W76.71.823	403'	
81	050-02	18141	2700 Baublitz Rd. at Nancy Lee Ct	Cistern	Eng	12,000	17D7	4459 B6	N39.46.791	W76.74.113	662'	
82	050-02	18142	Raintree Farm Ct	Cistern	Eng	12,000	17B8	4459 A6	N39.46.250	W76.74.983	610'	
83	050-02	18143	Hensen Garth btwn Chellis & Woodsyde	Cistern	Eng	10,000	17C9	4459 A8	N39.45.565	W76.74.289	610'	
84	050-02	18144	Hunters Glen Ct	Cistern	Eng	12,000	17C8	4459 B7	N39.46.286	W76.74.460	545'	
85	050-02	18145	Worthington Court RD	Cistern	Eng	12,000	17D8		N39.46.212	W76.73.853	551'	
86	050-02	18150	Walnut Ave, w/of Greenspring Ave	Cistern	Eng	30,000	17C8	4459 A7	N39.46.145	W76.74.693	594'	Har Sinai Jewish Comm Ctr
87	050-03	18146	2310 Tufton Springs Ln	Cistern	Eng	12,000	17E5	4459 D4	N39.47.807	W76.72.814	505'	
88	050-03	18147	Long Ridge & Holtz	Cistern	Eng	12,000	17E6	4459 D5	N39.47.134	W76.72.663	502'	
89	050-03	18148	12300 Dover Rd	Cistern	Eng	12,000	17E8	4459 D7	N39.49.218	W76.73.866	325'	In Fence
90	050-06B	18149	Caves Rd W. of Park Heights	Dry Hydrant	Eng	1200 GPM	17D13	4577 C1	N39.26.139	W076.44.081		
91	050-10	18151	Dover Rd & Tufton Ave	Dry Hydrant	Eng	1250 GPM	17D2	4459 B1	N39.49.558	W76.73.999	308'	
92	050-10	18152	across 12839 Dover Rd	Cistern	Eng	12,000	17D5	4459 C1	N39.47.777	W76.73.461	508'	
93	050-10		2401 Dover Rd	Dry Hydrant	Eng	Unknown						
94	050-11	18153	13109 Pendleton Ct off Knox Avenue	Cistern	Eng	12,000	17G-4	4459 F3	N39.48.670	W76.72.082	587.	
95	050-14A	18154	Padonia Rd, e/of Falls Rd	Cistern	Eng	30,000	18B11	4460 A1	N39.44.819	W76.98.306	580'	

Baltimore County Fire Department Rural Water Sources

	Box	ID #	Location	Type	Access	Capacity	ADC Grid	ADC Grid New Format	Latitude	Longitude	Elevation	Notes:
96	050-16	18155	2318 Velvet Ridge Dr	Dry Hydrant	Eng	1250 GPM	25E1	4577 C2	N39.25.783	W076.44.009		
97	050-17	18156	3200 Hunting Tweed off of Park Heights	Cistern	Eng	12,000	17A11	4458 J9	N39.44.809	W76.75.879	515'	at the dead end
98	056-01A	18157	820 Nicodemus Rd	Dry Hydrant	Eng	1100 GPM	15K11	4457 G9	N39 26.883	W076 50.088	700'	Covenant of Grace Church
99	056-01B	18158	1135 Saffell Rd	Cistern	Eng	12,000	15J12	4457 E10	N39.44.204	W76.84.854	574'	
100	056-01C	18159	across from 1236 Saffell Road	Cistern	Eng	12,000	15J12	4457 D10	N39.43.823	W76.85.613	541'	near end of
101	056-15	18160	5715 Deer Park Rd	Dry hydrant	Eng	1,000 GPM	23H1	4575 E2	N39.42.823	W76.85.613	417'	Northside W of Berryman's
102	056-17	18161	Timber Spring Ct	Cistern	Eng	12,000	15H11	4457 F9	N39.44.561	W76.84.292	594'	
103	060-05	18104	2038 Freeland Rd	Dry Hydrant	Eng	1250 GPM	2F6	4007 G10	N39.41.050	W076.43.292		Churchhill Pond
104	060-10	18162	19810 Middletown Rd	Cistern	Eng	30,000	2H10	4119 F4	N39.66.576	W76.71.151	732'	Bull Sawmill Rd side/PrettyBoy ES
105	060-10	18163	Pine Ayr Cir	Cistern	Eng	12,000	2 K-12	4119 J5	N39.65.859	W76.69.883	719'	
106	060-11	18164	Richroy Ct	Dry Hydrant	Eng	1250 GPM	2H13	4119 H6	N39 39.055	W076 42.253	690'	Phillips Purchase Pond
107	060-15	18165	Farm Meadow Ct off Walker Rd	Cistern	Eng	12,000	2 K-11	4119 K5	N39.66.238	W76.69.235	682	
108	060-19	18166	Walker Station Ct	Cistern	Eng	12,000	3D13	4120 C6	N39.65.411	W76.66.758	427	
109	060-19	18167	Timothy's Manor Ct	Cistern	Eng	12,000	7D1	4120 C7	N39.64.964	W76.66.919	427	
110	060-21	18168	Frederick Rd (Little Falls)	Dry Hydrant	Eng	1500 GPM	7E2	4120 E8	N39.38.409	W076.39.621		Parking Lot across from Park Inn
111	060-21	18169	Haileys Court off York Road	Cistern	Eng	12,000	7E3	4120 E9	N39.63.503	W76.65.867	574'	
112	060-22	18170	Ensor Farm Ct. & Middletown Rd	Cistern	Eng	12,000	7D4	4120 C10	N39.63.066	W76.66.892	535'	
113	060-22	18171	Cascade View Court off York Rd	Cistern	Eng	12,000	7F6	4234E1	N39.62.018	W76.65.523	443'	Little Falls development
114	060-22	18172	Montclair Ct W off York Rd	Cistern	Eng	12,000	7F6	4234E1	N39.62.018	W76.65.523	450'	Montclair development
115	060-22	18173	Sta 60 18615 Middletown Rd	Cistern	Eng	30,000	7-C3	4120 C9	N39.63.448	W76.67.278	584'	East side(R) of driveway loop
116	060-24	18174	1316 Stablersville Rd & Tyson Rd	Dry Hyd Sw	Eng	1000 GPM	3K13	4120 K6	N39.65.210	W76.62.618	538'	Third MineBranch, Bridge Swivel
117	060-25	18175	Vernon Rd W of Garrett Rd	Dry Hyd Sw	Eng	1000 GPM	8-D2	4121 D8	N39.64.284	76.60.321	328'	2nd Mine Branch, Bridge Swivel
118	085-01	18080	Fringer Rd & Rt 30	Cistern	Eng	30,000	9J5	4343 F2	N39.55.429	W76.84.013	636'	
119	085-07	18077	14711 Old Hanover Rd	Cistern	Eng	12,500		4343 J6	N39.53.068	W76.82.229	516'	at Station 42
120	085-10	18079	13944 Old Hanover Road	Cistern	Eng	150K		4343 G9	N39.50.790	W76.82.892	639'	Suburban Propane

	Box	ID #	Location	Type	Access	Capacity	ADC Grid	ADC Grid New Format	Latitude	Longitude	Elevation	Notes:
121	085-11	18078	Woodens Ln	Cistern	Eng	30,000	9H13	4343 D9	N39.50.931	W76.85.025	516'	
122	085-14	18081	4195 Saint Paul Rd (Outdoor Unlimited)	Dry Hydrant	Eng	1100 GPM	9H4	4343 F1	N39 33.500	W76 50.816	660'	Access: 15810 HANOVER PIKE
123	085-20	18082	5th District Elem School; 3725 Mt Carmel Rd	Cistern	Eng	30,000	5H9	4232 F4	N39.60.151	W76.77.681	505'	5th District Elem School
124	085-21	18083	Gunpowder Road btwn Falls & Mt. Carmel Rd	Dry Hydrant	Eng	1100 GPM	5A6	4232 D2	N39.61.609	W76.79.289	446'	
125	085-27	18086	Gunpowder Rd @ Balto Cty Prop.	Dry Hydrant	Eng	1300 GPM	1J7		39.654663	-76.779382		
126	085-28	18085	19250 Resh Mill Rd	Dry Hydrant	Eng			4118 B6	N39.66.586	W76.80.284	689'	Pond behind Barn

In County / Out of County Resources

Baltimore County		**Carroll County**	**York County**
Tankers 2000 Gal. or more	**Tanker Support Units**	Co 2 Hampstead Eng/Tanker 24: 1500 gal. 1500 gpm	***Winterstown Tanker 45 3,000***
Chestnut Ridge Eng / Tanker 503: 3,000 gals	Butler TSU 491: 1,000 gpm	Co 3 Westminister Special Unit 3: 300 gal. 750 gpm	***Eureka Tanker 54: 4,000 gal***
Hereford Tanker 446 : 3,000 gals	Chestnut Ridge TSU: 504 1500 gpm	Co 4 Manchester Eng/Tanker 43: 1500 gal. 1500 gpm	Eureka Water SU Eng 54-4 1750 gp
Kingsville Tanker 488 : 4,000 gals	Cockeysville TSU 394 1,000 gpm	Co 4 Manchester Eng 44: 1500 gal. 1500 gpm	***Fawn Grove Tanker 56: 2,500***
Maryland Line Tanker 454 2,650 gal	Hereford TSU 444: 1,000 gpm	Co 4 Manchester Brush 45: 300 gal. 750 gpm	Fawn Grove Water SU Eng 56-1
Martins State Airport - Tanker 4000 gal	Jacksonville TSU 474: 750 gpm	Co 5 Taneytown Eng/Tanker 54: 1500 gal 1500 gpm	***Delta Tanker 57: 4,000 gal***
Howard County		Co 5 Taneytown Eng 52 (4wd): 500 gal 1500 gpm	Rose Hose Eng 58-1, -2: 1,000 g
Fifth District Tanker 5 4,000 gal.		***Co 6 Pleasant Valley Tanker 6: 3250 gal. 1500 gpm***	Shrewsbury Eng: 61-1,-2; 1,000 g
West Friendship Tanker 3 3,000 gal.		Co 6 Pleasant Valley Special Unit 6: 500 gal 1500 gpm	***Glen Rock Tanker 59: 3,000 gal***
West Friendship Tanker 3-4 2,500 gal.		Co 7 Lineboro Eng/Tanker 73: 1500 gal. 1250 gpm	Glen Rock Brush 59 1000 gpm mids
**** NOTE ** *BOLD/ITALIC* denotes Large Capacity Tanker**		Co 9 Reese Brush 95: 300 gal. 1000 gpm	**Harford County**
		Co 10 New Windsor Brush 105: 200 gal 1000 gpm	***Fallston Tanker 1321: 3,000 gal.***
		Co 11 Harney Eng/Tanker 112: 2500 gal. 1250 gpm	***Norrisville Tanker 1025: 2,500 gal.***
		Co 12 Sykesville Eng 124: 1500 gal. 2000 gpm	Jarrettsville Supply 781:1,500 GPM
		Co 13 Gamber Eng/Tanker 133: 2500 gal 1250 gpm	***APG Tanker 1221: 2,500 gal***
		Co 13 Gamber Brush 135: 250 gal. 750 gpm	**Level Tanker 121 : 3,500 gal**
		Co 14 Winfield Tanker 14: 3500 gal. 1500 gpm	Level Supply 181 1750 GPM

APPENDIX E:
FULL HAZUS LEVEL 2 REPORTS

Hazus-MH: Flood Event Report

Region Name: Baltimore 100-yr Flood

Flood Scenario: 100-yr flood_Baltimore

Print Date: Sunday, October 27, 2013

Disclaimer:

Totals only reflect data for those census tracts/blocks included in the user's study region.

The estimates of social and economic impacts contained in this report were produced using Hazus loss estimation methodology software which is based on current scientific and engineering knowledge. There are uncertainties inherent in any loss estimation technique. Therefore, there may be significant differences between the modeled results contained in this report and the actual social

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General Description of the Region

Hazus is a regional multi-hazard loss estimation model that was developed by the Federal Emergency Management Agency (FEMA) and the National Institute of Building Sciences (NIBS). The primary purpose of Hazus is to provide a methodology and software application to develop multi-hazard losses at a regional scale. These loss estimates would be used primarily by local, state and regional officials to plan and stimulate efforts to reduce risks from multi-hazards and to prepare for emergency response and recovery.

The flood loss estimates provided in this report were based on a region that included 1 county(ies) from the following state(s):

- Maryland

Note:
Appendix A contains a complete listing of the counties contained in the region.

The geographical size of the region is 599 square miles and contains 7,879 census blocks. The region contains over 300 thousand households and has a total population of 754,292 people (2000 Census Bureau data). The distribution of population by State and County for the study region is provided in Appendix B.

There are an estimated 269,655 buildings in the region with a total building replacement value (excluding contents) of 59,023 million dollars (2006 dollars). Approximately 92.61% of the buildings (and 75.50% of the building value) are associated with residential housing.

Building Inventory

General Building Stock

Hazus estimates that there are 269,655 buildings in the region which have an aggregate total replacement value of 59,023 million (2006 dollars). Table 1 and Table 2 present the relative distribution of the value with respect to the general occupancies by Study Region and Scenario respectively. Appendix B provides a general distribution of the building value by State and County.

Table 1
Building Exposure by Occupancy Type for the Study Region

Occupancy	Exposure ($1000)	Percent of Total
Residential	44,564,549	75.5%
Commercial	10,305,313	17.5%
Industrial	1,993,397	3.4%
Agricultural	157,750	0.3%
Religion	974,720	1.7%
Government	334,611	0.6%
Education	692,717	1.2%
Total	**59,023,057**	**100.00%**

Table 2
Building Exposure by Occupancy Type for the Scenario

Occupancy	Exposure ($1000)	Percent of Total
Residential	8,411,234	72.0%
Commercial	2,307,332	19.7%
Industrial	612,170	5.2%
Agricultural	49,407	0.4%
Religion	175,977	1.5%
Government	49,140	0.4%
Education	79,043	0.7%
Total	**11,684,303**	**100.00%**

Essential Facility Inventory

For essential facilities, there are 25 hospitals in the region with a total bed capacity of 1,800 beds. There are 375 schools, 65 fire stations, 20 police stations and 1 emergency operation center.

Flood Scenario Parameters

Hazus used the following set of information to define the flood parameters for the flood loss estimate provided in this report.

Study Region Name:	Baltimore 100-yr Flood
Scenario Name:	100-yr flood_Baltimore
Return Period Analyzed:	100
Analysis Options Analyzed:	No What-Ifs

Building Damage

General Building Stock Damage

Hazus estimates that about 1,595 buildings will be at least moderately damaged. This is over 72% of the total number of buildings in the scenario. There are an estimated 309 buildings that will be completely destroyed. The definition of the 'damage states' is provided in Volume 1: Chapter 5.3 of the Hazus Flood Technical Manual. Table 3 below summarizes the expected damage by general occupancy for the buildings in the region. Table 4 summarizes the expected damage by general building type.

Table 3: Expected Building Damage by Occupancy

	1-10		11-20		21-30		31-40		41-50		Substantially	
Occupancy	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Agriculture	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Commercial	0	0.00	7	77.78	1	11.11	0	0.00	0	0.00	1	11.11
Education	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Government	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Industrial	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	1	100.00
Religion	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Residential	0	0.00	54	3.41	526	33.19	217	13.69	481	30.35	307	19.37
Total	**0**		**61**		**527**		**217**		**481**		**309**	

Table 4: Expected Building Damage by Building Type

	1-10		11-20		21-30		31-40		41-50		Substantially	
Building Type	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Concrete	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
ManufHousing	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	4	100.00
Masonry	0	0.00	13	3.08	148	35.07	53	12.56	128	30.33	80	18.96
Steel	0	0.00	6	75.00	1	12.50	0	0.00	0	0.00	1	12.50
Wood	0	0.00	41	3.55	376	32.58	163	14.12	352	30.50	222	19.24

Essential Facility Damage

Before the flood analyzed in this scenario, the region had 1,800 hospital beds available for use. On the day of the scenario flood event, the model estimates that 1,800 hospital beds are available in the region.

Table 5: Expected Damage to Essential Facilities

		# Facilities		
Classification	Total	At Least Moderate	At Least Substantial	Loss of Use
Fire Stations	65	0	0	0
Hospitals	25	0	0	0
Police Stations	20	0	0	0
Schools	375	3	0	3

If this report displays all zeros or is blank, two possibilities can explain this.

(1) None of your facilities were flooded. This can be checked by mapping the inventory data on the depth grid.

(2) The analysis was not run. This can be tested by checking the run box on the Analysis Menu and seeing if a message box asks you to replace the existing results.

Induced Flood Damage

Debris Generation

Hazus estimates the amount of debris that will be generated by the flood. The model breaks debris into three general categories: 1) Finishes (dry wall, insulation, etc.), 2) Structural (wood, brick, etc.) and 3) Foundations (concrete slab, concrete block, rebar, etc.). This distinction is made because of the different types of material handling equipment required to handle the debris.

The model estimates that a total of 97,511 tons of debris will be generated. Of the total amount, Finishes comprises 29% of the total, Structure comprises 38% of the total. If the debris tonnage is converted into an estimated number of truckloads, it will require 3,900 truckloads (@25 tons/truck) to remove the debris generated by the flood.

Social Impact

Shelter Requirements

Hazus estimates the number of households that are expected to be displaced from their homes due to the flood and the associated potential evacuation. Hazus also estimates those displaced people that will require accommodations in temporary public shelters. The model estimates 3,796 households will be displaced due to the flood. Displacement includes households evacuated from within or very near to the inundated area. Of these, 8,311 people (out of a total population of 754,292) will seek temporary shelter in public shelters.

Economic Loss

The total economic loss estimated for the flood is 749.12 million dollars, which represents 6.41 % of the total replacement value of the scenario buildings.

Building-Related Losses

The building losses are broken into two categories: direct building losses and business interruption losses. The direct building losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the flood. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the flood.

The total building-related losses were 745.55 million dollars. 0% of the estimated losses were related to the business interruption of the region. The residential occupancies made up 44.65% of the total loss. Table 6 below provides a summary of the losses associated with the building damage.

Table 6: Building-Related Economic Loss Estimates

(Millions of dollars)

Category	Area	Residential	Commercial	Industrial	Others	Total
Building Loss						
	Building	207.74	90.20	25.38	6.48	329.81
	Content	126.31	182.81	62.83	26.77	398.72
	Inventory	0.00	4.98	11.69	0.35	17.03
	Subtotal	**334.05**	**277.99**	**99.91**	**33.60**	**745.55**
Business Interruption						
	Income	0.03	0.97	0.01	0.03	1.03
	Relocation	0.24	0.22	0.01	0.01	0.48
	Rental Income	0.07	0.16	0.00	0.00	0.23
	Wage	0.09	0.81	0.01	0.92	1.83
	Subtotal	**0.43**	**2.16**	**0.02**	**0.96**	**3.57**
ALL	**Total**	**334.48**	**280.15**	**99.93**	**34.56**	**749.12**

Appendix A: County Listing for the Region

Maryland

- Baltimore

Appendix B: Regional Population and Building Value Data

	Population	Building Value (thousands of dollars) Residential	Non-Residential	Total
Maryland				
Baltimore	754,292	44,564,549	14,458,508	59,023,057
Total	**754,292**	**44,564,549**	**14,458,508**	**59,023,057**
Total Study Region	**754,292**	**44,564,549**	**14,458,508**	**59,023,057**

Hazus-MH: Flood Event Report

Region Name: Baltimore County_coastal

Flood Scenario: Coastal

Print Date: Monday, October 28, 2013

Disclaimer:

Totals only reflect data for those census tracts/blocks included in the user's study region.

The estimates of social and economic impacts contained in this report were produced using Hazus loss estimation methodology software which is based on current scientific and engineering knowledge. There are uncertainties inherent in any loss estimation technique. Therefore, there may be significant differences between the modeled results contained in this report and the actual social

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General Description of the Region

Hazus is a regional multi-hazard loss estimation model that was developed by the Federal Emergency Management Agency (FEMA) and the National Institute of Building Sciences (NIBS). The primary purpose of Hazus is to provide a methodology and software application to develop multi-hazard losses at a regional scale. These loss estimates would be used primarily by local, state and regional officials to plan and stimulate efforts to reduce risks from multi-hazards and to prepare for emergency response and recovery.

The flood loss estimates provided in this report were based on a region that included 1 county(ies) from the following state(s):

- Maryland

Note:
Appendix A contains a complete listing of the counties contained in the region.

The geographical size of the region is 599 square miles and contains 7,879 census blocks. The region contains over 300 thousand households and has a total population of 754,292 people (2000 Census Bureau data). The distribution of population by State and County for the study region is provided in Appendix B.

There are an estimated 269,655 buildings in the region with a total building replacement value (excluding contents) of 59,023 million dollars (2006 dollars). Approximately 92.61% of the buildings (and 75.50% of the building value) are associated with residential housing.

Building Inventory

General Building Stock

Hazus estimates that there are 269,655 buildings in the region which have an aggregate total replacement value of 59,023 million (2006 dollars). Table 1 and Table 2 present the relative distribution of the value with respect to the general occupancies by Study Region and Scenario respectively. Appendix B provides a general distribution of the building value by State and County.

Table 1
Building Exposure by Occupancy Type for the Study Region

Occupancy	Exposure ($1000)	Percent of Total
Residential	44,564,549	75.5%
Commercial	10,305,313	17.5%
Industrial	1,993,397	3.4%
Agricultural	157,750	0.3%
Religion	974,720	1.7%
Government	334,611	0.6%
Education	692,717	1.2%
Total	**59,023,057**	**100.00%**

Table 2
Building Exposure by Occupancy Type for the Scenario

Occupancy	Exposure ($1000)	Percent of Total
Residential	1,477,380	80.7%
Commercial	239,978	13.1%
Industrial	59,684	3.3%
Agricultural	3,352	0.2%
Religion	14,650	0.8%
Government	17,971	1.0%
Education	17,824	1.0%
Total	**1,830,839**	**100.00%**

Essential Facility Inventory

For essential facilities, there are 25 hospitals in the region with a total bed capacity of 1,800 beds. There are 375 schools, 65 fire stations, 20 police stations and 1 emergency operation center.

Flood Scenario Parameters

Hazus used the following set of information to define the flood parameters for the flood loss estimate provided in this report.

Study Region Name:	Baltimore County_coastal
Scenario Name:	Coastal
Return Period Analyzed:	100
Analysis Options Analyzed:	No What-Ifs

Building Damage

General Building Stock Damage

Hazus estimates that about 89 buildings will be at least moderately damaged. This is over 27% of the total number of buildings in the scenario. There are an estimated 0 buildings that will be completely destroyed. The definition of the 'damage states' is provided in Volume 1: Chapter 5.3 of the Hazus Flood Technical Manual. Table 3 below summarizes the expected damage by general occupancy for the buildings in the region. Table 4 summarizes the expected damage by general building type.

Table 3: Expected Building Damage by Occupancy

	1-10		11-20		21-30		31-40		41-50		Substantially	
Occupancy	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Agriculture	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Commercial	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Education	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Government	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Industrial	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Religion	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Residential	0	0.00	28	31.46	61	68.54	0	0.00	0	0.00	0	0.00
Total	**0**		**28**		**61**		**0**		**0**		**0**	

Table 4: Expected Building Damage by Building Type

Building Type	1-10		11-20		21-30		31-40		41-50		Substantially	
	Count	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Concrete	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
ManufHousing	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Masonry	0	0.00	6	28.57	15	71.43	0	0.00	0	0.00	0	0.00
Steel	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Wood	0	0.00	22	32.35	46	67.65	0	0.00	0	0.00	0	0.00

Essential Facility Damage

Before the flood analyzed in this scenario, the region had 1,800 hospital beds available for use. On the day of the scenario flood event, the model estimates that 1,800 hospital beds are available in the region.

Table 5: Expected Damage to Essential Facilities

		# Facilities		
Classification	Total	At Least Moderate	At Least Substantial	Loss of Use
Fire Stations	65	0	0	0
Hospitals	25	0	0	0
Police Stations	20	0	0	0
Schools	375	0	0	0

If this report displays all zeros or is blank, two possibilities can explain this.

(1) None of your facilities were flooded. This can be checked by mapping the inventory data on the depth grid.

(2) The analysis was not run. This can be tested by checking the run box on the Analysis Menu and seeing if a message box asks you to replace the existing results.

Induced Flood Damage

Debris Generation

Hazus estimates the amount of debris that will be generated by the flood. The model breaks debris into three general categories: 1) Finishes (dry wall, insulation, etc.), 2) Structural (wood, brick, etc.) and 3) Foundations (concrete slab, concrete block, rebar, etc.). This distinction is made because of the different types of material handling equipment required to handle the debris.

The model estimates that a total of 1,145 tons of debris will be generated. Of the total amount, Finishes comprises 97% of the total, Structure comprises 1% of the total. If the debris tonnage is converted into an estimated number of truckloads, it will require 46 truckloads (@25 tons/truck) to remove the debris generated by the flood.

Social Impact

Shelter Requirements

Hazus estimates the number of households that are expected to be displaced from their homes due to the flood and the associated potential evacuation. Hazus also estimates those displaced people that will require accommodations in temporary public shelters. The model estimates 579 households will be displaced due to the flood. Displacement includes households evacuated from within or very near to the inundated area. Of these, 1,006 people (out of a total population of 754,292) will seek temporary shelter in public shelters.

Economic Loss

The total economic loss estimated for the flood is 14.42 million dollars, which represents 0.79 % of the total replacement value of the scenario buildings.

Building-Related Losses

The building losses are broken into two categories: direct building losses and business interruption losses. The direct building losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the flood. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the flood.

The total building-related losses were 14.27 million dollars. 1% of the estimated losses were related to the business interruption of the region. The residential occupancies made up 62.16% of the total loss. Table 6 below provides a summary of the losses associated with the building damage.

Table 6: Building-Related Economic Loss Estimates

(Millions of dollars)

Category	Area	Residential	Commercial	Industrial	Others	Total
Building Loss						
	Building	5.78	1.03	0.17	0.13	7.10
	Content	3.17	2.93	0.19	0.81	7.11
	Inventory	0.00	0.02	0.04	0.00	0.06
	Subtotal	**8.95**	**3.98**	**0.40**	**0.94**	**14.27**
Business Interruption						
	Income	0.00	0.03	0.00	0.00	0.03
	Relocation	0.01	0.01	0.00	0.00	0.02
	Rental Income	0.00	0.00	0.00	0.00	0.00
	Wage	0.00	0.02	0.00	0.07	0.09
	Subtotal	**0.01**	**0.06**	**0.00**	**0.07**	**0.14**
ALL	**Total**	**8.96**	**4.04**	**0.40**	**1.01**	**14.42**

Appendix A: County Listing for the Region

Maryland

- Baltimore

Appendix B: Regional Population and Building Value Data

	Population	Building Value (thousands of dollars)		
		Residential	Non-Residential	Total
Maryland				
Baltimore	754,292	44,564,549	14,458,508	59,023,057
Total	**754,292**	**44,564,549**	**14,458,508**	**59,023,057**
Total Study Region	**754,292**	**44,564,549**	**14,458,508**	**59,023,057**

Hazus-MH: Earthquake Event Report

Region Name: Baltimore County HMP

Earthquake Scenario: Baltimore County Epicenter

Print Date: October 17, 2013

Totals only reflect data for those census tracts/blocks included in the user's study region.

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General Description of the Region

Hazus is a regional earthquake loss estimation model that was developed by the Federal Emergency Management Agency and the National Institute of Building Sciences. The primary purpose of Hazus is to provide a methodology and software application to develop earthquake losses at a regional scale. These loss estimates would be used primarily by local, state and regional officials to plan and stimulate efforts to reduce risks from earthquakes and to prepare for emergency response and recovery.

The earthquake loss estimates provided in this report was based on a region that includes 1 county(ies) from the following state(s):

Maryland

Note:
Appendix A contains a complete listing of the counties contained in the region.

The geographical size of the region is 607.12 square miles and contains 204 census tracts. There are over 299 thousand households in the region which has a total population of 754,292 people (2002 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 269 thousand buildings in the region with a total building replacement value (excluding contents) of 59,023 (millions of dollars). Approximately 93.00 % of the buildings (and 76.00% of the building value) are associated with residential housing.

The replacement value of the transportation and utility lifeline systems is estimated to be 4,696 and 5,599 (millions of dollars) , respectively.

Building and Lifeline Inventory

Building Inventory

Hazus estimates that there are 269 thousand buildings in the region which have an aggregate total replacement value of 59,023 (millions of dollars) . Appendix B provides a general distribution of the building value by State and County.

In terms of building construction types found in the region, wood frame construction makes up 66% of the building inventory. The remaining percentage is distributed between the other general building types.

Critical Facility Inventory

Hazus breaks critical facilities into two (2) groups: essential facilities and high potential loss facilities (HPL). Essential facilities include hospitals, medical clinics, schools, fire stations, police stations and emergency operations facilities. High potential loss facilities include dams, levees, military installations, nuclear power plants and hazardous material sites.

For essential facilities, there are 25 hospitals in the region with a total bed capacity of 1,800 beds. There are 375 schools, 65 fire stations, 20 police stations and 1 emergency operation facilities. With respect to high potential loss facilities (HPL), there are 11 dams identified within the region. Of these, 4 of the dams are classified as 'high hazard'. The inventory also includes 66 hazardous material sites, 0 military installations and 0 nuclear power plants.

Transportation and Utility Lifeline Inventory

Within Hazus, the lifeline inventory is divided between transportation and utility lifeline systems. There are seven (7) transportation systems that include highways, railways, light rail, bus, ports, ferry and airports. There are six (6) utility systems that include potable water, wastewater, natural gas, crude & refined oil, electric power and communications. The lifeline inventory data are provided in Tables 1 and 2.

The total value of the lifeline inventory is over 10,295.00 (millions of dollars). This inventory includes over 507 kilometers of highways, 449 bridges, 11,839 kilometers of pipes.

Table 1: Transportation System Lifeline Inventory

System	Component	# Locations/ # Segments	Replacement value (millions of dollars)
Highway	Bridges	449	717.80
	Segments	331	3,605.70
	Tunnels	0	0.00
		Subtotal	**4,323.50**
Railways	Bridges	2	0.40
	Facilities	6	16.00
	Segments	160	176.80
	Tunnels	0	0.00
		Subtotal	**193.10**
Light Rail	Bridges	0	0.00
	Facilities	17	45.30
	Segments	23	59.30
	Tunnels	0	0.00
		Subtotal	**104.60**
Bus	Facilities	1	1.10
		Subtotal	**1.10**
Ferry	Facilities	0	0.00
		Subtotal	**0.00**
Port	Facilities	13	26.00
		Subtotal	**26.00**
Airport	Facilities	1	10.70
	Runways	1	38.00
		Subtotal	**48.60**
		Total	**4,696.90**

Table 2: Utility System Lifeline Inventory

System	Component	# Locations / Segments	Replacement value (millions of dollars)
Potable Water	Distribution Lines	NA	118.40
	Facilities	3	4,852.80
	Pipelines	0	0.00
		Subtotal	**4,971.20**
Waste Water	Distribution Lines	NA	71.00
	Facilities	4	197.80
	Pipelines	0	0.00
		Subtotal	**268.80**
Natural Gas	Distribution Lines	NA	47.40
	Facilities	2	2.20
	Pipelines	0	0.00
		Subtotal	**49.50**
Oil Systems	Facilities	0	0.00
	Pipelines	0	0.00
		Subtotal	**0.00**
Electrical Power	Facilities	5	544.50
		Subtotal	**544.50**
Communication	Facilities	18	1.80
		Subtotal	**1.80**
		Total	**5,835.90**

Earthquake Scenario

Hazus uses the following set of information to define the earthquake parameters used for the earthquake loss estimate provided in this report.

Scenario Name	Baltimore County Epicenter
Type of Earthquake	Arbitrary
Fault Name	NA
Historical Epicenter ID #	NA
Probabilistic Return Period	NA
Longitude of Epicenter	-76.80
Latitude of Epicenter	39.36
Earthquake Magnitude	5.00
Depth (Km)	10.00
Rupture Length (Km)	NA
Rupture Orientation (degrees)	NA
Attenuation Function	Central & East US (CEUS 2008)

Building Damage

Hazus estimates that about 22,754 buildings will be at least moderately damaged. This is over 8.00 % of the buildings in the region. There are an estimated 843 buildings that will be damaged beyond repair. The definition of the 'damage states' is provided in Volume 1: Chapter 5 of the Hazus technical manual. Table 3 below summarizes the expected damage by general occupancy for the buildings in the region. Table 4 below summarizes the expected damage by general building type.

Table 3: Expected Building Damage by Occupancy

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Agriculture	601	0.29	99	0.27	63	0.36	17	0.42	3	0.35
Commercial	9,866	4.69	1,782	4.91	1,374	7.75	417	9.97	75	8.92
Education	344	0.16	66	0.18	54	0.30	15	0.37	3	0.35
Government	246	0.12	50	0.14	46	0.26	14	0.35	3	0.32
Industrial	2,769	1.31	419	1.15	348	1.96	106	2.53	19	2.22
Other Residential	19,106	9.07	3,344	9.21	1,805	10.18	439	10.50	76	8.97
Religion	830	0.39	162	0.45	108	0.61	32	0.77	6	0.73
Single Family	176,824	83.97	30,392	83.69	13,932	78.58	3,140	75.10	659	78.14
Total	**210,586**		**36,314**		**17,731**		**4,180**		**843**	

Table 4: Expected Building Damage by Building Type (All Design Levels)

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Wood	144,895	68.81	23304	64.17	7,924	44.69	907	21.69	71	8.42
Steel	6,963	3.31	1103	3.04	1,058	5.97	328	7.84	58	6.94
Concrete	3,345	1.59	516	1.42	448	2.53	123	2.94	15	1.82
Precast	462	0.22	70	0.19	85	0.48	40	0.95	4	0.42
RM	2,793	1.33	324	0.89	353	1.99	138	3.31	7	0.78
URM	50,027	23.76	10804	29.75	7,763	43.78	2,632	62.96	687	81.44
MH	2,102	1.00	192	0.53	99	0.56	13	0.31	2	0.18
Total	**210,586**		**36,314**		**17,731**		**4,180**		**843**	

*Note:
RM Reinforced Masonry
URM Unreinforced Masonry
MH Manufactured Housing

Essential Facility Damage

Before the earthquake, the region had 1,800 hospital beds available for use. On the day of the earthquake, the model estimates that only 993 hospital beds (55.00%) are available for use by patients already in the hospital and those injured by the earthquake. After one week, 74.00% of the beds will be back in service. By 30 days, 90.00% will be operational.

Table 5: Expected Damage to Essential Facilities

		# Facilities		
Classification	**Total**	**At Least Moderate Damage > 50%**	**Complete Damage > 50%**	**With Functionality > 50% on day 1**
Hospitals	25	4	0	17
Schools	375	53	0	215
EOCs	1	0	0	0
PoliceStations	20	2	0	13
FireStations	65	3	0	48

Transportation and Utility Lifeline Damage

Table 6 provides damage estimates for the transportation system.

Table 6: Expected Damage to the Transportation Systems

System	Component	Number of Locations				
		Locations/ Segments	With at Least Mod. Damage	With Complete Damage	With Functionality > 50 %	
					After Day 1	After Day 7
Highway	Segments	331	0	0	331	331
	Bridges	449	14	1	435	445
	Tunnels	0	0	0	0	0
Railways	Segments	160	0	0	160	160
	Bridges	2	0	0	2	2
	Tunnels	0	0	0	0	0
	Facilities	6	0	0	6	6
Light Rail	Segments	23	0	0	23	23
	Bridges	0	0	0	0	0
	Tunnels	0	0	0	0	0
	Facilities	17	3	0	17	17
Bus	Facilities	1	0	0	1	1
Ferry	Facilities	0	0	0	0	0
Port	Facilities	13	0	0	13	13
Airport	Facilities	1	0	0	1	1
	Runways	1	0	0	1	1

Note: Roadway segments, railroad tracks and light rail tracks are assumed to be damaged by ground failure only. If ground failure maps are not provided, damage estimates to these components will not be computed.

Tables 7-9 provide information on the damage to the utility lifeline systems. Table 7 provides damage to the utility system facilities. Table 8 provides estimates on the number of leaks and breaks by the pipelines of the utility systems. For electric power and potable water, Hazus performs a simplified system performance analysis. Table 9 provides a summary of the system performance information.

Table 7 : Expected Utility System Facility Damage

System	# of Locations				
	Total #	With at Least Moderate Damage	With Complete Damage	with Functionality > 50 %	
				After Day 1	After Day 7
Potable Water	3	0	0	3	3
Waste Water	4	0	0	4	4
Natural Gas	2	2	0	0	2
Oil Systems	0	0	0	0	0
Electrical Power	5	2	0	3	5
Communication	18	11	0	18	18

Table 8 : Expected Utility System Pipeline Damage (Site Specific)

System	Total Pipelines Length (kms)	Number of Leaks	Number of Breaks
Potable Water	5,920	152	38
Waste Water	3,552	76	19
Natural Gas	2,368	26	7
Oil	0	0	0

Table 9: Expected Potable Water and Electric Power System Performance

	Total # of Households	Number of Households without Service				
		At Day 1	At Day 3	At Day 7	At Day 30	At Day 90
Potable Water	299,877	0	0	0	0	0
Electric Power		73,463	43,946	15,785	2,479	94

Induced Earthquake Damage

Fire Following Earthquake

Fires often occur after an earthquake. Because of the number of fires and the lack of water to fight the fires, they can often burn out of control. Hazus uses a Monte Carlo simulation model to estimate the number of ignitions and the amount of burnt area. For this scenario, the model estimates that there will be 1 ignitions that will burn about 0.18 sq. mi 0.03 % of the region's total area.) The model also estimates that the fires will displace about 298 people and burn about 26 (millions of dollars) of building value.

Debris Generation

Hazus estimates the amount of debris that will be generated by the earthquake. The model breaks the debris into two general categories: a) Brick/Wood and b) Reinforced Concrete/Steel. This distinction is made because of the different types of material handling equipment required to handle the debris.

The model estimates that a total of 0.81 million tons of debris will be generated. Of the total amount, Brick/Wood comprises 60.00% of the total, with the remainder being Reinforced Concrete/Steel. If the debris tonnage is converted to an estimated number of truckloads, it will require 32,400 truckloads (@25 tons/truck) to remove the debris generated by the earthquake.

Social Impact

Shelter Requirement

Hazus estimates the number of households that are expected to be displaced from their homes due to the earthquake and the number of displaced people that will require accommodations in temporary public shelters. The model estimates 2,373 households to be displaced due to the earthquake. Of these, 1,456 people (out of a total population of 754,292) will seek temporary shelter in public shelters.

Casualties

Hazus estimates the number of people that will be injured and killed by the earthquake. The casualties are broken down into four (4) severity levels that describe the extent of the injuries. The levels are described as follows;

- Severity Level 1: Injuries will require medical attention but hospitalization is not needed.
- Severity Level 2: Injuries will require hospitalization but are not considered life-threatening
- Severity Level 3: Injuries will require hospitalization and can become life threatening if not promptly treated.
- Severity Level 4: Victims are killed by the earthquake.

The casualty estimates are provided for three (3) times of day: 2:00 AM, 2:00 PM and 5:00 PM. These times represent the periods of the day that different sectors of the community are at their peak occupancy loads. The 2:00 AM estimate considers that the residential occupancy load is maximum, the 2:00 PM estimate considers that the educational, commercial and industrial sector loads are maximum and 5:00 PM represents peak commute time.

Table 10 provides a summary of the casualties estimated for this earthquake

Table 10: Casualty Estimates

		Level 1	Level 2	Level 3	Level 4
2 AM	Commercial	6	1	0	0
	Commuting	0	0	0	0
	Educational	0	0	0	0
	Hotels	1	0	0	0
	Industrial	5	1	0	0
	Other-Residential	152	30	4	7
	Single Family	524	103	12	24
	Total	**689**	**135**	**17**	**32**
2 PM	Commercial	352	70	8	16
	Commuting	1	1	2	0
	Educational	88	18	2	5
	Hotels	0	0	0	0
	Industrial	39	7	1	2
	Other-Residential	27	5	1	1
	Single Family	90	18	2	4
	Total	**596**	**120**	**17**	**28**
5 PM	Commercial	263	53	6	12
	Commuting	31	37	68	13
	Educational	14	3	0	1
	Hotels	0	0	0	0
	Industrial	24	5	1	1
	Other-Residential	60	12	2	3
	Single Family	209	42	5	10
	Total	**602**	**152**	**83**	**40**

Economic Loss

The total economic loss estimated for the earthquake is 2,598.85 (millions of dollars), which includes building and lifeline related losses based on the region's available inventory. The following three sections provide more detailed information about these losses.

Building-Related Losses

The building losses are broken into two categories: direct building losses and business interruption losses. The direct building losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the earthquake. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the earthquake.

The total building-related losses were 2,394.19 (millions of dollars); 20 % of the estimated losses were related to the business interruption of the region. By far, the largest loss was sustained by the residential occupancies which made up over 63 % of the total loss. Table 11 below provides a summary of the losses associated with the building damage.

Table 11: Building-Related Economic Loss Estimates

(Millions of dollars)

Category	Area	Single Family	Other Residential	Commercial	Industrial	Others	Total
Income Losses							
	Wage	0.00	12.45	76.49	1.53	5.78	96.25
	Capital-Related	0.00	5.15	61.47	0.91	1.01	68.54
	Rental	28.73	28.35	40.60	0.64	2.37	100.69
	Relocation	106.73	18.17	63.19	3.69	16.66	208.45
	Subtotal	**135.46**	**64.12**	**241.76**	**6.77**	**25.82**	**473.93**
Capital Stock Losses							
	Structural	157.35	40.43	66.95	8.43	14.44	287.60
	Non_Structural	561.65	236.77	223.44	35.55	50.52	1,107.93
	Content	233.23	78.99	143.81	26.01	33.46	515.49
	Inventory	0.00	0.00	3.41	5.51	0.31	9.23
	Subtotal	**952.22**	**356.19**	**437.61**	**75.50**	**98.74**	**1,920.26**
	Total	**1,087.68**	**420.31**	**679.37**	**82.27**	**124.56**	**2,394.19**

Transportation and Utility Lifeline Losses

For the transportation and utility lifeline systems, Hazus computes the direct repair cost for each component only. There are no losses computed by Hazus for business interruption due to lifeline outages. Tables 12 & 13 provide a detailed breakdown in the expected lifeline losses.

Hazus estimates the long-term economic impacts to the region for 15 years after the earthquake. The model quantifies this information in terms of income and employment changes within the region. Table 14 presents the results of the region for the given earthquake.

Table 12: Transportation System Economic Losses

(Millions of dollars)

System	Component	Inventory Value	Economic Loss	Loss Ratio (%)
Highway	Segments	3,605.74	$0.00	0.00
	Bridges	717.78	$22.44	3.13
	Tunnels	0.00	$0.00	0.00
	Subtotal	**4323.50**	**22.40**	
Railways	Segments	176.78	$0.00	0.00
	Bridges	0.35	$0.00	0.59
	Tunnels	0.00	$0.00	0.00
	Facilities	15.98	$1.18	7.40
	Subtotal	**193.10**	**1.20**	
Light Rail	Segments	59.32	$0.00	0.00
	Bridges	0.00	$0.00	0.00
	Tunnels	0.00	$0.00	0.00
	Facilities	45.27	$8.07	17.83
	Subtotal	**104.60**	**8.10**	
Bus	Facilities	1.08	$0.06	5.69
	Subtotal	**1.10**	**0.10**	
Ferry	Facilities	0.00	$0.00	0.00
	Subtotal	**0.00**	**0.00**	
Port	Facilities	25.96	$1.17	4.53
	Subtotal	**26.00**	**1.20**	
Airport	Facilities	10.65	$0.39	3.66
	Runways	37.96	$0.00	0.00
	Subtotal	**48.60**	**0.40**	
	Total	**4696.90**	**33.30**	

Table 13: Utility System Economic Losses

(Millions of dollars)

System	Component	Inventory Value	Economic Loss	Loss Ratio (%)
Potable Water	Pipelines	0.00	$0.00	0.00
	Facilities	4,852.80	$105.89	2.18
	Distribution Lines	118.40	$0.68	0.58
	Subtotal	**4,971.23**	**$106.58**	
Waste Water	Pipelines	0.00	$0.00	0.00
	Facilities	197.80	$2.36	1.19
	Distribution Lines	71.00	$0.34	0.48
	Subtotal	**268.84**	**$2.70**	
Natural Gas	Pipelines	0.00	$0.00	0.00
	Facilities	2.20	$0.56	26.11
	Distribution Lines	47.40	$0.12	0.25
	Subtotal	**49.52**	**$0.68**	
Oil Systems	Pipelines	0.00	$0.00	0.00
	Facilities	0.00	$0.00	0.00
	Subtotal	**0.00**	**$0.00**	
Electrical Power	Facilities	544.50	$61.07	11.22
	Subtotal	**544.50**	**$61.07**	
Communication	Facilities	1.80	$0.30	16.91
	Subtotal	**1.78**	**$0.30**	
	Total	**5,835.87**	**$171.33**	

Table 14. Indirect Economic Impact with outside aid

(Employment as # of people and Income in millions of $)

LOSS		Total	%

Appendix A: County Listing for the Region

Baltimore,MD

Appendix B: Regional Population and Building Value Data

State	County Name	Population	Building Value (millions of dollars)		
			Residential	Non-Residential	Total
Maryland					
	Baltimore	754,292	44,564	14,458	59,023
Total State		**754,292**	**44,564**	**14,458**	**59,023**
Total Region		**754,292**	**44,564**	**14,458**	**59,023**

Hazus-MH: Hurricane Event Report

Region Name: Baltimore County HMP

Hurricane Scenario: Probabilistic 1000-year Return Period

Print Date: Thursday, October 17, 2013

Disclaimer:
Totals only reflect data for those census tracts/blocks included in the user's study region.

The estimates of social and economic impacts contained in this report were produced using Hazus loss estimation methodology software which is based on current scientific and engineering knowledge. There are uncertainties inherent in any loss estimation technique. Therefore, there may be significant differences between the modeled results contained in this report and the actual social and economic losses following a specific Hurricane. These results can be improved by using enhanced inventory data.

Table of Contents

General Description of the Region

Hazus is a regional multi-hazard loss estimation model that was developed by the Federal Emergency Management Agency and the National Institute of Building Sciences. The primary purpose of Hazus is to provide a methodology and software application to develop multi-hazard losses at a regional scale. These loss estimates would be used primarily by local, state and regional officials to plan and stimulate efforts to reduce risks from multi-hazards and to prepare for emergency response and recovery.

The hurricane loss estimates provided in this report are based on a region that includes 1 county(ies) from the following state(s):

- Maryland

Note:
Appendix A contains a complete listing of the counties contained in the region.

The geographical size of the region is 607.28 square miles and contains 204 census tracts. There are over 299 thousand households in the region and has a total population of 754,292 people (2000 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 269 thousand buildings in the region with a total building replacement value (excluding contents) of 59,023 million dollars (2006 dollars). Approximately 93% of the buildings (and 76% of the building value) are associated with residential housing.

Building Inventory

General Building Stock

Hazus estimates that there are 269,655 buildings in the region which have an aggregate total replacement value of 59,023 million (2006 dollars). Table 1 presents the relative distribution of the value with respect to the general occupancies. Appendix B provides a general distribution of the building value by State and County.

Table 1: Building Exposure by Occupancy Type

Occupancy	Exposure ($1000)	Percent of Tot
Residential	44,564,549	75.5%
Commercial	10,305,313	17.5%
Industrial	1,993,397	3.4%
Agricultural	157,750	0.3%
Religious	974,720	1.7%
Government	334,611	0.6%
Education	692,717	1.2%
Total	**59,023,057**	**100.0%**

Essential Facility Inventory

For essential facilities, there are 25 hospitals in the region with a total bed capacity of 1,800 beds. There are 375 schools, 65 fire stations, 20 police stations and 1 emergency operation facilities.

Hurricane Scenario

Hazus used the following set of information to define the hurricane parameters for the hurricane loss estimate provided in this report.

Scenario Name:	Probabilistic
Type:	Probabilistic

Building Damage

General Building Stock Damage

Hazus estimates that about 4,067 buildings will be at least moderately damaged. This is over 2% of the total number of buildings in the region. There are an estimated 123 buildings that will be completely destroyed. The definition of the 'damage states' is provided in Volume 1: Chapter 6 of the Hazus Hurricane technical manual. Table 2 below summarizes the expected damage by general occupancy for the buildings in the region. Table 3 summarizes the expected damage by general building type.

Table 2: Expected Building Damage by Occupancy : 1000 - year Event

	None		Minor		Moderate		Severe		Destruction	
Occupancy	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Agriculture	701	89.39	63	8.06	14	1.73	6	0.75	1	0.07
Commercial	12,382	91.63	939	6.95	175	1.30	18	0.13	0	0.00
Education	446	92.47	32	6.61	4	0.88	0	0.03	0	0.00
Government	331	92.09	24	6.75	4	1.10	0	0.06	0	0.00
Industrial	3,348	91.48	257	7.02	47	1.30	7	0.19	0	0.01
Religion	1,051	92.29	79	6.95	8	0.74	0	0.02	0	0.00
Residential	217,017	86.91	28,918	11.58	3,590	1.44	70	0.03	122	0.05
Total	**235,276**		**30,312**		**3,843**		**101**		**123**	

Table 3: Expected Building Damage by Building Type : 1000 - year Event

Building Type	None		Minor		Moderate		Severe		Destruction	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Concrete	2,906	90.97	245	7.67	42	1.32	1	0.04	0	0.00
Masonry	61,693	85.90	8,321	11.59	1,741	2.42	39	0.05	26	0.04
MH	2,127	98.90	16	0.76	5	0.25	0	0.00	2	0.08
Steel	7,645	91.67	556	6.67	123	1.48	15	0.18	0	0.00
Wood	153,741	87.65	19,885	11.34	1,641	0.94	43	0.02	85	0.05

Essential Facility Damage

Before the hurricane, the region had no hospital beds available for use. On the day of the hurricane, the model estimates that 1228 hospital beds (0%) are available for use. After one week, none of the beds will be in service. By 30 days, none will be operational.

Table 4: Expected Damage to Essential Facilities

		# Facilities		
Classification	**Total**	**Probability of at Least Moderate Damage > 50%**	**Probability of Complete Damage > 50%**	**Expected Loss of Use < 1 day**
EOCs	1	0	0	1
Fire Stations	65	0	0	65
Hospitals	25	8	0	13
Police Stations	20	0	0	20
Schools	375	0	0	150

Induced Hurricane Damage

Debris Generation

Hazus estimates the amount of debris that will be generated by the hurricane. The model breaks the debris into four general categories: a) Brick/Wood, b) Reinforced Concrete/Steel, c) Eligible Tree Debris, and d) Other Tree Debris. This distinction is made because of the different types of material handling equipment required to handle the debris.

The model estimates that a total of 314,170 tons of debris will be generated. Of the total amount, 153,219 tons (49%) is Other Tree Debris. Of the remaining 160,951 tons, Brick/Wood comprises 49% of the total, Reinforced Concrete/Steel comprises of 0% of the total, with the remainder being Eligible Tree Debris. If the building debris tonnage is converted to an estimated number of truckloads, it will require 3139 truckloads (@25 tons/truck) to remove the building debris generated by the hurricane. The number of Eligible Tree Debris truckloads will depend on how the 82,487 tons of Eligible Tree Debris are collected and processed. The volume of tree debris generally ranges from about 4 cubic yards per ton for chipped or compacted tree debris to about 10 cubic yards per ton for bulkier, uncompacted debris.

Social Impact

Shelter Requirement

Hazus estimates the number of households that are expected to be displaced from their homes due to the hurricane and the number of displaced people that will require accommodations in temporary public shelters . The model estimates 8 households to be displaced due to the hurricane. Of these, 1 people (out of a total population of 754,292) will seek temporary shelter in public shelters.

Economic Loss

The total economic loss estimated for the hurricane is 543.6 million dollars, which represents 0.92 % of the total replacement value of the region's buildings.

Building-Related Losses

The building related losses are broken into two categories: direct property damage losses and business interruption losses. The direct property damage losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the hurricane. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the hurricane.

The total property damage losses were 544 million dollars. 2% of the estimated losses were related to the business interruption of the region. By far, the largest loss was sustained by the residential occupancies which made up over 90% of the total loss. Table 4 below provides a summary of the losses associated with the building damage.

Table 5: Building-Related Economic Loss Estimates

(Thousands of dollars)

Category	Area	Residential	Commercial	Industrial	Others	Total
Property Damage						
	Building	393,025.22	19,505.75	5,335.88	4,174.81	422,041.66
	Content	65,473.39	3,909.49	2,933.43	929.60	73,245.92
	Inventory	0.00	115.90	660.44	53.32	829.66
	Subtotal	**458,498.61**	**23,531.14**	**8,929.75**	**5,157.73**	**496,117.23**
Business Interruption Loss						
	Income	0.00	3,040.54	63.40	437.36	3,541.29
	Relocation	22,141.01	3,495.62	306.27	626.16	26,569.06
	Rental	10,727.20	1,738.54	52.14	52.18	12,570.06
	Wage	0.00	2,475.21	105.26	2,266.00	4,846.47
	Subtotal	**32,868.21**	**10,749.91**	**527.06**	**3,381.70**	**47,526.88**
Total						
	Total	**491,366.83**	**34,281.05**	**9,456.81**	**8,539.43**	**543,644.11**

Appendix A: County Listing for the Region

Maryland

- Baltimore

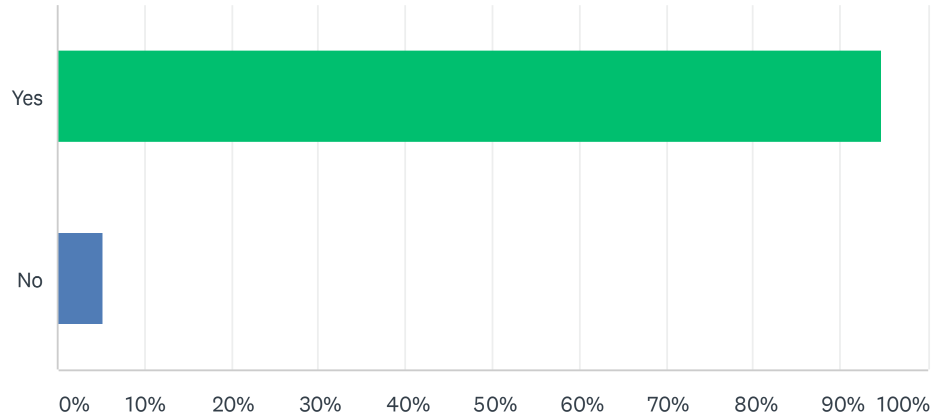
Appendix B: Regional Population and Building Value Data

		Building Value (thousands of dollars)		
	Population	Residential	Non-Residential	Total
Maryland				
Baltimore	754,292	44,564,549	14,458,508	59,023,057
Total	**754,292**	**44,564,549**	**14,458,508**	**59,023,057**
Study Region Total	**754,292**	**44,564,549**	**14,458,508**	**59,023,057**

APPENDIX F: PUBLIC SURVEY RESULTS

Q1 Are you a resident of Baltimore County?

Answered: 152 Skipped: 0



ANSWER CHOICES	RESPONSES	
Yes	94.74%	144
No	5.26%	8
TOTAL		152

Q2 Please provide the community where you currently live.

Answered: 148 Skipped: 4

#	RESPONSES	DATE
1	Mays Chapel	5/13/2021 2:24 PM
2	Windsor Mill	5/12/2021 12:28 PM
3	Reisterstown	5/10/2021 12:59 PM
4	Pikesville	5/10/2021 10:42 AM
5	21208	5/10/2021 10:18 AM
6	Lutherville-Timonium	5/10/2021 10:18 AM
7	Owings Mills	5/7/2021 2:59 PM
8	Hoot Owl Hills (Parkton)	5/3/2021 11:09 AM
9	Cockeysville	4/18/2021 8:46 PM
10	Jacksonville	4/10/2021 10:41 AM
11	Jacksonville	4/8/2021 1:03 PM
12	Paradise/Catonsville	4/8/2021 11:49 AM
13	Lutherville	4/8/2021 11:32 AM
14	Gwynn Oak	3/30/2021 11:22 PM
15	Middle river	3/30/2021 10:58 PM
16	Middle River	3/30/2021 1:54 PM
17	Upperco	3/30/2021 10:46 AM
18	Timonium	3/30/2021 12:19 AM
19	Rosedale-Greenview Park	3/29/2021 9:19 PM
20	Rosedale	3/29/2021 7:06 PM
21	Baldwin	3/29/2021 7:06 PM
22	Kingdville	3/29/2021 6:11 PM
23	Essex	3/29/2021 5:16 PM
24	Cockeysville	3/29/2021 12:51 PM
25	Cockeysville	3/29/2021 11:51 AM
26	Catonsville	3/29/2021 11:50 AM
27	Essex	3/29/2021 11:49 AM
28	Towson	3/29/2021 11:48 AM
29	Cockeysville	3/29/2021 11:03 AM
30	Towson	3/29/2021 10:37 AM
31	Montgomery county MD	3/29/2021 10:36 AM
32	Mt. Washington/Pikesvillel	3/29/2021 10:28 AM
33	Idlewylde	3/22/2021 12:54 PM

34	Glen Arm	3/22/2021 9:32 AM
35	Perry Hall	3/13/2021 8:12 AM
36	Idlewylde	3/10/2021 4:29 PM
37	Ruxton Ridge/West Towson	3/10/2021 12:42 PM
38	Jacksonville	3/10/2021 12:41 PM
39	sparks	3/10/2021 8:25 AM
40	21209	3/10/2021 8:00 AM
41	Owings Mills	3/10/2021 7:25 AM
42	Edgemere	3/10/2021 12:05 AM
43	Catonsville	3/9/2021 6:30 PM
44	Middle River-White Marsh Estates	3/7/2021 10:29 AM
45	Fullerton	3/6/2021 1:33 PM
46	Cockeysville	3/5/2021 11:53 PM
47	Timonium	3/5/2021 9:40 PM
48	Dundalk	3/4/2021 6:55 PM
49	Longford	3/4/2021 9:32 AM
50	Dulaney Forest	3/4/2021 9:00 AM
51	Hunt Club	3/3/2021 8:29 PM
52	Cockeysville	3/3/2021 10:59 AM
53	Randallstown	3/3/2021 10:59 AM
54	21093	3/3/2021 9:49 AM
55	Parkville	3/3/2021 9:18 AM
56	Lutherville	3/3/2021 8:41 AM
57	Fountain Hill, Timonium	3/3/2021 8:26 AM
58	Towson	3/3/2021 2:51 AM
59	Owings Mills	3/2/2021 10:10 PM
60	Halethorpe	3/2/2021 10:04 PM
61	Hereford Zone	3/2/2021 9:50 PM
62	Dundalk	3/2/2021 9:43 PM
63	Carney	3/2/2021 6:53 PM
64	Towson	3/2/2021 6:28 PM
65	pickwick	3/2/2021 6:20 PM
66	Lutherville	3/2/2021 6:02 PM
67	Pot Spring	3/2/2021 5:35 PM
68	WHITE HALL	3/2/2021 5:10 PM
69	Woodbridge Valley	3/2/2021 4:36 PM
70	Cockeysville	3/2/2021 2:50 PM
71	Fullerton	3/2/2021 2:23 PM

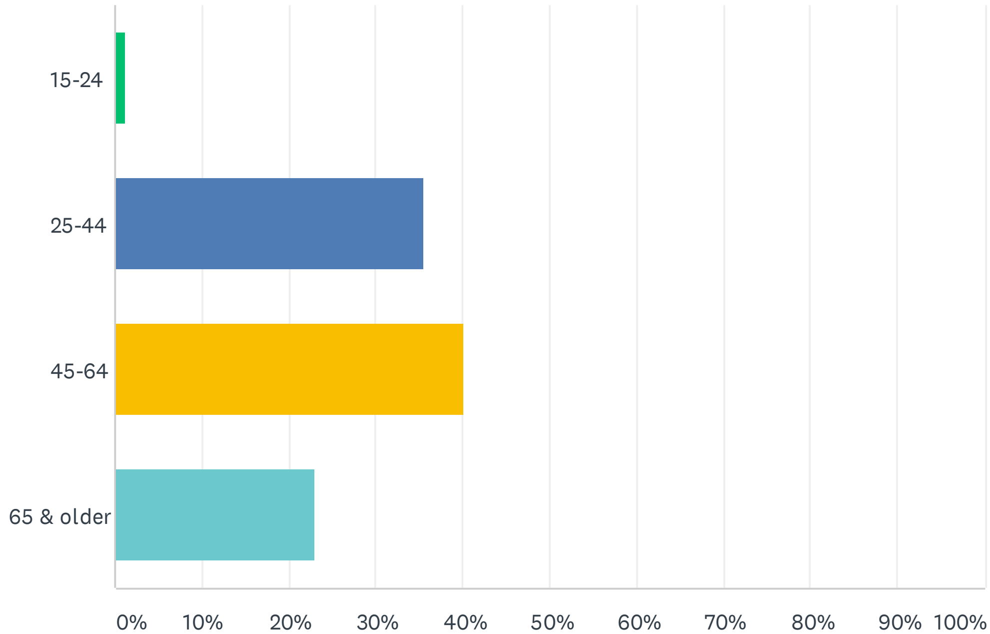
72	Perry Hall	3/2/2021 1:55 PM
73	Timonium	3/2/2021 1:51 PM
74	Pot Spring	3/2/2021 1:22 PM
75	Timonium	3/2/2021 1:13 PM
76	Edmondson Heights	3/2/2021 1:01 PM
77	Carney	3/2/2021 12:27 PM
78	Turner Station	3/2/2021 12:23 PM
79	Garrison	3/2/2021 12:19 PM
80	Timonium	3/2/2021 11:49 AM
81	Riderwood	3/2/2021 11:15 AM
82	Deertree apts. Cockeysville	3/2/2021 11:06 AM
83	Mays Chapel	3/2/2021 10:42 AM
84	Dulaney Village	3/2/2021 8:46 AM
85	Timonium / Spring Lake	3/2/2021 8:08 AM
86	Cockeysville	3/2/2021 7:39 AM
87	Cockeysville	3/1/2021 10:36 PM
88	Timonium	3/1/2021 9:56 PM
89	Timonium	3/1/2021 9:43 PM
90	Mays CHAPEL	3/1/2021 8:37 PM
91	Mays Chapel	3/1/2021 7:04 PM
92	Timonium	3/1/2021 6:37 PM
93	Cockeysville	3/1/2021 6:24 PM
94	Mays Chapel	3/1/2021 6:15 PM
95	Wellington Valley	3/1/2021 5:36 PM
96	Mays Chapel	3/1/2021 5:21 PM
97	Timonium	3/1/2021 5:17 PM
98	Lutherville	3/1/2021 5:17 PM
99	Cockeysville	3/1/2021 4:51 PM
100	Lutherville Timonium	3/1/2021 4:31 PM
101	Pot Spring	3/1/2021 4:29 PM
102	Lutherville	3/1/2021 4:27 PM
103	Strathmore	3/1/2021 4:11 PM
104	21220	3/1/2021 3:44 PM
105	Harford County	3/1/2021 8:16 AM
106	Dundalk	2/24/2021 9:45 AM
107	Catonsville	2/24/2021 5:18 AM
108	Owings Mills	2/23/2021 12:03 PM
109	Dundalk	2/23/2021 11:08 AM

110	Nottingham	2/23/2021 10:51 AM
111	White Hall	2/19/2021 10:53 PM
112	Abingdon	2/18/2021 12:10 AM
113	end of Windsor Mill Road	2/17/2021 3:20 PM
114	Lutherville	2/17/2021 7:09 AM
115	Towson	2/17/2021 12:04 AM
116	Hunt Valley	2/16/2021 9:09 PM
117	Arbutus	2/16/2021 9:03 PM
118	Villages of Winterset	2/16/2021 9:02 PM
119	upperco	2/16/2021 8:21 PM
120	Glen Arm	2/16/2021 8:19 PM
121	Chatterleigh	2/16/2021 7:47 PM
122	Lutherville	2/16/2021 7:33 PM
123	Reisterstown	2/16/2021 7:25 PM
124	Hampton	2/16/2021 7:25 PM
125	Timonium	2/16/2021 7:25 PM
126	Parkville	2/16/2021 7:07 PM
127	Windsor Mill	2/16/2021 6:55 PM
128	Dundalk	2/16/2021 6:54 PM
129	Parkton	2/16/2021 6:51 PM
130	Chippendale in Cub Hill	2/16/2021 6:47 PM
131	Rosedale	2/16/2021 6:45 PM
132	Middle River	2/16/2021 6:43 PM
133	Catonsville	2/16/2021 6:38 PM
134	Parkville	2/16/2021 6:37 PM
135	Glen arm	2/16/2021 5:20 PM
136	Middle River	2/16/2021 4:02 PM
137	Springlake (Timonium)	2/16/2021 3:50 PM
138	Baldwin	2/16/2021 3:38 PM
139	21222	2/16/2021 3:29 PM
140	Howard County	2/16/2021 3:15 PM
141	Carroll County	12/18/2020 1:56 PM
142	Harford County	12/18/2020 12:44 PM
143	Gaywood	12/18/2020 11:43 AM
144	Westminster/ Carroll County	12/18/2020 11:28 AM
145	Bowleys Quarters	12/18/2020 10:37 AM
146	Lutherville	12/14/2020 6:50 PM
147	Cumberland	12/1/2020 12:17 PM

148	Catonsville	11/25/2020 7:32 AM

Q3 In what age group do you belong?

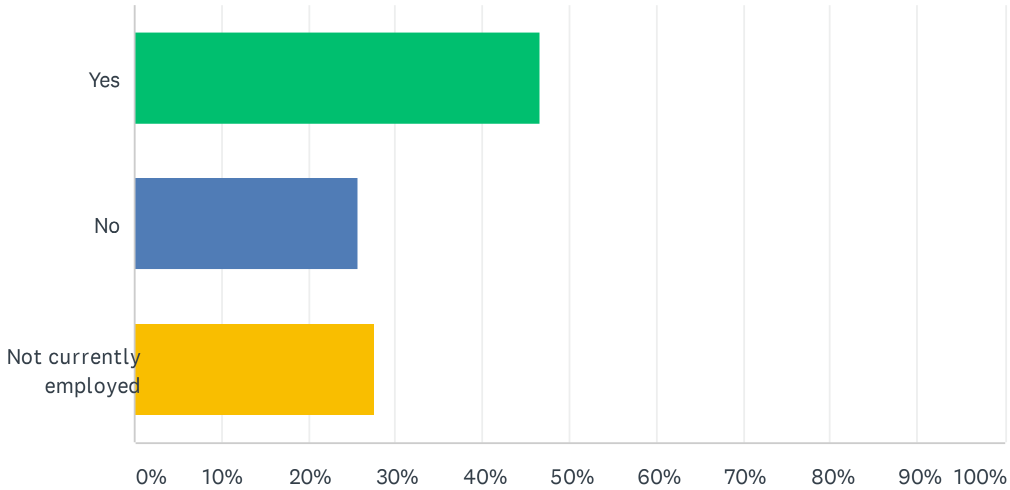
Answered: 152 Skipped: 0



ANSWER CHOICES	RESPONSES	
15-24	1.32%	2
25-44	35.53%	54
45-64	40.13%	61
65 & older	23.03%	35
TOTAL		152

Q4 Do you work in Baltimore County?

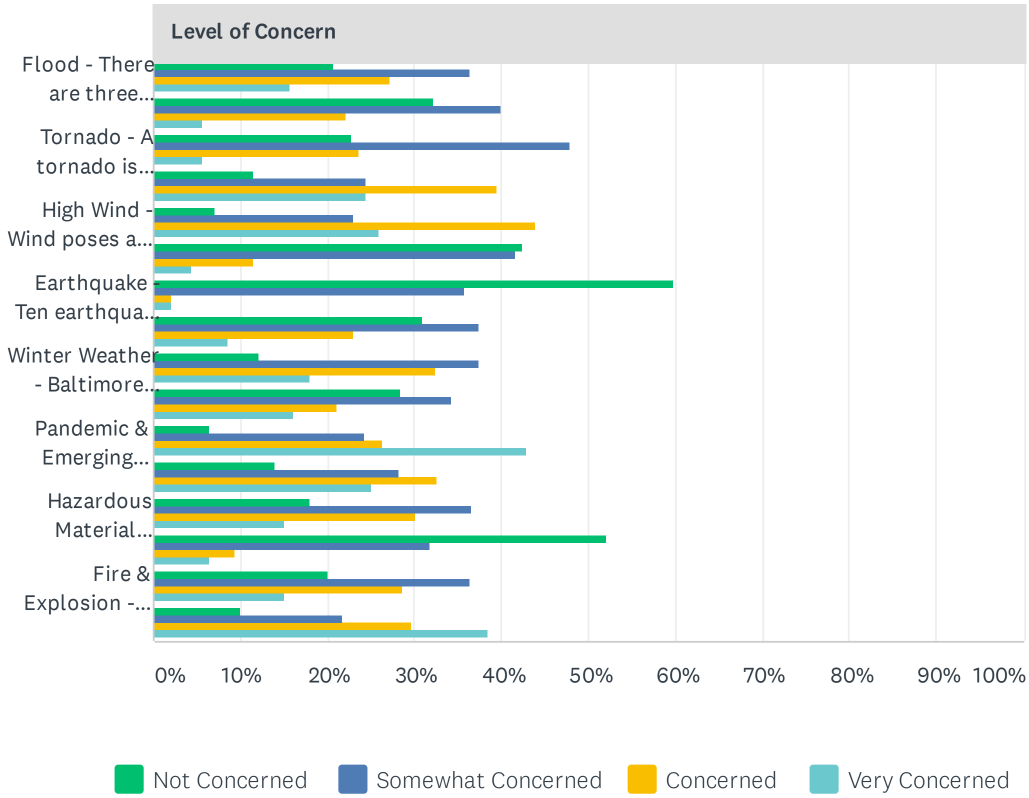
Answered: 152 Skipped: 0



ANSWER CHOICES	RESPONSES	
Yes	46.71%	71
No	25.66%	39
Not currently employed	27.63%	42
TOTAL		152

Q5 Please indicate your level of concern for each hazard.

Answered: 140 Skipped: 12



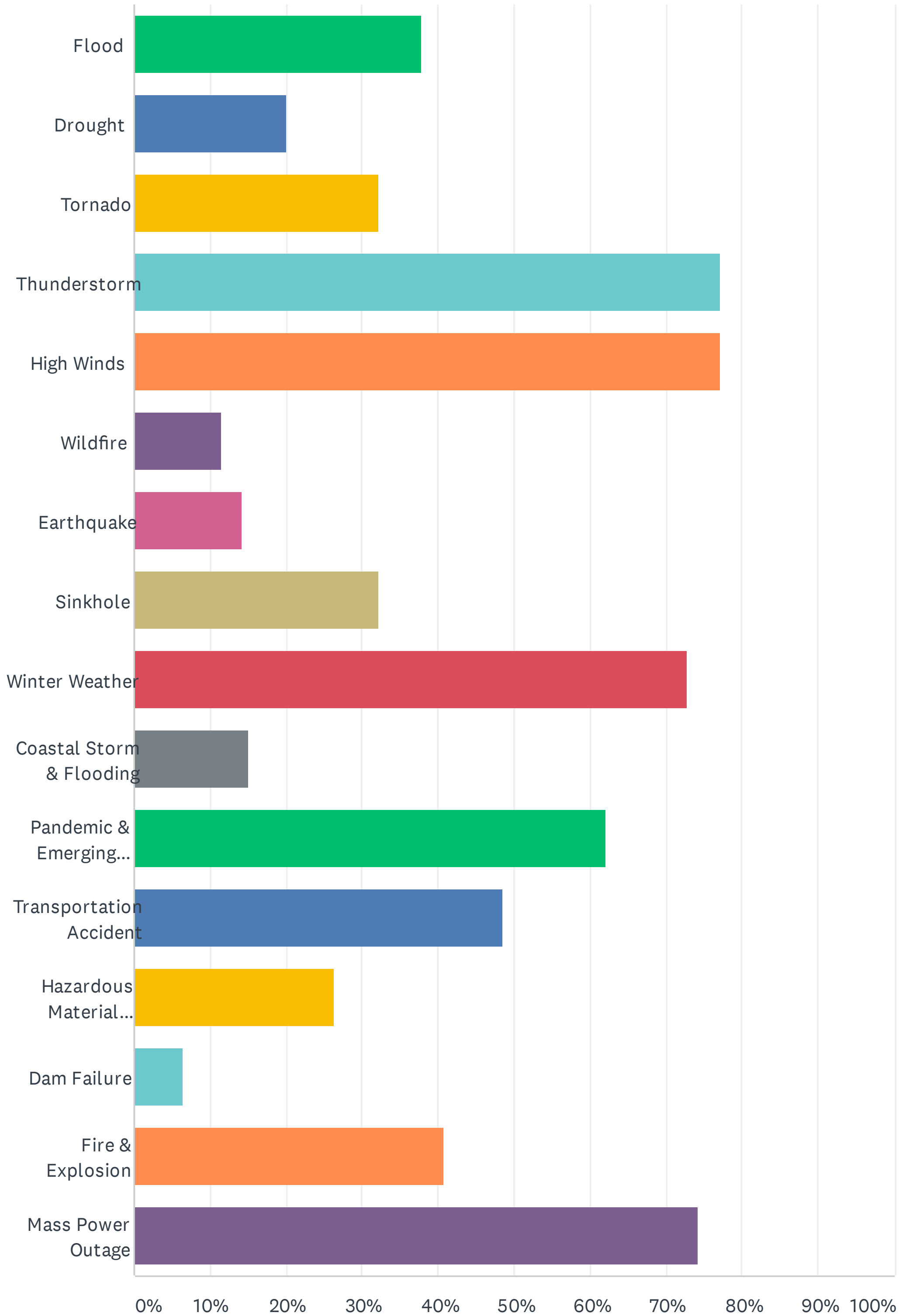
Level of Concern					
	NOT CONCERNED	SOMEWHAT CONCERNED	CONCERNED	VERY CONCERNED	TOTAL
Flood - There are three primary factors that contribute to flooding in Baltimore County: geography, climate, and soils. Baltimore County's geographic location in the mid-Atlantic region, with its coastal presence on the Chesapeake Bay, and its inland terrain, make the County susceptible to coastal, riverine, and flash flooding.	20.71% 29	36.43% 51	27.14% 38	15.71% 22	140
Drought - Drought has the potential to affect the environmental, economic, and social systems within Baltimore County. Residents, farms, and businesses need a constant, reliable supply of water, and a reduction in that supply will have physical and economic impacts. As the population in Baltimore County continues to grow, the demand for water will increase as more and more is consumed for residential, commercial, agricultural and industrial uses.	32.14% 45	40.00% 56	22.14% 31	5.71% 8	140
Tornado - A tornado is defined as a violently rotating column of air extending from a thunderstorm to the ground. A tornado can occur anywhere given the proper conditions. There are several types of areas that are particularly susceptible to high loss in the event of a tornado touchdown: mobile homes, high density housing, and structures built prior to 1940.	22.86% 32	47.86% 67	23.57% 33	5.71% 8	140
Thunderstorm - Thunderstorms are always accompanied by lightning and have the potential to cause damage via flooding, hail, strong winds, and tornadoes. Thunderstorms pose a threat to Baltimore County because they are always accompanied by some combination of the aforementioned.	11.51% 16	24.46% 34	39.57% 55	24.46% 34	139
High Wind - Wind poses a threat to Baltimore County in many forms, including winds produced by severe thunderstorms and tropical weather systems, such as hurricanes. The damaging effects of high wind can include blowing debris from trees and structures, interruptions to above ground power and communication systems, and intensified effects of winter weather.	7.19% 10	23.02% 32	43.88% 61	25.90% 36	139
Wildfire - Wildfires are a threat to Baltimore County for two primary reasons. First, the amount of development, particularly residential, that has taken place within wooded areas has increased the number of structures that are along the Wildland-Urban Interface (WUI) and within the Wildland-Urban Intermix. Second, wildfires have the ability to interact with other natural hazards, especially drought.	42.45% 59	41.73% 58	11.51% 16	4.32% 6	139
Earthquake - Ten earthquakes with epicenters in Baltimore County have been recorded starting in 1906. These were considered minor earthquakes and caused minimal property damage. Buildings and infrastructure most vulnerable to earthquake damage in Baltimore County are older structures built prior to the adoption of modern building codes.	59.85% 82	35.77% 49	2.19% 3	2.19% 3	137
Sinkhole - Baltimore County is well known for its Cockeysville Marble geologic formation, a carbonate	30.94% 43	37.41% 52	23.02% 32	8.63% 12	139

rock, characterized by its disrupted surface drainage due to loss of surface water to the subsurface. Areas that are underlain by this carbonate rock and others like it make Baltimore County susceptible to collapse sinkholes.					
Winter Weather - Baltimore County has a long history of winter weather events that have caused property loss, personal injury, and in some cases, fatalities. Winter weather most commonly takes the form of snowfall, but it can also take the form of freezing rain, sleet, or extreme cold.	12.23% 17	37.41% 52	32.37% 45	17.99% 25	139
Coastal Storm & Flooding - Baltimore County has approximately 175 miles of shoreline along the Patapsco, Back, Middle, and Gunpowder Rivers. This eastern coastal shoreline has been vulnerable to hurricanes and tropical systems. These storms have caused intense coastal flooding and shoreline erosion resulting in extensive loss of property, injuries, and even loss of life.	28.47% 39	34.31% 47	21.17% 29	16.06% 22	137
Pandemic & Emerging Infectious Disease - Pandemics happen when a new virus emerges to infect people and can spread between people sustainably. This hazard strains the healthcare system, requires school closures, causes high rates of illness.Previous events that exemplify this hazard include the 1918 Spanish flu, the 2003 SARS outbreak (which had pandemic potential), 2009 Swine flu influenza, and now COVID-19.	6.43% 9	24.29% 34	26.43% 37	42.86% 60	140
Transportation Accident - Includes both roadway and railway accidents.	14.07% 19	28.15% 38	32.59% 44	25.19% 34	135
Hazardous Material Incident - Hazardous materials are defined as any items or agents (biological, chemical, physical) which have the potential to cause harm to humans, animals, or the environment, either by themselves or through interaction with other factors. A hazardous material incident may occur via spilling, leaking, emission of toxic vapors, or any other process that enables the material to escape its container, enter the environment, and create a potential hazard.	17.99% 25	36.69% 51	30.22% 42	15.11% 21	139
Dam Failure - Baltimore County may be affected by the failure of five high hazard dams, all of which are located within or on the border of Baltimore County. However, there is no record of a high hazard dam failure in Baltimore County. In addition to these five dams, there are fifteen significant and low risk dams located within the County.	52.17% 72	31.88% 44	9.42% 13	6.52% 9	138
Fire & Explosion - Each year people are injured at home or work by flammable substances accidentally catching fire or exploding. In some cases, household hazards are caused by relatively harmless chemicals, such as ammonia and bleach, being mixed together to create dangerous gases. In the workplace, activities which involve using or creating chemicals, vapors, liquids, gases, solids or dusts that can readily burn or explode is hazardous.	20.00% 28	36.43% 51	28.57% 40	15.00% 21	140
Mass Power Outage - Baltimore County is serviced by the Baltimore Gas and Electric Company (BGE). Presently, BGE serves roughly 362,334 residents within the County. In general, smaller power outages	10.14% 14	21.74% 30	29.71% 41	38.41% 53	138

caused by adverse weather and minor storms are most likely to occur. However, major storms and severe-impact storms, such as Hurricane Isabel in 2003, are still a possibility and have a likelihood of occurring about once every year.					

Q6 Please choose from the below list to indicate which hazard events you feel may particularly affect your community. (Please check all that apply.)

Answered: 140   Skipped: 12



ANSWER CHOICES	RESPONSES	
Flood	37.86%	53
Drought	20.00%	28
Tornado	32.14%	45
Thunderstorm	77.14%	108
High Winds	77.14%	108
Wildfire	11.43%	16
Earthquake	14.29%	20
Sinkhole	32.14%	45
Winter Weather	72.86%	102
Coastal Storm & Flooding	15.00%	21
Pandemic & Emerging Infectious Disease	62.14%	87
Transportation Accident	48.57%	68
Hazardous Material Incident	26.43%	37
Dam Failure	6.43%	9
Fire & Explosion	40.71%	57
Mass Power Outage	74.29%	104
Total Respondents: 140		

Q7 Are you concerned with any other hazards not identified in this survey?

Answered: 83 Skipped: 69

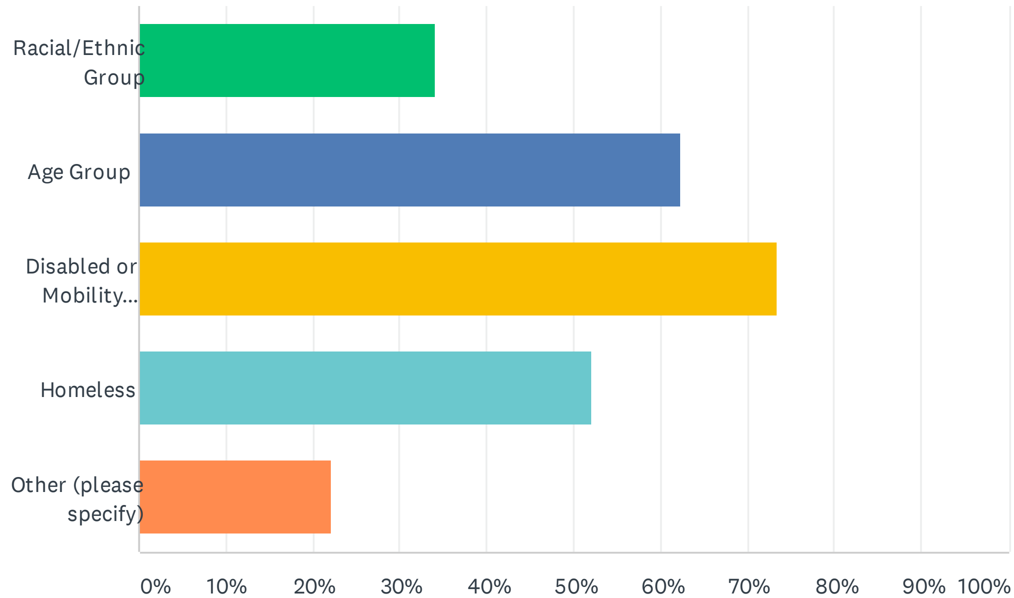
#	RESPONSES	DATE
1	No	5/13/2021 2:26 PM
2	Water pipe failure, loss of water access	5/10/2021 1:02 PM
3	Gun Violence / School Shootings	5/10/2021 12:09 PM
4	Drinking water interruption	5/10/2021 10:42 AM
5	Cybersecurity failures, particularly impacting local schools.	5/10/2021 10:19 AM
6	mosquitoes carrying disease; mice and rat infestation	5/7/2021 3:08 PM
7	83 Noise pollution from semi air brakes that rattle my home @ ~100 yards away	5/3/2021 11:12 AM
8	Winter storms are mention however ice storms with their effect on the electric grid are a particular concern for well dependent communities.	4/10/2021 10:50 AM
9	No	3/30/2021 11:23 PM
10	Not at this time.	3/30/2021 1:57 PM
11	No	3/30/2021 12:21 AM
12	No	3/29/2021 7:10 PM
13	Traffic	3/29/2021 5:24 PM
14	Mass shooting preparedness	3/29/2021 11:51 AM
15	Air quality problems (similar to the clouds of pollution that waft into Japan/Korea from China)	3/29/2021 11:11 AM
16	No	3/29/2021 10:39 AM
17	Major water main breaks. The underground infrastructure in my neighborhood (half city, half county) is very old.	3/29/2021 10:38 AM
18	No	3/22/2021 12:56 PM
19	Extreme heat	3/13/2021 8:15 AM
20	Excessive heat	3/10/2021 4:30 PM
21	hurricanes	3/10/2021 8:27 AM
22	Local white supremacist national groups committing acts of terrorism targeting govt, individuals, groups or community institution eg houses of worship	3/10/2021 8:08 AM
23	No	3/10/2021 7:26 AM
24	No	3/10/2021 12:09 AM
25	Chemtrails in our area--what are they and how do they originate? Is this causing damage to the trees in particular?	3/7/2021 10:38 AM
26	No	3/4/2021 9:34 AM
27	terrorist activity given our proximity to Washington DC	3/4/2021 9:04 AM
28	Overdevelopment ruining natural habitats, causing flooding, and affecting traffic increasing traffic incidents.	3/3/2021 9:52 AM
29	invasive insects affecting agriculture, plants, trees in Baltimore County and daily life that may be particularly destructive-murder hornets for example.	3/3/2021 9:25 AM

30	Cyber attacks on critical infrastructure and/or government services.	3/3/2021 2:53 AM
31	no	3/2/2021 10:14 PM
32	Affects of the tremendous amounts of road salt applied to north county roads during winter weather and the affects it will have on our well water.	3/2/2021 9:55 PM
33	Transportation is due to our close proximity to the port of Baltimore which could cause a domino effect event should an accident there occur. Ecological disaster as well, but are,of course, caused by a primary event.	3/2/2021 9:52 PM
34	Mass water service outage	3/2/2021 6:56 PM
35	Water pollution. Mass casualty terrorism event.	3/2/2021 6:31 PM
36	No	3/2/2021 6:07 PM
37	no	3/2/2021 5:40 PM
38	no	3/2/2021 5:14 PM
39	Loss of tree canopy-increased air pollution Erosion due to poor stream and storm water management	3/2/2021 2:29 PM
40	The current service delivery model for technical rescue response, as well as the lack of a minimum staffing standard for trained personnel.	3/2/2021 1:26 PM
41	Over use of lawn care chemicals and services. Lack of any storm water management such as cisterns.	3/2/2021 1:08 PM
42	None	3/2/2021 12:28 PM
43	No	3/2/2021 11:51 AM
44	protecting drinking water	3/2/2021 11:19 AM
45	No	3/2/2021 11:14 AM
46	High Taxes caused by inept politicians and wasteful spending.	3/2/2021 10:46 AM
47	No	3/2/2021 8:48 AM
48	Crime	3/2/2021 7:42 AM
49	Non commercial fertilizers and pesticides	3/1/2021 6:40 PM
50	No	3/1/2021 5:38 PM
51	Handicapped/elderly need special attention/consideration especially in a disaster.	3/1/2021 5:26 PM
52	Crimes against citizens. Noise pollution.	3/1/2021 5:23 PM
53	Influx of families living in small homes, with way too many people living in each home, cause for concern for the small children that live there, particularly in basement bedrooms with no escape due to fire.	3/1/2021 4:57 PM
54	No	3/1/2021 4:29 PM
55	no	3/1/2021 4:15 PM
56	No.	2/24/2021 9:46 AM
57	Domestic terrorism and hate-based violence.	2/23/2021 12:07 PM
58	No	2/19/2021 10:55 PM
59	Technological/man-made	2/18/2021 12:12 AM
60	Public Uprising, Violence	2/17/2021 3:31 PM
61	No	2/17/2021 7:10 AM
62	No	2/17/2021 12:06 AM
63	Uncontrolled, widespread civil unrest. Massive power outages caused by terrorism—ie Ted	2/16/2021 9:20 PM

	Koppel's book Lights Out.	
64	crime	2/16/2021 8:27 PM
65	Water quality from farm runoff	2/16/2021 8:24 PM
66	None	2/16/2021 7:50 PM
67	No	2/16/2021 7:27 PM
68	Ordinary citizens unprepared for any kind of serious event or disaster waiting for the government to take care of every little problem, like leaky pipes.	2/16/2021 7:14 PM
69	Tsunami	2/16/2021 6:57 PM
70	No	2/16/2021 6:56 PM
71	Aliens	2/16/2021 6:55 PM
72	No	2/16/2021 6:47 PM
73	No	2/16/2021 6:41 PM
74	Social unrest, terrorist attack (domestic and foreign)	2/16/2021 6:40 PM
75	Nope	2/16/2021 5:22 PM
76	Rabid wildlife	2/16/2021 3:41 PM
77	Active threat - extreme heat	2/16/2021 3:17 PM
78	no	12/18/2020 1:58 PM
79	No	12/18/2020 12:50 PM
80	No	12/18/2020 11:30 AM
81	n/a	12/14/2020 6:51 PM
82	No.	12/1/2020 12:34 PM
83	No	11/25/2020 7:36 AM

Q8 Please indicate the group(s) on which you based your answer, if it is listed, or describe it in the box below. (The listed groups are only meant to serve as initial ideas.)

Answered: 117 Skipped: 35



ANSWER CHOICES	RESPONSES	
Racial/Ethnic Group	34.19%	40
Age Group	62.39%	73
Disabled or Mobility Impaired/Medically Dependent	73.50%	86
Homeless	52.14%	61
Other (please specify)	22.22%	26
Total Respondents: 117		

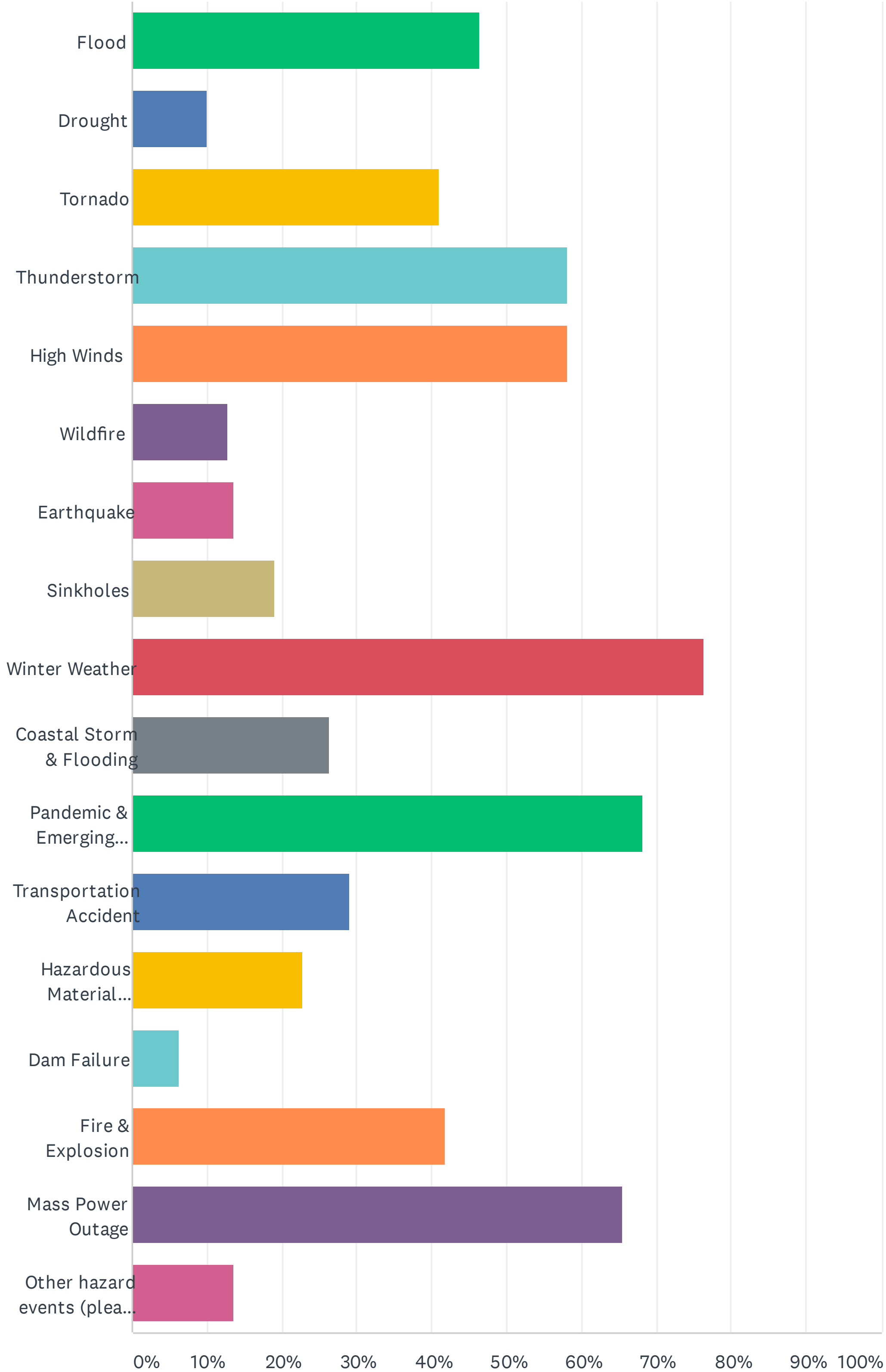
#	OTHER (PLEASE SPECIFY)	DATE
1	Mobile home owners	3/30/2021 1:58 PM
2	Citizen	3/10/2021 7:27 AM
3	Stop with the identity politics. ALL citizens are equally important. Until you understand that, things will not improve.	3/5/2021 9:44 PM
4	No specific group, residents in general.	3/3/2021 9:53 AM
5	everyone not listed above, if it can affect one group it can affect all.	3/3/2021 9:27 AM
6	This question is irrelevant	3/3/2021 8:42 AM
7	All groups are effected Mother Nature is not choosy	3/2/2021 10:18 PM
8	Not applicable	3/2/2021 9:56 PM
9	Those people without technology such as smartphones or computers to stay in touch with	3/2/2021 9:54 PM

	emergency notifications.	
10	We are all at risk-the environment does not discriminate	3/2/2021 2:31 PM
11	All citizens of, and visitors to Baltimore County.	3/2/2021 1:27 PM
12	Any type of group quarters: jail, nursing home, assisted living, dorms	3/2/2021 11:22 AM
13	None	3/2/2021 11:15 AM
14	Society at large	3/2/2021 7:43 AM
15	Low income groups	3/1/2021 6:42 PM
16	People in Mays Chapel	3/1/2021 6:19 PM
17	small children and elderly	3/1/2021 4:59 PM
18	Elderly	2/18/2021 12:14 AM
19	SR citizens	2/16/2021 8:28 PM
20	Children	2/16/2021 6:58 PM
21	No	2/16/2021 6:57 PM
22	Those for whom English is a second language	2/16/2021 6:43 PM
23	Low income	2/16/2021 3:42 PM
24	none	12/18/2020 1:59 PM
25	Home owners in an flood plain	12/18/2020 11:32 AM
26	CDC Social Vulnerability Index	11/25/2020 7:38 AM

Q9 Based on the group(s) you have selected in the previous question, please select which hazard events you feel may particularly affect those group? (Multiple options may be chosen.)

Answered: 110 Skipped: 42

Baltimore County Hazard Mitigation Plan Public Survey



ANSWER CHOICES	RESPONSES	
Flood	46.36%	51
Drought	10.00%	11
Tornado	40.91%	45
Thunderstorm	58.18%	64
High Winds	58.18%	64
Wildfire	12.73%	14
Earthquake	13.64%	15
Sinkholes	19.09%	21
Winter Weather	76.36%	84
Coastal Storm & Flooding	26.36%	29
Pandemic & Emerging Infectious Disease	68.18%	75
Transportation Accident	29.09%	32
Hazardous Material Incident	22.73%	25
Dam Failure	6.36%	7
Fire & Explosion	41.82%	46
Mass Power Outage	65.45%	72
Other hazard events (please describe)	13.64%	15
Total Respondents: 110		

#	OTHER HAZARD EVENTS (PLEASE DESCRIBE)	DATE
1	All of the above occurring in neighboring jurisdictions, too. Vulnerable groups are also subject to hazards befalling the City. A flood in Mt Washington makes it difficult for County residents to get to important services.	3/29/2021 10:42 AM
2	White nationalist terror event	3/10/2021 8:11 AM
3	invasive insects	3/3/2021 9:27 AM
4	All groups are effected Mother Nature is not choosy	3/2/2021 10:18 PM
5	None	3/2/2021 9:56 PM
6	all	3/2/2021 2:31 PM
7	The biggest impact is due to lack of mobility or financial means to respond	3/2/2021 11:22 AM
8	Stupid politicians that come up with REDICULOUS surveys. How do you plan to stop a sink hole?	3/2/2021 10:50 AM
9	Crime	3/2/2021 7:43 AM
10	City chemical accidents	2/24/2021 5:31 AM
11	Technological/Man-made	2/18/2021 12:14 AM
12	Everything affects marginalized or at-risk groups (disabled, elderly) more.	2/16/2021 7:28 PM
13	Aliens	2/16/2021 6:56 PM

14	Test	12/1/2020 12:35 PM
15	Summer heat exposure	11/25/2020 7:38 AM

APPENDIX G:
FEDERAL AND STATE
GRANT FUNDING SOURCES

Federal & State Grant Funding Sources

The following is a list of Federal and State Grants that may assist in implementing local Hazard Mitigation Plans. This information is subject to change at any time; contact the federal or state agency for current grant status.

Grant Program Name	Address and Telephone Contact Information	Eligible Activities	Federal, State and Local Cost Share Requirements	Other Program Characteristics	Grant Application Due Date
Federal Emergency Management Agency, Hazard Mitigation Grant Program (HMGP)	Maryland Emergency Management Agency 5401Rue Saint Lo Drive Reisterstown, MD 21401	Flood Proofing, acquisition and relocation of flood prone properties, wind resistant or retrofit, stormwater improvements, education and awareness, All Hazards Mitigation Planning. Acquisition, relocation, elevation and flood-proofing of flood-prone insured properties, flood mitigation planning.	Federal - 75% State - 12.5% Local - 12.5%	Local government must be in compliance with the National Flood Insurance Program to be eligible. Projects must be cost effective, environmentally sound and solve a problem. Repetitive loss properties are a high priority.	After a Presidential Disaster Declaration
Federal Emergency Management Agency, Hazard Mitigation Grant Program (HMGP)	Maryland Emergency Management Agency 5401Rue Saint Lo Drive Reisterstown, MD 21401	Grants can be used for management costs, information dissemination, planning, technical assistance and mitigation projects.	Federal - 75% Local - 25%	Local governments must be in compliance with the National Flood Insurance Program to be eligible. Projects must be environmentally sound and cost effective.	TBD
Federal Emergency Management Agency, Hazard Mitigation Grant Program (HMGP)	Maryland Emergency Management Agency 5401Rue Saint Lo Drive Reisterstown, MD 21401	Repair of Infrastructure damaged during a flood that results in a Presidential disaster declaration. Cost effective mitigation measures may be eligible during the repair of damaged facilities.	Federal - 75% State - 12.5% Local - 12.5%	Available for public assets: roads, government buildings, bridges, etc.	After a Presidential Disaster Declaration

Grant Program Name	Address and Telephone Contact Information	Eligible Activities	Federal, State and Local Cost Share Requirements	Other Program Characteristics	Grant Application Due Date
Federal Emergency Management Agency, Pre Disaster Mitigation Grant Program (PDM)	Maryland Emergency Management Agency 5401Rue Saint Lo Drive Reisterstown, MD 21401	Funding these plans and projects reduces overall risks to the population and structures, while also reducing reliance on funding from actual disaster declarations.	Federal - 75% Non Federal - 25%	PDM grants are to be awarded on a competitive basis and without reference to state allocations, quotas, or other formula-based allocation of funds.	TBD
Federal Emergency Management Agency, Flood Mitigation Assistance Program (FMA)	Maryland Emergency Management Agency 5401Rue Saint Lo Drive Reisterstown, MD 21401	Assist States and communities to implement measures that reduce or eliminate the long-term risk of flood damage to buildings, manufactured homes, and other structures insured under the National Flood Insurance Program.	Federal - 75% Non Federal - 25%	Available once a Flood Mitigation Plan has been developed and approved by FEMA.	TBD
National Flood Insurance Program (NFIP)	Maryland Emergency Management Agency 5401Rue Saint Lo Drive Reisterstown, MD 21401	Provides financial protection by enabling persons to purchase insurance against floods, mudslide or flood related erosion.	Varies	Includes Federally backed insurance against flooding, available to individuals and businesses that participate in the NFIP	Anytime
Economic Development Administration, Economic Adjustment Program	U.S. Department of Commerce Economic Development Administration Curtis Center, Suite 140 South Independence Square West Philadelphia, PA 19106-3821 215-597-4603	Improvements and reconstruction of public facilities after a disaster or industry closing. Research studies designed to facilitate economic development.	Federal - 50%-70% Local- 30%-50%	Documenting economic distress, job impact and proposing a project that is consistent with a Comprehensive Economic Development Strategy are important funding selection criteria.	Anytime

Grant Program Name	Address and Telephone Contact Information	Eligible Activities	Federal, State and Local Cost Share Requirements	Other Program Characteristics	Grant Application Due Date
Economic Development Administration, Public Works and Development Facilities	U.S. Department of Commerce Economic Development Administration Curtis Center, Suite 140 South Independence Square West Philadelphia, PA 19106-3821 215-597-4603	Water and sewer, Industrial access roads, rail spurs, port improvements technological and related infrastructure	Federal - 50%-70% Local- 30%-50%	Documenting economic distress, job impact and projects that is consistency with a Comprehensive Economic Development Strategy are important funding selection criteria.	Anytime
Small Business Administration (SBA) Pre-disaster Mitigation Loan Program	Herbert L. Mitchell, Office of Disaster Assistance, Small Business Administration, 409 3rd Street, SW, Washington, DC 20415;202-205-6734	Activities done for the purpose of protecting real and personal property against disaster related damage.	No information	The mitigation measures must protect property or contents from damage that may be caused by future disasters and must conform to the priorities and goals of the state or local government's mitigation plan.	Anytime
Community Development Block Grants / Entitlement Grants	Office of Block Grant Assistance, 451 Seventy Street SW., Washington, DC 20410-7000;202-708-3587	Used for long-term recovery needs, such as: rehabilitation residential and commercial building; homeownership assistance, including down-payment assistance and interest rate subsidies; building new replacement housing; code enforcement; acquiring, construction, or reconstructing public facilities.	No information	Citizen participation procedures must be followed. At least 70 percent of funds must be used for activities that principally benefit persons of low and moderate income. Formula grants to entitlement communities.	After a Presidential Disaster Declaration

Grant Program Name	Address and Telephone Contact Information	Eligible Activities	Federal, State and Local Cost Share Requirements	Other Program Characteristics	Grant Application Due Date
Community Development Block Grants / States Program	Office of Block Grant Assistance, 451 Seventy Street SW., Washington, DC 20410-7000;202-708-3587	Used for long-term recovery needs, such as: rehabilitation residential and commercial building; homeownership assistance, including down-payment assistance and interest rate subsidies; building new replacement housing; code enforcement; acquiring, construction, or reconstructing public facilities.	No information	Citizen participation procedures must be followed. At least 70 percent of funds must be used for activities that principally benefit persons of low and moderate income. Formula grants to States for non-entitlement communities.	After a Presidential Disaster Declaration
Fire Suppression Assistance Program	Infrastructure Division, Response and Recovery Directorate, FEMA, 500 C Street SW., Washington DC 20472 ; 202-646-4240.	Provides real-time assistance for the suppression of any fire on public (non-Federal) or privately owned forest or grassland that threatens to become a major disaster.	Federal - 70% Local - 30%	The State must first meet annual floor cost (f percent of average fiscal year fire costs) on a single declared fire. After the State's out-of-pocket expenses exceed twice the average fiscal year costs, funds are made available for 100 percent of all costs for each declared fire.	Funds form President's Disaster Relief Fund for use in a designated emergency or major disaster area.
Historic Preservation: Repair and Restoration of Disaster-Damaged Historic Properties	Infrastructure Division, Response and Recovery Directorate, FEMA, 500 C Street SW., Washington DC 20472 ; 202-646-4621.	To evaluate the effects of repairs to, restoration of, or mitigation hazards to disaster-damaged historic structures working in concert with the requirements of the Stafford Act.	Federal - 75% Local - 25%	Eligible to State and local governments, and any political subdivision of a State. Also, eligible are private non-profit organizations that operate educational, utility, emergency, or medical facilities.	After a Presidential Disaster Declaration
Transportation: Emergency Relief Program	Director, Office of Program Administration, FHWA, DOT, 400 Seventh Street SW., Washington, DC 20590; 202-366-0450	Provides aid for the repair of Federal-aid roads and roads on Federal lands.	Federal - 100%	Application is submitted by the State department of transportation for damages to Federal-aid highway routes, and by the applicable Federal agency for damages to roads on Federal lands.	After serious damage to Federal-aid roads or roads on Federal lands caused by a natural disaster or by catastrophic failure.

Grant Program Name	Address and Telephone Contact Information	Eligible Activities	Federal, State and Local Cost Share Requirements	Other Program Characteristics	Grant Application Due Date
Animals: Emergency Haying and Grazing	Emergency and Non-insured Assistance Programs, FSA, USDA, P.O. Box 2415, Washington, DC 20013; 202-720-4053	To help livestock producers in approved counties when the growth and yield of hay and pasture have been substantially reduced because of a widespread natural disaster.	No information	Assistance is provided by the Secretary of Agriculture to harvest hay or graze cropland or other commercial use of forage devoted to the Conservation Reserve Program (CRP0 in response to a drought or other similar emergency.	Anytime
Emergency Watershed Protection Program	Natural Resources Conservation Service 14th and Independence Avenue, SW Washington, DC 20250	Implementing emergency recovery measures for runoff retardation and erosion prevention to relieve imminent hazards to life and property created by a natural disaster that causes a sudden impairment of a watershed.	Federal - 75% Local - 25%	It cannot fund operation and maintenance work or repair private or public transportation facilities or utilities. The work cannot adversely affect downstream water rights and funds cannot be used to install measures not essential to the reduction of hazards.	TBD
Watershed Protection and Flood Prevention Program	Natural Resources Conservation Service 14th and Independence Avenue, SW Washington, DC 20250	To provide technical and financial assistance in carrying out works of improvement to protect, develop, and utilize the land and water resources in watersheds.	Varies due to project type.	Watershed area must not exceed 250,000 acres. Capacity of a single structure is limited to 25,000 acre-feet of total capacity and 12,500 acre-feet of floodwater detention capacity.	TBD
Watershed Surveys and Planning	Natural Resources Conservation Service 14th and Independence Avenue, SW Washington, DC 20250	To provide planning assistance to Federal, State, and local agencies for the development of coordinated water and related programs in watersheds and river basins. Emphasis is on flood damage reduction, erosion control, water conservation, preservation of wetlands and water quality improvements.	No information	These watershed plans form the basis for installing needed works of improvement and include estimated benefits and costs, cost-sharing, operation and maintenance arrangements, and other information necessary to justify the need for Federal assistance in carrying out the plan.	Anytime

Grant Program Name	Address and Telephone Contact Information	Eligible Activities	Federal, State and Local Cost Share Requirements	Other Program Characteristics	Grant Application Due Date
Emergency Advance Measures for Flood Prevention	USACE Washington DC 20314; 202-761-4561	To perform activities prior to flooding or flood fight that would assist in protecting against loss of life and damages to property due to flooding.	No information	There must be an immediate threat of unusual flooding present before advance measures can be considered. Any work performed under this program will be temporary in nature and must have a favorable benefit cost ratio.	TBD
Emergency Streambank and Shoreline Protection	USACE Washington DC 20314; 202-761-4561	Authorizes the construction of emergency streambank protection measures to prevent damage to highways, bridge approaches, municipal water supply systems, sewage disposal plants, and other essential public works facilities endangered by floods or storms due to bank erosion.	No information	Churches, hospitals, schools, and other non-profit service facilities may also be protected under this program. This authority does not apply to privately-owned property or structures.	TBD
Small Flood Control Projects	USACE Washington DC 20314; 202-761-4561	Authorizes the construction of small flood control projects that have not already been specifically authorized by Congress.	No information	There are two general categories of projects: structural and nonstructural. Structural projects may include levees, floodwalls, diversion channels, pumping plants, and bridge modifications. Nonstructural projects have little or no effect on water surface elevations, and may include flood proofing, the relocation of structures, and flood warning systems.	TBD
Flood: Emergency Advance Measures for Flood Prevention	USACE Washington DC 20314; 202-761-4561	To mitigate, before an event, the potential loss of life and damages to property due to floods.	No information	Assistance may consist of temporary levees, channel cleaning, preparation for abnormal snowpacks, etc.	Anytime

Grant Program Name	Address and Telephone Contact Information	Eligible Activities	Federal, State and Local Cost Share Requirements	Other Program Characteristics	Grant Application Due Date
Continuing Authorities Program (CAP)	USACE Washington DC 20314; 202-761-4561	Initiates a short reconnaissance effort to determine Federal interest in proceeding. If there is interest, a feasibility study is preformed.	Federal - 65% Local- 35%	A local sponsor must identify the problem and request assistance. Small flood control projects are also available.	Anytime
Hazardous Materials: State Access to the Oil Spill Liability Trust Fund	Director, USCG National Pollution Funds Center, Suite 1000, 4200 Wilson Boulevard, Arlington, VA 22203-1804; 202-493-6700.	To encourage greater State participation in response to actual or threatened discharges of oil.	No information	Eligible to States and U.S. Trust Territories and possessions.	Anytime
Emergency Management Assistance (EMA)	Maryland Emergency Management Agency 5401Rue Saint Lo Drive Reisterstown, MD 21401	Funds may be used for salaries, travel expenses, and other administrative cost essential to the day-to-day operations of State and Local emergency management agencies. Program also includes management processes that ensure coordinated planning, accountability for progress, and trained qualified staffing.	Federal - 50%	EMA funded activities may include specific mitigation management efforts not otherwise eligible for Federal funding. Management Assistance program funds may not be used for construction, repairs, equipment, materials or physical operations required for damage mitigation projects for public or private buildings, roads, bridges, or other facilities.	Anytime
Community Assistance Program, State Support Services Element (CAP-SSSE)	CFDA Number: 97.023	Entering Floodplain Management Data into the Community Information System (CIS) (Required), Strategic Planning, Ordinance Assistance, CAP GAP Analysis, Community Assistance Visits and Community Assistance Contacts (Required), etc.	Local - 25%	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.	No information

Grant Program Name	Address and Telephone Contact Information	Eligible Activities	Federal, State and Local Cost Share Requirements	Other Program Characteristics	Grant Application Due Date
Cooperating Technical Partners	CFDA Number: 97.045	Flood Hazard Mapping products	Federal - 100%	Provides technical assistance, training, and/or data to support flood hazard data development activities.	TBD
Map Modernization Management Support	CFDA Number: 97.070	Community outreach on Flood Mapping	Federal - 100%	Provides funding to supplement, not supplant, ongoing flood hazard mapping management efforts by the local, regional, or State agencies.	TBD
National Dam Safety Program	CFDA Number: 97.041	Dam safety training for state personnel, increase in the number of dam inspections, Emergency Action Plans, etc.	No information	Provides financial assistance to the states for strengthening their dam safety programs.	Anytime
Assistant to Firefighters Grant	Source: U.S. Fire Administration CFDA Number: 97.044	Vehicles, safety equipment, protective equipment, etc.	Federal Grant Funds match depended upon population served by Fire Departments and nonaffiliated EMS organizations	Provides assistance to local fire department to protect citizens and firefighters against the effects of fire and fire-related incidents	Annually in September projects are due.
Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)	CFDA Number: 97.023	Clean-up of Superfund Sites	Federal - 100%	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.	TBD

Grant Program Name	Address and Telephone Contact Information	Eligible Activities	Federal, State and Local Cost Share Requirements	Other Program Characteristics	Grant Application Due Date
Homeland Security Grant Program (HSGP)	CFDA Number: 97.067	Planning, organization, equipment, training, and exercise needs at the state and local levels to prevent, protect against, respond to, and recover from acts of terrorism and other catastrophic events	Federal - Up to 75% State - at least 25%	Enhances the capacity of State and local emergency responders to prevent, respond to, and recover from a weapon of mass destruction (WMD) terrorism incident involving chemical, biological, radiological, nuclear, and explosive (CBRNE) devices and cyber attacks.	TBD
State Fire Training System Grants	Source: U.S. Fire Administration CFDA Number: 97.043	Provide support for the Nation's 50 State Fire Training Systems in delivering training and education programs to the Nation's fire and emergency services personnel.	Not Available	Provide financial assistance to State Fire Training Systems for the delivery of a variety of National Fire Academy (NFA) courses/programs.	Annually in August
Superfund Amendments and Reauthorization Act	CFDA Number: 97.020	Training in emergency planning, preparedness, mitigation, response, and recovery capabilities associated with hazardous chemicals.	Federal - no more than 80% Non-Federal - at least 20%	Individuals who would be eligible for this training include public officials, fire and police personnel, medical personnel, first responders, and other tribal response and planning personnel	TBD

APPENDIX H:
HAZARD MITIGATION PLANNING COMMITTEE MEETING NOTES

BALTIMORE COUNTY, MARYLAND

HAZARD MITIGATION PLAN

HMP Stakeholder Meeting #1
November 24, 2020
10:00 AM

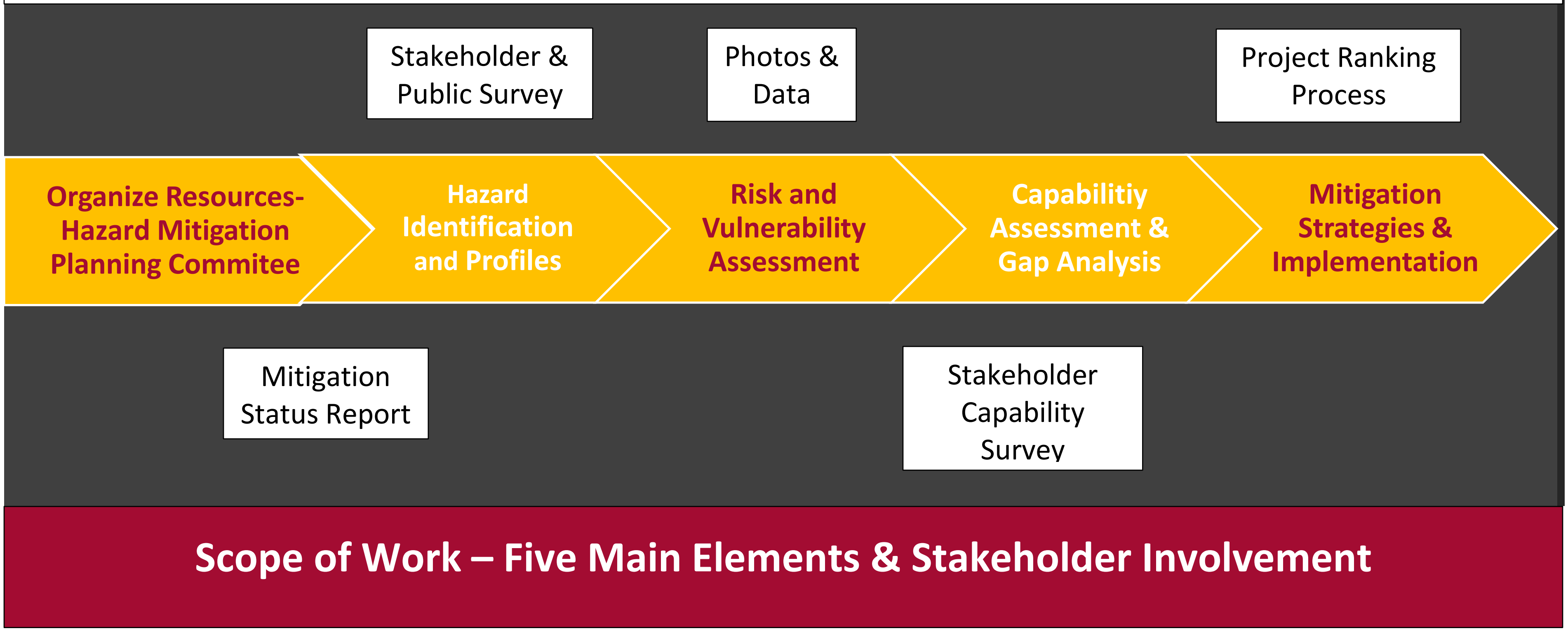
Agenda:

- Hazard Mitigation Plan (HMP) Project Overview
- Planning Project Timeline
- 2015 Hazard Identification & Risk Assessment Results
- Public Survey
  - Community Perspective – HMPC Stakeholder Results
  - Public Survey Available – TBD
- Website Preview
- Mitigation Status Report Fillable PDF
- Data & Photo Request
- Next Meeting Date – End of January 2021

HMP Committee Members in attendance:

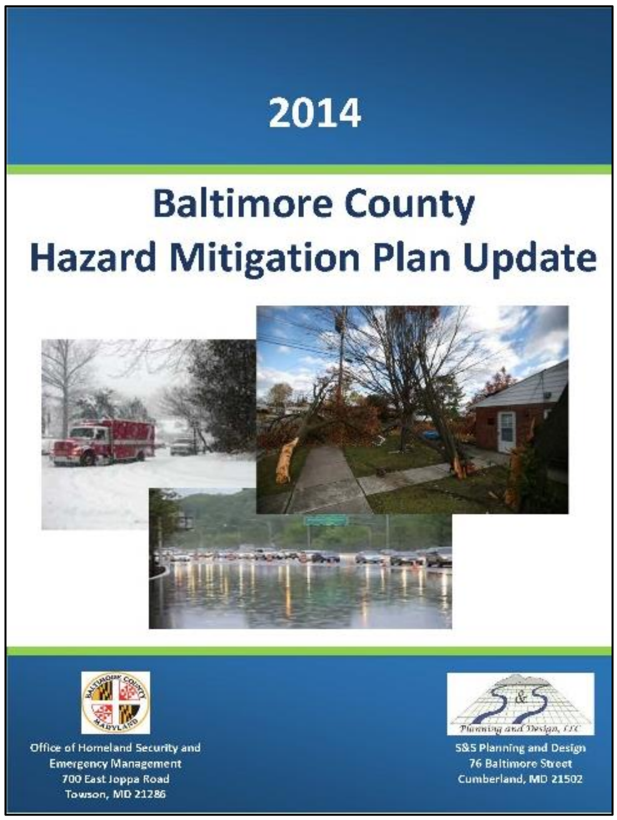
David Bycoff, Project Manager	Emergency Management
Paul Lurz, Project Manager	Emergency Management
Caitlin Merritt	Planning (Landmarks preservation)
Debra Shindale	OBF/Property Management
Douglas Adams	Dept. of Public Works
Brady Locher	Dept. of Environmental Protection & Sustainability
Matt Gawel	Permits, Approval, & Inspections
Joseph Fraker	Planning
Thomas Ramey	Fire

PROJECT OVERVIEW GRAPHIC BELOW: ITEMS SHOWN IN THE WHITE BOXES ARE THOSE ITEMS THAT REQUIRE HMP COMMITTEE MEMBER COMPLETION. ITEMS LISTED WITHIN THE YELLOW ARROWS WILL BE DEVELOPED AND/OR UPDATED AND PRESENTED AT HMP COMMITTEE MEETINGS.



The 2021 Hazard Mitigation Plan Update will include:

- New Hazard Mitigation Planning Committee
- New Public Outreach Initiatives including Project Website
- New Formatting
- Updated Data & Analysis
- New Capability Assessment & Plan Integration
- New Mitigation Actions & Projects



Cover of the 2014 Hazard Mitigation Plan.

BALTIMORE COUNTY HMP PROJECT TIMELINE										
	October	Nov.	Dec.	Jan.	Feb.	March	April	May	June	July
Project Milestones										
Organize Resources & Planning Team										
Planning Committee Meeting #1		*								
2015 Mitigation Strategies Update Process										
HIRA 2020-2021 Update										
Mitigation Strategies Report										
Public Outreach Campaign (Website, Survey, Social Media)										
Planning Committee Meeting #2				*						
Hazard Vulnerability Assessment										
Capability Assessment & Gaps										
Planning Committee Meeting #3						*				
2021 Mitigation Actions & Projects										
DRAFT PLAN										
Local & Public Review & Comments										
State & FEMA Review & Comments										
Adoption by Baltimore County										

2015 Hazards Identification & Risk Assessment (HIRA) Results & 2021 HIRA Process

While the FEMA requirements refer to natural hazards, Baltimore County chose to include Technological Hazards, as well in the 2015 Plan. To update the Plan, a new HIRA will be completed. One additional hazard has been added, **Pandemic & Emerging Infectious Disease.**

The new HIRA will include data on frequency of event, damages, deaths and injuries, geographic extent, and community perspective. The new HIRA results will be presented and discussed at the January Hazard Mitigation Planning Committee (HMPC) stakeholder meeting.

Table 1-3. Baltimore County Hazard Assessment, 2013

Hazard	Risk
Flooding (Tidal/Coastal)	High
Drought	Medium
Flooding (Flash/Riverine)	High
Soil Movement	Medium-low
Thunderstorm*	Medium-high
Tornado	Medium
Wildfire	Medium
High Wind*	Medium
Winter Weather	Medium-high
Earthquake	Medium-low
Extreme Heat	Medium
* Indicates a new hazard added by the HMPC	

Table 1-4. Technological Hazard Assessment, 2013

Hazard	Risk
Technological	
Transportation Accident	High
Hazardous Materials	High
Dam Failure	Medium
Fire & Explosion	Medium-high
Mass Power Outage*	Medium-high
** Indicates a new hazard added by the HMPC*	

Community Perspective Survey

To update the HIRA, data must be gathered. One source of data is information on how the community perceives the hazards that impact Baltimore County. The HMPC stakeholder group has been requested to take the Community Perspective Online Survey.

- **Stakeholder Survey**

Click here: https://www.surveymonkey.com/r/LR7FV5C

Following the completion of the Stakeholder Survey by the HMPC stakeholders, the survey will be made available to the public on the newly developed Baltimore County Hazard Mitigation Plan website.

- **Public Survey Available**

As part of the 2021 Hazard Mitigation Plan Update, a project website has been developed for use throughout the project. The website is for stakeholder and public use. A draft preview of the website is available here.

Website Preview

Mitigation Status Report Fillable PDF

Mitigation actions and projects developed for the 2015 Baltimore County Hazard Mitigation Plan need to be reviewed and a status update provided. To accomplish this task, HMPC stakeholder assistance is needed. SP&D has developed a fillable PDF form for this purpose. The form will be distributed to all HMPC stakeholders for completion. Following the completion of this form by HMPC stakeholders, SP&D will compile results and produce a mitigation status report for review and discussion at the January HMPC stakeholder meeting

Project Type Hazard/Mitigation Actions/Projects	Responsible Agency	Complete	Incomplete (No Work Completed)	Partial (Some Work Completed)	Ongoing
Public Outreach					
FLOOD Continue to provide information on the County's web site about flood risk and vulnerability. **COASTAL STORM AND FLOODING** Continue to provide information on the County's web site about coastal storm risk and vulnerability.					
Project 1: Add a section regarding flood insurance to both the "Flash Floods and Other Flooding" and "Hurricanes and Tropical Storms" webpages.	Office of Homeland Security and Emergency Management	○	○	○	○
2020 Status Update:					
Project 2: Utilize these webpages to publicize outreach activities, such as workshops and public meetings.	Office of Homeland Security and Emergency Management	○	○	○	○
2020 Status Update:					
Training					
THUNDERSTORM Provide staff training in the form of a damage assessment course so that emergency personnel are up to date on the latest techniques for assessing thunderstorm related damage, as well as any other major natural disaster. This course, and those like it, would be beneficial to new staff members, and provide a refresher for current staff. **TORNADO** Provide staff training in the form of a damage assessment course so that emergency personnel are up to date on the latest techniques for assessing tornado damage, as well as any other major natural disaster. This course, and those like it, would be beneficial to new staff members, and provide a refresher for current staff.					
Project 1: Schedule a damage assessment "refresher" course for appropriate staff members of responsible agencies and departments as defined in the Emergency Operations Plan 2011.	Office of Homeland Security and Emergency Management	○	○	○	○
2020 Status Update:					
Project 2: Building upon staff training for damage assessments, consider the acquisition of, and staff training in the use of, tools such as GPS-enabled cameras, which could greatly aid in the damage assessment process.	Office of Homeland Security and Emergency Management	○	○	○	○
2020 Status Update:					

Data & Photo Request

SP&D will send request for data to specific HMPC stakeholders following this initial meeting. In addition, photos of hazard events are requested. Please email photos to vsmith@smithp-d.com.

Next Steps

1. Completion of Community Perspective Survey by HMPC Stakeholders.
2. Completion of New Hazard Identification & Risk Assessment (HIRA) by SP&D.
3. Completion of Mitigation Status Report Fillable PDF by HMPC Stakeholders.

4. Completion of Mitigation Status Report for inclusion in 2021 HMP Update by SP&D.
5. Data table updates and integration into 2021 HMP Update by SP&D.
6. Reformatting of the 2015 Plan to match new branding, refer to website.
7. Collection of public outreach and stakeholder engagement.
8. Launch of project website, social media and public survey.

****Next Meeting Date – End of January 2021****

HMP Stakeholder Meeting #2
February 23, 2021
11:00 AM – 12:00 PM

Agenda:

- Stakeholder Hazard Identification & Risk Assessment (HIRA) Results
- Mitigation Action Items Status Update Results
- New Hazard: Pandemic and Emerging Infectious Diseases
- HAZUS analysis of Historic Buildings
- Social Vulnerability Index (SVI) for County and hazard with geographic extent (e.g., flood hazard)
- Capability Assessment

HMP Stakeholders in Attendance:

Ashley Morris	Fire Department - Emergency Management
Brady Locher	Department of Environmental Protection and Sustainability
Caitlin Merritt	Planning (Landmarks Preservation)
David Bycoffe	Fire Department - Emergency Management
Irene Debye	Fire Department
Kritty Udhin	Department of Environmental Protection and Sustainability
Matthew Carpenter	Office of Budget and Finance
Matt Gawel	Permits, Approvals and Inspections
Paul Lurz	Fire Department - Emergency Management
Terry Curtis	Department of Public Works
Terry Sapp	Department of Health
Thomas Ramey	Fire Department

Baltimore County HMP Project Timeline - 2021										
	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	April	May	June	July
Project Milestones										
Organize Resources & Planning Team										
Planning Committee Meeting #1		*								
2015 Mitigation Strategies Update Process										
HIRA 2020-2021 Update										
Mitigation Strategies Report										
Public Outreach (Website, Survey, Social Media)										
Planning Committee Meeting #2					*					
Hazard Vulnerability Assessment										
Capability Assessment & Gaps										
Planning Committee Meeting #3						*				
2021 Mitigation Actions & Projects										
DRAFT PLAN										
Local & Public Review & Comments										
State & FEMA Review & Comments										
Adoption by Baltimore County										

Important Topics

- The meeting focused on six (6) major updates to the Plan Update, two of which are already completed components: the HIRA and the mitigation action items status updates.
    - HIRA and mitigation action items status updates are included as appendices to the Plan Update. Additionally, the entire appendix (including method and data) for the HIRA is available on the project website: www.baltimorecohazardplan.org

- The new hazard chapter, *Pandemic and Emerging Infectious Diseases*, was also introduced. This hazard was identified by stakeholders during the first meeting and it was determined the hazard should be added to the Plan Update.
- Two major addition to the Plan Update that did not exist in the previous plan iteration include: 1.) an enhanced HAZUS (level 2) analysis of the County's historic buildings, and 2.) a Social Vulnerability Index (SVI) conducted for the County and for hazards with a well-defined (e.g., flood hazards) geographic extent.
- The Capability Assessment is currently underway for the County and SP&D will be asking for additional stakeholder input via a fillable PDF to complete the assessment.

Public Outreach

- SP&D is collecting pictures for the plan update.
    - Pictures should be specific to Baltimore County, depict a hazard included in the HMP, relatively recent, and high quality.
    - Please submit all pictures to emessick@smithp-d.com
- Public Outreach by stakeholders is an important aspect for the planning process as well as plan approval.
    - Mention the HMP in meetings, post about the plan update on social media (if approved), link to the plan update website, etc. Please provide us with the date and a short description of the outreach activity.

Next Steps

- New content to be added to the project website as it is completed.
    - This includes things like chapter excerpts, mapping, and some analysis results.
- Capability Assessment Results
    - CA materials will be sent to stakeholders via email. They will receive targeted emails so that people are only asked to fill out information that is related to their department or area of expertise.
- Developing Mitigation Action Items
    - New action items and mitigation projects will be created for hazards and old/existing actions and projects will either be updated or removed based upon stakeholder input.
    - If you have an idea for an action item or mitigation project related to one of the hazards in the HMP, please email them to emessick@smithp-d.cpm
- **NEXT MEETING DATE**
    - The next meeting date will be scheduled the end of March 2021. A Doodle Poll with several options to determine an exact date and time that works for everyone will be sent to stakeholders.

HMP Stakeholder Meeting #3
March 31, 2021
10:00 AM – 11:30 AM

Agenda:

- Capability Assessment Review
- Mitigation Action Items Workshop
- Draft Hazard Chapters Distribution Process
- Next Steps

HMP Stakeholders in Attendance:

Ashley Morris	Fire Department - Emergency Management
Brady Locher	Department of Environmental Protection and Sustainability
Bill Skibinski	Planning
Caitlin Merritt	Planning (Landmarks Preservation)
David Bycoffe	Fire Department - Emergency Management
Doug Adams	Department of Public Works
Irene Debye	Fire Department
Kathy Suter	Fire Department/Emergency Management
Kritty Udhin	Department of Environmental Protection and Sustainability
Paul Lurz	Fire Department - Emergency Management
Richard Muth	Baltimore County Public Schools
Terry Curtis	Department of Public Works (Floodplain Manager)
Thomas Ramey	Fire Department

Baltimore County HMP Project Timeline - 2021									
	Oct.	**Nov.**	**Dec.**	**Jan.**	**Feb.**	**Mar.**	**April**	**May**	**June**
Project Milestones									
Organize Resources & Planning Team									
Planning Committee Meeting #1		*							
2015 Mitigation Strategies Update Process									
HIRA 2020-2021 Update									
Mitigation Strategies Report									
Public Outreach (Website, Survey, Social Media)									
Planning Committee Meeting #2					*				
Hazard Vulnerability Assessment									
Capability Assessment & Gaps									
Planning Committee Meeting #3						*			
2021 Mitigation Actions & Projects									
DRAFT PLAN									
Local & Public Review & Comments									
State & FEMA Review & Comments									
Adoption by Baltimore County									

Capability Assessment Review

- The meeting provided an overview of the Capability Assessment results as well as the feedback that has been provided thus far. Stakeholders were informed that they may still provide feedback for the capability assessment by utilizing the fillable PDF that was sent to them.

- Updates to the capability assessment have been made based upon stakeholder feedback and updates will continue to occur as more feedback is received.
- It was highlighted that Baltimore County's current capabilities are robust and they have many existing planning documents, regulations, policies, tools, and staff/departments that provide important hazard mitigation capabilities.

Mitigation Action Item Workshop

- The stakeholders focused on discussing mitigation action items and determining which items should be included in the 2021 Plan Update. Stakeholders were asked if each action item should be included (Y/N?), the responsible entity, and any relevant comments.

MITIGATION ACTION ITEMS – NEW & EXISTING			
Action Item	**Include (Y/N)?**	**Responsible Entity**	**Comment(s)**
FLOOD HAZARD			
*1. Conduct site visits for flood prone historic resources to verify several facts regarding them, including: if and where they currently exist in space. Targeted site visits for a small group of sites could be conducted for particularly important resources, or for resources that have a lot of unknowns.			
*2. Request new FEMA Risk Map Product be produced for coastal/riverine using new DFIRM. Previous risk map product was completed in 2014 for coastal only.			
*3. Draft and/or update FEMA elevation certificates for County buildings located in the SFHA (CAP project).			
*4. Target blighted and/or vacant properties within the flood plain for potential acquisition. Consider adjacent flood prone properties for acquisition and potential open space-parks and recreation and/or restoration opportunities.			

  - Input was gathered for all action items, including comments, inclusion (y/n), and the responsible entity for some.

- Draft hazard chapters will be sent to stakeholders regularly for review and comment.
  - Because we are on a tight timeline for completion, we wanted to provide small portions of the plan to review, rather than providing a draft of the entire plan to be reviewed at once.
  - Roughly 2-3 draft chapters will be sent at regular intervals.
  - The first chapters sent to stakeholders for review will be: *Chapter 14: Pandemic and Emerging Infectious Diseases, Chapter 15: Technological and Man-Made hazards,* and *Chapter 8: High Winds*

Public Outreach

- SP&D is collecting pictures for the plan update.
  - Pictures should be specific to Baltimore County, depict a hazard included in the HMP, relatively recent, and high quality.

  - Please submit all pictures to emessick@smithp-d.com
- Public Outreach by stakeholders is an important aspect for the planning process as well as plan approval.
  - Please share about the plan update on social media (if approved), link to the plan update website, etc. Please provide us with the date and a short description of the outreach activity.

Next Steps

- **Mitigation Action Items Prioritization**
  - The next step in the action item process is prioritizing them in order of importance (low to high)
  - To do this, stakeholders decided they would prefer to utilize a "prioritization tool" rather than having a dedicated meeting.
    - The possibility was discussed that stakeholders may need to meet later to discuss any prioritization disagreements that might occur.
- **Draft Chapters for Review**
  - Chapters will be sent out to stakeholders on a regular basis for review.
- **Complete Draft Plan** for review by late May 2021
- **NEXT MEETING DATE**
  - The next meeting date is TBD and is dependent upon if there is a need for one to further discuss mitigation action item prioritization.

APPENDIX I:
NFIP REPETITIVE LOSS DATA

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