

HAZARD IDENTIFICATION & RISK ASSESSMENT

HOWARD COUNTY, MARYLAND

2017

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SECTION 2
INTRODUCTION
&
BACKGROUND

Introduction & Background

Contents of this Section

I. Introduction
II. Key Terminology
III. Assessing Risk at the County Level

I. INTRODUCTION

This section discusses the guidance and strategic goals that influenced the planning process.

The Hazard Identification and Risk Assessment (HIRA) is a comprehensive analysis of manmade and natural hazards for the jurisdiction of Howard County, Maryland. The HIRA was developed in 2014 and 2015 to serve as a foundational document for emergency preparedness planning efforts within the jurisdiction. Development of the HIRA was led by the Howard County Office of Emergency Management under the authority of the Emergency Management Advisory Group. The HIRA reflects a whole-community approach to risk assessment involving local government stakeholders, private-sector partners, and private citizens.

Overview

This section provides an overview of the sections.

The Hazard Identification and Risk Assessment (HIRA) is broken into six sections and three annexes:

Section 1: Table of Contents

Section 2: Introduction & Background
An overview of the HIRA, key terminology, and the HIRA approach to risk assessment.

Section 3: Risk Management & Planning
A guide for using the HIRA to support preparedness and response efforts.

Section 4: Planning Process
An overview of the HIRA strategic plan, the planning process, and participating partners.

Section 5: Interpreting the Hazard Profiles
A guide to understanding the information contained in the HIRA hazard profiles.

Section 6: Risk Overview
An overview of the HIRA results.

Section 7-8: Hazard Profiles, Manmade & Natural Hazards
Complete risk assessments of each HIRA hazard.

Scope & Organization

This section details the hazards addressed by the HIRA and the organization of information within each hazard profile.

The Hazard Identification and Risk Assessment (HIRA) provides an in-depth profile, risk assessment, and consequence analysis of 16 manmade hazards and 10 natural hazards. The hazards addressed by the HIRA include:

ADVERSARIAL/INTENTIONAL HAZARDS	TECHNOLOGICAL/ACCIDENTAL HAZARDS	NATURAL HAZARDS
▪ Chemical Attack ▪ Biological Attack ▪ Radiological Attack ▪ Nuclear Blast ▪ Active Assailant ▪ Cyber/Communications Infrastructure Attack ▪ Explosives ▪ Civil Unrest	▪ Utility Disruption ▪ Structure Fire ▪ Transportation Hazard ▪ Dam Failure ▪ Unintentional Chemical Substance Release/Hazmat ▪ Disease Epidemic/Unintentional Biological Hazard ▪ Unintentional Radiological Substance Release ▪ Unintentional Cyber/Communications Infrastructure Failure	▪ Animal/Pest Infestation ▪ Drought ▪ Earthquake ▪ Floods ▪ Hurricane/Tropical Storm ▪ Lightning ▪ Severe Winter Weather ▪ Space weather ▪ Tornadoes ▪ Wildfires

Each of the hazard profiles included in the HIRA is organized into the following sections and sub-sections:

I. **OVERVIEW**
   - Definition
   - Risk Profile
   - Risk Matrix
   - Risk Ranking

II. **HAZARD CHARACTERISTICS**
   - Description of the Hazard
   - Local Context

III. **LIKELIHOOD ANALYSIS**
   - Occurrence of the Hazard
   - Future Likelihood of the Hazard

IV. **CONSEQUENCE ANALYSIS**
   - Consequence Overview
   - Consequence Analysis: Likely Hazard Scenario
   - Consequence Analysis: Worst-Case Hazard Scenario
   - Public Perception

Additional information on the organization and contents of the hazard profiles can be found in the Section 4: Interpreting the Hazard Profiles.

II. KEY TERMINOLOGY

This section defines key words and phrases that will be used throughout the HIRA.

Communicating risk-related concepts can be challenging. Many of the terms used in risk assessment have colloquial meanings that confuse and distract from the intended message. The following definitions are established and expanded upon in the U.S. Dept. of Homeland Security Risk Lexicon[1] and will be used throughout the Hazard Identification and Risk Assessment (HIRA):

HAZARD
A potential source or cause of harm or difficulty. A hazard can be natural or manmade.

EMERGENCY-LEVEL HAZARD EVENT
A hazard event that requires a response from at least two Howard County agencies or partners.

NATURAL HAZARD
A source of harm or difficulty created by a meteorological, environmental, or geological phenomenon.

MANMADE HAZARD
A hazard that originates in some way from human activity. Manmade hazards include Adversarial/Intentional hazards and Technological/Accidental hazards.

ADVERSARIAL/INTENTIONAL HAZARD
A manmade hazard created by a deliberate action or planned course of action.

TECHNOLOGICAL/ACCIDENTAL HAZARD
A manmade hazard created by negligence, error, or unintended failure.

RISK
The potential for an unwanted outcome resulting from an event. Risk is a function of the hazard likelihood and its associated consequences.

LIKELIHOOD
The conditional probability of observing a particular event in a given span of time.

CONSEQUENCE
The effect of an event, incident, or occurrence. Consequence in the HIRA includes impacts to property, health & safety, critical facilities, response capacity, the environment, the economy, and standard of living/quality of life. Analysis of consequence in the HIRA also incorporates the Warning Time and Duration of the hazard.

THREAT
An occurrence that has the potential to cause harm or difficulty. Unlike hazards, threats are always directed at an entity, asset, system, network, or geographic area. For the purpose of calculating risk, the threat of an intentional hazard is generally estimated as the likelihood of an attack.

VULNERABILITY
A physical feature or operational attribute that renders an entity, asset, system, network, or geographic area open to exploitation or susceptible to a given hazard. In calculating the risk of an intentional hazard, the common measurement of vulnerability is the likelihood that an attack is successful.

ASSET
A person, structure, facility, information, material, or process that has value.

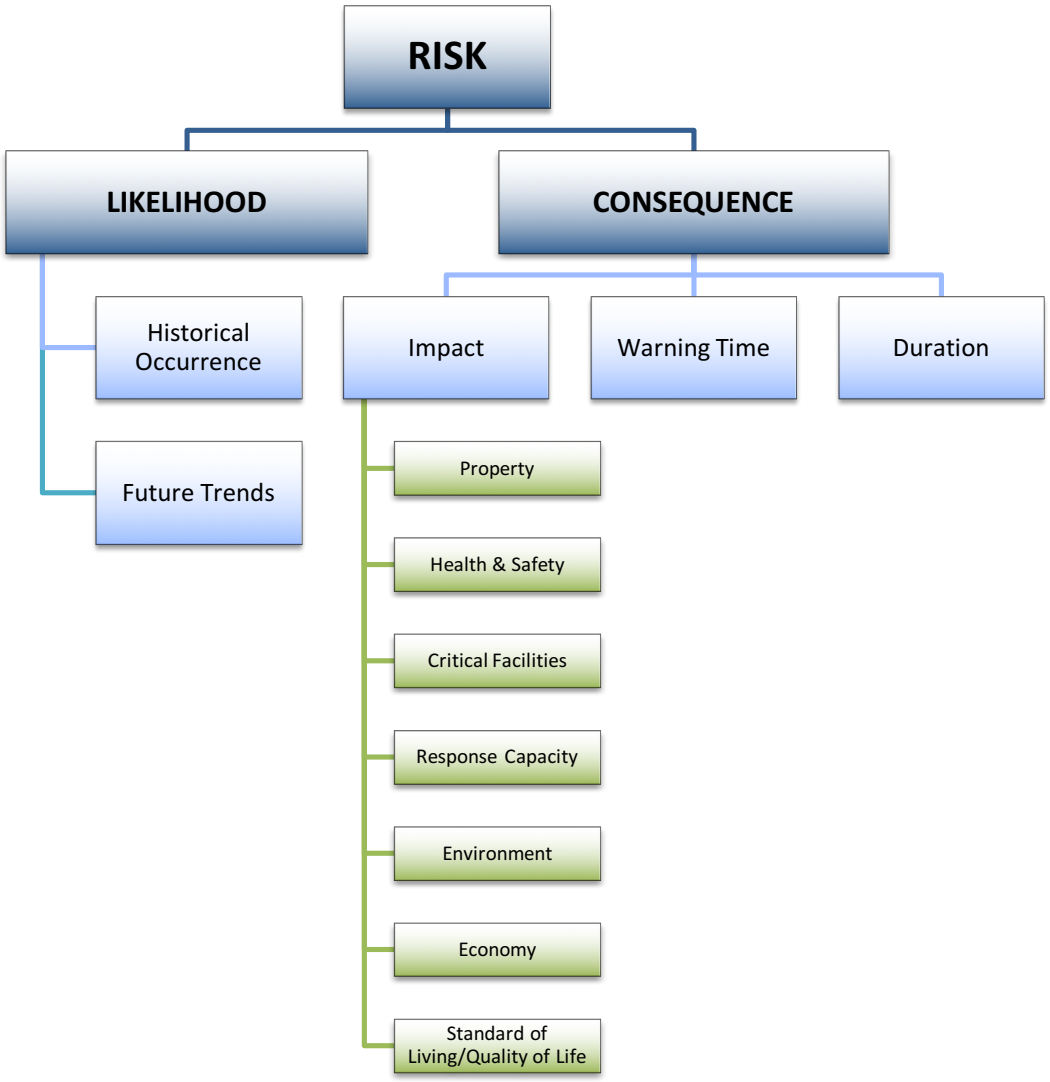
[1] *DHS Risk Lexicon: 2010 Edition*, U.S. Dept. of Homeland Security Risk Steering Committee (2010). Available at https://www.dhs.gov/xlibrary/assets/dhs-risk-lexicon-2010.pdf (last accessed August 27, 2014).

III. ASSESSING RISK AT THE COUNTY LEVEL

This section discusses the components of risk as they are evaluated in the HIRA.

There are many ways to assess risk. In its most basic form, a risk assessment is a process that collects information and assigns values to risks. Risk values can be used for the purpose of informing priorities, developing or comparing courses of action, and informing decision making.

Risk is most easily understood by analyzing the component parts of risk. The HIRA defines the components of risk in the following manner: Risk is a function of Likelihood and Consequence. Likelihood is defined by historical occurrence and future trends. Consequence is defined by Warning Time, Duration, and Impact. Impact itself is defined by impacts to property, health & safety, critical facilities, response capacity, the environment, the economy, and standard of living/quality of life. The chart below demonstrates this relationship visually:



In the field of risk assessment, there are several approaches to understanding the components of risk. While the HIRA understands risk as a function of likelihood and consequence (commonly written as *RISK = LIKELIHOOD * CONSEQUENCE*), it is also common to see risk demonstrated as a function of threats, assets, vulnerabilities, and/or consequences (commonly written as some variation of *RISK = THREAT * VULNERABILITY * CONSEQUENCE*). Although they appear quite different, there is significant overlap between the variables measured by these two approaches. The latter approach is most effective when assessing the risk of targeted threats to specific assets. The likelihood/consequence formula used by the HIRA was chosen for its effectiveness when measuring and comparing all hazards (not just targeted threats) where the asset at stake is the entire county.

The approach used by the Hazard Identification and Risk Assessment (HIRA) was designed to be easily adaptable for a wide variety of planning purposes. Guidance for applying the information contained in the HIRA can be found in the Risk Management & Planning section.

The Howard County Risk Tool

This section outlines the tool developed by the HIRA to evaluate hazard risk.

The Howard County Risk Tool is the key to understanding and interpreting hazard risk. The Risk Tool converts hazard information into a set of numerical scores that allow for comparison across many natural and manmade hazard types. With the appropriate information, any hazard can be processed through the Risk Tool for comparison with HIRA data. Similarly, any existing HIRA risk score can be easily interpreted by referencing the quantitative levels outlined in the Risk Tool. The tool has been designed so that the resulting risk score is transparent, replicable, and scientifically defensible.

The Risk Tool reflects the components of risk outlined earlier in this section. Every hazard is assigned a numerical score in each of the four risk assessment categories: Likelihood, Impact, Warning Time, and Duration. Numerical scores range from 1 to 4 based on criteria that are defined explicitly in the tool. The scores from each section are multiplied by the assigned weighting factor. Likelihood is weighted at 50% of the Risk Score. Consequence is made up of Impact (40%), Warning Time (5%), and Duration (5%) for a combined total of 50% of the Risk Score. Once multiplied by the weighting factor, the sum of the scores becomes the total Risk Score for the hazard.

HOWARD COUNTY RISK TOOL

LIKELIHOOD FACTORS

LIKELIHOOD

Estimated chance of a single hazard event occurring in a given year based on historical incidence and trend forecasting.

UNLIKELY (1)	INFREQUENT (2)	LIKELY (3)	VERY LIKELY (4)
No documented occurrence. Less than 1% chance of annual occurrence.	1-10% chance of annual occurrence.	11-30% chance of annual occurrence.	30+% chance of occurrence annually.

CONSEQUENCE FACTORS

IMPACT

Estimated effect of a single hazard event on property, health & safety, critical facility functioning, response capacity, the environment, the economy, and standard of living.

LIMITED (1)	SIGNIFICANT (2)	CRITICAL (3)	CATASTROPHIC (4)
▪ Property damage is less than 5% of critical and non-critical infrastructure. ▪ Injuries are manageable with existing resources, no fatalities. ▪ Shutdown of critical facilities for less than 24 hours. ▪ Local resources are adequate to support the response. ▪ Little to no environmental impact. ▪ Little to no economic impact. ▪ Standard of living is only minimally disrupted.	▪ Property damage is 5-25% of critical and non- critical infrastructure. ▪ Injuries are manageable, may include at least one death. ▪ Critical facilities are down for 1-7 days. ▪ Local and mutual aid resources are adequate to perform response, with limited or no state assistance. ▪ Moderate environmental impact. ▪ Moderate economic impact. ▪ Standard of living is moderately affected.	▪ Property damage is between 26-50% of critical and non-critical infrastructure. ▪ Multiple deaths and serious injuries are probable. ▪ Shut down of critical facilities 1-4 weeks. ▪ Local resources are expended and require sustained support from mutual aid partners and/or the state/federal government. ▪ Serious environmental impact. ▪ Serious economic impact. ▪ Standard of living is seriously affected.	▪ Property damage is severe, greater than 50% of critical and non-critical infrastructure affected. ▪ Multiple deaths and serious injuries exceed jurisdiction response capacity. ▪ Shut down of critical facilities will be more than one month. ▪ Response capacity is overwhelmed and requires significant and long lasting state and federal government support. ▪ Severe environmental impact. ▪ Severe economic impact. ▪ Standard of living is extremely impacted and may not be fully recoverable.

WARNING TIME

Estimated time of awareness prior to the onset of the hazard event.

VERY LONG (1)	LONG (2)	MODERATE (3)	SHORT (4)
More than 24 hours	12-24 hours	6-12 hours	Less than six hours

DURATION

Estimated time from onset to conclusion of the hazard event.

SHORT (1)	MODERATE (2)	LONG (3)	VERY LONG (4)
Less than six hours	6-24 hours	Less than one week	More than one week

RISK SCORE WEIGHTING

LIKELIHOOD	IMPACT	WARNING TIME	DURATION
[50%]	[40%]	[5%]	[5%]
			

RISK = LIKELIHOOD + CONSEQUENCE

SECTION 3

RISK MANAGEMENT & PLANNING

Risk Management & Planning

Contents of this Section

I. Planning with the HIRA

- Establishing a Common Language
- Setting Priorities
- Justifying Existing Plans
- Evaluating Prevention, Protection, & Mitigation Actions
- Responding to an Emergency

I. PLANNING WITH THE HIRA

The Overview section defines the hazard and summarizes the hazard risk profile.

The Hazard Identification and Risk Assessment (HIRA) was developed to be used for a wide variety of planning and risk management purposes. Data contained in the HIRA can be easily integrated into new and existing plans. Integrating information from the HIRA encourages a data-driven approach to preparedness decision making.

Benefits of using the HIRA include:

- Improving risk communication by establishing a common language
- Setting data-driven planning priorities
- Justifying existing planning priorities
- Evaluating and comparing prevention, protection, and mitigation actions
- Anticipating challenges during an emergency event

Establishing a Common Language

This section describes how to use the HIRA to add consistency and clarity to planning efforts.

Communicating risk management concepts can be difficult and confusing. Words and ideas are frequently misused, and errors in communication can cause serious consequences. The risk terminology used in the HIRA is consistent with existing guidance and has been vetted and approved by a committee of high-level representatives from Howard County's top emergency management stakeholder organizations. Referencing hazards using HIRA-established terminology allows for easy and accurate communication of ideas and helps promote the perception that all Howard County planning documents are working toward the same shared goals.

Example: Integrating consistent HIRA terminology into an existing plan

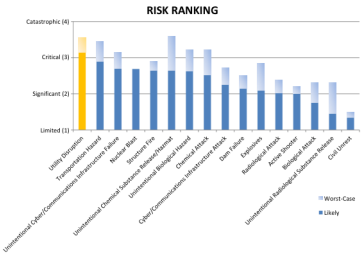
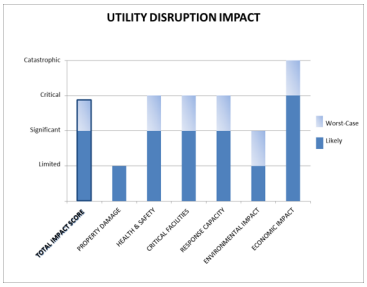
> The agency has taken steps to prepare for all ~~emergencies~~ hazards. The agency has taken special steps to prevent ~~attack hazards~~ Adversarial/Intentional hazards. The agency is particularly concerned about ~~gunmen and bombs~~ Active Assailant hazards and Explosives hazards. The agency recognizes the risk

Setting Priorities

This section describes how to use the HIRA to set emergency preparedness priorities.

Emergency preparedness priorities are frequently determined based on gut feelings and an unwillingness to deviate from the way things have been done in the past. History has made it abundantly clear that the scariest or most talked-about hazards are not always the hazards that pose the greatest risk to the jurisdiction. It is essential that emergency preparedness decisions are made based on data whenever possible. The HIRA provides a scientifically defensible foundation for preparedness decision making.

Example: Using the HIRA to prioritize preparedness activities

> The agency has dedicated preparedness efforts to mitigate the risk of Utility Disruption hazards. Utility Disruption hazards were identified as the hazard that poses the highest risk to Howard County by the Hazard Identification and Risk Assessment (HIRA).
>
> 
>
>
> The HIRA anticipates the property damage and environmental impact of a Utility Disruption hazard to be limited, so preparedness efforts will concentrate on mitigating risk to the economy, health & safety, response capacity, and critical facilities.
>
> 
>

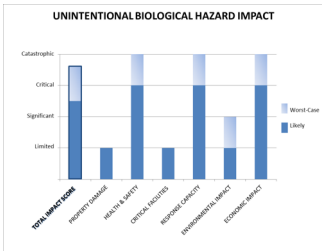
Justifying Existing Plans

This section describes how to use the HIRA to provide justification for existing preparedness plans.

Many preparedness priorities are based on years of experience but lack the hard data to support what decision makers already know to be true. The information contained in the HIRA can be used to provide a solidly defensible foundation for any number of existing planning decisions.

Example: Using the HIRA to justify existing plans

The agency has long invested significant resources into disease pandemic preparedness. Although Disease Epidemic/ Unintentional Biological hazards are not the highest in overall risk to our community, the Health & Safety impact from a Disease Epidemic/ Unintentional Biological hazard is expected to be higher than 90% of other hazards addressed in the HIRA. Furthermore, the anticipated impact to Response Capacity is considered critical, and the actions we have taken over the past ten years will work to ensure a robust health care response.



Evaluating Prevention, Protection, & Mitigation Actions

This section describes how to use the HIRA to evaluate risk management activities.

Risk management is the process of controlling risk by changing the likelihood or expected consequences from any given hazard. Prevention, protection, and mitigation activities are all approaches to managing risk. The HIRA assigns a risk score to every hazard that incorporates that hazard's likelihood of occurrence and expected consequence. An effective risk management action should reference the likelihood and/or consequence of the hazard as illustrated by the HIRA and demonstrate how the proposed action will reduce the future likelihood and/or the expected consequence of the hazard. A proposed action that does not reduce the likelihood or the consequence of the hazard is not an effective risk management solution.

Example: Using the HIRA to evaluate risk management actions

The agency needs to evaluate three proposals for managing the risk of a Radiological Attack hazard.

- Option A proposes to purchase radiation-resistant uniforms for employees at public facilities.
- Option B proposes to purchase a new system that helps EMS and hospitals manage high-casualty incidents.
- Option C proposes to increase the law enforcement presence in public facilities.

Option A does not effectively reduce hazard risk. When describing the consequences of a Radiological Attack, the HIRA explains that most health & safety impacts result from the traditional explosives used in the attack. The low level of radiation present in most Radiological Attacks will cause fear but will not significantly impact health & safety. Option A does not reduce likelihood or consequence.

Option B effectively reduces hazard risk by reducing the consequence of a Radiological Attack. Mass casualty systems can reduce two of the key impact areas identified by the HIRA (response capacity and health & safety). Option B will also reduce the consequence of other hazard types.

Option C effectively reduces hazard risk by reducing the likelihood of a Radiological Attack. Police presence can reduce the future likelihood of attack.

Responding to an Emergency

This section describes how to use the HIRA anticipate challenges during an emergency event.

During an emergency, planning decisions made in seconds have consequences that last lifetimes. It may take hours or days for planning teams to access the data they need to make educated response decisions. Although experienced emergency managers can quickly identify planning priorities, it is easy for things to slip between the cracks. The HIRA Consequence Analysis provides an easy-to-understand overview of the expected consequences during an emergency-level hazard event.

Example: Using the HIRA as a planning tool during an emergency event.

Emergency Manager

The flu pandemic is getting worse. We've increased support for the Health Department and Hospitals. Is there anything else we should be worried about?

EOC Tech

The HIRA says that staffing may become a concern at response agencies and critical facilities if enough of their staff becomes sick.

Emergency Manager

Great catch. Contact police, fire, and utilities and see what we can do to support their staffing needs.

SECTION 4

PLANNING PROCESS

Planning Process

Contents of this Section

I. Planning Overview
II. Planning Process
III. Planning Partners

I. PLANNING OVERVIEW

This section discusses the guidance and strategic goals that influenced the planning process.

The Hazard Identification and Risk Assessment (HIRA) provides a detailed examination of the hazards that may affect Howard County. The HIRA combines best practice guidance with local stakeholder expertise to create a hazard identification and risk assessment that meets or exceeds industry standards while remaining relevant and specific to the Howard County context.

The HIRA and the accompanying quick-reference sheets were developed to support the emergency preparedness efforts of all Howard County government agencies, private-sector stakeholders, and the public. The HIRA is a foundational document and was developed to satisfy the needs of many Howard County planning and policy initiatives. Howard County initiatives that will build upon this foundation include but are not limited to:

- The County Emergency Operations Plan
- Hazard-Specific Response Annexes to the EOP
- The County Recovery Plan
- The Strategic Plan
- The Multi-Year Training and Exercise Plan
- The Comprehensive Mitigation Plan
- The Public Information and Warning/Communications Plan
- EMAP Accreditation

Guidance from literature, industry accreditation standards, and model programs was essential to the development of the HIRA. The federal documents *Understanding Your Risk: Identifying Hazards and Estimating Losses,*[1] *Local Mitigation Planning Handbook*[2] *(44 CFR 201.6),* and *Integrating Manmade Hazards Into Mitigation Planning*[3] provided federal insight into the risk assessment process.

[1] *Understanding Your Risks: Identifying Hazards and Estimating Losses,* FEMA. Available at https://www.fema.gov/media-library/assets/documents/4241 (last accessed August 25, 2014).
[2] *Local Mitigation Planning Handbook,* FEMA, Available at http://www.fema.gov/media-library-data/20130726-1910-25045-9160/fema_local_mitigation_handbook.pdf (last accessed September 19, 2016).
[3] *Integrating Manmade Hazards Into Mitigation Planning,* FEMA. Available at http://www.fema.gov/media-library/assets/documents/4528 (last accessed August 25, 2014).

The HIRA was developed to meet all risk assessment recommendations of the Emergency Management Accreditation Program.[4] EMAP Standard 4.3 provides important guidance on Hazard Identification, Risk Assessment, and Consequence Analysis. This standard states that an Emergency Management Program should use a broad range of sources to identify the natural and human-caused hazards that potentially impact the jurisdiction. Standard 4.3 also states that a risk assessment and consequence analysis should consider the impact on the public, responders, continuity of operations, property, facilities and infrastructure, the environment, the economic condition of the jurisdiction, and the public's confidence in the jurisdiction's government.

II. PLANNING PROCESS

This section discusses the steps that were essential to the completion of the HIRA.

The HIRA project was completed over five phases. The phases of the HIRA project and the associated objectives are as follows:

Planning Phase	Key Objectives
Phase I	Assemble a multidisciplinary Steering Committee to: ▪ Create and validate the list of hazards to be addressed ▪ Identify components for consequence analysis ▪ Create and validate the Howard County Risk Tool ▪ Identify Subject Matter Experts for scenario development and consequence analysis
Phase II	Work with the Scenario Development Experts to: ▪ Develop hazard scenarios to guide consequence analysis
Phase III	Work with Subject Matter Experts to: ▪ Conduct a hazard-specific consequence analysis that includes warning time, duration, impact to property, impact to life and health, impact to critical facilities, impact to response capacity, impact to the environment, and impact to the economy ▪ Establish the historical likelihood of each hazard based on local occurrence Conduct a Community Survey on Hazards to: ▪ Evaluate public confidence in government response, confidence in personal preparedness, and perceived impact to standard of living/quality of life
Phase IV	Conduct a Subject Matter Expert Workshop to: ▪ Review and validate the results of the consequence analysis ▪ Validate total consequence scores ▪ Assign future likelihood scores based on historical likelihood and future trends
Phase V	Assemble the Steering Committee to: ▪ Review and validate the final risk assessment results

[4] *Emergency Management Standard,* Emergency Management Accreditation Program. Available at http://www.emaponline.org/index.php/root/for-programs/23-2013-emergency-management-standard (last accessed August 25, 2014).

III. PLANNING PARTNERS

This section identifies key stakeholders and their roles in the development and completion of the HIRA.

The development of the Hazard Identification and Risk Assessment (HIRA) involved extensive support from traditional response organizations, government agencies, private-sector partners, and engaged members of the public. Partners in the development of the HIRA can be broken into six groups:

- HIRA Planning Work Group
- HIRA Steering Committee
- Scenario Development Experts
- Subject Matter Experts
- Engaged Public Partners
- Other Supporting Partners

Although several agencies and individuals supported the HIRA project at multiple levels, the organization and function of each group was unique.

HIRA Planning Work Group: The Planning Work Group was responsible for the development and management of the HIRA project from inception to completion. The Planning Work Group drafted all HIRA documents, managed all HIRA data, facilitated meetings, and coordinated the involvement of all HIRA stakeholders. The Planning Work Group was comprised of staff from the Howard County Office of Emergency Management.

HIRA Steering Committee: The HIRA Steering Committee provided strategic guidance and support throughout the HIRA project. The Steering Committee was responsible for reviewing and validating all materials and processes developed by the Planning Work Group. The Steering Committee played an essential role in the identification and selection of Scenario Development Experts and local Subject Matter Experts.

Scenario Development Experts: Scenario Development Experts were selected by the Steering Committee for their expertise in one or more of the hazard categories. Using their expertise and understanding of the local context, the Scenario Development Experts created likely and worst-case scenarios for each of the 26 hazards addressed by the HIRA.

Subject Matter Experts: Subject Matter Experts were selected by the Steering Committee for their expertise in one or more of the subjects areas included in the consequence analysis and risk assessment. The multidisciplinary team of Subject Matter Experts was composed of 23 community experts with diverse backgrounds and areas of expertise. Subject Matter Experts used the likely and worst-case hazard scenarios as guides to calculate the anticipated impacts in each of the major consequence areas. At the end of the data collection period, the Subject Matter Expert Workshop brought many experts together to interpret our findings and attempt to build consensus on several of the more subjective components of the risk assessment.

Engaged Public Partners: Public involvement was a key component of the HIRA process. Howard County citizens were invited to participate in the process through the Community Survey on Hazards. In total, 463 members of the public provided information to support the analysis of public confidence and hazard perception.

Other Supporting Partners: Throughout the HIRA project, the Planning Work Group received support from technical experts, industry professionals, and other community stakeholders. The Other Supporting Partners provided essential guidance during the project's development and review.

HIRA Planning Work Group	
Organization	**Representative**
HC Office of Emergency Management	Birch Barron
HC Office of Emergency Management	Mike Hinson
HC Office of Emergency Management	Lisa Crow
HC Office of Emergency Management	Kasia Fertala
HC Office of Emergency Management	Ben Yelin
HIRA Steering Committee	
Organization	**Representative**
HC Office of Emergency Management	Birch Barron
HC Office of Emergency Management	Mike Hinson
HC Office of Emergency Management	Tom McNeal
HC Police Department	Mike Price
HC Police Department	Chris Neubauer
HC Dept. of Fire & Rescue Services	BC Gordon Wallace
HC Health Department	Sheila Palmiotto
HC Dept. of Technology & Communication Services	Glenn Hansen
HC Dept. of Public Works	Kris Singleton
HC Dept. of County Administration	Nancy Gray
Columbia Association	Sean Harbaugh
JHU Applied Physics Laboratory	John Contestabile

Scenario Development Experts		
Hazard Specialization	**Representative(s)**	**Organization**
▪ Chemical Attack ▪ Biological Attack ▪ Radiological Attack ▪ Nuclear Blast ▪ Explosives ▪ Unintentional Chemical Release/Hazmat ▪ Unintentional Radiological Substance Release ▪ Structure Fire ▪ Transportation Hazard ▪ Wildfire	Gordon Wallace	HC Dept. of Fire & Rescue Services
▪ Active Assailant ▪ Chemical Attack ▪ Biological Attack ▪ Radiological Attack ▪ Explosives ▪ Civil Unrest	Mike Price	HC Police Department
▪ Disease Epidemic/Unintentional Biological Hazard ▪ Biological Attack ▪ Utility Disruption ▪ Plant/Animal Infestation	Shantu Scatliffe, Giselle Bonilla, Alicia McClelland, Bert Nixon	HC Health Department

▪ Cyber/Comm. Attack ▪ Unintentional Cyber/Comm. Failure	Glenn Hansen	HC Dept. of Technology & Communication Services
▪ Utility Disruption	Steve Gerwin	HC Dept. of Public Works
▪ Dam Failure ▪ Flood	Mark Richmond	HC Dept. of Public Works
▪ Drought ▪ Earthquake ▪ Hurricane/Tropical Storm ▪ Lightning ▪ Severe Winter Storm ▪ Space Weather ▪ Tornado/Wind Storm	Tom McNeal, Mike Hinson, Birch Barron	Office of Emergency Management
Subject Matter Experts		
Area of Expertise	**Representative(s)**	**Organization**
▪ Health & Safety ▪ Response Capacity – Fire/Rescue ▪ Historical Occurrence	Gordon Wallace	HC Dept. of Fire & Rescue Services
▪ Health & Safety ▪ Response Capacity – Health Dept. ▪ Historical Occurrence	Alicia McClelland, Shantu Scatliffe, Giselle Bonilla	HC Health Department
▪ Response Capacity – Police ▪ Historical Occurrence	Mike Price	HC Police Department
▪ Critical Facilities – Cyber/Communications Infrastructure ▪ Historical Occurrence	Glenn Hansen, Paula McCreary	HC Dept. of Technology & Communication Services
▪ Critical Facilities – Utilities ▪ Historical Occurrence	Steve Gerwin	HC Dept. of Public Works
▪ Critical Facilities – Transportation	Kris Jagarapu, Bill Malone	HC Dept. of Public Works
▪ Historical Occurrence	Mark Richmond	HC Dept. of Public Works
▪ Critical Facilities – Energy	Mike Fowler	Baltimore Gas and Electric
▪ Response Capacity – Emergency Management	Tom McNeal	HC Office of Emergency Management
▪ Response Capacity – Hospital System	Gene Mellin	Howard County General Hospital
▪ Property & Infrastructure	Bob Frances, Sean Kelly, Sarah Flaig	HC Dept. of Inspections, Licenses, and Permits
▪ Economics	Daraius Irani	Regional Economic Studies Institute, Towson University
▪ Economics	Larry Twele, Vernon Thompson	HC Economic Development Authority
▪ Environment	Susan Overstreet, Beth Burgess	HC Dept. of Planning and Zoning
▪ Environment	Bert Nixon	HC Health Department
▪ Access and Functional Needs	Michelle Henry	HC Dept. of Citizen Services
Other Supporting Partners		
Support Area	**Representative(s)**	**Organization**
▪ Guidance – Economic analysis	Anirban Basu	Sage Policy Group, Inc.

▪ Guidance – Risk calculation	Chris Gifford, Mark Gabriele, Richard Waddell	JHU Applied Physics Laboratory
▪ Technical Support – Public information	Maria Hogg	HC Dept. of Fire & Rescue Services
▪ Technical Support – GIS Mapping	John Bussiere, Rob Slivinsky	HC Dept. of Technology & Communication Services

SECTION 5

INTERPRETING THE HAZARD PROFILES

Interpreting the Hazard Profiles

Contents of this Section

Guidance for interpreting HIRA hazard profiles:

I. Overview Guide
II. Hazard Characteristics Guide
III. Likelihood Analysis Guide
IV. Consequence Analysis Guide
V. HIRA Planning Assumptions

The information contained within the HIRA hazard profiles is intended to be interpreted and used for a wide variety of emergency preparedness and planning efforts. Profile organization is consistent among all hazard profiles to allow for easy comparison between hazards. The information and analysis contained in the hazard profiles comes from many distinct sources including published literature, unpublished internal documents, Subject Matter Expert consultation, and independent calculation. This section is a detailed guide to the interpretation of the hazard profiles.

There are 16 manmade hazards and 10 natural hazards profiled by the HIRA. Each of the hazard profiles included in the HIRA is organized into the following sections and sub-sections:

V. OVERVIEW
- Definition
- Risk Profile
- Risk Matrix
- Risk Ranking

VI. HAZARD CHARACTERISTICS
- Description of the Hazard
- Local Context

VII. LIKELIHOOD ANALYSIS
- Occurrence of the Hazard
- Future Likelihood of the Hazard

VIII. CONSEQUENCE ANALYSIS
- Consequence Analysis Overview
- Consequence Analysis: Likely Hazard Scenario
- Consequence Analysis: Worst-Case Hazard Scenario
- Consequence Analysis: Public Perception

I. OVERVIEW GUIDE

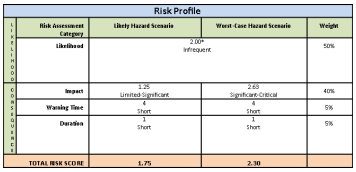
The Overview section defines the hazard and summarizes the hazard risk profile.

Definition

The Definition section contains a concise definition of the hazard. This section establishes the official characterization of the hazard for use in all subsequent Howard County planning and policy efforts. There is a lack of consistent guidance for categorizing and defining hazards, but the hazard definitions contained in the HIRA seek to reflect federal and state guidance whenever possible. All definitions included in the HIRA were selected and approved by the HIRA Steering Committee.

Risk Profile

The Risk Profile section contains the completed risk table specific to the profiled hazard as established by the Howard County Risk Tool. The table characterizes the Likelihood, Consequence, and Risk of the hazard in numerical terms.



Risk Profile			
Risk Assessment Category	Likely Hazard Scenario	Worst-Case Hazard Scenario	Weight
Likelihood	2.00* Infrequent		50%
Impact	1.25 Limited-Significant	2.63 Significant-Critical	40%
Warning Time	4 Short	4 Short	5%
Duration	1 Short	1 Short	5%
TOTAL RISK SCORE	1.75	2.30	

The risk assessment for each hazard is based off of a Likely and a Worst-Case scenario for that specific hazard category. Likely and Worst-Case scenarios were developed by the HIRA Scenario Development Expert team.

- Likely Hazard Scenario refers to the emergency-level hazard scenario that is most likely to occur within the jurisdiction. An emergency-level hazard is any hazard that requires a response from at least two agencies.
- Worst-Case Hazard Scenario refers to the worst hazard scenario that could reasonably occur within the jurisdiction.

The Likelihood of hazard occurrence is characterized by the row labeled Likelihood.

- The Likelihood score was determined by the HIRA Subject Matter Expert teams. Expert teams analyzed historical occurrence data and future trends to assign each hazard an annual probability of future hazard occurrence. This probability was translated into a numerical score as outlined by the Risk Tool.
- The Likelihood score reflects the likelihood of occurrence of any emergency-level hazard in the given category and does not differentiate between Likely and Worst-Case scenarios.

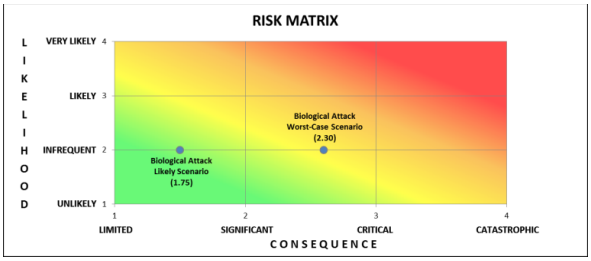
The hazard Consequence is characterized by the rows labeled Impact, Warning Time, and Duration.

- The Impact score was determined by the Consequence Analysis and Subject Matter Expert teams. Expert teams considered Consequence Analysis data and Risk Tool specifications to assign each hazard a Total Impact Score.
- The Warning Time score was assigned by Subject Matter Experts using Risk Tool specifications.
- The Duration score was assigned by Subject Matter Experts using Risk Tool specifications.

The Total Risk Score for each hazard was calculated as specified in the Risk Tool. Scores for Likelihood, Impact, Warning Time, and Duration were multiplied by their associated weighting factor and summed.

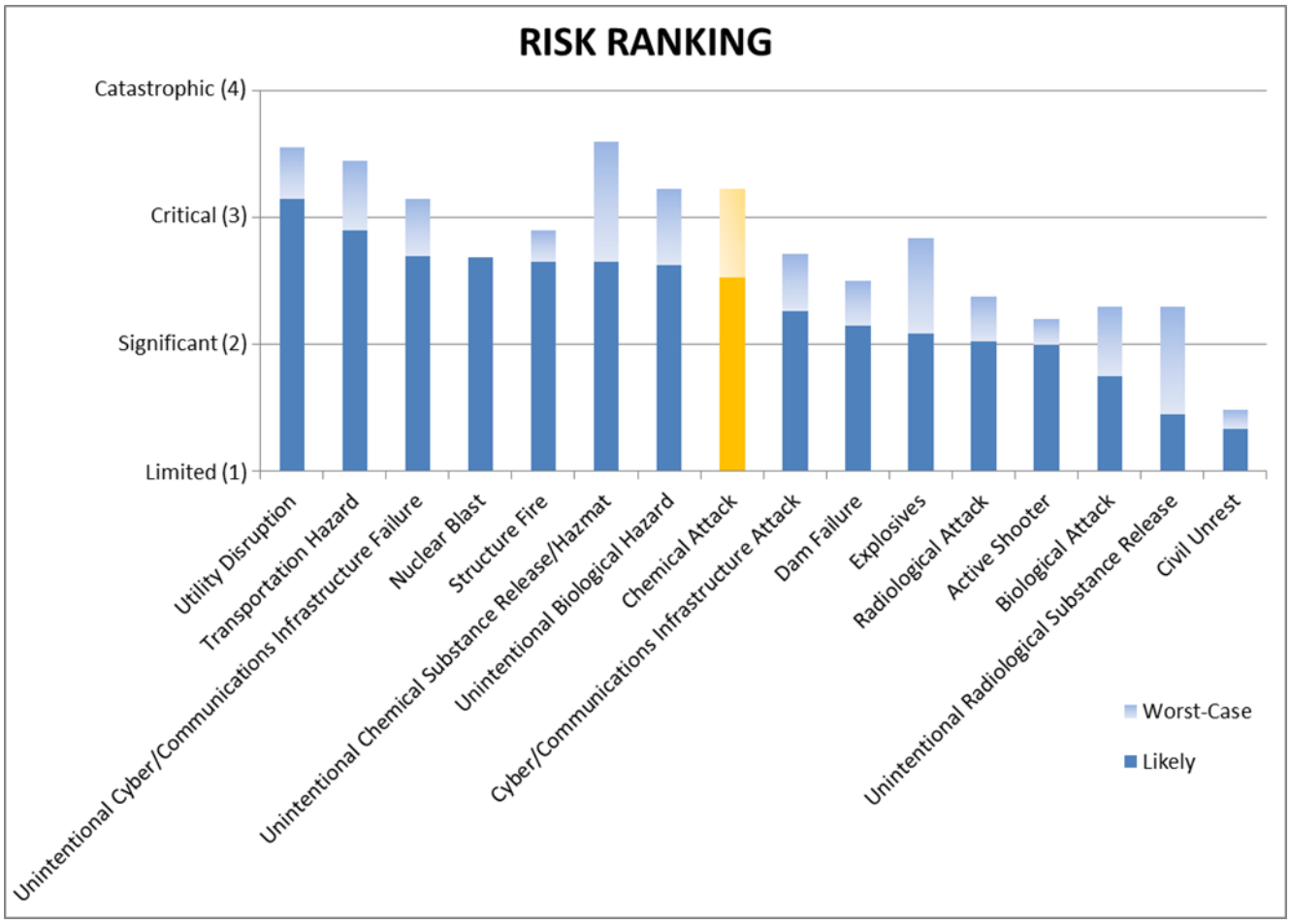
Risk Matrix

The Risk Matrix section contains a graphical illustration of the hazard and its associated Likely and Worst-Case risk. The Risk Matrix demonstrates Likelihood on the graph's Y axis and Consequence on the graph's X axis. The risk score of the hazard is included below the label of each hazard.



Risk Ranking

The Risk Ranking section contains a graphical representation of the Likely and Worst-Case risk scores for each hazard. The hazards are organized from highest risk to lowest risk based on Likely risk score. Worst-Case risk score is demonstrated by a light-blue extension above each risk bar. Where no Worst-Case bar is visible, Worst-Case risk is equivalent to Likely risk. The risk rankings are divided by natural and manmade hazards. The subject of the hazard profile is in gold.



II. HAZARD CHARACTERISTICS GUIDE

The Hazard Characteristics section provides a detailed characterization of the hazard and the local context as it relates to the hazard.

Description of the Hazard

The Description of the Hazard section further elaborates on the concise hazard characterization provided in the initial Definition. This section derives information from many sources including published literature, federal guidance, and Subject Matter Expert consultation. Information in this section is specific to the hazard and is not specific to Howard County.

Local Context

The Local Context section factors specific to Howard County that may impact local risk from a specific hazard. This section may include factors specific to Howard County that affect the likelihood of a hazard's occurrence within the planning area. This section may also include locations, features, or population factors that affect Howard County's vulnerability to the hazard.

III. LIKELIHOOD ANALYSIS GUIDE

The Likelihood Analysis section characterizes the historical occurrence and future likelihood of the hazard in the planning area.

Occurrence of the Hazard

The Occurrence of the Hazard section details the documented occurrence of the hazard inside the planning area during the reviewed time period. Historical Occurrence information comes from internal records and Subject Matter Expert consultation. The reviewed time period reflects the availability of reliable hazard occurrence data in the jurisdiction.

The Notable Incidents sub-section also contains brief profiles of typical or notable occurrences of the hazard in the jurisdiction.

Future Likelihood of the Hazard for Howard County

The Future Likelihood Table outlines the historical and future likelihood of the hazard occurrence inside the planning area.

Future Likelihood of the Hazard in Howard County	
Historical Average (time period)	0 recorded events (1996-2014)
Historical Annual Probability	0% chance of annual occurrence
Future Likelihood Expected to Deviate from Historical Likelihood (Yes/No)	Yes
Future Annual Probability	1-10% chance of annual occurrence
Future Likelihood Score	2.00 (Infrequent)
Future Likelihood reflects the likelihood of any emergency-level hazard event and does not differentiate between Likely and Worst-Case scenarios.	

- Historical Average is calculated based on the Historical Occurrence profiled in the Occurrence of the Hazard section.
- Historical Annual Probability is calculated based on the Historical Average.
- Future Likelihood expectations and Future Annual Probability are decided by Subject Matter Experts through analysis of historical occurrence data and future trends.
- Future Likelihood Score was derived from the Future Annual Probability as outlined by the Risk Tool.
- Future Likelihood reflects the likelihood of any emergency-level hazard event and does not differentiate between Likely and Worst-Case scenarios.

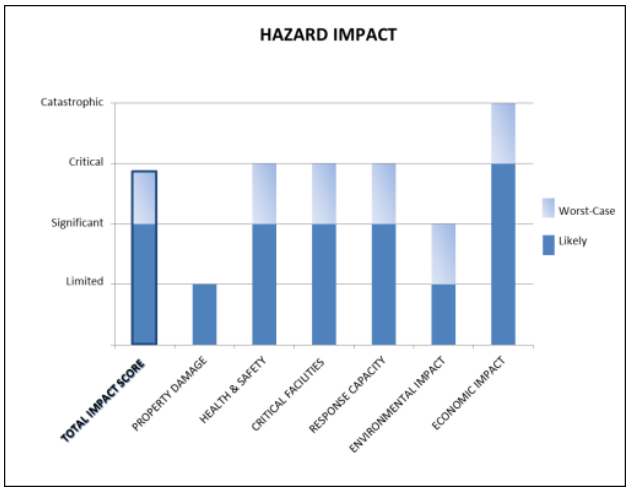
The Considerations sub-section elaborates on the information contained in the Future Likelihood Table. If the future likelihood of hazard occurrence is expected to deviate from historical trends, the factors involved are elaborated in this sub-section. Information in the Considerations sub-section was derived from Subject Matter Expert analysis of historical occurrence and future data trends.

IV. CONSEQUENCE ANALYSIS GUIDE

The Consequence Analysis section provides a detailed characterization of the anticipated consequences of likely and worst-case hazard events. This section characterizes impacts to property, health & safety, critical facilities, response capacity, the environment, and the economy. This section also characterizes public perceptions of each hazard, the perceived impact to personal safety and standard of living, and public confidence in response capability.

Consequence Overview

The Consequence Analysis Overview section contains a graphical representation of the hazard's anticipated impact to property, health & safety, critical facilities, response capacity, the environment, and the local economy.



- The Total Impact Score was determined by Subject Matter Expert teams through extensive consideration of Consequence Analysis data and specifications outlined in the Risk Tool.
- The Impact score for each consequence sub-category was derived from the Consequence Analysis using specifications outlined in the Risk Tool.
- Worst-Case impact score is demonstrated by a light-blue extension above each impact bar. Where no Worst-Case bar is visible, Worst-Case impact is equivalent to Likely impact.

The Warning Time and Duration Table provides additional detail on the anticipated duration of the hazard and the expected warning time prior to hazard onset.

Warning Time & Duration		
	Likely	Worst-Case
WARNING TIME	*Short. No warning time prior to an attack.*	*Short. No warning time prior to an attack.*
DURATION	*Short. Initial hazard will likely last less than 20 minutes. It may take up to 4 hours to declare the hazard location safe.*	*Short. Initial hazard will likely last from 30 minutes– 4 hours. It may take up to 48 hours to remove the hazard and stabilize all people exposed to the hazardous agent.*

- Warning Time refers to the time of awareness prior to the onset of the hazard.
- Duration refers to the time from the onset of the hazard to the point when the hazard ceases to threaten life, property, critical facilities, response capacity, the environment, or the economy.
- Warning Time and Duration are assigned descriptive levels to coincide with the associate score as specified in the Risk Tool.

Consequence Analysis: Likely & Worst-Case Hazard Scenarios

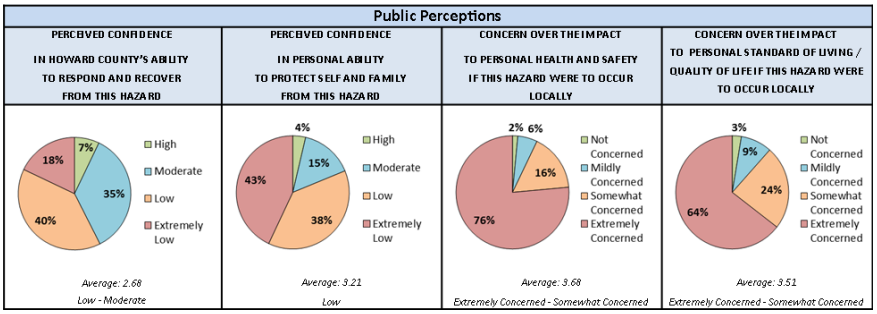
The Consequence Analysis section provides a detailed description of the hazard's anticipated impact to property, health & safety, critical facilities, response capacity, the environment, and the local economy. Each consequence sub-category is assigned a descriptive level to coincide with the associated score as specified in the Risk Tool. The information contained in the Consequence Analysis reflects the data and experience of Subject Matter Experts in each respective field.

Consequence Analysis Likely		
PROPERTY DAMAGE	*Limited*	0% damage to critical and non-critical infrastructure. Anything beyond superficial damage to buildings and structures is unlikely.
HEALTH & SAFETY	*Limited*	No deaths likely. Deaths that do occur could be caused by agent-induced respiratory failure. 20 injuries likely. Injuries will likely only affect those who come into direct contact with the biological agent. The nature of injury will depend on the biological agent, but may include respiratory distress, fever, headache, muscle pain, nausea, and vomiting.
CRITICAL FACILITIES	*Limited*	*Utilities* – Shutdown unlikely. No effect on utilities. *Information/Communications* – Shutdown unlikely. No major impact on information or communications infrastructure.
RESPONSE CAPACITY	*Significant*	*Police* – Mutual aid needed. Terrorism response automatically triggers federal law enforcement involvement. *Fire & Rescue* – Local Resources Adequate. Little to no impact on response capability and continuity of operations. *Health* – Local resources adequate. Health Department operations will not be affected. *Hospitals* – Local resources adequate. Hospital system would successfully manage the patient surge. *Emergency Management* – Local resources adequate. Limited impact to Emergency Management capability.
ENVIRONMENTAL IMPACT	*Limited*	Limited to no environmental impact. Less than a day of clean-up. Impact to a localized area.
ECONOMIC IMPACT	*Limited*	Minimal loss of economic output due to the limited area affected. Other costs include cleanup and healthcare for those affected. 0 jobs lost.
TOTAL IMPACT	*Limited-*	Total Impact Score: 1.25 on a scale of 1 (Limited) to 4 (Catastrophic).
Limited	*Significant*	*Critical*	*Catastrophic*

- Property Damage details the anticipated percentage of Howard County critical and non-critical infrastructure that will suffer damage from the hazard and the type of damage that is expected.
- Health & Safety details the number of deaths and injuries that are expected to result from the hazard and the types of deaths and injuries that are expected.
- Critical Facilities details the expected shutdown duration of essential functions. Utilities, Information/Communication, and Transportation are each assigned a descriptive level to coincide with the associated score as specified in the Risk Tool.
- Response Capacity details the expected shutdown duration of essential response functions. Police, Fire & Rescue, Health, Hospitals, and Emergency Management are each assigned a descriptive level to coincide with the associated score as specified in the Risk Tool.
- Environmental Impact details the hazard's expected impact to the environment.
- Economic Impact details the hazard's impact to the economy of Howard County. Loss of economic output and job loss refer only to the hazard's anticipated effect on the gross domestic product of the jurisdiction as calculated by Subject Matter Expert analysis. Information in this section does not include the costs associated with cleanup or healthcare for those affected.
- The Total Impact Score was determined by Subject Matter Expert teams through extensive consideration of Consequence Analysis data and specifications outlined in the Risk Tool.

Public Perception

The Public Perception section elaborates on the public's confidence and perceptions of consequence as they relate to each hazard category. The associated table illustrates the public response to the questions posed by the Community Survey on Hazards.



The associated table illustrates the public response to the following questions posed by the Community Survey on Hazards:

- Q1: "Please rate your confidence in Howard County's ability to respond to and recover from this hazard."
- Q2: "Please rate your confidence in your own ability to protect yourself and your family from this hazard."
- Q3: "How concerned would you be for the physical safety of yourself and your loved ones if this hazard event were to occur in Howard County? (assume that you are in the County but not in the immediate hazard area)."
- Q4: "How concerned would you be for your ability to maintain your current standard of living and quality of life if this hazard event were to occur in Howard County? (assume that you are in the County but not in the immediate hazard area)."

V. HIRA PLANNING ASSUMPTIONS

This section details the strategic assumptions made during the development of the HIRA.

It is important to understand the assumptions made by the Howard County Hazard Identification and Risk Assessment (HIRA). Assumptions are pieces of information that are assumed to be true in order to draw conclusions from the available data. If an assumption is in doubt or proves to be inaccurate, the conclusions based on this assumption may also be incorrect. Prior to interpreting the information in the HIRA, it is important to review the planning assumptions to assure its continued validity.

- The HIRA assumes that the likelihood and expected consequences of the included hazards have not changed since the data was collected.
  Analysis: The HIRA is updated at strategic intervals. However, if there is reason to believe that there have been significant changes to the likelihood or expected consequence of a hazard since the last update, caution should be taken when interpreting the Risk Score.

- The HIRA assumes that Subject Matter Experts provided accurate insight into their designated area of expertise.
  Analysis: Great effort was put forth to select a team of local Subject Matter Experts with exceedingly high levels of knowledge, experience, and access to information in their designated areas of expertise. However, if there is reason to believe that information provided by Subject Matter Experts is not accurate, caution should be taken when interpreting all components of the HIRA.

- The Risk Scores for the Worst-Case hazard scenarios assume that the likelihood of the hazard occurring inside the planning area is equal to the likelihood of the Worst-Case hazard occurring inside the planning area.
  Analysis: Although data is unavailable for rare events, it is likely that the Worst-Case hazard scenario is far less likely than indicated by the Likelihood score. The Worst-Case scenario is intended primarily to demonstrate the possible severity of the hazard. Caution should be taken when interpreting Worst-Case Risk Scores in the absence of additional data.

- The Impact score assumes hazards with the highest possible Impact score (4=Catastrophic) are equal.
  Analysis: A limitation of the Risk Tool is that it is unable to capture differences in Impact among catastrophic events. A hazard event resulting in 50 deaths will receive the same Impact score as a hazard event resulting in 500 deaths. Similarly, a hazard event resulting in 50 deaths will receive the same Impact score as a hazard event with no deaths resulting in catastrophic consequences to property, the environment, and the economy. Caution should be taken when interpreting the Impact score in absence of the full Consequence Analysis.

- The Public Perception tables assume that the sampled population is representative of the entire population in Howard County.
  Analysis: The information on Public Perception is intended to be interpreted with caution. Although effort was made to sample outside of traditional government circles, the sample of 463 respondents was not random and may not be representative of the entire population. Caution should be taken when drawing broad conclusions from Public Perception results.

SECTION 6

RISK OVERVIEW

Risk Overview

Contents of this Section

- **I.** Hazard Definitions
- **II.** Risk Overview Charts

I. HAZARD DEFINITIONS

This section defines the hazard and summarizes the hazard risk profile.

The Howard County Hazard Identification and Risk Assessment (HIRA) provides a detailed analysis of 16 manmade hazards and 10 natural hazards. Below is a description of each of the hazards addressed in the HIRA:

ADVERSARIAL/INTENTIONAL HAZARDS	
Chemical Attack: A Chemical Attack hazard results from the intentional release of potentially harmful chemicals into the environment. Agents used in Chemical Attacks include poisonous vapors, aerosols, liquids, and solids that have toxic effects.	**Active Assailant:** An Active Assailant hazard refers to an individual actively engaging in killing or attempting to kill people in a confined or populated area. Active Assailant hazards are typically characterized by the assailant's intent to kill with no pattern or method to their selection of victims.
Biological Attack: A Biological Attack is an intentional release of viruses, bacteria, or other germs (agents) used to cause illness or death in people, animals, or plants. Biological agents can be introduced and spread through a population by air, through direct contact, through water, or through food.	**Cyber/Communications Infrastructure Attack:** A Cyber/Communications Infrastructure Attack is an intentional disruption or manipulation of the information and communication systems used to collect, filter, process, create, and distribute data. An attack of this type may seek to impact data or manipulate data to impact physical infrastructure.
Radiological Attack: A Radiological Attack hazard occurs when a population is intentionally exposed to radiation through a non-nuclear mechanism. A Radiological Attack may take the form of a radiological exposure device (RED) or a radiological dispersal device (also known as a dirty bomb or RDD).	**Explosives:** An Explosives hazard occurs when an explosive device is intentionally used to cause harm to people, property, operational capacity, or the environment.
Nuclear Blast: A nuclear blast is the result of a device that uses a nuclear reaction to create an explosion far more powerful than that of conventional explosives. When nuclear weapons or improvised nuclear devices (INDs) explode, the energy is violently released in the form of a blast wave, intense light, heat, and radiation.	**Civil Unrest:** Civil Unrest is often the result of ideological conflict and may include protests, riots, demonstrations, civil disobedience, and other forms of obstruction. Although many expressions of Civil Unrest are safe and legal, a Civil Unrest hazard occurs when the level of public disorder becomes a threat to health, safety, and property.

TECHNOLOGICAL/ACCIDENTAL HAZARDS	
Utility Disruption: A Utility Disruption hazard occurs when the disruption of the gas, water, or electrical infrastructure has the potential to cause harm. Utility Disruption hazards can be intentional, unintentional, or occur as a cascading effect of another hazard.	**Unintentional Chemical Substance Release/Hazmat:** An Unintentional Chemical Substance Release/Hazmat hazard occurs when a chemical with the potential to cause harm is accidentally released into the environment. Chemical hazardous materials come in the form of explosives, flammable and combustible substances, and poisons.
Structure Fire: A Structure Fire hazard is an uncontrolled fire involving any building or structure. Structure Fires can occur in a residential, commercial, or industrial setting. Fires can easily spread from one structure to another, and the size of a Structure Fire hazard is constantly evolving.	**Disease Epidemic/Unintentional Biological Hazard:** An Disease Epidemic/Unintentional Biological Hazard is the natural or inadvertent spread of potentially harmful viruses, bacteria, parasites, or other biological disease-causing agents. Disease Epidemic/Unintentional Biological Hazards typically result from the natural spread of infectious disease (epidemics/pandemics), but they may also result from the accidental release of biological agents from health care facilities, research institutions, or industrial operations.
Transportation Hazard: A Transportation Hazard occurs whenever a vehicle accident or collision has the potential to cause harm. Any vehicle is capable of being involved in a Transportation Hazard. The most common types of Transportation Hazards involve automobiles, trains, airplanes, or boats.	**Unintentional Radiological Substance Release:** An Unintentional Radiological Substance Release hazard occurs when radiation is accidentally discharged into the environment. Unintentional Radiological Substance Release can occur as the result of a nuclear power plant accident, a transportation accident, or a workplace incident involving radioactive materials.
Dam Failure: A Dam Failure hazard occurs when part or all of a dam's water-retaining barrier becomes damaged causing the uncontrolled release of water downstream. A Dam Failure hazard can be the result of a design or construction error, insufficient maintenance, human error, or internal erosion. Dam Failures can also occur as the result of an intentional attack or as a cascading effect of natural hazards such as flooding, earthquakes, or geological instability.	**Unintentional Cyber/Communications Infrastructure Failure:** An Unintentional Cyber/Communications Infrastructure Failure hazard occurs when an accidental disruption affects computerized data, information systems, or other communication systems. Unintentional failure may result from human error, infrastructure limitations, or the cascading effects of another hazard.

Natural Hazards	
Drought: A drought is a condition of moisture deficit sufficient to have an adverse effect on vegetation, animals, and humans over a sizeable area. It usually refers to a period of below-normal rainfall, but drought can also be caused by drying bores or lakes or anything that reduces the amount of liquid water	**Earthquake:** An earthquake is a sudden release of energy from the earth's crust that creates seismic waves. Tectonic plates become stuck, thus putting a strain on the ground. When the strain becomes so great that rocks give way, fault lines occur. At the earth's surface, earthquakes may manifest themselves

available.	by a shaking or displacement of the ground.
Flooding: Flooding is defined as the accumulation of water that exceeds a physical barrier or collects in a low lying area that leads to the inundation of an area. Flooding typically results from large scale weather systems that generate prolonged or highly impactful rainfall. Other conditions such as winter snow thaws, over-saturated soil, ice jams breaking apart, and urbanization can cause flooding as well.	**Hurricanes/Tropical Storms:** Hurricanes, tropical storms, and typhoons are collectively known as tropical cyclones. NOAA defines a tropical cyclone as a "warm-core non-frontal synoptic-scale cyclone, originating over tropical or subtropical waters, with organized deep convection and a closed surface wind circulation about a well-defined center. Once formed, a tropical cyclone is maintained by the extraction of heat energy from the ocean at high temperature and heat export at the low temperatures of the upper troposphere."
Lightning: Lightning events are generated by atmospheric imbalance and turbulence due to a combination of conditions. Lightning, which occurs during all thunderstorms, can strike anywhere. Generated by the buildup of charged ions in a thundercloud, the discharge of a lightning bolt interacts with the best conducting object or surface on the ground.	**Severe Winter Weather:** A winter storm is a weather event that produces forms of precipitation caused by cold temperatures, such as snow, sleet, ice, and freezing rain, while ground temperatures are cold enough to cause precipitation to freeze. Windy conditions may also be present during a winter storm.
Tornadoes: A tornado is "a violently rotating column of air, pendant from a cumuliform cloud or underneath a cumuliform cloud, and often (but not always) visible as a funnel cloud." Tornadoes are related to larger vortex formations, and therefore often form in convective cells such as thunderstorms or in the right forward quadrant of a hurricane, far from the hurricane eye.	**Wildfires:** Wildfires are uncontrolled forest fires, grassland fires, rangeland, or urban-interface fires which consume natural fuels and spread in response to the environment. Wildfires can be either a natural phenomenon or human-caused. The frequency and severity of wildfires depends on both weather and human activity.
Animal-Pest Infestation: Pest infestation is the occurrence of one or more pest species in an area or location where their numbers and impact are currently or potentially at intolerable levels.	**Space Weather:** Space weather refers to a variety of eruptions of mass and energy from the solar surface. Flares, prominences, sunspots, and coronal mass ejections are the common harbingers of solar activity, as are plages and other related phenomena seen at other wavelengths. They all involve sudden releases of stored magnetic energy, which accelerates the hot gases near the surface or in the corona of the Sun.

II. RISK OVERVIEW CHARTS

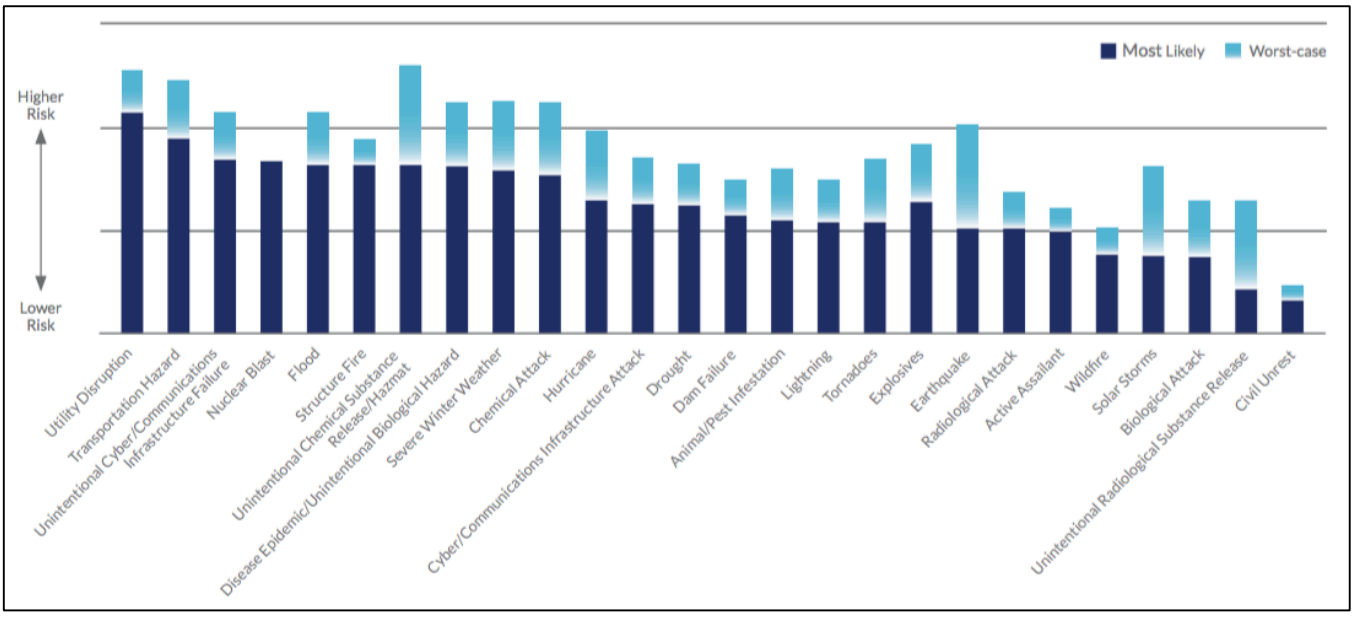
The Risk Overview charts compare hazards based on Risk Score, Likelihood, Total Impact, Impact to Property, Impact to Health & Safety, Impact to Critical Facilities, Impact to Response Capacity, Impact to the Environment, and Impact to the Economy.

All information is specific to Howard County.

Unless otherwise noted, charts are based on the most likely hazard scenario with the worst-case scenario represented as a shaded extension above each bar.

Risk Ranking

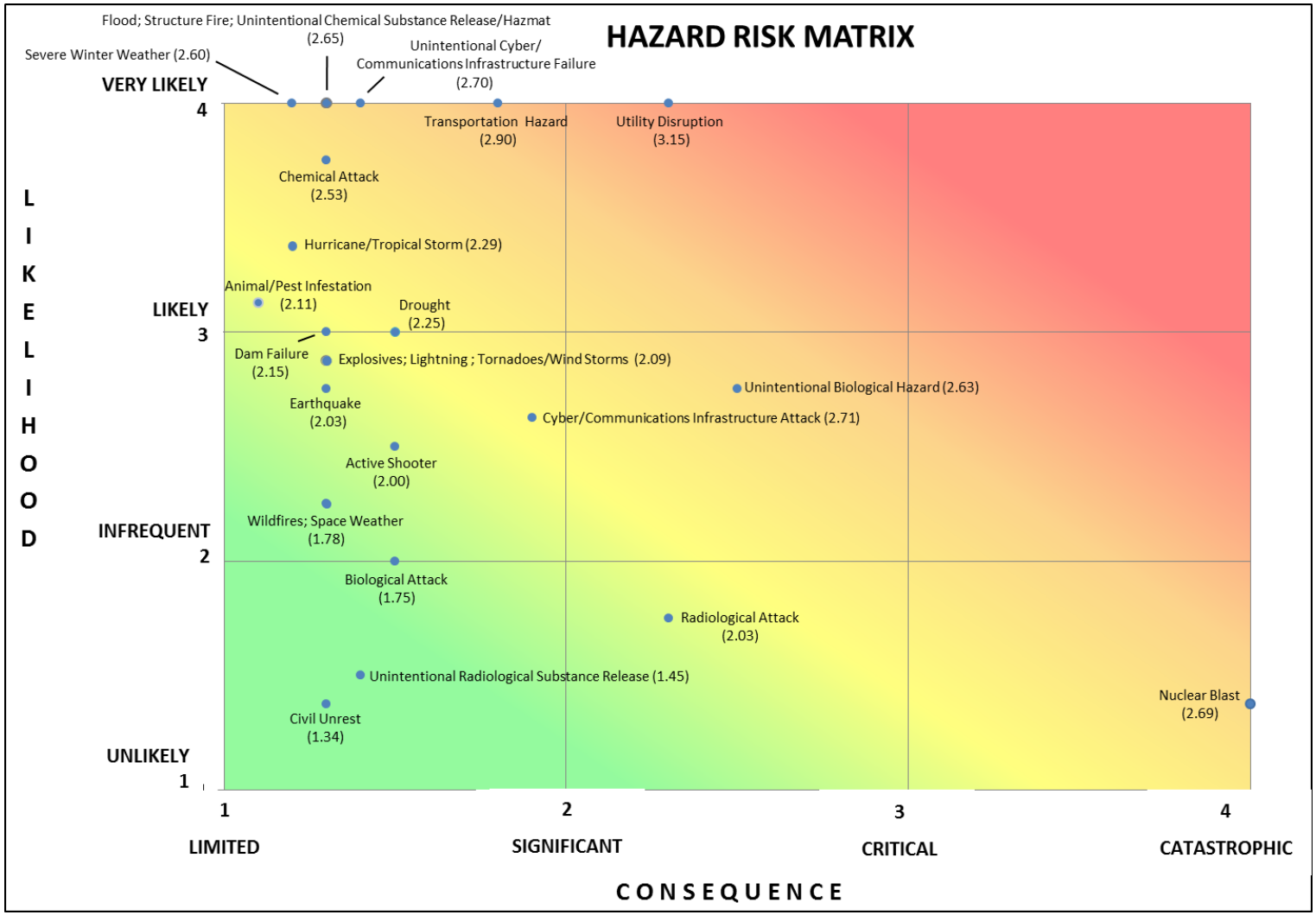
The Risk Ranking lists hazards by total Risk Score. Risk is a function of Likelihood and Consequence. Ranking is from highest risk to lowest risk.



Where no Worst-Case bar is visible, Worst-Case risk is equivalent to Likely risk

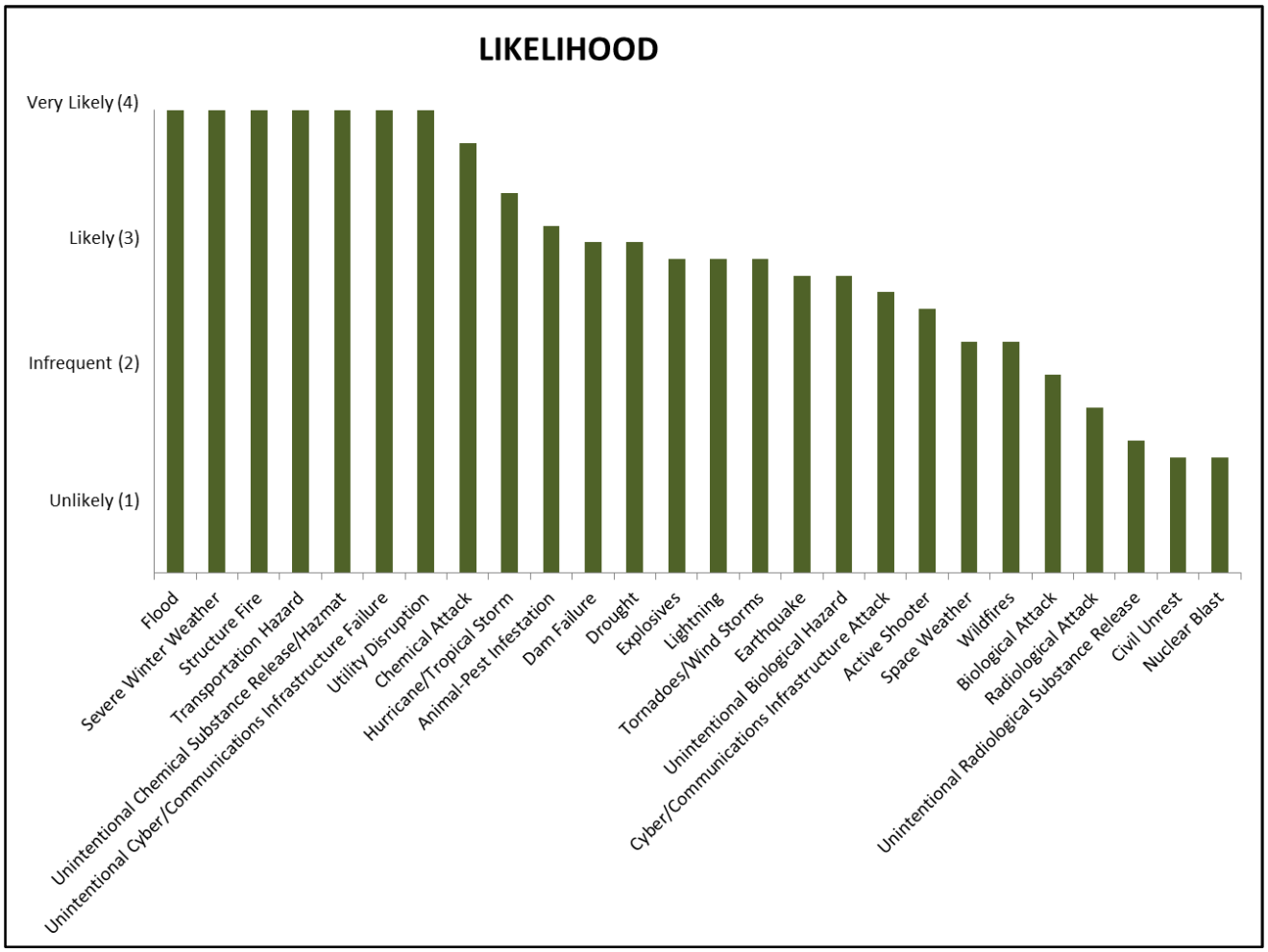
Risk Matrix

The Risk Matrix illustrates hazard risk graphically by Likelihood and Consequence. Hazards are plotted base on the most likely hazard scenario. Total Risk Score is noted in parentheses for each hazard category.



Likelihood

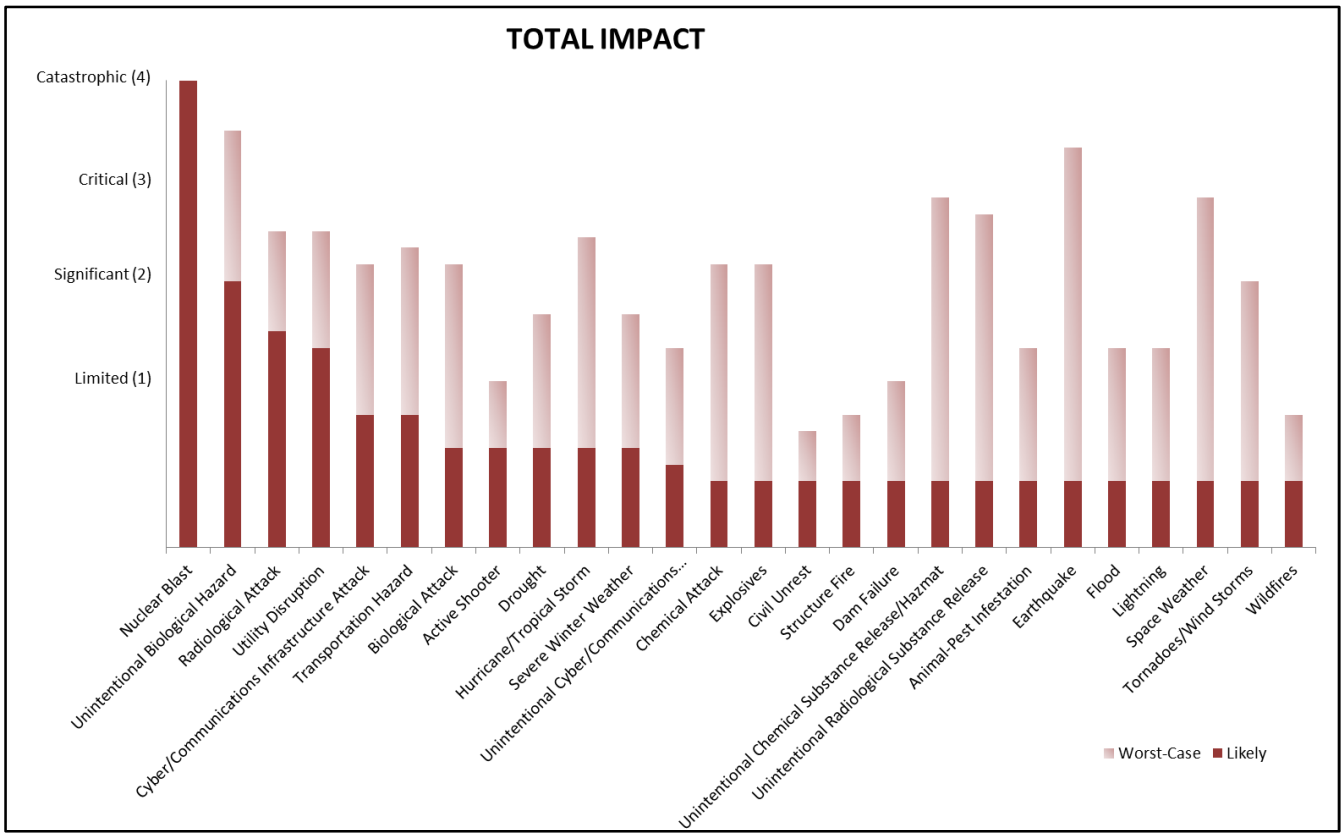
The Likelihood chart lists hazards by the anticipated future annual likelihood of the hazard's occurrence.
Very Likely = 30+ chance of annual occurrence. *Likely* = 11-30% chance of annual occurrence.
Infrequent = 1-10% chance of annual occurrence. *Unlikely* = Less than 1% chance of annual occurrence.



The likelihood that a hazard will occur does not differentiate between Likely and Worst-Case.

Total Impact

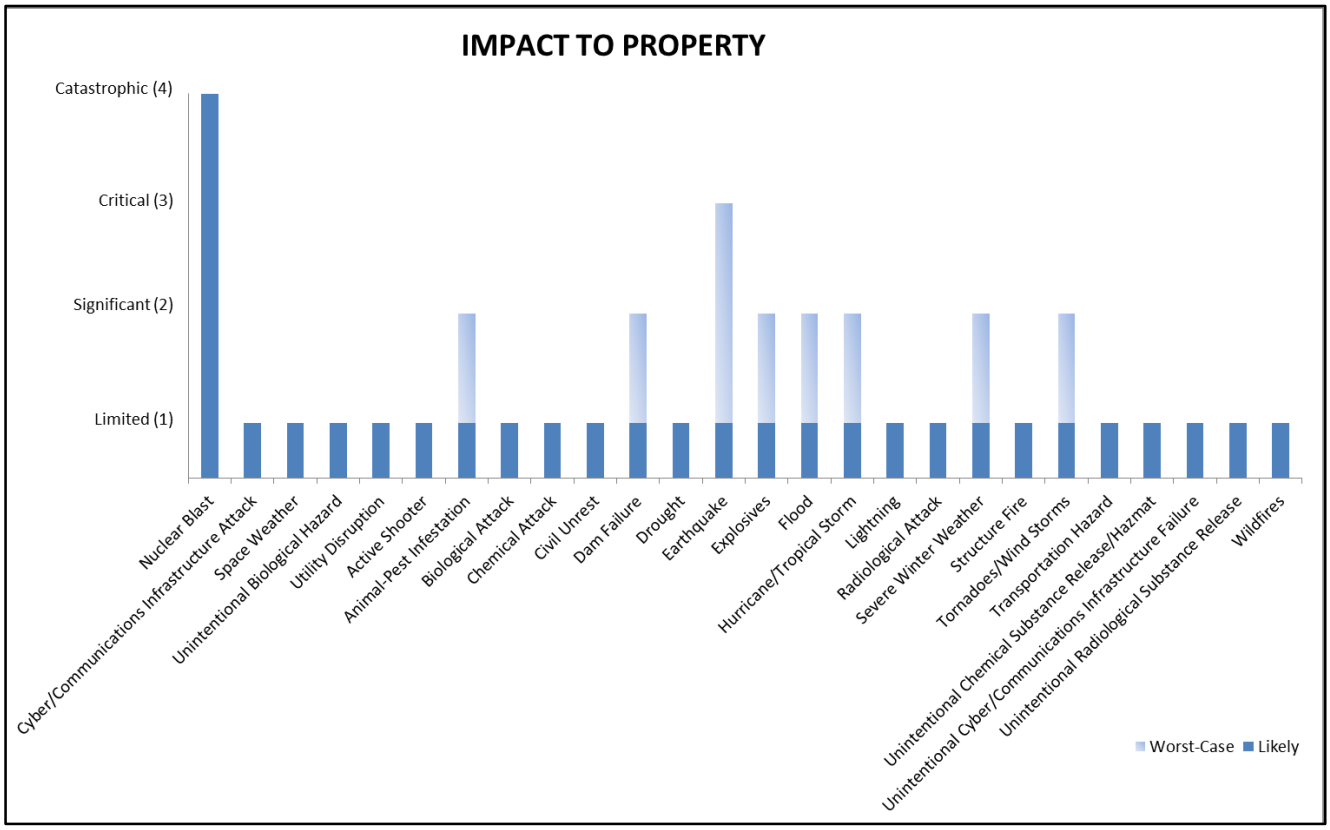
The Total Impact chart lists hazards by Total Impact Score. Total Impact is a combined measure that includes impact to property, health & safety, critical facilities, response capacity, the environment, and the economy.



Where no Worst-Case bar is visible, Worst-Case impact is equivalent to Likely impact.

Impact to Property

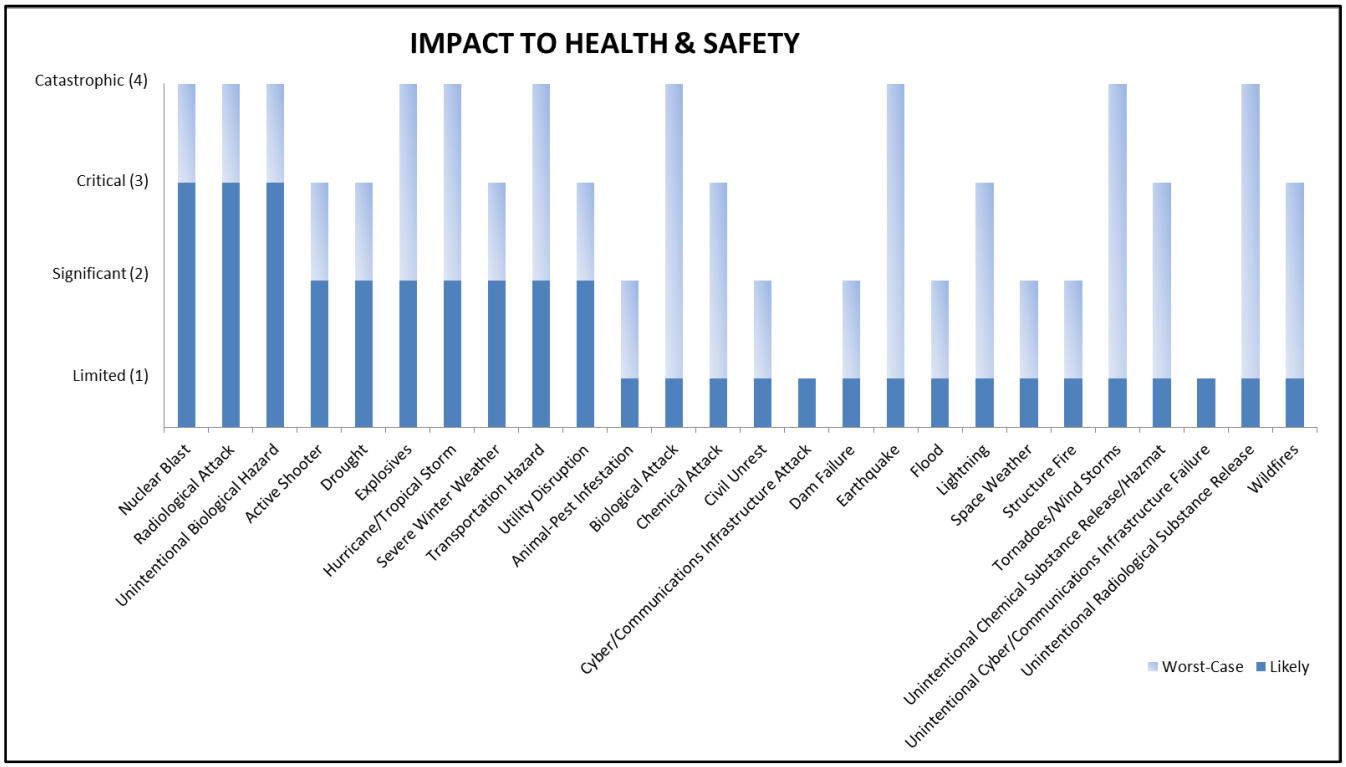
The Impact to Property chart lists hazards and their associated impact to critical and non-critical infrastructure.



Where no Worst-Case bar is visible, Worst-Case impact is equivalent to Likely impact.

Impact to Health & Safety

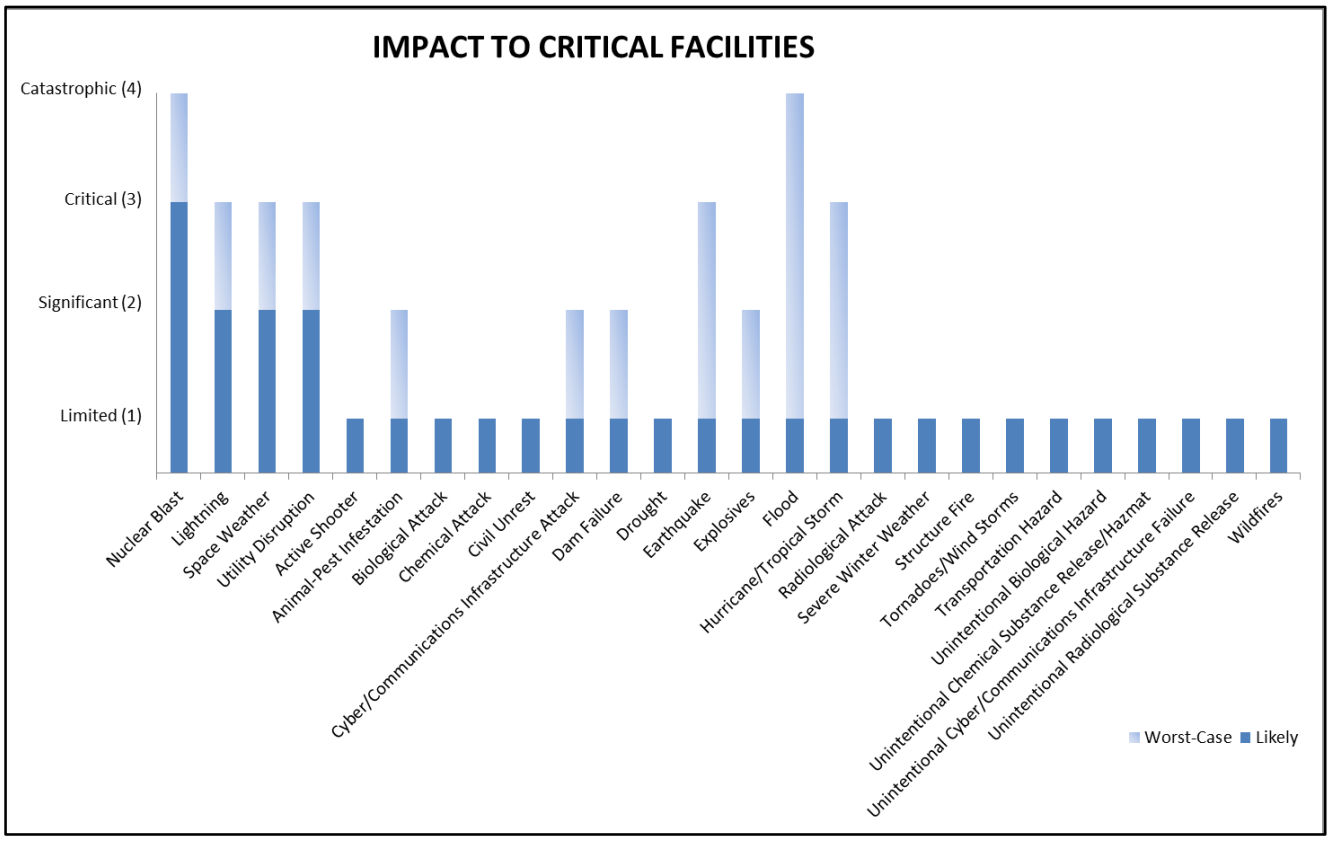
The Impact to Health & Safety chart lists hazards and their associated impact to life and health.



Where no Worst-Case bar is visible, Worst-Case impact is equivalent to Likely impact.

Impact to Critical Facilities

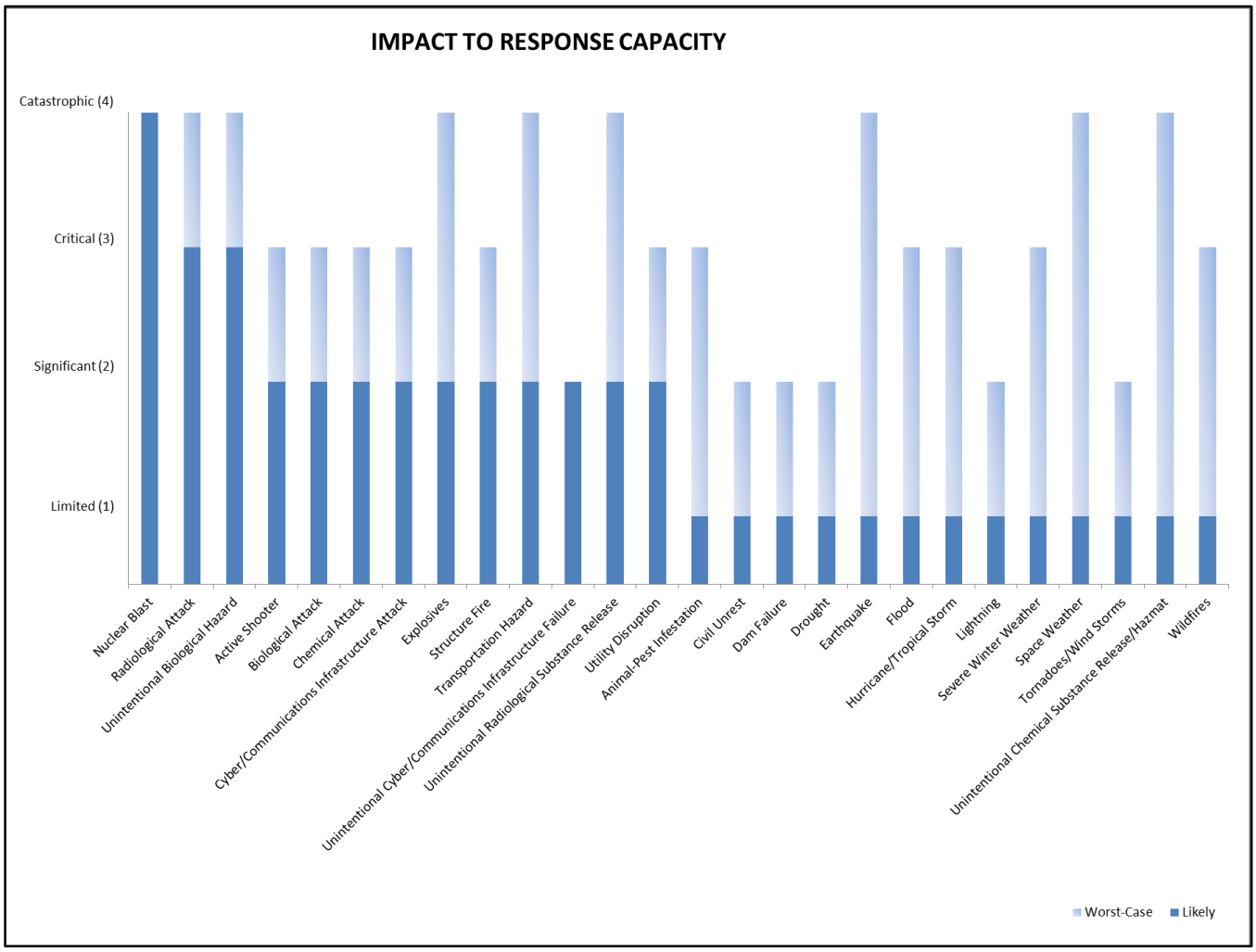
The Impact to Critical Facilities chart lists hazards and their associated impact to critical functions including utilities, information/communication systems, and transportation.



Where no Worst-Case bar is visible, Worst-Case impact is equivalent to Likely impact.

Impact to Response Capacity

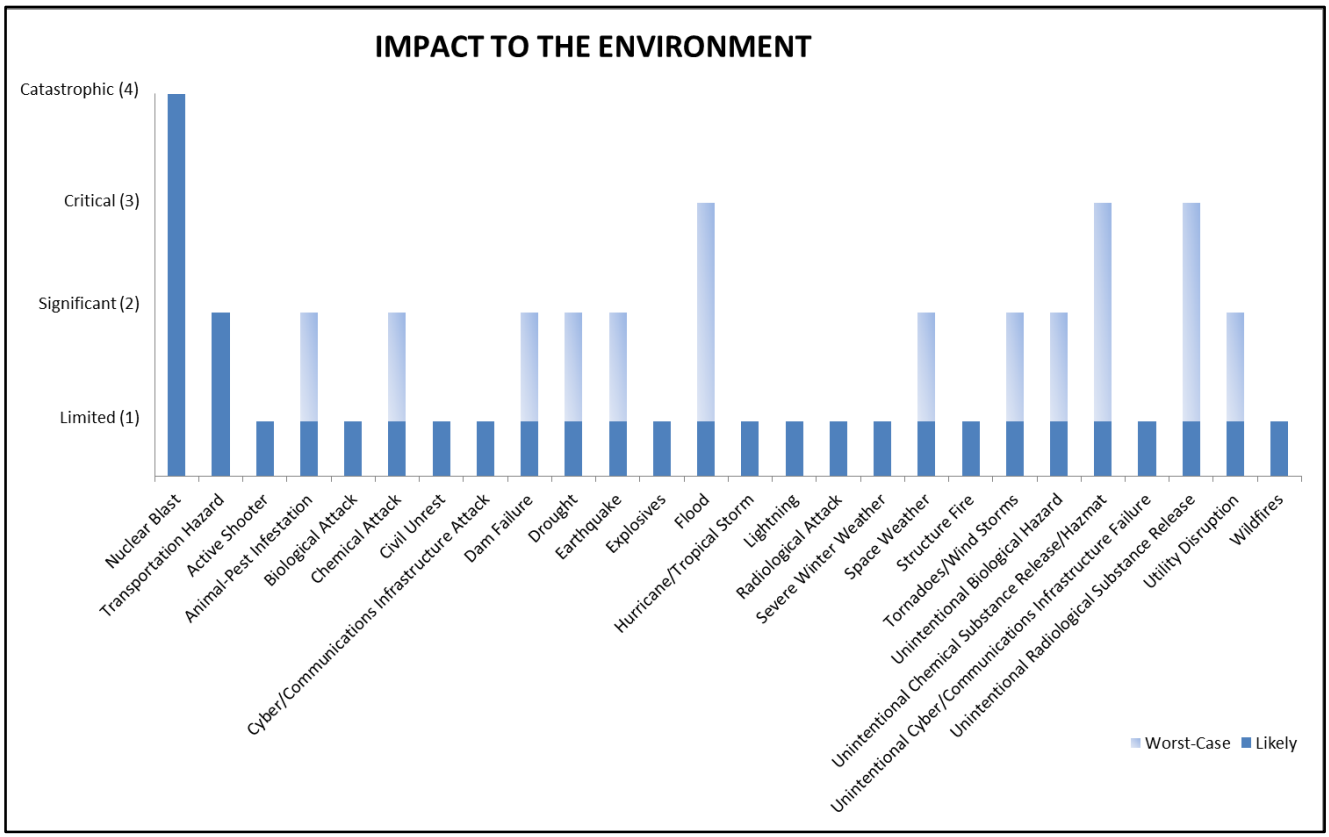
The Impact to Response Capacity chart lists hazards and their associated impact to response systems including police, fire & rescue, health, hospitals, and emergency management.



Where no Worst-Case bar is visible, Worst-Case impact is equivalent to Likely impact.

Impact to the Environment

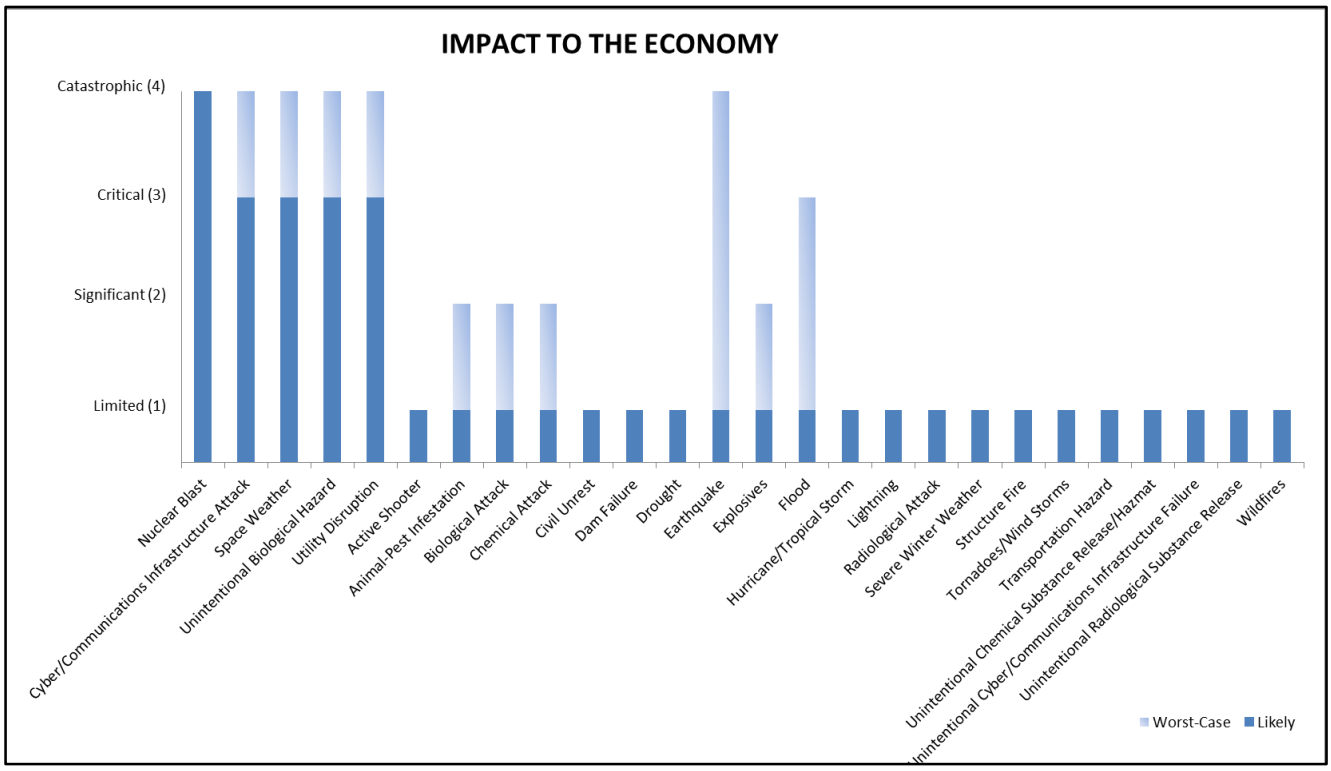
The Impact to the Environment chart lists hazards and their associated impact to the air, land, water, and wildlife.



Where no Worst-Case bar is visible, Worst-Case impact is equivalent to Likely impact.

Impact to the Economy

The Impact to the Economy chart lists hazards and their associated impact to the gross domestic product and economic functions in the region.



Where no Worst-Case bar is visible, Worst-Case impact is equivalent to Likely impact.

SECTION 7

MANMADE HAZARD PROFILES

Active Assailant

I. OVERVIEW

The Overview section defines the hazard and summarizes the hazard risk profile.

Definition

This section defines the scope of the hazard category. The terminology and characterization established in this section should be consistent throughout all Howard County planning documents.

An Active Assailant hazard refers to "an individual actively engaged in killing or attempting to kill people in a confined or populated area."[1] Active Assailant hazards, occasionally referred to as active killers, active shooters, or active threats, are typically characterized by the assailant's intent to kill with no pattern or method to their selection of victims. Typically, Active Assailants use firearms and work alone. However, an Active Assailant hazard can involve multiple shooters and/or weapons other than firearms.

Risk Profile

The Risk Profile section presents the Risk Score for the hazard in a range from 1 (lowest risk) to 4 (highest risk). Risk Score is a function of Likelihood and Consequence.

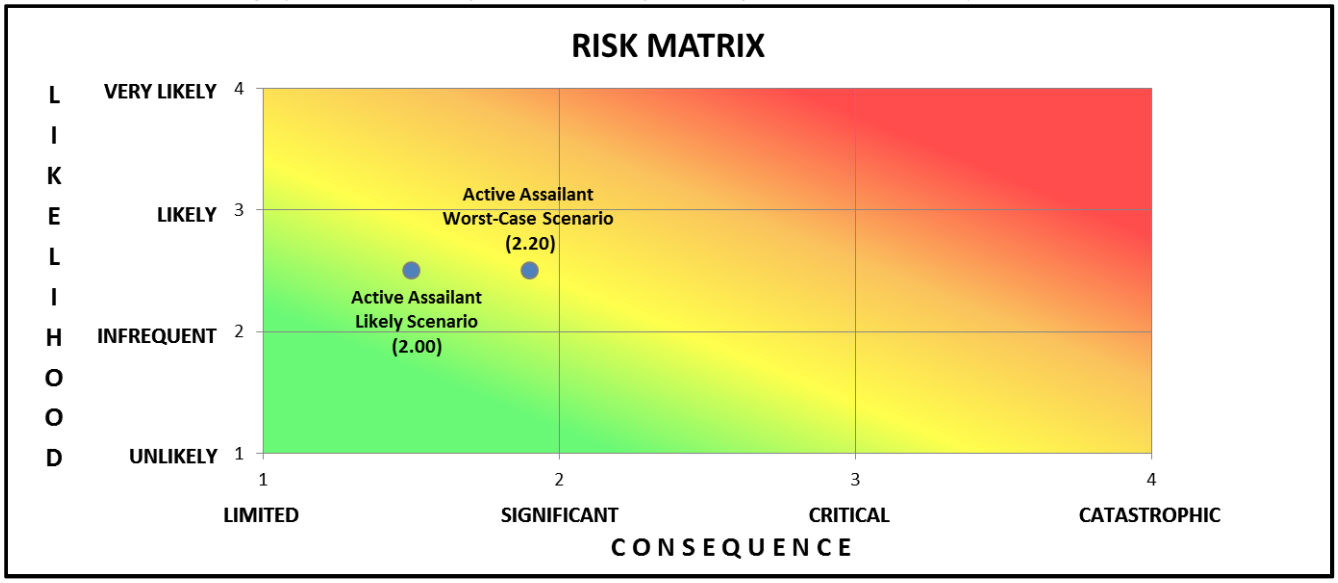
Active Assailant Risk Profile				
	Risk Assessment Category	**Likely Hazard Scenario**	**Worst-Case Hazard Scenario**	**Weight**
LIKELIHOOD	**Likelihood**	2.50* Infrequent-Likely		50%
CONSEQUENCE	**Impact**	1.25 Limited-Significant	1.75 Limited-Significant	40%
	Warning Time	4 Short	4 Short	5%
	Duration	1 Short	1 Short	5%
	TOTAL RISK SCORE	**2.00**	**2.20**	

**The Likelihood Score reflects the likelihood of any emergency-level hazard event and does not differentiate between Likely and Worst-Case scenarios.*

[1] *Active Shooter, How to Respond*, U.S. Dept. of Homeland Security (2008). Available at http://www.dhs.gov/xlibrary/assets/active_shooter_booklet.pdf (last accessed March 26, 2014).

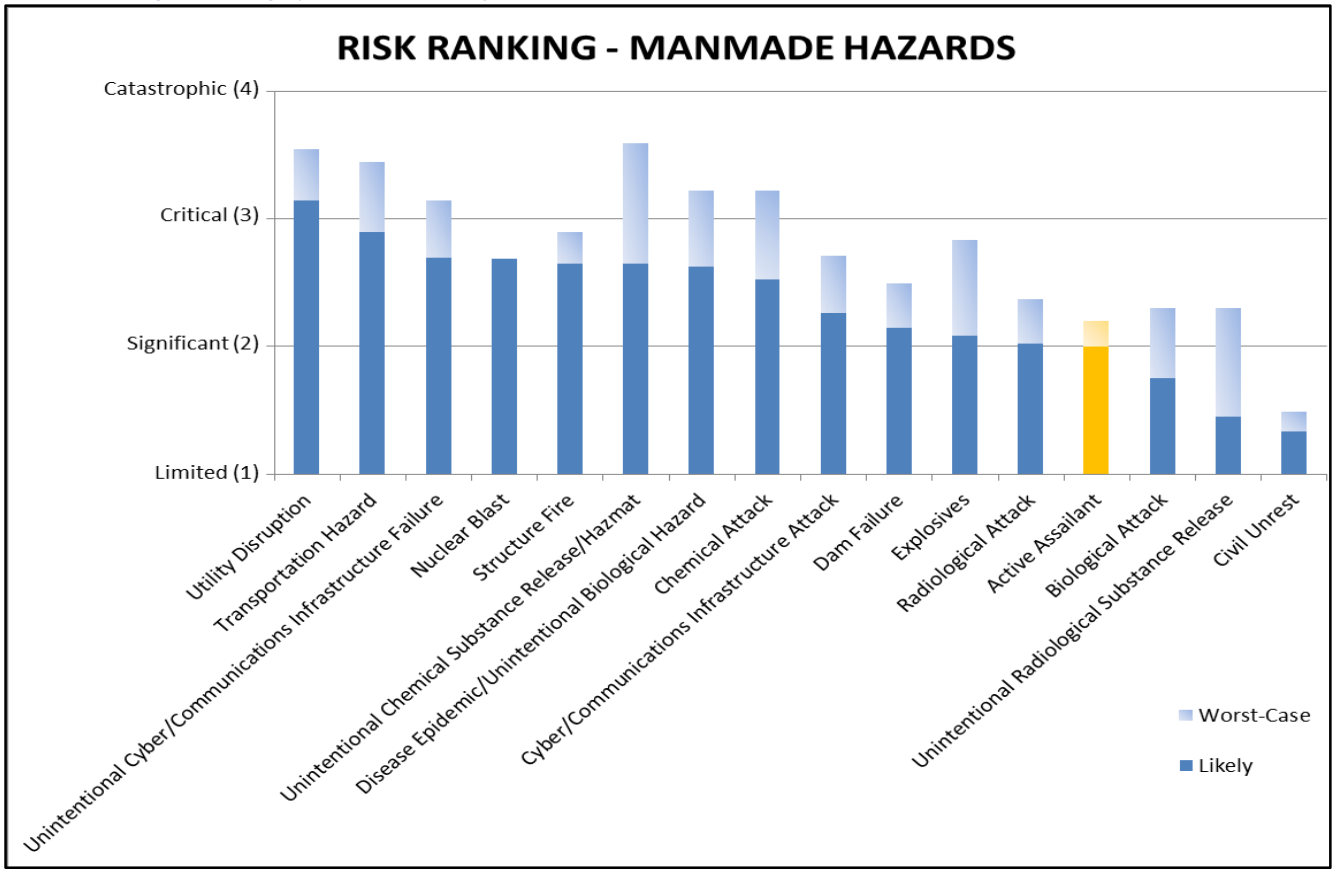
Risk Matrix

The Risk Matrix chart is a graphical illustration of hazard Risk as a function of Likelihood and Consequence.



Risk Ranking

The Risk Ranking chart is a graphical illustration of hazard Risk as it relates to other hazards.



Where no Worst-Case bar is visible, Worst-Case Risk is equivalent to Likely Risk.

II. HAZARD CHARACTERISTICS

The Hazard Characteristics section provides a detailed characterization of the hazard and the local context as it relates to the hazard.

Description of the Hazard

The characteristics of an Active Assailant hazard[2] are variable depending on the location, the number of individuals involved, and the weapon or weapons used in the attack. Most Active Assailant attacks involve some type of firearm, and approximately 36% of Active Assailant attacks involve more than one weapon. Weapons used in Active Assailant attacks have included handguns, hunting rifles, assault rifles, shotguns, knives.

98% of Active Assailant incidents are carried out by a single assailant. However, rare incidents involve two or more attackers.

Nearly half of Active Assailant attacks occur in commercial facilities such as office buildings, factories, malls, or other retail locations. Another 29% of Active Assailant incidents occur in schools.

Active Assailant attacks typically result in anywhere from 0-7 deaths and injuries. Most Active Assailant attacks result in fewer than five deaths. However, in extreme cases Active Assailant incidents have resulted in over 30 fatalities with up to 20 additional wounded. Incidents may involve hundreds of bystanders who witness violence or need to shelter in place while the incident unfolds.

Active Assailant attacks typically last less than 15 minutes. However, it may take several hours to ensure that the area is safe. Very few Active Assailant events last longer than one day.

Local Context

The Local Context section describes community attributes that affect the likelihood of the hazard's occurrence or vulnerability to the hazard's consequences.

An Active Assailant attack can occur anywhere in Howard County. Likely targets for Active Assailant attacks in Howard County include densely populated public areas such as schools, commercial facilities, event venues, and office buildings. However, Active Assailant attacks in the United States have involved an extremely wide range of locations, weapons, and motivating factors, and it is difficult to predict specific locations or vulnerability factors at a county level.[3]

[2] *Active Shooter Recommendations and Analysis for Risk Mitigation*, New York City Police Dept. Available at http://www.nyc.gov/html/nypd/downloads/pdf/counterterrorism/ActiveShooter.pdf (last accessed April 1, 2014).
[3] *Manmade Hazard Identification and Risk Assessment Workshop (unpublished)*, Howard County OEM (2014).

III. LIKELIHOOD ANALYSIS

The Likelihood Analysis section characterizes the historical occurrence and future likelihood of the hazard in the planning area.

Occurrence of the Hazard

The Occurrence of the Hazard section details the historical occurrence of the hazard in the planning area.

There has been 1 Active Assailant hazard event in Howard County during the reviewed time period (1964-2014).

Notable Incidents in Howard County

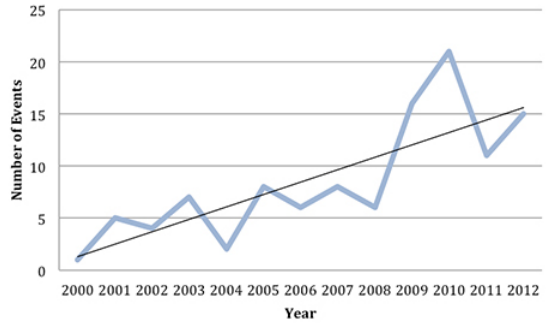
2014 Columbia Mall Shooting - A single assailant brought a concealed shotgun and several crude explosives into The Mall in Columbia on January 25th, 2014. The shooter opened fire in a second-story retail store, killing two employees, striking a third person in the foot, and ultimately taking his own life. The assailant did not know any of the victims prior to the attack.

Future Likelihood of the Hazard for Howard County

The Future Likelihood section anticipates the future occurrence rate of the hazard based on historical likelihood and future trends. This section also addresses factors that may cause the future likelihood to deviate from historical trends.

Future Likelihood of an Active Assailant Attack Hazard in Howard County	
Historical Average (time period)	1 event every 50 years (1964-2014)
Historical Annual Probability	2% chance of annual occurrence
Future Likelihood Expected to Deviate from Historical Likelihood (Yes/No)	Yes
Future Annual Probability	1-30% chance of annual occurrence
Future Likelihood Score[4]	2.5 (Infrequent-Likely)
Future Likelihood reflects the likelihood of any emergency-level hazard event and does not differentiate between Likely and Worst-Case scenarios.	

Considerations: The future likelihood of an Active Assailant attack in Howard County is expected to be slightly higher than indicated by the historical occurrence rate alone. Likelihood estimates for a future attack have a wide range of variability, but current estimates predict a 1-30% chance of annual occurrence, or one event every 3-99 years. The increased incidence of Active Assailant attacks[4] and increased media attention at the national level both contribute to the increased likelihood of Active Assailant attacks in the future.



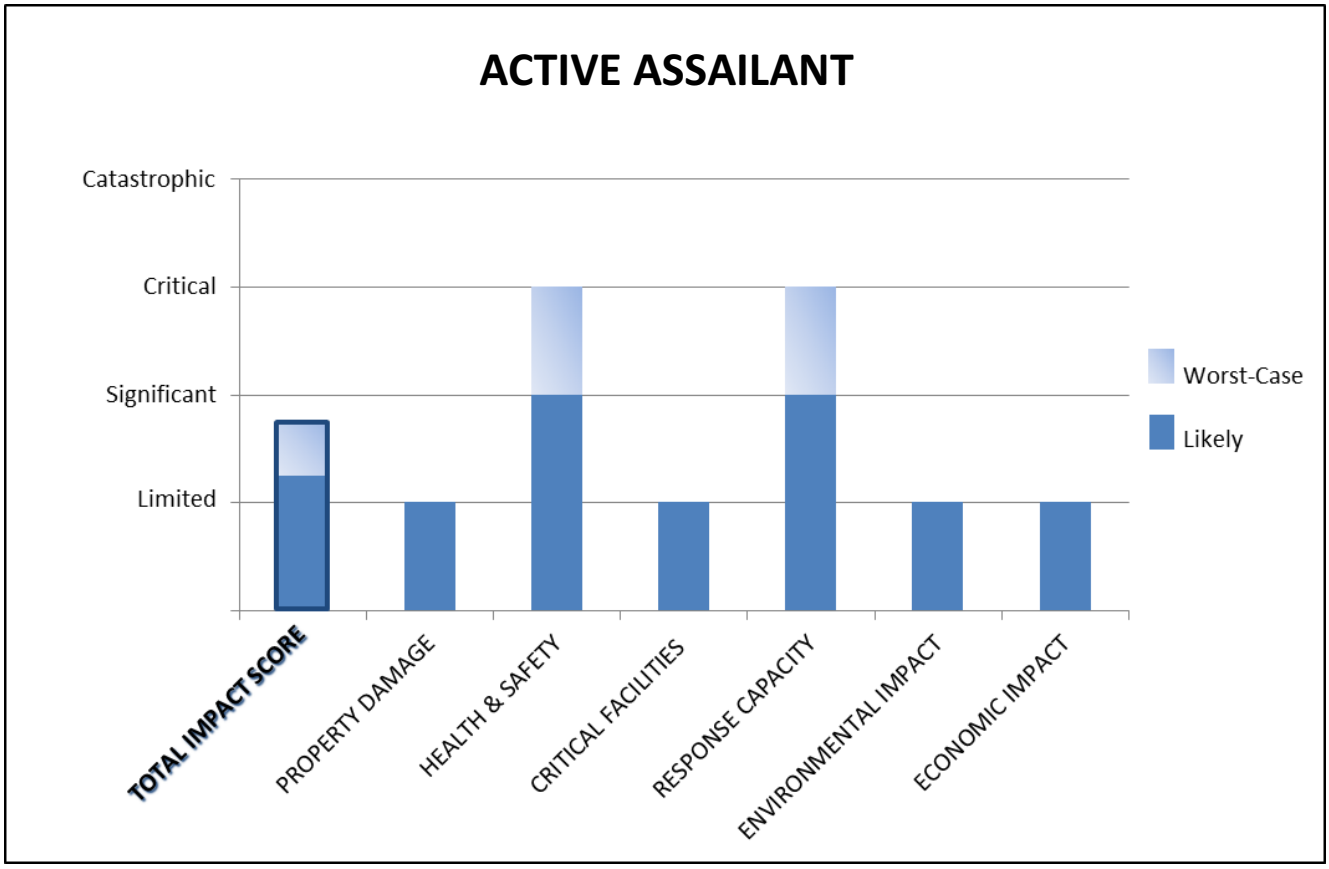
Active Assailant events in the U.S. (2000-2012)[4]

[4] *Active ShooterEvents from 2000-2012,* Federal Bureau of Investigation (2014). Available at http://leb.fbi.gov/2014/january/active-shooter-events-from-2000-to-2012 (last accessed July 1, 2014).

IV. CONSEQUENCE ANALYSIS

The Consequence Analysis section provides a detailed characterization of the anticipated consequences of likely and worst-case hazard events. This section characterizes impacts to property, health & safety, critical facilities, response capacity, the environment, and the economy. This section also characterizes public perceptions of each hazard, the perceived impact to personal safety and standard of living, and public confidence in response capability.

Consequence Analysis Overview



Where no Worst-Case bar is visible, Worst-Case impact is equivalent to Likely impact.

Active Assailant Warning Time & Duration		
	Likely	**Worst-Case**
WARNING TIME	*Short.* No warning time prior to an attack.	*Short.* No warning time prior to an attack.
DURATION	*Short.* 7-10 minutes for the initial attack. It may take 1-2 hours to declare the hazard location safe.	*Short.* 15 minutes for the initial attack. It may take 1-2 hours to declare the hazard location safe.

Consequence Analysis: Likely Hazard Scenario

The Consequence Analysis table details the anticipated consequences of the most likely hazard scenario.

Active Assailant Consequence Analysis Likely		
PROPERTY DAMAGE	*Limited*	• 0% damage to critical and non-critical infrastructure. • Bullet holes may cause superficial damage. Anything beyond superficial damage to buildings and structures is unlikely.
HEALTH & SAFETY	*Significant*	• 3-7 deaths likely. Most deaths would likely be due to penetrating trauma and blood loss from bullet wounds. • 5-7 injuries likely. Most injuries would likely be due to penetrating trauma from bullet wounds.
CRITICAL FACILITIES	*Limited*	• *Utilities* – Shutdown unlikely. No effect on utilities. • *Information/Communications* – Shutdown unlikely. No major impact on information or communications infrastructure. • *Transportation* – Traffic delays for less than one day. Public mobility will be impacted in a localized area.
RESPONSE CAPACITY	*Significant*	• *Police* – Mutual aid needed. No great impact to response capability. Road manpower will be slightly reduced. • *Fire & Rescue* – Moderate need for state or federal assistance. Mutual aid resources will be necessary to cover calls during event until units can be cleared. • *Health* – Local resources adequate. Health Department operations will not be affected. • *Hospitals* – Local resources adequate. No impact on the hospital system. • *Emergency Management* – Local resources adequate. Limited impact to Emergency Management capability.
ENVIRONMENTAL IMPACT	*Limited*	• Limited to no environmental impact. Less than a day of clean-up. Impact to a localized area.
ECONOMIC IMPACT	*Limited*	• Minimal loss of economic output due to the limited area affected. Other costs include cleanup and healthcare for those affected. • 0 jobs lost. • Temporary business disruption in the area of the attack. Damage to image possible.
TOTAL IMPACT	*Limited - Significant*	• Total Impact Score: 1.25 on a scale of 1 (Limited) to 4 (Catastrophic).
Limited	*Significant*	*Critical*	*Catastrophic*

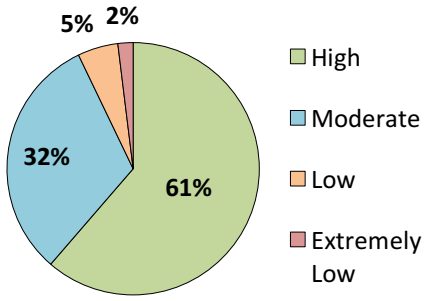
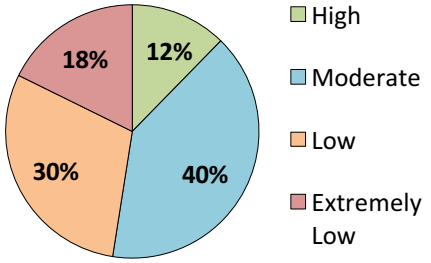
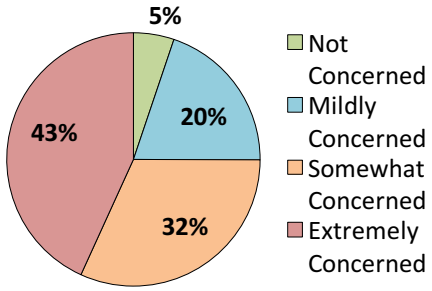
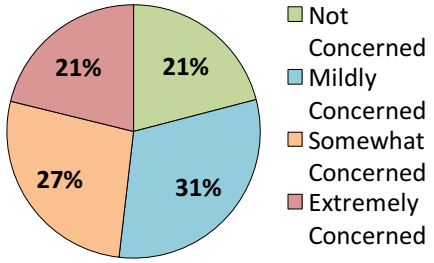
Consequence Analysis: Worst-Case Hazard Scenario

The Consequence Analysis: Worst-Case table details the anticipated consequences of the worst-case hazard scenario.

Active Assailant Consequence Analysis Worst-Case		
PROPERTY DAMAGE	*Limited*	• 0% damage to critical and non-critical infrastructure. • Bullet holes may cause superficial damage. Anything beyond superficial damage to buildings and structures is unlikely.
HEALTH & SAFETY	*Critical*	• 10-20 deaths likely. Most deaths would likely be due to penetrating trauma and blood loss from bullet wounds. • 30-40 injuries likely. Most injuries would likely be due to penetrating trauma from bullet wounds.
CRITICAL FACILITIES	*Limited*	• *Utilities* – Shutdown unlikely. No effect on utilities. • *Information/Communications* – Shutdown unlikely. No major impact on information or communications infrastructure. • *Transportation* – Traffic delays for less than one day. Public mobility will be impacted in a localized area.
RESPONSE CAPACITY	*Critical*	• *Police* – Mutual aid needed. No great impact to response capability. Road manpower will be slightly reduced. Assistance will be needed to support both tactical and patrol efforts. • *Fire & Rescue* – Moderate need for state or federal assistance. Significant impact on fire/EMS capability. Significant mutual aid would be required to maintain regular calls for service and incident support. • *Health* – Moderate need for state or federal assistance. Essential Health Department functions likely will not be affected. Emergency and Response, PIO and Community Health could be needed to support local response. • *Hospitals* – Mutual aid needed. Patient surge could cause delay in the Emergency Department. The hospital would treat minor injuries and stabilize major injuries, but trauma patients would be diverted to trauma centers. • *Emergency Management* – Local resources adequate. Limited impact to Emergency Management capability.
ENVIRONMENTAL IMPACT	*Limited*	• Limited to no environmental impact. Less than a day of clean-up. Impact to a localized area.
ECONOMIC IMPACT	*Limited*	• Minimal loss of economic output due to the limited area affected. Other costs include cleanup and healthcare for those affected. • 0 jobs lost. • Temporary business disruption in the area of the attack. Damage to image possible.
TOTAL IMPACT	*Limited - Significant*	• Total Impact Score: 1.75 on a scale of 1 (Limited) to 4 (Catastrophic).
Limited	*Significant*	*Critical*	*Catastrophic*

Consequence Analysis: Public Perception

The Consequence Analysis: Public Perception table characterizes public perceptions of each hazard. Details include public confidence in personal ability to respond to each hazard, public confidence in Howard County's ability to respond to each hazard, and each hazard's perceived impact to personal safety and standard of living.

Active Assailant Public Perceptions			
PERCEIVED CONFIDENCE IN HOWARD COUNTY'S ABILITY TO RESPOND AND RECOVER FROM THIS HAZARD	**PERCEIVED CONFIDENCE IN PERSONAL ABILITY TO PROTECT SELF AND FAMILY FROM THIS HAZARD**	**CONCERN OVER THE IMPACT TO PERSONAL HEALTH AND SAFETY IF THIS HAZARD WERE TO OCCUR LOCALLY**	**CONCERN OVER THE IMPACT TO PERSONAL STANDARD OF LIVING / QUALITY OF LIFE IF THIS HAZARD WERE TO OCCUR LOCALLY**
			
Average: 1.48 *High - Moderate*	*2.53* *Moderate - Low*	*3.13* *Somewhat Concerned*	*2.48* *Mildly Concerned - Somewhat Concerned*

Biological Attack

I. OVERVIEW

The Overview section defines the hazard and summarizes the hazard risk profile.

Definition

This section defines the scope of the hazard category. The terminology and characterization established in this section should be consistent throughout all Howard County planning documents.

A Biological Attack is an intentional release of viruses, bacteria, or other germs (agents) used to cause illness or death in people, animals, or plants.[1] Biological agents can be introduced and spread through a population by air, direct contact, water, or food. Although biological agents are not easy to grow and maintain, once introduced to a population they can be challenging to detect.

Risk Profile

The Risk Profile section presents the Risk Score for the hazard in a range from 1 (lowest risk) to 4 (highest risk). Risk Score is a function of Likelihood and Consequence.

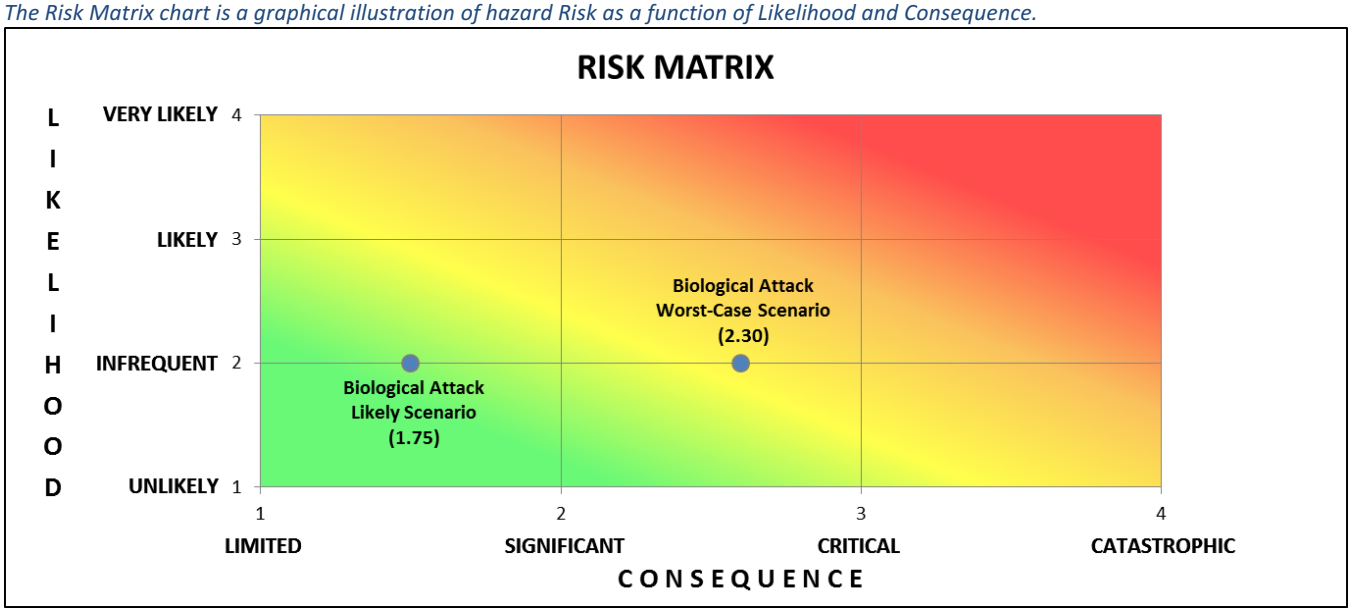
Biological Attack Risk Profile				
	Risk Assessment Category	**Likely Hazard Scenario**	**Worst-Case Hazard Scenario**	**Weight**
LIKELIHOOD	**Likelihood**	2.00* Infrequent		50%
CONSEQUENCE	**Impact**	1.25 Limited-Significant	2.63 Significant-Critical	40%
	Warning Time	4 Short	4 Short	5%
	Duration	1 Short	1 Short	5%
TOTAL RISK SCORE		**1.75**	**2.30**	

**The Likelihood Score reflects the likelihood of any emergency-level hazard event and does not differentiate between Likely and Worst-Case scenarios.*

[1] *Bioterrorism Overview,* CDC. Available at http://www.bt.cdc.gov/bioterrorism/overview.asp (last accessed March 26, 2014).

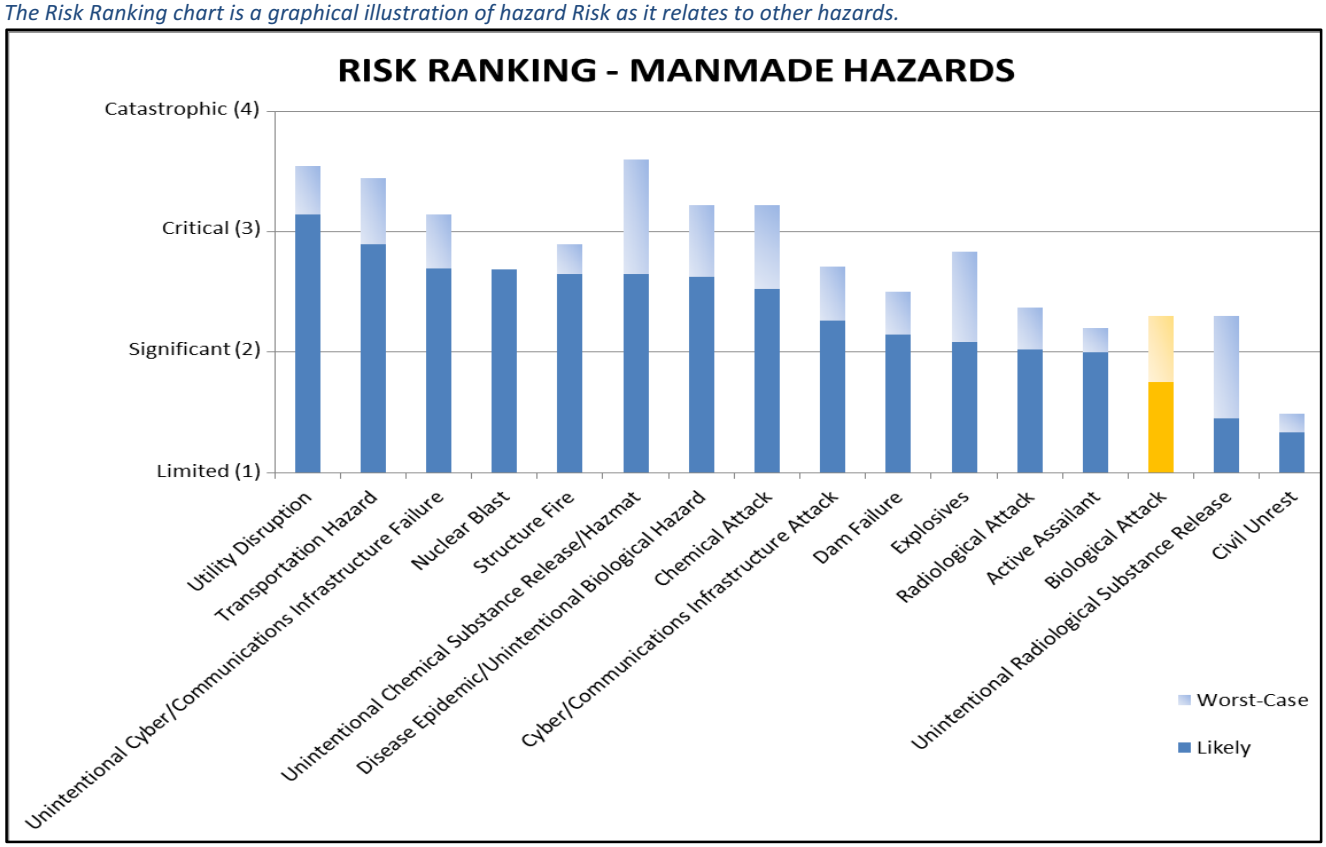
Risk Matrix

The Risk Matrix chart is a graphical illustration of hazard Risk as a function of Likelihood and Consequence.



Risk Ranking

The Risk Ranking chart is a graphical illustration of hazard Risk as it relates to other hazards.



Where no Worst-Case bar is visible, Worst-Case Risk is equivalent to Likely Risk.

II. HAZARD CHARACTERISTICS

The Hazard Characteristics section provides a detailed characterization of the hazard and the local context as it relates to the hazard.

Description of the Hazard

The Centers for Disease Control and Prevention (CDC) separates bioterrorism agents into three categories by how easily they can be spread and the severity of illness or death they cause. Category A agents pose the highest risk to the public and national security, Category B agents are the second highest priority, and Category C agents represent emerging threats.

Category A agents

- Can be easily spread or transmitted from person to person
- Result in high death rates and have the potential for major public health impact
- Might cause public panic and social disruption
- Require special action for public health preparedness

Category B agents

- Are moderately easy to spread
- Result in moderate illness rates and low death rates
- Require specific enhancements of laboratory capacity and enhanced disease monitoring

Category C agents

- Could be engineered for mass spread in the future
- Are easily available
- Are easily produced and spread
- Have potential for high morbidity and mortality rates and major health impact in the future

A biological disease agent can be delivered in a variety of ways. Some attack methods are overt, such as the delivery of an agent through the mail. Other methods involve discreet introduction into air, food, or water, and those infected may not even realize they have been the subjects of an attack.[2]

It is rare to have any advanced warning of a Biological Attack. In the event of a discrete release of an easily spread biological agent, the attack may be unrecognized for days or even weeks following the initial release.

The number of people affected by a Biological Attack is largely dependent on the location of the attack and the agent involved. Biological Attack hazards can directly affect as few as one person or as many as millions. Factors that affect the number of people who come into contact with the agent include the ease of transmission, the area affected, and the population density at the point of attack. Some biological agents can be dealt with using existing laboratory and monitoring capacity. However, others may require significant enhancement of laboratory and monitoring capabilities.

[2] *Biological Attack: What It Is*, U.S. Dept. of Homeland Security. Available at http://www.dhs.gov/biological-attack-what-it (last accessed April 1, 2014).

Not all biological agents are contagious, and there is quite a bit of variability when it comes to disease spread. Some biological agents cause adverse effects in individuals but do not result in those individuals becoming contagious. Other biological agents are very difficult to spread and require contact with bodily fluids or other special circumstances to transmit disease. The most contagious biological agents can be quickly and easily spread from person to person through means that require little to no direct contact with an infected individual.

There is significant variability in the severity of illness caused by biological agents. Many agents cause pain or discomfort with few lasting effects. However, some agents can cause permanent damage or death. Deaths from disease can vary greatly depending on the biological agent in question, with case fatality rates ranging from 0% to nearly 100%.

The duration of a Biological Attack hazard is largely dependent on the biological agent in question. An attack involving an agent that is not easily spread can be over in a matter of minutes. An attack involving an easily spread biological agent may take weeks or even months to get the hazard under control.

Local Context

The Local Context section describes community attributes that affect the likelihood of the hazard's occurrence or vulnerability to the hazard's consequences.

A Biological Attack may occur anywhere in Howard County. Likely targets for Biological Attacks in Howard County include densely populated public areas such as schools, commercial facilities, event venues, and office buildings.

The location of Howard County may increase local vulnerability to Biological Attacks and other terrorism-related attacks. Howard County is in close proximity to valuable terrorist targets including Washington, D.C., the City of Baltimore, the Port of Baltimore, and the Baltimore Washington International Airport. Due to its proximity to the National Capital Region, many federal agencies, defense contractors, and high-profile targets maintain facilities within Howard County.[3]

[3] *Manmade Hazard Identification and Risk Assessment Workshop (unpublished)*, Howard County OEM (2014).

III. LIKELIHOOD ANALYSIS

The Likelihood Analysis section characterizes the historical occurrence and future likelihood of the hazard in the planning area.

Occurrence of the Hazard

The Occurrence of the Hazard section details the historical occurrence of the hazard in the planning area.

There have been 0 confirmed Biological Attack hazard events in Howard County during the reviewed time period (1996-2014).

Notable Incidents in Howard County

Although there have been no notable Biological Attack hazard events in Howard County, the fear of biological attack persists. Suspicious powders and substances are frequently reported as biological hazards. Emergency responders in Howard County were called out to 17 biological hazard incidents between 2008 and 2013. None of these incidents were confirmed as legitimate Biological Attack hazards during this time.[4]

Future Likelihood of the Hazard for Howard County

The Future Likelihood section anticipates the future occurrence rate of the hazard based on historical likelihood and future trends. This section also addresses factors that may cause the future likelihood to deviate from historical trends.

Future Likelihood of a Biological Attack Hazard in Howard County	
Historical Average (time period)	0 recorded events (1996-2014)
Historical Annual Probability	0% chance of annual occurrence
Future Likelihood Expected to Deviate from Historical Likelihood (Yes/No)	Yes
Future Annual Probability	1-10% chance of annual occurrence
Future Likelihood Score	2.00 (Infrequent)
Future Likelihood reflects the likelihood of any emergency-level hazard event and does not differentiate between Likely and Worst-Case scenarios.	

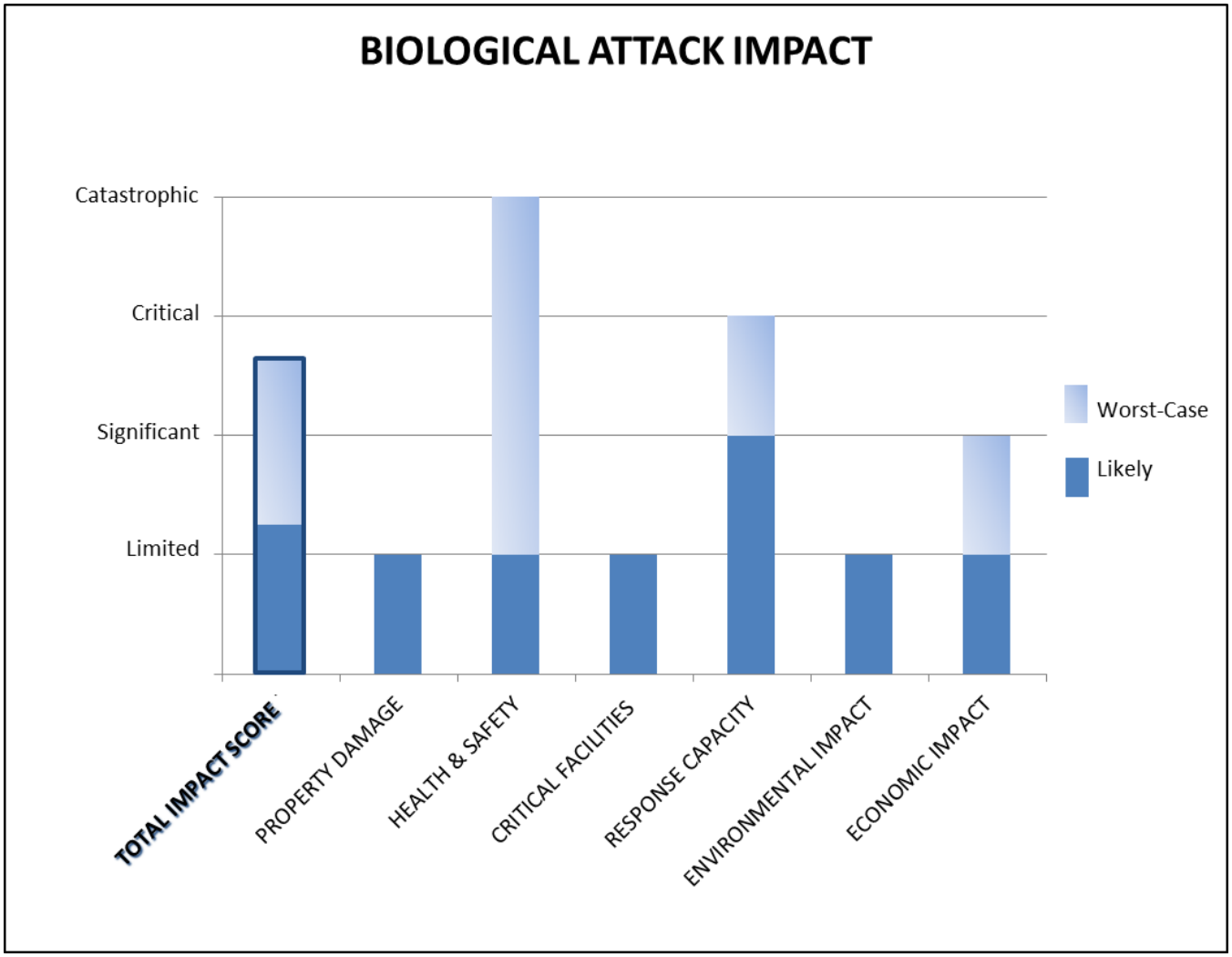
Considerations: The future likelihood of a Biological Attack in Howard County is expected to be slightly higher than indicated by the historical occurrence rate alone. Although the likelihood remains low, estimates predict a 1-10% chance of annual occurrence, or one event every 10-99 years. A future annual probability of 1-10% classifies the likelihood of a Biological Attack as Infrequent. Successful Biological Attacks in nearby jurisdictions, the increased threat of terrorism, and Howard County's proximity to high-value terrorist targets contribute to a slight increase in the likelihood of a Biological Attack in the future.3

[4] *Howard County CAD Report 1/01/2008 – 12/31/2013 (unpublished)*, Howard County DFRS (2014).

IV. CONSEQUENCE ANALYSIS

The Consequence Analysis section provides a detailed characterization of the anticipated consequences of likely and worst-case hazard events. This section characterizes impacts to property, health & safety, critical facilities, response capacity, the environment, and the economy. This section also characterizes public perceptions of each hazard, the perceived impact to personal safety and standard of living, and public confidence in response capability.

Consequence Analysis Overview



Where no Worst-Case bar is visible, Worst-Case impact is equivalent to Likely impact.

Biological Attack Warning Time & Duration		
	Likely	**Worst-Case**
WARNING TIME	*Short.* No warning time prior to an attack.	*Short.* No warning time prior to an attack.
DURATION	*Short.* Initial hazard will likely last less than 20 minutes. It may take up to 4 hours to declare the hazard location safe.	*Short.* Initial hazard will likely last from 30 minutes – 4 hours. It may take up to 48 hours to remove the hazard and stabilize all people exposed to the hazardous agent.

Consequence Analysis: Likely Hazard Scenario

The Consequence Analysis table details the anticipated consequences of the most likely hazard scenario.

Biological Attack Consequence Analysis Likely		
PROPERTY DAMAGE	*Limited*	• 0% damage to critical and non-critical infrastructure. • Anything beyond superficial damage to buildings and structures is unlikely.
HEALTH & SAFETY	*Limited*	• No deaths likely. Deaths that do occur could be caused by agent-induced respiratory failure. • 20 injuries likely. Injuries will likely only affect those who come into direct contact with the biological agent. The nature of injury will depend on the biological agent, but may include respiratory distress, fever, headache, muscle pain, nausea, and vomiting.
CRITICAL FACILITIES	*Limited*	• *Utilities* – Shutdown unlikely. No effect on utilities. • *Information/Communications* – Shutdown unlikely. No major impact on information or communications infrastructure. • *Transportation* – Shutdown unlikely. Impacts to transportation will be minor and short-term.
RESPONSE CAPACITY	*Significant*	• *Police* – Mutual aid needed. Terrorism response automatically triggers federal law enforcement involvement. • *Fire & Rescue* – Local Resources Adequate. Little to no impact on response capability and continuity of operations. • *Health* – Federal and State assistance neede. Biological release associated with terrorism automatically triggers State and Federal investigations. Communicable Disease, Community Health, and Emergency Preparedness and Response will be impacted but could likely manage local response. • *Hospitals* – Local resources adequate. Hospital system would successfully manage the patient surge. • *Emergency Management* – Local resources adequate. Limited impact to Emergency Management capability.
ENVIRONMENTAL IMPACT	*Limited*	• Limited to no environmental impact. Less than a day of clean-up. Impact to a localized area.
ECONOMIC IMPACT	*Limited*	• Minimal loss of economic output due to the limited area affected. Other costs include cleanup and healthcare for those affected. • 0 jobs lost. • Limited businesses closure may occur depending on the location of the attack.
TOTAL IMPACT	*Limited-Significant*	• Total Impact Score: 1.25 on a scale of 1 (Limited) to 4 (Catastrophic).
Limited	*Significant*	*Critical*	*Catastrophic*

Consequence Analysis: Worst-Case Hazard Scenario

The Consequence Analysis: Worst-Case table details the anticipated consequences of the worst-case hazard scenario.

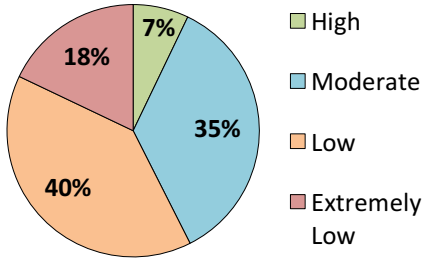
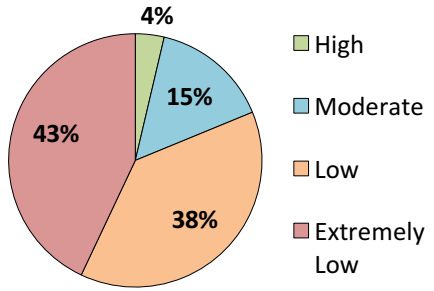
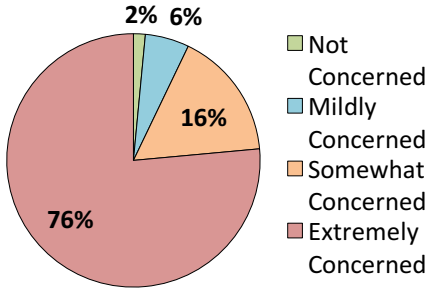
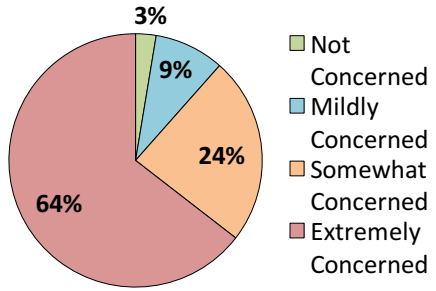
Biological Attack Consequence Analysis Worst-Case		
PROPERTY DAMAGE	*Limited*	• 0% damage to critical and non-critical infrastructure. • Anything beyond superficial damage to buildings and structures is unlikely.
HEALTH & SAFETY	*Catastrophic*	• 35 deaths likely. The nature of the injury and death will depend on the biological agent, but may include respiratory failure, dehydration, or severe complications due to infection. • Up to 300 injuries likely. The nature of injury and death will depend on the biological agent, but may include respiratory failure, dehydration, or severe complications due to infection.
CRITICAL FACILITIES	*Limited*	• *Utilities* – Shut unlikely. Water treatment facility shutdown is unlikely but possible if decontamination efforts contaminate the facility. Utilities will continue to function, but waste water may be released into rivers for up to one day. • *Information/Communications* – No shutdown. No major impact on information or communications infrastructure. • *Transportation* – Delays for less than one day. Some localized road closures will occur, but delays will not be excessive. Impacts to transportation will be minor and short-term.
RESPONSE CAPACITY	*Critical*	• *Police* – Moderate need for state or federal assistance. Terrorism response automatically triggers federal law enforcement involvement. • *Fire & Rescue* – Significant and long-lasting need for state or federal assistance. EMS resources could experience significant strain. • *Health* – Significant and long-lasting need for state or federal assistance. Essential Health Department functions will continue. Non-essential functions will be affected as resources are diverted to sustain emergency response activities at the point of dispensing. Essential functions that will continue include attention directed to patients, immunizations, clinics, and high-risk Communications. Non-essential functions that may be suspended include administrative functions, non-essential communications, and filing. • *Hospitals* – Mutual aid needed. The patient surge would stress the hospital system and would most likely impact neighboring hospitals as well. The Emergency Department would be unable to accept new patients. Incoming patients would be diverted to other facilities. Emergency Department surge would strain the hospital system for up to 72 hours. • *Emergency Management* – Mutual aid needed. Support may be necessary to cover the Emergency Management staffing & planning for hazmat cleanup, sheltering efforts, investigation follow-up, and public information coordination. Prolonged planning may necessitate double shifts.
ENVIRONMENTAL IMPACT	*Limited*	• Limited environmental impact. Less than a day of clean-up. Impact to a localized area. Release of the agent could lead to limited contamination of air, water and land. A substance that can kill or debilitate humans may also kill or debilitate other animal life in the area. Once the biological agent is removed from the environment, there should be no residual impacts to air, water and land. Lasting environmental impact will be minimal, but public feelings of perceived environmental danger may be much longer lasting.
ECONOMIC IMPACT	*Significant*	• $12,000 in lost economic output. Other costs include cleanup and healthcare for those affected. • 0.09 jobs lost. • General panic, massive individual flight, and traffic gridlock lead to business closures lasting an indefinite period of time. Business recovery period depends on impact to facilities, staff, and public image.
TOTAL IMPACT	*Significant - Critical*	• Total Impact Score: 2.63 on a scale of 1 (Limited) to 4 (Catastrophic).
Limited		*Significant* / *Critical* / *Catastrophic*

Consequence Analysis: Public Perception

The Consequence Analysis: Public Perception table characterizes public perceptions of each hazard. Details include public confidence in personal ability to respond to each hazard, public confidence in Howard County's ability to respond to each hazard, and each hazard's perceived impact to personal safety and standard of living.

Biological Attack

Public Perceptions

PERCEIVED CONFIDENCE IN HOWARD COUNTY'S ABILITY TO RESPOND AND RECOVER FROM THIS HAZARD	PERCEIVED CONFIDENCE IN PERSONAL ABILITY TO PROTECT SELF AND FAMILY FROM THIS HAZARD	CONCERN OVER THE IMPACT TO PERSONAL HEALTH AND SAFETY IF THIS HAZARD WERE TO OCCUR LOCALLY	CONCERN OVER THE IMPACT TO PERSONAL STANDARD OF LIVING / QUALITY OF LIFE IF THIS HAZARD WERE TO OCCUR LOCALLY
			
Average: 2.68 *Low - Moderate*	*Average: 3.21* *Low*	*Average: 3.68* *Extremely Concerned - Somewhat Concerned*	*Average: 3.51* *Extremely Concerned - Somewhat Concerned*

Chemical Attack

I. OVERVIEW

The Overview section defines the hazard and summarizes the hazard risk profile.

Definition

This section defines the scope of the hazard category. The terminology and characterization established in this section should be consistent throughout all Howard County planning documents.

A Chemical Attack is the intentional release of potentially harmful chemicals into the environment. Agents used in a Chemical Attack include poisonous vapors, aerosols, liquids, and solids that have toxic effects on people, animals, or plants (chemicals used to create Explosives hazards are profiled separately).[1] The effects of a Chemical Attack may be immediate (within seconds) or delayed (2 to 48 hours).

Risk Profile

The Risk Profile section presents the Risk Score for the hazard in a range from 1 (lowest risk) to 4 (highest risk). Risk Score is a function of Likelihood and Consequence.

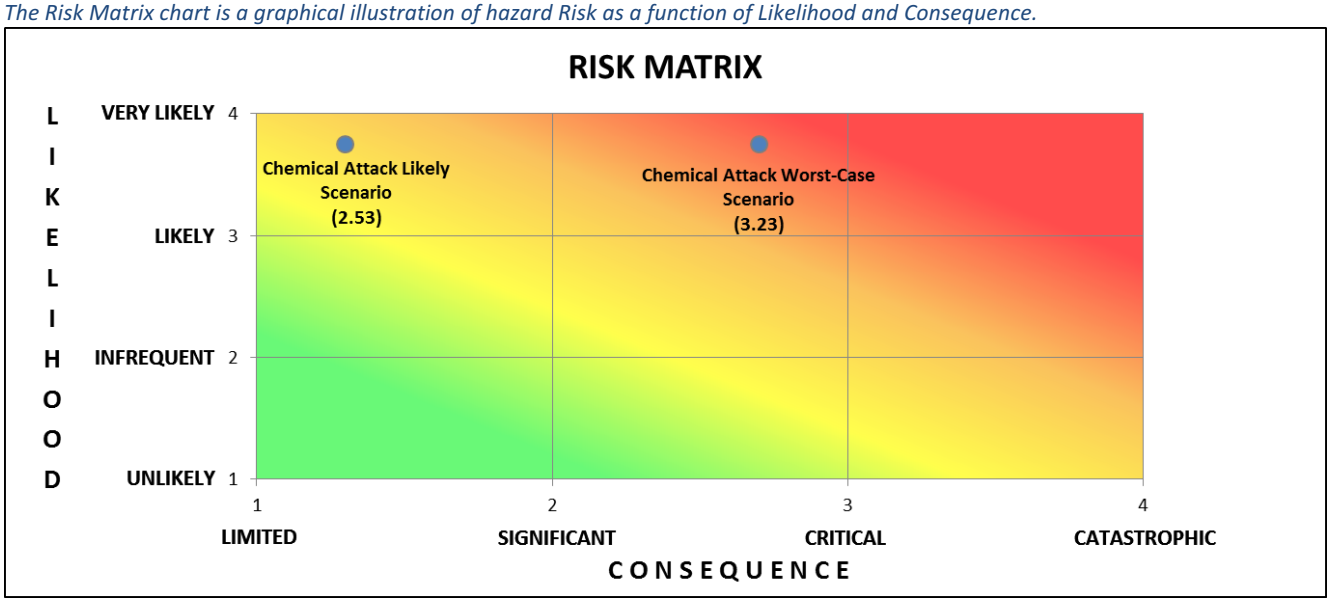
Chemical Attack Risk Profile				
	Risk Assessment Category	**Likely Hazard Scenario**	**Worst-Case Hazard Scenario**	**Weight**
LIKELIHOOD	**Likelihood**	3.75* Likely-Very Likely		50%
CONSEQUENCE	**Impact**	1 Limited	2.63 Significant-Critical	40%
	Warning Time	4 Short	4 Short	5%
	Duration	1 Short	2 Moderate	5%
TOTAL RISK SCORE		**2.53**	**3.23**	

**The Likelihood Score reflects the likelihood of any emergency-level hazard event and does not differentiate between Likely and Worst-Case scenarios.*

[1] *Chemical Threats,* FEMA. Available at http://www.ready.gov/chemical-threats (last accessed March 26, 2014).

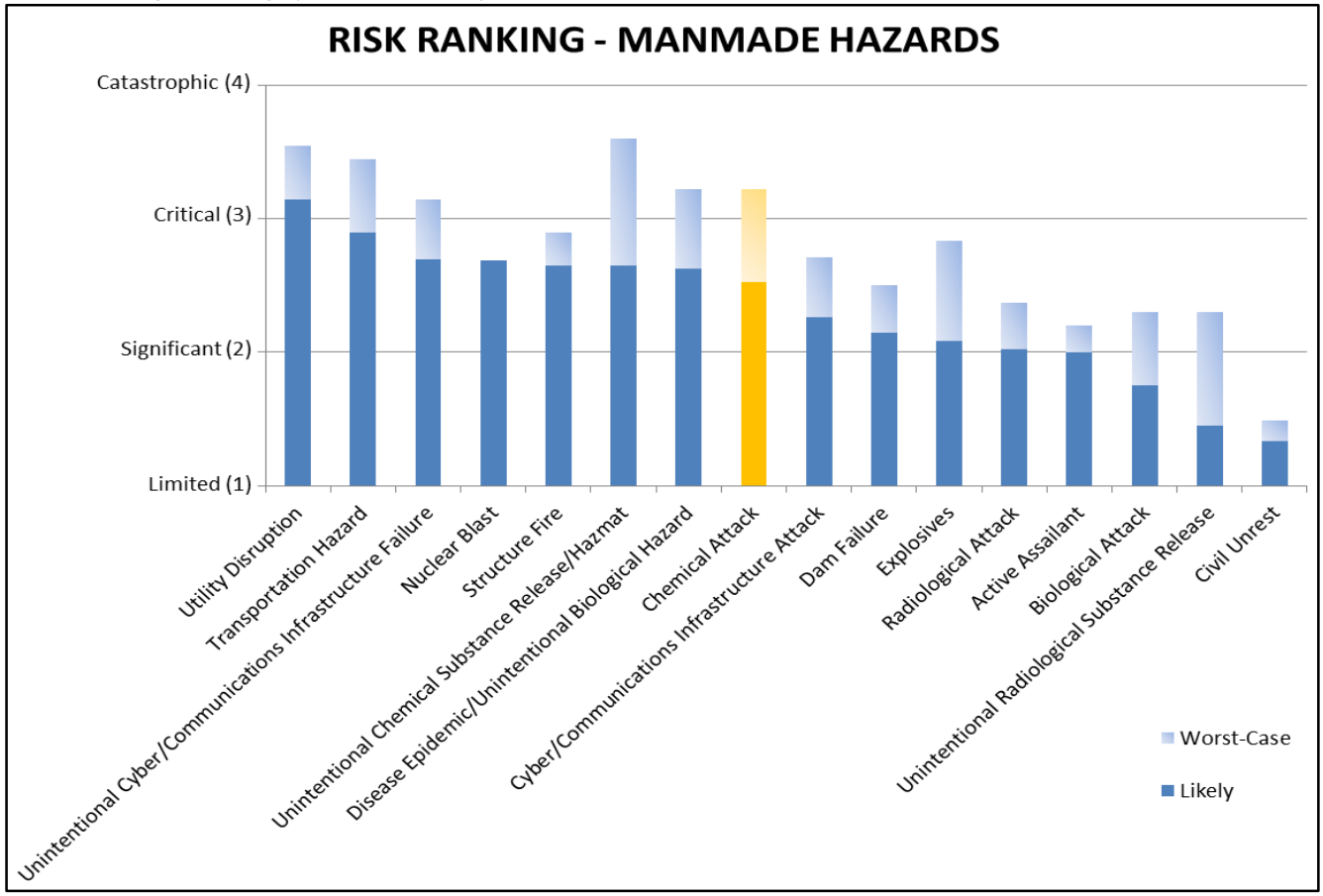
Risk Matrix

The Risk Matrix chart is a graphical illustration of hazard Risk as a function of Likelihood and Consequence.



Risk Ranking

The Risk Ranking chart is a graphical illustration of hazard Risk as it relates to other hazards.



Where no Worst-Case bar is visible, Worst-Case Risk is equivalent to Likely Risk.

II. HAZARD CHARACTERISTICS

The Hazard Characteristics section provides a detailed characterization of the hazard and the local context as it relates to the hazard.

Description of the Hazard

The Centers for Disease Control and Prevention (CDC) categorizes hazardous chemicals by exposure effect, including biotoxins, blister agents, blood agents, caustics, choking agents, incapacitating agents, long-acting anticoagulants, metals, nerve agents, organic solvents, riot control agents, toxic alcohols, and vomiting agents.[2]

During a Chemical Attack, toxic chemical agents could be introduced into the environment through ventilation systems, by aerosolizing devices or sprayers, through chemical-dispersing bombs or explosives, by sabotaging of facilities containing chemicals, or through food and water. Chemical agents used in attacks are frequently directly toxic to humans, and they may also be highly combustible, explosive, or corrosive.[3] However, chemical agents are challenging to produce, usually dissipate rapidly outdoors, and can be difficult to deliver in lethal concentrations.

It is rare to have any advanced warning of a Chemical Attack.

The severity of illness associated with a Chemical Attack depends largely on the specific chemical agent and the size of the exposure dose. Many chemical agents result in short-term pain, discomfort, and disorientation. However, inhalation or skin absorption of many chemical agents can cause permanent health problems or death.

Most health effects from a Chemical Attack occur in the minutes immediately following the attack. However, it can be very time consuming to remove some types of chemical hazards from the environment. Certain types of chemicals may continue to be a hazard for days or weeks following the initial attack.

Chemical Attacks have the highest likelihood of causing harm if they take place in a closed public space, such as inside an office or onboard public transportation. Chemical Attacks can also occur outdoors, although the risk of a high-dose exposure is much lower.

Hazardous chemicals require special care to remove from the environment. Many chemical hazards can be neutralized using existing hazardous materials response equipment, but in the case of large-scale environmental contamination, equipment needs may extend beyond what is readily available in the jurisdiction.

The size of the area affected in a Chemical Attack varies depending on the chemical agent and method of delivery. A small-scale chemical release in an enclosed area will expand to fill the enclosed area, while a large attack introducing a chemical into the air or water could impact many square miles. The specific extent of a Chemical Attack hazard may unknown during the immediate response phase.

[2] For additional information see *Chemical Emergencies Overview,* CDC. Available at http://www.bt.cdc.gov/chemical/overview.asp (last accessed March 26, 2014).
[3] *Chemical Attack: Warfare Agents, Industrial Chemicals, and Toxins,* U.S. Dept. of Homeland Security. Available at http://www.dhs.gov/xlibrary/assets/prep_chemical_fact_sheet.pdf (last accessed April 1, 2014).

Local Context

The Local Context section describes community attributes that affect the likelihood of the hazard's occurrence or vulnerability to the hazard's consequences.

A Chemical Attack may occur anywhere in Howard County. Likely targets for Chemical Attacks in Howard County include densely populated public areas such as schools, commercial facilities, event venues, and office buildings.

The location of Howard County may increase local vulnerability to Chemical Attacks and other terrorism-related attacks. Howard County is in close proximity to valuable terrorist targets including Washington, D.C., the City of Baltimore, the Port of Baltimore, and the Baltimore Washington International Airport. Due to its proximity to the National Capital Region, many federal agencies, defense contractors, and high-profile targets maintain facilities within Howard County.

Access to toxic chemicals may affect vulnerability to a Chemical Attack. The frequent transport of hazardous chemicals through Howard County increases the likelihood of intentional harmful misuses or manipulation, especially along railroads and major roadways.[4]

III. LIKELIHOOD ANALYSIS

The Likelihood Analysis section characterizes the historical occurrence and future likelihood of the hazard in the planning area.

Occurrence of the Hazard

The Occurrence of the Hazard section details the historical occurrence of the hazard in the planning area.

There have been 4 small-scale Chemical Attack hazard events in Howard County during the reviewed time period (2004-2014).

Notable Incidents in Howard County

All Howard County Chemical Attacks in recent history have been minor incidents. Local Chemical Attack hazards include a caustic powder thrown at an individual and the use of a chemical agent to destroy a yard and property.

Future Likelihood of the Hazard for Howard County

The Future Likelihood section anticipates the future occurrence rate of the hazard based on historical likelihood and future trends. This section also addresses factors that may cause the future likelihood to deviate from historical trends.

Future Likelihood of a Chemical Attack Hazard in Howard County	
Historical Average (time period)	1 event every 2.5 years (2004-2014)
Historical Annual Probability	40% chance of annual occurrence
Future Likelihood Expected to Deviate from Historical Likelihood (Yes/No)	No
Future Annual Probability	40% chance of annual occurrence
Future Likelihood Score[4]	3.75 (Likely-Very Likely)
Future Likelihood reflects the likelihood of any emergency-level hazard event and does not differentiate between Likely and Worst-Case scenarios.	

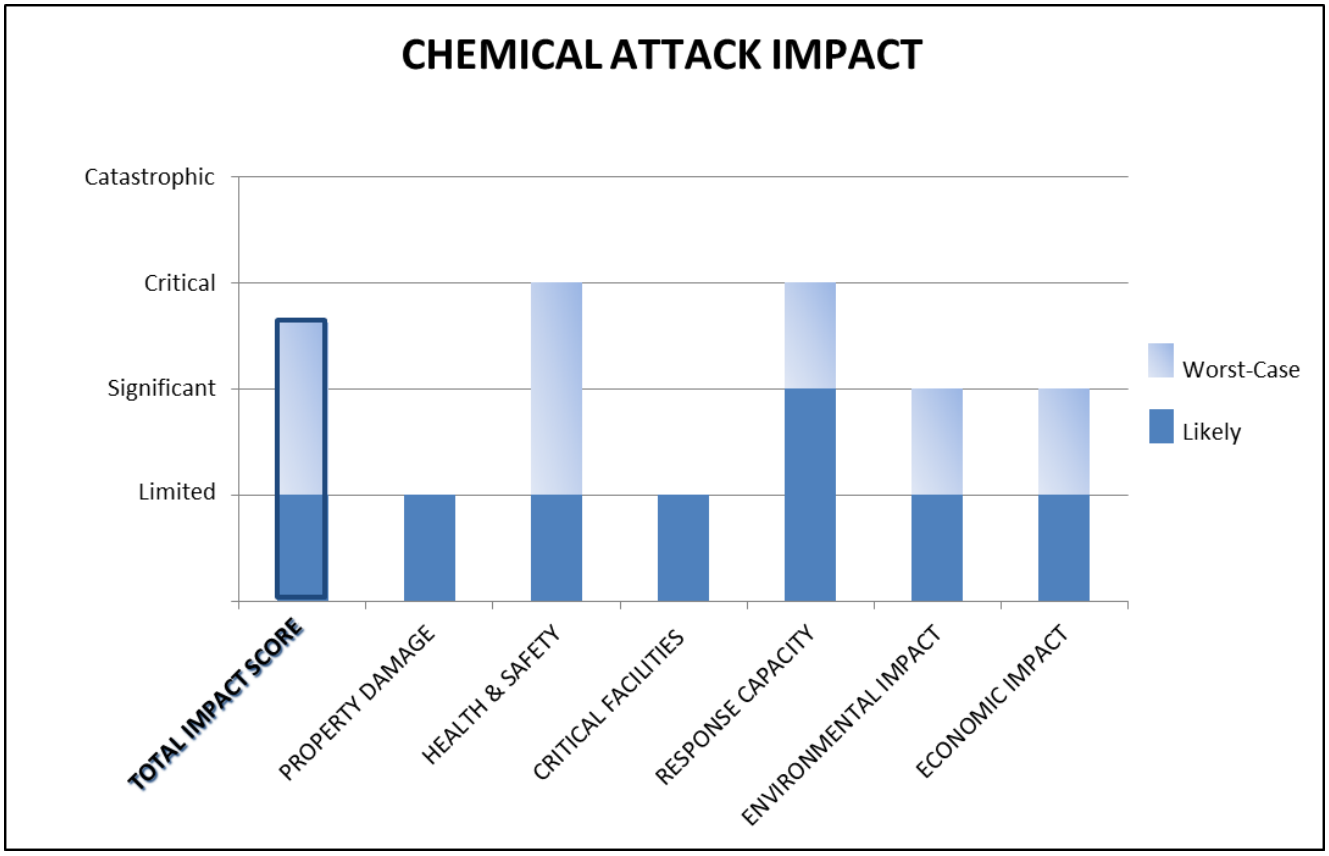
Considerations: The future likelihood of Chemical Attack in Howard County is not expected to be significantly different from the historical occurrence rate. All Howard County Chemical Attacks have been minor incidents.

[4] *Manmade Hazard Identification and Risk Assessment Workshop (unpublished)*, Howard County OEM (2014).

IV. CONSEQUENCE ANALYSIS

The Consequence Analysis section provides a detailed characterization of the anticipated consequences of likely and worst-case hazard events. This section characterizes impacts to property, health & safety, critical facilities, response capacity, the environment, and the economy. This section also characterizes public perceptions of each hazard, the perceived impact to personal safety and standard of living, and public confidence in response capability.

Consequence Analysis Overview



Where no Worst-Case bar is visible, Worst-Case impact is equivalent to Likely impact.

Chemical Attack Warning Time & Duration		
	Likely	**Worst-Case**
WARNING TIME	*Short.* No warning time prior to an attack.	*Short.* No warning time prior to an attack.
DURATION	*Short.* 1-2 hours to remove the hazard.	*Moderate.* Hazard onset is nearly instantaneous. It may take up to 12 hours to declare the hazard location safe.

Consequence Analysis: Likely Hazard Scenario

The Consequence Analysis table details the anticipated consequences of the most likely hazard scenario.

Chemical Attack Consequence Analysis Likely		
PROPERTY DAMAGE	*Limited*	• 0% damage to critical and non-critical infrastructure. • Anything beyond superficial damage to buildings and structures is unlikely.
HEALTH & SAFETY	*Limited*	• No deaths likely. Deaths that do occur could be caused by respiratory failure from inhalation. • 4 injuries likely. Injuries will likely affect only those who come into direct contact with the chemical agent. Injuries likely involve skin or mucous membrane irritation. Injuries may be severe if not decontaminated or treated rapidly.
CRITICAL FACILITIES	*Limited*	• *Utilities* – Shutdown unlikely. No effect on utilities. • *Information/Communications* – Shutdown unlikely. No major impact on information or communications infrastructure. • *Transportation* – Shutdown unlikely. Impacts to transportation will be minor and short-term.
RESPONSE CAPACITY	*Significant*	• *Police* – Mutual aid needed. Terrorism response automatically triggers federal law enforcement involvement. • *Fire & Rescue* – Local Resources Adequate. Hazmat Response Team would be unavailable for other responses within the jurisdiction for several hours. Mutual aid coverage would ensure continuity of operations. • *Health* – Local resources adequate. Essential Health Department operations will not be affected. – State & Federal assistance needed. Chemical release associated with terrorism automatically triggers State and Federal investigations. Communicable disease, environmental health and emergency department response will be impacted but could likely manage local response. • *Hospitals* • Local resources adequate. No impact on the hospital system. • *Emergency Management* – Local resources adequate. Limited impact to Emergency Management capability.
ENVIRONMENTAL IMPACT	*Limited*	• No environmental impact. Less than a day of clean-up. Impact to a localized area.
ECONOMIC IMPACT	*Limited*	• Minimal loss of economic output due to the limited area affected. Other costs include cleanup and healthcare for those affected. • 0 jobs lost. • Limited building closure may occur depending on the location of the attack.
TOTAL IMPACT	*Limited*	• Total Impact Score: 1.0 on a scale of 1 (Limited) to 4 (Catastrophic).
Limited	*Significant*	*Critical*	*Catastrophic*

Consequence Analysis: Worst-Case Hazard Scenario

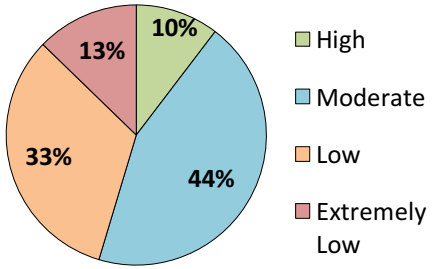
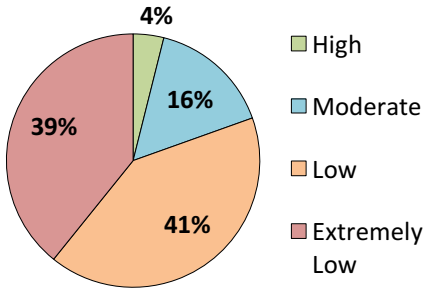
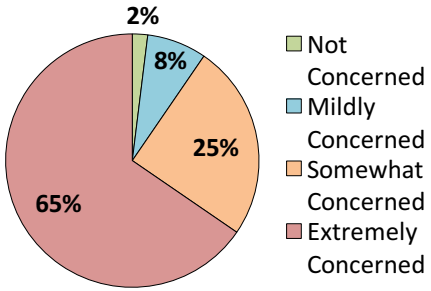
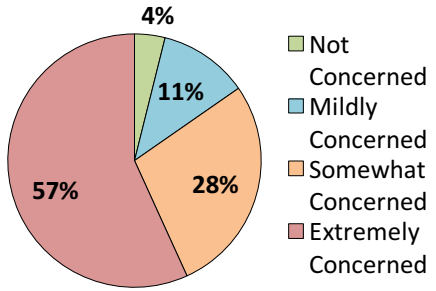
The Consequence Analysis: Worst-Case table details the anticipated consequences of the worst-case hazard scenario.

Chemical Attack Consequence Analysis Worst-Case		
PROPERTY DAMAGE	*Limited*	• 0% damage to critical and non-critical infrastructure. • Anything beyond superficial damage to buildings and structures is unlikely.
HEALTH & SAFETY	*Critical*	• 20-40 deaths likely. 10-20% of the population affected by a chemical attack could die from the attack, depending on the agent identification and available access to possible antidotes. Most deaths would likely be caused by respiratory failure from depression of the central nervous system. • 120-160 injuries likely. 60-80% of the population affected by a chemical attack could sustain injuries. Injuries would likely include serious impact to the neurological system and/or central nervous system.
CRITICAL FACILITIES	*Limited*	• *Utilities* – Shut down less than one day. Water treatment facility shutdown is unlikely but possible if decontamination efforts contaminate the facility. Utilities will continue to function, but waste water may be released into rivers for up to one day. • *Information/Communications* – No shutdown. No major impact on information or communications infrastructure. • *Transportation* – Delays for less than one day. Public mobility will be severely impacted, but delays will not last longer than one day. Major transportation arteries will be closed, and diverted traffic will cause extensive delays.
RESPONSE CAPACITY	*Critical*	• *Police* – Significant and long-lasting need for state or federal assistance. Considered a terrorist attack, federal law enforcement would lead the response. • *Fire & Rescue* – Moderate need for state or federal assistance. There would be long-lasting impact to hazmat response capabilities, and regional EMS resources would be overwhelmed. Significant mutual aid assistance would be required in order to maintain regular calls for service. • *Health* – Significant need for state or federal assistance. Essential Health Department functions will be impacted. Heath, Emergency Preparedness and Response, Communicable Diseases, Environmental Health, and Community Health Bureau functions will be affected the greatest due to the emergency response. • *Hospitals* – Moderate need for state or federal assistance. Agent-specific medical supplies are likely available at the hospital for many agents (federal resources on-location). If the attack involves an exotic chemical, additional state and federal support will be needed. There will likely be a large turnout of psychological casualties (walking-well). The hospital has no ability to decontaminate walk-ins without DFRS support. The Emergency Department would not be capable of handling the patient surge, resulting in ED closure and the diverted patients. Fatality management would be a challenge for the hospital and others in the region. Normal hospital functions should return to normal in 48 hours. • *Emergency Management* – Local resources adequate. Limited impact to Emergency Management capability.
ENVIRONMENTAL IMPACT	*Significant*	• Significant environmental impact. Some loss of species, vegetation and short term pollution. If the hazardous area extends outside, air, water, and soil may be contaminated. A chemical that can kill or debilitate humans may also kill or debilitate other animal life in the area. Once the chemical is removed from the environment, there will likely be no residual impacts to air, water and land.
ECONOMIC IMPACT	*Significant*	• $230,000 in lost economic output. Other costs include cleanup and healthcare for those affected. • 1.85 jobs lost. • General panic, massive individual flight, and traffic gridlock lead to business closures lasting an indefinite period of time. Business recovery period depends on impact to facilities, staff, and public image.
TOTAL IMPACT	*Significant - Critical*	• Total Impact Score: 2.63 on a scale of 1 (Limited) to 4 (Catastrophic).
Limited	*Significant*	*Critical*	*Catastrophic*

Consequence Analysis: Public Perception

The Consequence Analysis: Public Perception table characterizes public perceptions of each hazard. Details include public confidence in personal ability to respond to each hazard, public confidence in Howard County's ability to respond to each hazard, and each hazard's perceived impact to personal safety and standard of living.

Chemical Attack
Public Perceptions

PERCEIVED CONFIDENCE IN HOWARD COUNTY'S ABILITY TO RESPOND AND RECOVER FROM THIS HAZARD	PERCEIVED CONFIDENCE IN PERSONAL ABILITY TO PROTECT SELF AND FAMILY FROM THIS HAZARD	CONCERN OVER THE IMPACT TO PERSONAL HEALTH AND SAFETY IF THIS HAZARD WERE TO OCCUR LOCALLY	CONCERN OVER THE IMPACT TO PERSONAL STANDARD OF LIVING / QUALITY OF LIFE IF THIS HAZARD WERE TO OCCUR LOCALLY
			
Average: 2.48 *Moderate - Low*	*Average: 3.16* *Low*	*Average: 3.54* *Extremely Concerned - Somewhat Concerned*	*Average: 3.38* *Somewhat Concerned - Extremely Concerned*

Civil Unrest

I. OVERVIEW

The Overview section defines the hazard and summarizes the hazard risk profile.

Definition

This section defines the scope of the hazard category. The terminology and characterization established in this section should be consistent throughout all Howard County planning documents.

A Civil Unrest hazard occurs when public disorder has the potential to cause damage or harm. Civil Unrest is often the result of ideological conflict and may include protests, riots, demonstrations, civil disobedience, and other forms of public obstruction. Not all displays of civil unrest are Civil Unrest hazards. Although many expressions of civil unrest are safe and legal, a Civil Unrest hazard occurs when the level of public disorder becomes a threat to health, safety, and property.

Risk Profile

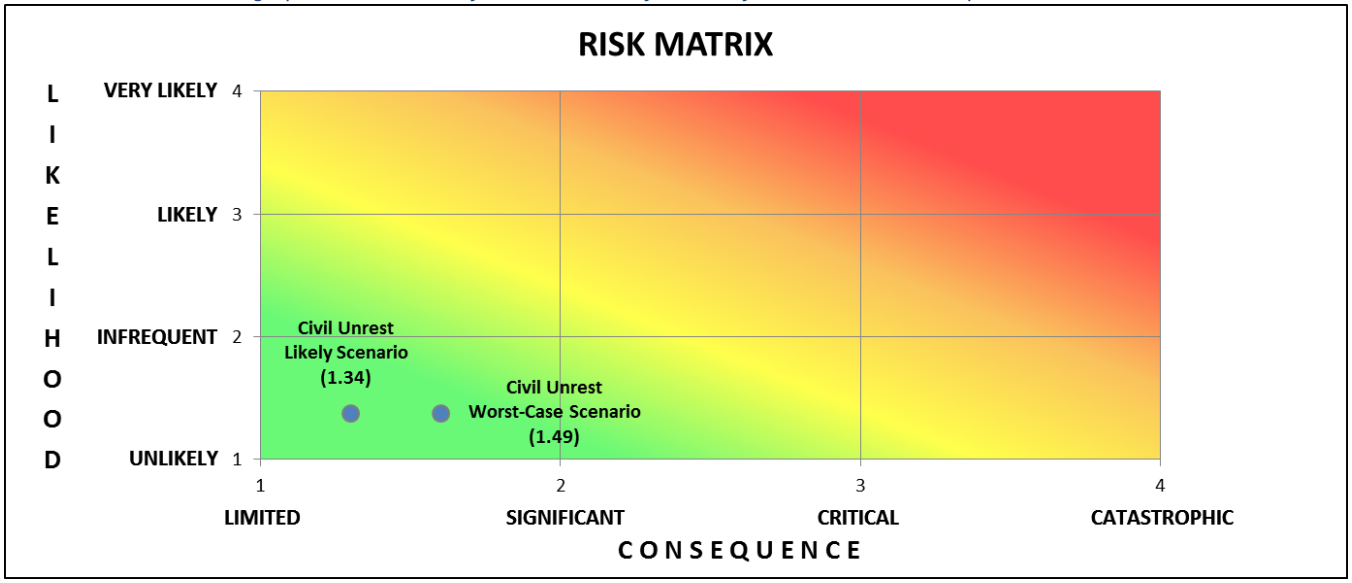
The Risk Profile section presents the Risk Score for the hazard in a range from 1 (lowest risk) to 4 (highest risk). Risk Score is a function of Likelihood and Consequence.

Civil Unrest Risk Profile				
	Risk Assessment Category	**Likely Hazard Scenario**	**Worst-Case Hazard Scenario**	**Weight**
LIKELIHOOD	**Likelihood**	1.38* Unlikely-Infrequent		50%
CONSEQUENCE	**Impact**	1.00 Limited	1.38 Limited-Significant	40%
	Warning Time	4 Short	4 Short	5%
	Duration	1 Short	1 Short	5%
TOTAL RISK SCORE		**1.34**	**1.49**	

**The Likelihood Score reflects the likelihood of any emergency-level hazard event and does not differentiate between Likely and Worst-Case scenarios.*

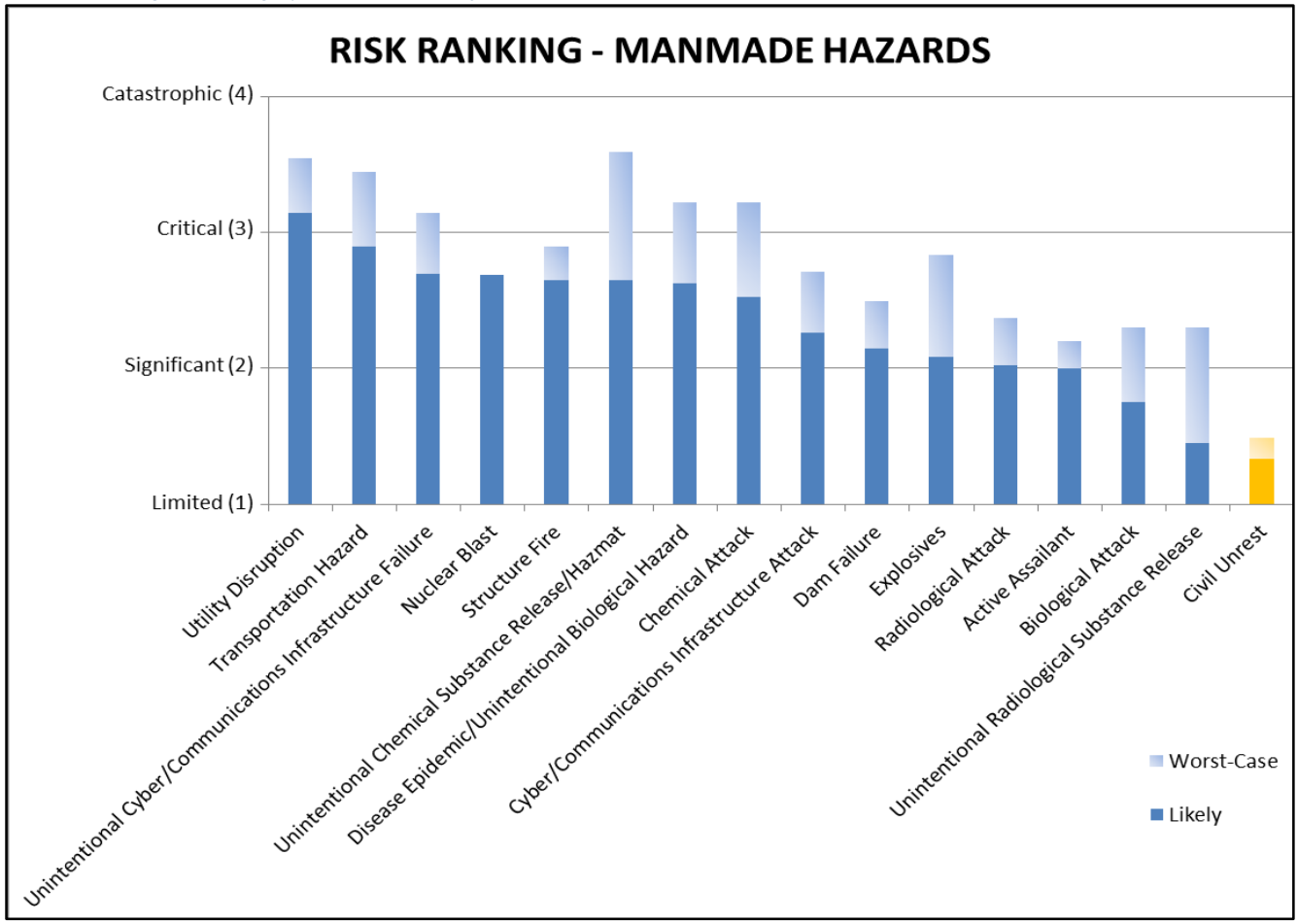
Risk Matrix

The Risk Matrix chart is a graphical illustration of hazard Risk as a function of Likelihood and Consequence.



Risk Ranking

The Risk Ranking chart is a graphical illustration of hazard Risk as it relates to other hazards.



Where no Worst-Case bar is visible, Worst-Case Risk is equivalent to Likely Risk.

II. HAZARD CHARACTERISTICS

The Hazard Characteristics section provides a detailed characterization of the hazard and the local context as it relates to the hazard.

Description of the Hazard

A Civil Unrest hazard may come in the form of a small sit in or act of civil disobedience, a protest, or a full-scale riot. The intention behind Civil Unrest actions may vary greatly from once incident to another. Many individuals engaged in Civil Unrest wish to peacefully draw media attention, others hope to disrupt traffic or commerce, and still others simply wish to instigate violence.

Some Civil Unrest hazards occur without warning, although many times authorities are aware of the potential for a hazard with an advanced warning of one day or more.

The area involved in a Civil Unrest hazard can vary. The area disrupted by a small sit in can occupy a section of street ¼ mile long or smaller. On the other end of the spectrum, a large protest may occupy several miles. Depending on the size of the event, a Civil Unrest hazard may involve anywhere from 1 to 250,000 participants.

The duration of a Civil Unrest hazard can last one hour to several days. Recovery from a minor incident can take less than one day, while recovery from a major incident can take up to a week.

Local Context

The Local Context section describes community attributes that affect the likelihood of the hazard's occurrence or vulnerability to the hazard's consequences.

A Civil Unrest hazard can occur anywhere in Howard County. Many Civil Unrest hazards are the result of social, political, or economic tensions. These hazards are likely to occur in areas with social or political significance. Locations that are vulnerable to Civil Unrest include government buildings, controversial defense or research facilities, locations where historical tensions exist, and locations with a high level of visibility or media attention. Not all Civil Unrest hazards are ideologically based. Civil Unrest hazards may also occur anywhere that people come together, particularly if drugs or alcohol are involved.[1]

[1] *Manmade Hazard Identification and Risk Assessment Workshop (unpublished)*, Howard County OEM (2014).

III. LIKELIHOOD ANALYSIS

The Likelihood Analysis section characterizes the historical occurrence and future likelihood of the hazard in the planning area.

Occurrence of the Hazard

The Occurrence of the Hazard section details the historical occurrence of the hazard in the planning area.

There have been 0 Civil Unrest hazard events in Howard County during the reviewed time period (1996-2014).

Notable Incidents in Howard County

Howard County has experienced unruly crowds associated with concerts or gatherings, but none of these situations has escalated beyond control.

Future Likelihood of the Hazard for Howard County

The Future Likelihood section anticipates the future occurrence rate of the hazard based on historical likelihood and future trends. This section also addresses factors that may cause the future likelihood to deviate from historical trends.

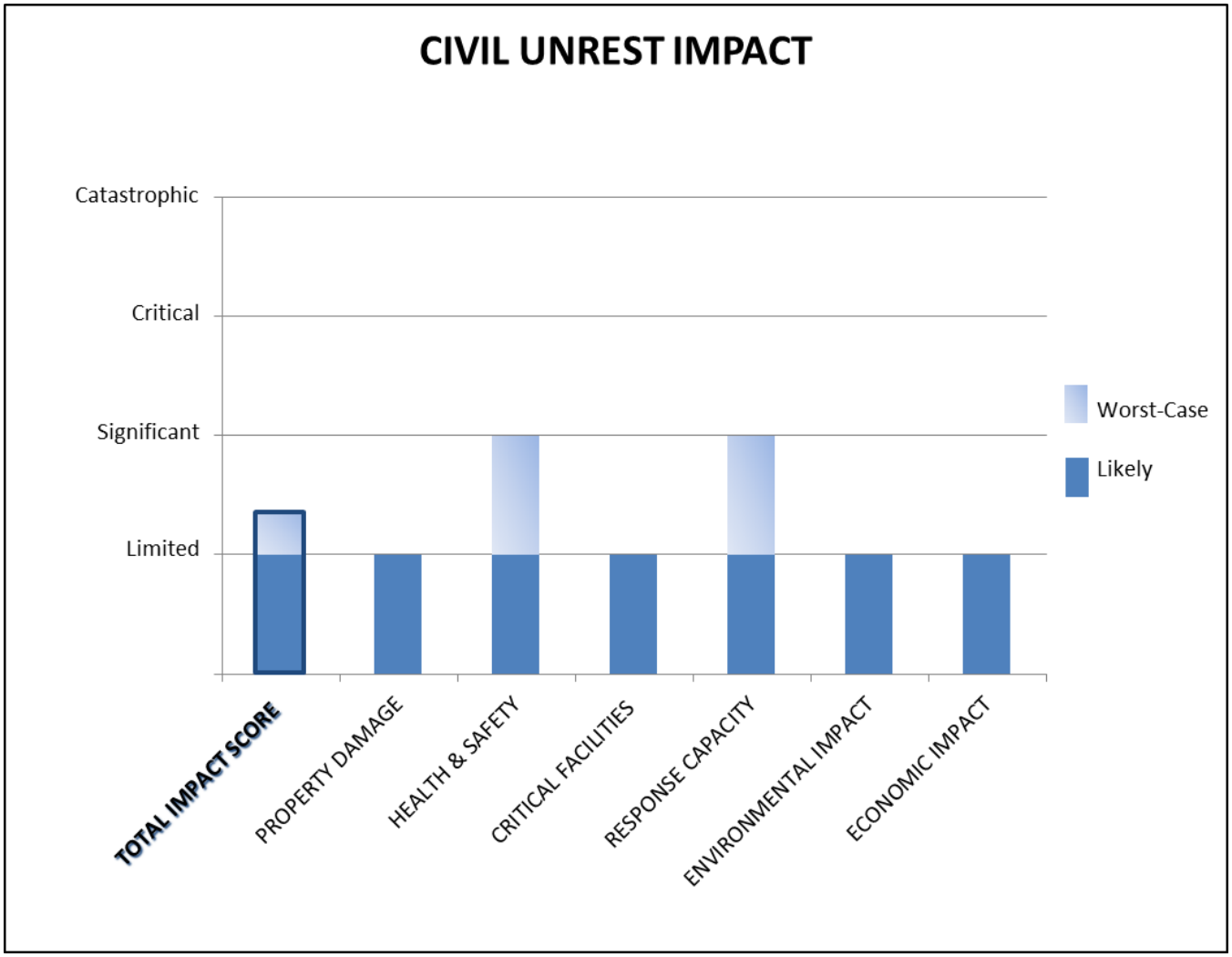
Future Likelihood of a Civil Unrest Hazard in Howard County	
Historical Average (time period)	0 recorded events (2000-2014)
Historical Annual Probability	0% chance of annual occurrence
Future Likelihood Expected to Deviate from Historical Likelihood (Yes/No)	No
Future Annual Probability	0-1% chance of annual occurrence
Future Likelihood Score	1.38 (Unlikely-Infrequent)
Future Likelihood reflects the likelihood of any emergency-level hazard event and does not differentiate between Likely and Worst-Case scenarios.	

Considerations: The future likelihood of a Civil Unrest hazard in Howard County is not expected to be significantly different from the historical occurrence rate. A future annual probability of 0-1% classifies the likelihood of a Civil Unrest hazard as Unlikely. Although societal tension and population polarization are increasing nationally, the probability of a Civil Unrest hazard in Howard County is not expected to increase.

IV. CONSEQUENCE ANALYSIS

The Consequence Analysis section provides a detailed characterization of the anticipated consequences of likely and worst-case hazard events. This section characterizes impacts to property, health & safety, critical facilities, response capacity, the environment, and the economy. This section also characterizes public perceptions of each hazard, the perceived impact to personal safety and standard of living, and public confidence in response capability.

Consequence Analysis Overview



Where no Worst-Case bar is visible, Worst-Case impact is equivalent to Likely impact.

Civil Unrest Warning Time & Duration		
	Likely	**Worst-Case**
WARNING TIME	*Short.* 2-4 hours of warning prior to the Civil Unrest activity reaching hazardous levels.	*Short.* Less than 20 minutes of warning prior to the Civil Unrest activity reaching hazardous levels.
DURATION	*Short.* 2-3 hours to remove the hazard.	*Short.* 2-3 hours to remove the hazard.

Consequence Analysis: Likely Hazard Scenario

The Consequence Analysis table details the anticipated consequences of the most likely hazard scenario.

Civil Unrest Consequence Analysis Likely		
PROPERTY DAMAGE	*Limited*	• 0% damage to critical and non-critical infrastructure. • Anything beyond superficial damage to buildings and structures is unlikely.
HEALTH & SAFETY	*Limited*	• No deaths likely. • No injuries likely.
CRITICAL FACILITIES	*Limited*	• *Utilities* – Shutdown unlikely. No effect on utilities. • *Information/Communications* – Shutdown unlikely. No major impact on information or communications infrastructure. • *Transportation* – Shutdown unlikely. Impacts to transportation will be minor and short-term.
RESPONSE CAPACITY	*Limited*	• *Police* – Local resources adequate. No impact on response capability or continuity of operations. • *Fire & Rescue* – Local resources adequate. No impact on response capability or continuity of operations. • *Health* – Local resources adequate. Health Department operations will not be affected. • *Hospitals* – Local resources adequate. No impact on the hospital system. • *Emergency Management* – Local resources adequate. Limited impact to Emergency Management capability.
ENVIRONMENTAL IMPACT	*Limited*	• Limited environmental impact. Less than a day of clean-up. Impact to a localized area.
ECONOMIC IMPACT	*Limited*	• Minimal loss of economic output due to the limited area affected. Other costs include cleanup of the hazard area. • 0 jobs lost. • Minor business disruption in a localized area is possible.
TOTAL IMPACT	*Limited*	• Total Impact Score: 1.00 on a scale of 1 (Limited) to 4 (Catastrophic).
Limited	*Significant*	*Critical*	*Catastrophic*

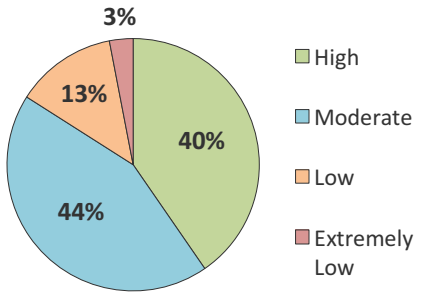
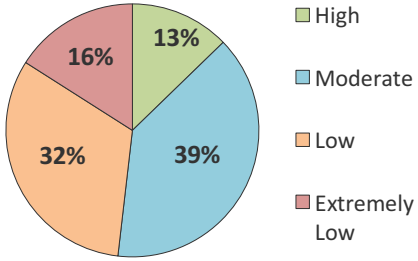
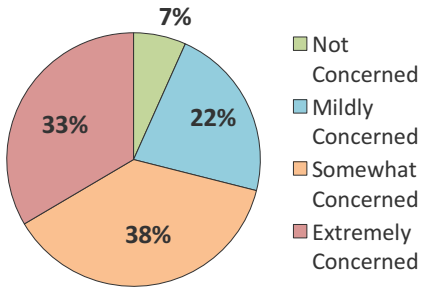
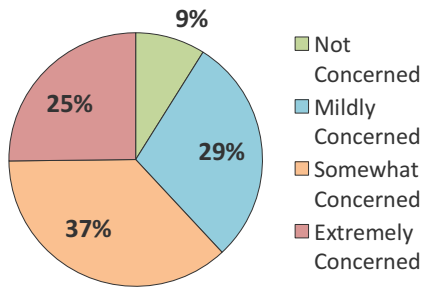
Consequence Analysis: Worst-Case Hazard Scenario

The Consequence Analysis: Worst-Case table details the anticipated consequences of the worst-case hazard scenario.

Civil Unrest Consequence Analysis Worst-Case		
PROPERTY DAMAGE	*Limited*	• 0% damage to critical and non-critical infrastructure. • Anything beyond superficial damage to buildings and structures is unlikely. Superficial property damage may occur near the site of the Civil Unrest hazard. Damage may include broken glass and localized fires.
HEALTH & SAFETY	*Significant*	• 1-10 deaths likely. Most deaths and injuries are likely the result of violent altercations or stampeding. • 30-40 injuries likely. Most deaths and injuries are likely the result of violent altercations or stampeding.
CRITICAL FACILITIES	*Limited*	• *Utilities* – Shutdown unlikely. No effect on utilities. • *Information/Communications* – Shutdown unlikely. No major impact on information or communications infrastructure. • *Transportation* – Shutdown unlikely. Impacts to transportation will be localized to the area of the hazard. Traffic delays will be minor and short-term.
RESPONSE CAPACITY	*Significant*	• *Police* – Local resources adequate. Road patrol staffing may be slightly depleted. • *Fire & Rescue* – Moderate need for state or federal assistance. Minor disruption of response capability. Heavy mutual aid response may be necessary. • *Health* – Local resources adequate. Essential Health Department operations will not be affected. Emergency Prepardness and Response may be needed to support local response. • *Hospitals* – Local resources adequate. Emergency Department patient surge is expected, but local resources would likely be sufficient. Ambulance traffic may be rerouted, resulting in increased Emergency Department wait times. • *Emergency Management* – Local resources adequate. Limited impact to Emergency Management capability.
ENVIRONMENTAL IMPACT	*Limited*	• Limited environmental impact. Less than a day of clean-up. Impact to a localized area.
ECONOMIC IMPACT	*Limited*	• $19,000 in lost economic output. Other costs include cleanup and healthcare for those affected. • 0.15 jobs lost. • Limited business disruption may occur in the hazard area. County image may suffer.
TOTAL IMPACT	*Limited-Significant*	• Total Impact Score: 1.38 on a scale of 1 (Limited) to 4 (Catastrophic).
Limited	*Significant*	*Critical*	*Catastrophic*

Consequence Analysis: Public Perception

The Consequence Analysis: Public Perception table characterizes public perceptions of each hazard. Details include public confidence in personal ability to respond to each hazard, public confidence in Howard County's ability to respond to each hazard, and each hazard's perceived impact to personal safety and standard of living.

Civil Unrest Public Perceptions			
PERCEIVED CONFIDENCE IN HOWARD COUNTY'S ABILITY TO RESPOND AND RECOVER FROM THIS HAZARD	**PERCEIVED CONFIDENCE IN PERSONAL ABILITY TO PROTECT SELF AND FAMILY FROM THIS HAZARD**	**CONCERN OVER THE IMPACT TO PERSONAL HEALTH AND SAFETY IF THIS HAZARD WERE TO OCCUR LOCALLY**	**CONCERN OVER THE IMPACT TO PERSONAL STANDARD OF LIVING / QUALITY OF LIFE IF THIS HAZARD WERE TO OCCUR LOCALLY**
			
Average: 1.79 *Moderate*	*Average: 2.51* *Low - Moderate*	*Average: 2.98* *Somewhat Concerned*	*Average: 2.79* *Somewhat Concerned*

Cyber/Communications Infrastructure Attack

I. OVERVIEW

The Overview section defines the hazard and summarizes the hazard risk profile.

Definition

This section defines the scope of the hazard category. The terminology and characterization established in this section should be consistent throughout all Howard County planning documents.

A Cyber/Communications Infrastructure Attack is an intentional disruption or manipulation of the information and communication systems used to collect, filter, process, create, and distribute data. A Cyber/Communications Infrastructure Attack may seek to impact data or physical infrastructure.

Risk Profile

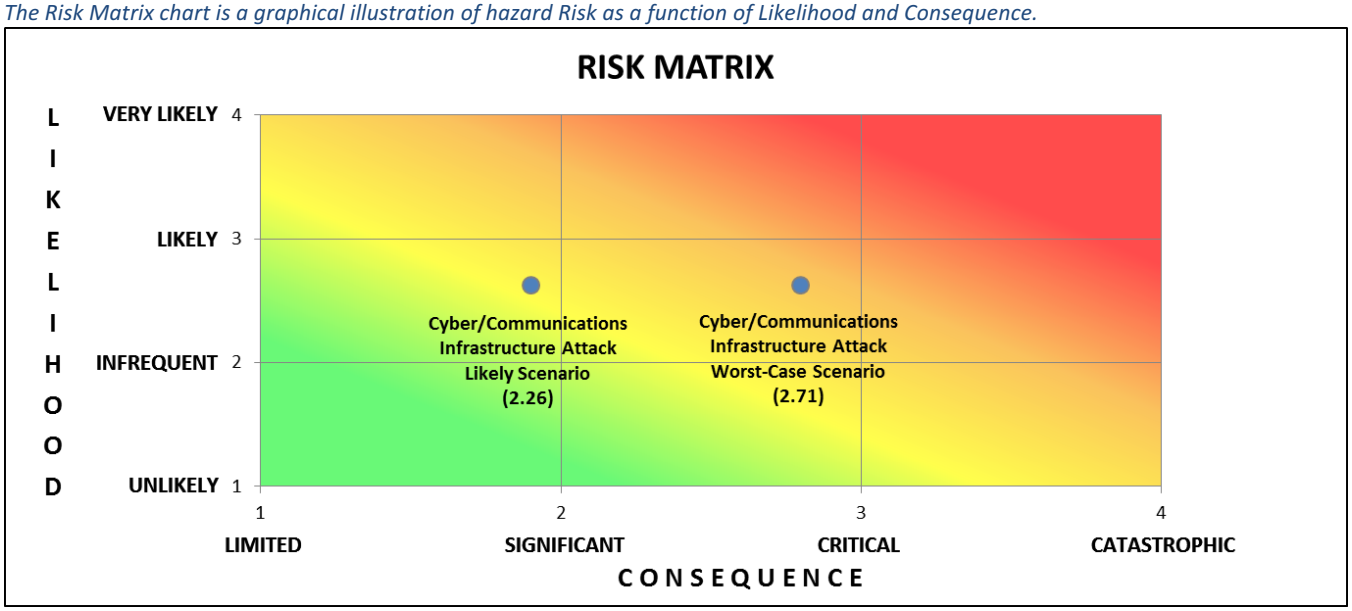
The Risk Profile section presents the Risk Score for the hazard in a range from 1 (lowest risk) to 4 (highest risk). Risk Score is a function of Likelihood and Consequence.

Cyber/Communications Infrastructure Attack Risk Profile				
	Risk Assessment Category	**Likely Hazard Scenario**	**Worst-Case Hazard Scenario**	**Weight**
LIKELIHOOD	**Likelihood**	2.63* Infrequent-Likely		50%
CONSEQUENCE	**Impact**	1.50 Limited-Significant	2.63 Significant-Critical	40%
	Warning Time	4 Short	4 Short	5%
	Duration	3 Long	3 Long	5%
TOTAL RISK SCORE		**2.26**	**2.71**	

**The Likelihood Score reflects the likelihood of any emergency-level hazard event and does not differentiate between Likely and Worst-Case scenarios.*

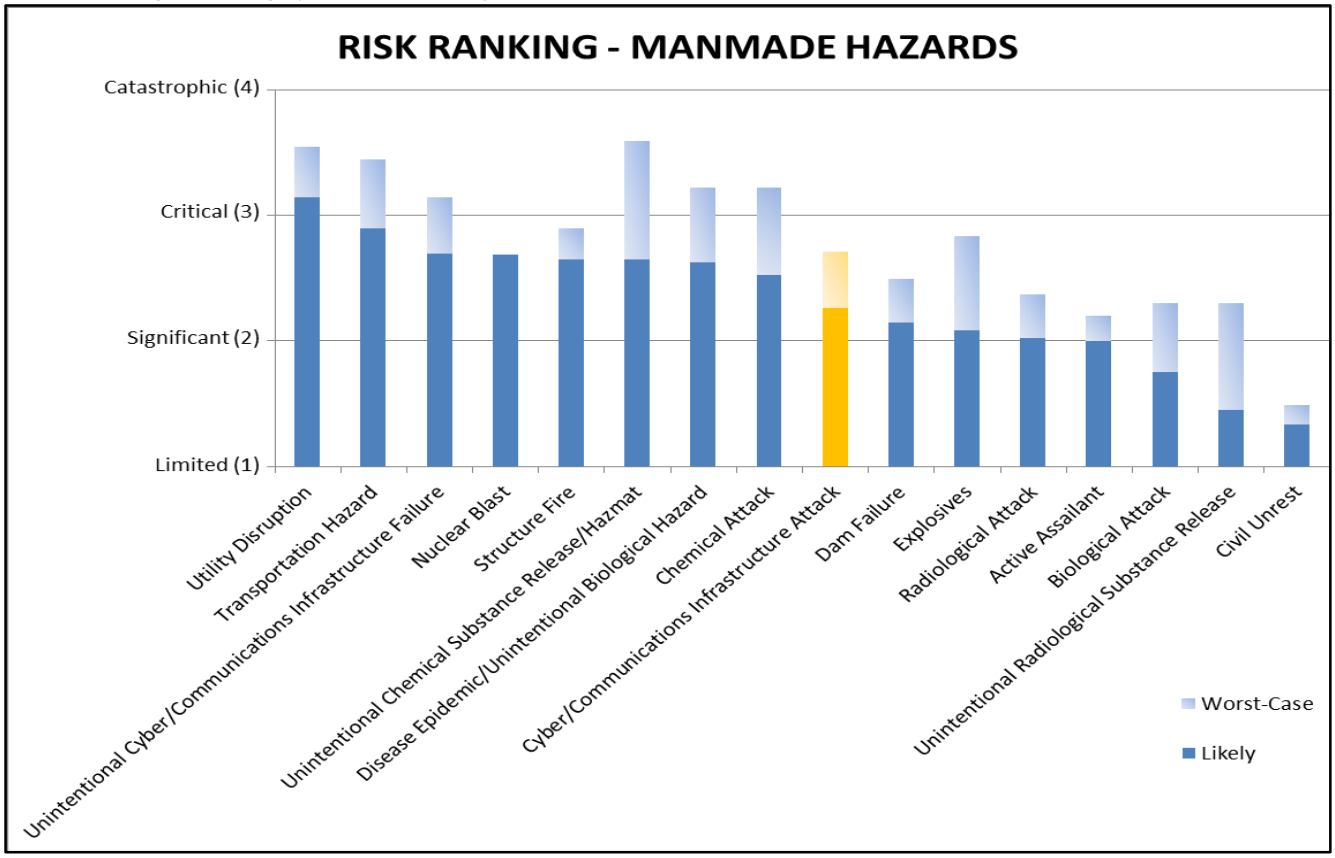
Risk Matrix

The Risk Matrix chart is a graphical illustration of hazard Risk as a function of Likelihood and Consequence.



Risk Ranking

The Risk Ranking chart is a graphical illustration of hazard Risk as it relates to other hazards.



Where no Worst-Case bar is visible, Worst-Case Risk is equivalent to Likely Risk.

II. HAZARD CHARACTERISTICS

The Hazard Characteristics section provides a detailed characterization of the hazard and the local context as it relates to the hazard.

Description of the Hazard

A cyber/communications infrastructure attack may seek to impact data or physical infrastructure. Attacks against data compromise the integrity or availability of computerized information or information systems. Attacks against physical infrastructure manipulate computerized information to cause "beyond the computer" harm to people, property, operational capacity, or the environment. Cyber/Communications Infrastructure Attacks commonly target computer software using malicious programs such as viruses, trojan horses, and worms, but may also target hardware through physical attacks on servers, cables, satellites, or communication centers.[1,2]

A smaller-scale Cyber/Communications Infrastructure Attack may target individually owned devices such as computers or mobile phones. Attacks that are larger in scale can disrupt transportation, power, and other services or seek to access private information from government and commercial networks. Depending on the scope of the attack, Cyber/Communications Infrastructure Attack hazards can impact anywhere from a single computer to data networks spreading across the entire country.

It is rare to have any advanced warning of a Cyber/Communications Infrastructure Attack.

Some Cyber/Communications Infrastructure Attacks may seek to gain access to private information for the purpose of espionage or identity theft. Other attacks wish to alter data for personal, financial, or political gain. Still other attacks use cyber tactics as a mechanism to cause social disruption or cause fear.

Cyber/Communications Infrastructure Attacks can also be used as a mechanism to create physical consequences, such as the manipulation or disruption of traffic lights, gas line pressure systems, or radio and 911 call center communications.

The initial Cyber/Communications Infrastructure Attack may only take several minutes. However, it can take hours, days, or even weeks to identify and control the hazard.

Local Context

The Local Context section describes community attributes that affect the likelihood of the hazard's occurrence or vulnerability to the hazard's consequences.

A Cyber/Communications Infrastructure Attack may occur anywhere that relies on electronic information and communications systems, and all of Howard County is susceptible to the effects of this attack. Vulnerability to the consequences of a Cyber/Communications Infrastructure Attack increases as essential functions become increasingly reliant on electronic information and communications systems. Possible targets for Cyber/Communications Infrastructure Attacks in Howard County include government communications networks, databases containing sensitive personal information, and the System Control and Data Acquisition (SCADA) systems that monitor and control industrial processes.[3]

[1] For additional information see *Cyber Attack,* FEMA. Available at http://www.ready.gov/cyber-attack (last accessed March 27, 2014).
[2] For additional information see *Strategic National Risk Assessment,* U.S. Dept. of Homeland Security (2011). Available at http://www.dhs.gov/xlibrary/assets/rma-strategic-national-risk-assessment-ppd8.pdf (last accessed March 27, 2014).
[3] *Manmade Hazard Identification and Risk Assessment Workshop (unpublished)*, Howard County OEM (2014).

III. LIKELIHOOD ANALYSIS

The Likelihood Analysis section characterizes the historical occurrence and future likelihood of the hazard in the planning area.

Occurrence of the Hazard

The Occurrence of the Hazard section details the historical occurrence of the hazard in the planning area.

There has never been a successful emergency-level Cyber/Communications Infrastructure Attack in Howard County (an emergency-level Cyber/Communications Infrastructure Attack is an incident that requires a multi-agency response). However, every day Howard County experiences attacks that result in user impact, loss of access to information systems, and the need to repair or replace hardware or software. There are over 3,000 minor damaging Cyber/Communications Infrastructure Attacks in Howard County each year.

Notable Incidents in Howard County

General phishing attacks, searches for protected data, and system exploits allowing the entry of harmful software may take place thousands of times each day. These attacks most commonly result in the release of protected information or cause damage to individual software and hardware.

2013 Trojan Attack – A trojan was placed in the Howard County network that allowed access to protected information and caused data damage to a large portion of the County network. The trojan was identified, and data was restored from backup. Although it was quickly stopped, this hazard had the potential to cause significant damage if unchecked.

Future Likelihood of the Hazard for Howard County

The Future Likelihood section anticipates the future occurrence rate of the hazard based on historical likelihood and future trends. This section also addresses factors that may cause the future likelihood to deviate from historical trends.

Future Likelihood of a Cyber/Communications Infrastructure Attack Hazard in Howard County	
Historical Average (time period)	0 recorded emergency-level events (2000-2014)
Historical Annual Probability	0% chance of annual occurrence
Future Likelihood Expected to Deviate from Historical Likelihood (Yes/No)	Yes
Future Annual Probability	1-30% chance of annual occurrence
Future Likelihood Score	2.63 (Infrequent-Likely)
Future Likelihood reflects the likelihood of any emergency-level hazard event and does not differentiate between Likely and Worst-Case scenarios.	

Considerations: The future likelihood of an emergency-level Cyber/Communications Infrastructure Attack in Howard County is expected to be higher than indicated by the historical occurrence rate alone. Likelihood estimates for an emergency-level attack have a wide range of variability, but current estimates predict a 1-30% chance of annual occurrence, or one event every 3-99 years. A future annual probability of 1-30% classifies the likelihood of a Cyber/Communications Infrastructure Attack as Infrequent to Likely.

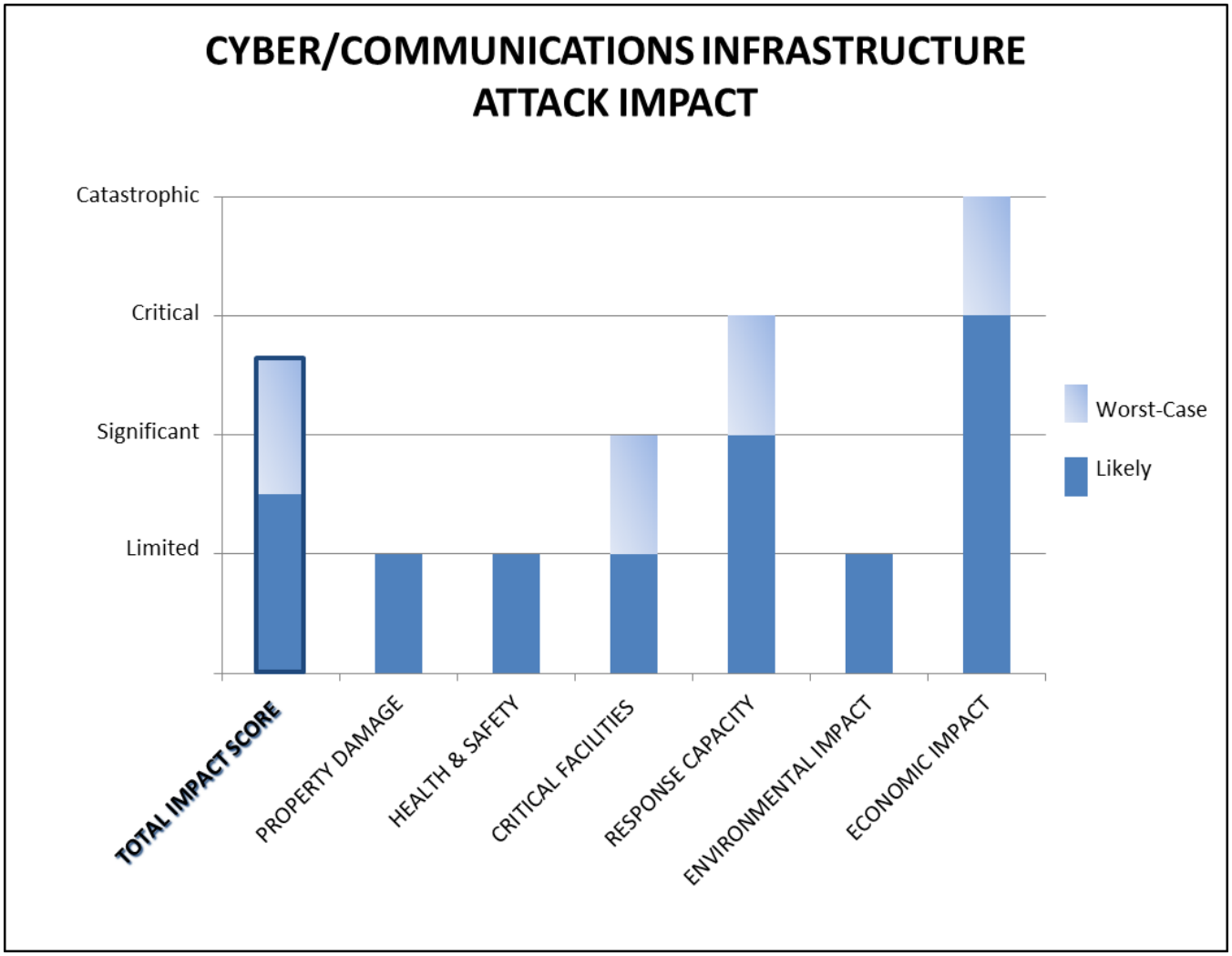
Howard County has never experienced a successful emergency-level Cyber/Communications Infrastructure Attack, but several factors contribute to the expected increase in likelihood. Rapid advances in technology and a growing number of parties interested in data-gathering or system-damaging attacks contribute to the increased likelihood of an emergency-level cyber attack. Likewise, the likelihood of an attack increases as Howard County increases its reliance on electronic information systems. The current Howard County average of over 3,000 minor cyber attacks each year demonstrates the possibility of a successful emergency-level attack inside the

planning area. The County's proximity to high value targets also contribute to an increase in the likelihood of an emergency-level Cyber/Communications Infrastructure Attack in the future.3

IV. CONSEQUENCE ANALYSIS

The Consequence Analysis section provides a detailed characterization of the anticipated consequences of likely and worst-case hazard events. This section characterizes impacts to property, health & safety, critical facilities, response capacity, the environment, and the economy. This section also characterizes public perceptions of each hazard, the perceived impact to personal safety and standard of living, and public confidence in response capability.

Consequence Analysis Overview



Where no Worst-Case bar is visible, Worst-Case impact is equivalent to Likely impact.

Cyber/Communications Infrastructure Attack Warning Time & Duration		
	Likely	**Worst-Case**
WARNING TIME	*Short.* No warning time prior to an attack.	*Short.* No warning time prior to an attack.
DURATION	*Long.* 36 hours to complete a limited restore of damaged information/communications functions. Up to 5 days to restore all damaged systems.	*Long.* 36 hours to complete a limited restore of damaged information/communications functions. Up to 5 days to restore all damaged systems.

Consequence Analysis: Likely Hazard Scenario

The Consequence Analysis table details the anticipated consequences of the most likely hazard scenario.

Cyber/Communications Infrastructure Attack Consequence Analysis Likely		
PROPERTY DAMAGE	*Limited*	• 0% damage to critical and non-critical infrastructure. • Damage to buildings and structures is unlikely.
HEALTH & SAFETY	*Limited*	• Deaths are very unlikely. • Injuries are very unlikely.
CRITICAL FACILITIES	*Limited*	• *Utilities* – Shutdown unlikely or very short in duration. Little to no impact on water supply and waste water systems. Systems can be restored manually within hours. • *Information/Communications* – Little to no shutdown for nearly all users. A small number of individual users (fewer than five) may lose access to networks or hardware. • *Transportation* – Shutdown unlikely. Transportation routes will not be impacted.
RESPONSE CAPACITY	*Significant*	• *Police* – Local resources adequate. If the nature of the Cyber/Communications Infrastructure Attack necessitates a terrorism response, federal law enforcement involvement will be triggered automatically. • *Fire & Rescue* – Mutual aid needed. If Cyber Attacks target physical infrastructure, fire/rescue resources may be strained by efforts to support the restoration of services. • *Health* – Local resources adequate. Health Department may experience temporary service disruptions for a small number of users. • *Hospitals* – Local resources adequate. Provided that water supply is not affected, hospital operations will not be affected. • *Emergency Management* – Local resources adequate. Limited impact to Emergency Management capability.
ENVIRONMENTAL IMPACT	*Limited*	• No environmental impact, provided that the communications infrastructure outage does not result in any industrial or wastewater treatment plant discharges or spills.
ECONOMIC IMPACT	*Critical*	• $170 million in lost economic output. Other costs include cleanup and healthcare for those affected. • 1,378 jobs lost.
TOTAL IMPACT	*Limited-Significant*	• Total Impact Score: 1.50 on a scale of 1 (Limited) to 4 (Catastrophic).
Limited	*Significant*	*Critical*	*Catastrophic*

Consequence Analysis: Worst-Case Hazard Scenario

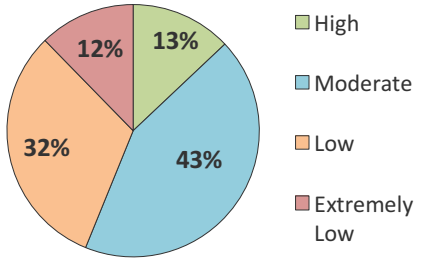
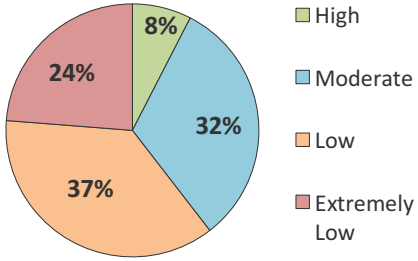
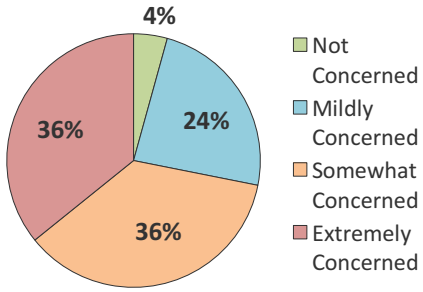
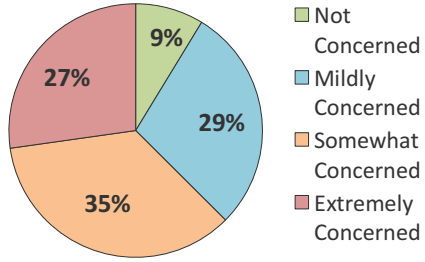
The Consequence Analysis: Worst-Case table details the anticipated consequences of the worst-case hazard scenario.

Cyber/Communications Infrastructure Attack Consequence Analysis Worst-Case		
PROPERTY DAMAGE	*Limited*	• 0% damage to critical and non-critical infrastructure. • Anything beyond superficial damage to buildings and structures is unlikely.
HEALTH & SAFETY	*Limited*	• 0 deaths likely. • 0 injuries likely. • Although direct deaths and injuries are unlikely, those that occur are likely due to cascade effects (indirect consequences of the hazard). In the event of a Cyber Attack targeting power or utilities infrastructure, hospitals may be unable to provide essential services. There may also be a chance of death or injury due to heat, extreme weather, or exposure to adverse environmental conditions.
CRITICAL FACILITIES	*Significant*	• *Utilities* – Shutdown for up to 12 hours. If the Cyber/Communications Infrastructure Attack targets utilities systems, water supply and waste water treatment will be shut down for several hours. • *Information/Communications* – Shutdown for 1-5 days. Email systems and access to internet may be unavailable. VoIP phone systems will be offline, but cell phones will likely remain operational. • *Transportation* – Delays for 1-3 days. If the attack targets traffic control systems, significant transportation delays will occur.
RESPONSE CAPACITY	*Critical*	• *Police* – Mutual aid needed. If the nature of the Cyber/Communications Infrastructure Attack necessitates a terrorism response, federal law enforcement involvement will be triggered automatically. • *Fire & Rescue* – Moderate need for state or federal assistance. If attacks target infrastructure, fire/rescue resources may be significantly strained by efforts to support the restoration of services. • *Health* – Moderate need for state or federal assistance. Health Department operations could be disrupted. External support will be necessary to maintain communications capabilities. • *Hospitals* – Moderate need for state or federal assistance. A network/internet outage would cause most hospitals services to be unavailable. Basic patient treatment could continue, but support services would be unavailable. Patient flow may be slowed considerably. If the Cyber/Communications Infrastructure Attack resulted in a water or power outage, the hospital would face significant challenges. Evacuation may be necessary, and hospital services would be constrained to limited stabilization. The economic impact of a hospital shutdown would be significant. • *Emergency Management* – Local resources adequate. Continuity of Operations plans would be activated, but impact to Emergency Management capability would be minimal.
ENVIRONMENTAL IMPACT	*Limited*	• Limited environmental impact, provided that the communications infrastructure outage does not result in any industrial or wastewater treatment plant discharges or spills. Prolonged outage of communications systems may result in delays for some environmental protection services, and the extent of secondary environmental consequences is difficult to predict.
ECONOMIC IMPACT	*Catastrophic*	• $681 million in lost economic output. Other costs include cleanup and healthcare for those affected. • 5,500 jobs lost. • All business will likely cease for several days. Transportation delays significantly impact local businesses. Serious damage may occur to the reputation of Howard County infrastructure and its ability to support business.
TOTAL IMPACT	*Significant - Critical*	• Total Impact Score: 2.63 on a scale of 1 (Limited) to 4 (Catastrophic).
Limited	*Significant*	*Critical*	*Catastrophic*

Consequence Analysis: Public Perception

The Consequence Analysis: Public Perception table characterizes public perceptions of each hazard. Details include public confidence in personal ability to respond to each hazard, public confidence in Howard County's ability to respond to each hazard, and each hazard's perceived impact to personal safety and standard of living.

Cyber/Communications Infrastructure Attack
Public Perceptions

PERCEIVED CONFIDENCE IN HOWARD COUNTY'S ABILITY TO RESPOND AND RECOVER FROM THIS HAZARD	PERCEIVED CONFIDENCE IN PERSONAL ABILITY TO PROTECT SELF AND FAMILY FROM THIS HAZARD	CONCERN OVER THE IMPACT TO PERSONAL HEALTH AND SAFETY IF THIS HAZARD WERE TO OCCUR LOCALLY	CONCERN OVER THE IMPACT TO PERSONAL STANDARD OF LIVING / QUALITY OF LIFE IF THIS HAZARD WERE TO OCCUR LOCALLY
			
Average: 2.43 *Moderate - Low*	*Average: 2.77* *Moderate*	*Average: 3.03* *Somewhat Concerned*	*Average: 2.82* *Somewhat Concerned*

Dam Failure

I. OVERVIEW

The Overview section defines the hazard and summarizes the hazard risk profile.

Definition

This section defines the scope of the hazard category. The terminology and characterization established in this section should be consistent throughout all Howard County planning documents.

A Dam Failure hazard occurs when part or all of a dam's water-retaining barrier becomes damaged causing the uncontrolled release of water downstream. Dam Failure can lead to rapid flooding of downstream land. A Dam Failure can be the result of a design or construction error, insufficient maintenance, human error, or internal erosion. Dam Failures can also occur as the result of an intentional attack or as a cascading effect of natural hazards such as flooding, earthquakes, or geological instability.

Risk Profile

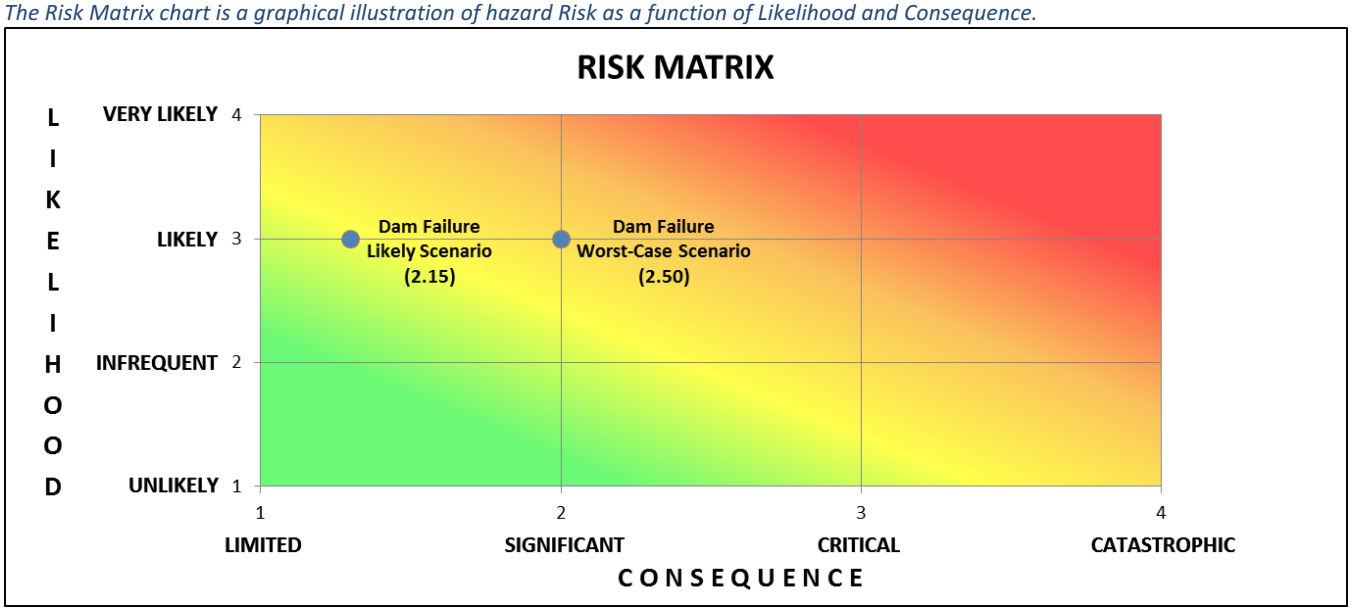
The Risk Profile section presents the Risk Score for the hazard in a range from 1 (lowest risk) to 4 (highest risk). Risk Score is a function of Likelihood and Consequence.

Dam Failure Risk Profile				
	Risk Assessment Category	**Likely Hazard Scenario**	**Worst-Case Hazard Scenario**	**Weight**
LIKELIHOOD	**Likelihood**	3.00* Likely		50%
CONSEQUENCE	**Impact**	1.00 Limited	1.75 Limited-Significant	40%
	Warning Time	4 Short	4 Short	5%
	Duration	1 Short	2 Moderate	5%
TOTAL RISK SCORE		**2.15**	**2.50**	

**The Likelihood Score reflects the likelihood of any emergency-level hazard event and does not differentiate between Likely and Worst-Case scenarios.*

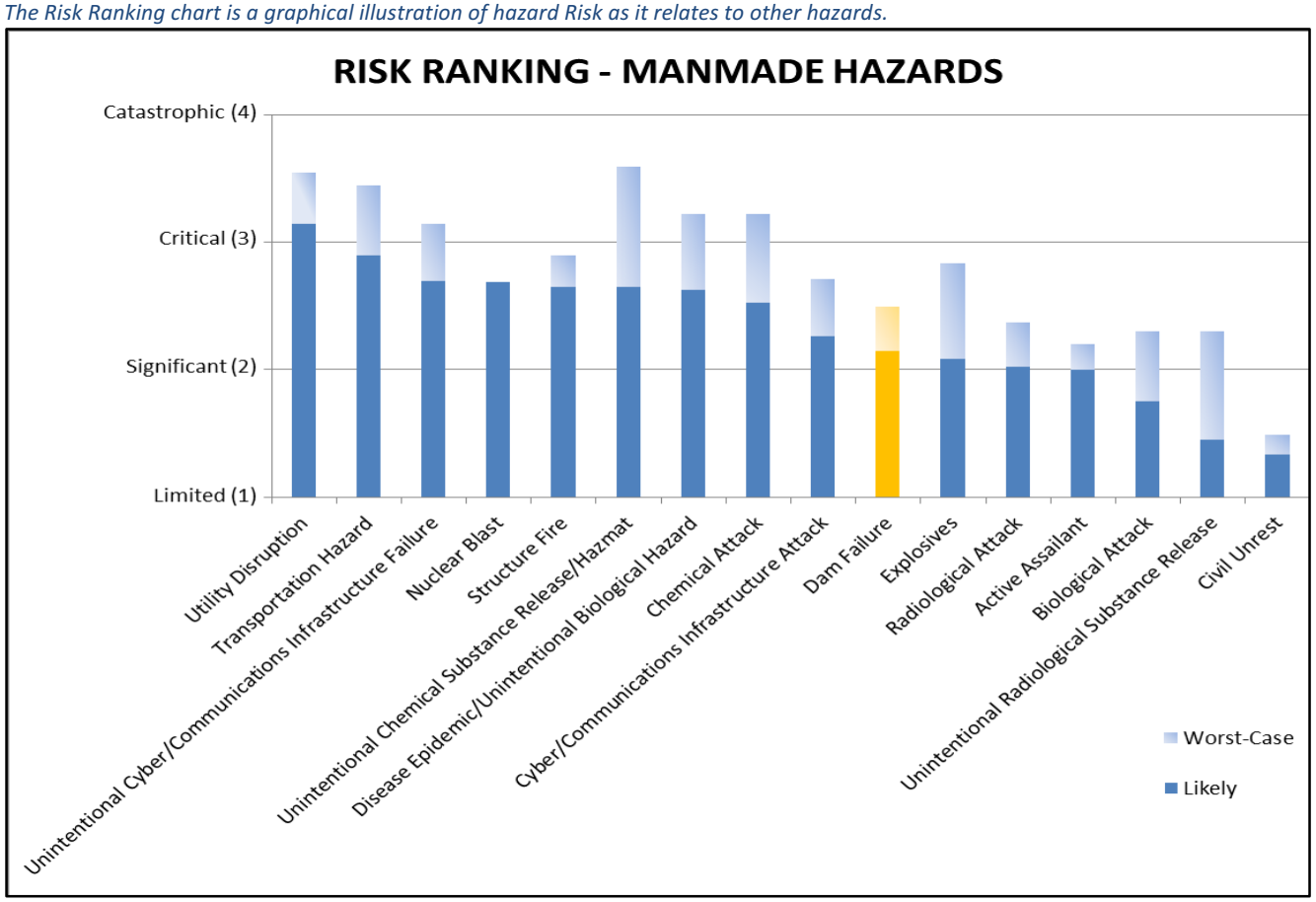
Risk Matrix

The Risk Matrix chart is a graphical illustration of hazard Risk as a function of Likelihood and Consequence.



Risk Ranking

The Risk Ranking chart is a graphical illustration of hazard Risk as it relates to other hazards.



Where no Worst-Case bar is visible, Worst-Case Risk is equivalent to Likely Risk.

II. HAZARD CHARACTERISTICS

The Hazard Characteristics section provides a detailed characterization of the hazard and the local context as it relates to the hazard.

Description of the Hazard

The Maryland Department of the Environment[1] classifies dams as follows:

- High Hazard Dams: Probable loss of life; major increases in existing flood levels at houses, buildings, major interstates and state roads with more than 6 lives in jeopardy.
- Significant Hazard Dams: Possible loss of life, significant increased flood risks to roads and buildings with no more than 2 houses or 6 lives in jeopardy.
- Low Hazard Dams: Unlikely loss of life; minor increases to existing flood levels at road and buildings.

Dam Failure can occur regardless of the type of dam or size of the body of water. Large dams can be complex structures reaching hundreds of feet into the air, but small earthen dams retaining ponds and streams can also pose a threat.

Signs of imminent Dam Failure due to flash flooding or structural defects may occur over the span of several hours. Depending on the speed of the failure, there may be a brief window of warning time prior to the release of water. On some occasions a Dam Failure or breach can occur with days or weeks of warning time as a result of slow debris jams or slow-onset flooding.

Flooding from a Dam Failure can occur suddenly or gradually. Flooding during a sudden Dam Failure occurs nearly instantaneously with a forward shock-wave travelling rapidly downstream. Flooding from gradual Dam Failures may take anywhere from 15 minutes to 24 hours as excess water is released in the form of a gradual flow.

The consequences of a Dam Failure are dependent on the size of the body of water, the location of the dam, and the characteristics of the downstream floodplain. A minor failure of a Low Hazard dam may only result in minor increases to existing flood levels. However, the failure of a High Hazard dam may result in rapid increases in existing flood levels for several miles along downstream rivers and floodplains. A minor Dam Failure may wash out into small streams or fields and never impact any populated area. However, a major Dam Failure may greatly increase flood levels at houses, buildings, and major interstates and state roads.

Local Context

The Local Context section describes community attributes that affect the likelihood of the hazard's occurrence or vulnerability to the hazard's consequences.

Dam Failures can occur anywhere that dams exist. Howard County has over 2,000 small earthen dams on ponds, streams, and minor bodies of water. Of the recognized dams in Howard County, only seven are rated as Significant Hazard or High Hazard dams.[2,3]

[1] *Facts About Maryland's Dam Safety Program,* Maryland Dept. of the Environment. Available at http://www.mde.state.md.us/assets/document/damsafety/DamSafetyFactSheet.pdf (last accessed April 2, 2014).

Notable Dams in Howard County	
HIGH HAZARD DAMS	
Centennial Park Dam (MD Dam #284)	▪ Location: Centennial Lake, approximately one mile from the intersection of US Route 29 and MD Route 108 (Lat: 39.242073; Long: -76.858048) ▪ Height: 39.5 ft. ▪ Built: 1985 ▪ Drainage Area: 3.48 sq. mi.
Columbia Gateway Dam (MD Dam #75)	▪ Location: Above Samuel Morse Drive, approximately ¼ mile from the intersection of Columbia Gateway Drive (Lat: 39.170898; Long: -76.809161) ▪ Height: 32 ft. ▪ Built: 1970 ▪ Drainage Area 1.5 sq. mi.
SIGNIFICANT HAZARD DAMS	
Lake Elkhorn Dam (MD Dam #125)	▪ Location: Lake Elkhorn, approximately ¾ of a mile north of the intersection of MD Routes 32 and Broken Land Parkway (Lat: 39.10560; Long: -77.14860) ▪ Height: 32 ft. ▪ Built: 1974 ▪ Drainage Area: 3.7 sq. mi.
Wilde Lake Dam (MD Dam #51)	▪ Location: Wilde Lake, west of Little Patuxent Parkway (Lat: 39.22325; Long: -76.85929) ▪ Height: 15 ft. ▪ Built: 1967 ▪ Drainage Area: 3.6 sq. mi.
North Laurel Park Dam (MD Dam #377)	▪ Location: Sewall Avenue, approximately ¼ mile north of the intersection of Sewall Avenue and Baltimore Avenue in Laurel, MD (Lat: 39.115078; Long: -76.848921) ▪ Height: 29.5 ft. ▪ Built: 2000 ▪ Drainage Area: 0.31 sq. mi.
Wyndemere Dam (MD Dam #365)	▪ Location: Old Scaggsville Road, approximately ¾ mile north of the intersection of Old Scaggsville Road and MD Route 216 in Laurel, MD (Lat: 39.121616; Long: -76.858225) ▪ Height: 12 ft. ▪ Built: 1995 ▪ Drainage Area: 0.12 sq. mi.
Hobbit's Glen Golf Course (MD Dam #431)	▪ Location: Hobbit's Glen Golf Course, approximately ¼ mile north of Willow Bottom Road (Lat: 39.2273; Long: -77.9057) ▪ Height: 17 ft. ▪ Built: 1966 ▪ Drainage Area: 0.36 sq. mi.

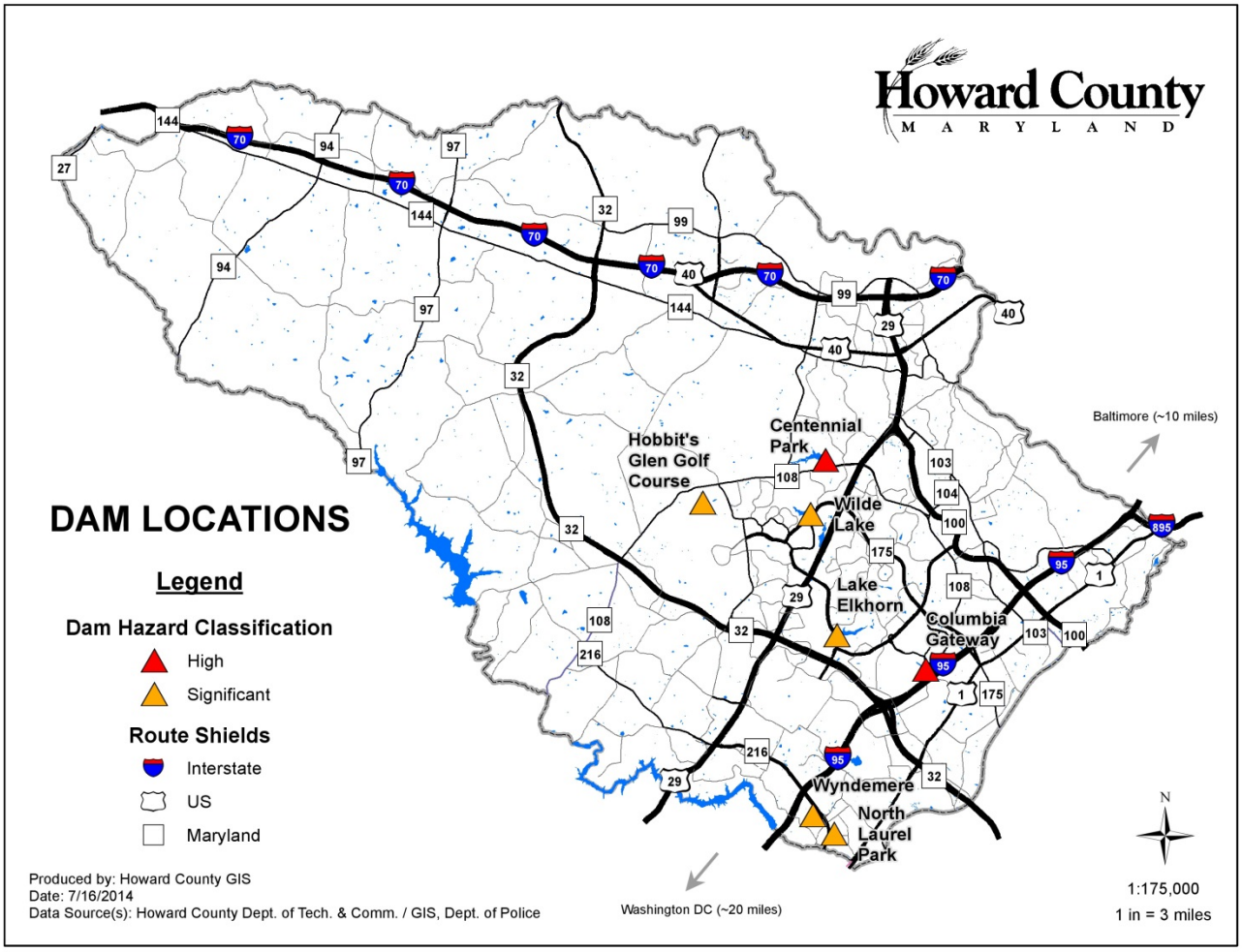
A Dam Failure hazard is only expected to directly impact the homes, businesses, and transportation routes in the drainage area of Howard County's high and significant hazard dams. Areas outside of the dam drainage area are unlikely to be directly affected by the Dam Failure hazard.

[2] For additional information see *Flood Mitigation Plan,* Howard County Dept. of Public Works (2010). Available at http://www.howardcountymd.gov/uploadedFiles/Home/Environment/Environmental_Services/FinalHowardCountyfmp.pdf (last accessed April 2, 2014).

[3] *Emergency Action Plan: High and Significant Hazard Dams in Howard County,* Howard County Stormwater Management Division/Columbia Association (2012).

Dam Locations

This map identifies High-Hazard and Significant-Hazard dams in Howard County.



III. LIKELIHOOD ANALYSIS

The Likelihood Analysis section characterizes the historical occurrence and future likelihood of the hazard in the planning area.

Occurrence of the Hazard

The Occurrence of the Hazard section details the historical occurrence of the hazard in the planning area.

There have been 3 confirmed Dam Failure hazard events in Howard County during the reviewed time period (1999-2014). All have been relatively minor incidents.

Notable Incidents in Howard County

June, 2006 Dam Failure - A low-hazard earthen dam retaining a stormwater management pond in Columbia experienced a barrel pipe collapse. The rapid release of water through the collapsed pipe resulted in the loss of a portion of the earthen embankment. Sediment from the partially failed dam flowed into the stream below the pond. The water from the pond emptied into a wooded valley and caused no damage to private property. The total cost to replace the pipe outlet and repair the damage was $208,000.



Future Likelihood of the Hazard for Howard County

The Future Likelihood section anticipates the future occurrence rate of the hazard based on historical likelihood and future trends. This section also addresses factors that may cause the future likelihood to deviate from historical trends.

Future Likelihood of a Dam Failure Hazard in Howard County	
Historical Average (time period)	1 event every 5 years (1999-2014)
Historical Annual Probability	20% chance of annual occurrence
Future Likelihood Expected to Deviate from Historical Likelihood (Yes/No)	No
Future Annual Probability	20% chance of annual occurrence
Future Likelihood Score	3.00 (Likely)
Future Likelihood reflects the likelihood of any emergency-level hazard event and does not differentiate between Likely and Worst-Case scenarios.	

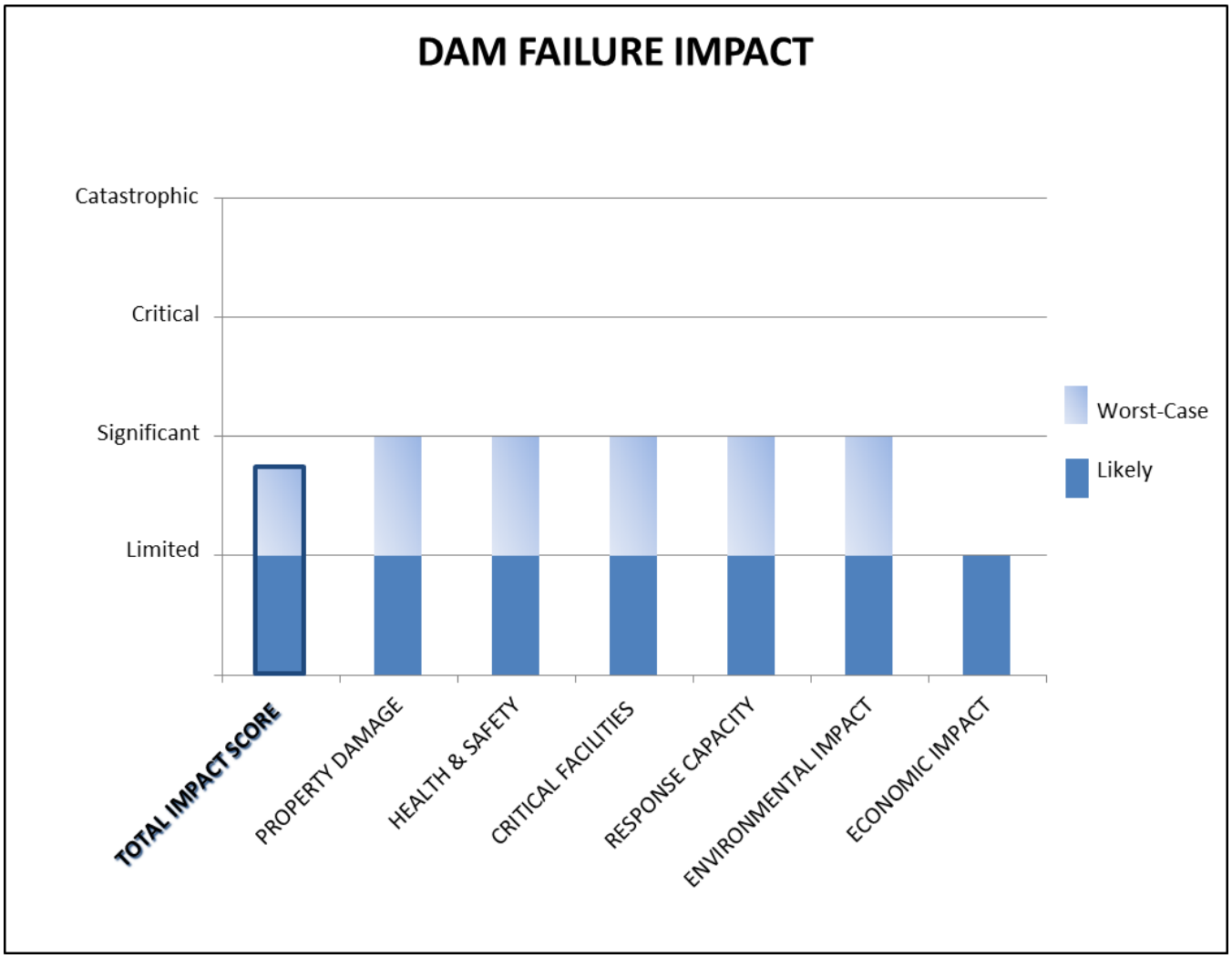
Considerations: The future likelihood of Dam Failure in Howard County is not expected to be significantly different from the historical occurrence rate. A future annual probability of 20% classifies the likelihood of a Dam Failure hazard as Likely. An expected increase in rainfall levels and extreme storms may result in a slight

increase in the likelihood of Dam Failure over time.[4] Aging dam infrastructure may also contribute to a slight increase in the likelihood of Dam Failure in the future.[5]

IV. CONSEQUENCE ANALYSIS

The Consequence Analysis section provides a detailed characterization of the anticipated consequences of likely and worst-case hazard events. This section characterizes impacts to property, health & safety, critical facilities, response capacity, the environment, and the economy. This section also characterizes public perceptions of each hazard, the perceived impact to personal safety and standard of living, and public confidence in response capability.

Consequence Analysis Overview



Where no Worst-Case bar is visible, Worst-Case impact is equivalent to Likely impact.

[4] *Third National Climate Assessment,* U.S. Global Change Research Program (2014). Available at http://nca2014.globalchange.gov/ (last accessed June 26, 2014).
[5] *Manmade Hazard Identification and Risk Assessment Workshop (unpublished)*, Howard County OEM (2014).

Dam Failure Warning Time & Duration		
	Likely	**Worst-Case**
WARNING TIME	*Short.* There may be a gradually accelerating release of water over several hours.	*Short.* There may be a rapidly accelerating release of water over 15-20 minutes.
DURATION	*Short.* Water levels rise rapidly for 15-20 minutes. Water levels will likely drop down to pre-failure levels within 1 hour.	*Moderate.* Water levels rise rapidly for 15-20 minutes. A wave of water will progress downstream over a period of 1 hour. Water levels will likely drop down to pre-failure levels within 1-3 hours.

Consequence Analysis: Likely Hazard Scenario

The Consequence Analysis table details the anticipated consequences of the most likely hazard scenario.

Dam Failure Consequence Analysis Likely		
PROPERTY DAMAGE	*Limited*	• Near 0% damage to critical and non-critical infrastructure. • Minimal crop damage and river bank deterioration is likely following a minor Dam Failure hazard. Significant damage to buildings and structures is unlikely.
HEALTH & SAFETY	*Limited*	• 0 deaths likely. • 0 injuries likely.
CRITICAL FACILITIES	*Limited*	• *Utilities* – Disruptions for up to 12 hours. Water or sewer lines may be washed out, but services will be recovered within hours. • *Information/Communications* – Shutdown unlikely. No major impact on information or communications infrastructure. • *Transportation* – Shutdown unlikely. Transportation routes will not be impacted.
RESPONSE CAPACITY	*Limited*	• *Police* – Local resources adequate. • *Fire & Rescue* – Local resources adequate. No impact on response capability or continuity of operations. • *Health* – Local resources adequate. Health Department operations will not be affected. • *Hospitals* – Local resources adequate. No strain on the hospital system. • *Emergency Management* – Local resources adequate. Limited impact to Emergency Management capability.
ENVIRONMENTAL IMPACT	*Limited*	• Limited environmental impact. Minor water pollution may occur as sediment trapped behind the dam is released and flooding erodes stream banks.
ECONOMIC IMPACT	*Limited*	• $38,000 in lost economic output. Other costs include cleanup and healthcare for those affected. • 0.3 jobs lost. • Businesses in the flood area may close for limited rehab.
TOTAL IMPACT	*Limited*	• Total Impact Score: 1.00 on a scale of 1 (Limited) to 4 (Catastrophic).
Limited	*Significant*	*Critical*	*Catastrophic*

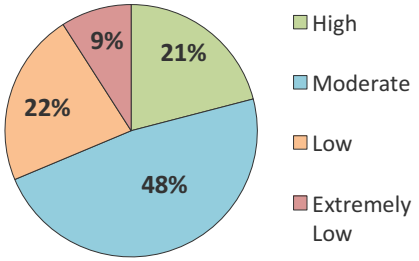
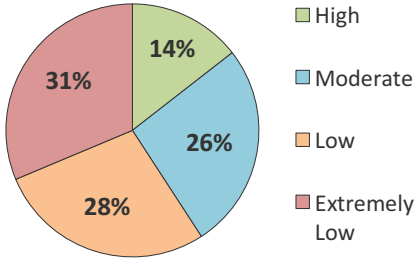
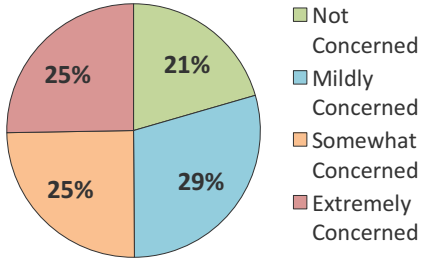
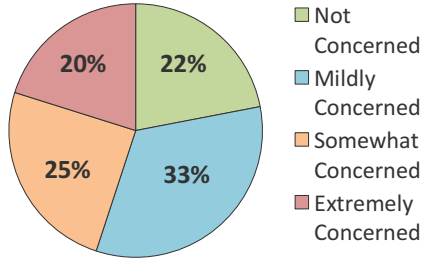
Consequence Analysis: Worst-Case Hazard Scenario

The Consequence Analysis: Worst-Case table details the anticipated consequences of the worst-case hazard scenario.

Dam Failure Consequence Analysis Worst-Case		
PROPERTY DAMAGE	*Significant*	• 5-10% damage to critical and non-critical infrastructure. • High levels of structural damage to roads, buildings, and infrastructure in the flood zone. Long-term water damage, erosion, and crop damage is likely.
HEALTH & SAFETY	*Significant*	• 3-4 deaths likely. Deaths are likely due to physical trauma or drowning. • 10 injuries likely. Injuries are likely due to physical trauma or drowning.
CRITICAL FACILITIES	*Significant*	• *Utilities* – Disruptions for up to 12 hours. Water or sewer lines may be washed out, but services will be recovered within hours. • *Information/Communications* – Shutdown unlikely. No major impact on information or communications infrastructure. • *Transportation* – Delays for 1-5 days. Flooding may wash out essential transportation infrastructure, requiring significant recovery efforts. Bridges will remain unharmed, but roadway embankments will wash out require replacement. Transportation routes may be shut down for days, and detours to accommodate repairs will cause significant delays.
RESPONSE CAPACITY	*Significant*	• *Police* – Mutual aid needed. The Sherriff's Office and Maryland State Police may be needed to support operations. • *Fire & Rescue* – Moderate need for state or federal assistance. There will be moderate strain on emergency services capability. • *Health* – Mutual aid needed. Regular Health Department operations will not be affected. Health Emergency Preparedness, Communicable Diseases, and Environmental Health functions will be altered due to the emergency response. • *Hospitals* – Local resources adequate. No strain on the hospital system. • *Emergency Management* – Local resources adequate. Limited impact to Emergency Management capability.
ENVIRONMENTAL IMPACT	*Significant*	• Significant environmental impact. Water pollution may occur as sediment trapped behind the dam is released and flooding erodes stream banks. Some loss of wildlife and vegetation is likely during flooding. Ongoing environmental consequences may arise from trash and debris carried downstream from the dam and across the flood plain.
ECONOMIC IMPACT	*Limited*	• $1.14 million in lost economic output. Other costs include cleanup and healthcare for those affected. • 9.2 jobs lost. • Businesses in impacted areas close and transportation routes may be disrupted for several days.
TOTAL IMPACT	*Limited-Significant*	• Total Impact Score: 1.75 on a scale of 1 (Limited) to 4 (Catastrophic).
Limited	*Significant*	*Critical* / *Catastrophic*

Consequence Analysis: Public Perception

The Consequence Analysis: Public Perception table characterizes public perceptions of each hazard. Details include public confidence in personal ability to respond to each hazard, public confidence in Howard County's ability to respond to each hazard, and each hazard's perceived impact to personal safety and standard of living.

Dam Failure Public Perceptions			
PERCEIVED CONFIDENCE IN HOWARD COUNTY'S ABILITY TO RESPOND AND RECOVER FROM THIS HAZARD	**PERCEIVED CONFIDENCE IN PERSONAL ABILITY TO PROTECT SELF AND FAMILY FROM THIS HAZARD**	**CONCERN OVER THE IMPACT TO PERSONAL HEALTH AND SAFETY IF THIS HAZARD WERE TO OCCUR LOCALLY**	**CONCERN OVER THE IMPACT TO PERSONAL STANDARD OF LIVING / QUALITY OF LIFE IF THIS HAZARD WERE TO OCCUR LOCALLY**
			
Average: 2.19 *Moderate*	*Average: 2.76* *Low*	*Average: 2.55* *Somewhat Concerned - Mildly Concerned*	*Average: 2.44* *Mildly Concerned - Somewhat Concerned*

Disease Epidemic/Unintentional Biological Hazard

I. OVERVIEW

The Overview section defines the hazard and summarizes the hazard risk profile.

Definition

This section defines the scope of the hazard category. The terminology and characterization established in this section should be consistent throughout all Howard County planning documents.

A Disease Epidemic/Unintentional Biological Hazard is the natural or inadvertent spread of potentially harmful viruses, bacteria, parasites, or other biological disease-causing agents. Disease Epidemic/Unintentional Biological Hazards can result from the natural spread of infectious disease or from the accidental release of biological agents from health care facilities, research institutions, and industrial operations.

Risk Profile

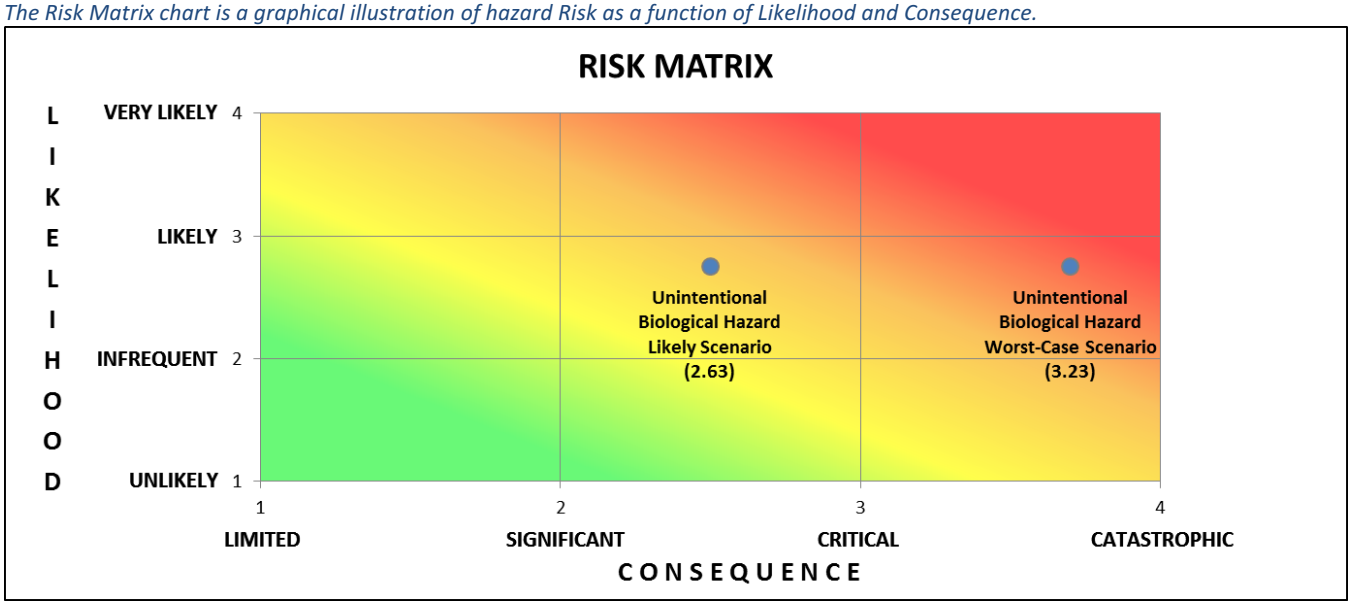
The Risk Profile section presents the Risk Score for the hazard in a range from 1 (lowest risk) to 4 (highest risk). Risk Score is a function of Likelihood and Consequence.

Disease Epidemic/Unintentional Biological Hazard Risk Profile				
	Risk Assessment Category	**Likely Hazard Scenario**	**Worst-Case Hazard Scenario**	**Weight**
LIKELIHOOD	**Likelihood**	2.75* Infrequent-Likely		50%
CONSEQUENCE	**Impact**	2.50 Significant-Critical	3.63 Critical-Catastrophic	40%
	Warning Time	1 Very Long	4 Short	5%
	Duration	4 Very Long	4 Very Long	5%
	TOTAL RISK SCORE	**2.63**	**3.23**	

**The Likelihood Score reflects the likelihood of any emergency-level hazard event and does not differentiate between Likely and Worst-Case scenarios.*

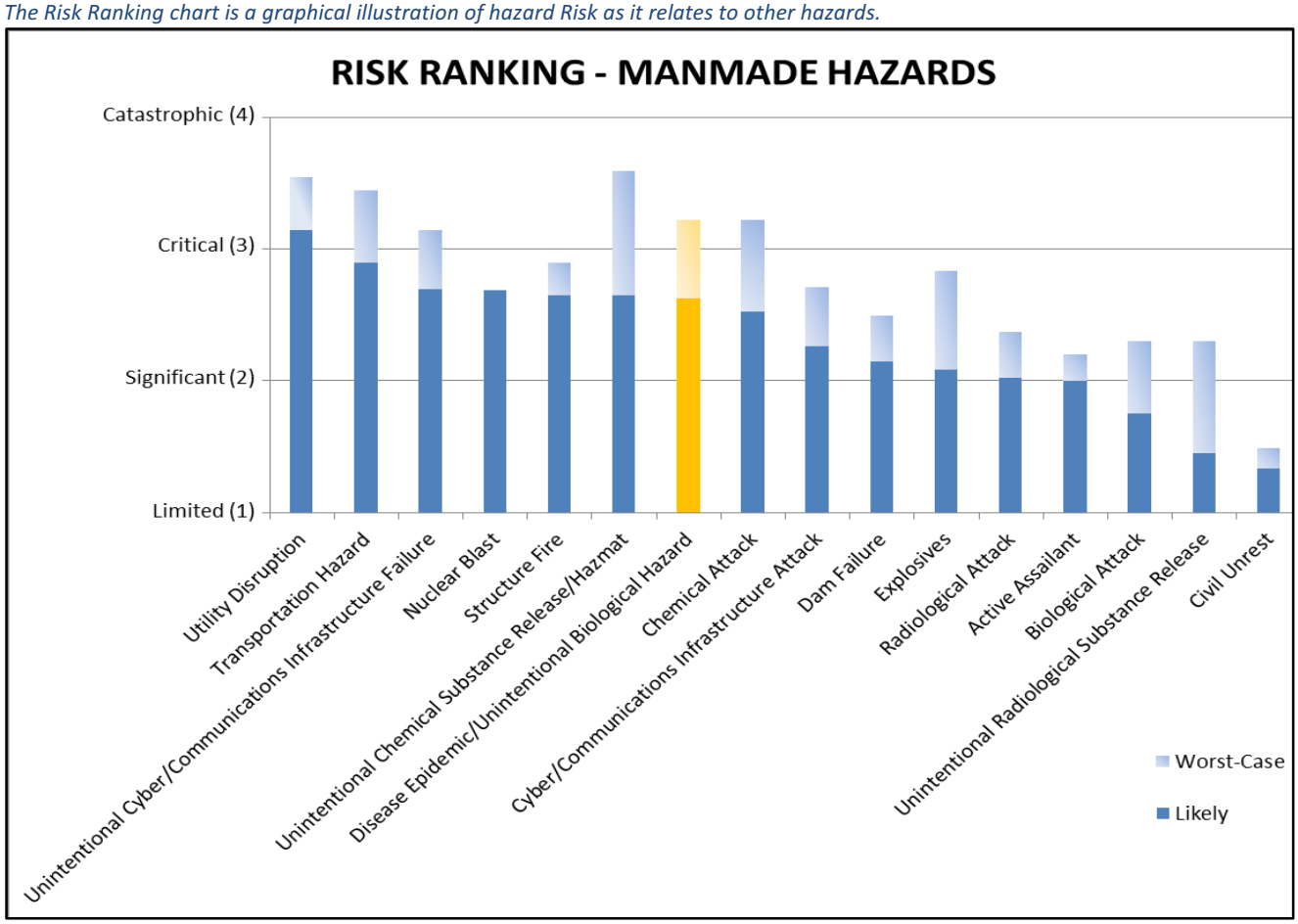
Risk Matrix

The Risk Matrix chart is a graphical illustration of hazard Risk as a function of Likelihood and Consequence.



Risk Ranking

The Risk Ranking chart is a graphical illustration of hazard Risk as it relates to other hazards.



Where no Worst-Case bar is visible, Worst-Case Risk is equivalent to Likely Risk.

II. HAZARD CHARACTERISTICS

The Hazard Characteristics section provides a detailed characterization of the hazard and the local context as it relates to the hazard.

Description of the Hazard

The most common Disease Epidemic/Unintentional Biological Hazard events are caused by the natural spread of infectious diseases. These disease outbreaks occur naturally as potentially harmful biological agents are passed from one person to another, acquired through contaminated food or water, or transmitted via animal bite. However, Disease Epidemic/Unintentional Biological Hazards may also occur if disease agents are accidentally released from health care facilities, research institutions, and industrial operations. Individuals may be exposed to harmful biological agents if the agents are not stored correctly, if safety controls malfunction, or if safety procedures are not followed.

The characteristics of a Disease Epidemic/Unintentional Biological Hazard event are extremely variable depending on the biological agent involved. Many biological agents are very difficult to spread and can require contact with bodily fluids or other special circumstances to transmit disease. On the other end of the spectrum, some biological agents can be quickly and easily spread from person to person with little or no physical contact necessary.

There is also extensive variability when it comes to the severity of illness caused by biological agents. Many agents cause pain or discomfort with few lasting effects. However, some agents can cause permanent damage or death. Deaths from disease can vary greatly depending on the biological agent in question, with case fatality rates ranging from 0% to nearly 100%.

The availability of advanced warning of an Disease Epidemic/Unintentional Biological Hazard is highly variable based on the specific incident, the speed of onset, and the effectiveness of surveillance mechanisms. . . Adding complexity to the issue, the existence of a Disease Epidemic/Unintentional Biological Hazard may not be recognized for days or even weeks after the start of the disease spread. Depending on the characteristics of the biological agent and the spread of disease, Disease Epidemic/Unintentional Biological Hazards can directly affect as few as one person or as many as millions.

The duration of a Disease Epidemic/Unintentional Biological Hazard event is largely dependent on the biological agent in question. A hazard involving an agent that is not easily spread can be over in a matter of minutes. However, if the hazard involves an easily transmitted biological agent, it can take weeks or even months to control the spread of disease.

Local Context

The Local Context section describes community attributes that affect the likelihood of the hazard's occurrence or vulnerability to the hazard's consequences.

A Disease Epidemic/Unintentional Biological Hazard can occur anywhere in Howard County. Densely populated areas are especially vulnerable to communicable disease outbreaks due to the increased speed and likelihood of disease transmission. Vulnerability to communicable diseases also increases with population mobility and increased exposure to individuals from diverse geographic regions. Over 60% of Howard County residents

commute outside of the jurisdiction to work in the DC or Baltimore regions.[1] Additionally, the close proximity to major interstate highways, an international airport, and an international shipping port all increase Howard County's vulnerability to the introduction and spread of communicable diseases.[2]

III. LIKELIHOOD ANALYSIS

The Likelihood Analysis section characterizes the historical occurrence and future likelihood of the hazard in the planning area.

Occurrence of the Hazard

The Occurrence of the Hazard section details the historical occurrence of the hazard in the planning area.

There has been 1 emergency-level Disease Epidemic/Unintentional Biological Hazard event in Howard County during the reviewed time period (1994-2014).

Notable Incidents in Howard County

2009 H1N1 Epidemic – The H1N1 strain of the influenza virus infected an estimated 61 million Americans and resulted in an estimated 274,000 hospitalizations and 12,470 deaths.[3] Howard County engaged in an emergency health response to avoid a local epidemic. In total, 40,001 local residents received the H1N1 vaccination at drive-through vaccination points, flu clinics, schools, and community centers.

Future Likelihood of the Hazard for Howard County

The Future Likelihood section anticipates the future occurrence rate of the hazard based on historical likelihood and future trends. This section also addresses factors that may cause the future likelihood to deviate from historical trends.

Future Likelihood of a Disease Epidemic/Unintentional Biological Hazard in Howard County	
Historical Average (time period)	1 event every 20 years (1994-2014)
Historical Annual Probability	5% chance of annual occurrence
Future Likelihood Expected to Deviate from Historical Likelihood (Yes/No)	Yes
Future Annual Probability	11-30% chance of annual occurrence
Future Likelihood Score	2.75 (Infrequent-Likely)
Future Likelihood reflects the likelihood of any emergency-level hazard event and does not differentiate between Likely and Worst-Case scenarios.	

Considerations: The future likelihood of an Disease Epidemic/Unintentional Biological Hazard in Howard County is expected to be slightly higher than indicated by the historical occurrence rate alone. Estimates predict an 11-30% chance of annual occurrence, or one event every 3-9 years. A future annual probability of 11-30% classifies the likelihood of an Disease Epidemic/Unintentional Biological Hazard as Likely.

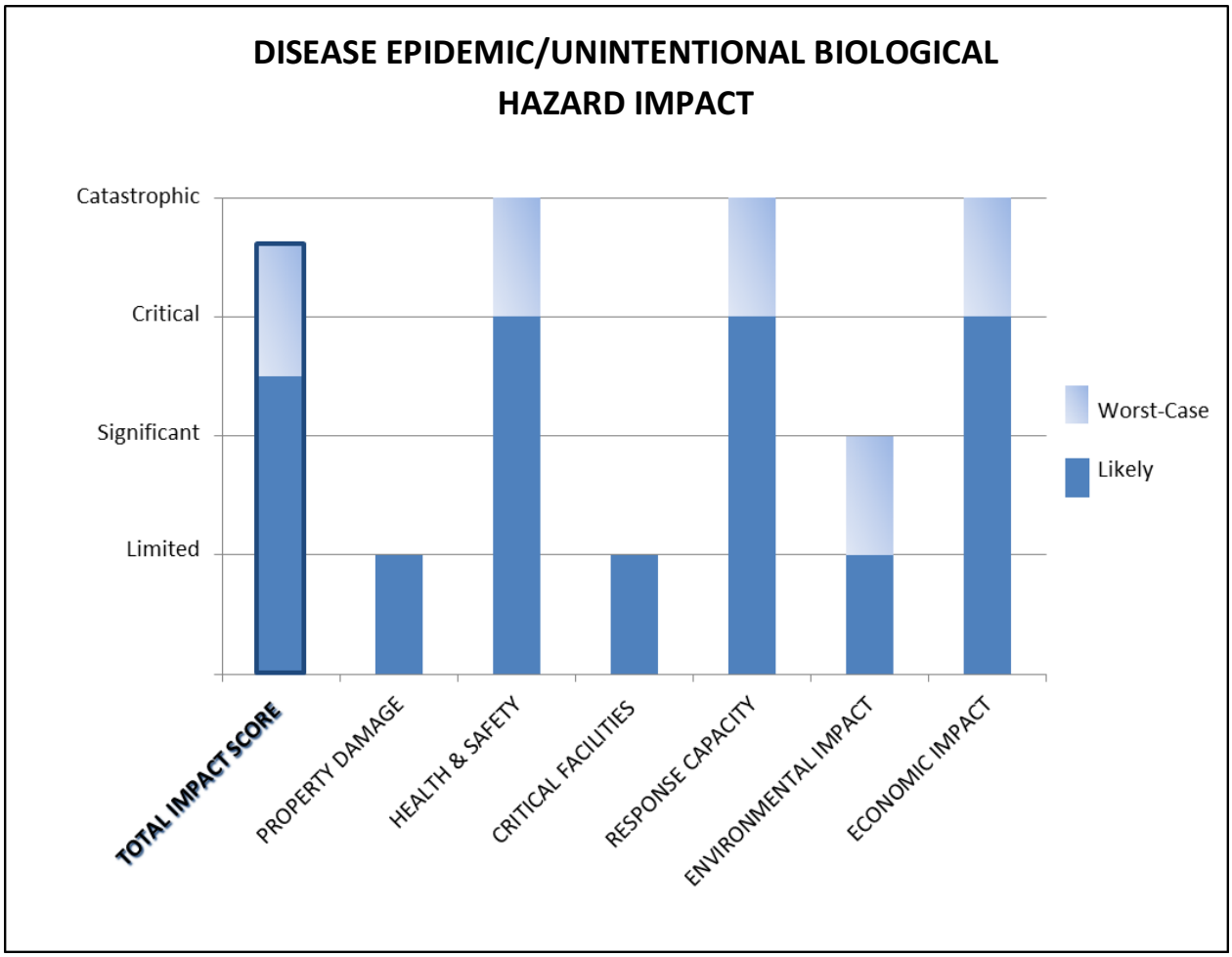
[1] *Research Report: 2000 Census Journey to Work,* Howard County Department of Planning and Zoning (2003). Available at http://countyofhowardmd.us/DisplayPrimary.aspx?id=4294968176#research (last accessed June 30, 2014).
[2] *Manmade Hazard Identification and Risk Assessment Workshop (unpublished)*, Howard County OEM (2014).
[3] *H1N1 Flu – General Info,* CDC. Available at http://www.cdc.gov/h1n1flu/estimates_2009_h1n1.htm (last accessed June 2, 2014).

Several factors contribute to the expected increase in future likelihood. Within Howard County, a rapidly growing population and an increase in interstate and international travel are expected to facilitate the introduction and spread of infectious diseases. Disease surveillance also indicates that the incidence of disease epidemics is increasing globally due to increased population mobility, the emergence of novel diseases, and an increased resistance to current treatment strategies.2

IV. CONSEQUENCE ANALYSIS

The Consequence Analysis section provides a detailed characterization of the anticipated consequences of likely and worst-case hazard events. This section characterizes impacts to property, health & safety, critical facilities, response capacity, the environment, and the economy. This section also characterizes public perceptions of each hazard, the perceived impact to personal safety and standard of living, and public confidence in response capability.

Consequence Analysis Overview



Where no Worst-Case bar is visible, Worst-Case impact is equivalent to Likely impact.

Disease Epidemic/Unintentional Biological Hazard Warning Time & Duration		
	Likely	**Worst-Case**
WARNING TIME	*Very Long.* The hazard will likely begin with a gradually accelerating spread of the biological agent over a period of weeks or months. There may be 2-4 weeks of warning between the time the disease is recognized as a threat to the time that it becomes a true health emergency.	*Short.* The hazard may begin with a rapidly accelerating spread of the biological agent. The disease may reach health emergency levels before the disease is officially recognized as a threat.
DURATION	*Very Long.* The disease outbreak may last for up to 3 months.	*Very Long.* The disease outbreak may last for up to 6 months.

Consequence Analysis: Likely Hazard Scenario

The Consequence Analysis table details the anticipated consequences of the most likely hazard scenario.

Disease Epidemic/Unintentional Biological Hazard Consequence Analysis Likely		
PROPERTY DAMAGE	*Limited*	• 0% damage to critical and non-critical infrastructure. • Damage to buildings and structures is unlikely.
HEALTH & SAFETY	*Critical*	• Fewer than 3 deaths likely. The nature of biological hazard death will depend on the biological agent. Cause of death may include complications due to infection, respiratory failure, or organ failure. • Up to 3,000 injuries likely. The nature of biological hazard injuries will depend on the biological agent. Injuries may include severe symptoms such as fever, coughing, vomiting, diarrhea, nausea, seizures, or shortness of breath.
CRITICAL FACILITIES	*Limited*	• *Utilities* – Shutdown unlikely. No effect on utilities. • *Information/Communications* – Shutdown unlikely. No major impact on information or communications infrastructure. • *Transportation* – Shutdown unlikely. Impacts to transportation will be minor. However, if an Disease Epidemic/Unintentional Biological Hazard event occurs during a major winter weather event, staffing shortages will likely cause traffic delays.
RESPONSE CAPACITY	*Critical*	• *Police* – Local resources adequate. • *Fire & Rescue* – Moderate need for state or federal assistance. EMS resources may experience significant strain. • *Health* – Moderate need for state or federal assistance. Essential Health Department functions will continue, but non-essential functions will be affected due to the emergency response. • *Hospitals* – Local resources adequate. Minor strain on the hospital system is likely, but the hospital will likely be able to maintain services. • *Emergency Management* – Local resources adequate. Limited impact to Emergency Management capability.
ENVIRONMENTAL IMPACT	*Limited*	• Limited to no environmental impact.
ECONOMIC IMPACT	*Critical*	• $258 million in lost economic output. Other costs include cleanup and healthcare for those affected. • 2,090 jobs lost. • Business activities will slow gradually at first, but ultimately many business activities will cease entirely. Massive job loss will extend for months beyond the disease outbreak.
TOTAL IMPACT	*Significant-Critical*	• Total Impact Score: 2.50 on a scale of 1 (Limited) to 4 (Catastrophic).
Limited	*Significant*	*Critical*	*Catastrophic*

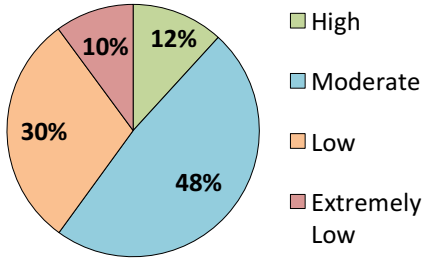
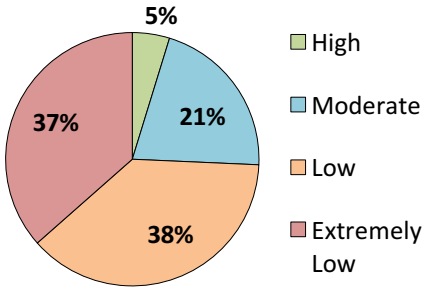
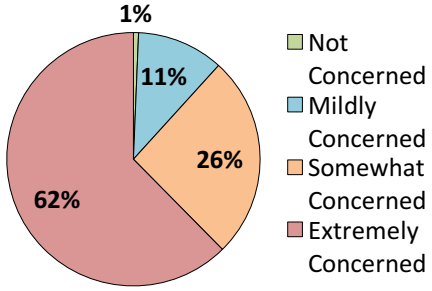
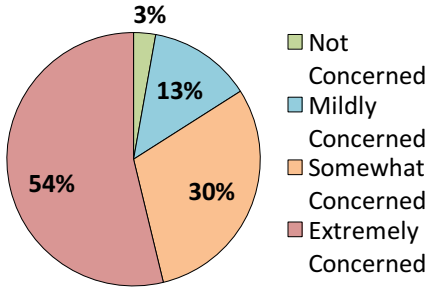
Consequence Analysis: Worst-Case Hazard Scenario

The Consequence Analysis: Worst-Case table details the anticipated consequences of the worst-case hazard scenario.

Disease Epidemic/Unintentional Biological Hazard Consequence Analysis Worst-Case		
PROPERTY DAMAGE	*Limited*	• 0% damage to critical and non-critical infrastructure. • Damage to buildings and structures is unlikely.
HEALTH & SAFETY	*Catastrophic*	• 5,000-15,000 deaths likely. The nature of biological hazard death will depend on the biological agent. Cause of death may include complications due to infection, respiratory failure, cardiac arrest, organ failure, or internal bleeding. • 100,000 injuries likely. The nature of biological hazard injuries will depend on the biological agent. Injuries may include severe symptoms such as fever, coughing, vomiting, diarrhea, nausea, seizures, shortness of breath, cold sweats, or hemorrhaging.
CRITICAL FACILITIES	*Limited*	• *Utilities* – Shutdown unlikely. Critical mission functions will remain covered. Staff shortage will cause delay of non-essential business functions. • *Information/Communications* – Shutdown unlikely. If key personnel are removed from the workforce, essential behind-the-scenes functions (like data backup, etc.) will be delayed. This will not likely have an impact on essential functions, but if this happens to coincide with an emergency need for tech assistance, it has the potential to cause significant problems to information and communications systems. • *Transportation* – Shutdown unlikely. Impacts to transportation will be minor. However, if an Disease Epidemic/Unintentional Biological Hazard event occurs during a major winter weather event, staffing shortages will likely cause traffic delays. Staffing shortages will make it difficult to keep main transportation routes open during a winter weather event. Transportation resources will be diverted to state roads, and an inordinate amount of resources will be diverted to open roads for 911 calls.
RESPONSE CAPACITY	*Catastrophic*	• *Police* – Local resources adequate. • *Fire & Rescue* – Significant and long-lasting need for state or federal assistance. EMS resources could experience significant strain. • *Health* – Significant and long-lasting need for state or federal assistance. All Health Department functions will be affected to prioritize emergency response at EOC/DOC, points of dispensing, and call centers. Immunization will be prioritized and most staff will be diverted to point of dispensing centers. Everyday clinic functions and health promotion programs may be suspended. Other suspended services may include: provider referral for uninsured, health care referral services, WIC services (food/nutrition assistance for pregnant women, infants, and children), and birth certificate printing. • *Hospitals* – Moderate need for state or federal assistance. Staffing at the hospital would be extremely strained. The number of people hospitalized due to the Biological Hazard will likely occupy all hospital beds. The availability of critical care and equipment for respiratory patients will be very limited. Staffing concerns will likely cancel most elective non-emergent surgeries. Ancillary services will likely be delayed or canceled. Loss of maintenance staff may lead to the loss of available patient rooms. • *Emergency Management* – Mutual aid needed. Loss of staff may necessitate mutual aid assistance to support essential Emergency Management operations.
ENVIRONMENTAL IMPACT	*Significant*	• Significant to critical environmental impact. Direct environmental impact is limited. However, impacts to the workforce from a disease outbreak could cause significant cascading environmental effects. Employee shortages could impact garbage disposal, wastewater treatment, maintenance of public spaces, and food safety.
ECONOMIC IMPACT	*Catastrophic*	• $2.2 billion in lost economic output. Other costs include cleanup and healthcare for those affected. • 17,900 jobs lost. • Business activities cease gradually at first followed by a near-complete shutdown. Massive job loss will extend for months beyond the disease outbreak. Long-term damage to Howard County image is likely.
TOTAL IMPACT	*Critical-Catastrophic*	• Total Impact Score: 3.63 on a scale of 1 (Limited) to 4 (Catastrophic).
Limited	*Significant*	*Critical*	*Catastrophic*

Consequence Analysis: Public Perception

The Consequence Analysis: Public Perception table characterizes public perceptions of each hazard. Details include public confidence in personal ability to respond to each hazard, public confidence in Howard County's ability to respond to each hazard, and each hazard's perceived impact to personal safety and standard of living.

Disease Epidemic/Unintentional Biological Hazard Public Perceptions			
PERCEIVED CONFIDENCE IN HOWARD COUNTY'S ABILITY TO RESPOND AND RECOVER FROM THIS HAZARD	**PERCEIVED CONFIDENCE IN PERSONAL ABILITY TO PROTECT SELF AND FAMILY FROM THIS HAZARD**	**CONCERN OVER THE IMPACT TO PERSONAL HEALTH AND SAFETY IF THIS HAZARD WERE TO OCCUR LOCALLY**	**CONCERN OVER THE IMPACT TO PERSONAL STANDARD OF LIVING / QUALITY OF LIFE IF THIS HAZARD WERE TO OCCUR LOCALLY**
			
Average: 2.40 *Moderate - Low*	*Average: 3.06* *Low*	*Average: 3.50* *Extremely Concerned - Somewhat Concerned*	*Average: 3.35* *Somewhat Concerned - Extremely Concerned*

Explosives

I. OVERVIEW

The Overview section defines the hazard and summarizes the hazard risk profile.

Definition

This section defines the scope of the hazard category. The terminology and characterization established in this section should be consistent throughout all Howard County planning documents.

An Explosives hazard occurs when an explosive device is intentionally used to cause harm to people, property, operational capacity, or the environment (unintentional explosive chemical substance release/hazmat hazards are profiled separately).

Risk Profile

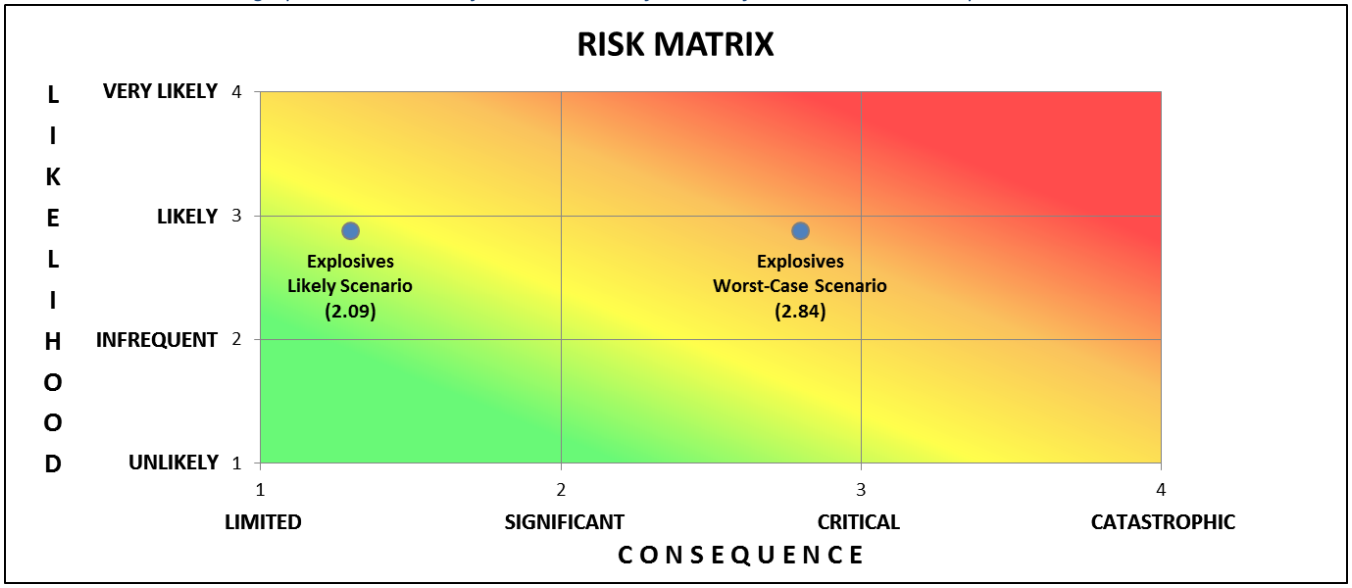
The Risk Profile section presents the Risk Score for the hazard in a range from 1 (lowest risk) to 4 (highest risk). Risk Score is a function of Likelihood and Consequence.

Explosives Hazard Risk Profile				
	Risk Assessment Category	**Likely Hazard Scenario**	**Worst-Case Hazard Scenario**	**Weight**
LIKELIHOOD	**Likelihood**	2.88* Infrequent-Likely		50%
CONSEQUENCE	**Impact**	1.00 Limited	2.63 Significant-Critical	40%
	Warning Time	4 Short	4 Short	5%
	Duration	1 Short	3 Long	5%
TOTAL RISK SCORE		**2.09**	**2.84**	

**The Likelihood Score reflects the likelihood of any emergency-level hazard event and does not differentiate between Likely and Worst-Case scenarios.*

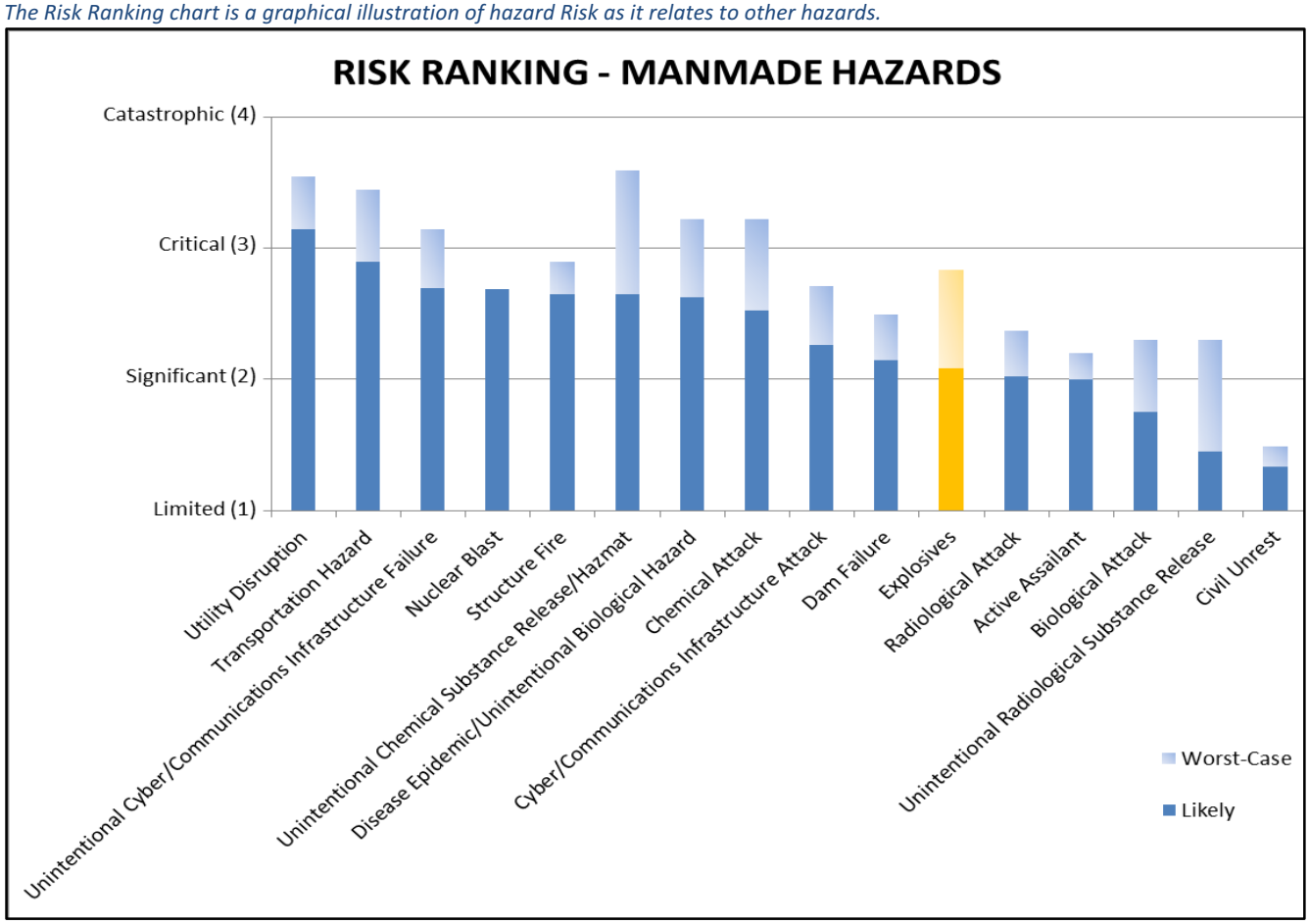
Risk Matrix

The Risk Matrix chart is a graphical illustration of hazard Risk as a function of Likelihood and Consequence.



Risk Ranking

The Risk Ranking chart is a graphical illustration of hazard Risk as it relates to other hazards.



Where no Worst-Case bar is visible, Worst-Case Risk is equivalent to Likely Risk.

II. HAZARD CHARACTERISTICS

The Hazard Characteristics section provides a detailed characterization of the hazard and the local context as it relates to the hazard.

Description of the Hazard

Explosive devices can be easily transported as man-portable improvised explosive devices (IEDs), vehicle-borne IEDs, or vessel (watercraft) IEDs. Explosive devices can be easily concealed and may be detonated from a remote location.[1,2]

It is rare to have any advanced warning of an Explosive attack, and the location of the attack will greatly affect the outcome. It is possible to have an IED attack take place in sparsely populated areas, but typical IED targets include densely populated locations such as office buildings, public gathering areas, special events, commercial areas, and transportation systems.

Depending on the explosive capacity, an Explosive device can directly impact an area anywhere from 40' to one mile from the source of the explosion. Explosive capacity is measured in pounds, referring to the weight of TNT needed to create an equivalent explosion. The capacity of an improvised explosive device can range from 1-10lbs for a small letter bomb, pipe bomb, or small package. A vest or container can contain a bomb with an explosive capacity of up to 20lbs. Cars, SUVs, and minivans can carry bombs with 500-4,000lbs of explosive capacity. A full-sized delivery truck bomb can reach 10,000lbs of explosive capacity.[3]

The onset of an Explosives attack hazard is typically instantaneous. However, it can take several hours to ensure that the area of the attack is safe. Secondary hazards such as fire, utility disruption, and transportation disruption may take a day or more to resolve.

Local Context

The Local Context section describes community attributes that affect the likelihood of the hazard's occurrence or vulnerability to the hazard's consequences.

An Explosives attack can occur anywhere in Howard County. Likely targets for Explosives attacks in Howard County include densely populated public areas such as schools, commercial facilities, event venues, and office buildings.

The location of Howard County may increase local vulnerability to Explosives hazards and other terrorism-related attacks. Howard County is in close proximity to valuable terrorist targets including Washington, D.C., the City of Baltimore, the Port of Baltimore, and the Baltimore Washington International Airport. Due to its proximity to the National Capital Region, many federal agencies, defense contractors, and high-profile targets maintain facilities within Howard County.[4]

[1] For additional information see *Explosions,* FEMA. Available at http://www.ready.gov/explosions (last accessed March 27, 2014).
[2] For additional information see *Strategic National Risk Assessment,* U.S. Dept. of Homeland Security (2011). Available at http://www.dhs.gov/xlibrary/assets/rma-strategic-national-risk-assessment-ppd8.pdf (last accessed March 27, 2014).
[3] For additional information see *IED Attack: Improvised Explosive Devices,* U.S. Dept. of Homeland Security. Available at http://www.dhs.gov/xlibrary/assets/prep_ied_fact_sheet.pdf (last accessed April 2, 2014).
[4] *Manmade Hazard Identification and Risk Assessment Workshop (unpublished)*, Howard County OEM (2014).

III. LIKELIHOOD ANALYSIS

The Likelihood Analysis section characterizes the historical occurrence and future likelihood of the hazard in the planning area.

Occurrence of the Hazard

The Occurrence of the Hazard section details the historical occurrence of the hazard in the planning area.

There have been 0 successful Explosive attack hazard events in Howard County during the reviewed time period (2000-2014). However, there were 8 responses to confirmed Explosives threats in Howard County between 2010 and 2014, although all were disarmed prior to detonation. Between 1996 and 2014, County response agencies have responded to 47 calls for removal of explosive devices.[5]

Notable Incidents in Howard County

All recent Explosives hazard events in Howard County have been minor incidents. Local events typically involve experimentation with homemade chemical bombs. During the 2014 Active Assailant attack at the Columbia Mall, the assailant was armed with several small homemade explosives. The explosives were never detonated.

Future Likelihood of the Hazard for Howard County

The Future Likelihood section anticipates the future occurrence rate of the hazard based on historical likelihood and future trends. This section also addresses factors that may cause the future likelihood to deviate from historical trends.

Future Likelihood of an Explosives Hazard in Howard County	
Historical Average (time period)	0 recorded events (2000-2014)
Historical Annual Probability	0% chance of annual occurrence
Future Likelihood Expected to Deviate from Historical Likelihood (Yes/No)	Yes
Future Annual Probability	11-30% chance of annual occurrence
Future Likelihood Score	2.88 (Infrequent-Likely)
Future Likelihood reflects the likelihood of any emergency-level hazard event and does not differentiate between Likely and Worst-Case scenarios.	

Considerations: The future likelihood of an Explosives attack hazard in Howard County is expected to be significantly higher than indicated by the historical occurrence rate alone. Estimates predict an 11-30% chance of annual occurrence, or one event every 3-9 years. A future annual probability of 11-30% classifies the likelihood of an Explosives hazard as Likely.

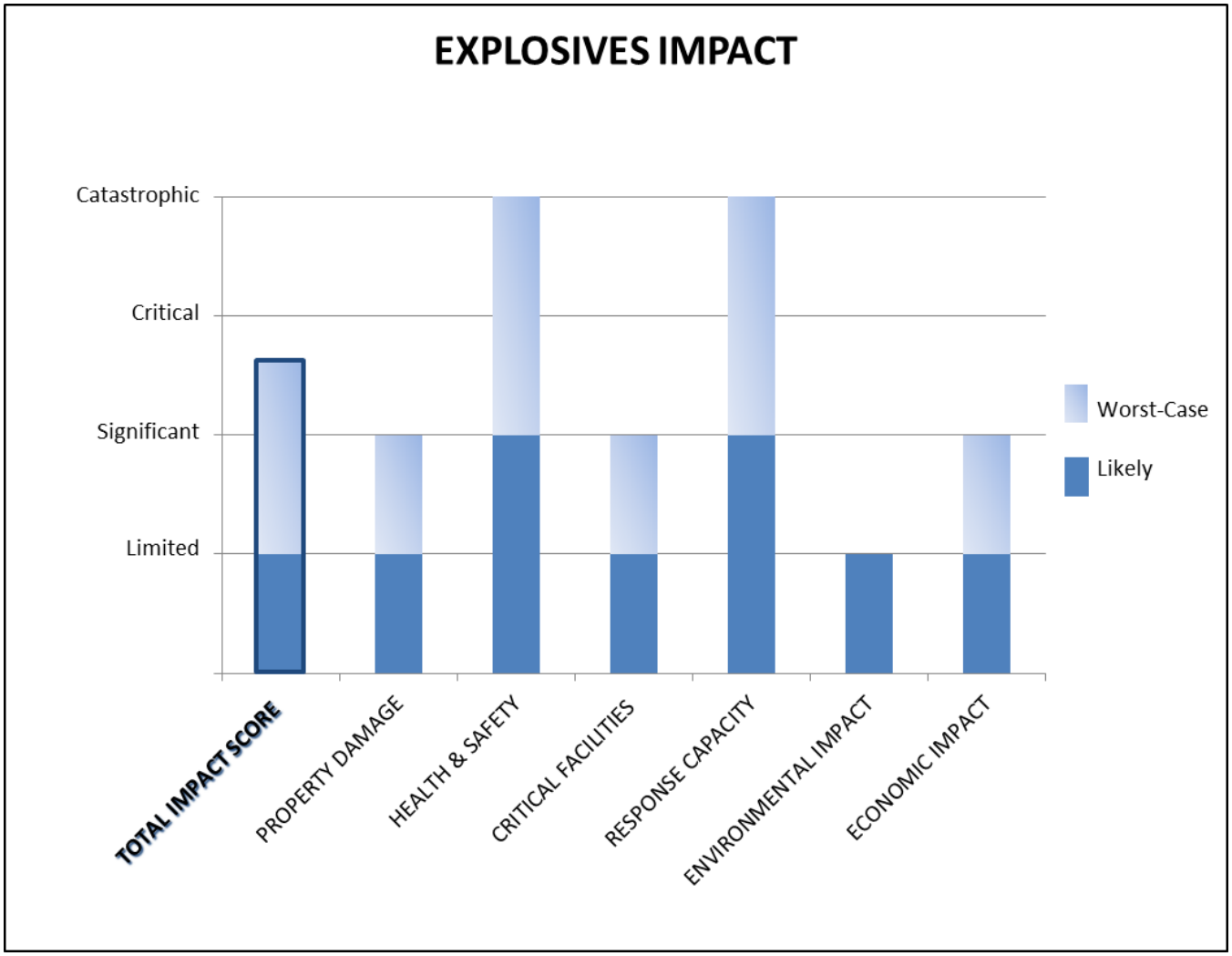
Howard County has not experienced a successful Explosives attack in recent history, but several factors contribute to the expected increase in future likelihood. The Howard County average of two attempted Explosives Attacks each year demonstrates the possibility of a successful attack in the future. The increased threat of terrorism and the County's proximity to high value terrorist targets also contribute to an increase in the likelihood of an Explosives attack in the future. A final factor contributing to the increased likelihood is access to information. The rapidly increasing online availability of bomb-making information and access to extremist ideologies contributes greatly to the increased future likelihood of an Explosives attack in Howard County.4

[5] *Howard County CAD Report 1/01/1996 – 12/31/2013 (unpublished)*, Howard County DFRS (2014).

IV. CONSEQUENCE ANALYSIS

The Consequence Analysis section provides a detailed characterization of the anticipated consequences of likely and worst-case hazard events. This section characterizes impacts to property, health & safety, critical facilities, response capacity, the environment, and the economy. This section also characterizes public perceptions of each hazard, the perceived impact to personal safety and standard of living, and public confidence in response capability.

Consequence Analysis Overview



Where no Worst-Case bar is visible, Worst-Case impact is equivalent to Likely impact.

Explosives Hazard Warning Time & Duration		
	Likely	**Worst-Case**
WARNING TIME	*Short.* No warning time prior to an attack.	*Short.* No warning time prior to an attack.
DURATION	*Short.* Hazard onset is nearly instantaneous. It may take 2-4 hours to declare the hazard location safe.	*Long.* Hazard onset is nearly instantaneous. It may take 6-36 hours to declare the hazard location safe.

Consequence Analysis: Likely Hazard Scenario

The Consequence Analysis table details the anticipated consequences of the most likely hazard scenario.

Explosives Hazard Consequence Analysis Likely		
PROPERTY DAMAGE	*Limited*	• Near 0% damage to critical and non-critical infrastructure. • A small explosive device is unlikely to cause anything beyond superficial damage to buildings and structures.
HEALTH & SAFETY	*Significant*	• 2-4 deaths likely. Deaths are likely the result of physical trauma. • 20 injuries likely. Injuries are likely the result of physical trauma. The severity is highly dependent on proximity to the explosive device.
CRITICAL FACILITIES	*Limited*	• *Utilities* – Shutdown unlikely. No effect on utilities. • *Information/Communications* – Shutdown unlikely. No major impact on information or communications infrastructure. • *Transportation* – Delays for less than 12 hours. Impacts to transportation will be minor and short-term. Road closures will be localized, and delays will not be excessive.
RESPONSE CAPACITY	*Significant*	• *Police* – Local resources adequate. • *Fire & Rescue* – Moderate need for state or federal assistance. Resources would be committed to the incident for secondary device standby, structural collapse assessment, and mass casualty management. EMS resources would be strained, requiring mutual aid assistance for response and Continuity of Operations. • *Health* – Local resources adequate. Health Department operations will not be affected. • *Hospitals* – Local resources adequate. The Emergency Department would reroute patients to trauma centers, but the response would likely be no different from day-to-day operations. • *Emergency Management* – Local resources adequate. Limited impact to Emergency Management capability.
ENVIRONMENTAL IMPACT	*Limited*	• Limited to no environmental impact. Less than a day of clean-up. Impact to a localized area.
ECONOMIC IMPACT	*Limited*	• Minimal loss of economic output due to the limited area affected. Other costs include cleanup and healthcare for those affected. • 0 jobs lost. • Limited business disruption in the immediate hazard area. Some damage to Howard County image is possible.
TOTAL IMPACT	*Limited*	• Total Impact Score: 1.00 on a scale of 1 (Limited) to 4 (Catastrophic).
Limited	*Significant*	*Critical*	*Catastrophic*

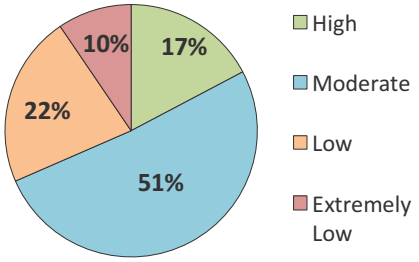
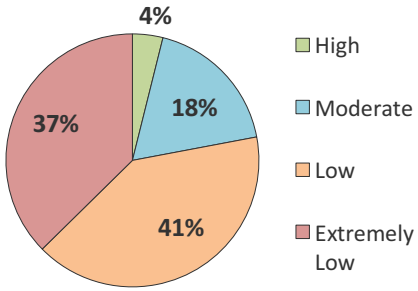
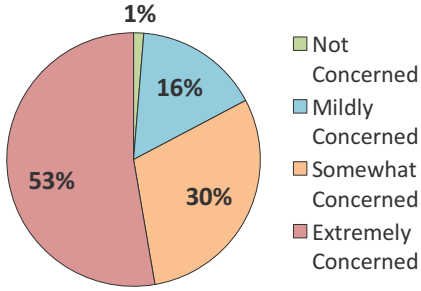
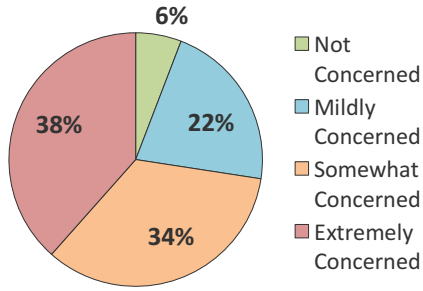
Consequence Analysis: Worst-Case Hazard Scenario

The Consequence Analysis: Worst-Case table details the anticipated consequences of the worst-case hazard scenario.

Explosives Hazard Consequence Analysis Worst-Case		
PROPERTY DAMAGE	*Significant*	• 5-10% damage to critical and non-critical infrastructure. • A large explosive device will likely cause significant structural damage and building collapse in the immediate area. The attack may cause superficial damage to property and structures within several blocks of the attack site.
HEALTH & SAFETY	*Catastrophic*	• 100+ deaths likely. • 100-300 injuries likely. • Deaths and injuries are likely the result of physical trauma resulting from the explosive blast and the subsequent structural collapse.
CRITICAL FACILITIES	*Significant*	• *Utilities* – Shutdown unlikely. No effect on utilities. • *Information/Communications* – Shutdown unlikely. No major impact on information or communications infrastructure. • *Transportation* – Delays for 3-5 days. Initial transportation delays will be caused by people exiting the hazard area. Major closures will occur in the immediate aftermath of the attack, and localized transportation routes will be closed for several days to accommodate emergency response and debris removal efforts.
RESPONSE CAPACITY	*Catastrophic*	• *Police* – Significant and long-lasting need for federal assistance. Moderate strain to response capacity and depleted road strength. Terrorism response automatically triggers federal law enforcement involvement. • *Fire & Rescue* – Significant and long-lasting need for federal assistance. There will likely be long-lasting impact to fire/rescue hazardous materials response capabilities. Regional EMS resources will be overwhelmed. Significant mutual aid assistance will likely be required to maintain regular calls for service. • *Health* – Mutual aid needed. Essential Health Department operations could potentially be affected, but Health Emergency Preparedness and Response and Community Health will be necessary to support the emergency response and coordinate health resources, shelter operations • *Hospitals* – Mutual aid needed. The hospital Emergency Department will likely be entirely full due to the patient surge. All minor injuries and illnesses will be diverted to other hospitals. Emergency walk-ins will continue to receive treatment, but there will be extensive delays. • *Emergency Management* – Mutual aid needed. Emergency Management may need assistance to coordinate planning resources, investigation activities, and shelter operations. Long shifts may necessitate additional Emergency Management staff support or incident management staff to sustain extended response and recovery activities.
ENVIRONMENTAL IMPACT	*Limited*	• Limited to no environmental impact. Impact to a localized area.
ECONOMIC IMPACT	*Significant*	• $550,000 in lost economic output. Other costs include cleanup and healthcare for those affected. • 4.4 jobs lost. • Business closures and job disruption are likely in the impacted area. Howard County image is likely to suffer.
TOTAL IMPACT	*Significant - Critical*	• Total Impact Score: 2.63 on a scale of 1 (Limited) to 4 (Catastrophic).
Limited	*Significant*	*Critical* / *Catastrophic*

Consequence Analysis: Public Perception

The Consequence Analysis: Public Perception table characterizes public perceptions of each hazard. Details include public confidence in personal ability to respond to each hazard, public confidence in Howard County's ability to respond to each hazard, and each hazard's perceived impact to personal safety and standard of living.

Explosives Hazard Public Perceptions			
PERCEIVED CONFIDENCE IN HOWARD COUNTY'S ABILITY TO RESPOND AND RECOVER FROM THIS HAZARD	**PERCEIVED CONFIDENCE IN PERSONAL ABILITY TO PROTECT SELF AND FAMILY FROM THIS HAZARD**	**CONCERN OVER THE IMPACT TO PERSONAL HEALTH AND SAFETY IF THIS HAZARD WERE TO OCCUR LOCALLY**	**CONCERN OVER THE IMPACT TO PERSONAL STANDARD OF LIVING / QUALITY OF LIFE IF THIS HAZARD WERE TO OCCUR LOCALLY**
			
Average: 2.24 *Moderate*	*Average: 3.11* *Low*	*Average: 3.34* *Somewhat Concerned - Extremely Concerned*	*Average: 3.05* *Somewhat Concerned*

Radiological Attack

I. OVERVIEW

The Overview section defines the hazard and summarizes the hazard risk profile.

Definition

This section defines the scope of the hazard category. The terminology and characterization established in this section should be consistent throughout all Howard County planning documents.

A Radiological Attack hazard occurs when a population is intentionally exposed to radiation through a non-nuclear mechanism (nuclear weapon hazards are profiled separately). A Radiological Attack may take the form of a radiological exposure device (RED) or a radiological dispersal device (also known as a dirty bomb or RDD).[1] A radiological exposure device is a hidden sealed source containing radioactive material. A radiological dispersal device, or dirty bomb, is a mix of traditional explosives and radioactive powder or pellets. Radiological exposure devices and radiological dispersal devices (dirty bombs) are not capable of creating an atomic blast.

Risk Profile

The Risk Profile section presents the Risk Score for the hazard in a range from 1 (lowest risk) to 4 (highest risk). Risk Score is a function of Likelihood and Consequence.

Radiological Attack Risk Profile

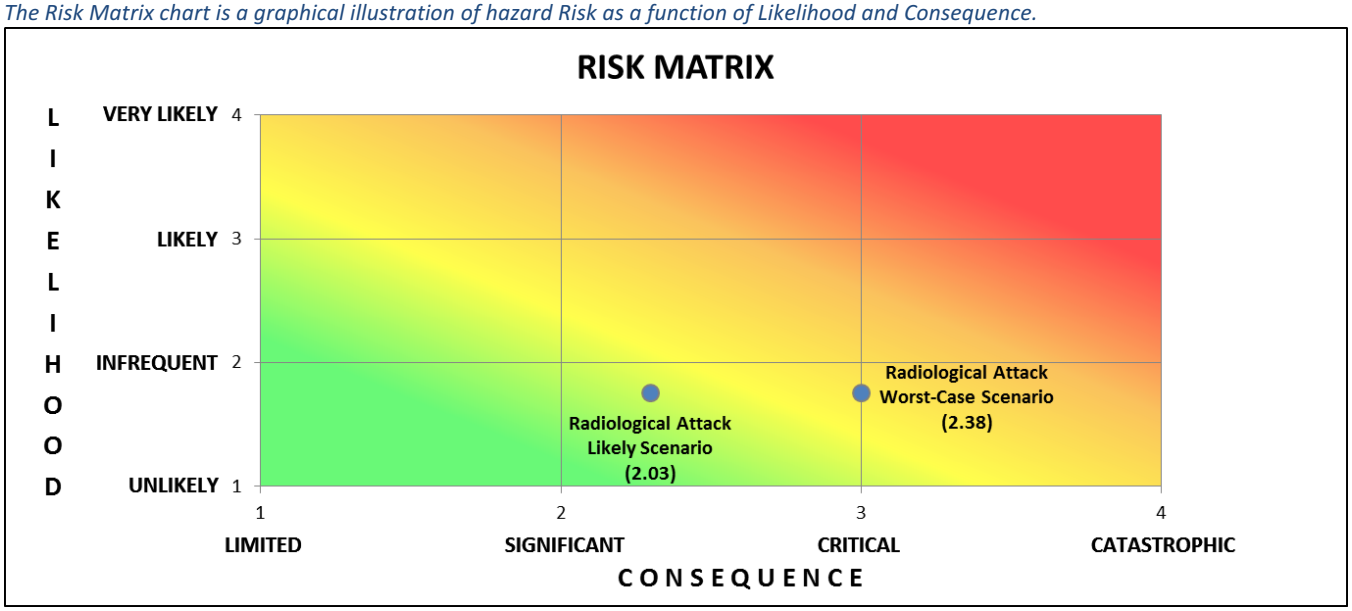
	Risk Assessment Category	Likely Hazard Scenario	Worst-Case Hazard Scenario	Weight
LIKELIHOOD	**Likelihood**	1.75* Unlikely-Infrequent		50%
CONSEQUENCE	**Impact**	2.13 Significant-Critical	2.88 Significant-Critical	40%
	Warning Time	4 Short	4 Short	5%
	Duration	2 Moderate	3 Long	5%
TOTAL RISK SCORE		**2.03**	**2.38**	

**The Likelihood Score reflects the likelihood of any emergency-level hazard event and does not differentiate between Likely and Worst-Case scenarios.*

[1] *More Information on Types of Radiation Emergencies,* CDC. Available at http://www.bt.cdc.gov/radiation/moretypes.asp#rdd (last accessed March 26, 2014).

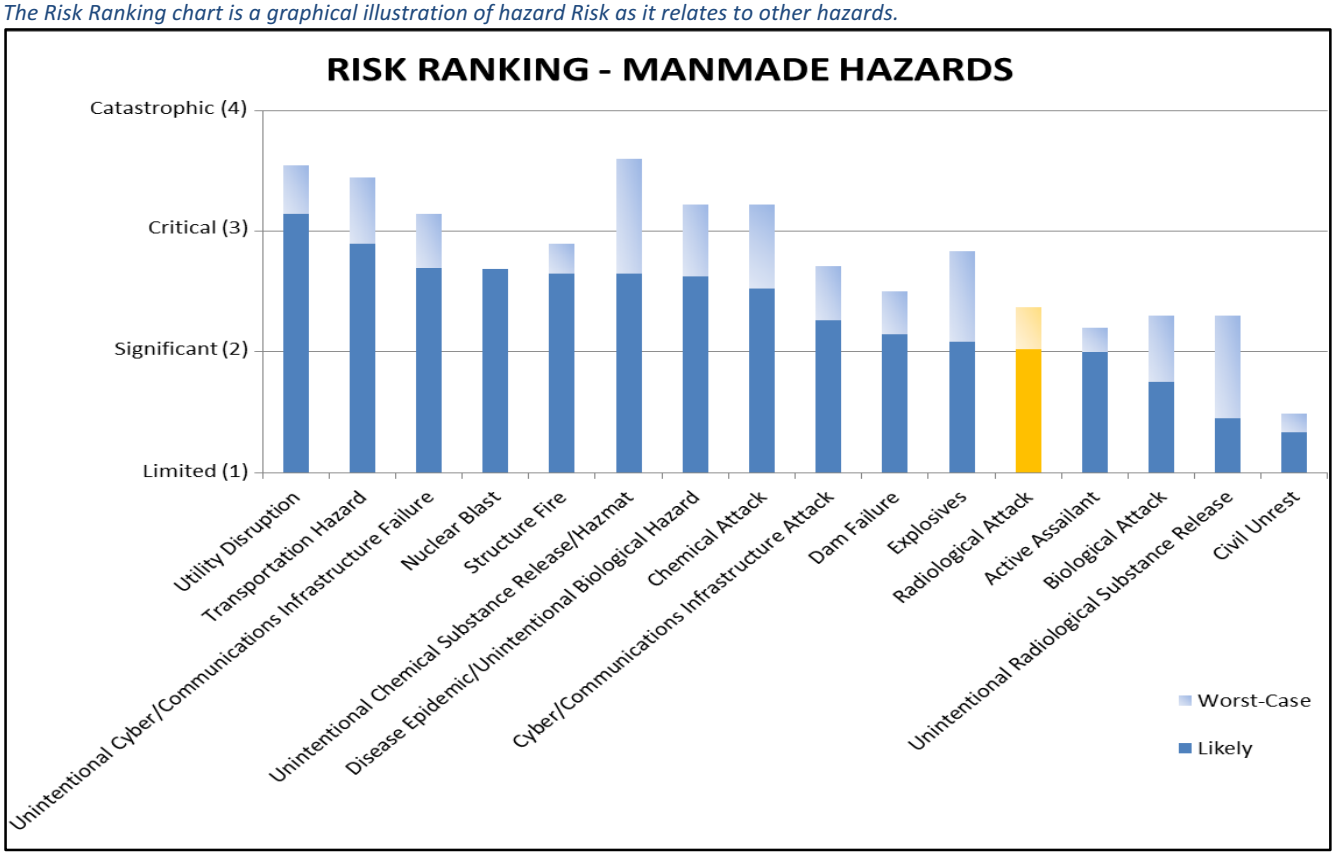
Risk Matrix

The Risk Matrix chart is a graphical illustration of hazard Risk as a function of Likelihood and Consequence.



Risk Ranking

The Risk Ranking chart is a graphical illustration of hazard Risk as it relates to other hazards.



Where no Worst-Case bar is visible, Worst-Case Risk is equivalent to Likely Risk.

II. HAZARD CHARACTERISTICS

The Hazard Characteristics section provides a detailed characterization of the hazard and the local context as it relates to the hazard.

Description of the Hazard

Radiological Attacks may take several forms. Radiological exposure devices (REDs) are non-explosive devices containing radioactive material or emitting radiation. Radiological exposure devices contain no explosives and are typically concealed in such a manner that people who come into close proximity to the RED receive exposure to radiation. REDs have extremely localized effects and may only affect people who are in physical contact or extremely close proximity to the device.

Radiological dispersal devices, or dirty bombs, use traditional explosives to disperse radioactive material. A dirty bomb blast carries radioactive material into the surrounding area. The area affected by an RDD explosion may range from less than a city block to several square miles. The spread of radioactive materials depends greatly on weather conditions, the type and amount of radioactive material, and the presence of barriers in the surrounding environment. However, the level of radiation dispersed by a dirty bomb is typically too small to cause significant harm, so the area affected is dependent primarily on the size of the traditional explosive device.[2] Like REDs, dirty bombs are incapable of creating an atomic blast and should not be confused with improvised nuclear devices.

The explosive capacity of a dirty bomb is measured in pounds. This unit of measurement refers to the weight of TNT that would be required to release an equivalent level of explosive energy. The explosive capacity of a dirty bomb can range from 1-10lbs for a small letter bomb, pipe bomb, or small package. A vest or container can contain a bomb with an explosive capacity of up to 20lbs. Cars, SUVs, and minivans can carry bombs with 500-4,000lbs of explosive capacity. A full-sized delivery truck bomb can reach 10,000lbs of explosive capacity.[3]

It is rare to have any advanced warning of a radiological attack.

It is possible to have a Radiological Attack take place in a sparsely populated area, but typical Radiological Attack targets include densely populated locations such as office buildings, public gathering areas, special events, commercial areas, and transportation systems. The radiological exposure from a Radiological Attack depends greatly on the type of radioactive material dispersed. Exposure to radiation from an RED or dirty bomb may be minimal. Radiation dose is largely dependent on time, distance, and shielding.

The duration of a Radiological Attack is highly dependent on the mechanism of the attack. An RED may cause exposure for hours or even several days if the low dose of radiation goes unnoticed. A dirty bomb explosive hazard is typically instantaneous. Radioactive material released from the dirty bomb will decay rapidly during the first hours following the explosion. However, it can take several hours to bring the hazard under control and ensure that the area is safe. Secondary hazards such as fire, utility disruption, and transportation disruption may take a day or more to resolve.

[2] For additional information see *Radiological Attack: Dirty Bombs and Other Devices,* U.S. Dept. of Homeland Security (2004). Available at http://www.dhs.gov/xlibrary/assets/prep_radiological_fact_sheet.pdf (last accessed April 3, 2014).
[3] For additional information see *IED Attack: Improvised Explosive Devices,* U.S. Dept. of Homeland Security. Available at http://www.dhs.gov/xlibrary/assets/prep_ied_fact_sheet.pdf (last accessed April 2, 2014).

Local Context

The Local Context section describes community attributes that affect the likelihood of the hazard's occurrence or vulnerability to the hazard's consequences.

A Radiological Attack may occur anywhere in Howard County. Likely targets for Radiological Attacks in Howard County include densely populated public areas such as schools, commercial facilities, event venues, and office buildings.

The location of Howard County may increase local vulnerability to Radiological Attacks and other terrorism-related attacks. Howard County is in close proximity to valuable terrorist targets including Washington, D.C., the City of Baltimore, the Port of Baltimore, and the Baltimore Washington International Airport. Due to its proximity to the National Capital Region, many federal agencies, defense contractors, and high-profile targets maintain facilities within Howard County.[4]

III. LIKELIHOOD ANALYSIS

The Likelihood Analysis section characterizes the historical occurrence and future likelihood of the hazard in the planning area.

Occurrence of the Hazard

The Occurrence of the Hazard section details the historical occurrence of the hazard in the planning area.

There have been 0 Radiological Attack hazard events in Howard County during the reviewed time period (1996-2014).

Future Likelihood of the Hazard for Howard County

The Future Likelihood section anticipates the future occurrence rate of the hazard based on historical likelihood and future trends. This section also addresses factors that may cause the future likelihood to deviate from historical trends.

Future Likelihood of a Radiological Attack Hazard in Howard County	
Historical Average (time period)	0 recorded events (1996-2014)
Historical Annual Probability	0% chance of annual occurrence
Future Likelihood Expected to Deviate from Historical Likelihood (Yes/No)	Yes
Future Annual Probability	1-10% chance of annual occurrence
Future Likelihood Score	1.75 (Unlikely-Infrequent)
Future Likelihood reflects the likelihood of any emergency-level hazard event and does not differentiate between Likely and Worst-Case scenarios.	

Considerations: The future likelihood of a Radiological Attack in Howard County is expected to be slightly higher than indicated by the historical occurrence rate alone. Although the likelihood still remains low, estimates predict a 1-10% chance of annual occurrence, or one event every 10-99 years. A future annual probability of 1-10% classifies the likelihood of a Radiological Attack hazard as Infrequent.

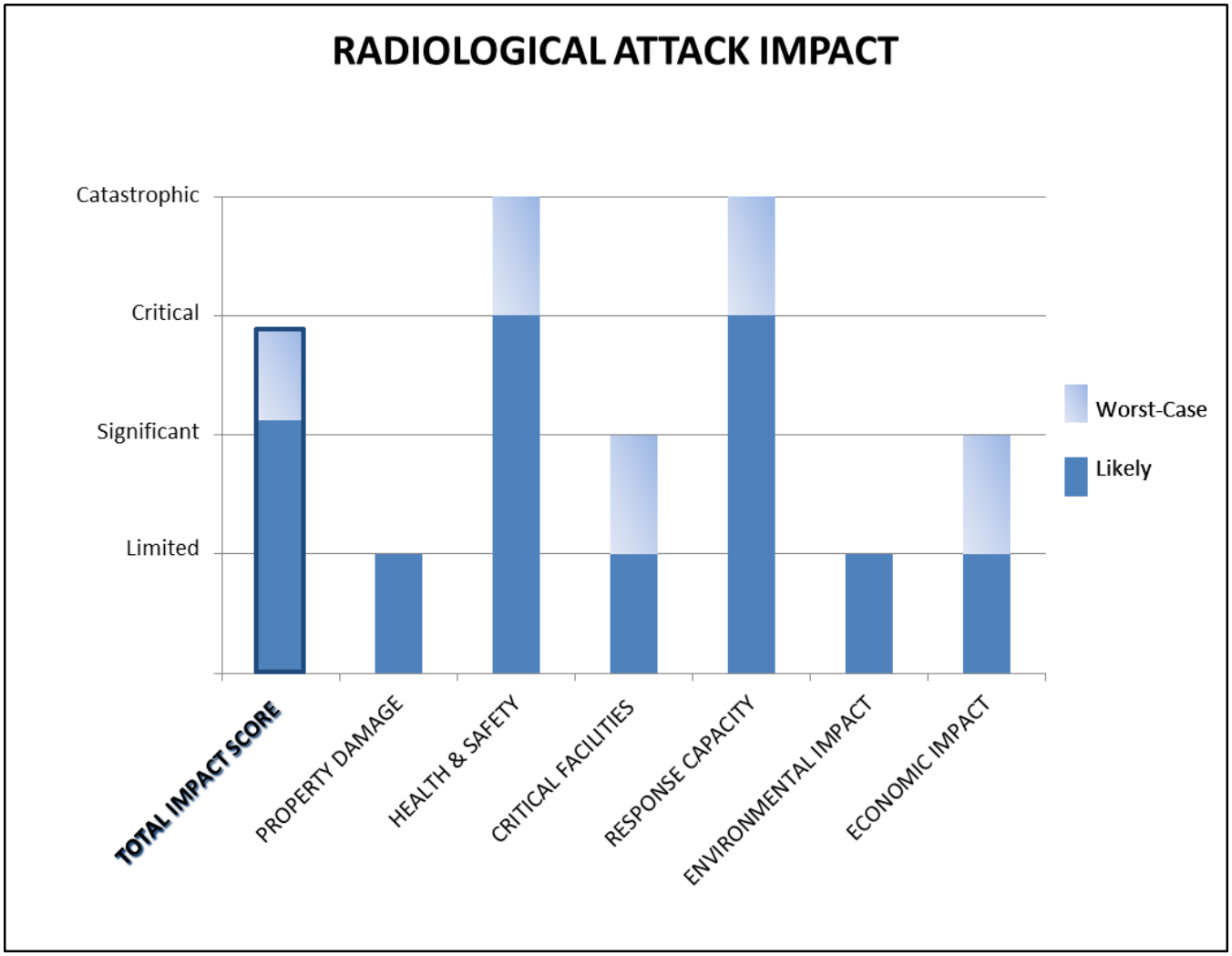
Howard County has never experienced a Radiological Attack, but several factors contribute to the expected increase in likelihood. Radiological Attacks in the United States and abroad demonstrate the possibility of a successful attack inside Howard County. The increased threat of terrorism and the County's proximity to high value terrorist targets also contribute to a slight increase in the likelihood of a Radiological Attack in the future.4

[4] *Manmade Hazard Identification and Risk Assessment Workshop (unpublished)*, Howard County OEM (2014).

IV. CONSEQUENCE ANALYSIS

The Consequence Analysis section provides a detailed characterization of the anticipated consequences of likely and worst-case hazard events. This section characterizes impacts to property, health & safety, critical facilities, response capacity, the environment, and the economy. This section also characterizes public perceptions of each hazard, the perceived impact to personal safety and standard of living, and public confidence in response capability.

Consequence Analysis Overview



Where no Worst-Case bar is visible, Worst-Case impact is equivalent to Likely impact.

Radiological Attack Warning Time & Duration		
	Likely	**Worst-Case**
WARNING TIME	*Short.* No warning time prior to an attack.	*Short.* No warning time prior to an attack.
DURATION	*Moderate.* Hazard onset is nearly instantaneous. It may take 6-12 hours to declare the hazard location safe.	*Long.* Hazard onset is nearly instantaneous. It may take up to 72 hours to declare the hazard location safe.

Consequence Analysis: Likely Hazard Scenario

The Consequence Analysis table details the anticipated consequences of the most likely hazard scenario.

Radiological Attack Consequence Analysis Likely		
PROPERTY DAMAGE	*Limited*	• 0% damage to critical and non-critical infrastructure. • The explosion from a small radiological dispersion device may cause minor superficial damage to walls and glass in a localized area. Structural damage will likely be minor. Property damage from a Radiological Attack hazard will likely be the result of the explosive rather than the radiation.
HEALTH & SAFETY	*Critical*	• 20-50 deaths likely. • 100 injuries likely. • The number of deaths and injuries is largely dependent on the population density at the site of the attack. Deaths and injuries are most likely due to trauma from the explosive blast rather than the radiation. The radioactive material dispersed during a Radiological Attack may cause fear, but it is unlikely to cause any significant health impact.
CRITICAL FACILITIES	*Limited*	• *Utilities* – Shutdown unlikely. No effect on utilities. • *Information/Communications* – Shutdown unlikely. No major impact on information or communications infrastructure. • *Transportation* – Delays for less than 1 day. Impacts to transportation will be minor and short-term. Road closures will be limited to a localized area, and delays will not be excessive.
RESPONSE CAPACITY	*Critical*	• *Police* – Mutual aid needed. Terrorism response automatically triggers federal law enforcement involvement. • *Fire & Rescue* – Moderate need for state or federal assistance. There will likely be long-lasting impact to hazardous materials response capabilities. Regional EMS resources will be overwhelmed. Significant mutual aid assistance will be required in order to maintain regular calls for service. • *Health* – Local resources adequate. Health Department operations will not be affected. • *Hospitals* – Local resources adequate. No major impact to the hospital system. Hospital decontamination will likely be unnecessary if decontamination takes place at the attack site. A large influx of psychological casualties (worried well) may put limited strain on the hospital system. • *Emergency Management* – Moderate need for state or federal assistance. Significant planning support may be necessary for hazardous materials cleanup and terrorism investigation.
ENVIRONMENTAL IMPACT	*Limited*	• Limited environmental impact. The explosive blast may cause limited air, water, and land contamination within the impacted area. The radiation will likely disburse rapidly from the environment, and consequences to air, water, and land should be limited.
ECONOMIC IMPACT	*Limited*	• Minimal loss of economic output due to the limited area affected. Other costs include cleanup and healthcare for those affected. • 0 jobs lost. • Temporary business closures are likely in the immediate hazard area. Damage to Howard County image may be significant.
TOTAL IMPACT	*Significant-Critical*	• Total Impact Score: 2.13 on a scale of 1 (Limited) to 4 (Catastrophic).
Limited	*Significant*	*Critical*	*Catastrophic*

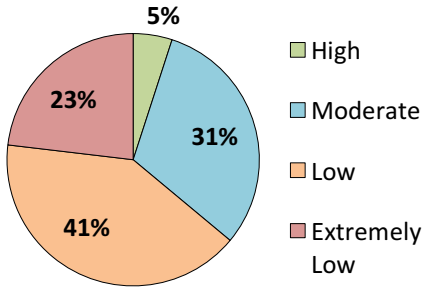
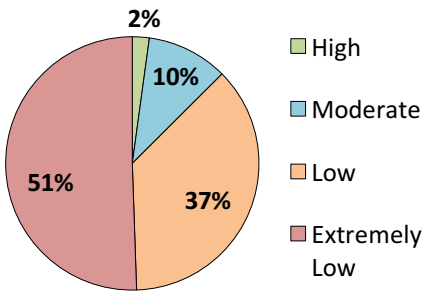
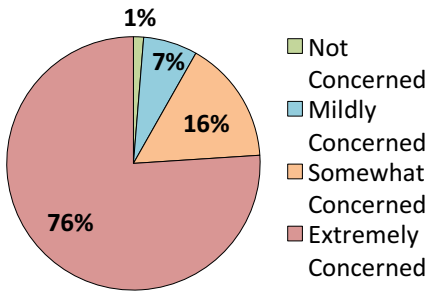
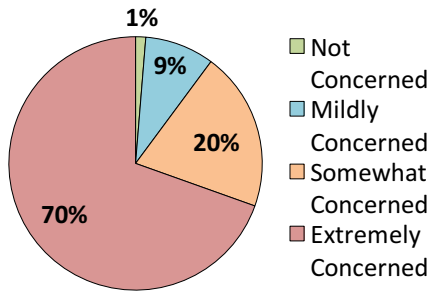
Consequence Analysis: Worst-Case Hazard Scenario

The Consequence Analysis: Worst-Case table details the anticipated consequences of the worst-case hazard scenario.

Radiological Attack Consequence Analysis Worst-Case		
PROPERTY DAMAGE	*Limited*	• 3% damage to critical and non-critical infrastructure. • The explosion from a large radiological dispersion device could be sufficient to cause building collapse. The attack may cause superficial damage to property and structures within several blocks of the attack site. Most of the property damage from a Radiological Attack hazard will be the result of the explosive rather than the radiation.
HEALTH & SAFETY	*Catastrophic*	• 50-100 deaths likely. • 100-300 injuries likely. • The number of deaths and injuries is largely dependent on the population density at the site of the attack. Deaths and injuries are most likely due to trauma from the explosive blast rather than the radiation. The radioactive material dispersed during a Radiological Attack may cause fear, but it is unlikely to cause any significant health impact.
CRITICAL FACILITIES	*Significant*	• *Utilities* – Shutdown unlikely. No effect on utilities. • *Information/Communications* – Shutdown unlikely. No major impact on information or communications infrastructure. • *Transportation* – Delays for 3-5 days. Major transportation delays will be caused by people exiting the surrounding area. Major closures will occur in the immediate aftermath of the attack, and localized transportation routes will be closed for several days to accommodate emergency response and debris removal efforts.
RESPONSE CAPACITY	*Catastrophic*	• *Police* – Mutual aid needed. Terrorism response automatically triggers federal law enforcement involvement. • *Fire & Rescue* – Significant and long-lasting need for state or federal assistance. There will likely be long-lasting impact to hazardous materials response capabilities. Regional EMS resources will be overwhelmed. Significant mutual aid assistance will be required in order to maintain regular calls for service. • *Health* – Moderate need for state or federal assistance. Regular Health Department operations will not be affected. Health Emergency Preparedness, Communicable Diseases, and Environmental Health functions will be altered due to the emergency response. • *Hospitals* – Mutual aid needed. Howard County General Hospital is not a trauma center, resulting in the need to divert all explosive blast injuries to other hospitals. A large influx of psychological casualties (worried well) may create strain on the Emergency Department. • *Emergency Management* – Moderate need for state or federal assistance. Significant planning support may be necessary for hazardous materials cleanup and terrorism investigation. There is no significant impact to Emergency Management Continuity of Operations.
ENVIRONMENTAL IMPACT	*Limited*	• Limited environmental impact. The explosive blast may cause limited air, water, and land contamination within the impacted area. The radiation will likely disburse rapidly from the environment, and consequences to air, water, and land should be limited. Lasting environmental impact will be minimal, but public perceptions of environmental danger may significantly outlast any actual environmental impact.
ECONOMIC IMPACT	*Significant*	• Minimal loss of economic output due to the limited area affected. Other costs include cleanup and healthcare for those affected. • 0 jobs lost. • Temporary job loss is likely in the impacted area. Significant impact on Howard County image.
TOTAL IMPACT	*Significant - Critical*	• Total Impact Score: 2.88 on a scale of 1 (Limited) to 4 (Catastrophic).
Limited	*Significant*	*Critical* / *Catastrophic*

Consequence Analysis: Public Perception

The Consequence Analysis: Public Perception table characterizes public perceptions of each hazard. Details include public confidence in personal ability to respond to each hazard, public confidence in Howard County's ability to respond to each hazard, and each hazard's perceived impact to personal safety and standard of living.

Radiological Attack Public Perceptions			
PERCEIVED CONFIDENCE IN HOWARD COUNTY'S ABILITY TO RESPOND AND RECOVER FROM THIS HAZARD	**PERCEIVED CONFIDENCE IN PERSONAL ABILITY TO PROTECT SELF AND FAMILY FROM THIS HAZARD**	**CONCERN OVER THE IMPACT TO PERSONAL HEALTH AND SAFETY IF THIS HAZARD WERE TO OCCUR LOCALLY**	**CONCERN OVER THE IMPACT TO PERSONAL STANDARD OF LIVING / QUALITY OF LIFE IF THIS HAZARD WERE TO OCCUR LOCALLY**
			
Average: 2.83 *Low*	*Average: 3.36* *Low – Extremely Low*	*Average: 3.67* *Extremely Concerned - Somewhat Concerned*	*Average: 3.58* *Extremely Concerned - Somewhat Concerned*

Nuclear Blast

I. OVERVIEW

The Overview section defines the hazard and summarizes the hazard risk profile.

Definition

This section defines the scope of the hazard category. The terminology and characterization established in this section should be consistent throughout all Howard County planning documents.

A nuclear blast is the result of a device that uses a nuclear reaction to create an explosion far more powerful than that of conventional explosives.[1] When nuclear weapons or improvised nuclear devices (INDs) explode, they give off energy in the form of a blast wave, intense light, heat, and radiation.

Risk Profile

The Risk Profile section presents the Risk Score for the hazard in a range from 1 (lowest risk) to 4 (highest risk). Risk Score is a function of Likelihood and Consequence.

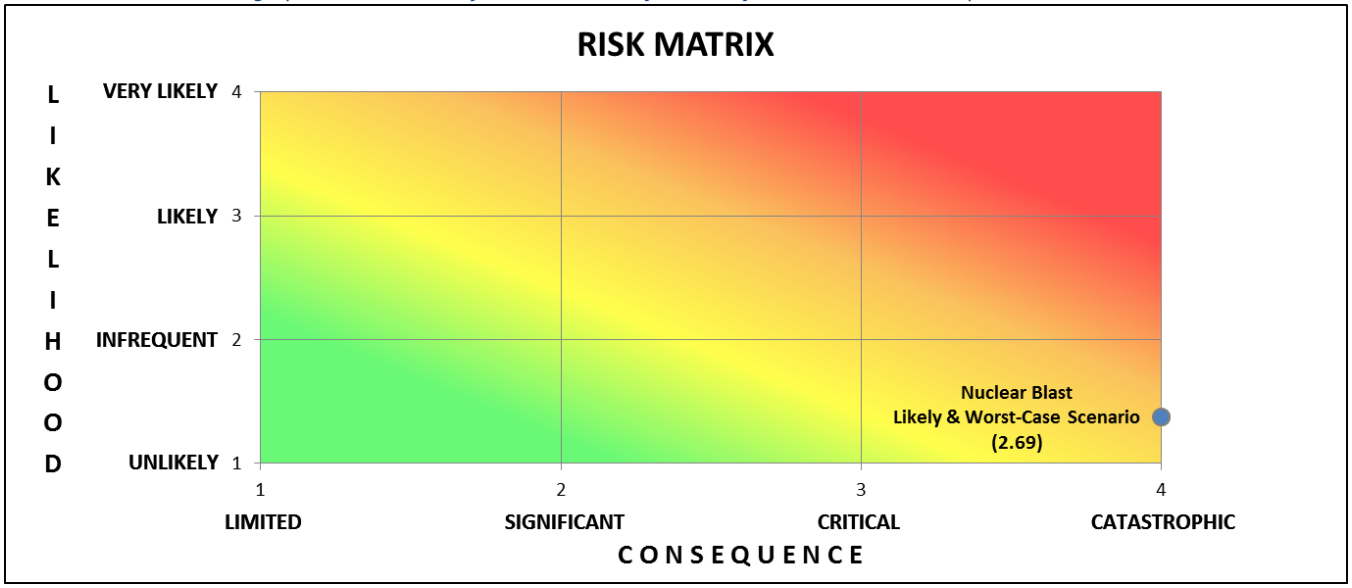
Nuclear Blast Risk Profile				
	Risk Assessment Category	**Likely Hazard Scenario**	**Worst-Case Hazard Scenario**	**Weight**
LIKELIHOOD	**Likelihood**	1.38* Unlikely-Infrequent		50%
CONSEQUENCE	**Impact**	4.00 Catastrophic	4.00 Catastrophic	40%
	Warning Time	4 Short	4 Short	5%
	Duration	4 Very Long	4 Very Long	5%
	TOTAL RISK SCORE	**2.69**	**2.69**	

**The Likelihood Score reflects the likelihood of any emergency-level hazard event and does not differentiate between Likely and Worst-Case scenarios.*

[1] *More Information on Types of Radiation Emergencies,* CDC. Available at http://www.bt.cdc.gov/radiation/moretypes.asp#rdd (last accessed March 26, 2014).

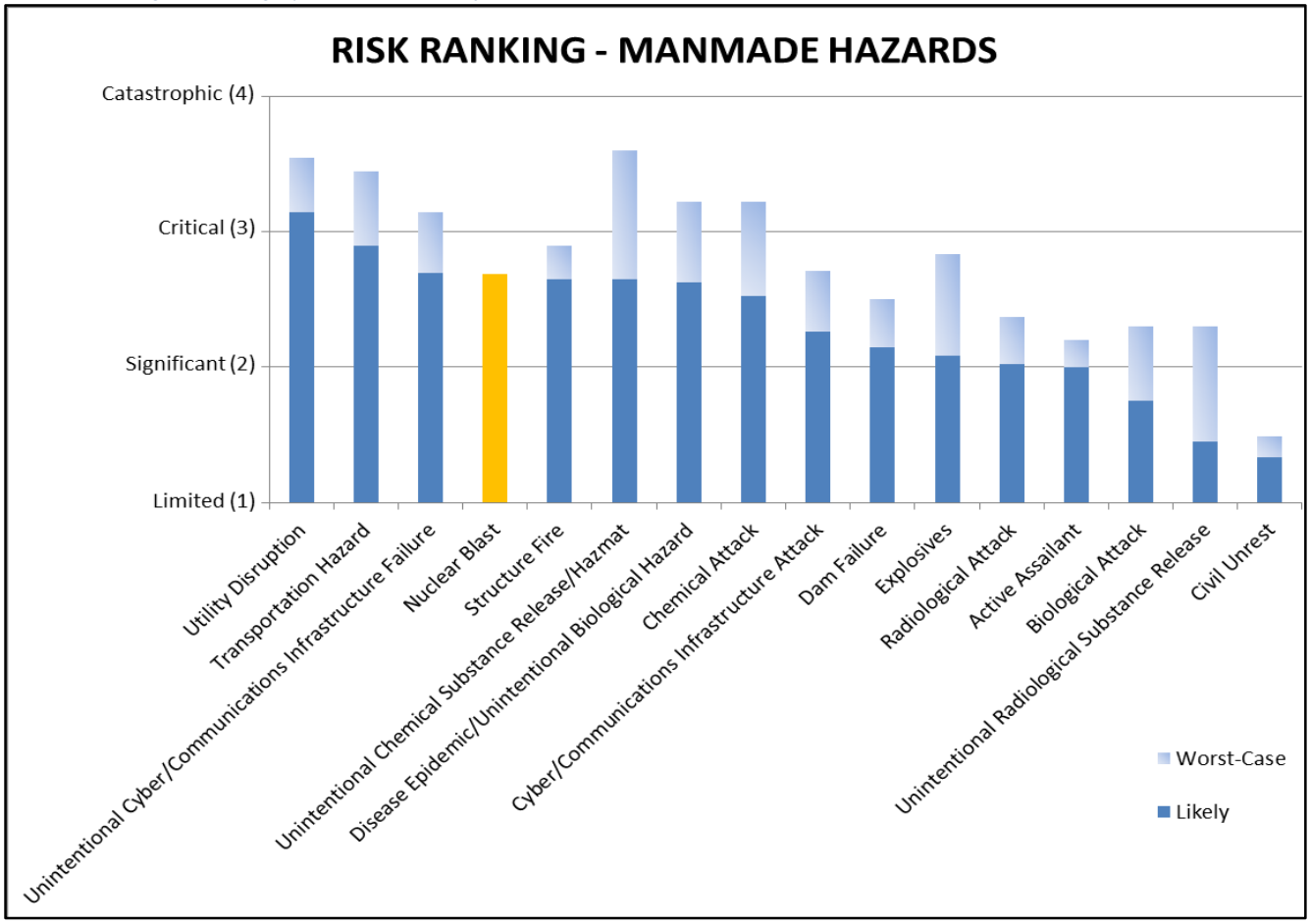
Risk Matrix

The Risk Matrix chart is a graphical illustration of hazard Risk as a function of Likelihood and Consequence.



Risk Ranking

The Risk Ranking chart is a graphical illustration of hazard Risk as it relates to other hazards.



Where no Worst-Case bar is visible, Worst-Case Risk is equivalent to Likely Risk.

II. HAZARD CHARACTERISTICS

The Hazard Characteristics section provides a detailed characterization of the hazard and the local context as it relates to the hazard.

Description of the Hazard

A Nuclear Blast is hazardous in many distinct ways. A nuclear detonation results in a large fireball that vaporizes everything within the immediate blast area and carries it upward. Light and heat radiate outward from the explosion, and an electromagnetic pulse expands outward nearly instantaneously. A blast wave generates overpressure and propagates rapidly out from the epicenter. Prompt radiation levels are high near the epicenter during the first minute of the explosion but decrease rapidly with time and distance. As the debris cloud cools, dust-like particles of radioactive material are dispersed by the wind and drop back to earth as fallout.[2]

It is rare to have any advanced warning of a Nuclear Blast detonated at ground level. Although there are systems in place to detect the launch of nuclear missiles, the advanced warning time may be measured in minutes rather than hours.

Explosive capacity for nuclear weapons is measured in kilotons (1kt = 1,000 tons) or megatons (1Mt = 1,000,000 tons). This unit of measurement refers to the weight of TNT that would be required to release an equivalent level of explosive energy. The energy yield of a Nuclear Blast can vary greatly. The lightest tactical nuclear weapons have a yield of 0.01kt. Bombs like those dropped in WWII have a yield of 13-20kt. Modern nuclear weapons like those used by the U.S. and Russian militaries can have explosive yields of 40-50Mt.

The area affected by a Nuclear Blast will vary depending on the explosive yield of the bomb. A 0.1kt explosion will have a Severe Damage Zone of 200 yards, a Moderate Damage zone extending to ¼ mile, and a Light Damage Zone extending to 1 mile from the epicenter of the explosion. A 1kt explosion will have a Severe Damage Zone of ¼ mile, a Moderate Damage zone extending to ½ mile, and a Light Damage Zone extending to 2 miles from the epicenter of the explosion. An explosion greater than 10kt will have a Severe Damage Zone of at least ½ mile, a Moderate Damage zone extending to 1 mile, and a Light Damage Zone extending to 3 mile from the epicenter of the explosion.2

The electromagnetic pulse (EMP) emitted by a Nuclear Blast can easily span across states.

Depending on the wind and weather conditions at the site of the attack, radioactive fallout can occur many miles from the blast. The highest concentrations of radiation fall closest to the detonation site, while exposure outside of the blast radius is greatly affected by weather. Radiation dose from fallout is largely dependent on time, distance, and shielding.

The size of a Nuclear Blast makes it unlikely that a nuclear weapon attack could occur without directly impacting a significant percentage of the population in the region of the attack. In the case of a military or terrorist attack, the Nuclear Blast will likely be targeted at an urban area for maximum impact.

The onset of a Nuclear Blast hazard is immediate, but effects of the blast can cause the affected area to remain hazardous for many years. Blast effects, thermal effects, and the electromagnetic pulse following a nuclear explosion are nearly instantaneous. Radioactive fallout decays rapidly in the hours following a nuclear

[2] *Nuclear Detonation: Weapons, Improvised Nuclear Devices,* U.S. Dept. of Health & Human Services. Available at http://www.remm.nlm.gov/nuclearexplosion.htm (last accessed Marcy 26, 2014).

detonation. After 3 hours, initial radiation exposure rates are down to 20%, exposure rates are down to 10% after 8 hours, and exposure rates fall to 1% after 48 hours. Radioactive contamination in the blast area is highly dependent on the type and yield of the nuclear explosive device. A large Nuclear Blast can cause result in radioactive contamination that remains hazardous for up to 10 years.

Local Context

The Local Context section describes community attributes that affect the likelihood of the hazard's occurrence or vulnerability to the hazard's consequences.

The entire planning area is susceptible to the effects of a Nuclear Blast. Given the large geographic scope of a Nuclear Blast, an attack many miles away in the DC or Baltimore area may create a catastrophic hazard inside Howard County.

The location of Howard County may increase local vulnerability to a Nuclear Blast hazard and other terrorism-related attacks. Howard County is in close proximity to valuable military and terrorist targets including Washington, D.C., the City of Baltimore, the Port of Baltimore, and the Baltimore Washington International Airport. Due to its proximity to the National Capital Region, many federal agencies, defense contractors, and high-profile targets maintain facilities within Howard County.[3]

III. LIKELIHOOD ANALYSIS

The Likelihood Analysis section characterizes the historical occurrence and future likelihood of the hazard in the planning area.

Occurrence of the Hazard

The Occurrence of the Hazard section details the historical occurrence of the hazard in the planning area.

There has never been a Nuclear Blast hazard in Howard County (1945-2014).

Future Likelihood of the Hazard for Howard County

The Future Likelihood section anticipates the future occurrence rate of the hazard based on historical likelihood and future trends. This section also addresses factors that may cause the future likelihood to deviate from historical trends.

Future Likelihood of a Nuclear Blast Hazard in Howard County	
Historical Average (time period)	0 recorded events (1945-2014)
Historical Annual Probability	0% chance of annual occurrence
Future Likelihood Expected to Deviate from Historical Likelihood (Yes/No)	No
Future Annual Probability	0-1% chance of annual occurrence
Future Likelihood Score	1.38 (Unlikely-Infrequent)
Future Likelihood reflects the likelihood of any emergency-level hazard event and does not differentiate between Likely and Worst-Case scenarios.	

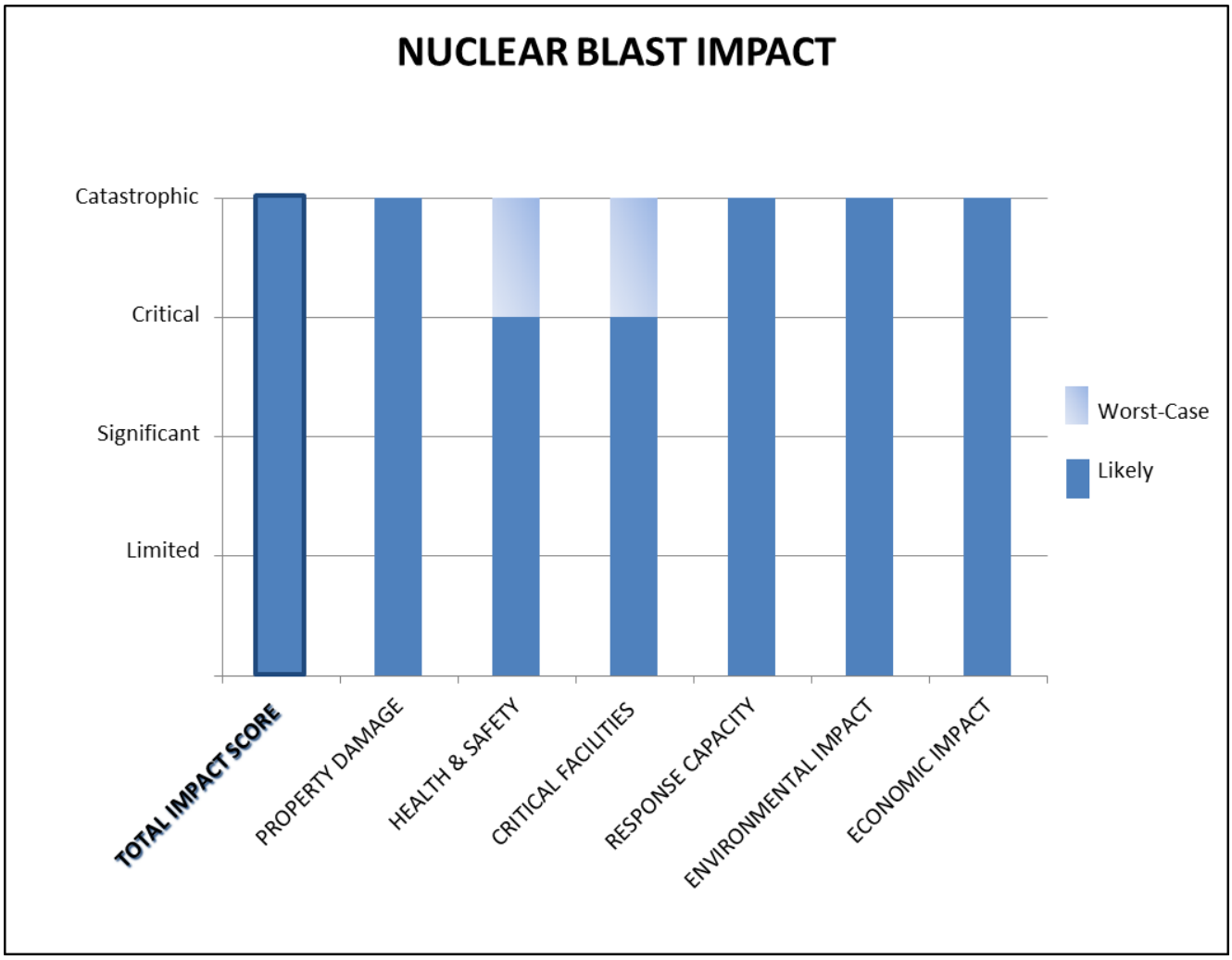
Considerations: The future likelihood of a Nuclear Blast hazard in Howard County is not expected to be significantly different from the historical occurrence rate. A future annual probability of 0-1% classifies the likelihood of a Nuclear Blast hazard as Unlikely. Increases in geopolitical tensions and the proliferation of nuclear technology may result in a slight increase in likelihood over time.3

[3] *Manmade Hazard Identification and Risk Assessment Workshop (unpublished)*, Howard County OEM (2014).

IV. CONSEQUENCE ANALYSIS

The Consequence Analysis section provides a detailed characterization of the anticipated consequences of likely and worst-case hazard events. This section characterizes impacts to property, health & safety, critical facilities, response capacity, the environment, and the economy. This section also characterizes public perceptions of each hazard, the perceived impact to personal safety and standard of living, and public confidence in response capability.

Consequence Analysis Overview



Where no Worst-Case bar is visible, Worst-Case impact is equivalent to Likely impact.

Nuclear Blast Warning Time & Duration		
	Likely	**Worst-Case**
WARNING TIME	*Short.* No warning time likely prior to an attack. In some cases there may be a short warning time of up to 1 hour.	*Short.* No warning time prior to an attack.
DURATION	*Very Long.* In the event of a Nuclear Blast in a neighboring region, onset of the EMP hazard is nearly instantaneous. Hazard conditions from radioactive fallout will likely take 1-4 hours to reach Howard County. It may take months to declare the hazard location safe.	*Very Long.* In the event of a Nuclear Blast in Howard County, onset of the hazard is nearly instantaneous. Radiation will likely persist at a hazardous level for many years. It may take up to 10 years to declare the hazard location safe.

Consequence Analysis: Likely Hazard Scenario

The Consequence Analysis table details the anticipated consequences of the most likely hazard scenario.

Nuclear Attack Consequence Analysis **Likely**		
PROPERTY DAMAGE	*Catastrophic*	• 70% damage to critical and non-critical infrastructure. • The electromagnetic pulse from a nuclear blast in a neighboring jurisdiction would cause significant disruption to electronics equipment in Howard County. Radioactive fallout may necessitate decontamination efforts, but structural damage will be minimal.
HEALTH & SAFETY	*Critical*	• Many deaths likely, although the exact number is difficult to predict. • Many injuries likely, although the exact number is difficult to predict. • In the case of a nuclear blast in a neighboring jurisdiction, deaths and injuries in Howard County would likely be due to cascading effects rather than direct effects of the attack itself. Radiation sickness may result from radioactive fallout. Any number of health emergencies could result from EMP-related electrical problems, overwhelmed emergency response systems, public panic, and the chaos of mass evacuation and resettlement. Long-term health concerns will persist as communities struggle to support the massive influx of refugees.
CRITICAL FACILITIES	*Critical*	• *Utilities* – Shut down for days or weeks. If employees are unable to work, drinking water and waste water systems will shut down within a day. • *Information/Communications* – Shut down for days or weeks. The electromagnetic pulse will cause significant damage to all electronically based systems, including phone service and internet access. • *Transportation* – Extensive delays for weeks or months. Evacuation will cause severe traffic delays on nearly all transportation routes. Transportation staff will be unavailable for work for an extended period of time. Due to contamination and staffing constraints, very minor transportation infrastructure problems will cause extensive delays in the weeks and months following the nuclear event.
RESPONSE CAPACITY	*Catastrophic*	• *Police* – Mutual aid needed. Terrorism response automatically triggers federal law enforcement involvement. • *Fire & Rescue* – Significant and long-lasting need for state or federal assistance. Response capability would be severely strained even if a nuclear blast were to occur in a neighboring jurisdiction. Maintaining continuity of operations would be difficult due to the similar response strains faced by neighboring jurisdictions. • *Health* – Significant and long-lasting need for state or federal assistance. Nearly all Health Department operations will be severely affected due to shelter in place recommendations, evacuation of staff, and emergency response. • *Hospitals* – Significant and long-lasting need for state or federal assistance. Significant strain on hospital capacity. The hospital will likely be completely full for up to one month, and the large number of psychological casualties (worried well) will continue to strain the system for months. If the water supply or the hospital structure becomes contaminated, the hospital will be out of service for an extended period of time. • *Emergency Management* – Significant and long-lasting need for state or federal assistance. Considerable ongoing assistance may be necessary to support Emergency Management in sheltering activities, evacuation planning, response coordination, and recovery planning. Loss of staff may necessitate significant assistance to support EOC operations and MAC coordination.
ENVIRONMENTAL IMPACT	*Catastrophic*	• Critical to Catastrophic environmental impact. Long term pollution and contamination. Loss of species. Renewable, but only after some time. Radioactive material would contaminate the air, water, and land for months. Radiological materials that can kill or debilitate humans may also kill or debilitate other animal life in the area. The contamination will include surface drinking water supply sources for the region (the Patuxent Reservoirs) as well as the recharge areas for local drinking water wells in the County. Agricultural land will not be usable for cropland or animal pasture. If the radiation kills plants, this could result in bare soil that would be more subject to erosion, which could further damage the soil and pollute nearby streams. Local species like honeybees and pollinators could be killed. Damage to electrical systems from the electromagnetic pulse may lead to additional environmental contamination as treatment and environmental protection facilities lose function.
ECONOMIC IMPACT	*Catastrophic*	• $10 billion in lost economic output. Other costs include cleanup and healthcare for those affected. • 81,000 jobs lost. • Business ceases. Job loss and recovery incalculable.
TOTAL IMPACT	*Catastrophic*	• Total Impact Score: 4.00 on a scale of 1 (Limited) to 4 (Catastrophic).
Limited	*Significant*	*Critical*	*Catastrophic*

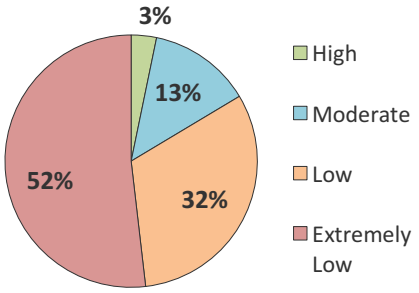
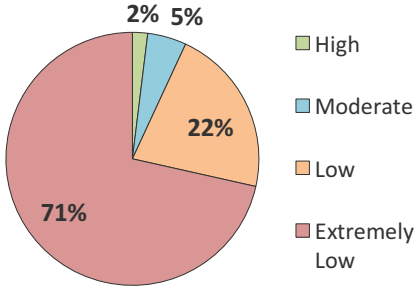
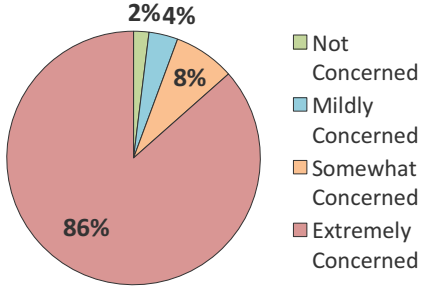
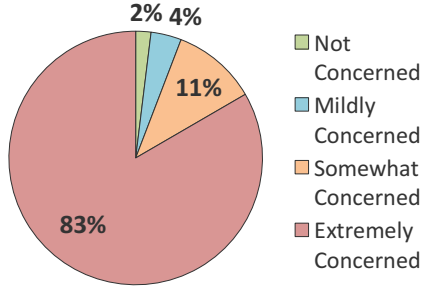
Consequence Analysis: Worst-Case Hazard Scenario

The Consequence Analysis: Worst-Case table details the anticipated consequences of the worst-case hazard scenario.

Nuclear Attack Consequence Analysis Worst-Case		
PROPERTY DAMAGE	*Catastrophic*	• 100% damage to critical and non-critical infrastructure. • Damage would come from many sources, including the nuclear fireball, blast overpressure, electromagnetic pulse, and prompt and delayed radiation.
HEALTH & SAFETY	*Catastrophic*	• 10,000-20,000 deaths likely. • 100,000+ injuries likely. • Deaths and injuries will likely be the result of complete vaporization, radiation sickness, overpressure blast injuries, or trauma from structural collapse. Multiple deaths and injuries will also occur from any number of cascading effects from the overpressure blast, radioactive fallout, EMP, and mass evacuation.
CRITICAL FACILITIES	*Catastrophic*	• *Utilities* – Shut down for 10+ years. Total shutdown of all system will occur. Restoring service will require a complete rebuild of infrastructure. • *Information/Communications* – Shut down for 10+ years. Restoring service will require a complete rebuild of information and communications infrastructure. • *Transportation* – Shut down for 10+ years. A large percentage of transportation infrastructure will be destroyed by the blast. Remaining routes will be shut down by mass evacuations. Damages to transportation infrastructure will take more than a decade to rebuild.
RESPONSE CAPACITY	*Catastrophic*	• *Police* – Significant and long-lasting need for state or federal assistance. Local law-enforcement capabilities would be non-existent. • *Fire & Rescue* – Significant and long-lasting need for state or federal assistance. There would be no local response capability or continuity of operations. • *Health* – Significant and long-lasting need for state or federal assistance. Health Department operations will be completely disrupted. • *Hospitals* – Significant and long-lasting need for state or federal assistance. All hospital services and facility would be completely unavailable. • *Emergency Management* – Significant and long-lasting need for state or federal assistance. Local Emergency Management would be rendered completely ineffective. Surviving staff would likely evacuate with the rest of the population, and all local Emergency Management functions would be off-line.
ENVIRONMENTAL IMPACT	*Catastrophic*	• Catastrophic environmental impact. Species extinction is expected, generational birth defects are likely among surviving animal life, and the area will not be livable or renewable. The radioactive blast would damage or destroy plant and animal life within the impact zone. The radioactive material would contaminate the air, water, and land for ten years or more. The contamination will include surface drinking water supply sources for the region (the Patuxent Reservoirs) as well as the recharge areas for local drinking water wells in the County. The contamination will be carried downstream via the Patapsco and Patuxent Rivers to the Chesapeake Bay. Agricultural land will not be usable for cropland or animal pasture. In areas where vegetation has been damaged or destroyed, the bare soil will be more subject to erosion, which could further damage the soil and pollute nearby streams. Plant and animal life that remains in the area or moves into the area over the next ten years may be killed or debilitated by the residual radioactive materials. A nuclear blast would affect electronics and therefore shutdown many communications systems, causing significant challenges in communicating essential environmental safety information to the public. The weather and shifting winds after the nuclear blast may cause further contamination. Failed sewage systems due to failed pumps or computer technology may cause contamination or sewage issues. Flooding could occur if floodgates are controlled by computers or electronics affected by the blast. Mass fatalities could cause environmental pollution in the form of soil and water contamination.
ECONOMIC IMPACT	*Catastrophic*	• $200 billion in lost economic output. Other costs include cleanup and healthcare for those affected. • 162,000 jobs lost. • All County and Regional economic activity is gone for at least 10 years.
TOTAL IMPACT	*Catastrophic*	• Total Impact Score: 4.00 on a scale of 1 (Limited) to 4 (Catastrophic).
Limited	*Significant*	*Critical*	*Catastrophic*

Consequence Analysis: Public Perception

The Consequence Analysis: Public Perception table characterizes public perceptions of each hazard. Details include public confidence in personal ability to respond to each hazard, public confidence in Howard County's ability to respond to each hazard, and each hazard's perceived impact to personal safety and standard of living.

Nuclear Blast Public Perceptions			
PERCEIVED CONFIDENCE IN HOWARD COUNTY'S ABILITY TO RESPOND AND RECOVER FROM THIS HAZARD	**PERCEIVED CONFIDENCE IN PERSONAL ABILITY TO PROTECT SELF AND FAMILY FROM THIS HAZARD**	**CONCERN OVER THE IMPACT TO PERSONAL HEALTH AND SAFETY IF THIS HAZARD WERE TO OCCUR LOCALLY**	**CONCERN OVER THE IMPACT TO PERSONAL STANDARD OF LIVING / QUALITY OF LIFE IF THIS HAZARD WERE TO OCCUR LOCALLY**
			
Average: 3.32 *Low – Extremely Low*	*Average: 3.63* *Extremely Low - Low*	*Average: 3.79* *Extremely Concerned*	*Average: 3.76* *Extremely Concerned*

Structure Fire

I. OVERVIEW

The Overview section defines the hazard and summarizes the hazard risk profile.

Definition

This section defines the scope of the hazard category. The terminology and characterization established in this section should be consistent throughout all Howard County planning documents.

A Structure Fire hazard is an uncontrolled fire involving any building or structure. Structure Fires can occur in a residential, commercial, or industrial setting. Fires can easily spread from one structure to another, and the size of a Structure Fire hazard is constantly evolving. Structure Fire hazards can be caused intentionally or unintentionally, but often the origin of the fire is not known until after the hazard has been brought under control.

Risk Profile

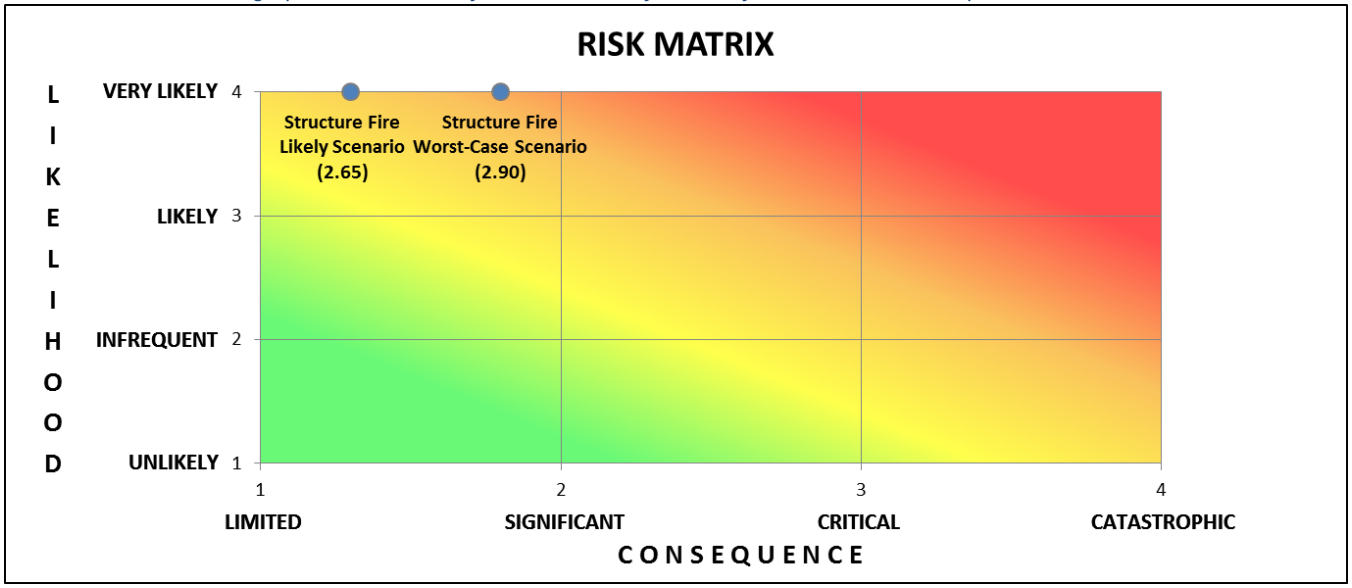
The Risk Profile section presents the Risk Score for the hazard in a range from 1 (lowest risk) to 4 (highest risk). Risk Score is a function of Likelihood and Consequence.

Structure Fire Risk Profile				
	Risk Assessment Category	**Likely Hazard Scenario**	**Worst-Case Hazard Scenario**	**Weight**
LIKELIHOOD	**Likelihood**	4.00* Very Likely		50%
CONSEQUENCE	**Impact**	1.00 Limited	1.50 Limited-Significant	40%
	Warning Time	4 Short	4 Short	5%
	Duration	1 Short	2 Moderate	5%
TOTAL RISK SCORE		**2.65**	**2.90**	

**The Likelihood Score reflects the likelihood of any emergency-level hazard event and does not differentiate between Likely and Worst-Case scenarios.*

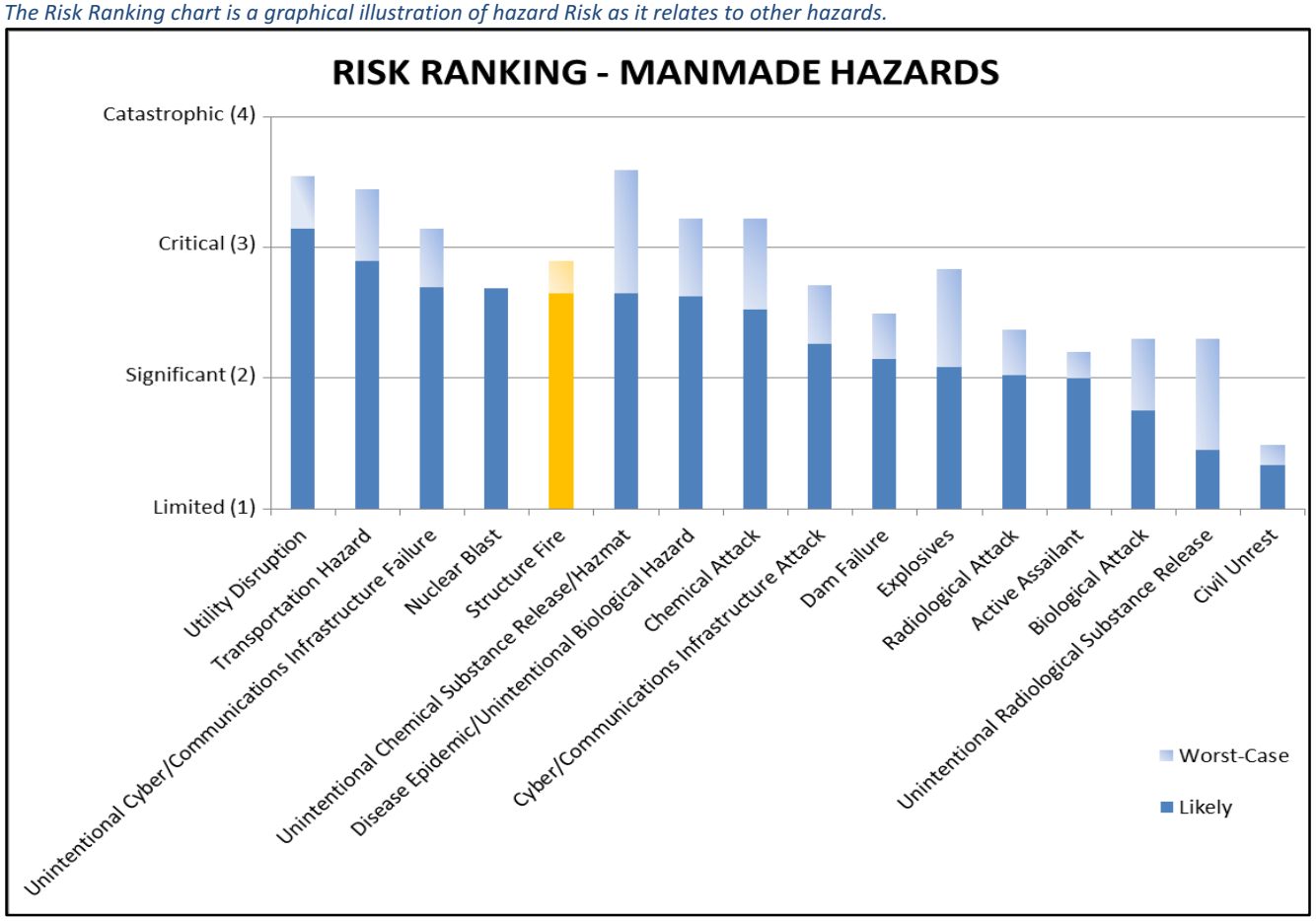
Risk Matrix

The Risk Matrix chart is a graphical illustration of hazard Risk as a function of Likelihood and Consequence.



Risk Ranking

The Risk Ranking chart is a graphical illustration of hazard Risk as it relates to other hazards.



Where no Worst-Case bar is visible, Worst-Case Risk is equivalent to Likely Risk.

II. HAZARD CHARACTERISTICS

The Hazard Characteristics section provides a detailed characterization of the hazard and the local context as it relates to the hazard.

Description of the Hazard

A Structure Fire can occur in nearly any manmade structure and may involve a single building or many structures over multiple city blocks. The number of people affected depends greatly on the type of structure involved and the population density within. Fires may affect vacant structures, residential homes, or highly populated commercial areas or apartment buildings. People occupy commercial and industrial structures more densely during the day and residential structures more densely at night, so the time of day a hazard occurs directly impacts the number of people affected by a fire in any given structure.

Vulnerability to Structure Fire hazard is highly dependent on the type of construction involved and the fire-prevention safeguards incorporated into the design. The International Building Code categorizes constructions into five types based on their level of fire resistance:

- *Type I & II: Fire Resistive/Noncombustible* – Building elements are of noncombustible materials. Examples of Type I and Type II construction include modern commercial structures and high-rise buildings built with concrete, protected steel, reinforced masonry, and other noncombustible materials.
- *Type III*: *Ordinary* – Exterior walls are of noncombustible materials. Interior building elements may consist of other materials permitted by code. Examples of Type III construction include older buildings with unreinforced masonry walls and conventional wood roofs.
- *Type IV: Heavy Timber* – Exterior walls are of noncombustible materials, and the interior building elements are of solid or laminated wood without concealed spaces. Examples of Type IV construction include older buildings that use large-dimensional lumber for structural support.
- *Type V: Wood-Framed* – Structural elements, exterior, and interior walls are of any materials permitted by code. Construction may include fire-resistant and non-fire-resistant materials. Examples of Type V construction include modern homes with combustible wood-framed walls and roofs.

It is rare to have any advanced warning of a Structure Fire hazard. Structure Fires may take anywhere from several hours to a day or more to extinguish. Structure Fire hazards caused by large wildland fires can take multiple days to extinguish.

Local Context

The Local Context section describes community attributes that affect the likelihood of the hazard's occurrence or vulnerability to the hazard's consequences.

A Structure Fire hazard may occur anywhere in Howard County. Areas that are densely populated and densely developed are particularly vulnerable to Structure Fire hazards. Structure Fires may spread rapidly in locations with congested infrastructure. Although many structures in Howard County were built relatively recently, there are also many historic areas where construction is unlikely to comply with all modern fire safety laws and regulations.[1]

[1] *Manmade Hazard Identification and Risk Assessment Workshop (unpublished)*, Howard County OEM (2014).

III. LIKELIHOOD ANALYSIS

The Likelihood Analysis section characterizes the historical occurrence and future likelihood of the hazard in the planning area.

Occurrence of the Hazard

The Occurrence of the Hazard section details the historical occurrence of the hazard in the planning area.

There have been 2,222 Structure Fire responses in Howard County during the reviewed time period (2008-2013).[2]

Notable Incidents in Howard County

The large majority of Structure Fire hazards in Howard County are residential cooking-related fires.

1999 Ellicott City Fire – A 6-alarm fire destroyed multiple businesses in downtown Ellicott City. The fire took several hours to contain and caused over $1 million in damage.

Future Likelihood of the Hazard for Howard County

The Future Likelihood section anticipates the future occurrence rate of the hazard based on historical likelihood and future trends. This section also addresses factors that may cause the future likelihood to deviate from historical trends.

Future Likelihood of a Structure Fire Hazard in Howard County	
Historical Average (time period)	444 events every year (2008-2013)
Historical Annual Probability	100% chance of annual occurrence
Future Likelihood Expected to Deviate from Historical Likelihood (Yes/No)	No
Future Annual Probability	100% chance of annual occurrence
Future Likelihood Score	4.00 (Very Likely)
Future Likelihood reflects the likelihood of any emergency-level hazard event and does not differentiate between Likely and Worst-Case scenarios.	

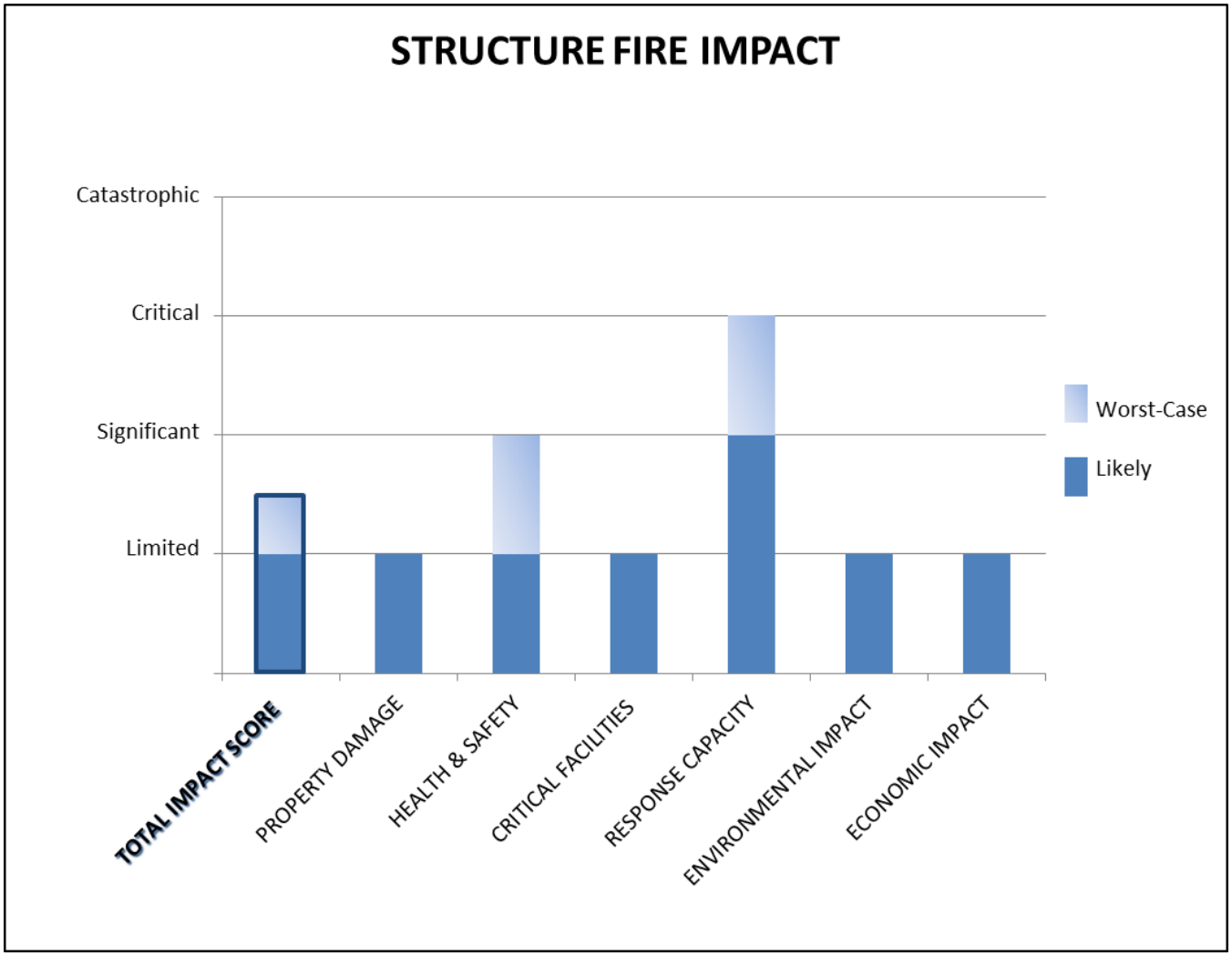
Considerations: The future likelihood of Structure Fire hazard in Howard County is not expected to be significantly different from the historical occurrence rate. A future annual probability of 100% classifies the likelihood of a Structure Fire hazard as Very Likely. Increases in population density and development density will increase the number of structures available to burn. However, fire prevention safeguards built into modern constructions are expected to contribute to a slight decline in the overall likelihood of Structure Fire hazard in the future.1

[2] *Howard County CAD Report 1/01/2008 – 12/31/2013 (unpublished)*, Howard County DFRS (2014).

IV. CONSEQUENCE ANALYSIS

The Consequence Analysis section provides a detailed characterization of the anticipated consequences of likely and worst-case hazard events. This section characterizes impacts to property, health & safety, critical facilities, response capacity, the environment, and the economy. This section also characterizes public perceptions of each hazard, the perceived impact to personal safety and standard of living, and public confidence in response capability.

Consequence Analysis Overview



Where no Worst-Case bar is visible, Worst-Case impact is equivalent to Likely impact.

Structure Fire Warning Time & Duration		
	Likely	**Worst-Case**
WARNING TIME	*Short.* No warning time prior to the onset of the hazard.	*Short.* No warning time prior to the onset of the hazard.
DURATION	*Short.* 2-6 hours to remove the hazard and declare the hazard location safe.	*Moderate.* 12-24 hours to remove the hazard and declare the hazard location safe.

Consequence Analysis: Likely Hazard Scenario

The Consequence Analysis table details the anticipated consequences of the most likely hazard scenario.

Structure Fire Consequence Analysis Likely		
PROPERTY DAMAGE	*Limited*	• 0% damage to critical and non-critical infrastructure. • Anything beyond superficial damage to buildings and structures is unlikely. Localized fire and water damage is likely for structures involved in or in close proximity to the fire.
HEALTH & SAFETY	*Limited*	• 0 deaths likely. • 1-2 injuries likely. • Fire deaths and injuries are likely due to smoke inhalation, burns, or trauma due to structural collapse.
CRITICAL FACILITIES	*Limited*	• *Utilities* – Shutdown unlikely. No effect on utilities. • *Information/Communications* – Shutdown unlikely. No major impact on information or communications infrastructure • *Transportation* – Delays for less than 6 hours. Impacts to transportation will be minor and short-term. Road closures will be extremely localized, and delays will not be excessive.
RESPONSE CAPACITY	*Significant*	• *Police* – Local resources adequate. • *Fire & Rescue* – Mutual aid needed. Necessary mutual aid coverage should be readily available. No impact on response capability or Continuity of Operations. • *Health* – Local resources adequate. Essential Health Department operations will not be affected. Emergency Preparedness and Response and Environmental Health may be needed to support local response. • *Hospitals* – Local resources adequate. No impact on the hospital system. • *Emergency Management* – Local resources adequate. Limited impact to Emergency Management capability.
ENVIRONMENTAL IMPACT	*Limited*	• Limited environmental impact. Less than a day of clean-up. Impact to a localized area. Minimal localized air pollution may result from the burning of wood and synthetic materials. Air pollution will likely dissipate rapidly once the fire has been extinguished.
ECONOMIC IMPACT	*Limited*	• Minimal loss of economic output due to the limited area affected. Other costs include cleanup and healthcare for those affected. • 0 jobs lost.
TOTAL IMPACT	*Limited*	• Total Impact Score: 1.00 on a scale of 1 (Limited) to 4 (Catastrophic).
Limited	*Significant*	*Critical*	*Catastrophic*

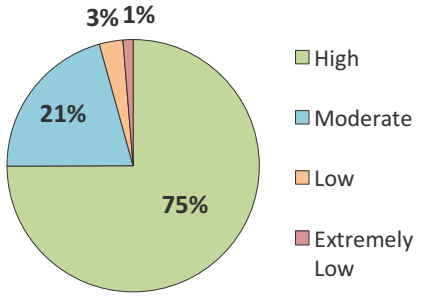
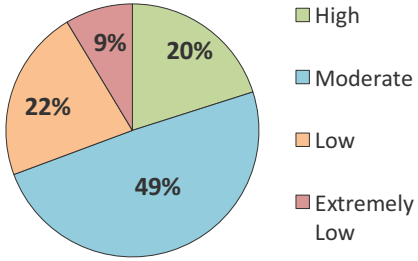
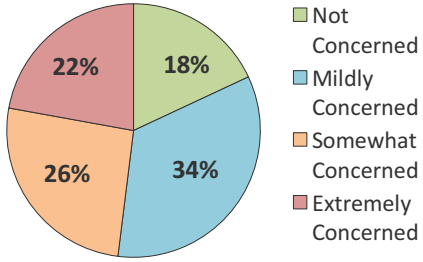
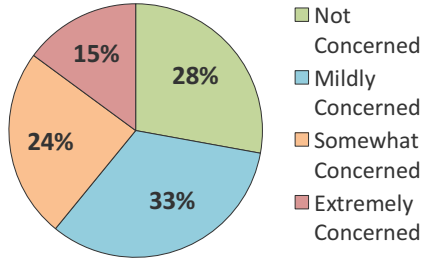
Consequence Analysis: Worst-Case Hazard Scenario

The Consequence Analysis: Worst-Case table details the anticipated consequences of the worst-case hazard scenario.

Structure Fire Consequence Analysis Worst-Case		
PROPERTY DAMAGE	*Limited*	• 0% damage to critical and non-critical infrastructure. • Anything beyond superficial damage to buildings and structures is unlikely. Localized fire and water damage is likely for structures involved in or in close proximity to the fire.
HEALTH & SAFETY	*Significant*	• 10-20 deaths likely. • 50+ injuries likely. • Fire deaths and injuries are likely due to smoke inhalation, burns, or trauma due to structural collapse.
CRITICAL FACILITIES	*Limited*	• *Utilities* – Diminished water capacity for the duration of fire suppression efforts (12-24 hours). Water supply to homes and businesses will remain functional at a diminished capacity in the localized hazard area due to fire suppression efforts. Water for fire suppression activities will become scarce if suppression activities continue for an extended period of time. • *Information/Communications* – No shutdown. No major impact on information or communications infrastructure. • *Transportation* – Delays for up to one day. Impacts to transportation will be minor and short-term. Road closures will be localized, and delays will not be excessive.
RESPONSE CAPACITY	*Critical*	• *Police* – Local resources adequate. • *Fire & Rescue* – Moderate need for federal assistance. Sustained fire suppression activities will strain emergency service delivery. Substantial mutual aid resources will be necessary to stabilize the hazard and maintain regular service coverage. • *Health* – Mutual aid needed. Regular Health Department operations will not be affected. Health Emergency Preparedness might be necessary to support the emergency response. • *Hospitals* – Local resources adequate. The Emergency Department would be very busy treating injuries from the Structure Fire hazard. Additional resources may be needed if the number of patients exceeds Emergency Department capacity. Mass casualty and triage activities may be necessary, but plans are in place to manage a patient surge of this size. Major disruption of regular hospital activities is unlikely. • *Emergency Management* – Local resources adequate. Limited impact to Emergency Management capability.
ENVIRONMENTAL IMPACT	*Limited*	• Limited environmental impact. Less than a day of clean-up. Impact to a localized area. Moderate localized air pollution may result from the burning of wood and synthetic materials. Air pollution will likely dissipate rapidly once the fire has been extinguished.
ECONOMIC IMPACT	*Limited*	• $170,000 in lost economic output. Other costs include cleanup and healthcare for those affected. • 1.4 jobs lost. • Business activities will be impacted in a localized area near the hazard.
TOTAL IMPACT	*Limited-Significant*	• Total Impact Score: 1.50 on a scale of 1 (Limited) to 4 (Catastrophic).
Limited	*Significant*	*Critical*	*Catastrophic*

Consequence Analysis: Public Perception

The Consequence Analysis: Public Perception table characterizes public perceptions of each hazard. Details include public confidence in personal ability to respond to each hazard, public confidence in Howard County's ability to respond to each hazard, and each hazard's perceived impact to personal safety and standard of living.

Structure Fire Public Perceptions			
PERCEIVED CONFIDENCE IN HOWARD COUNTY'S ABILITY TO RESPOND AND RECOVER FROM THIS HAZARD	**PERCEIVED CONFIDENCE IN PERSONAL ABILITY TO PROTECT SELF AND FAMILY FROM THIS HAZARD**	**CONCERN OVER THE IMPACT TO PERSONAL HEALTH AND SAFETY IF THIS HAZARD WERE TO OCCUR LOCALLY**	**CONCERN OVER THE IMPACT TO PERSONAL STANDARD OF LIVING / QUALITY OF LIFE IF THIS HAZARD WERE TO OCCUR LOCALLY**
			
Average: 1.31 *High - Moderate*	*Average: 2.19* *Moderate*	*Average: 2.53* *Somewhat Concerned - Mildly Concerned*	*Average: 2.26* *Mildly Concerned - Somewhat Concerned*

Transportation Hazard

I. OVERVIEW

The Overview section defines the hazard and summarizes the hazard risk profile.

Definition

This section defines the scope of the hazard category. The terminology and characterization established in this section should be consistent throughout all Howard County planning documents.

A Transportation Hazard occurs whenever a vehicle accident or collision has the potential to cause harm. Any vehicle is capable of being involved in a Transportation Hazard. The most common types of Transportation Hazards involve automobiles, trains, airplanes, or boats. A transportation hazard can involve one or multiple vehicles, and cascading effects may include the release of hazardous materials (profiled separately).

Risk Profile

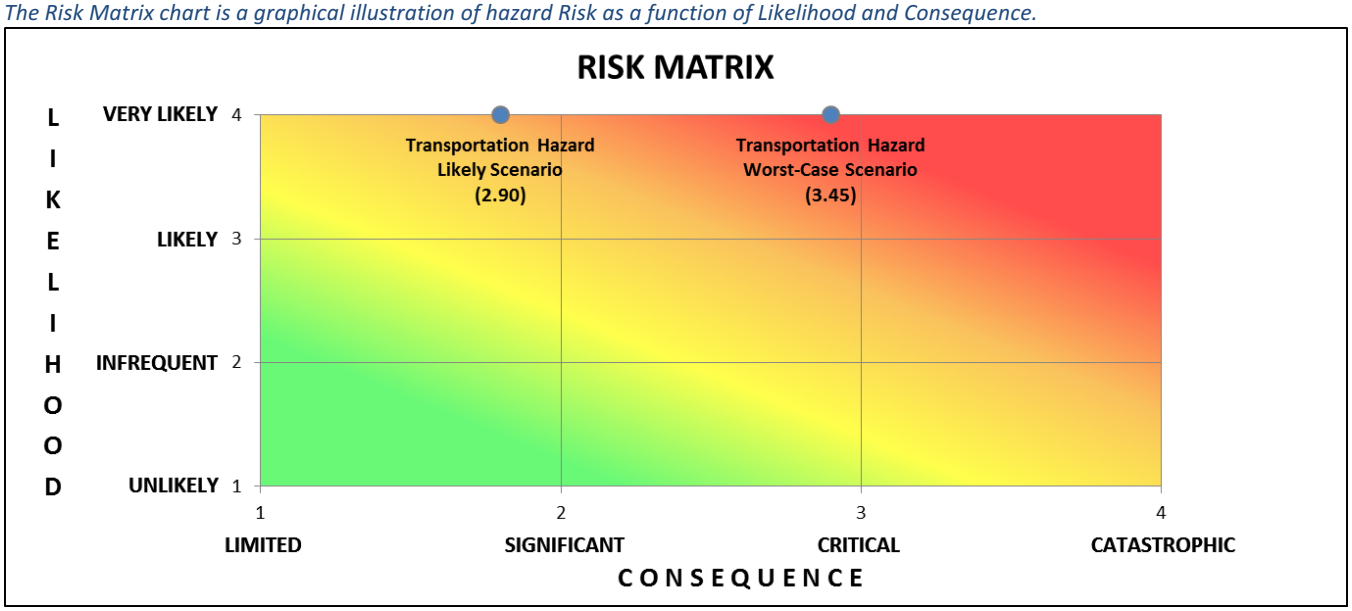
The Risk Profile section presents the Risk Score for the hazard in a range from 1 (lowest risk) to 4 (highest risk). Risk Score is a function of Likelihood and Consequence.

Transportation Hazard Risk Profile				
	Risk Assessment Category	**Likely Hazard Scenario**	**Worst-Case Hazard Scenario**	**Weight**
LIKELIHOOD	**Likelihood**	4.00* Very Likely		50%
CONSEQUENCE	**Impact**	1.50 Limited-Significant	2.75 Significant-Critical	40%
	Warning Time	4 Short	4 Short	5%
	Duration	2 Moderate	3 Long	5%
TOTAL RISK SCORE		**2.90**	**3.45**	

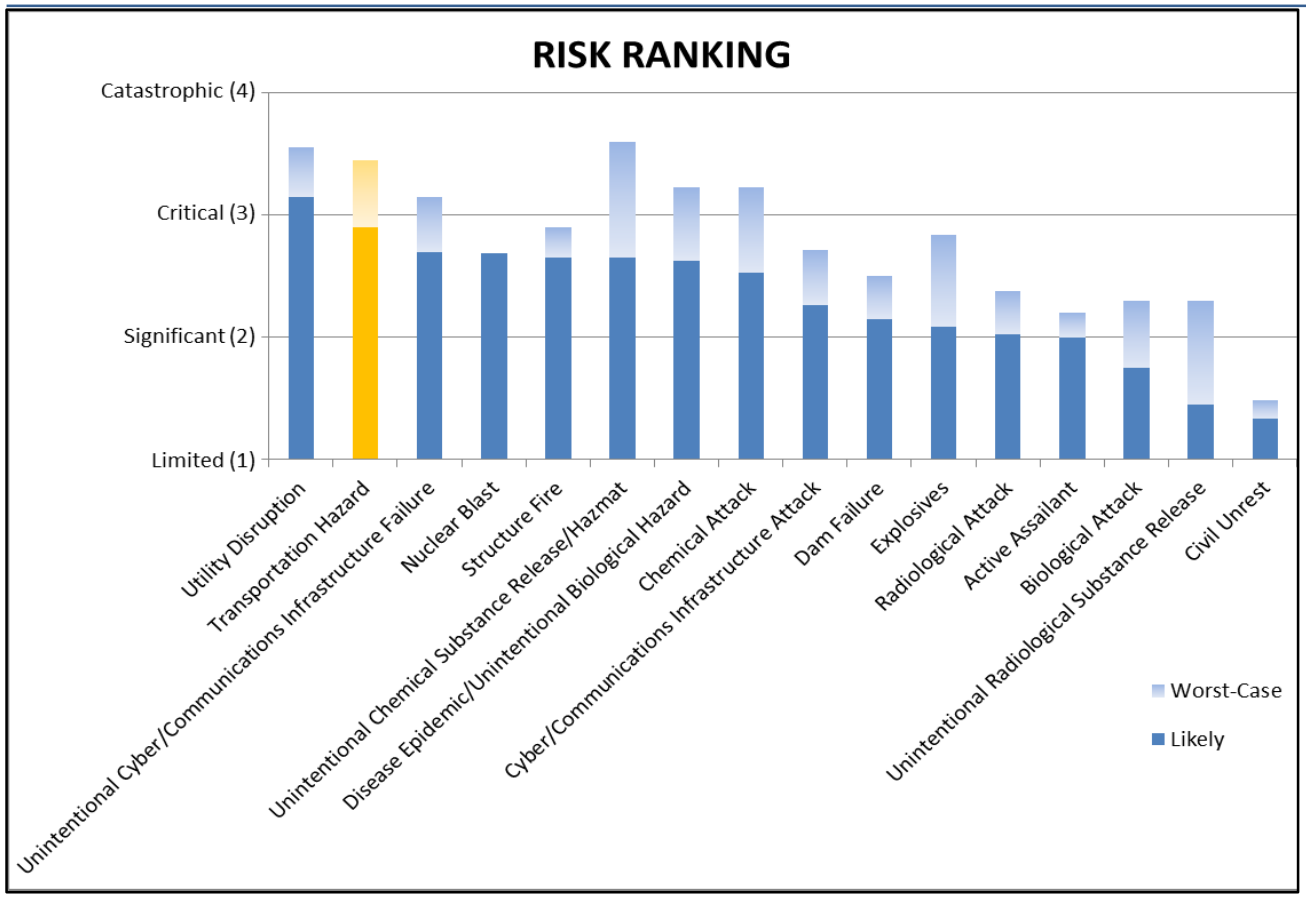
**The Likelihood Score reflects the likelihood of any emergency-level hazard event and does not differentiate between Likely and Worst-Case scenarios.*

Risk Matrix

The Risk Matrix chart is a graphical illustration of hazard Risk as a function of Likelihood and Consequence.



Risk Ranking



The Risk Ranking chart is a graphical illustration of hazard Risk as it relates to other hazards.
Where no Worst-Case bar is visible, Worst-Case Risk is equivalent to Likely Risk.

II. HAZARD CHARACTERISTICS

The Hazard Characteristics section provides a detailed characterization of the hazard and the local context as it relates to the hazard.

Description of the Hazard

A Transportation Hazard can involve road vehicles, trains, airplanes, or boats, and the characteristics of the hazard depend greatly on the vehicles involved. The hazard may involve one vehicle or many vehicles.

Although a Transportation Hazard can occur nearly anywhere, affected areas are typically in close proximity to roadways, railways, or other locations with high levels of vehicle traffic areas. Because dangerous substances are often moved from one place to another via truck, train, or ship, Transportation Hazards can involve the release of hazardous materials including combustible, explosive, radiological, biological, or otherwise toxic substances.

It is rare to have any advanced warning of a Transportation Hazard event. Transportation Hazards typically occur over the span of seconds or minutes. Secondary hazards such as fire, transportation disruption, and the release of hazardous materials may take several hours to bring under control.

Local Context

The Local Context section describes community attributes that affect the likelihood of the hazard's occurrence or vulnerability to the hazard's consequences.

A Transportation Hazard can occur anywhere in Howard County. Transportation Hazards are most likely to occur along heavily trafficked transportation routes. Areas along major arterial roads and interstate highways are especially vulnerable to Transportation Hazards involving road vehicles. The eastern portion of Howard County experiences the highest levels of road traffic, averaging several hundred thousand vehicles daily.

There are also many areas in Howard County where a train-caused Transportation Hazard could occur. There is a heavily-trafficked freight rail line that runs along most of Howard County's northern border. Trains on this line intersect major road transportation routes and travel through several urban and suburban communities. The MARC Camden Line commuter train also passes through western Howard County many times a day on its path between Baltimore and Washington, D.C.

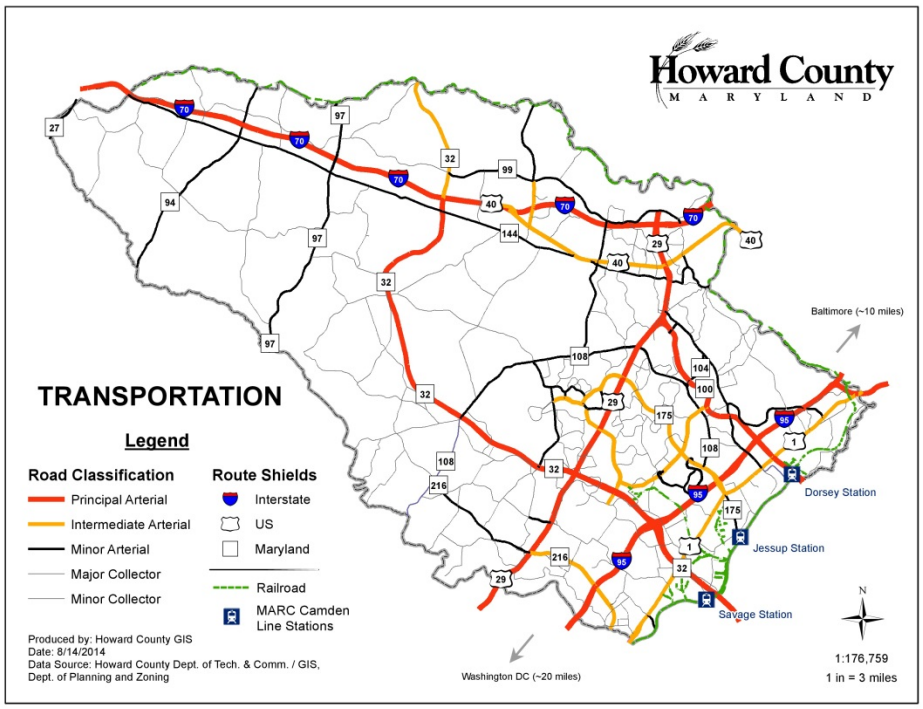
Aviation Transportation Hazards are also a possibility in Howard County. Although there are no active airports in Howard County, airplanes frequently fly low over the western portion of the county on approach to the Baltimore Washington National Airport. Given the high volume of air traffic above Howard County and the proximity to multiple high-traffic airports, an aviation hazard can occur anywhere inside the planning area.

Transportation Hazards involving water vehicles are unlikely. There are no large bodies of water in Howard County, and the small lakes and reservoirs within the planning area do not allow motorized water vehicles.[1]

[1] *Manmade Hazard Identification and Risk Assessment Workshop (unpublished)*, Howard County OEM (2014).

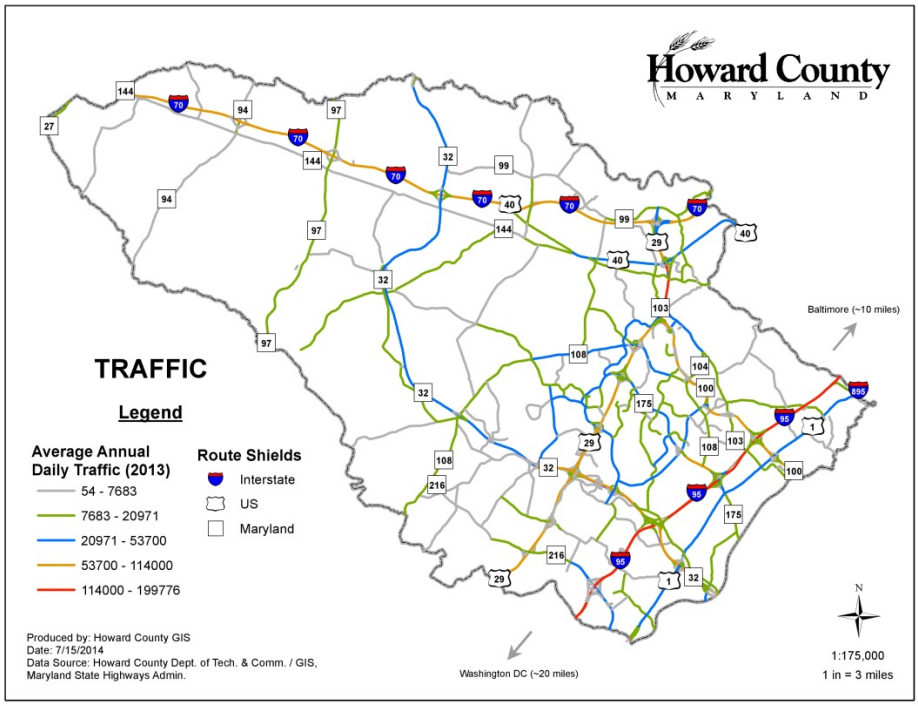
Transportation

This map identifies the major transportation routes in Howard County.



Traffic

This map identifies the level of daily traffic through Howard County.



III. LIKELIHOOD ANALYSIS

The Likelihood Analysis section characterizes the historical occurrence and future likelihood of the hazard in the planning area.

Occurrence of the Hazard

The Occurrence of the Hazard section details the historical occurrence of the hazard in the planning area.

There have been 786 Transportation Hazard responses requiring extrication or rescue and an additional 960 vehicle fire responses in Howard County during the reviewed time period (2008-2013).[2]

Most Transportation Hazards in Howard County involve a small number of passenger vehicles, and only a very small percentage of accidents involve fatalities.

Notable Incidents in Howard County

2012 Ellicott City Train Derailment – A CSX freight train derailed as it was passing over the bridge in downtown Ellicott City. The cause of the accident was unclear. A total of 21 rail cars went off their tracks, fatally burying two bystanders. The derailment caused an estimated $2.2 million in damage.

1982 Columbia Aircraft Crash – A Beech D95A crashed in Columbia as a result of pilot error. Five people died in the accident.

1962 Ellicott City Aircraft Crash – United Airlines Flight 297 collided with a flock of swans while preparing to land at Washington National Airport. The aircraft lost control and broke apart mid-air, crashing outside of Ellicott City and killing all 17 people aboard the plane.

Future Likelihood of the Hazard for Howard County

The Future Likelihood section anticipates the future occurrence rate of the hazard based on historical likelihood and future trends. This section also addresses factors that may cause the future likelihood to deviate from historical trends.

Future Likelihood of a Transportation Hazard in Howard County	
Historical Average (time period)	349 events every year (2008-2013)
Historical Annual Probability	100% chance of annual occurrence
Future Likelihood Expected to Deviate from Historical Likelihood (Yes/No)	No
Future Annual Probability	100% chance of annual occurrence
Future Likelihood Score	4.00 (Very Likely)
Future Likelihood reflects the likelihood of any emergency-level hazard event and does not differentiate between Likely and Worst-Case scenarios.	

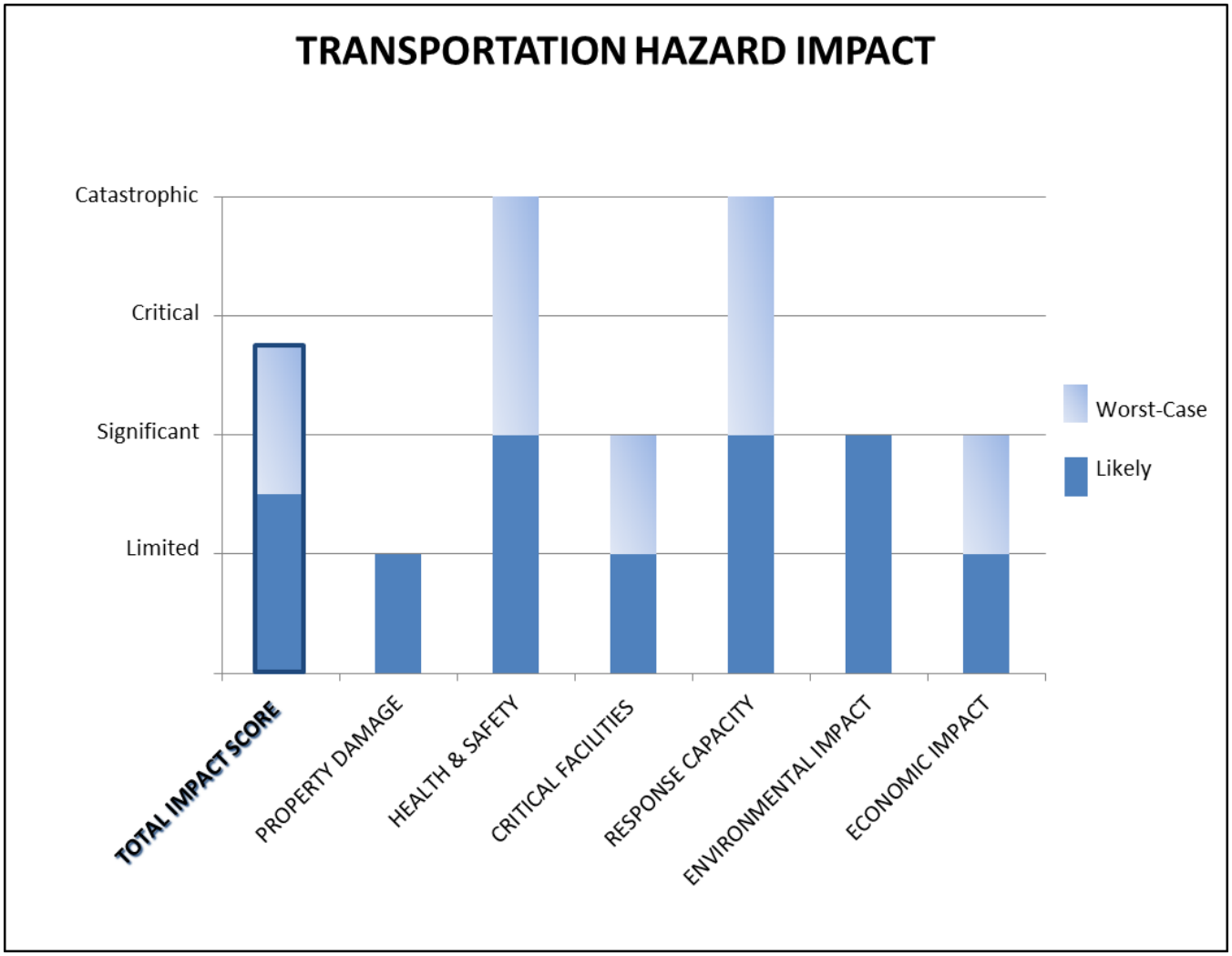
Considerations: The future likelihood of a Transportation Hazard in Howard County is not expected to be significantly different from the historical occurrence rate. A future annual probability of 100% classifies the likelihood of a Transportation Hazard as Very Likely. The growing population and increase in motor vehicle traffic is expected to result in a slight increase in the likelihood of Transportation Hazard over time.1

[2] *Howard County CAD Report 1/01/2008 – 12/31/2013 (unpublished)*, Howard County DFRS (2014).

IV. CONSEQUENCE ANALYSIS

The Consequence Analysis section provides a detailed characterization of the anticipated consequences of likely and worst-case hazard events. This section characterizes impacts to property, health & safety, critical facilities, response capacity, the environment, and the economy. This section also characterizes public perceptions of each hazard, the perceived impact to personal safety and standard of living, and public confidence in response capability.

Consequence Analysis Overview



Where no Worst-Case bar is visible, Worst-Case impact is equivalent to Likely impact.

Transportation Hazard Warning Time & Duration		
	Likely	**Worst-Case**
WARNING TIME	*Short.* No warning time prior to the onset of the hazard.	*Short.* No warning time prior to the onset of the hazard.
DURATION	*Moderate.* 2 hours to stabilize the hazard. Up to 12 hours to declare the hazard location safe and return to pre-hazard conditions.	*Long.* 12 hours to stabilize the hazard. Up to 72 hours to declare the hazard location safe and return to pre-hazard conditions.

Consequence Analysis: Likely Hazard Scenario

The Consequence Analysis table details the anticipated consequences of the most likely hazard scenario.

Transportation Hazard Consequence Analysis Likely		
PROPERTY DAMAGE	*Limited*	• 0% damage to critical and non-critical infrastructure. • Anything beyond superficial damage to buildings and structures is unlikely. Minor damage may occur to property in a localized area around the hazard.
HEALTH & SAFETY	*Significant*	• 1-4 deaths likely. • 6-8 injuries likely. • Physical trauma is the most common cause of injury and death in a Transportation Hazard event.
CRITICAL FACILITIES	*Limited*	• *Utilities* – Shutdown unlikely. No effect on utilities. • *Information/Communications* – Shutdown unlikely. No major impact on information or communications infrastructure. • *Transportation* – Delays for less than 6 hours. Impacts to transportation will be minor and short-term. Road closures will be extremely localized, and delays will not be excessive.
RESPONSE CAPACITY	*Significant*	• *Police* – Local resources adequate. • *Fire & Rescue* – Mutual aid needed. Some mutual aid assistance required. • *Health* – Local resources adequate. Health Department operations will not be affected. • *Hospitals* – Local resources adequate. No impact on the hospital system. • *Emergency Management* – Local resources adequate. Limited impact to Emergency Management capability.
ENVIRONMENTAL IMPACT	*Significant*	• Limited to significant environmental impact. Minor air pollution may result from the burning of petroleum hydrocarbons and synthetic materials. Hazardous liquid spills may cause soil contamination and water pollution in a localized area. If hazardous materials enter nearby waterways, the contamination may extend beyond a localized area.
ECONOMIC IMPACT	*Limited*	• $228,000 in lost economic output. Other costs include cleanup and healthcare for those affected. • 1.8 jobs lost. • Limited impact to local businesses.
TOTAL IMPACT	*Limited-Significant*	• Total Impact Score: 1.50 on a scale of 1 (Limited) to 4 (Catastrophic).
Limited	*Significant*	*Critical*	*Catastrophic*

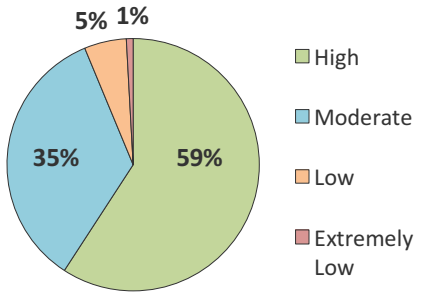
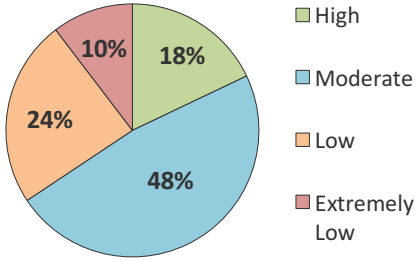
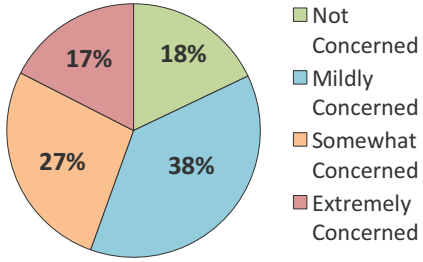
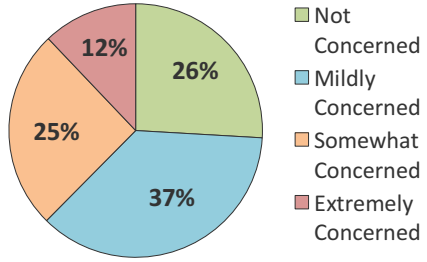
Consequence Analysis: Worst-Case Hazard Scenario

The Consequence Analysis: Worst-Case table details the anticipated consequences of the worst-case hazard scenario.

Transportation Hazard Consequence Analysis Worst-Case		
PROPERTY DAMAGE	*Limited*	• 1-3% damage to critical and non-critical infrastructure. • A major Transportation Hazard event may cause significant damage to buildings, property, and infrastructure in the hazard area.
HEALTH & SAFETY	*Catastrophic*	• 100-200 deaths likely. • 20 injuries likely. • Physical trauma is the most common cause of injury and death in a Transportation Hazard event. Large-scale automobile or train hazards will likely result in a high number of injuries, while an aircraft crash hazard will likely result in fewer injuries and many more deaths.
CRITICAL FACILITIES	*Significant*	• *Utilities* – Utilities will be disrupted for the duration of fire suppression efforts (up to 12 hours). Extended fire suppression efforts will result in diminished (but functional) water supply to homes and businesses in a localized area. • *Information/Communications* – No shutdown. No major impact on information or communications infrastructure. • *Transportation* – Delays for 1-3 days. Public mobility will be severely impacted in the immediate aftermath of the hazard event. Major transportation arteries will be closed, and diverted traffic will cause extensive delays. Emergency vehicles will have difficulty reaching the scene. Localized transportation delays will last for several days.
RESPONSE CAPACITY	*Catastrophic*	• *Police* – Moderate need for state or federal assistance. • *Fire & Rescue* – Significant and long-lasting need for state or federal assistance. Response will strain local resources. Various mutual aid response operations will be necessary. • *Health* – Local resources adequate. Health Department operations will not be affected. • *Hospitals* – Mutual aid needed. Patient surge would put some strain on the Emergency Department, but there would be no great impact on hospital emergency functions. • *Emergency Management* – Local resources adequate. Limited impact to Emergency Management capability.
ENVIRONMENTAL IMPACT	*Significant*	• Significant environmental impact. Some loss of species, vegetation, and short term pollution is likely. Limited air pollution may result from the burning of petroleum hydrocarbons and synthetic materials. Hazardous liquid spills may cause soil contamination and water pollution. The water pollution may kill aquatic life in the nearby waterways. The soil contamination and water pollution may have impacts beyond the immediately affected area if the leak is located within the Patuxent Reservoirs watershed (a surface drinking water supply source) or the recharge area of a groundwater drinking water supply source.
ECONOMIC IMPACT	*Significant*	• $13.5 million in lost economic output. Other costs include cleanup and healthcare for those affected. • 109 jobs lost. • Businesses will be impacted in the wider crash area.
TOTAL IMPACT	*Significant - Critical*	• Total Impact Score: 2.75 on a scale of 1 (Limited) to 4 (Catastrophic).
Limited	*Significant*	*Critical*	*Catastrophic*

Consequence Analysis: Public Perception

The Consequence Analysis: Public Perception table characterizes public perceptions of each hazard. Details include public confidence in personal ability to respond to each hazard, public confidence in Howard County's ability to respond to each hazard, and each hazard's perceived impact to personal safety and standard of living.

Transportation Hazard Public Perceptions			
PERCEIVED CONFIDENCE IN HOWARD COUNTY'S ABILITY TO RESPOND AND RECOVER FROM THIS HAZARD	**PERCEIVED CONFIDENCE IN PERSONAL ABILITY TO PROTECT SELF AND FAMILY FROM THIS HAZARD**	**CONCERN OVER THE IMPACT TO PERSONAL HEALTH AND SAFETY IF THIS HAZARD WERE TO OCCUR LOCALLY**	**CONCERN OVER THE IMPACT TO PERSONAL STANDARD OF LIVING / QUALITY OF LIFE IF THIS HAZARD WERE TO OCCUR LOCALLY**
			
Average: 1.48 *High - Moderate*	*Average: 2.27* *Moderate - Low*	*Average: 2.44* *Mildly Concerned - Somewhat Concerned*	*Average: 2.24* *Mildly Concerned*

Unintentional Chemical Substance Release/Hazmat

I. OVERVIEW

The Overview section defines the hazard and summarizes the hazard risk profile.

Definition

This section defines the scope of the hazard category. The terminology and characterization established in this section should be consistent throughout all Howard County planning documents.

An Unintentional Chemical Substance Release/Hazmat hazard occurs when a chemical with the potential to cause harm is accidentally released into the environment. Hazardous materials come in the form of explosives, flammable and combustible substances, and poisons (biological hazards and radiological hazards are profiled separately).[1,2]

Risk Profile

The Risk Profile section presents the Risk Score for the hazard in a range from 1 (lowest risk) to 4 (highest risk). Risk Score is a function of Likelihood and Consequence.

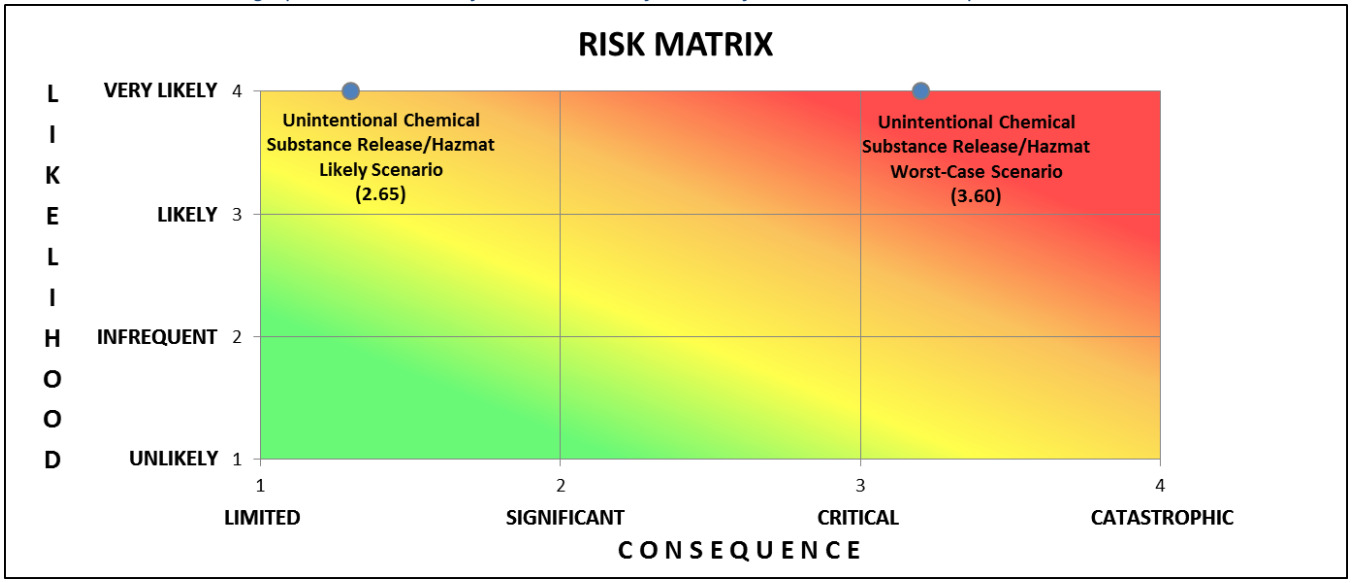
Unintentional Chemical Substance Release/Hazmat Risk Profile				
	Risk Assessment Category	**Likely Hazard Scenario**	**Worst-Case Hazard Scenario**	**Weight**
LIKELIHOOD	**Likelihood**	4.00* Very Likely		50%
CONSEQUENCE	**Impact**	1.00 Limited	3.13 Critical-Catastrophic	40%
	Warning Time	4 Short	4 Short	5%
	Duration	1 Short	3 Long	5%
TOTAL RISK SCORE		**2.65**	**3.60**	

[1] For additional information see *Chemical Emergencies Overview,* CDC. Available at http://www.bt.cdc.gov/chemical/overview.asp (last accessed March 26, 2014).
[2] For additional information see *Hazardous Materials Incidents,* FEMA. Available at http://www.ready.gov/hazardous-materials-incidents (last accessed March 26, 2014).

**The Likelihood Score reflects the likelihood of any emergency-level hazard event and does not differentiate between Likely and Worst-Case scenarios.*

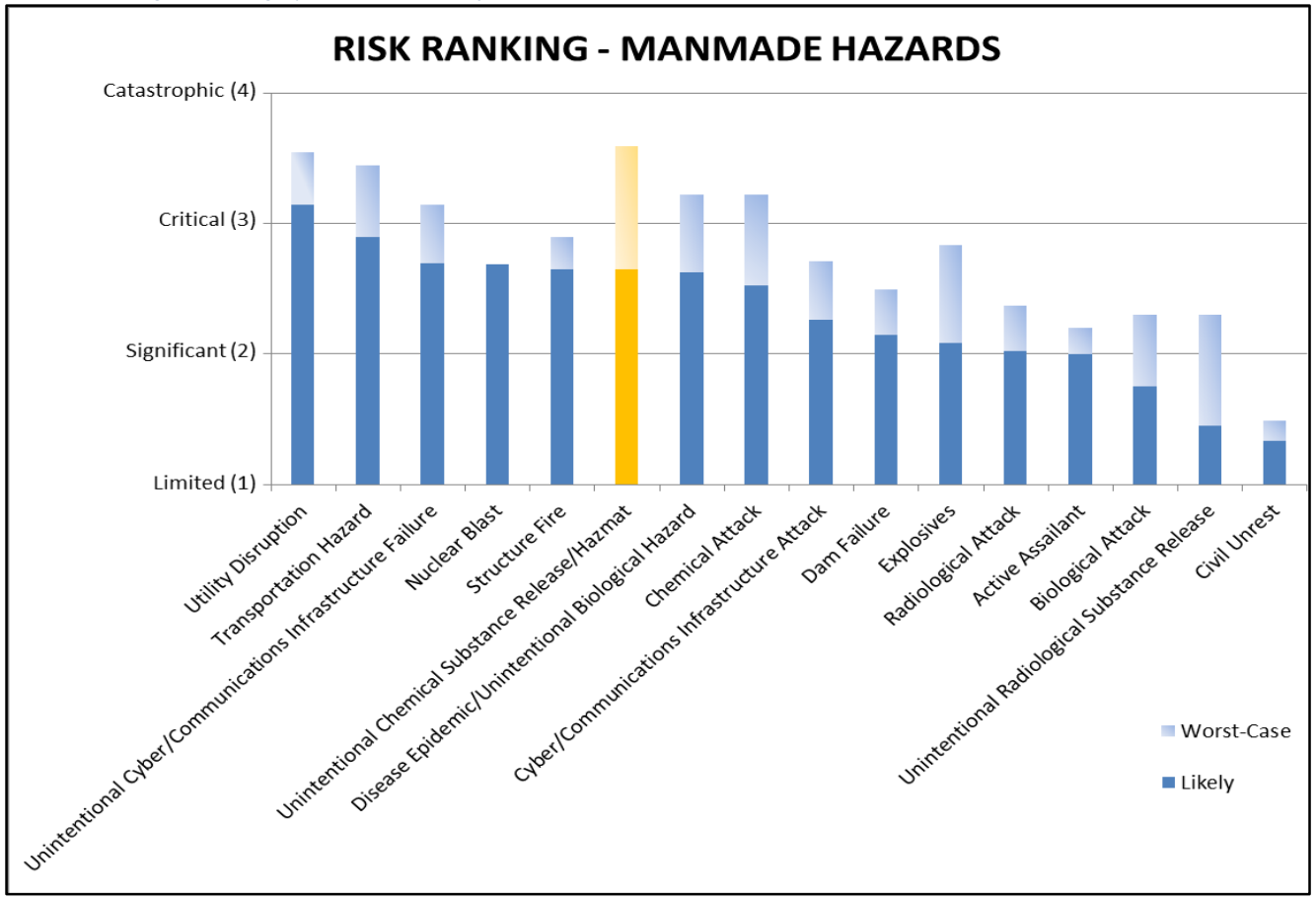
Risk Matrix

The Risk Matrix chart is a graphical illustration of hazard Risk as a function of Likelihood and Consequence.



Risk Ranking

The Risk Ranking chart is a graphical illustration of hazard Risk as it relates to other hazards.



Where no Worst-Case bar is visible, Worst-Case Risk is equivalent to Likely Risk.

II. HAZARD CHARACTERISTICS

The Hazard Characteristics section provides a detailed characterization of the hazard and the local context as it relates to the hazard.

Description of the Hazard

An Unintentional Chemical Substance Release/Hazmat hazard can occur in an industrial setting or as the result of a transportation accident. Many hazardous chemicals are used in industry, and accidental exposure to these chemicals may occur if they are not stored correctly, if safety controls malfunction, or if safety procedures are not followed. Hazardous chemicals are also commonly transported by trucks and rail, and transportation accidents involving hazardous chemicals can result in an hazard. Hazardous chemicals are even present in a controlled form in many commercial areas, schools, and homes. Hazardous chemicals are frequently directly toxic to humans, and they may also be highly combustible, explosive, or corrosive.[1,2]

It is rare to have any advanced warning of an unintentional chemical substance release.

The size of the area affected by an Unintentional Chemical Substance Release depends on the specific chemical agent and the way it was introduced into the environment. A small-scale chemical release may not extend beyond the initial spill area, while a large release that introduces a hazardous chemical into the air or water can impact many square miles. Industrial sites and transportation zones where some of the most hazardous chemicals are found may not be densely populated. However, hazardous chemicals from these incidents can easily reach more populated areas, especially if plumes are spread by the wind or hazardous materials contaminate a water source.

The severity of illness associated with an Unintentional Chemical Substance Release depends greatly on the specific chemical agent and the size of the exposure dose. Many chemical agents result in short-term pain, discomfort, and disorientation. However, inhalation or skin absorption of many chemical agents can cause permanent health problems or death.

Hazardous chemicals require special care to remove from the environment. Many chemical hazards can be neutralized using existing hazmat equipment. However, in the case of large-scale environmental contamination, chemical removal equipment needs may extend beyond what is readily available.

The duration of an Unintentional Chemical Substance Release/Hazmat hazard also depends greatly on the chemical agent involved and the way it was released into the environment. Most health effects from an Unintentional Chemical Substance Release occur in the minutes immediately following the attack. However, it can be extremely time consuming to remove some types of chemical hazards from the environment. Certain types of chemicals may cause a location to be hazardous for days or weeks following the initial attack.

Local Context

The Local Context section describes community attributes that affect the likelihood of the hazard's occurrence or vulnerability to the hazard's consequences.

Unintentional Chemical Substance Release/Hazmat hazards are most likely to occur in areas where hazardous chemicals are frequently kept or transported. Hazardous chemicals are transported regularly through Howard County, making areas near railways and major roadways particularly vulnerable to Unintentional Chemical Substance Release/Hazmat hazards. Other vulnerable locations in Howard County include areas in close proximity to industrial and research facilities where hazardous chemicals are used.[3]

[3] *Manmade Hazard Identification and Risk Assessment Workshop (unpublished)*, Howard County OEM (2014).

III. LIKELIHOOD ANALYSIS

The Likelihood Analysis section characterizes the historical occurrence and future likelihood of the hazard in the planning area.

Occurrence of the Hazard

The Occurrence of the Hazard section details the historical occurrence of the hazard in the planning area.

There have been 421 Unintentional Chemical Substance Release/Hazmat hazard responses involving chemical release, chemical reaction, or toxic conditions in Howard County during the reviewed time period (2008-2013). There were an additional 2,247 responses involving combustible/flammable liquid spills during this same time period, although this number includes minor leaks involving little contamination or damage.[4]

Notable Incidents in Howard County

A large percentage of Unintentional Chemical Substance Release/Hazmat hazard events in Howard County involve hydrocarbon spills such as oil, gasoline, or diesel fuel. Unintentional Chemical Substance Release/Hazmat hazards are also common in a household setting and typically involve the accidental release of mercury or other household chemicals.

Future Likelihood of the Hazard for Howard County

The Future Likelihood section anticipates the future occurrence rate of the hazard based on historical likelihood and future trends. This section also addresses factors that may cause the future likelihood to deviate from historical trends.

Future Likelihood of an Unintentional Chemical Substance Release/Hazmat Hazard in Howard County	
Historical Average (time period)	84 events every year (2008-2013)
Historical Annual Probability	100% chance of annual occurrence
Future Likelihood Expected to Deviate from Historical Likelihood (Yes/No)	No
Future Annual Probability	100% chance of annual occurrence
Future Likelihood Score	4.00 (Very Likely)
Future Likelihood reflects the likelihood of any emergency-level hazard event and does not differentiate between Likely and Worst-Case scenarios.	

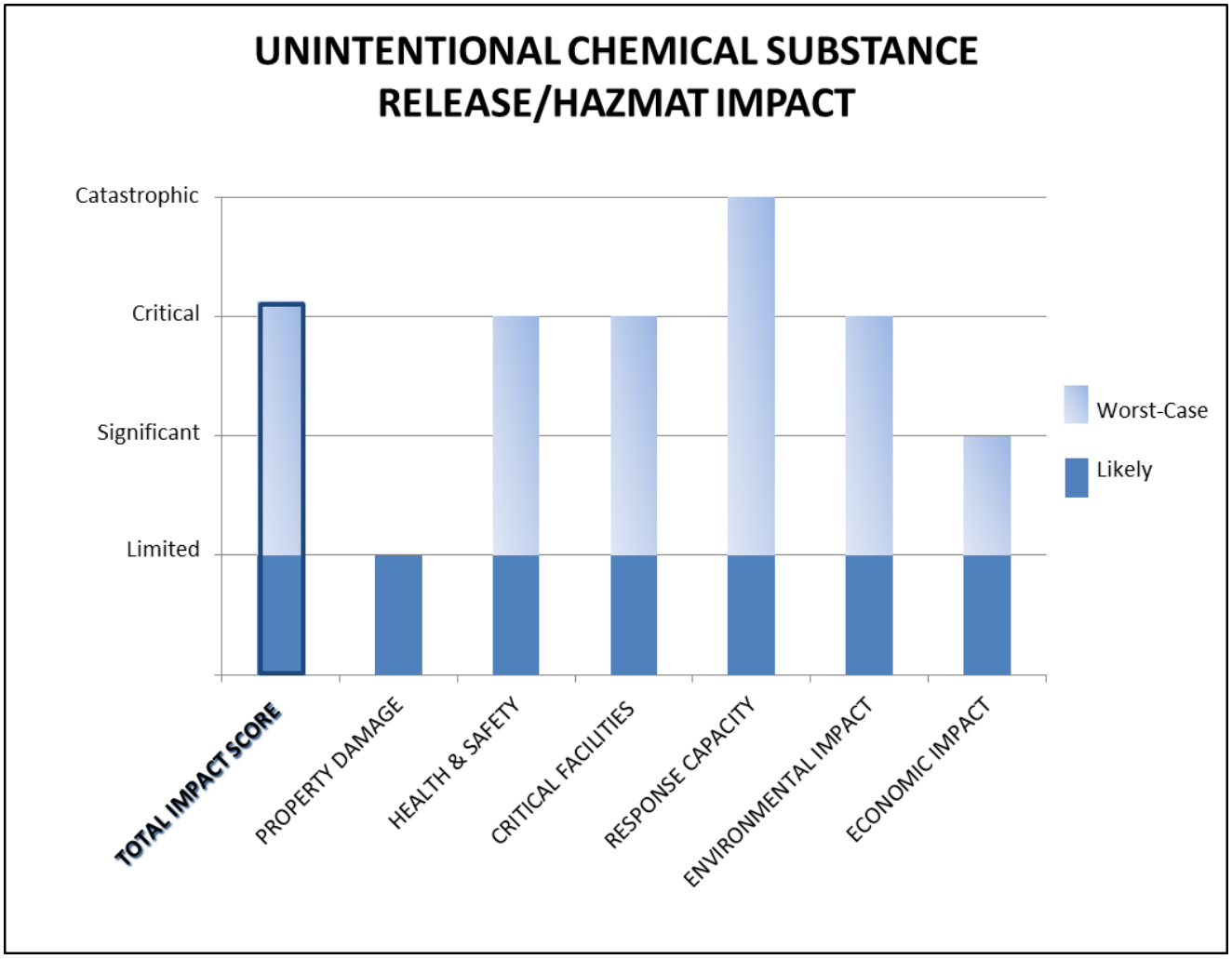
Considerations: The future likelihood of an Unintentional Chemical Release/Hazmat hazard in Howard County is not expected to be significantly different from the historical occurrence rate. A future annual probability of 100% classifies the likelihood of an Unintentional Chemical Substance Release/Hazmat hazard as Very Likely. Increases in traffic, increases in population, and deterioration of infrastructure will result in a slight increase in likelihood over time.3

[4] *Howard County CAD Report 1/01/2008 – 12/31/2013 (unpublished)*, Howard County DFRS (2014).

IV. CONSEQUENCE ANALYSIS

The Consequence Analysis section provides a detailed characterization of the anticipated consequences of likely and worst-case hazard events. This section characterizes impacts to property, health & safety, critical facilities, response capacity, the environment, and the economy. This section also characterizes public perceptions of each hazard, the perceived impact to personal safety and standard of living, and public confidence in response capability.

Consequence Analysis Overview



Where no Worst-Case bar is visible, Worst-Case impact is equivalent to Likely impact.

Unintentional Chemical Substance Release/Hazmat Hazard Warning Time & Duration		
	Likely	**Worst-Case**
WARNING TIME	*Short.* No warning time prior to the onset of the hazard.	*Short.* No warning time prior to the onset of the hazard.
DURATION	*Short.* Hazard onset is nearly instantaneous. It may take 1-2 hours to declare the hazard location safe.	*Long.* Location may be extremely hazardous for up to 12 hours. It may take days or weeks to stabilize environmental contamination and declare the hazard location safe.

Consequence Analysis: Likely Hazard Scenario

The Consequence Analysis table details the anticipated consequences of the most likely hazard scenario.

Unintentional Chemical Substance Release/Hazmat Hazard Consequence Analysis Likely		
PROPERTY DAMAGE	*Limited*	• 0% damage to critical and non-critical infrastructure. • Anything beyond superficial damage to buildings and structures is unlikely.
HEALTH & SAFETY	*Limited*	• 0 deaths likely. • 1-3 injuries likely. • Deaths and injuries depend on the nature of the chemical agent and may include neurological effects and/or respiratory failure.
CRITICAL FACILITIES	*Limited*	• *Utilities* – Shutdown unlikely. No effect on utilities. • *Information/Communications* – Shutdown unlikely. No major impact on information or communications infrastructure. • *Transportation* – Shutdown unlikely. Impacts to transportation will be minor and short-term.
RESPONSE CAPACITY	*Limited*	• *Police* – Local resources adequate. • *Fire & Rescue* – Local Resources Adequate. The hazard may tie up local hazardous materials response resources for several hours. Mutual aid coverage is readily available to maintain Continuity of Operations if there is a need for additional resources within the jurisdiction. • *Health* – Local resources adequate. Health Department operations will not be affected. • *Hospitals* – Local resources adequate. No impact on the hospital system. • *Emergency Management* – Local resources adequate. Limited impact to Emergency Management capability.
ENVIRONMENTAL IMPACT	*Limited*	• Limited to no environmental impact. Less than a day of clean-up. Impact to a localized area.
ECONOMIC IMPACT	*Limited*	• Minimal loss of economic output due to the limited area affected. Other costs include cleanup and healthcare for those affected. • 0 jobs lost. • Economic impact factors may include press coverage and public avoidance of area businesses surrounding impacted location.
TOTAL IMPACT	*Limited*	• Total Impact Score: 1.00 on a scale of 1 (Limited) to 4 (Catastrophic).
Limited	*Significant*	*Critical*	*Catastrophic*

Consequence Analysis: Worst-Case Hazard Scenario

The Consequence Analysis: Worst-Case table details the anticipated consequences of the worst-case hazard scenario.

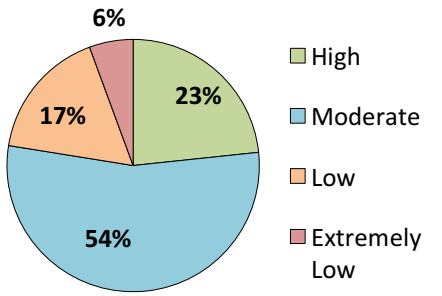
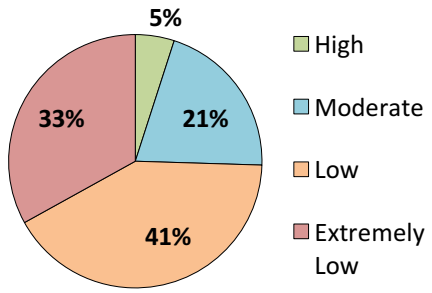
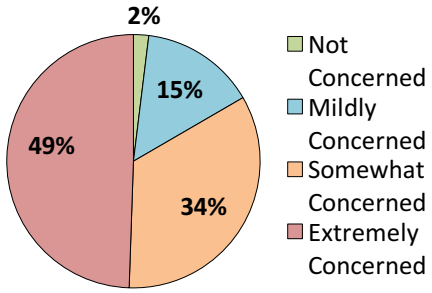
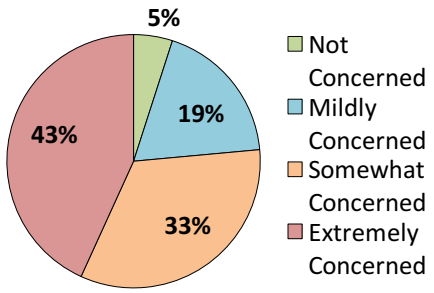
Unintentional Chemical Substance Release/Hazmat Hazard Consequence Analysis Worst-Case		
PROPERTY DAMAGE	*Limited*	• 0% damage to critical and non-critical infrastructure. • Anything beyond superficial damage to buildings and structures is unlikely.
HEALTH & SAFETY	*Critical*	• 10-50 deaths likely. • 100-300 injuries likely. • Deaths and injuries depend on the nature of the chemical agent and may include respiratory effects due to inhalation of toxic fumes/gases.
CRITICAL FACILITIES	*Critical*	• *Utilities* – Disruptions for up to 1 month. Water contamination may result in an extended shutdown of wastewater treatment plants for up to 1 month. Drains and toilets will continue to function, but sewage will be released into rivers. • *Information/Communications* – No shutdown. No major impact on information or communications infrastructure. • *Transportation* – Delays for less than one day. Public mobility will be severely impacted, but delays will not last longer than one day. Major transportation arteries will be closed, and diverted traffic will cause extensive delays. Emergency vehicles will have difficulty arriving on scene.
RESPONSE CAPACITY	*Catastrophic*	• *Police* – Mutual aid needed. • *Fire & Rescue* – Significant and long-lasting need for state or federal assistance. There will likely be a long-lasting impact to hazardous materials response capabilities. EMS resources will be overwhelmed. Significant mutual aid assistance will be required to maintain regular service. • *Health* – Significant and long-lasting need for state or federal assistance. Essential Health Department operations will be affected. Health Emergency Preparedness, Communicable Diseases, Community Health, and Environmental Health functions will be impacted the greatestdue to emergency response. • *Hospitals* – Moderate need for state or federal assistance. Agent-specific medical supplies are likely available at the hospital for many common chemical agents (federal resources maintained on-location in Howard County). If the incident involves an exotic chemical, then additional state or federal support may be necessary. The emergency room will not be capable of handling the patient surge, resulting in Emergency Department closure and the need to divert patients to alternate facilities. Fatality management will also be a challenge for the hospital and others in the region. The hospital has no ability to decontaminate walk-ins, and protecting the facility from contamination will be a primary concern. A large turnout of psychological casualties (walking well) will further strain hospital systems. Decontamination activities and sufficient hospital security measures may not be possible without County support. • *Emergency Management* – Mutual aid needed. Support may be needed to cover Emergency Management staffing during the planning process, hazmat cleanup, sheltering efforts, investigation follow-up, and public information effort. Continued planning may necessitate double shifts.
ENVIRONMENTAL IMPACT	*Critical*	• Critical environmental impact. Long-term pollution and contamination is likely. Loss of species may occur. Environmental resources are renewable but only after some time. The chemical release will cause immediate contamination of the air, water, and soil. Air contamination will continue until the hazardous materials have been removed, dispersed, and/or diluted. Water and soil contamination may continue at hazardous levels for days or weeks. Chemicals that can kill or debilitate humans may also kill or debilitate other animal life in the area. The water and soil contamination may have impacts beyond the immediately contaminated area if the contamination is located within the Patuxent Reservoirs watershed (a surface drinking water supply source) or the recharge area of a groundwater drinking water supply source.
ECONOMIC IMPACT	*Significant*	• $9.1 million in lost economic output. Other costs include cleanup and healthcare for those affected. • 74 jobs lost. • Business activities will cease in the area around the hazard location. Business and job retention depend on recovery efforts. Loss of income and productivity are likely. Damage to the Howard County image is possible.
TOTAL IMPACT	*Critical-Catastrophic*	• Total Impact Score: 3.13 on a scale of 1 (Limited) to 4 (Catastrophic).

Limited	*Significant*	*Critical*	*Catastrophic*

Consequence Analysis: Public Perception

The Consequence Analysis: Public Perception table characterizes public perceptions of each hazard. Details include public confidence in personal ability to respond to each hazard, public confidence in Howard County's ability to respond to each hazard, and each hazard's perceived impact to personal safety and standard of living.

Unintentional Chemical Substance Release/Hazmat Hazard
Public Perceptions

PERCEIVED CONFIDENCE IN HOWARD COUNTY'S ABILITY TO RESPOND AND RECOVER FROM THIS HAZARD	PERCEIVED CONFIDENCE IN PERSONAL ABILITY TO PROTECT SELF AND FAMILY FROM THIS HAZARD	CONCERN OVER THE IMPACT TO PERSONAL HEALTH AND SAFETY IF THIS HAZARD WERE TO OCCUR LOCALLY	CONCERN OVER THE IMPACT TO PERSONAL STANDARD OF LIVING / QUALITY OF LIFE IF THIS HAZARD WERE TO OCCUR LOCALLY
			
Average: 2.05 *Moderate*	*Average: 3.03* *Low*	*Average: 3.31* *Extremely Concerned - Somewhat Concerned*	*Average: 3.15* *Somewhat Concerned*

Unintentional Cyber/Communications Infrastructure Failure

I. OVERVIEW

The Overview section defines the hazard and summarizes the hazard risk profile.

Definition

This section defines the scope of the hazard category. The terminology and characterization established in this section should be consistent throughout all Howard County planning documents.

An Unintentional Cyber/Communications Infrastructure Failure hazard occurs when an accidental disruption affects computerized data, information systems, or other communication systems. Unintentional failure may result from human error, infrastructure limitations, or the cascading effects of another hazard.

Risk Profile

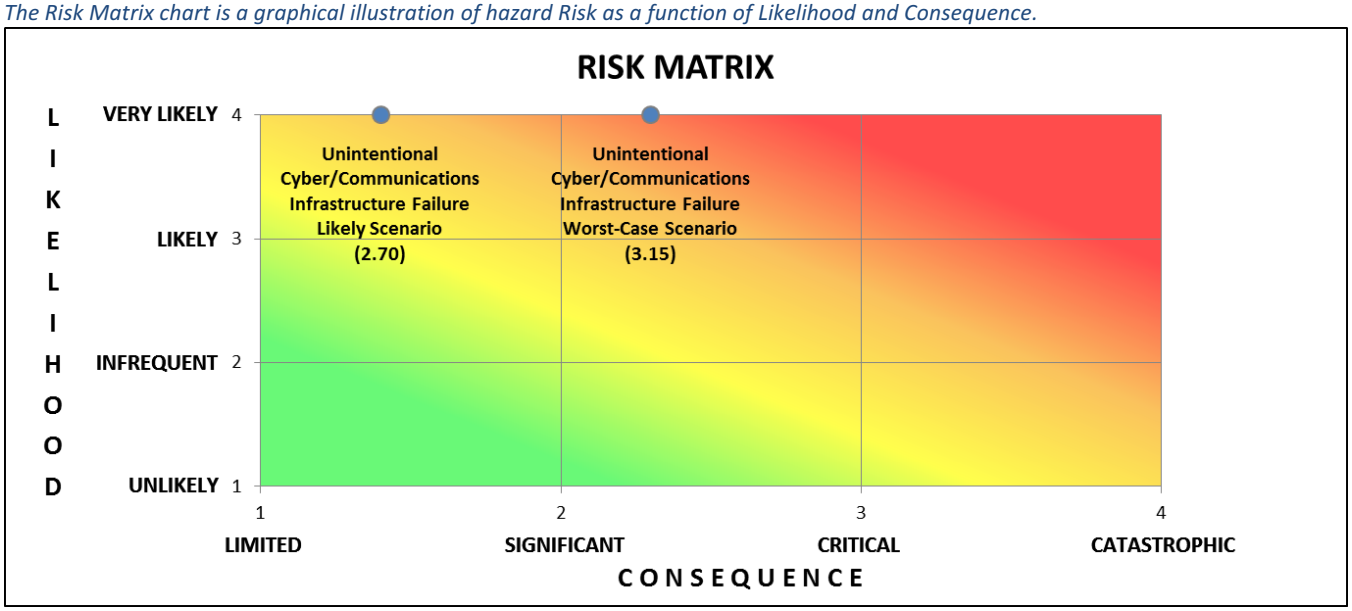
The Risk Profile section presents the Risk Score for the hazard in a range from 1 (lowest risk) to 4 (highest risk). Risk Score is a function of Likelihood and Consequence.

Unintentional Cyber/Communications Infrastructure Failure Risk Profile				
	Risk Assessment Category	**Likely Hazard Scenario**	**Worst-Case Hazard Scenario**	**Weight**
LIKELIHOOD	**Likelihood**	4.00* Very Likely		50%
CONSEQUENCE	**Impact**	1.13 Limited-Significant	2.00 Significant	40%
	Warning Time	4 Short	4 Short	5%
	Duration	1 Short	3 Long	5%
TOTAL RISK SCORE		**2.70**	**3.15**	

**The Likelihood Score reflects the likelihood of any emergency-level hazard event and does not differentiate between Likely and Worst-Case scenarios.*

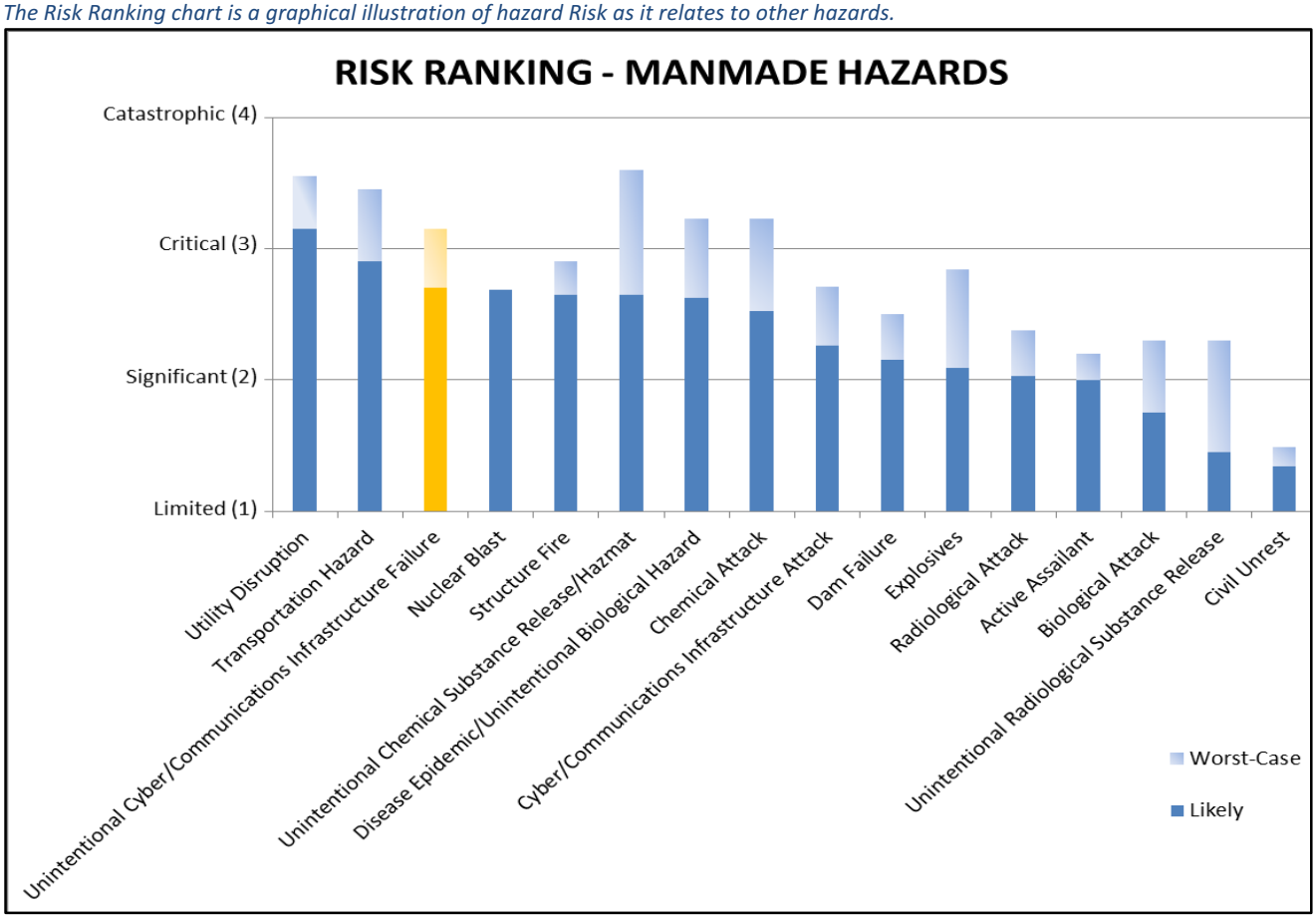
Risk Matrix

The Risk Matrix chart is a graphical illustration of hazard Risk as a function of Likelihood and Consequence.



Risk Ranking

The Risk Ranking chart is a graphical illustration of hazard Risk as it relates to other hazards.



Where no Worst-Case bar is visible, Worst-Case Risk is equivalent to Likely Risk.

II. HAZARD CHARACTERISTICS

The Hazard Characteristics section provides a detailed characterization of the hazard and the local context as it relates to the hazard.

Description of the Hazard

Unintentional Cyber/Communications Infrastructure Failures can compromise the integrity or availability of computerized information or information systems. A failure may range from a localized information or communication system outage to a large-scale data loss and disruption of communication infrastructure. Unintentional Cyber/Communications Infrastructure Failures can also affect physical infrastructure and cause "beyond the computer" harm to people, property, operational capacity, or the environment.

It is rare to have any advanced warning of an Unintentional Cyber/Communications Infrastructure Failure, and the area affected can vary greatly. Failures can range from a single computer outage to a complete data network outage spanning multiple jurisdictions.

Unintentional Cyber/Communications Infrastructure Failures can impact a community in a variety of ways. Failures commonly result in the damage or loss of information, including important personal, commercial, financial, or governmental data. Unintentional Cyber/Communications Infrastructure Failures can also result in physical consequences stemming from problems such as lost or inaccurate medical data or disruptions in emergency radio and 911 call center operations.

Depending on the size and scope of the failure, the duration of an Unintentional Cyber/Communications Infrastructure Failure may range from several hours to several days.

Local Context

The Local Context section describes community attributes that affect the likelihood of the hazard's occurrence or vulnerability to the hazard's consequences.

An Unintentional Cyber/Communications Infrastructure Failure hazard may occur anywhere that relies on electronic information and communications systems. All of Howard County is susceptible to the effects of a failure. Vulnerability to the consequences of an Unintentional Cyber/Communications Infrastructure Failure increases as essential functions become increasingly reliant on electronic information and communications systems.[1]

[1] *Manmade Hazard Identification and Risk Assessment Workshop (unpublished)*, Howard County OEM (2014).

III. LIKELIHOOD ANALYSIS

The Likelihood Analysis section characterizes the historical occurrence and future likelihood of the hazard in the planning area.

Occurrence of the Hazard

The Occurrence of the Hazard section details the historical occurrence of the hazard in the planning area.

There have been 6 emergency-level Unintentional Cyber/Communications Infrastructure Failure hazards in Howard County during the reviewed time period (2009-2014).

Notable Incidents in Howard County

2013 Radio Systems Outage – While completing regular maintenance on the power supply, a radio tower was taken offline. Emergency response organizations in that tower area lost ability to communicate by radio (roughly 10% of Howard County). Police and Fire/Rescue were forced to use alternate communications methods. Radio was restored in less than two hours.

2012 Radio Systems Outage – Equipment on a radio tower became damaged in high winds. The damage created radio dead spots in the tower area. Nearly one week passed before the damage was entirely repaired.

2010 911 Call Center Outage – While relocating the 911 Center, 911 communications lines were severed unintentionally. Howard County citizens were unable to reach 911 until calls were successfully rerouted to a backup call center 45 minutes later. Essential 911 functions were carried out by the backup call center, but several days passed before Howard County 911 infrastructure was restored.

Future Likelihood of the Hazard for Howard County

The Future Likelihood section anticipates the future occurrence rate of the hazard based on historical likelihood and future trends. This section also addresses factors that may cause the future likelihood to deviate from historical trends.

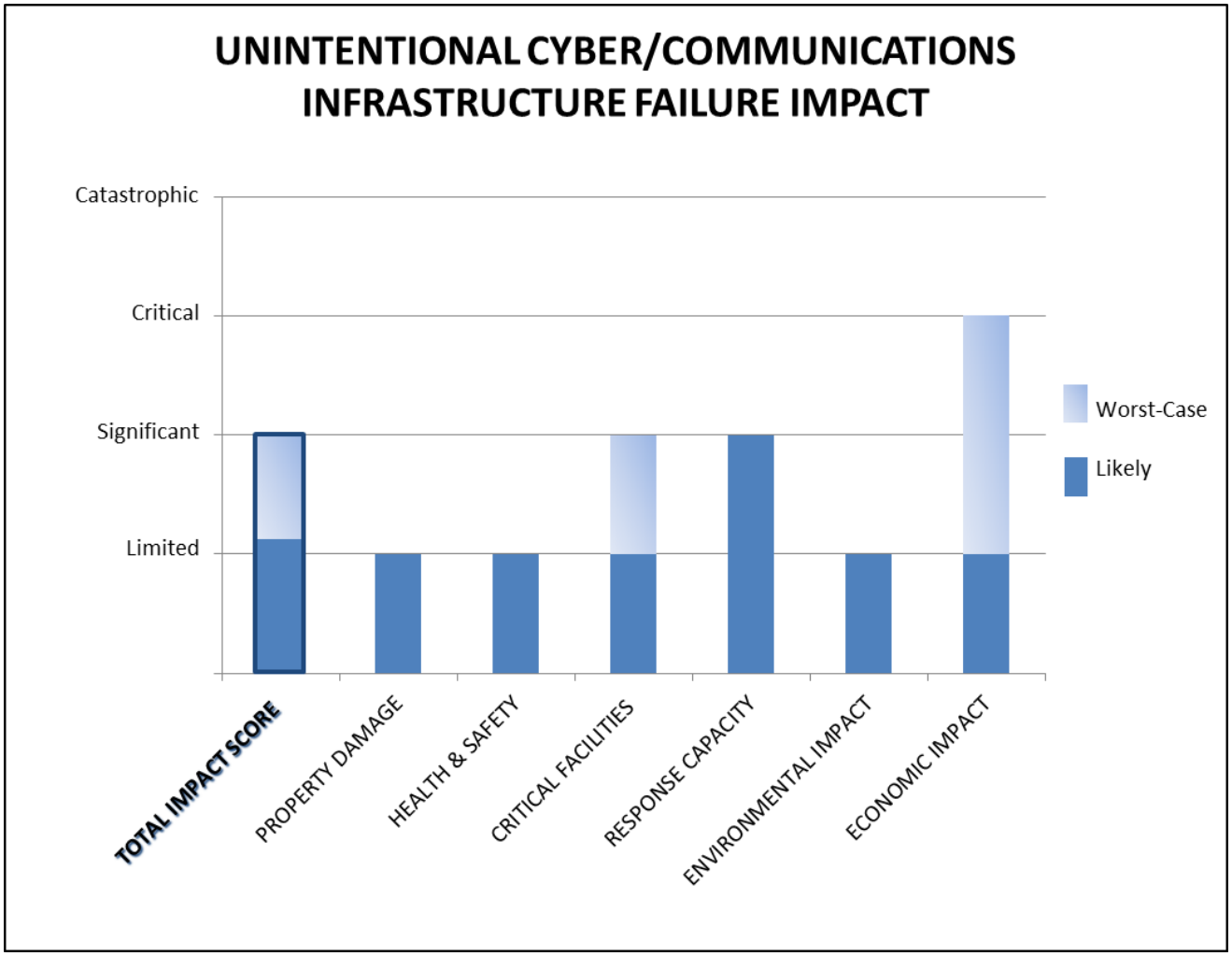
Future Likelihood of an Unintentional Cyber/Communications Infrastructure Failure Hazard in Howard County	
Historical Average (time period)	1.2 events every year (2009-2014)
Historical Annual Probability	100% chance of annual occurrence
Future Likelihood Expected to Deviate from Historical Likelihood (Yes/No)	No
Future Annual Probability	100% chance of annual occurrence
Future Likelihood Score	4.00 (Very Likely)
Future Likelihood reflects the likelihood of any emergency-level hazard event and does not differentiate between Likely and Worst-Case scenarios.	

Considerations: The future likelihood of an Unintentional Cyber/Communications Infrastructure Failure in Howard County is not expected to be significantly different from the historical occurrence rate. A future annual probability of 100% classifies the likelihood of an Unintentional Cyber/Communications Infrastructure Failure as Very Likely. Rapid advances in technology and an increased reliance on electronic information systems will result in a slight increase in likelihood over time.1

IV. CONSEQUENCE ANALYSIS

The Consequence Analysis section provides a detailed characterization of the anticipated consequences of likely and worst-case hazard events. This section characterizes impacts to property, health & safety, critical facilities, response capacity, the environment, and the economy. This section also characterizes public perceptions of each hazard, the perceived impact to personal safety and standard of living, and public confidence in response capability.

Consequence Analysis Overview



Where no Worst-Case bar is visible, Worst-Case impact is equivalent to Likely impact.

Unintentional Cyber/Communications Infrastructure Failure Warning Time & Duration		
	Likely	**Worst-Case**
WARNING TIME	*Short.* No warning time prior to the onset of the hazard.	*Short.* No warning time prior to the onset of the hazard.
DURATION	*Short.* 2 hours to restore all damaged systems.	*Long.* 36 hours to complete a limited restore of damaged information/communications functions. Up to 1 month to restore all damaged systems.

Consequence Analysis: Likely Hazard Scenario

The Consequence Analysis table details the anticipated consequences of the most likely hazard scenario.

Unintentional Cyber/Communications Infrastructure Failure Consequence Analysis Likely		
PROPERTY DAMAGE	*Limited*	• 0% damage to critical and non-critical infrastructure. • Anything beyond superficial damage to buildings and structures is unlikely.
HEALTH & SAFETY	*Limited*	• 0 deaths likely. • 0 injuries likely. • Deaths and injuries from an Unintentional Cyber/Communications Infrastructure Failure are very unlikely.
CRITICAL FACILITIES	*Limited*	• *Utilities* – Shutdown unlikely. No effect on utilities. • *Information/Communications* – Essential functions will be restored within several hours. Radio capacity may be diminished, and mobile data computers used by response organizations may lose connectivity for several hours. • *Transportation* – Shutdown unlikely. Transportation routes will not be impacted.
RESPONSE CAPACITY	*Significant*	• *Police* – Local resources adequate. No significant impact on response capability or Continuity of Operations. • *Fire & Rescue* – Mutual aid needed. Mutual aid support may be needed to provide mobile command units with alternate communications capabilities. Response times could be delayed during a radio or communications outage. • *Health* – Local resources adequate. Health Department operations will not be affected. • *Hospitals* – Local resources adequate. No impact on the hospital system. • *Emergency Management* – Local resources adequate. Limited impact to Emergency Management capability.
ENVIRONMENTAL IMPACT	*Limited*	• Little to no environmental impact.
ECONOMIC IMPACT	*Limited*	• Minimal loss of economic output due to the limited area affected. Other costs include cleanup and healthcare for those affected. • 0 jobs lost.
TOTAL IMPACT	*Limited-Significant*	• Total Impact Score: 1.13 on a scale of 1 (Limited) to 4 (Catastrophic).
Limited	*Significant*	*Critical*	*Catastrophic*

Consequence Analysis: Worst-Case Hazard Scenario

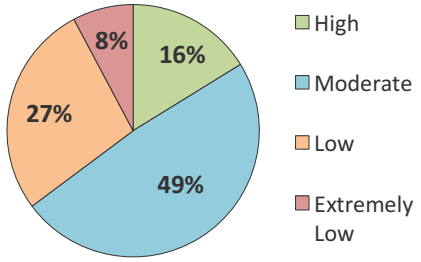
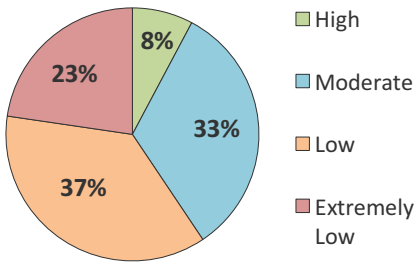
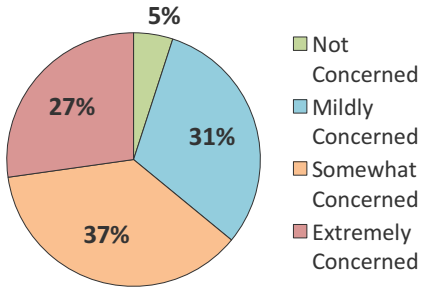
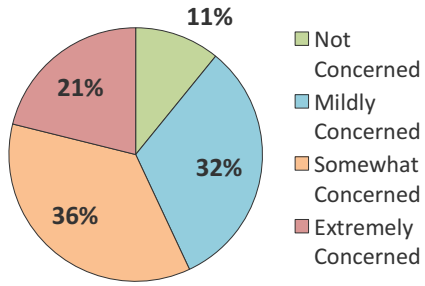
The Consequence Analysis: Worst-Case table details the anticipated consequences of the worst-case hazard scenario.

Unintentional Cyber/Communications Infrastructure Failure Consequence Analysis Worst-Case		
PROPERTY DAMAGE	*Limited*	• 0% damage to critical and non-critical infrastructure. • Anything beyond superficial damage to buildings and structures is unlikely.
HEALTH & SAFETY	*Limited*	• 0 deaths likely. • 0 injuries likely. • Deaths and injuries from an Unintentional Cyber/Communications Infrastructure Failure are very unlikely.
CRITICAL FACILITIES	*Significant*	• *Utilities* – Shut down less than one day. Utilities response may be slowed, but all essential functions will continue. • *Information/Communications* – Calls to the 911 call center may be disrupted for up to one hour. Radio communications may be nonfunctional (or function in a reduced capacity) for up to 48 hours. • *Transportation* – Shutdown unlikely. Transportation routes will not be impacted.
RESPONSE CAPACITY	*Significant*	• *Police* – Local resources adequate. No significant impact on response capability or Continuity of Operations. • *Fire & Rescue* – Mutual aid needed. Mutual aid support may be needed to provide mobile command units with alternate communications capabilities. Response times may be delayed during a radio or communications outage. Limited access to maps may delay response times. Payroll and administrative functions may not be operational, but this will have no major impact on response capability. • *Health* – Local resources adequate. Health Department operations will not be affected. • *Hospitals* – Mutual aid needed. Outage of hospital data systems will have a significant impact on hospital services. Many essential hospital services will be entirely unavailable during a network/internet outage. Basic patient treatment will continue, but diagnostic imaging, lab, and other data-dependent services will cease to function. Patient flow will be slowed considerably. • *Emergency Management* – Local resources adequate. Limited impact to Emergency Management capability.
ENVIRONMENTAL IMPACT	*Limited*	• Limited to no direct environmental impact. Prolonged outage of communications systems may result in delays for some environmental protection services, but the extent of secondary environmental consequences is difficult to predict.
ECONOMIC IMPACT	*Critical*	• $147.7 million in lost economic output. Other costs include cleanup and healthcare for those affected. • 1,195 jobs lost. • Network/internet outages will have significant impact on local business vendors.
TOTAL IMPACT	*Significant*	• Total Impact Score: 2.00 on a scale of 1 (Limited) to 4 (Catastrophic).
Limited	*Significant*	*Critical*	*Catastrophic*

Consequence Analysis: Public Perception

The Consequence Analysis: Public Perception table characterizes public perceptions of each hazard. Details include public confidence in personal ability to respond to each hazard, public confidence in Howard County's ability to respond to each hazard, and each hazard's perceived impact to personal safety and standard of living.

Unintentional Cyber/Communications Infrastructure Failure
Public Perceptions

PERCEIVED CONFIDENCE IN HOWARD COUNTY'S ABILITY TO RESPOND AND RECOVER FROM THIS HAZARD	PERCEIVED CONFIDENCE IN PERSONAL ABILITY TO PROTECT SELF AND FAMILY FROM THIS HAZARD	CONCERN OVER THE IMPACT TO PERSONAL HEALTH AND SAFETY IF THIS HAZARD WERE TO OCCUR LOCALLY	CONCERN OVER THE IMPACT TO PERSONAL STANDARD OF LIVING / QUALITY OF LIFE IF THIS HAZARD WERE TO OCCUR LOCALLY
			
Average: 2.27 *Moderate - Low*	*Average: 2.74* *Low - Moderate*	*Average: 2.87* *Somewhat Concerned*	*Average: 2.68* *Somewhat Concerned - Mildly Concerned*

Unintentional Radiological Substance Release

I. OVERVIEW

The Overview section defines the hazard and summarizes the hazard risk profile.

Definition

This section defines the scope of the hazard category. The terminology and characterization established in this section should be consistent throughout all Howard County planning documents.

An Unintentional Radiological Substance Release hazard occurs when radiation is accidentally discharged into the environment. Unintentional Radiological Substance Release may occur as the result of a nuclear power plant accident, a transportation accident, or a workplace incident involving radioactive materials.[1]

Risk Profile

The Risk Profile section presents the Risk Score for the hazard in a range from 1 (lowest risk) to 4 (highest risk). Risk Score is a function of Likelihood and Consequence.

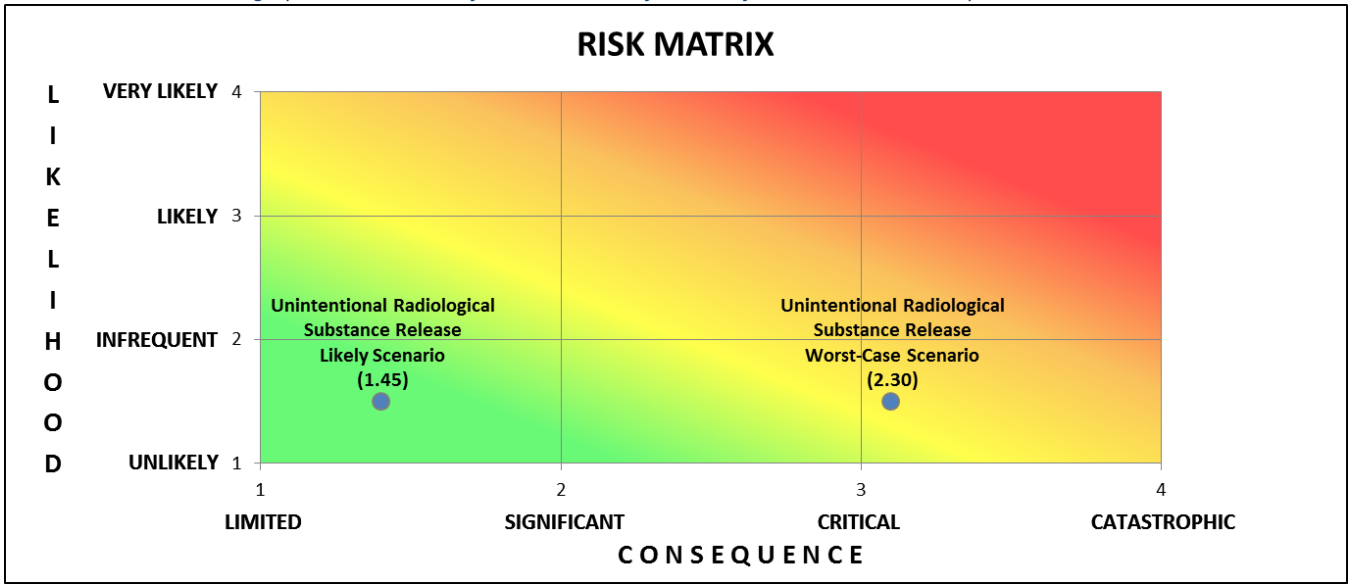
Unintentional Radiological Substance Release Risk Profile				
	Risk Assessment Category	**Likely Hazard Scenario**	**Worst-Case Hazard Scenario**	**Weight**
LIKELIHOOD	**Likelihood**	1.50* Unlikely-Infrequent		50%
CONSEQUENCE	**Impact**	1.00 Limited	3.00 Critical	40%
	Warning Time	4 Short	4 Short	5%
	Duration	2 Moderate	3 Long	5%
TOTAL RISK SCORE		**1.45**	**2.30**	

**The Likelihood Score reflects the likelihood of any emergency-level hazard event and does not differentiate between Likely and Worst-Case scenarios.*

[1] *More Information on Types of Radiation Emergencies,* CDC. Available at http://www.bt.cdc.gov/radiation/moretypes.asp#rdd (last accessed March 26, 2014).

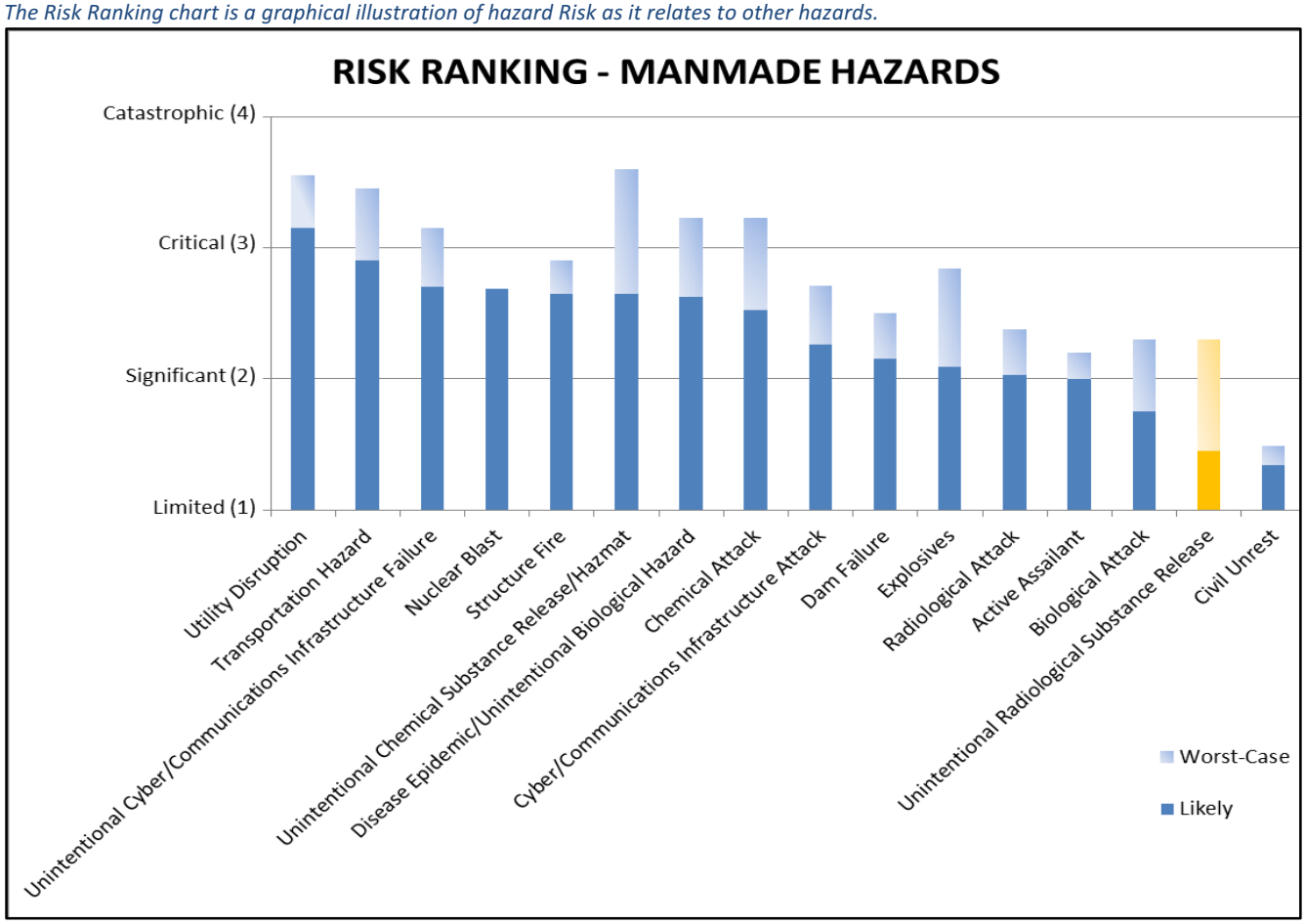
Risk Matrix

The Risk Matrix chart is a graphical illustration of hazard Risk as a function of Likelihood and Consequence.



Risk Ranking

The Risk Ranking chart is a graphical illustration of hazard Risk as it relates to other hazards.



Where no Worst-Case bar is visible, Worst-Case Risk is equivalent to Likely Risk.

II. HAZARD CHARACTERISTICS

The Hazard Characteristics section provides a detailed characterization of the hazard and the local context as it relates to the hazard.

Description of the Hazard

Radiological substances may be accidentally released into the environment in several different ways. An accident at a nuclear power plant can release a plume of dangerous radiation over an area. Radioactive materials in the plume can settle and contaminate people who are outdoors, buildings, food, water, and livestock. Radioactive materials are also commonly transported by trucks and rail, but transportation accidents involving radioactive material rarely result in significant exposure to radiation. Workplace radiation incidents may occur in health care facilities, research institutions, and industrial operations if radiation sources are not stored correctly, safety controls malfunction, or safety procedures are not followed.[1]

The area affected by an Unintentional Radiological Substance Release depends greatly on the mechanism of release. A small release may affect a relatively localized site or stretch of road around the release zone. A larger release can easily affect several square miles, especially if radioactive material is spread by wind or water. A major nuclear reactor release can affect many square miles.

Health effects from radiation exposure depend on several factors, including:

- The type and amount of radioactive material released.
- The length of time people were near the radioactive material, or the length of time the radioactive material was in or on the body.
- The proximity of individuals to the radioactive material or source of radiation.
- The parts of the body exposed to radiation.

The duration of an Unintentional Radiological Substance Release hazard depends greatly on the mechanism of release and the type and amount of radioactive material released into the environment. Following a small release of radiological substances, it can take up to 12 hours to remove the hazard and decontaminate the environment. Following a larger release, radiological materials can be present in heavy doses for up to up to 12 hours while water and soil contamination create an ongoing radiological hazard for days or weeks. Radioactive materials have the potential to cause contamination for months or even years, but an accidental release of this size is extremely unlikely.

Local Context

The Local Context section describes community attributes that affect the likelihood of the hazard's occurrence or vulnerability to the hazard's consequences.

Unintentional Radiological Substance Release hazards are most likely to occur in areas where radiological substances are frequently kept or transported. Radiological substances may be present in many of the medical centers and research facilities in and around Howard County. Radiological substances are transported through Howard County, making areas near railways and major roadways particularly vulnerable to Unintentional Radiological Substance Release hazards. There are no nuclear power plants in Howard County, and nuclear facilities in other jurisdictions are sufficiently distant that the risk of a hazard impacting Howard County is unlikely.[2]

[2] *Manmade Hazard Identification and Risk Assessment Workshop (unpublished)*, Howard County OEM (2014).

III. LIKELIHOOD ANALYSIS

The Likelihood Analysis section characterizes the historical occurrence and future likelihood of the hazard in the planning area.

Occurrence of the Hazard

The Occurrence of the Hazard section details the historical occurrence of the hazard in the planning area.

There have been 0 Unintentional Radiological Substance Release hazard events in Howard County during the reviewed time period (1996-2013).

Future Likelihood of the Hazard for Howard County

The Future Likelihood section anticipates the future occurrence rate of the hazard based on historical likelihood and future trends. This section also addresses factors that may cause the future likelihood to deviate from historical trends.

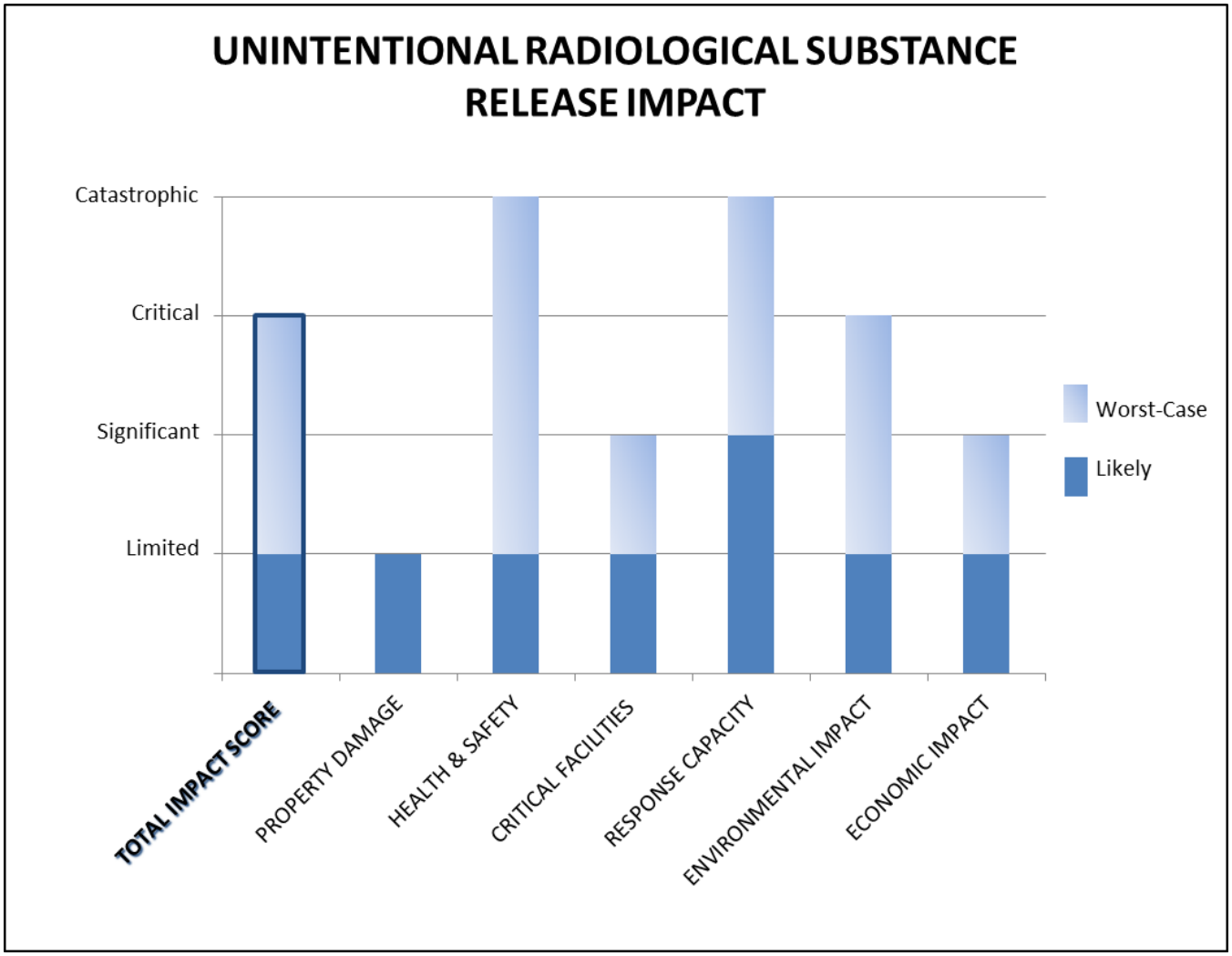
Future Likelihood of an Unintentional Radiological Substance Release Hazard in Howard County	
Historical Average (time period)	0 recorded events (2000-2014)
Historical Annual Probability	0% chance of annual occurrence
Future Likelihood Expected to Deviate from Historical Likelihood (Yes/No)	Yes
Future Annual Probability	1-10% chance of annual occurrence
Future Likelihood Score	1.50 (Unlikely-Infrequent)
Future Likelihood reflects the likelihood of any emergency-level hazard event and does not differentiate between Likely and Worst-Case scenarios.	

Considerations: The future likelihood of an Unintentional Radiological Substance Release in Howard County is expected to be slightly higher than indicated by the historical occurrence rate alone. Although the likelihood still remains low, estimates predict a 1-10% chance of annual occurrence, or one event every 10-99 years. A future annual probability of 1-10% classifies the likelihood of an Unintentional Radiological Substance Release hazard as Infrequent. The slight increase in future likelihood is attributed to the increased transport and use of radiological materials in Howard County.2

IV. CONSEQUENCE ANALYSIS

The Consequence Analysis section provides a detailed characterization of the anticipated consequences of likely and worst-case hazard events. This section characterizes impacts to property, health & safety, critical facilities, response capacity, the environment, and the economy. This section also characterizes public perceptions of each hazard, the perceived impact to personal safety and standard of living, and public confidence in response capability.

Consequence Analysis Overview



Where no Worst-Case bar is visible, Worst-Case impact is equivalent to Likely impact.

Unintentional Radiological Substance Release Warning Time & Duration		
	Likely	**Worst-Case**
WARNING TIME	*Short.* No warning time prior to the onset of the hazard.	*Short.* No warning time prior to the onset of the hazard.
DURATION	*Moderate.* Hazard onset is nearly instantaneous. It may take up to 12 hours to declare the hazard location safe.	*Long.* Location may be extremely hazardous for up to 12 hours. It may take days or weeks to stabilize environmental contamination and declare the hazard location safe.

Consequence Analysis: Likely Hazard Scenario

The Consequence Analysis table details the anticipated consequences of the most likely hazard scenario.

Unintentional Radiological Substance Release Consequence Analysis Likely		
PROPERTY DAMAGE	*Limited*	• 0% damage to critical and non-critical infrastructure. • Anything beyond superficial damage to buildings and structures is unlikely.
HEALTH & SAFETY	*Limited*	• 0 deaths likely. • 1-4 injuries likely. Injuries that occur are likely due to radiation exposure. Early symptoms of radiation sickness include nausea and vomiting, diarrhea, headache, and fever. Later symptoms of radiation sickness may include disorientation, fatigue, and hair loss.
CRITICAL FACILITIES	*Limited*	• *Utilities* – Shutdown unlikely. No effect on utilities. • *Information/Communications* – Shutdown unlikely. No major impact on information or communications infrastructure. • *Transportation* – Shutdown unlikely. Impacts to transportation will be minor and short-term.
RESPONSE CAPACITY	*Significant*	• *Police* – Local resources adequate. • *Fire & Rescue* – Moderate need for state or federal assistance. The hazard may tie up local hazardous materials response resources for several hours. Outside support will be necessary to maintain Continuity of Operations. • *Health* – Local resources adequate. Health Department operations will not be affected. • *Hospitals* – Local resources adequate. No impact on the hospital system. • *Emergency Management* – Local resources adequate. Limited impact to Emergency Management capability.
ENVIRONMENTAL IMPACT	*Limited*	• Limited to no environmental impact. Less than a day of clean-up. Impact to a localized area.
ECONOMIC IMPACT	*Limited*	• Minimal loss of economic output due to the limited area affected. Other costs include cleanup and healthcare for those affected. • 0 jobs lost. • Limited building closure may occur in the immediate area of the hazard.
TOTAL IMPACT	*Limited*	• Total Impact Score: 1.00 on a scale of 1 (Limited) to 4 (Catastrophic).

Limited	*Significant*	*Critical*	*Catastrophic*

Consequence Analysis: Worst-Case Hazard Scenario

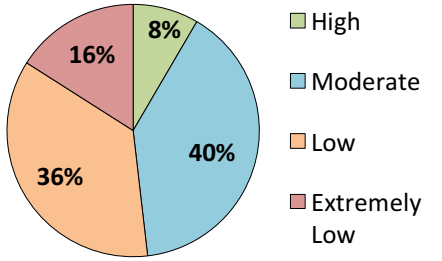
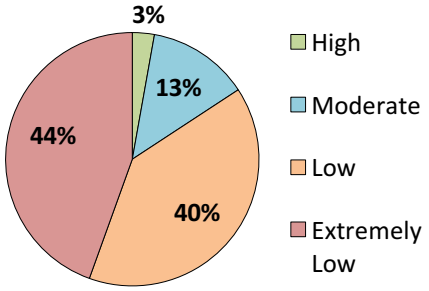
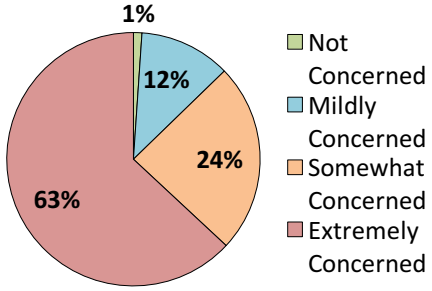
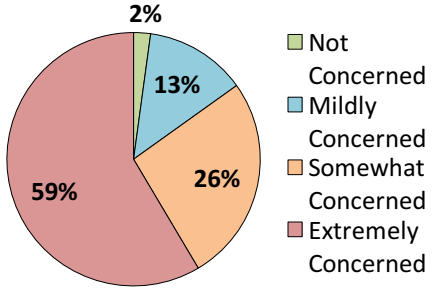
The Consequence Analysis: Worst-Case table details the anticipated consequences of the worst-case hazard scenario.

Unintentional Radiological Substance Release Consequence Analysis Worst-Case		
PROPERTY DAMAGE	*Limited*	• 0% damage to critical and non-critical infrastructure. • Anything beyond superficial damage to buildings and structures is unlikely.
HEALTH & SAFETY	*Catastrophic*	• Up to 100 deaths likely. The number of deaths depends heavily on the type of radiation released and the population density at the site of release. Deaths that occur are likely due to radiation exposure. High doses of radiation can lead to rapid death, but exposure to radiation can also increase the likelihood of several types of fatal diseases and cancers. • 100-300 injuries likely. The number of injuries depends heavily on the type of radiation released and the population density at the site of release. Injuries that occur are likely due to radiation exposure. Early symptoms of radiation sickness include nausea and vomiting, diarrhea, headache, and fever. Later symptoms of radiation sickness may include disorientation, fatigue, and hair loss. Although high doses of radiation will result in acute effects, chronic injuries from radiation may appear months or years following the initial exposure.
CRITICAL FACILITIES	*Significant*	• *Utilities* – Shutdown unlikely. No effect on utilities. • *Information/Communications* – Shutdown unlikely. No major impact on information or communications infrastructure. • *Transportation* – Delays for 1-3 days. Major transportation delays will be caused by evacuations and people exiting the area surrounding the hazard. Major road closures will occur, and transportation routes in the localized hazard area will be closed for several days.
RESPONSE CAPACITY	*Catastrophic*	• *Police* – Mutual aid needed. • *Fire & Rescue* – Significant and long-lasting need for state or federal assistance. If responders are exposed to radiation, it could have a significant impact on response capability and continuity of operations. • *Health* – Significant and long-lasting need for state or federal assistance. Regular Health Department operations will not be affected. Health Emergency Preparedness, Communicable Diseases, and Environmental Health functions will be altered due to emergency response. • *Hospitals* – Mutual aid needed. The hospital has no ability to decontaminate walk-ins, and protecting the facility from contamination will be a primary concern. Decontamination activities and sufficient hospital security measures may be impossible without outside support. The hospital has limited capacity for radiological monitoring. The Emergency Department will not be capable of handling the large patient surge. Patients will be diverted to other locations. The large turnout of psychological casualties (walking well) will likely strain the system for days. • *Emergency Management* – Moderate need for state or federal assistance. Significant assistance may be necessary to support sheltering activities, radiological hazardous materials cleanup, and financing for response and recovery efforts. If the radiological threat persists for an extended period of time, Emergency Management may require additional support for business, home, and infrastructure relocation.
ENVIRONMENTAL IMPACT	*Critical*	• Critical environmental impact. Long-term pollution and contamination is likely. Loss of species may occur. Environmental resources are renewable but only after some time. The release of radiological material will cause contamination of the air, water, and soil within the hazardous area. Air contamination will continue until the material has been removed, dispersed, and/or diluted. Water and soil contamination may continue at hazardous levels for days or weeks. Radiological materials that can kill or debilitate humans may also kill or debilitate other animal life in the area. The water and soil contamination may have impacts beyond the immediately contaminated area if the contamination occurs within the Patuxent Reservoirs watershed (a surface drinking water supply source) or the recharge area of a groundwater drinking water supply source. If the contamination occurs on agricultural land, the land will not be usable for cropland or animal pasture.
ECONOMIC IMPACT	*Significant*	• $9.1 million in lost economic output. Other costs include cleanup and healthcare for those affected. • 74 jobs lost. • Massive business disruption and closure is likely.
TOTAL IMPACT	*Critical*	• Total Impact Score: 3.00 on a scale of 1 (Limited) to 4 (Catastrophic).
Limited	*Significant*	*Critical*	*Catastrophic*

Consequence Analysis: Public Perception

The Consequence Analysis: Public Perception table characterizes public perceptions of each hazard. Details include public confidence in personal ability to respond to each hazard, public confidence in Howard County's ability to respond to each hazard, and each hazard's perceived impact to personal safety and standard of living.

Unintentional Radiological Substance Release
Public Perceptions

PERCEIVED CONFIDENCE IN HOWARD COUNTY'S ABILITY TO RESPOND AND RECOVER FROM THIS HAZARD	PERCEIVED CONFIDENCE IN PERSONAL ABILITY TO PROTECT SELF AND FAMILY FROM THIS HAZARD	CONCERN OVER THE IMPACT TO PERSONAL HEALTH AND SAFETY IF THIS HAZARD WERE TO OCCUR LOCALLY	CONCERN OVER THE IMPACT TO PERSONAL STANDARD OF LIVING / QUALITY OF LIFE IF THIS HAZARD WERE TO OCCUR LOCALLY
			
Average: 2.59 *Low - Moderate*	*Average: 3.26* *Low – Extremely Low*	*Average: 3.49* *Somewhat Concerned - Extremely Concerned*	*Average: 3.41* *Somewhat Concerned - Extremely Concerned*

Utility Disruption

I. OVERVIEW

The Overview section defines the hazard and summarizes the hazard risk profile.

Definition

This section defines the scope of the hazard category. The terminology and characterization established in this section should be consistent throughout all Howard County planning documents.

A Utility Disruption hazard occurs when the disruption of the gas, water, or electrical infrastructure has the potential to cause harm. Utility Disruption hazards can be intentional, unintentional, or occur as a cascading effect of another hazard.

Risk Profile

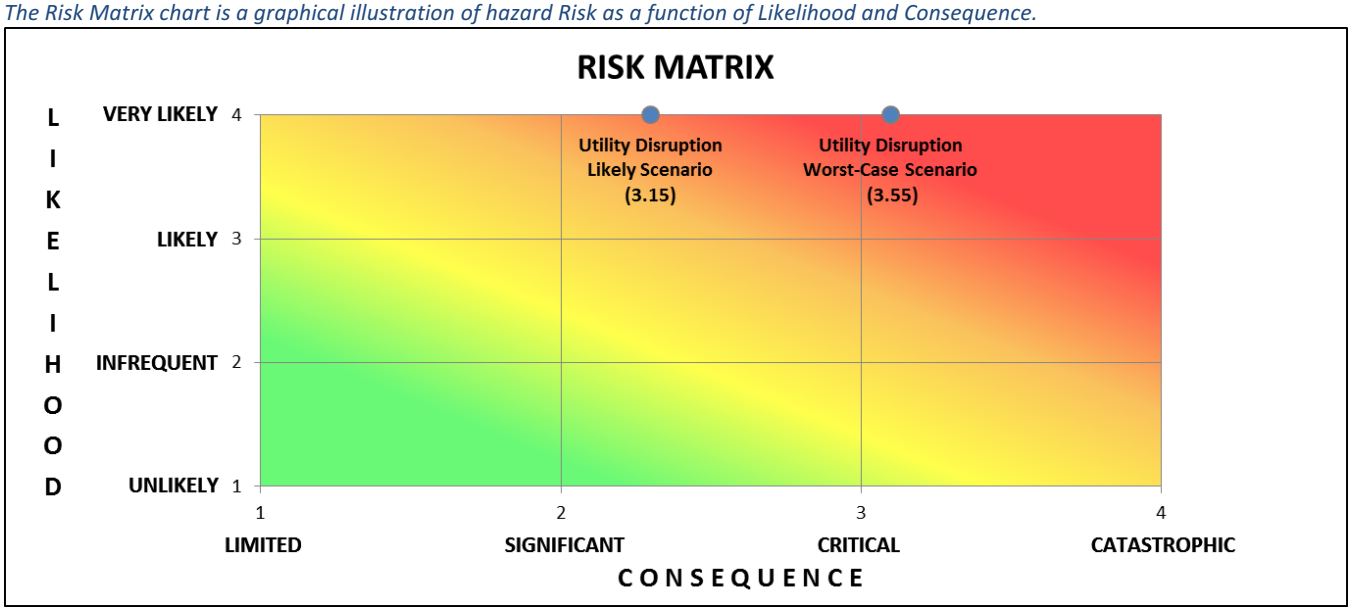
The Risk Profile section presents the Risk Score for the hazard in a range from 1 (lowest risk) to 4 (highest risk). Risk Score is a function of Likelihood and Consequence.

Utility Disruption Risk Profile				
	Risk Assessment Category	**Likely Hazard Scenario**	**Worst-Case Hazard Scenario**	**Weight**
LIKELIHOOD	**Likelihood**	4.00* Very Likely		50%
CONSEQUENCE	**Impact**	2.00 Significant	2.88 Significant-Critical	40%
	Warning Time	4 Short	4 Short	5%
	Duration	3 Long	4 Very Long	5%
TOTAL RISK SCORE		**3.15**	**3.55**	

**The Likelihood Score reflects the likelihood of any emergency-level hazard event and does not differentiate between Likely and Worst-Case scenarios.*

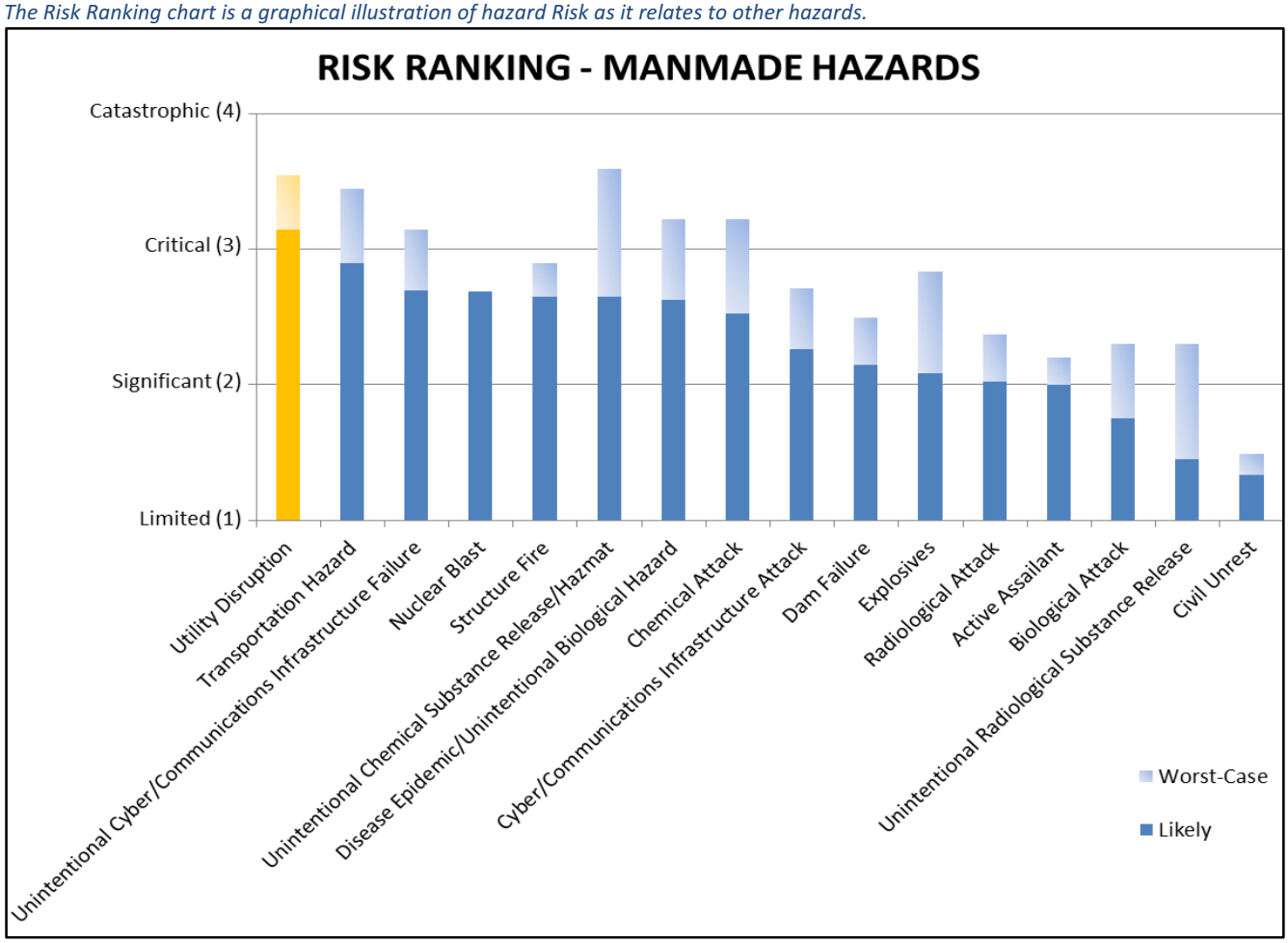
Risk Matrix

The Risk Matrix chart is a graphical illustration of hazard Risk as a function of Likelihood and Consequence.



Risk Ranking

The Risk Ranking chart is a graphical illustration of hazard Risk as it relates to other hazards.



Where no Worst-Case bar is visible, Worst-Case Risk is equivalent to Likely Risk.

II. HAZARD CHARACTERISTICS

The Hazard Characteristics section provides a detailed characterization of the hazard and the local context as it relates to the hazard.

Description of the Hazard

A Utility Disruption hazards can involve gas lines, water lines, waste water systems, or electrical infrastructure. The area affected by a Utility Disruption can range from one block to dozens of square miles. It is rare to have any advanced warning of a Utility Disruption, although disruptions may be anticipated prior to extreme weather events. A utility disruption hazard can occur nearly anywhere utility infrastructure exists.

The duration of a Utility Disruption hazard depends greatly on the cause of the disruption. Short-term disruptions may only last several minutes and are rarely hazardous. However, long-term Utilities Disruption hazards can last for several days.

Local Context

The Local Context section describes community attributes that affect the likelihood of the hazard's occurrence or vulnerability to the hazard's consequences.

A Utility Disruption hazard can occur anywhere that relies on electricity, natural gas, water, and sewage systems. All of Howard County is susceptible to the effects of a Utility Disruption.

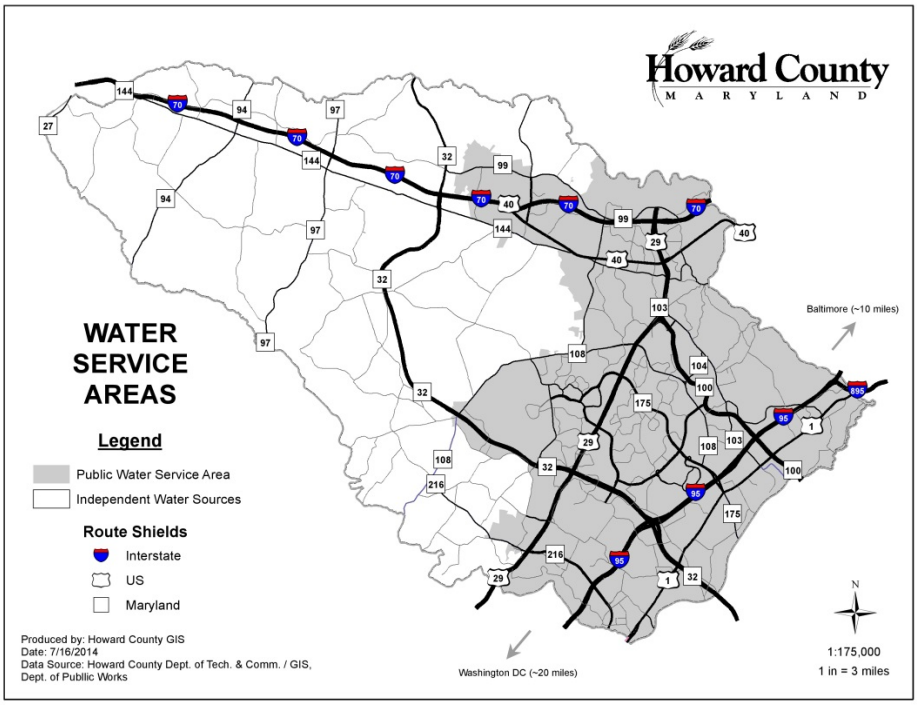
Utilities infrastructure is especially vulnerable to disruption from extreme weather. Ice storms, snow storms, tornadoes, hurricanes, flooding, and high winds can lead to the disruption of utility services. Conditions of extreme heat and cold during a Utility Disruption hazard also greatly increase the likelihood of adverse health effects.

In addition to weather-caused Utility Disruption, disruptions can also result from human error, aging infrastructure, or malfunctioning System Control and Data Acquisition (SCADA) systems.[1]

[1] *Manmade Hazard Identification and Risk Assessment Workshop (unpublished)*, Howard County OEM (2014).

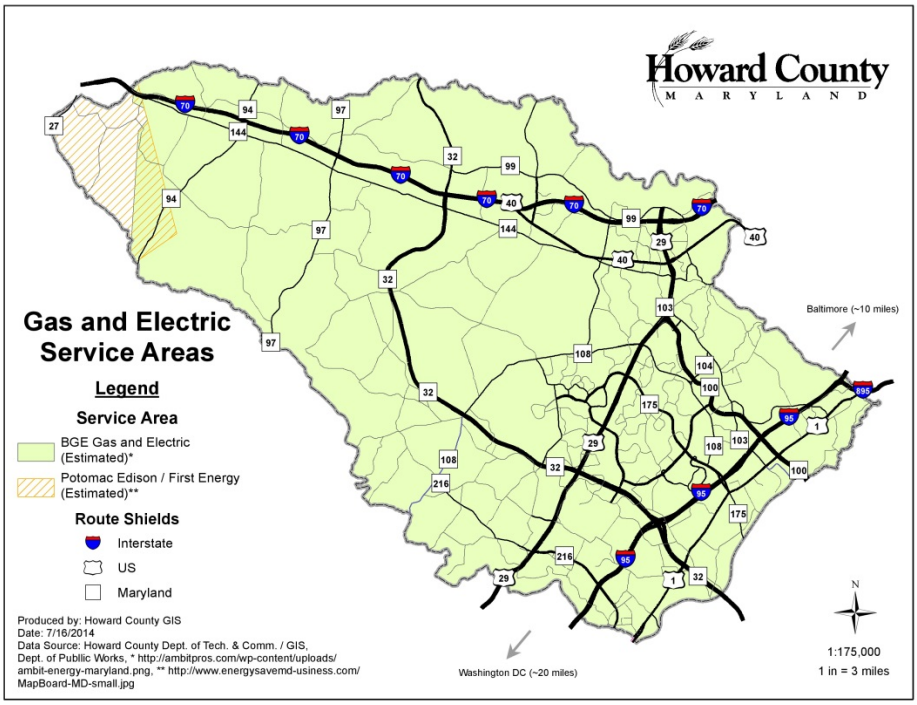
Water Service Areas

This map identifies the sources of water service in Howard County.



Gas & Electric Service Areas

This map identifies the sources of energy service in Howard County.



III. LIKELIHOOD ANALYSIS

The Likelihood Analysis section characterizes the historical occurrence and future likelihood of the hazard in the planning area.

Occurrence of the Hazard

The Occurrence of the Hazard section details the historical occurrence of the hazard in the planning area.

There have been 15 emergency-level Utility Disruption hazard events in Howard County during the reviewed time period (2008-2014).

Notable Incidents in Howard County

The great majority of Utility Disruption hazards in Howard County have been the result of extreme weather.

2012 Hurricane Sandy - A power outage at a water treatment plant resulted in the release of wastewater. Water contamination became a significant threat to health and the environment for those downstream from the plant. Water mains feeding Howard County from the City of Baltimore failed, and the drinking water supply was limited for a period of 1-2 weeks.

Future Likelihood of the Hazard for Howard County

The Future Likelihood section anticipates the future occurrence rate of the hazard based on historical likelihood and future trends. This section also addresses factors that may cause the future likelihood to deviate from historical trends.

Future Likelihood of a Utility Disruption Hazard in Howard County	
Historical Average (time period)	2.5 events every year (2008-2014)
Historical Annual Probability	100% chance of annual occurrence
Future Likelihood Expected to Deviate from Historical Likelihood (Yes/No)	No
Future Annual Probability	100% chance of annual occurrence
Future Likelihood Score	4.00 (Very Likely)
Future Likelihood reflects the likelihood of any emergency-level hazard event and does not differentiate between Likely and Worst-Case scenarios.	

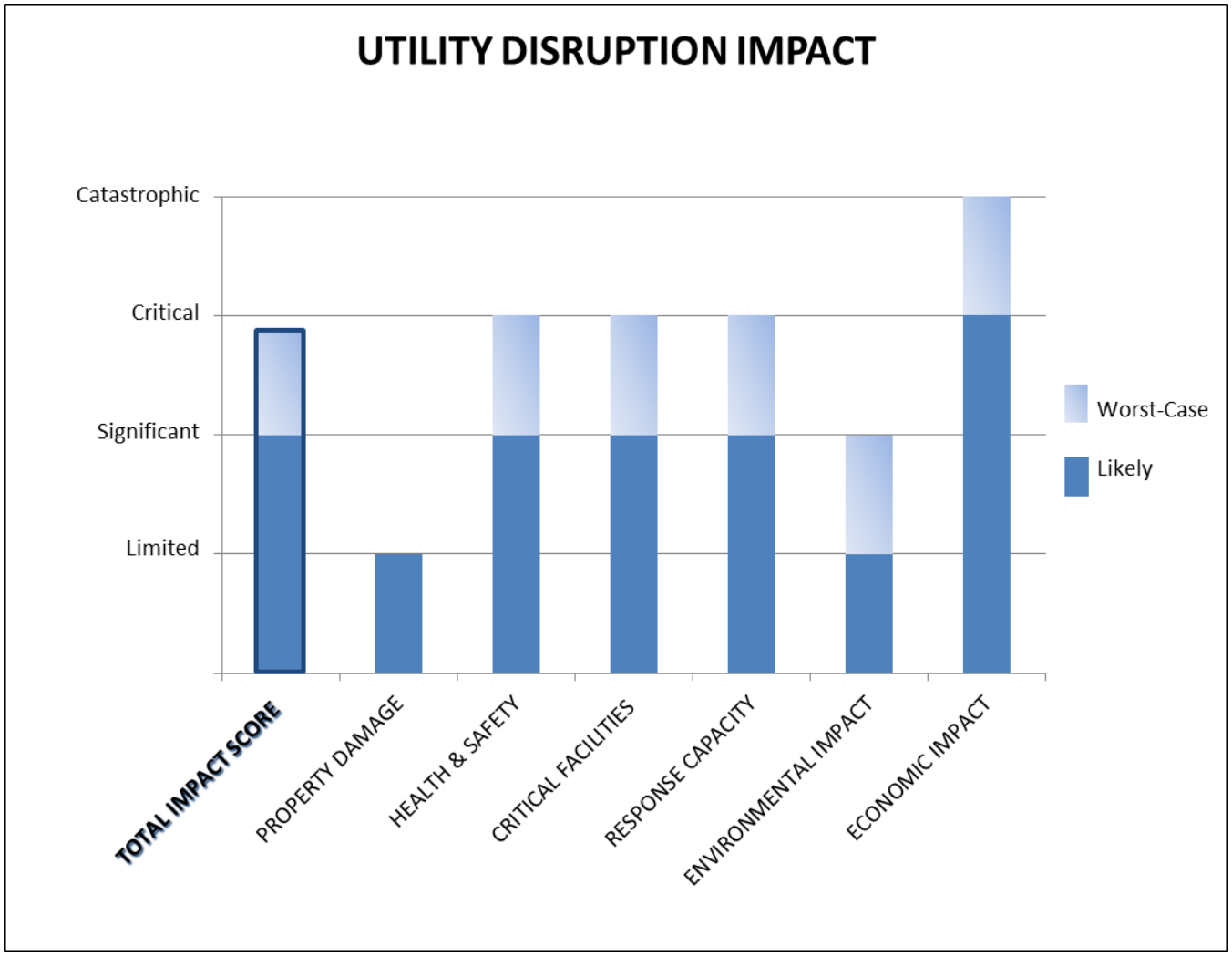
Considerations: The future likelihood of a Utility Disruption hazard in Howard County is not expected to be significantly different from the historical occurrence rate. A future annual probability of 100% classifies the likelihood of a Utility Disruption hazard as Very Likely. A predicted increase in rainfall levels and extreme storms is expected to result in a slight increase in the likelihood of Utility Disruption hazard over time.1,[2]

[2] *Third National Climate Assessment,* U.S. Global Change Research Program (2014). Available at http://nca2014.globalchange.gov/ (last accessed June 26, 2014).

IV. CONSEQUENCE ANALYSIS

The Consequence Analysis section provides a detailed characterization of the anticipated consequences of likely and worst-case hazard events. This section characterizes impacts to property, health & safety, critical facilities, response capacity, the environment, and the economy. This section also characterizes public perceptions of each hazard, the perceived impact to personal safety and standard of living, and public confidence in response capability.

Consequence Analysis Overview



Where no Worst-Case bar is visible, Worst-Case impact is equivalent to Likely impact.

Utility Disruption Hazard Warning Time & Duration		
	Likely	**Worst-Case**
WARNING TIME	*Short.* No warning time prior to the onset of the hazard.	*Short.* No warning time prior to the onset of the hazard.
DURATION	*Long.* It may take up to 3 days to stabilize the hazard and declare the hazard location safe.	*Very Long.* It may take up to 2 weeks to stabilize the hazard and declare the hazard location safe.

Consequence Analysis: Likely Hazard Scenario

The Consequence Analysis table details the anticipated consequences of the most likely hazard scenario.

Utility Disruption Hazard Consequence Analysis Likely		
PROPERTY DAMAGE	*Limited*	• 0% damage to critical and non-critical infrastructure. • Anything beyond superficial damage to buildings and structures is unlikely. If a Utility Disruption hazard occurs during cold weather, pipe freezing may cause flood damage to buildings and homes.
HEALTH & SAFETY	*Significant*	• 2-4 deaths likely, although more deaths are expected in extreme weather conditions. • 50+ injuries likely. • Deaths and injuries that occur are likely due to heat, extreme weather, or exposure to adverse environmental conditions. Cold weather injuries may result from hypothermia, shock, or severe cardiac arrest. Hot weather injuries may result from hyperthermia, dehydration, heat exhaustion, or severe heat stroke.
CRITICAL FACILITIES	*Significant*	• *Utilities* – Additional shutdown unlikely. Limited impact to utilities not affected by the primary disruption. • *Information/Communications* – Shutdown unlikely. No major impact on information or communications infrastructure. • *Transportation* – Delays for 1-3 days. Widespread traffic control systems outages may cause transportation delays.
RESPONSE CAPACITY	*Significant*	• *Police* – Local resources adequate. • *Fire & Rescue* – Mutual aid needed. Continuity of Operations will not be significantly affected for Howard County fire/rescue. • *Health* – Local resources adequate. Unless the Utility Disruption directly affects the Health Department, regular services will continue to function. Health Emergency Preparedness functions will be affected due to the emergency response. • *Hospitals* – Local resources adequate. If the hospital is not directly affected by the Utility Disruption, there will be no strain or impact on the hospital. If the hospital is affected, cold-weather power losses have very little impact. Warm-weather power losses (even short-term outages) may result in evacuation for heat concerns. • *Emergency Management* – Local resources adequate. Limited impact to Emergency Management capability.
ENVIRONMENTAL IMPACT	*Limited*	• Limited. Little to no environmental impact, assuming the Utility Disruption does not cause any accidental industrial or wastewater treatment plant discharges or spills. Less than a day of clean-up or impact to local area.
ECONOMIC IMPACT	*Critical*	• $343 million in lost economic output. Other costs include cleanup and healthcare for those affected. • 2,700 jobs lost. • Businesses may be impacted for 3 days or longer.
TOTAL IMPACT	*Significant*	• Total Impact Score: 2.00 on a scale of 1 (Limited) to 4 (Catastrophic).
Limited	*Significant*	*Critical*	*Catastrophic*

Consequence Analysis: Worst-Case Hazard Scenario

The Consequence Analysis: Worst-Case table details the anticipated consequences of the worst-case hazard scenario.

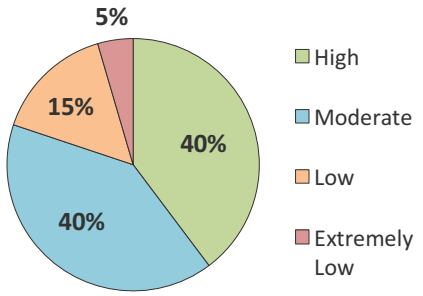
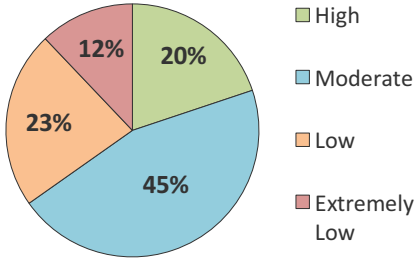
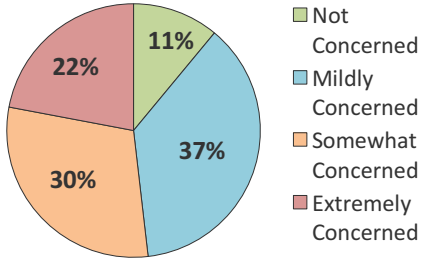
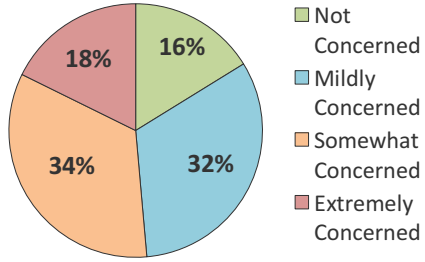
Utility Disruption Hazard Consequence Analysis Worst-Case		
PROPERTY DAMAGE	*Limited*	• 0% damage to critical and non-critical infrastructure. • Anything beyond superficial damage to buildings and structures is unlikely. If a Utility Disruption hazard occurs during cold weather, pipe freezing may cause flood damage to buildings and homes. Gas line disruptions may result in fire damage or explosions in rare cases.
HEALTH & SAFETY	*Critical*	• 20 deaths likely, although more deaths are expected in extreme weather conditions. • 100-300 injuries likely, although up to 50% of the population may experience minor adverse effects depending on weather conditions. • Deaths and injuries that occur are likely due to heat, extreme weather, or exposure to adverse environmental conditions. Cold weather injuries may result from hypothermia, shock, or severe cardiac arrest. Hot weather injuries may result from hyperthermia, dehydration, heat exhaustion, or severe heat stroke. Hospitals may be unable to provide essential services, potentially leading to death or exacerbation of existing health issues.
CRITICAL FACILITIES	*Critical*	• *Utilities* – Shutdown may last 2-3 weeks. Power may be unavailable. Volume and quality of water may be significantly disrupted. • *Information/Communications* – Shutdown unlikely. No major impact on information or communications infrastructure. Individual areas may go dark, but generator backup will keep most essential information and communications functions online. • *Transportation* – Delays for up to 2 weeks. Widespread traffic control systems outages may cause significant transportation delays.
RESPONSE CAPACITY	*Critical*	• *Police* – Local resources adequate. • *Fire & Rescue* – Moderate need for state or federal assistance. Response capability is highly dependent on the availability of generators & fuel. • *Health* – Moderate need for state or federal assistance. Regular Health Department operations will be significantly altered if a Utility Disruption hazard occurs during extreme weather conditions. Health Emergency Preparedness, Communicable Diseases, and Environmental Health functions will be altered due to the emergency response. Environmental Health will shift staff to inspect food quality and other prioritized tasks, resulting in the delay of regular health inspections and reports. Communicable disease surveillance may be suspended during the emergency operations. • *Hospitals* – Moderate need for state or federal assistance. If the hospital is affected, cold-weather power losses have very little impact. Warm-weather power losses (even short-term outages) may result in evacuation for heat concerns. Significant outside assistance will be necessary if water supply is limited or unavailable. If water and electricity are completely unavailable, the hospital will not be able to sustain operations. Complete evacuation will be necessary and all incoming patients will be diverted. • *Emergency Management* – Local resources adequate. Limited impact to Emergency Management capability. A long-lasting Utility Disruption hazard may necessitate ongoing Emergency Management support for shelter coordination and economic recovery efforts.
ENVIRONMENTAL IMPACT	*Significant*	• Significant. Some loss of species, loss of vegetation, and short term pollution will occur. Sewage system failures may result in overflows or discharges of untreated sewage that cause water pollution. Localized pollution may be significant if the Utility Disruption occurs over an extended period of time and/or if it contaminates the Patuxent Reservoirs watershed, a regional surface drinking water supply source. The pollution would be diluted over time with downstream flow.
ECONOMIC IMPACT	*Catastrophic*	• $3.25 billion in lost economic output. Other costs include cleanup and healthcare for those affected. • 26,282 jobs lost. • Businesses may be impacted for 2 weeks or longer.
TOTAL IMPACT	*Significant - Critical*	• Total Impact Score: 2.88 on a scale of 1 (Limited) to 4 (Catastrophic).
Limited	*Significant*	*Critical*	*Catastrophic*

Consequence Analysis: Public Perception

The Consequence Analysis: Public Perception table characterizes public perceptions of each hazard. Details include public confidence in personal ability to respond to each hazard, public confidence in Howard County's ability to respond to each hazard, and each hazard's perceived impact to personal safety and standard of living.

Utility Disruption Hazard

Public Perceptions

PERCEIVED CONFIDENCE IN HOWARD COUNTY'S ABILITY TO RESPOND AND RECOVER FROM THIS HAZARD	PERCEIVED CONFIDENCE IN PERSONAL ABILITY TO PROTECT SELF AND FAMILY FROM THIS HAZARD	CONCERN OVER THE IMPACT TO PERSONAL HEALTH AND SAFETY IF THIS HAZARD WERE TO OCCUR LOCALLY	CONCERN OVER THE IMPACT TO PERSONAL STANDARD OF LIVING / QUALITY OF LIFE IF THIS HAZARD WERE TO OCCUR LOCALLY
			
Average: 1.85 *Moderate*	*Average: 2.27* *Moderate - Low*	*Average: 2.63* *Somewhat Concerned - Mildly Concerned*	*Average: 2.53* *Somewhat Concerned - Mildly Concerned*

SECTION 8

NATURAL HAZARD PROFILES

Animal/Pest Infestation

I. OVERVIEW

The Overview section defines the hazard and summarizes the hazard risk profile.

Definition

This section defines the scope of the hazard category. The terminology and characterization established in this section should be consistent throughout all Howard County planning documents.

Pest infestation is the occurrence of one or more pest species in an area or location where their numbers and impact are currently or potentially at intolerable levels.

Risk Profile

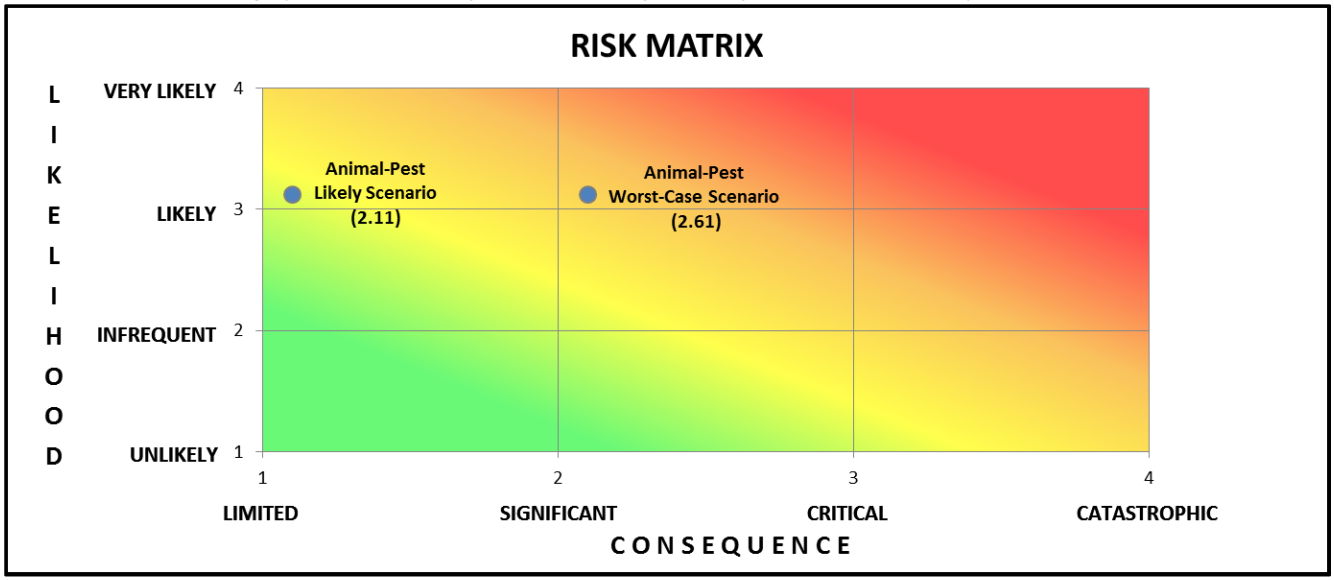
The Risk Profile section presents the Risk Score for the hazard in a range from 1 (lowest risk) to 4 (highest risk). Risk Score is a function of Likelihood and Consequence.

Animal/Pest Infestation Risk Profile				
	Risk Assessment Category	**Likely Hazard Scenario**	**Worst-Case Hazard Scenario**	**Weight**
LIKELIHOOD	**Likelihood**	3.125 Likely-Very Likely		50%
CONSEQUENCE	**Impact**	1 Limited	2 Significant	40%
	Warning Time	1 Very Long	1 Very Long	5%
	Duration	2 Moderate	4 Very Long	5%
TOTAL RISK SCORE		**2.11**	**2.61**	

**The Likelihood Score reflects the likelihood of any emergency-level hazard event and does not differentiate between Likely and Worst-Case scenarios.*

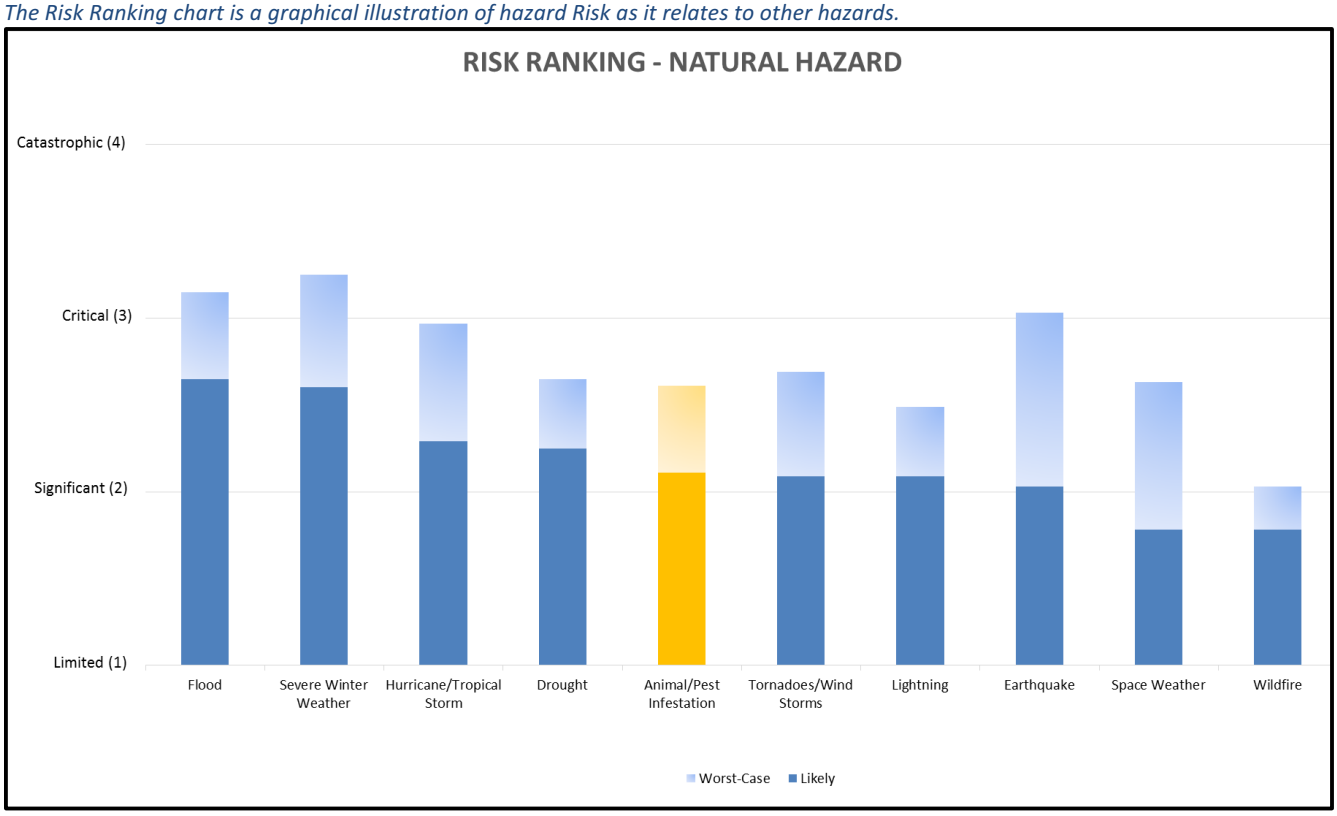
Risk Matrix

The Risk Matrix chart is a graphical illustration of hazard Risk as a function of Likelihood and Consequence.



Risk Ranking

The Risk Ranking chart is a graphical illustration of hazard Risk as it relates to other hazards.



Where no Worst-Case bar is visible, Worst-Case Risk is equivalent to Likely Risk.

II. HAZARD CHARACTERISTICS

The Hazard Characteristics section provides a detailed characterization of the hazard and the local context as it relates to the hazard.

Description of the Hazard

Pest infestations can cause immediate illness/injury and can hasten the spread of dangerous diseases, and thus pose a major health risk. The most common pests can generally be categorized as rodents and insects.

According to a 2013 survey, Rodent infestations affect nearly 29% of Americans and invade approximately 21 million homes each winter.[55] Rodents spread Salmonella and other bacteria through their droppings, can trigger allergies and asthma attacks as a result of a protein in their urine, and bring with them other diseases such as murine typhus, infectious jaundice, Weil's Disease and rat-bite fever.[56]

Insect pests include cockroaches, fleas, flies and termites. The most persistent insect pest over the past ten years have been Bed Bugs. Nearly all (99.6%) of pest professionals have treated bed bugs in the past year, according to a 2015 survey.[57] According to a 2011 study, one out of every five Americans had a bed bug infestation in their home or knew someone who encountered bed bugs at home or in a hotel. [58] Bed bugs are not considered dangerous, but can be a nuisance when they bite humans. Bite responses can range from an absence of any physical signs of a bite, to a small bite mark, to a serious allergic reaction.[59]

Local Context

The Local Context section describes community attributes that affect the likelihood of the hazard's occurrence or vulnerability to the hazard's consequences.

Pest infestations can happen in any geographical location. The manner and degree of the infestation can vary based on location. The incidence of bed bugs, for example, is three times higher in urban areas than in rural areas due to factors such as larger population size, apartment living and increased mobility.[60]

[55] PestWorld.Org, *Of Mice and Men: Rodent Infestations Plague Nearly a Third of Americans,* http://www.pestworld.org/news-hub/press-releases/of-mice-and-men-rodent-infestations-plague-nearly-a-third-of-americans/ (last accessed 3/21/16).
[56] Id.
[57] Pestworld.Org, *Bed Bug Facts & Statistics,* http://www.pestworld.org/all-things-bed-bugs/bed-bug-facts-statistics/ (last accessed 3/21/16)
[58] Id.
[59] Centers for Disease Control, *Bed Bugs FAQ,* http://www.cdc.gov/parasites/bedbugs/faqs.html (last accessed 3/21/16)
[60] Pestworld.Org, *Bed Bug Facts & Statistics,* http://www.pestworld.org/all-things-bed-bugs/bed-bug-facts-statistics/ (last accessed 3/21/16)

III. LIKELIHOOD ANALYSIS

The Likelihood Analysis section characterizes the historical occurrence and future likelihood of the hazard in the planning area.

Occurrence of the Hazard

The Occurrence of the Hazard section details the historical occurrence of the hazard in the planning area.

In the past ten years there has been a resurgence of bedbug infestations. The Maryland Department of Health and Mental Hygiene issued notification on November 10, 2008 that over the course of the past six months they noted an increase in bedbug investigations in Maryland that was consistent with increasing national reports. As of September 23, 2014 bedbug infestations are still being reported.

Future Likelihood of the Hazard for Howard County

The Future Likelihood section anticipates the future occurrence rate of the hazard based on historical likelihood and future trends. This section also addresses factors that may cause the future likelihood to deviate from historical trends.

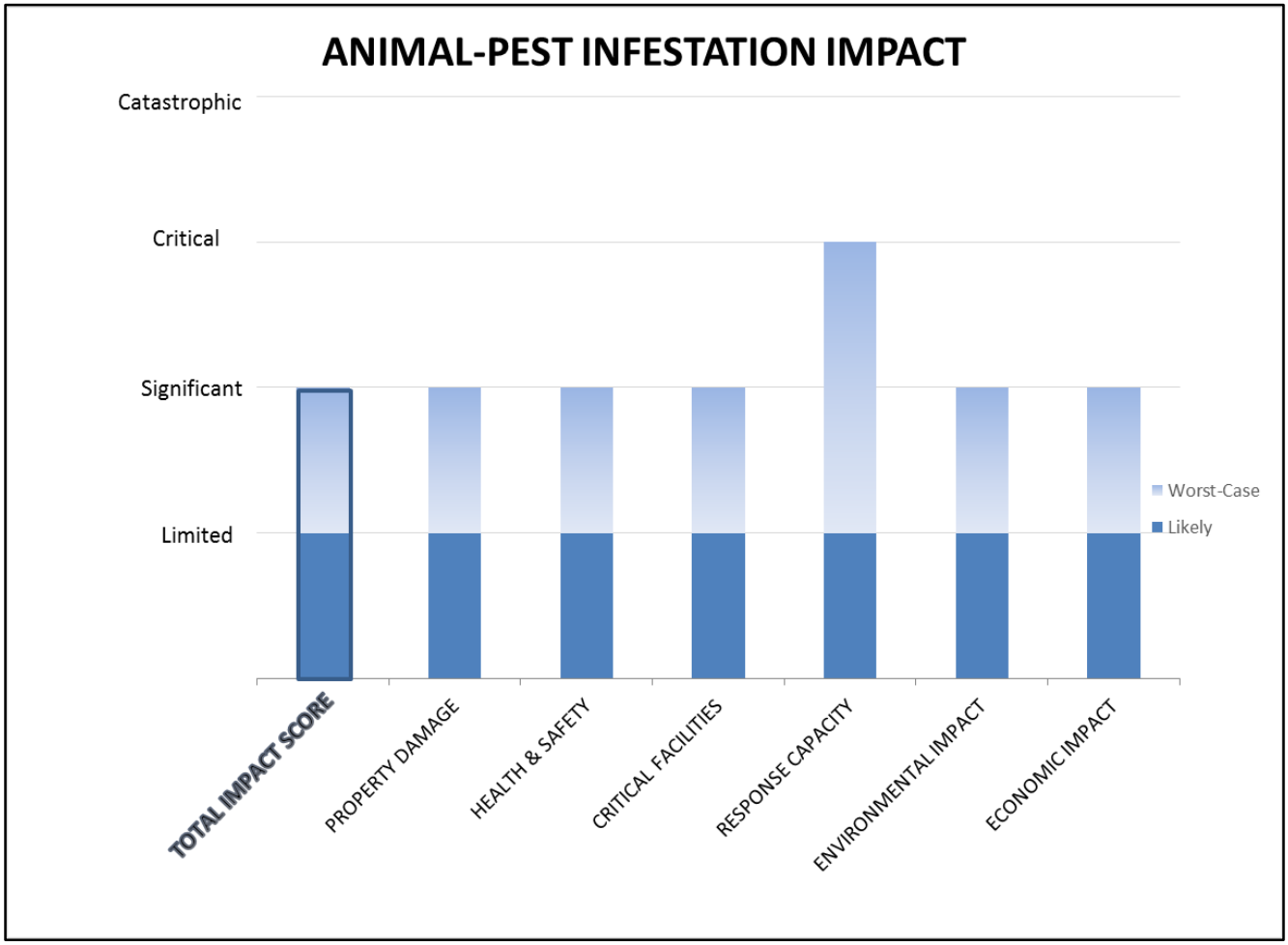
Future Likelihood of an Animal/Pest Infestation Hazard in Howard County	
Historical Average (time period)	0 events (requiring EOC activation) during reviewed time period (1964-2014)
Historical Annual Probability	0% chance of annual occurrence
Future Likelihood Expected to Deviate from Historical Likelihood (Yes/No)	Yes
Future Annual Probability	1-30% chance of annual occurrence
Future Likelihood Score[4]	2.5 (Infrequent-Likely)
Future Likelihood reflects the likelihood of any emergency-level hazard event and does not differentiate between Likely and Worst-Case scenarios.	

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IV. CONSEQUENCE ANALYSIS

The Consequence Analysis section provides a detailed characterization of the anticipated consequences of likely and worst-case hazard events. This section characterizes impacts to property, health & safety, critical facilities, response capacity, the environment, and the economy. This section also characterizes public perceptions of each hazard, the perceived impact to personal safety and standard of living, and public confidence in response capability.

Consequence Analysis Overview



Where no Worst-Case bar is visible, Worst-Case impact is equivalent to Likely impact.

Animal/Pest Infestation Warning Time & Duration		
	Likely	**Worst-Case**
WARNING TIME	*Very Long.* More than 24 hours.	*Very Long.* More than 24 hours.
DURATION	*Moderate.* 6-24 hours.	*Very Long.* More than one week.

Consequence Analysis: Likely Hazard Scenario

The Consequence Analysis table details the anticipated consequences of the most likely hazard scenario.

ANIMAL/PLANT INFESTATION Likely		
PROPERTY DAMAGE	*Limited*	• 0.5% of critical and non-critical infrastructure will be damaged. • No structural damage but significant loss in furniture and carpeting is expected.
HEALTH & SAFETY	*Limited*	• 0 deaths are expected. Most deaths would be unlikely but when they do occur, it is due to an occurrence in conjunction with other comorbidities. • 0-5 injuries are expected. Allergy, anxiety, and sleepiness are the most common causes of injuries.
CRITICAL FACILITIES	*Limited*	• *Utilities* – No critical facilities will be shut down and no outage is expected. • *Information/Communications* – Shutdown unlikely. No major impact on information or communications infrastructure. • *Transportation* – Shutdown unlikely. Impacts to transportation will be minor and short-term.
RESPONSE CAPACITY	*Limited*	• *Police* – Local resources adequate. No impact to response capability or continuity of operations. • *Fire & Rescue* –Local resources adequate. No impact to response capability and continuity of operations. • *Health* – Local resources adequate. Howard County Health Department operations will not be affected. The HDOC will be monitoring and recording infestations throughout the county with the assistance of Environmental Health. Informing the public and steps needed to ensure to maintain a healthy living environment will occur. • *Public Works* – Local resources adequate. No impact on response capability and continuity of operations.
ENVIRONMENTAL IMPACT	*Limited*	• Limited environmental impact is expected. Minimal impact on air, water, and land resources.
ECONOMIC IMPACT	*Limited*	• Limited economic impact. Negative impact on retail and County reputation in economic consequences.
TOTAL IMPACT	*Limited*	• Total Impact Score: 1.25 on a scale of 1 (Limited) to 4 (Catastrophic).
Limited	*Significant*	*Critical* / *Catastrophic*

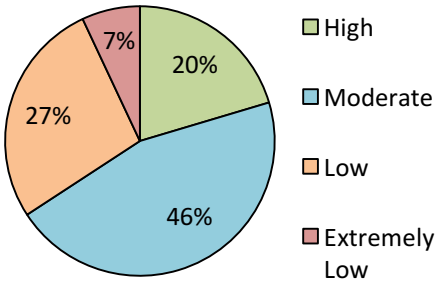
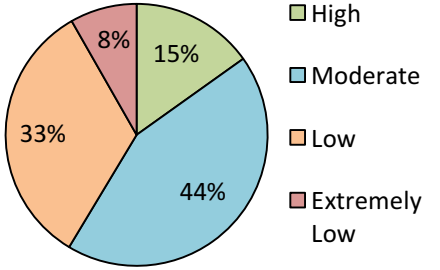
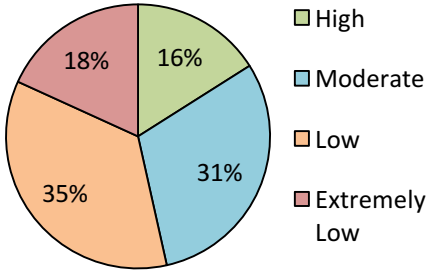
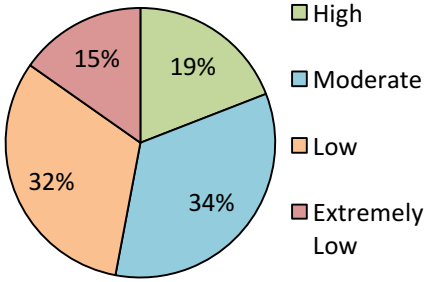
Consequence Analysis: Worst-Case Hazard Scenario

The Consequence Analysis: Worst-Case table details the anticipated consequences of the worst-case hazard scenario.

ANIMAL/PLANT INFESTATION **Worst-Case**		
PROPERTY DAMAGE	*Significant*	• Up to 10% of critical and non-critical infrastructure will be damaged. • Public water user to have bacteria in the water supply and re-infection to occur if not corrected.
HEALTH & SAFETY	*Significant*	• 0-2 deaths are expected. • 0-5 injuries are expected.
CRITICAL FACILITIES	*Significant*	• *Utilities* – No critical facilities will be shut down and no outage is expected. • *Information/Communications* – No shutdown. No major impact on information or communications infrastructure. • *Transportation* – Shutdown unlikely. Impacts to transportation will be minor and short-term.
RESPONSE CAPACITY	*Critical*	• *Police* – Local resources adequate. No impact to response capability or continuity of operations. • *Fire & Rescue* – Moderate need for state or federal assistance. Limited impact to response capability and continuity of operations. Water contingency plans and dealing with needs populations will be required. • *Health* – Moderate need for state or federal assistance. Howard County Health Department operations will not be affected. The HDOC will be monitoring and recording infestations throughout the county with the assistance of Environmental Health. Informing the public and steps needed to ensure to maintain a healthy living environment will occur. • *Public Works* – Moderate need for state or federal assistance. Fire response is most likely to be impacted.
ENVIRONMENTAL IMPACT	*Significant*	• Minimal impact to air and land resources, but there could be a loss of animal life if the water is consumed. • Limited- Significant environmental impact is expected.
ECONOMIC IMPACT	*Significant*	• Millions loss in dollar value.
TOTAL IMPACT	*Limited - Significant*	• Total Impact Score: 1.75 on a scale of 1 (Limited) to 4 (Catastrophic).
Limited	*Significant*	*Critical*	*Catastrophic*

Consequence Analysis: Public Perception

The Consequence Analysis: Public Perception table characterizes public perceptions of each hazard. Details include public confidence in personal ability to respond to each hazard, public confidence in Howard County's ability to respond to each hazard, and each hazard's perceived impact to personal safety and standard of living.

Public Perceptions on Animal and Plant Infestation			
PERCEIVED CONFIDENCE IN HOWARD COUNTY'S ABILITY TO RESPOND AND RECOVER FROM THIS HAZARD	**PERCEIVED CONFIDENCE IN PERSONAL ABILITY TO PROTECT SELF AND FAMILY FROM THIS HAZARD**	**CONCERN OVER THE IMPACT TO PERSONAL HEALTH AND SAFETY IF THIS HAZARD WERE TO OCCUR LOCALLY**	**CONCERN OVER THE IMPACT TO PERSONAL STANDARD OF LIVING / QUALITY OF LIFE IF THIS HAZARD WERE TO OCCUR LOCALLY**
			
Average: 2.79 *Moderate - Low*	*Average: 2.66* *Moderate - Low*	*Average: 2.44* *Low Concern*	*Average: 2.57* *Moderate – Low Concern*

Drought

I. OVERVIEW

The Overview section defines the hazard and summarizes the hazard risk profile.

Definition

This section defines the scope of the hazard category. The terminology and characterization established in this section should be consistent throughout all Howard County planning documents.

A drought is a condition of moisture deficit sufficient to have an adverse effect on vegetation, animals, and humans over a sizeable area. It usually refers to a period of below-normal rainfall, but drought can also be caused by drying bores or lakes or anything that reduces the amount of liquid water available.

Risk Profile

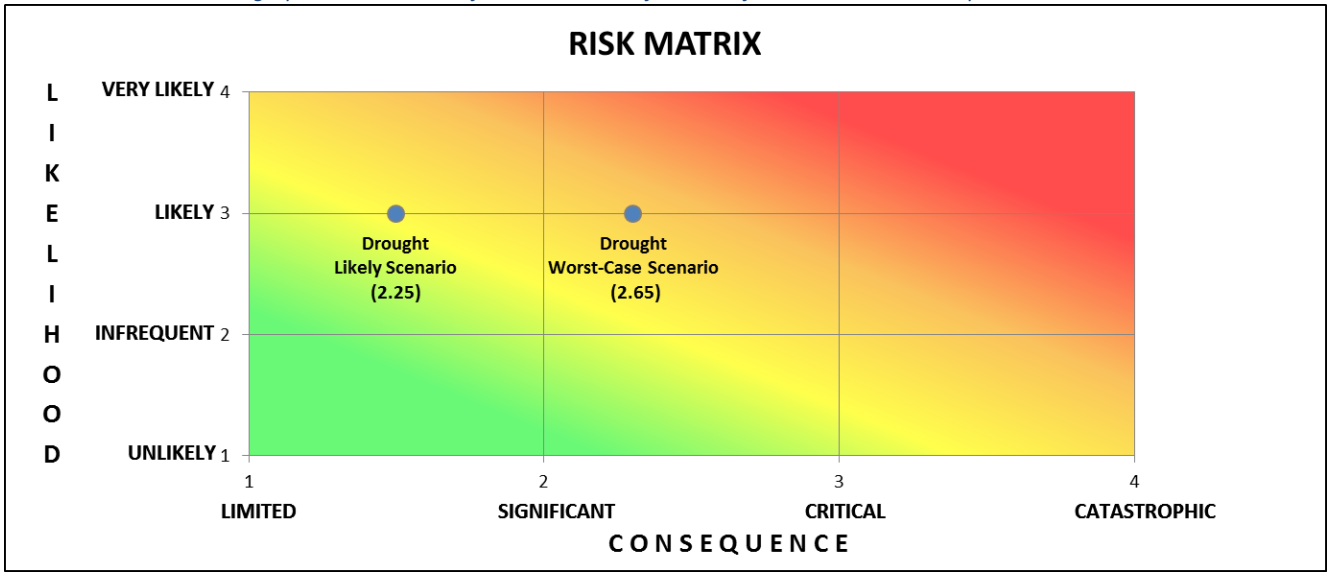
The Risk Profile section presents the Risk Score for the hazard in a range from 1 (lowest risk) to 4 (highest risk). Risk Score is a function of Likelihood and Consequence.

Drought Risk Profile				
	Risk Assessment Category	**Likely Hazard Scenario**	**Worst-Case Hazard Scenario**	**Weight**
LIKELIHOOD	**Likelihood**	3 Likely		50%
CONSEQUENCE	**Impact**	1.25 Limited-Significant	2.25 Significant-Critical	40%
	Warning Time	1 Very Long	1 Very Long	5%
	Duration	4 Very Long	4 Very Long	5%
TOTAL RISK SCORE		**2.25**	**2.65**	

**The Likelihood Score reflects the likelihood of any emergency-level hazard event and does not differentiate between Likely and Worst-Case scenarios.*

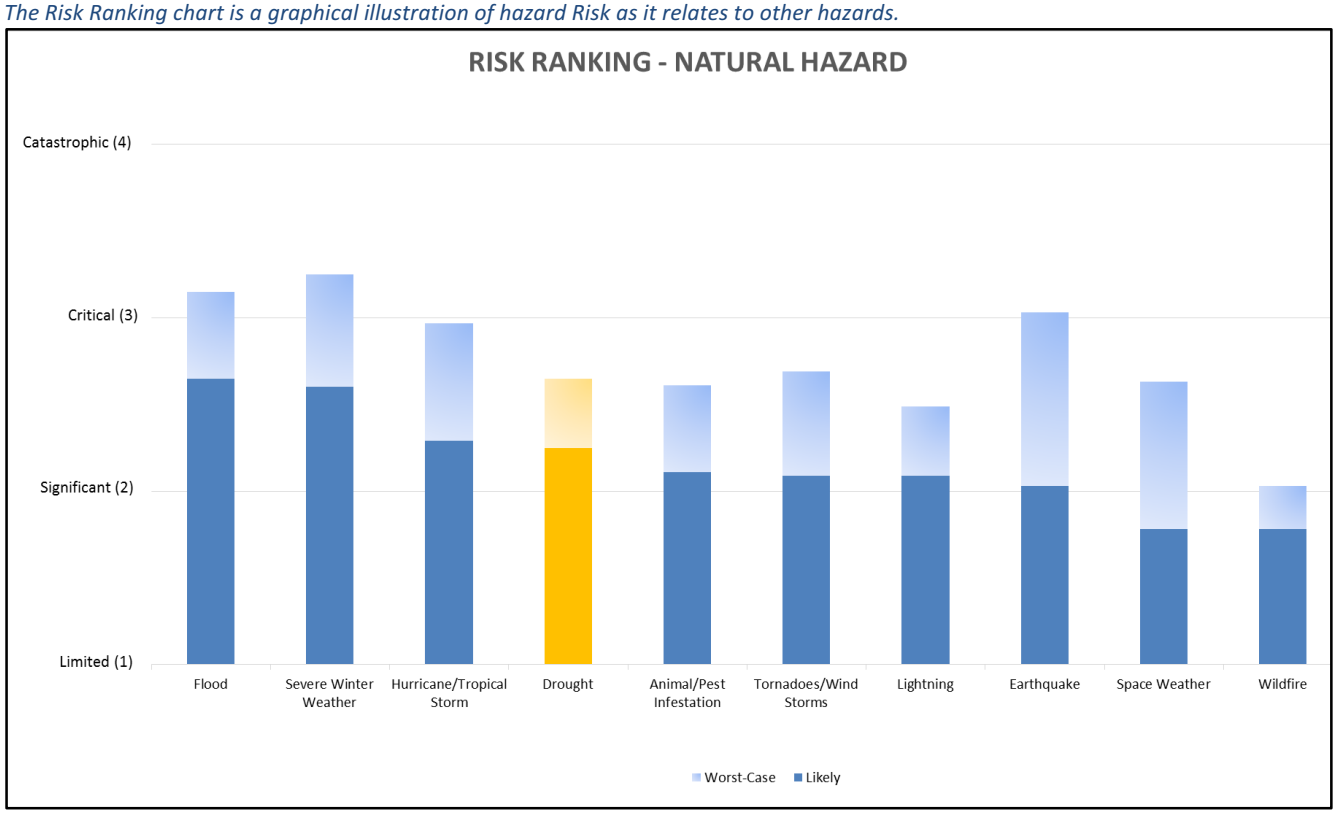
Risk Matrix

The Risk Matrix chart is a graphical illustration of hazard Risk as a function of Likelihood and Consequence.



Risk Ranking

The Risk Ranking chart is a graphical illustration of hazard Risk as it relates to other hazards.



Where no Worst-Case bar is visible, Worst-Case Risk is equivalent to Likely Risk.

II. HAZARD CHARACTERISTICS

The Hazard Characteristics section provides a detailed characterization of the hazard and the local context as it relates to the hazard.

Description of the Hazard

A drought is a condition of moisture deficit sufficient to have an adverse effect on vegetation, animals, and humans over a sizeable area."[61] It usually refers to a period of below-normal rainfall, but can also be caused by drying bores or lakes, or anything that reduces the amount of liquid water available. Drought is a recurring feature of nearly all the world's climatic regions.[62]

Local Context

The Local Context section describes community attributes that affect the likelihood of the hazard's occurrence or vulnerability to the hazard's consequences.

Droughts may occur anywhere in the United States. Different regions may be affected by drought conditions differently, depending on normal meteorological conditions (such as precipitation and temperature) and geological conditions (such as soil type and subsurface water levels).

Drought is possible throughout the planning area, and in the Central Maryland region in general. As there is no defined geographic boundary for this hazard, all properties within Howard County are exposed equally to the risk of drought. The probability of a drought occurring in any specific region depends on atmospheric and climatic conditions.

Duration and frequency can be used as indicators of potential severity. Variation in drought risks to people and property cannot be distinguished by area. The hazard has a uniform probability of occurrence across the entire County.

III. LIKELIHOOD ANALYSIS

The Likelihood Analysis section characterizes the historical occurrence and future likelihood of the hazard in the planning area.

Occurrence of the Hazard

The Occurrence of the Hazard section details the historical occurrence of the hazard in the planning area.

According to the NCDC database, Howard County has experienced 13 drought events from 1950 to 2011. All 13 events occurred between 1995 and 2007. The database provides no indication as to why no events were listed prior to 1995, although presumably occurrences followed the same pattern and frequency as shown in the NCDC list. Also note that the events are listed by months. If a drought lasted several continuous months, it is listed in the database as separate events. If the continuous months are combined into single events, the number of events is reduced from 13 to 7 events.

[61] *Definition of Drought*, http://md.water.usgs.gov/drought/define.html (last accessed April 9, 2012).
[62] For additional information about droughts, visit the National Integrated Drought Information System (NIDIS), www.drought.gov (last accessed April 9, 2012).

With a total of seven significant drought events between 1995 and 2011, Howard County experiences a severe drought event, on average, approximately once every two years. The seven events have occurred over a period of 16 years, which equates to approximately a 46% annual probability of future drought occurrences. Based on previous occurrences, it is reasonable to assume that droughts will continue to occur in Howard County. It is also equally reasonable to assume that the impact will be reasonable with no projected injuries, deaths, or property damage.

Future Likelihood of the Hazard for Howard County

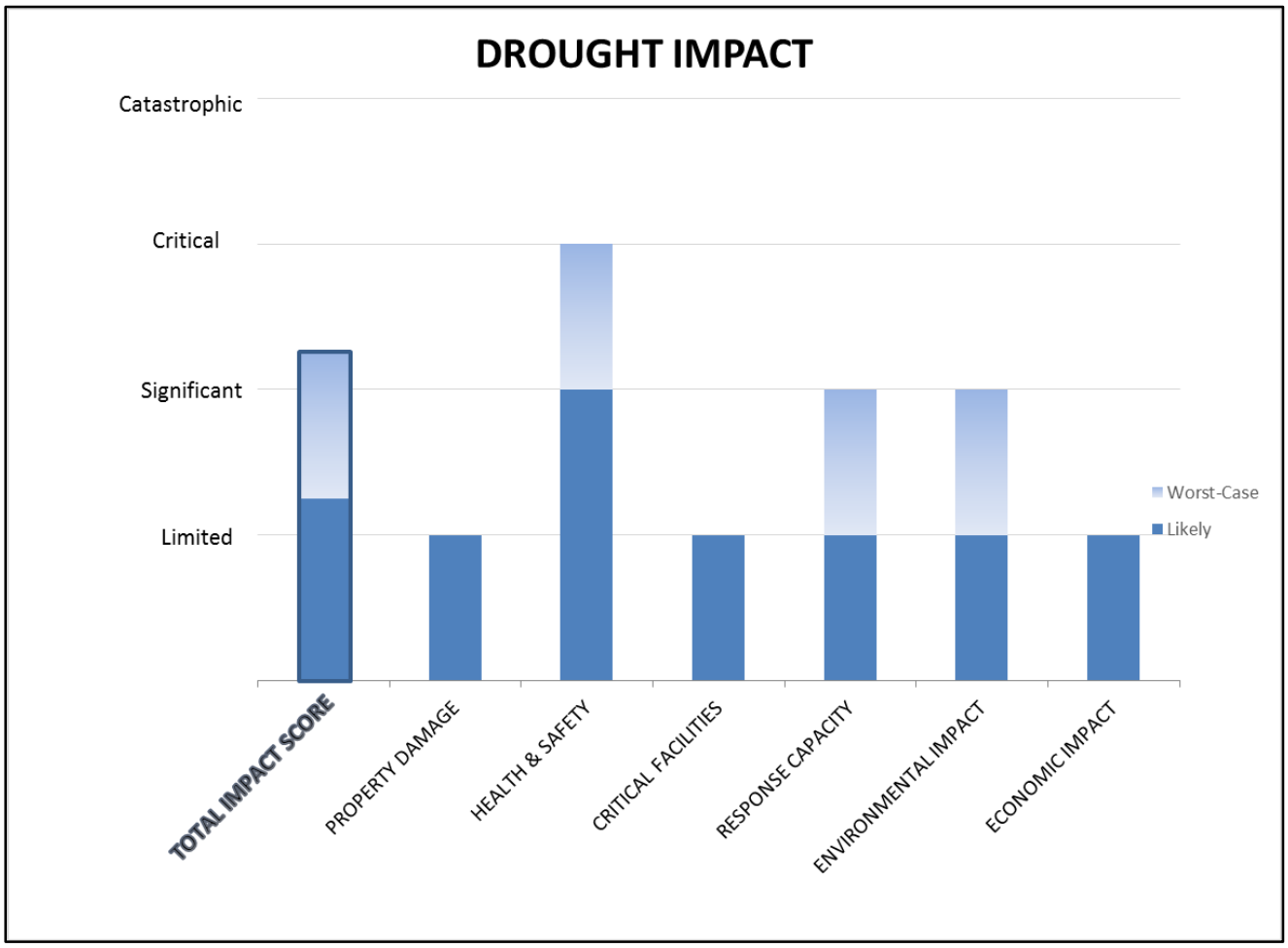
The Future Likelihood section anticipates the future occurrence rate of the hazard based on historical likelihood and future trends. This section also addresses factors that may cause the future likelihood to deviate from historical trends.

Future Likelihood of a Drought Hazard in Howard County	
Historical Average (time period)	Once every two years (1995-2011)
Historical Annual Probability	46% chance of annual occurrence
Future Likelihood Expected to Deviate from Historical Likelihood (Yes/No)	No
Future Annual Probability	11-30% chance of annual occurrence
Future Likelihood Score[4]	3 (Likely)
Future Likelihood reflects the likelihood of any emergency-level hazard event and does not differentiate between Likely and Worst-Case scenarios.	

IV. CONSEQUENCE ANALYSIS

The Consequence Analysis section provides a detailed characterization of the anticipated consequences of likely and worst-case hazard events. This section characterizes impacts to property, health & safety, critical facilities, response capacity, the environment, and the economy. This section also characterizes public perceptions of each hazard, the perceived impact to personal safety and standard of living, and public confidence in response capability.

Consequence Analysis Overview



Where no Worst-Case bar is visible, Worst-Case impact is equivalent to Likely impact.

Drought Warning Time & Duration		
	Likely	**Worst-Case**
WARNING TIME	*Very long.* Warning time of 3-5 days.	*Very long.* Warning time of 3-5 days.
DURATION	*Very Long.* 1-30 Days.	*Very long.* A drought could last for 2 months or longer.

Consequence Analysis: Likely Hazard Scenario

The Consequence Analysis table details the anticipated consequences of the most likely hazard scenario.

DROUGHT Likely		
PROPERTY DAMAGE	*Limited*	• 0% of critical and non-critical infrastructure damage if water service is uninterrupted • Damaged landscaping is expected.
HEALTH & SAFETY	*Significant*	• 1 death is expected. Heat related injuries (i.e. Heat Stroke) are the most common cause of death. • 0-5 injuries are expected. Dehydration, heat exhaustion, and heat stroke are the most common causes of injuries.
CRITICAL FACILITIES	*Limited*	• *Utilities* – No facility shut down or out of service is expected. • *Information/Communications* – No shutdown. No major impact on information or communications infrastructure. • *Transportation* – No delays or shutdowns expected.
RESPONSE CAPACITY	*Limited*	• *Police* – Local resources adequate. Minimal impact to response capability by law enforcement. • *Fire and Rescue* – Local resources adequate. Limited impact on the response capability, primarily to allow rehabilitation for crews working extended operations. • *Health* – Local resources adequate. Howard County Health Department operations will not be affected and will monitor the extreme heat incident from the HDOC.
ENVIRONMENTAL IMPACT	*Limited*	• Temporary spike in air pollution with minimal effect on water and land resources is expected.
ECONOMIC IMPACT	*Limited*	• Very limited amount of loss in dollar value. • Limited economic consequences. Probable shift in hours of construction projects and other outdoor projects. • Limited economic impact.
TOTAL IMPACT	*Limited-Significant*	• Total Impact Score: 1.25 on a scale of 1 (Limited) to 4 (Catastrophic).
Limited	*Significant*	*Critical*	*Catastrophic*

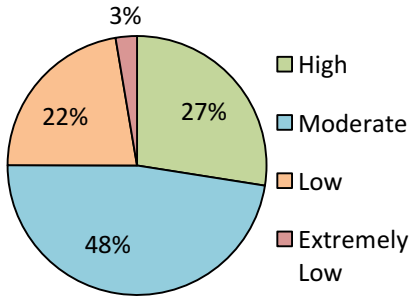
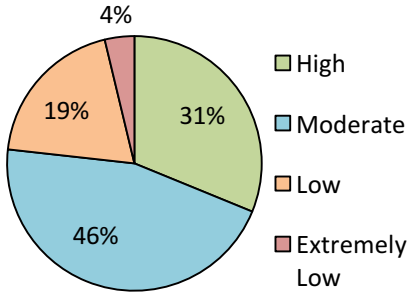
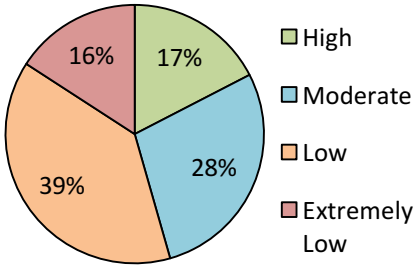
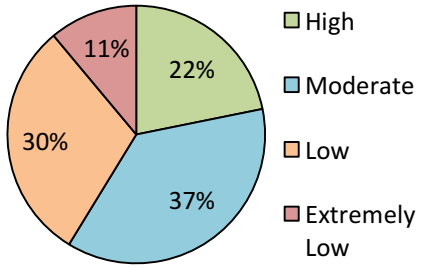
Consequence Analysis: Worst-Case Hazard Scenario

The Consequence Analysis: Worst-Case table details the anticipated consequences of the worst-case hazard scenario.

DROUGHT Worst-Case		
PROPERTY DAMAGE	*Limited*	• Up to 1% of critical and non-critical infrastructure will be damaged. • Damaged well pumps, landscaping, forests, and occasional fires are expected.
HEALTH & SAFETY	*Critical*	• 5 deaths are expected. Heat stroke is the most common cause of death. • 0-20 injuries are expected. Dehydration, heat exhaustion, and heat stroke are the most common causes of injuries.
CRITICAL FACILITIES	*Limited*	• *Utilities* – No facility shut down or out of service is expected. • *Information/Communications* – No shutdown. No major impact on information or communications infrastructure. • *Transportation* – No delays or shutdowns expected.
RESPONSE CAPACITY	*Limited*	• *Police* – Local resources adequate. • *Fire & Rescue* – Mutual aid needed. Water supply contingencies may need to be out in place for suppression efforts and water bans for stations may be used. • *Health* – Local resources adequate. Howard County Health Department operations will not be affected and will monitor the extreme heat incident from the HDOC.
ENVIRONMENTAL IMPACT	*Limited*	• Would cause increased air (ozone) and water pollution, drinking water reservoir would drop but a 40 day period of no/low rainfall is manageable for the large reservoir systems. Quality in the large reservoir systems would be affected. • The decline in water tables would affect stream levels to drop or dry up impacting aquatic and terrestrial life, including livestock, and may cause a loss of individuals, but not cause extinction. • If drought/heat is broken by heavy rains, this will cause an additional spike in water pollution and flooding. • Limited-Significant environmental impact is expected.
ECONOMIC IMPACT	*Limited*	• Limited economic impact.
TOTAL IMPACT	*Significant-Critical*	• Total Impact Score: 2.25 on a scale of 1 (Limited) to 4 (Catastrophic).
Limited	*Significant*	*Critical*	*Catastrophic*

Consequence Analysis: Public Perception

The Consequence Analysis: Public Perception table characterizes public perceptions of each hazard. Details include public confidence in personal ability to respond to each hazard, public confidence in Howard County's ability to respond to each hazard, and each hazard's perceived impact to personal safety and standard of living.

Public Perceptions On Drought			
PERCEIVED CONFIDENCE IN HOWARD COUNTY'S ABILITY TO RESPOND AND RECOVER FROM THIS HAZARD	**PERCEIVED CONFIDENCE IN PERSONAL ABILITY TO PROTECT SELF AND FAMILY FROM THIS HAZARD**	**CONCERN OVER THE IMPACT TO PERSONAL HEALTH AND SAFETY IF THIS HAZARD WERE TO OCCUR LOCALLY**	**CONCERN OVER THE IMPACT TO PERSONAL STANDARD OF LIVING / QUALITY OF LIFE IF THIS HAZARD WERE TO OCCUR LOCALLY**
			
Average: 3.00 *Moderate*	*Average: 3.04* *Moderate*	*Average: 2.47* *Moderately - Low Concern*	*Average: 2.69* *Moderately - Low Concern*

Earthquake

I. OVERVIEW

The Overview section defines the hazard and summarizes the hazard risk profile.

Definition

This section defines the scope of the hazard category. The terminology and characterization established in this section should be consistent throughout all Howard County planning documents.

An earthquake is a sudden release of energy from the earth's crust that creates seismic waves. Tectonic plates become stuck, thus putting a strain on the ground. When the strain becomes so great that rocks give way, fault lines occur. At the earth's surface, earthquakes may manifest themselves by a shaking or displacement of the ground.

Risk Profile

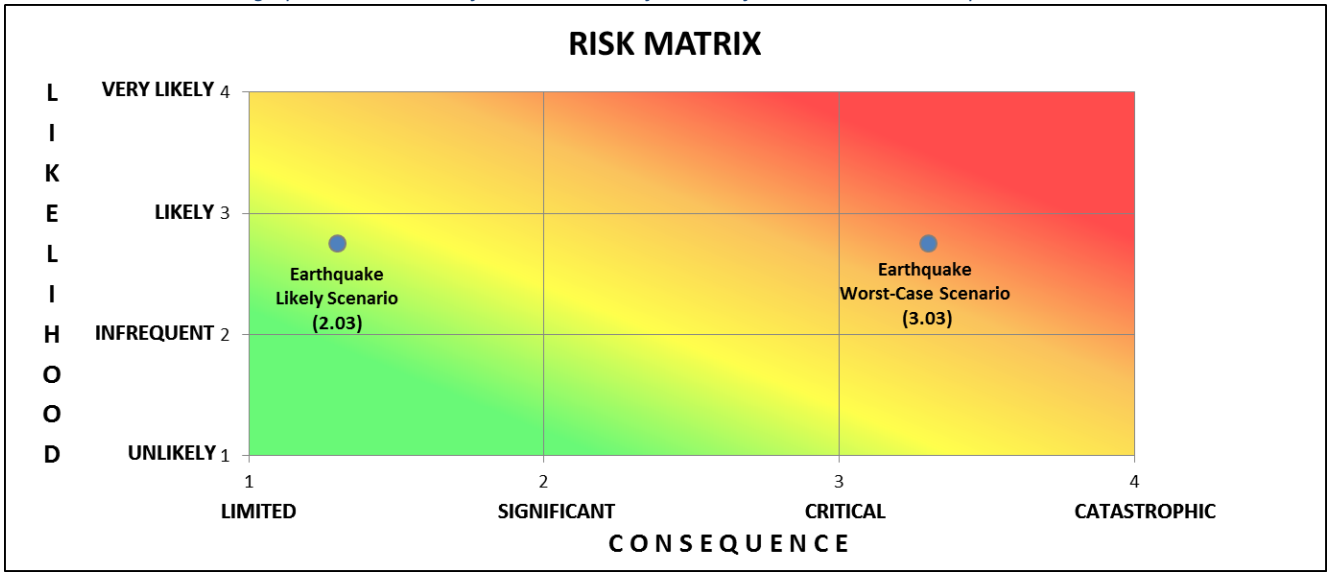
The Risk Profile section presents the Risk Score for the hazard in a range from 1 (lowest risk) to 4 (highest risk). Risk Score is a function of Likelihood and Consequence.

Earthquake Risk Profile				
	Risk Assessment Category	**Likely Hazard Scenario**	**Worst-Case Hazard Scenario**	**Weight**
LIKELIHOOD	**Likelihood**	2.75 Infrequent-Likely		50%
CONSEQUENCE	**Impact**	1 Limited	3.5 Critical-Catastrophic	40%
	Warning Time	4 Short	4 Short	5%
	Duration	1 Short	1 Short	5%
TOTAL RISK SCORE		**2.03**	**3.03**	

**The Likelihood Score reflects the likelihood of any emergency-level hazard event and does not differentiate between Likely and Worst-Case scenarios.*

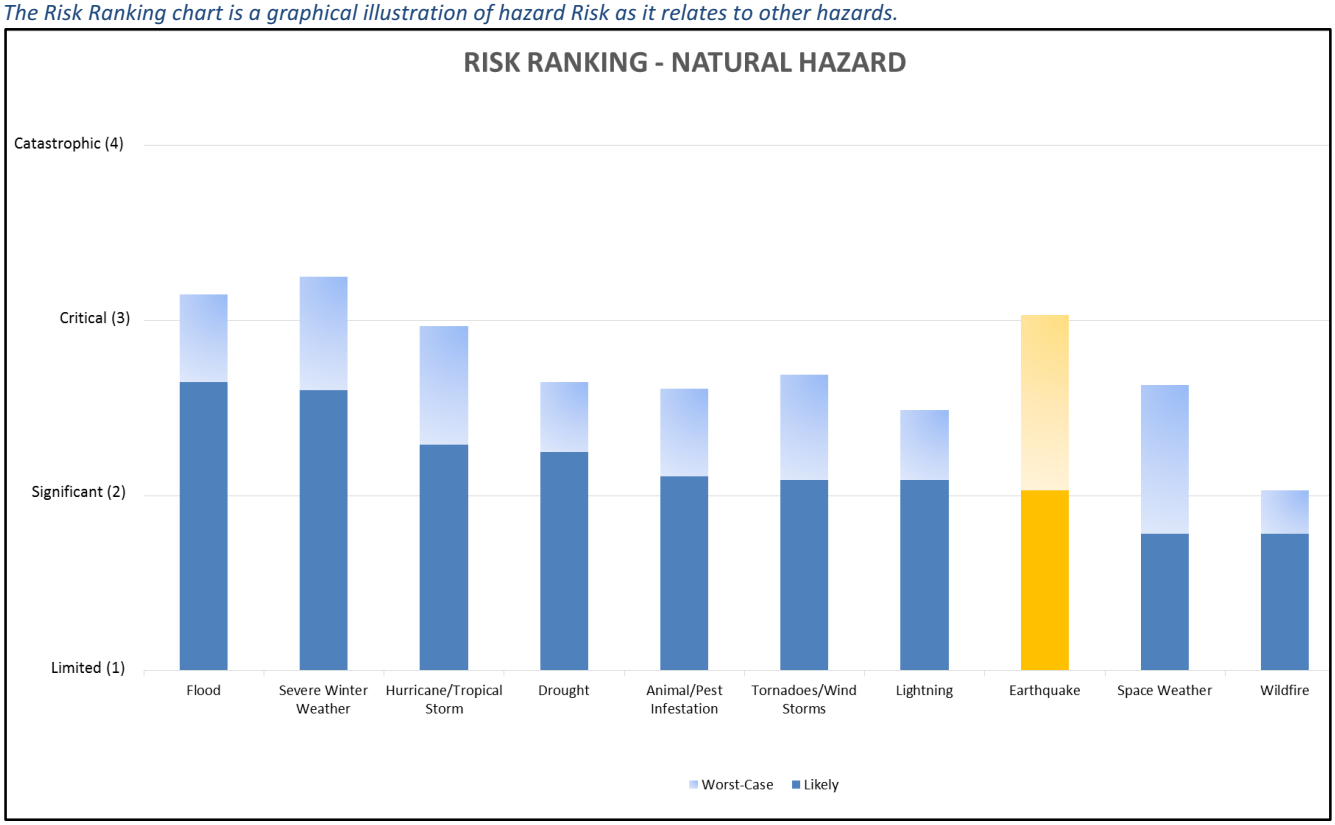
Risk Matrix

The Risk Matrix chart is a graphical illustration of hazard Risk as a function of Likelihood and Consequence.



Risk Ranking

The Risk Ranking chart is a graphical illustration of hazard Risk as it relates to other hazards.



Where no Worst-Case bar is visible, Worst-Case Risk is equivalent to Likely Risk.

II. HAZARD CHARACTERISTICS

The Hazard Characteristics section provides a detailed characterization of the hazard and the local context as it relates to the hazard.

Description of the Hazard

An earthquake is a sudden release of energy from the earth's crust that creates seismic waves. Tectonic plates become stuck, thus putting a strain on the ground. When the strain becomes so great that rocks give way, fault lines occur. At the Earth's surface, earthquakes may manifest themselves by a shaking or displacement of the ground. This may lead to loss of life and destruction of property. The size of an earthquake is expressed quantitatively as magnitude[63], while local strength of shaking is expressed as intensity.

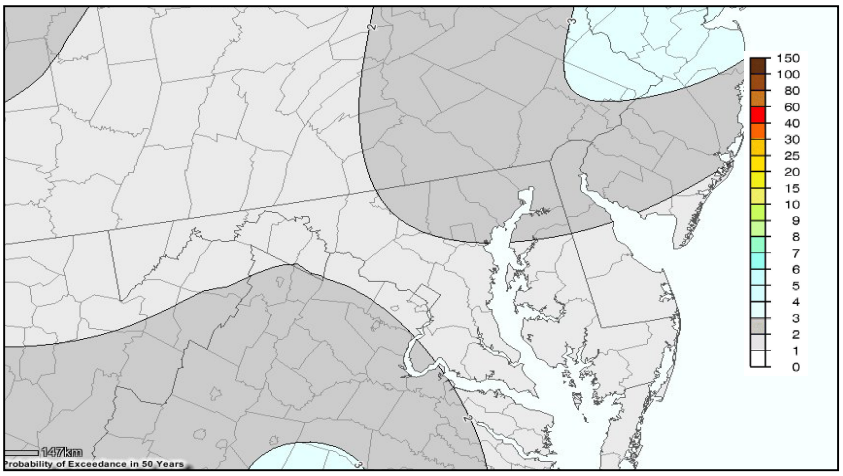
Local Context

The Local Context section describes community attributes that affect the likelihood of the hazard's occurrence or vulnerability to the hazard's consequences.

The entire planning area is susceptible to the effects of earthquakes. The map shows peak ground acceleration (pga) with a 10% chance of being exceeded over 50 years. The map shows a 1% to 2%g (the acceleration of gravity) range across most of Central Maryland, including Howard County. The FEMA How-To Guidance[64] suggests an earthquake hazard should be profiled if the pga is greater than 3%g. In other words, an earthquake only qualifies as a hazard if the ground acceleration reaches 3%g or greater.

The Figure below displays the Mid-Atlantic portion of a United States Geological Survey (USGS) earthquake hazard map produced in 2008.

Seismic Hazard Map, showing Peak Ground Acceleration in Percent of G, with 10% exceedance in 50 years
(Source: USGS, 2008)



[63] The inherent size of an earthquake is commonly expressed using a magnitude.
[64] FEMA 386-2, *FEMA How-To Guidance; Understanding Your Risks*, p 1-7 (2001).

There are several reasons why Howard County has particular vulnerability to Earthquakes. Most buildings in the County are not up to Earthquake Standards. Also, because earthquakes happen so infrequently in the area, most residents are not as familiar with what to do during an earthquake. The County also has a high prevalence of nursing homes where earthquakes could present additional vulnerabilities for citizens with functional needs.

III. LIKELIHOOD ANALYSIS

The Likelihood Analysis section characterizes the historical occurrence and future likelihood of the hazard in the planning area.

Occurrence of the Hazard

The Occurrence of the Hazard section details the historical occurrence of the hazard in the planning area.

Historically, there has been no record of earthquakes with an epicenter in Howard County, except for a cluster of small earthquakes in 1993 in Allview Estates in Columbia, MD[65]. But the County has experienced minor shaking from earthquakes located outside of the region. Maryland's USGS earthquake history was reviewed to identify past earthquake occurrences that have impacted Howard County. The data indicated that from March through December 1993, a series of two dozen small tremors occurred near Columbia, Maryland, ranging in magnitude from >1 to 2.7 on the Richter Scale. The State's earthquake history shows there have been seven significant earthquakes felt within the State between 1900 and 2014, most notably the August 2011 earthquake which had an epicenter in Central Virginia. . Of these seven events, the USGS's earthquake descriptions indicate that while several of these events were felt in Howard County, there were none that had a significant impact on the County nor were any damages or injuries reported

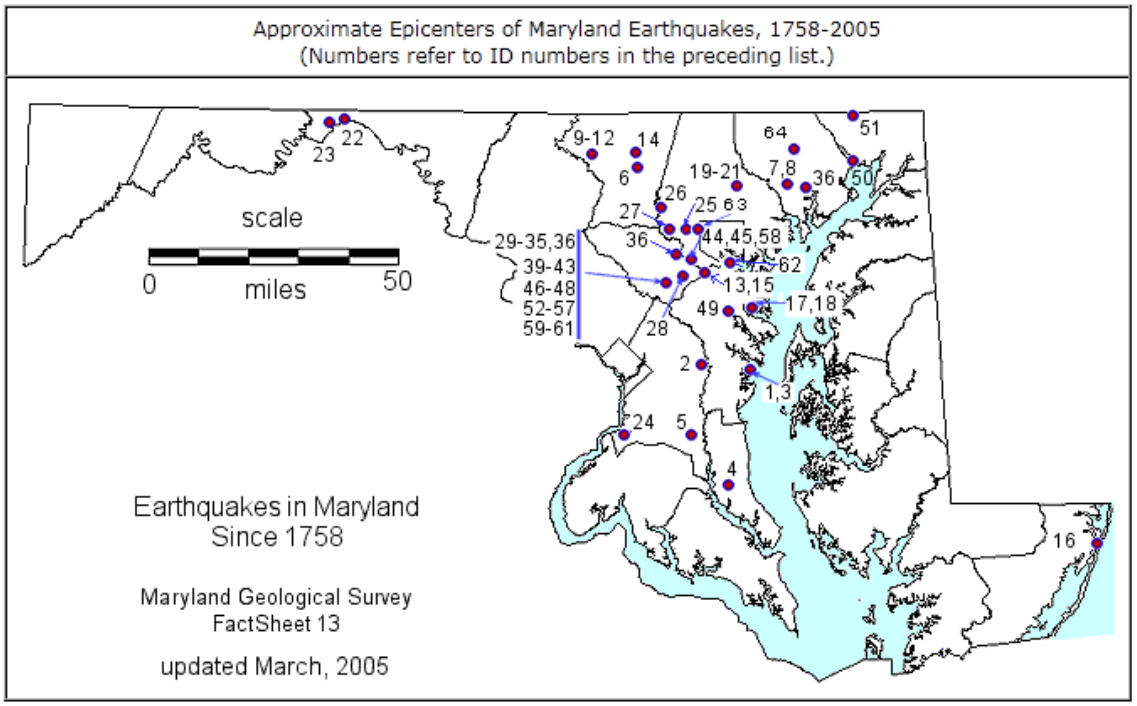
The USGS shows the earliest recorded earthquake with its epicenter in Maryland occurred in Annapolis on April 24, 1758. The shock lasted 30 seconds and could be felt as far away as Pennsylvania. In recent years, moderate-sized earthquakes in nearby states have been felt in Maryland with only minimal effects. On November 19, 1969, a 4.3 magnitude earthquake near Elgood, West Virginia was felt in Central Maryland, including Howard County. On February 28, 1973, residents throughout the Mid-Atlantic region were jolted awake by shock waves from a minor earthquake near the Delaware/New Jersey/Pennsylvania border. Numerous points in Northeastern Maryland reported this earthquake.[66]

Data from the Maryland Geological Survey (MGS) indicates there have been 64 earthquakes with epicenters in Maryland. Of these 64 earthquakes, 26 affected localities within Howard County.[67] Review of the events with epicenters in Howard County indicates these were all minor events, ranging in magnitude between 1.0 and 2.5.

The figure below shows the approximate epicenters of these earthquakes that occurred between 1758 and 2005.

[65] See Earthquakes and Maryland, http://www.mgs.md.gov/geology/geohazards/earthquakes_and_maryland.html (last accessed February 22, 2016).
[66] Id.
[67] See Summary of Maryland Earthquakes, 1758- 2005, http://www.mgs.md.gov/esic/fs/fs13.html (last accessed June 8, 2012).

Approximate Epicenter of Maryland Earthquakes
(Source: Maryland Geological Survey, Fact Sheet 13, March 2005)[68]



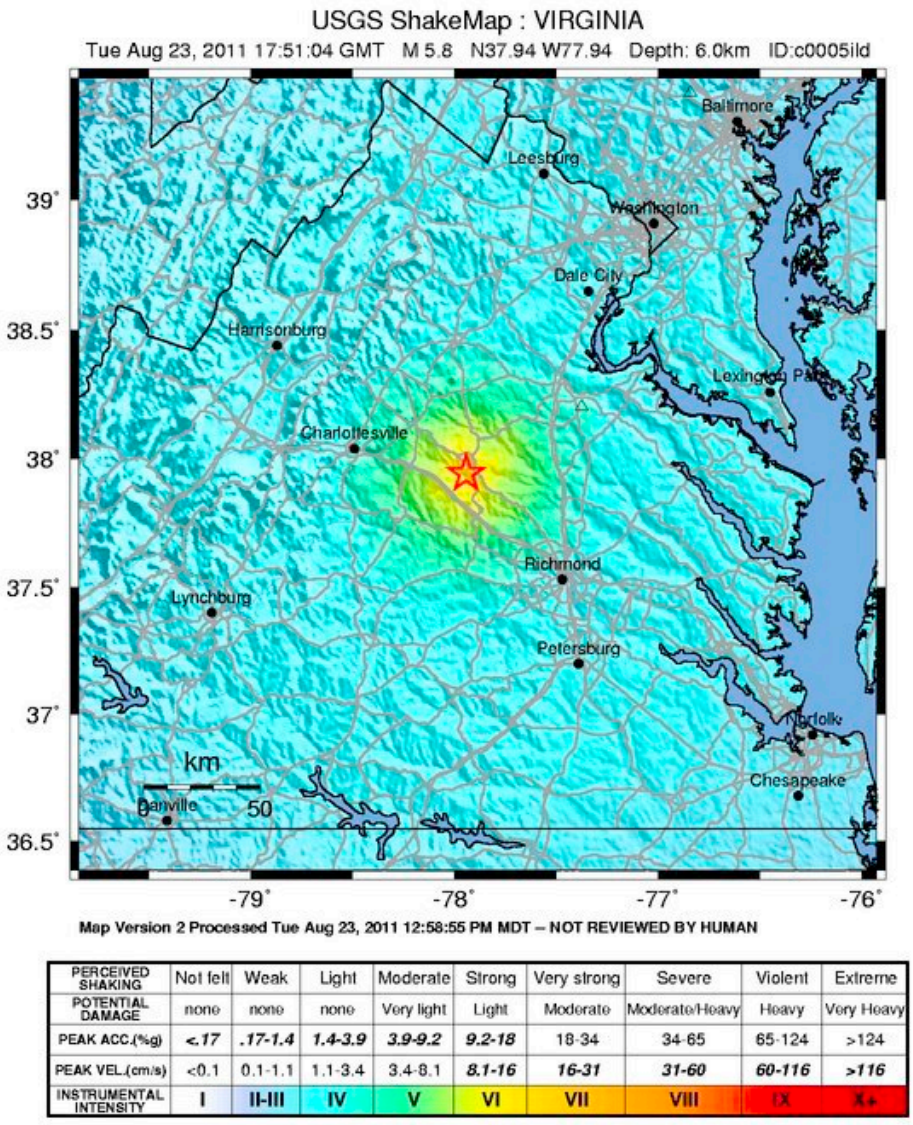
On August 23, 2011, Maryland experienced the effects of a nearby earthquake when a 5.8 magnitude quake centered in Virginia impacted much of the East Coast. Tremors were felt as far south as North Carolina, as far north as Buffalo and Boston, and as far west as Detroit. The epicenter of the earthquake was about 3.5 miles beneath Mineral, Virginia, which is 35 miles northwest of Richmond. The USGS indicated the earthquake was one of the strongest ever to occur in Virginia and the strongest felt in Maryland. After the ground shook for several seconds, buildings were evacuated and some businesses and agencies shut down for the afternoon. Rail travel was interrupted, and many commuters faced an early, congested rush hour.[69] Damage inspections after the earthquake found structural damage was limited, although in some areas there were significant localized damages. In Howard County, many residents were startled by the earthquake but there was no significant damage or injuries reported.[70]

The figure below is a USGS "shake map" that shows the intensity of shaking from the Mineral earthquake. Note that the area west of Baltimore, where Howard County is located, experienced weak to low shaking intensity and no expected damages.

[68] The reference numbers corresponds with a list of earthquakes from the Maryland Geological Survey. See *Summary of Maryland Earthquakes: 1758-2005*, http://www.mgs.md.gov/esic/fs/fs13.html (last accessed April 9, 2012).

[69] Calvert, Scott and Childs Walker, *Earthquake in Virginia Rattles Baltimore and the East Coast*, Baltimore Sun, August 23, 2011, available at http://articles.baltimoresun.com/2011-08-23/news/bs-md-earthquake-20110823_1_maryland-geological-survey-earthquake-smaller-temblors.
[70]Howard County Administration, *Howard County Earthquake Update*, August 23, 2011.

USGS Shake Map for the Mineral, Virginia Earthquake of 2011



PERCEIVED SHAKING	Not felt	Weak	Light	Moderate	Strong	Very strong	Severe	Violent	Extreme
POTENTIAL DAMAGE	none	none	none	Very light	Light	Moderate	Moderate/Heavy	Heavy	Very Heavy
PEAK ACC.(%g)	*<.17*	*.17-1.4*	*1.4-3.9*	*3.9-9.2*	*9.2-18*	18-34	34-65	65-124	>124
PEAK VEL.(cm/s)	<0.1	0.1-1.1	1.1-3.4	3.4-8.1	*8.1-16*	*16-31*	*31-60*	*60-116*	*>116*
INSTRUMENTAL INTENSITY	I	II-III	IV	V	VI	VII	VIII	IX	X+

The likelihood of significant earthquake damage in Howard County is low since the probability of the area being stricken by an earthquake is relatively low as compared to other parts of the country. Even though earthquakes do occur occasionally, the County is located in an area of very low seismic activity. Because of the very low risk associated with this hazard, a detailed risk assessment was not completed for earthquakes.

Future Likelihood of the Hazard for Howard County

The Future Likelihood section anticipates the future occurrence rate of the hazard based on historical likelihood and future trends. This section also addresses factors that may cause the future likelihood to deviate from historical trends.

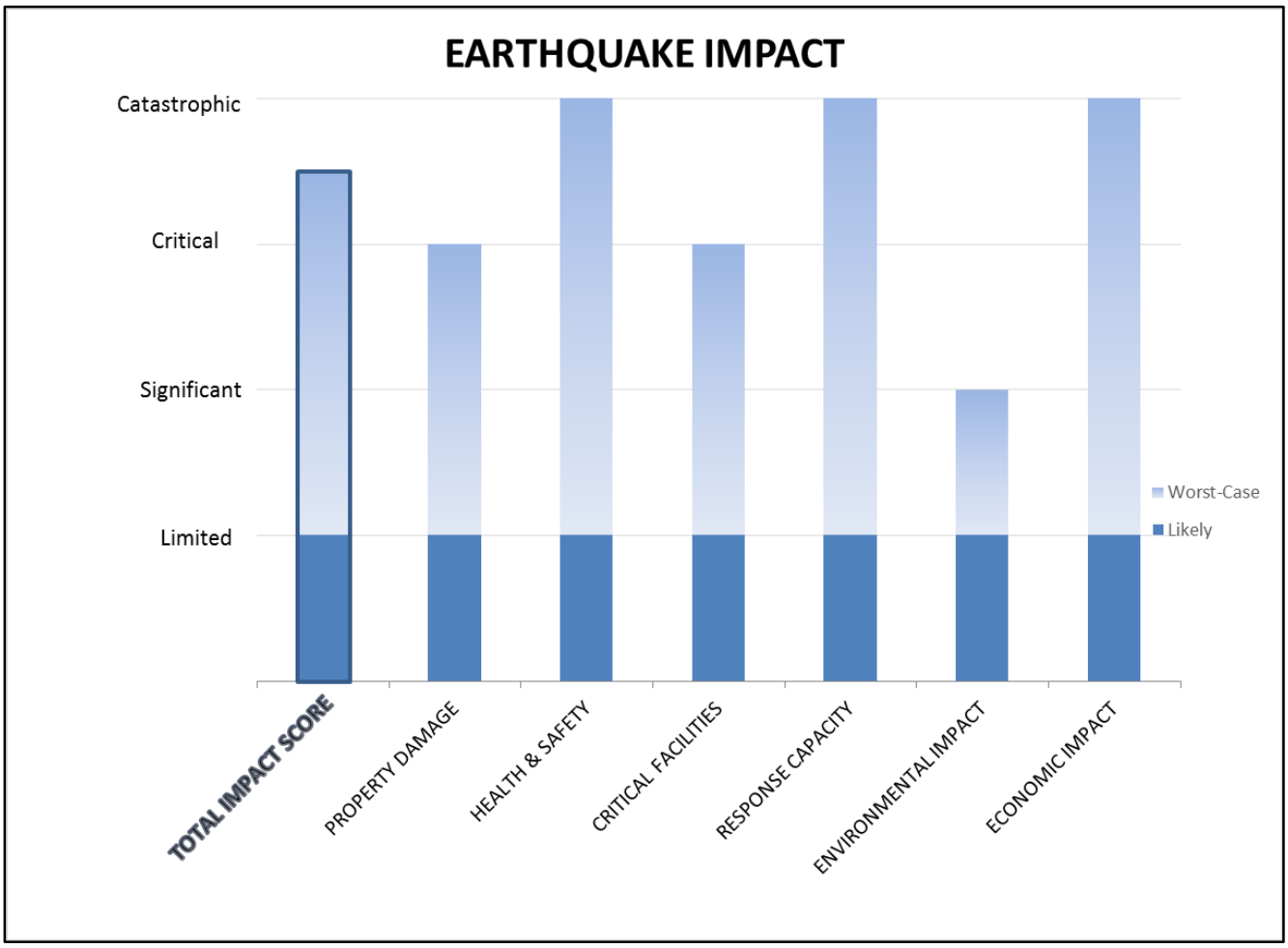
Future Likelihood of an Earthquake Hazard in Howard County	
Historical Average (time period)	10 events in 24 years (1990-2014)
Historical Annual Probability	41.6% chance of annual occurrence
Future Likelihood Expected to Deviate from Historical Likelihood (Yes/No)	Yes
Future Annual Probability	1-30% chance of annual occurrence
Future Likelihood Score[4]	2.75 (Infrequent-Likely)
Future Likelihood reflects the likelihood of any emergency-level hazard event and does not differentiate between Likely and Worst-Case scenarios.	

Considerations: While there is a very likely chance (30%+) of *any* earthquake occurring annually based on historical data, most earthquakes would be low enough in intensity that most residents would not feel them. The historical number of earthquakes large enough to force the activation of the EOC (like the 2011 earthquake) is much lower than the annual occurrence.

IV. CONSEQUENCE ANALYSIS

The Consequence Analysis section provides a detailed characterization of the anticipated consequences of likely and worst-case hazard events. This section characterizes impacts to property, health & safety, critical facilities, response capacity, the environment, and the economy. This section also characterizes public perceptions of each hazard, the perceived impact to personal safety and standard of living, and public confidence in response capability.

Consequence Analysis Overview



Where no Worst-Case bar is visible, Worst-Case impact is equivalent to Likely impact.

Earthquake Warning Time & Duration		
	Likely	**Worst-Case**
WARNING TIME	*Short.* No warning time prior to an attack.	*Short.* No warning time prior to an attack.
DURATION	*Short.* 5 seconds.	*Short.* 15 seconds.

Consequence Analysis: Likely Hazard Scenario

The Consequence Analysis table details the anticipated consequences of the most likely hazard scenario.

EARTHQUAKES Likely		
PROPERTY DAMAGE	*Limited*	• Up to 0.5% critical and non-critical infrastructure will be damaged. • Minor structural damage expected.
HEALTH & SAFETY	*Limited*	• *Health*- 0 deaths are expected. Being crushed by structural damage is the most common cause of death. • *Health*- 0-5 injuries are expected. Broken or fractured bones and internal bleeding are the most common causes of injuries.
CRITICAL FACILITIES	*Limited*	• Utilities – Water lines would be the only essential functions that will be out of service. Other outages unlikely. • *Information/Communications* – No shutdown. No major impact on information or communications infrastructure. • *Transportation* – Delays for less than one day. Some localized road closures will occur, but delays will not be excessive. Impacts to transportation will be minor and short-term.
RESPONSE CAPACITY	*Limited*	• *Police* – Local resources adequate. • *Fire & Rescue* – Local resources adequate. Should not impact operations. May require damage assessment teams. • *Health* – Local resources adequate. Howard County Health Department operations will not be affected after building has been cleared to be safe by emergency/ facility personnel. • *Public Works* – Local resources adequate with no impact response capability and continuity of operations.
ENVIRONMENTAL IMPACT	*Limited*	• Minimal environmental impact on air, water, and land is expected. • Limited environmental impact is expected.
ECONOMIC IMPACT	*Limited*	• May cause millions of loss in dollar value. • Retail losses due to closures and stock damage in economic consequences. • Limited economic impact.
TOTAL IMPACT	*Limited*	• Total Impact Score: 1 on a scale of 1 (Limited) to 4 (Catastrophic).
Limited	*Significant*	*Critical*	*Catastrophic*

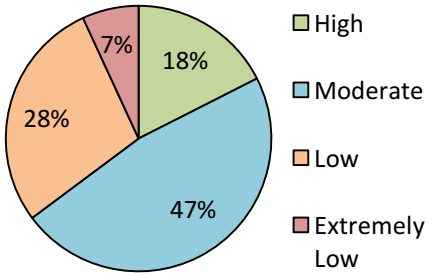
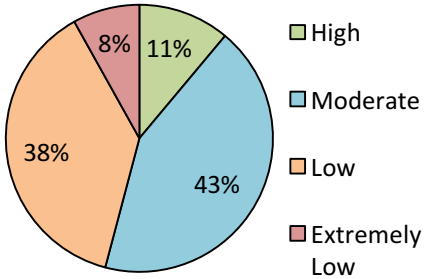
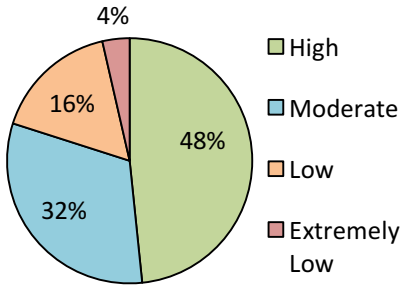
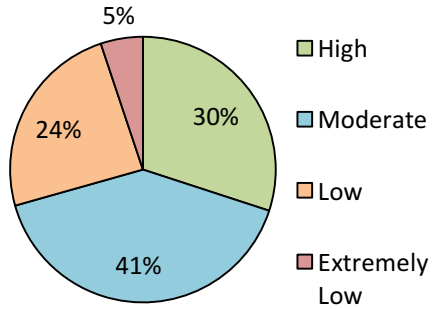
Consequence Analysis: Worst-Case Hazard Scenario

The Consequence Analysis: Worst-Case table details the anticipated consequences of the worst-case hazard scenario.

EARTHQUAKES Worst-Case		
PROPERTY DAMAGE	*Critical*	• Up to 80% critical and non-critical infrastructure will be damaged. • Catastrophic structural damage. Severely damaged sewer and water mains, dam, pipeline, roads, and bridges damage expected. • Significant structural damage to commercial and residential occupancies plus roads, rails, bridges, and utility services is expected.
HEALTH & SAFETY	*Catastrophic*	• 25-50 deaths are expected. Being crushed by structural damage are the most common causes of death. • 100-200 injuries are expected. Broken or fractured bones and internal bleeding are the most common causes of injuries.
CRITICAL FACILITIES	*Critical*	• *Transportation* – Transportation, water service, waste water, landfill, transfer station, and fire stations will be out of service. • *Information/Communications* – Significant/extended outage expected. • *Utilities* – Power will be out of service. Significant/extended outage expected, perhaps for a period of weeks or months.
RESPONSE CAPACITY	*Catastrophic*	• *Police* – Moderate need for state or federal assistance. Moderate impact on law enforcement due to security detail, traffic detail, and increased response to hazard calls. Additional resources required from Sherriff's office and possible State police. • *Fire & Rescue* – Severe and long-lasting need for state or federal assistance. Significant impact to response capability, alternate work schedules may be required, mutual assistance from non-impacted jurisdictions, US&R, DMAT, maybe DMORT. COOP will be needed. • *Health* – Moderate need for state or federal assistance. HCHD has COOP plans in place to ensure essential functions continue either on site (if possible) or at an alternate location. • *Public Works* – Moderate to significant and long lasting need for state or federal assistance with severe impact to response capability and continuity of operations.
ENVIRONMENTAL IMPACT	*Significant*	• Minimal direct impact on air, water, and land resources. May cause a loss of individual animals and plants. • Infrastructure damage can cause air, water, or land pollution if it disrupts facilities such as pipelines carrying hazardous materials industrial manufacturing plants, or sewage treatment plants. • If ponds or lake dams are damaged and release water, this could cause downstream flooding. • Limited-Significant environmental impact is expected.
ECONOMIC IMPACT	*Catastrophic*	• Hundreds of millions and up of loss in dollar value. • Business, government, and retail closures and residential dislocation with a minimum of 1-2 week evaluations before recovery begin in economic consequences.
TOTAL IMPACT	*Critical - Catastrophic*	• Total Impact Score: 3.5 on a scale of 1 (Limited) to 4 (Catastrophic).
Limited	*Significant*	*Critical*	*Catastrophic*

Consequence Analysis: Public Perception

The Consequence Analysis: Public Perception table characterizes public perceptions of each hazard. Details include public confidence in personal ability to respond to each hazard, public confidence in Howard County's ability to respond to each hazard, and each hazard's perceived impact to personal safety and standard of living.

Public Perceptions on Earthquakes			
PERCEIVED CONFIDENCE IN HOWARD COUNTY'S ABILITY TO RESPOND AND RECOVER FROM THIS HAZARD	**PERCEIVED CONFIDENCE IN PERSONAL ABILITY TO PROTECT SELF AND FAMILY FROM THIS HAZARD**	**CONCERN OVER THE IMPACT TO PERSONAL HEALTH AND SAFETY IF THIS HAZARD WERE TO OCCUR LOCALLY**	**CONCERN OVER THE IMPACT TO PERSONAL STANDARD OF LIVING / QUALITY OF LIFE IF THIS HAZARD WERE TO OCCUR LOCALLY**
			
Average: 2.75 *Moderate - Low*	*Average: 2.20* *Low*	*Average: 3.25* *Moderately Concerned*	*Average: 2.96* *Moderately - Low Concern*

Flood

I. OVERVIEW

The Overview section defines the hazard and summarizes the hazard risk profile.

Definition

This section defines the scope of the hazard category. The terminology and characterization established in this section should be consistent throughout all Howard County planning documents.

Flooding is defined as the accumulation of water that exceeds a physical barrier or collects in a low lying area that leads to the inundation of an area. Flooding typically results from large scale weather systems that generate prolonged or highly impactful rainfall. Other conditions such as winter snow thaws, over-saturated soil, ice jams breaking apart, and urbanization can cause flooding as well.

Risk Profile

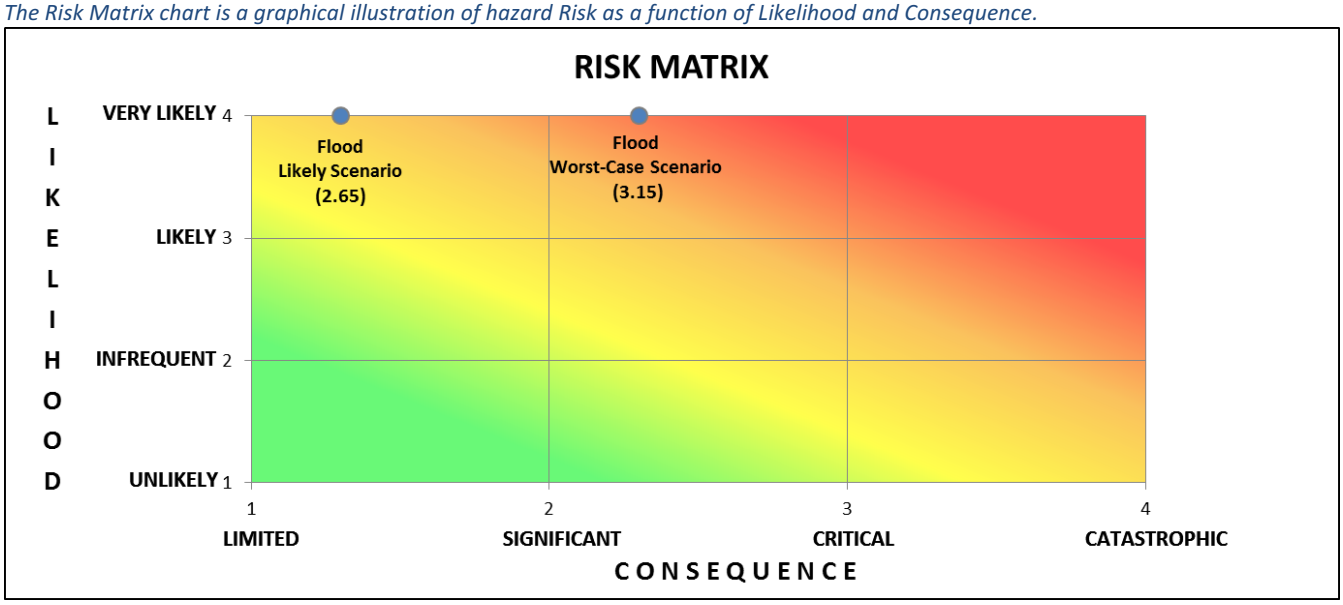
The Risk Profile section presents the Risk Score for the hazard in a range from 1 (lowest risk) to 4 (highest risk). Risk Score is a function of Likelihood and Consequence.

Flood Risk Profile				
	Risk Assessment Category	**Likely Hazard Scenario**	**Worst-Case Hazard Scenario**	**Weight**
LIKELIHOOD	**Likelihood**	4 Very Likely		50%
CONSEQUENCE	**Impact**	1 Limited	2 Significant	40%
	Warning Time	4 Short	4 Short	5%
	Duration	1 Short	3 Short	5%
TOTAL RISK SCORE		**2.65**	**3.15**	

**The Likelihood Score reflects the likelihood of any emergency-level hazard event and does not differentiate between Likely and Worst-Case scenarios.*

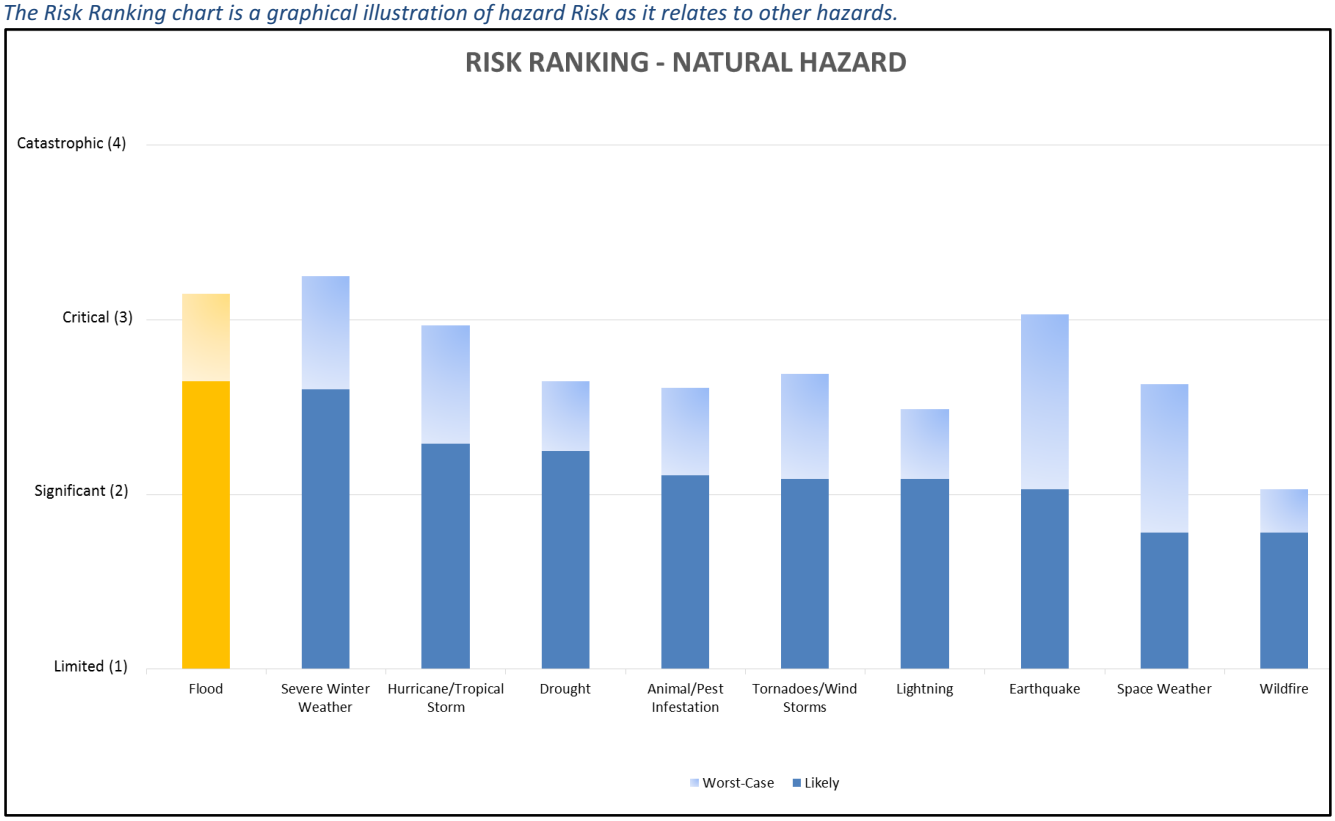
Risk Matrix

The Risk Matrix chart is a graphical illustration of hazard Risk as a function of Likelihood and Consequence.



Risk Ranking

The Risk Ranking chart is a graphical illustration of hazard Risk as it relates to other hazards.



Where no Worst-Case bar is visible, Worst-Case Risk is equivalent to Likely Risk.

II. HAZARD CHARACTERISTICS

The Hazard Characteristics section provides a detailed characterization of the hazard and the local context as it relates to the hazard.

Description of the Hazard

In the United States, hundreds of floods occur each year, making them one of the most common and costly natural hazards.[71] FEMA defines floods as "a general and temporary condition of partial or complete inundation of two or more acres of normally dry land area or of two or more properties (at least one of which is the policyholder's property) from: overflow of inland or tidal waters, unusual and rapid accumulation or runoff of surface waters from any source or mudflow."[72] It could also mean the "collapse or subsidence of land along the shore of a lake or similar body of water as a result of erosion or undermining caused by waves or currents of water exceeding anticipated cyclical levels that result in a flood as defined above."[73] Flooding typically results from large-scale weather systems that generate prolonged rainfall. Other conditions such as winter snow thaws, over-saturated soil, ice jams that break apart, and urbanization can cause flooding. In Howard County, flooding can follow weather events, including, but not limited to: tropical cyclones (either hurricanes or tropical storms), thunderstorms (convectional and frontal), heavy rain events, winter storms, spring thaws or a combination of these events.

Flooding is a natural event for rivers and streams. Howard County can be impacted by several different types of floods:

- Riverine flooding
- Flash flooding
- Urban flooding

Past flood events in Howard County have shown that many of the streams in the County carry both riverine and flash flood threats. Riverine flooding occurs when rivers, creeks, streams, reservoirs or channels receive too much water, which leads to the excess flow of water over its banks and onto the adjacent floodplain.[74] This type of flooding is often referred to as "overbank" flooding.

Riverine flooding generally occurs over a period of days or weeks. The common nomenclature associated with riverine flooding and floodplains include terms such as the 100-year flood.[75]

Flash floods fall under the riverine flooding category and involve a rapid rise in water level, high water velocity, and large amounts of debris. These types of floods can cause significant damage, including the tearing out of trees, undermining of buildings and bridges, and scouring new channels. The intensity of flash flooding is a function of the amount and duration of rainfall, steepness of the watershed, stream gradients, watershed

[71] Federal Interagency Floodplain Management Task Force, *Floodplain Management in the United States: An Assessment Report*, Volume 1, at 69 (1992).
[72] *FEMA: Definitions*, http://www.fema.gov/business/nfip/19def2.shtm#F (last accessed February 29, 2012).
[73] Id.
[74] A floodplain is a "land areas adjacent to rivers and streams that are subject to recurring inundation." See *Floodplain Definition and Flood Hazard Assessment*, http://www.srh.noaa.gov/mrx/hydro/flooddef.php (last accessed March 4, 2012).
[75] The 100-year flood is a flood which has a one percent chance of being equaled or exceeded in any given year.

vegetation, natural and artificial flood storage areas and configuration of the streambed and floodplain. Dam failure and ice jams may also lead to flash flooding.

Urban flooding is caused by a combination of excessive rainfall or snow melt events that over saturate soils and clog drainage areas. The result of urban flooding is ponding or overland flooding. In ponding events, water temporarily accumulates in an area until normal drainage allows it to flow away. Overland floods, which are also known as sheet flooding, occur when intense rainfall simply runs across the ground. In extreme cases, overland floods can rise to depths of more than a foot at relatively high velocities.[76]

Local Context

The Local Context section describes community attributes that affect the likelihood of the hazard's occurrence or vulnerability to the hazard's consequences.

Howard County's two major rivers (and their tributaries) are often the origin of riverine flooding in the County. These rivers are the Patuxent, which borders Prince George's and Montgomery Counties to the southwest, and the Patapsco, which borders Carroll and Baltimore Counties to the north and northeast. Both rivers are tributaries to the Chesapeake Bay. In Howard County, the Patuxent River watershed includes the main Patuxent River and two branches, the Middle Patuxent and Little Patuxent. Approximately three-quarters of Howard County's land area lies within the Patuxent watershed. The main Patuxent River branch begins at the most western point of Howard County. This river acts as a political boundary between Howard and Montgomery Counties and a source of drinking water for the National Capital Region. The river feeds into two reservoirs, the Rocky Gorge and the Triadelphia Reservoir. The Brighton and Howard Duckett Dams preserve these reservoirs. The Middle Patuxent and the Little Patuxent are two of the three major tributaries of the Patuxent River. The Middle Patuxent starts just south of Interstate 70 and runs through the middle of the County. The Little Patuxent runs southeast through Columbia and meets up with the Middle Patuxent in Savage.

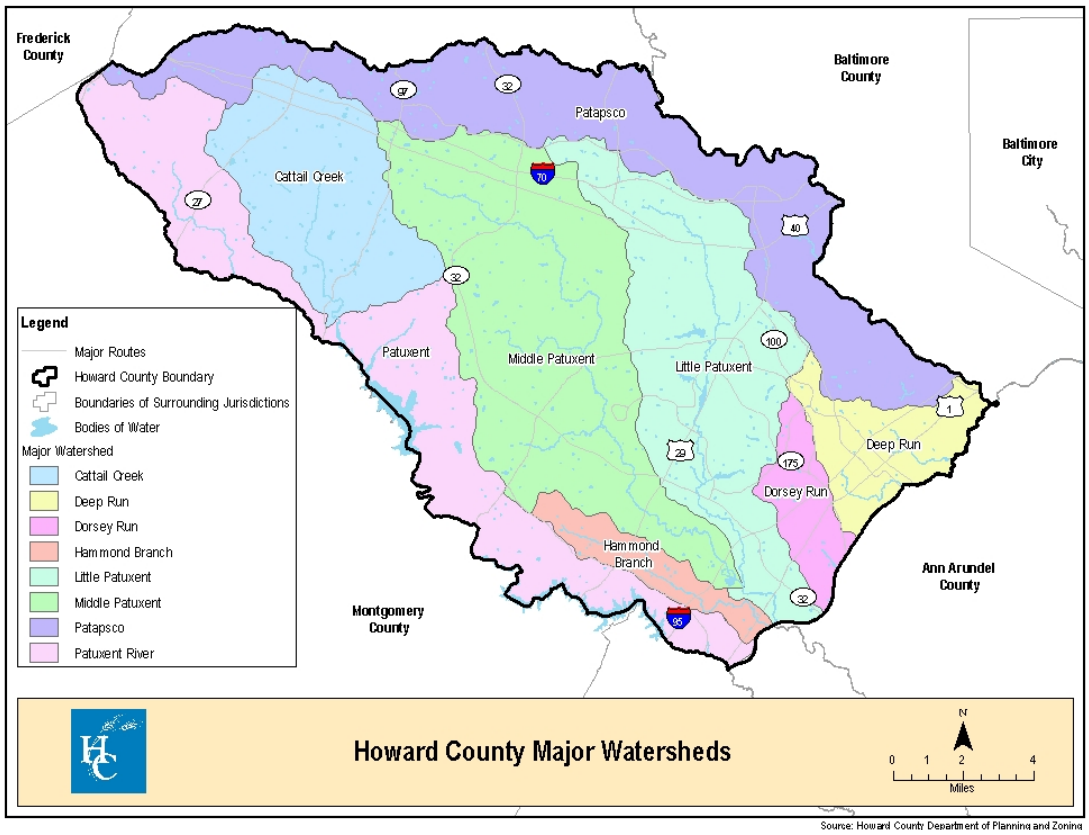
The Patapsco River watershed makes up the remaining quarter of the County's land area. The watershed is located to the extreme north and northwest of the County. The main portion of the Patapsco River acts as a political boundary for the northeast part of Howard County. The river splits into two branches, which serve as the borders for Carroll, Baltimore, and Howard Counties.

The Patuxent, Middle Patuxent, Little Patuxent and Patapsco River watersheds can be divided even further to include Cattail Creek, Deep Run, Dorsey Run, and Hammond Branch watersheds. In addition, the County has several other smaller tributaries. These include: Bonnie Branch, Clyde's Branch, Guilford Branch, Plumtree Branch, and the Tiber-Hudson Branch. All of these tributaries are susceptible to riverine flooding.

These major watersheds of Howard County are visually represented in the figure below.

[76] For additional information about floods, visit *NOAA's Flood Monitor,* http://www.noaawatch.gov/floods.php (last accessed February 29, 2012).

Howard County, Major Watersheds
(Source: Howard County, Planning and Zoning Department)



FEMA prepares and distributes Flood Insurance Rate Maps (FIRMs) to the public, which provide an overview of flood risk and identifies County land that is vulnerable to flooding. FIRMs are used to regulate new development and control the substantial improvement or repair of substantially damaged buildings. Flood Insurance Studies (FIS), often developed in conjunction with FIRMs, contain a narrative of the flood history of a community and discuss the engineering methods used to develop the FIRMs. The study also contains flood profiles for studied flooding sources and can be used to determine Base Flood Elevations (BFE) for some areas.[77]

The most recent Howard County FIS is dated December 4, 1986, and compiles previous flood information and data on numerous waterways. On November 30, 2009, FEMA released a preliminary FIS update for Howard County.

The Flood Mitigation Plan (FMP)[78] indicates that Preliminary Digital Flood Insurance Rate Maps (DFIRMs) were also released for Howard County in 2009 and are under the relevant departments' review.[79] These DFIRMs are made in response to the changing conditions affecting the County, including changes in land use, weather events, and improved techniques for assessing floodplains. These proposed DFIRMs will replace the FIRMs in full. As of the writing of the NHMP, the Department of Public Works is hosting public meetings to discuss and address any question raised by these proposed changes.[80]

The preliminary DFIRM includes new flood zone designations. The table below compares the effective flood zones with the new proposed flood zones. The most significant change is that the new maps replace Zone A with Zone AE, which includes detailed engineering methods to establish Base Flood Elevations (BFE).

Comparison of Flood Hazard Zones (Effective FIRM vs. Preliminary DFIRM)
(Source: Preliminary Flood Insurance Study – Howard County, November, 2009)

Effective Flood Zones	New Flood Zones
A1 – A30	AE
B	X
C	X

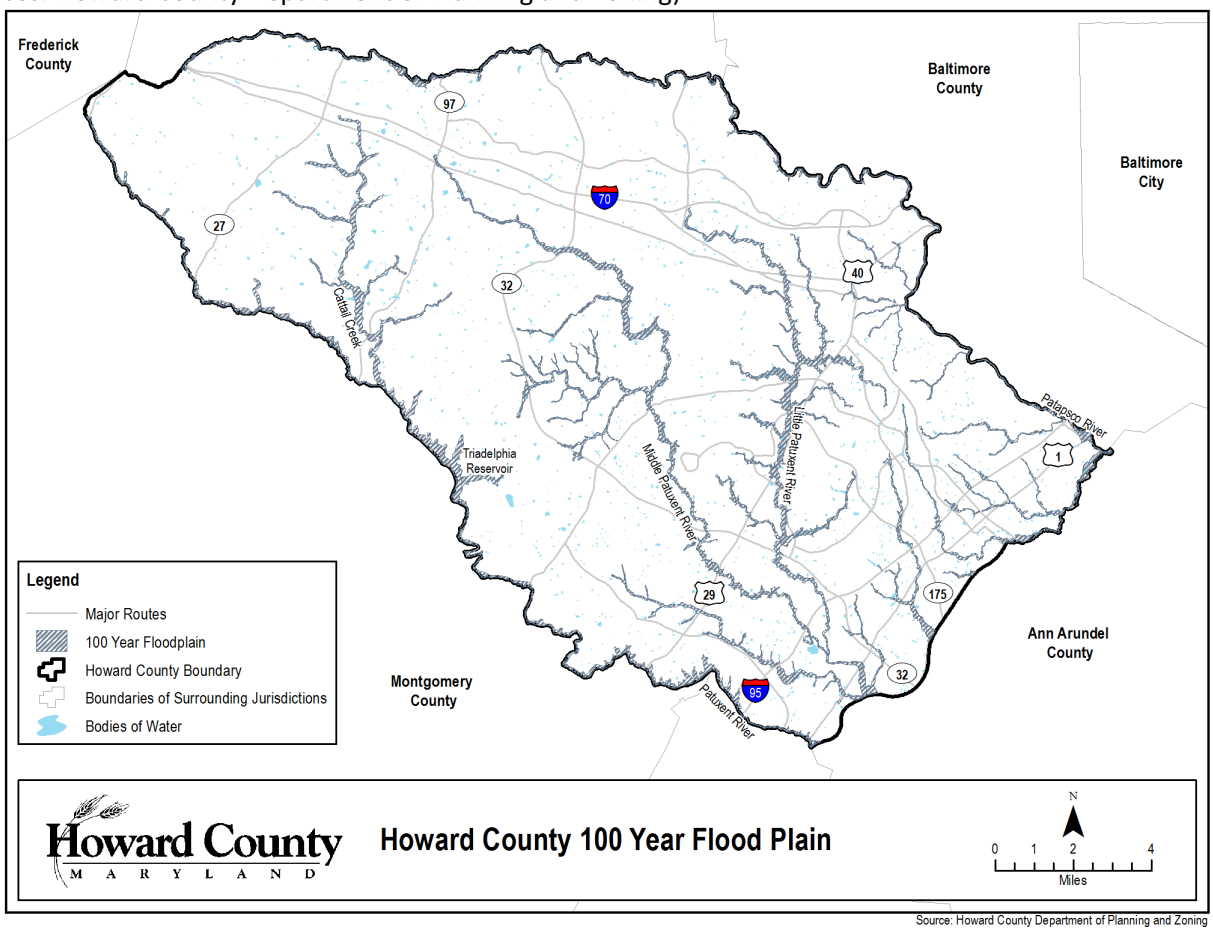
[77] The BFE is defined as the computed elevation to which floodwater is anticipated to rise during the base flood. It serves as the regulatory requirement for the elevation or flood-proofing of structures, which determines the flood insurance premium. See FEMA: Base Flood Elevations, http://www.fema.gov/plan/prevent/floodplain/nfipkeywords/base_flood_elevation.shtm (last accessed March 2, 2012).
[78] Deepa Srinivasan and Dr. Michael Scott, *Flood Mitigation Plan; Howard County, Maryland*, 39 (September 6, 2010) (draft manuscript on file with the Howard County Department of Public Works, Bureau of Environmental Services) [hereinafter as *Flood Mitigation Plan*].
[79] The new DFIRMS now include cross sections (with elevations), as well as the 100-year flood. Id.
[80] Please see http://www.howardcountymd.gov/dfirm.htm for more information regarding the DFIRM update process.

The preliminary Howard County DFIRM shows the following flood zones:

AE Zones along rivers and streams for which detailed engineering methods were used to determine BFEs.
Zone X (shaded). Moderate flood hazard areas between the limits of the base flood and the 0.2-percent-annual-chance (or 500-year) flood.
Zone X (un-shaded). The areas of minimal flood hazard, which are the areas outside the Special Flood Hazard Area (SFHA) and higher than the elevation of the 0.2-percent-annual-chance flood.

The figure below identifies the most current version of the 100-year floodplain for Howard County based on the DFIRM. As the figure below illustrates, the majority of the flood-prone areas are located in the eastern, and more urbanized, portion of the County. The Howard County FMP states that 6.4% of the County's land area is located within the 100-year floodplain and are susceptible to riverine, flash, and urban flooding.[81]

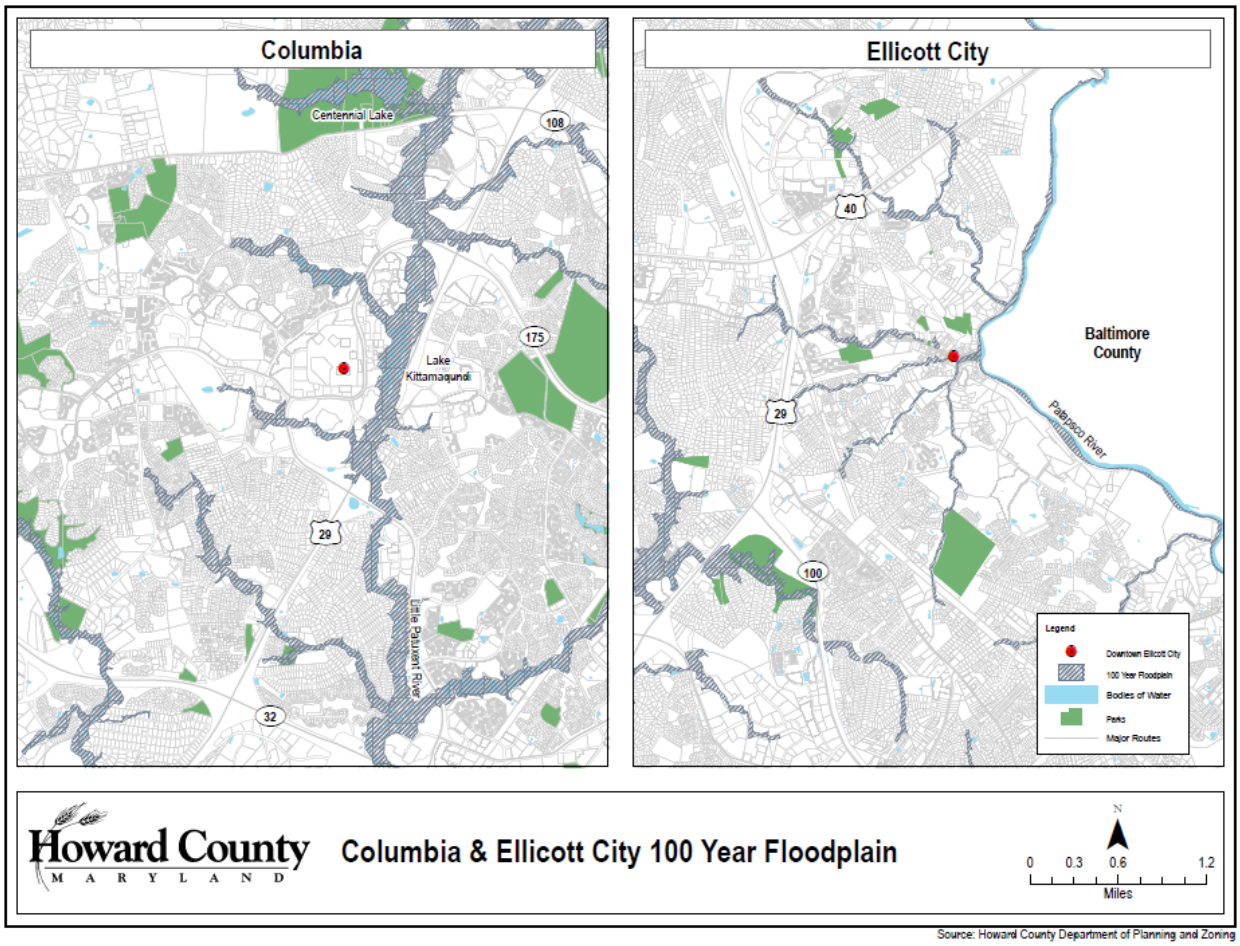
Howard County, 100-year Floodplain (preliminary DFIRM, May 15, 2012)[82]
(Sources: Howard County Department of Planning and Zoning)



[81] Id. at 18.
[82] As the floodplains are still being revised as of the date of this publication, both floodplain figures should not be viewed as definitive.

Ellicott City and Columbia are two areas in the region that are highly susceptible to flood damage due to urbanization.[83] Two DFIRM maps (one of Columbia, and another of Ellicott City) are included here below.

Columbia and Ellicott City, Maryland: 100-year Floodplain (preliminary DFIRM, May 22, 2012)
(Sources: Howard County Department of Planning and Zoning)



Howard County has particular vulnerabilities to floods. Some of the major cities in the County, such as Ellicott City, Elkridge and Allview are in low-lying areas. The aforementioned dams present another challenge. There are also many low-lying roads and railways in the County.

[83] Federal Emergency Management Agency, *Flood Insurance Study: Howard County, Maryland and Incorporated Areas*, 8 (Preliminary report, November 30, 2009), available at https://www.rampp-team.com/county_maps/maryland/howard/howard_revised_prelim/Howard_MD_RP_fis_tables_1.pdf [*hereinafter* Flood Insurance Study]

III. LIKELIHOOD ANALYSIS

The Likelihood Analysis section characterizes the historical occurrence and future likelihood of the hazard in the planning area.

Occurrence of the Hazard

The Occurrence of the Hazard section details the historical occurrence of the hazard in the planning area.

As noted above, the NCDC indicates there have been 88 flooding events in Howard County from 1996 to 2015. The majority of these events were labeled as flash floods, and caused no property damage, injuries or fatalities. Only 10 of the 88 flood events resulted in reported property damage. These ten flood events are listed below in Table 6.4.1-6.

Table 6.4.1-6
Howard County: Flood Events from 1996 to July 2016
Resulting in Property Damage
(Source: NOAA/NCDC)

Event ID	Location	Date	Event Type	Deaths	Injuries	Estimated Property Damage ($)	Estimate Crop Damage ($)
5541344	ALL	1/19/1996	Flash Flood	0	0	5,000	0
5560608	NW PORTION	6/19/1996	Flash Flood	0	0	20,000	0
5560609	NE PORTION	6/19/1996	Flash Flood	0	0	10,000	0
5561173	NW PORTION	6/19/1996	Flash Flood	0	0	30,000	0
5568228	ELKRIDGE	7/30/1996	Flash Flood	0	0	10,000	0
5572206	COUNTYWIDE	9/6/1996	Flash Flood	0	0	25,000	0
5569892	W PORTION	12/13/1996	Flash Flood	0	0	10,000	0
5515118	COUNTYWIDE	6/25/2006	Flash Flood	0	0	150,000	0
575659	SAVAGE	5/19/2015	Flood	1	0	10,000	0
593720	SAVAGE	7/6/2015	Flash Flood	0	0	5,000	0
651633	ELLICOTT CITY	7/30/2016	Flash Flood	2	0	22,400,000	0

Howard County has had numerous flooding incidents, including major events such as Tropical Storm Agnes in 1972, Hurricane Eloise in 1975, Hurricane Floyd in 1999, and Tropical Storm Lee in 2011, and most recently, the Ellicott City flooding event on July 30, 2016. Most incidents are the result of tropical systems, nor'easters or flash flooding from sudden, short-lived rainstorms. To develop the following flood history narratives, information was culled from FIS for Howard County and the NCDC database.

A significant flooding event occurred on July 30, 2016, when a strong storm dropped 6 inches of rain over Ellicott City over a span of two hours.[84] Massive flooding caused extensive damage to businesses and homes on Main Street in Old Town, Ellicott City. The July 2016 storm took two lives and caused at least $22.4 million in estimated damages. The storm caused extensive damage to 90 businesses and 107 homes. The figure below shows pictures of the July 2016 events.

July 30, 2016: Massive Flood Engulfs Main Street in Ellicott City, and Damages Local Homes and Businesses





Another notorious and destructive flooding event in Howard County was caused by Tropical Storm Agnes on June 21 – 23, 1972. The Howard County FIS estimates the total property damage from the storm to be as high as $41.2 million.[85] The majority of the damage occurred along the Patapsco River in Ellicott City and Elkridge areas. The total damage along the Patapsco River was estimated to be approximately $36 million.[86] Property damages along the Little Patuxent River totaled about $2.4 million[87] and damages along the Patuxent and Middle Patuxent totaled roughly $512,000.[88] An estimated $1.1 million[89] worth of damages occurred to roads

[84] The Baltimore Sun, *2 Dead, Emergency Declared After Historic Ellicott City Ragaed By Flash Flood,* http://www.baltimoresun.com/news/maryland/howard/ellicott-city/bs-md-ellicott-city-flood-20160731-story.html (last accessed October 6, 2016)

[85] The figure has been adjusted for inflation and is provided in 2010 dollars, based on the Consumer Price Index.

[86] Id.

[87] Id.

[88] Id.

[89] Id.

and bridges throughout the County. Meanwhile, the SHEDLUS database estimates the total property damage from Tropical Storm Agnes to be roughly $11.17 million.[90] This massive flood caused at least 3 fatalities. The figure below is a photograph showing the flooding that occurred along Main Street in downtown Ellicott City.

Hurricane Agnes, 1972: Flooding along Main Street in Downtown Ellicott City



(Source: The Times Newspaper, 1972)

Other significant flooding events that have impacted Howard County are summarized below. Section 6.4.4 below discusses Tropical Storm Lee and the subsequent flooding of Historic Ellicott City.

- **July 23, 2008:** A slow moving cold front produced waves of heavy showers in the afternoon and evening. Flash flooding occurred, closing several roads including I-95, the nation's main thoroughfare on the East Coast, near Elkridge.
- **June 23 – 26, 2006:** A storm system from the south caused torrential rain that continued for 4 days. The ground was saturated and low lying areas flooded as the area accumulated more than 10 inches of rain. A 2 to 3 feet storm surge, coupled with flood water, washed away part of Vollmerhausen Road Bridge and forced the closing of minor roads. Main Street in Ellicott City flooded, which broke a sewer line.
- **October 8, 2005:** Remnants of Tropical Strom Tammy caused prolonged heavy rainfall that measured 7 inches in 2 days. 10 roads in the County were flooded, 2 homes were damaged by the influx of mud, and a water rescue was conducted in Ellicott City.
- **Floods of 2003:** Howard County experienced several floods in 2003. First, on February 22nd, widespread flooding was caused by both melting snow from the snowstorm of February 14 – 18th combined with 1.5 to 3 inches of rain. Several roads were closed, including Route 108, Race Road, Furnace Avenue, Triadelphia Mill Road, and Toll House Road. 30 basements were flooded. A few months later, on June 7th – 20th, precipitation systems moved across the region, causing roads and waterways to flood off and on for nearly two weeks. River and stream levels remained high throughout this period, fed by up to 5 inches of rain a day. Several roads were closed multiple times including Furnace Avenue, South Entrance Road, Carris Mill Road, Warfield Road, Route 108, and Lime Kiln Road. On September 23rd, a few days after Hurricane Isabel brought rain to the region, a heavy rain storm brought 2.5 inches of rain

[90] Id.

in one day and flooded parts of the County. On November 19th, a strong line of thunderstorms brought 2 to 4 inches of rainfall, which resulted in the closure of several roads. Finally, on December 11th, a heavy overnight rainfall averaging 2 to 3 inches fell on snow-covered grounds, melting the snow. This led to the heightening of rivers and streams as well as the closure of several roads due to rising water.

- **September 16, 1999:** The remnants of Hurricane Floyd produced high winds and heavy rains that closed 200 roads and streets countywide. Businesses were threatened by the raging waters of the Patapsco River as its banks overflowed in Ellicott City. Rainfall measurements of 2 to 5 inches were reported throughout the day. County officials reported 17 homes were damaged, 350 basements were flooded, 2 people were rescued, and the Howard Country Fair was shut down for the first time in its 47 year history.
- **September 9, 1999:** Thunderstorms moved through the County, producing damaging winds and heavy rainfall across the area. Flooding occurred in Ellicott City, Dorsey, Columbia, and Elkridge. Portions of Route 1 were flooded and cars were trapped by the surrounding water. Water infiltrated homes near Columbia and Dorsey. Precipitation measurements showed 7.39 inches of rain near Columbia and 5.98 inches near Elkridge.
- **September 6, 1996:** The remnants of Hurricane Fran left up to 5 inches of rain in parts of the County and caused physical damage to the County with 40 mph sustained winds. Minor flooding occurred, 36,300 residents of Howard County lost power, and $34,300[91] of property damage was recorded.
- **June 19, 1996:** Storms poured 5.5 inches of rain into Howard County and flooded roads, bridges, and properties. Seneca Creek and Bennett Creek overflowed their banks, causing several roads to be temporarily closed. Two fatalities occurred when a couple rafting in the Patapsco River was swept over a dam in the raging current. $82,500[92] in property damage was reported.
- **September 22 – 26, 1975:** The remnants of Hurricane Eloise, coupled with snow from a previous storm, resulted in over 12 inches of rain in four days and caused both the Patuxent and Patapsco Rivers to overflow up to 24 feet above normal. Much of Ellicott City and Elkridge were again flooded, as some businesses had just reopened after recovering from the extensive damage caused by Hurricane Agnes. Mud and debris covered the landscape, and homes and businesses were declared unsafe.
- **August 1 – 4, 1971:** Heavy rain flooding caused numerous road closures and damaged several homes. The Patuxent River rose 25 feet in 30 minutes and mud slides damaged roads and bridges. Roads that were flooded and/or damaged included: Owen Brown Road, Morgan Road, Carroll's Mill Road, River Road, Mullinix Mill Road, Howard Chapel Road, Furnace Avenue, Mink Hollow Road, Route 108, Route 32, Centennial Lane, Bethany Lane, and Old Annapolis Road. An estimated $585,400[93] in County property damage was reported.
- **September 1952:** On Labor Day weekend, Hurricane Able's heavy rains swept through Howard County. A destructive flash flood caused a log jam in the mouth of the Tiber River and resulted in approximately $4.06[94] million dollars' worth of damage.
- **May 1894:** The Patapsco River flooded, causing extensive property damage. The flood resulted in approximately $149,228[95] in damage.
- **July 24, 1868:** 18 inches of rain fell on Howard County, causing the Patapsco River to overflow. Witnesses noted that the river rose approximately 30 feet in 30 minutes. The flood resulted in 37 fatalities and caused an estimated $4 million[96] in damage.

[91] Id.
[92] Id.
[93] Id.
[94] Id.
[95] Id.
[96] Id.

Future Likelihood of the Hazard for Howard County

The Future Likelihood section anticipates the future occurrence rate of the hazard based on historical likelihood and future trends. This section also addresses factors that may cause the future likelihood to deviate from historical trends.

Future Likelihood of a Flood Hazard in Howard County	
Historical Average (time period)	31 flood and 49 flash flood event every 19 years (1996-2014)
Historical Annual Probability	Near 100% chance of annual occurrence
Future Likelihood Expected to Deviate from Historical Likelihood (Yes/No)	Yes
Future Annual Probability	30%+ chance of annual occurrence
Future Likelihood Score[4]	4 (Very Likely)
Future Likelihood reflects the likelihood of any emergency-level hazard event and does not differentiate between Likely and Worst-Case scenarios.	

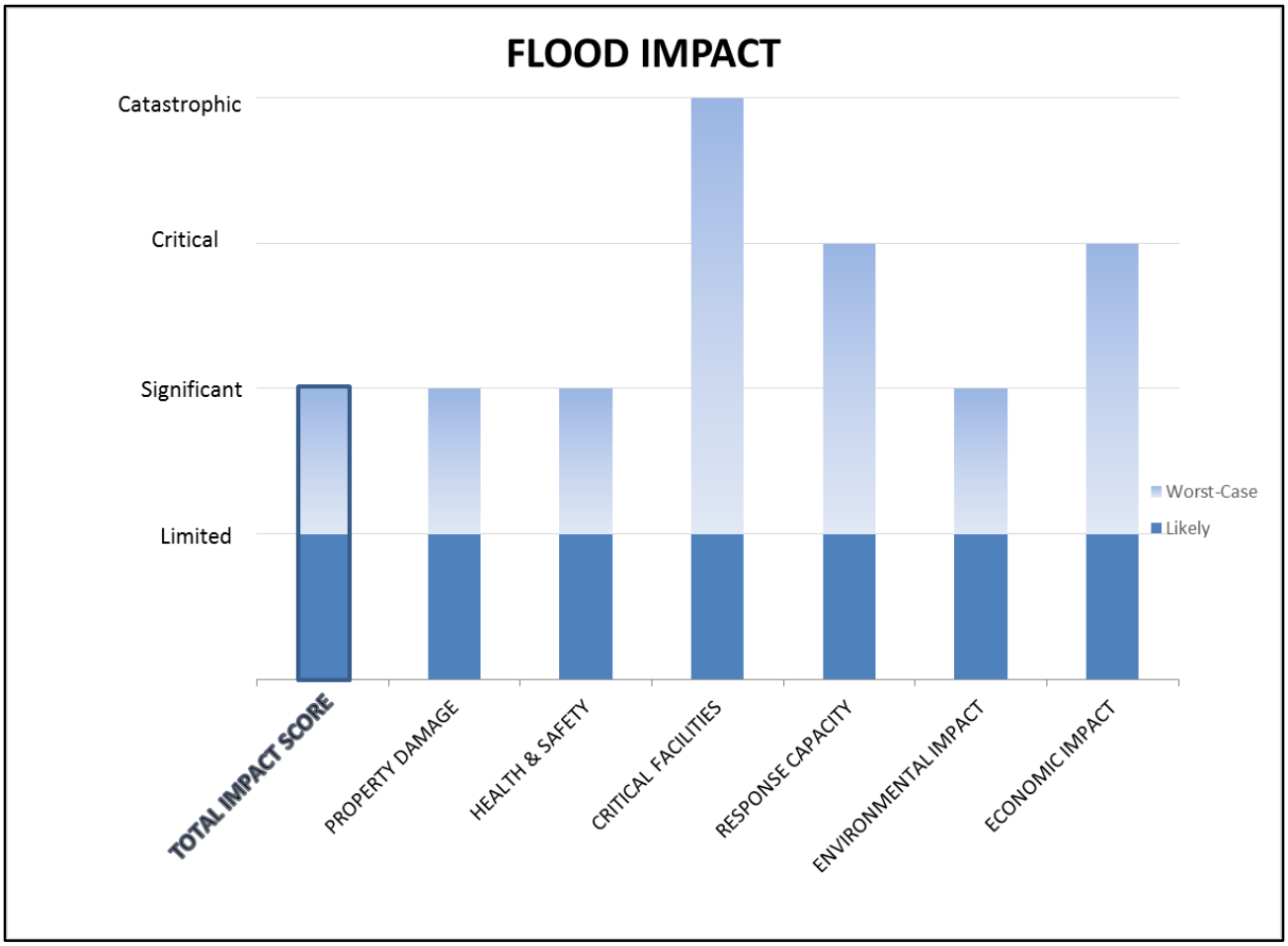
Considerations: There is an increased risk of flood events going forward based on the National Climate Assessment, which projects increased frequency of severe storms and rain. An expected increase in rainfall levels and extreme storms may result in a slight increase in the likelihood of flooding,.[97] Aging dam infrastructure may also contribute to a slight increase in the likelihood of flooding in the future.[98]

[97] *Third National Climate Assessment,* U.S. Global Change Research Program (2014). Available at http://nca2014.globalchange.gov/ (last accessed June 26, 2014).
[98] *Manmade Hazard Identification and Risk Assessment Workshop (unpublished)*, Howard County OEM (2014).

IV. CONSEQUENCE ANALYSIS

The Consequence Analysis section provides a detailed characterization of the anticipated consequences of likely and worst-case hazard events. This section characterizes impacts to property, health & safety, critical facilities, response capacity, the environment, and the economy. This section also characterizes public perceptions of each hazard, the perceived impact to personal safety and standard of living, and public confidence in response capability.

Consequence Analysis Overview



Where no Worst-Case bar is visible, Worst-Case impact is equivalent to Likely impact.

Flood Warning Time & Duration		
	Likely	**Worst-Case**
WARNING TIME	*Short.* No warning time prior to an attack.	*Short.* No warning time prior to an attack.
DURATION	*Short.* 7-10 minutes for the initial attack. It may take 1-2 hours to declare the hazard location safe.	*Short.* 15 minutes for the initial attack. It may take 1-2 hours to declare the hazard location safe.

Consequence Analysis: Likely Hazard Scenario

The Consequence Analysis table details the anticipated consequences of the most likely hazard scenario.

FLOODS **Likely**		
PROPERTY DAMAGE	*Limited*	• Less than 3% of critical and non-critical infrastructure will be damaged. • Debris on the roadway is expected. • Limited washouts at road edges and around some culverts are expected to be damaged.
HEALTH & SAFETY	*Limited*	• 0 deaths are expected. Vehicle in water and attempting to escape, walking near water, or electrocution are the most common causes of death. • 2 injuries are expected. Vehicle collisions and stranded drivers trying to escape are the most common causes of injuries.
CRITICAL FACILITIES	*Limited*	• *Utilities* – 4 hours maximum for shut down. • *Information/Communications* – Outage unlikely. • *Transportation* – Traffic delays for less than one day. Public mobility will be impacted in a affected area.
RESPONSE CAPACITY	*Limited*	• *Police* – Local resources adequate. • *Fire & Rescue* – Local resources adequate. Limited impact to response capability. Additional personnel will be necessary to assist with stranded motorists. • *Health* – Local resources adequate. Howard County Health Department has COOP plans in place to ensure essential functions continue either on site (if possible) or at an alternate location. • *Public Works* – Local resources adequate. Minimal Impact on response capability and continuity of operations.
ENVIRONMENTAL IMPACT	*Limited*	• Minimal Impact with a possible short-term spike in water pollution. • Mudslides or fallen trees can cause serious erosion or sediment pollution to the local water resource.
ECONOMIC IMPACT	*Limited*	• Millions of loss in dollar value in low lying areas. • Structural and business loss and disruption of transportation network in economic consequences.
TOTAL IMPACT	*Limited*	• Total Impact Score: 1 on a scale of 1 (Limited) to 4 (Catastrophic).
Limited	*Significant*	*Critical*	*Catastrophic*

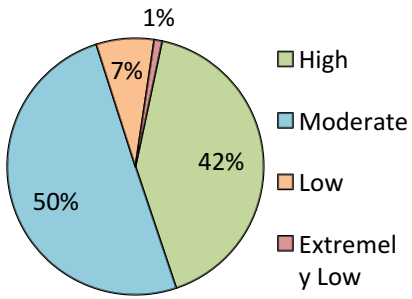
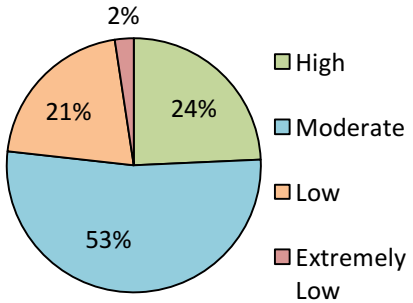
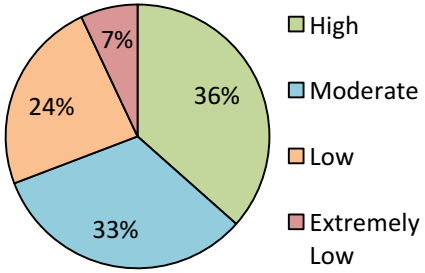
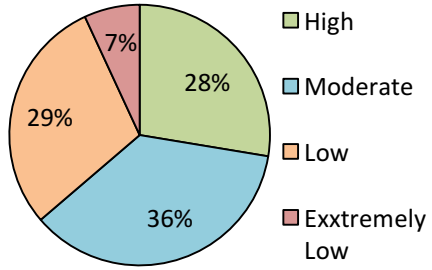
Consequence Analysis: Worst-Case Hazard Scenario

The Consequence Analysis: Worst-Case table details the anticipated consequences of the worst-case hazard scenario.

FLOODS **Worst-Case**		
PROPERTY DAMAGE	*Significant*	• Up to 40% critical and non-critical infrastructure will be damaged. • Earthen dams being in danger. • Ellicott City, Elkridge, and other low lying areas to be affected and downed trees and wires expected. • Major structural damage due to flowing water. • Downed trees, downed power lines, washed out roadways, and pipe/ culvert failures are expected..
HEALTH & SAFETY	*Significant*	• 0-10 deaths are expected. Vehicle in water and attempting to escape, walking near water, electrocution, or drown in home are the most common causes of death. • 20-30 injuries are expected. Vehicle in water and attempting to escape, walking near water, electrocution, roof collapse, lightning, or hydroplane are the most common causes of injuries.
CRITICAL FACILITIES	*Catastrophic*	• *Utilities* – Some utilities could be shut down for 1 week- 1 month. • *Transportation* – Bridges, railways, and roads will be shut down or out of service. • *Information/Communications* – Phone and electrical/power facilities will be out of service.
RESPONSE CAPACITY	*Critical*	• *Police* – Local resources adequate. No impact on response capability and continuity of operations. • *Health* – Moderate need for state or federal assistance. HCHD has COOP plans in place to ensure essential functions continue either on site (if possible) or at an alternate location. • *Fire & Rescue* – Local resources adequate. Limited impact to response capability. Additional personnel will be required to assist with the call volume. • *Public Works* – Moderate need for state or federal assistance. Significant impact as crews work multiple consecutive days in response.
ENVIRONMENTAL IMPACT	*Significant*	• Minimal impact on air quality. • Impacts to land resources will be limited to areas that are affected by flooding. • Most significant impact is to water resources due to increased water pollution due to the flooding. • Materials in the floodwaters can cause erosion, clogging water channels, or destroying animal habitats along the water's edge.
ECONOMIC IMPACT	*Critical*	• Hundreds of millions and up of loss in dollar value. • Business closures, costly clean-up, loss of employment, and transportation infrastructure disruption in economic consequences. • Critical economic impact.
TOTAL IMPACT	*Significant*	• Total Impact Score: 2 on a scale of 1 (Limited) to 4 (Catastrophic).
Limited	*Significant*	*Critical*	*Catastrophic*

Consequence Analysis: Public Perception

The Consequence Analysis: Public Perception table characterizes public perceptions of each hazard. Details include public confidence in personal ability to respond to each hazard, public confidence in Howard County's ability to respond to each hazard, and each hazard's perceived impact to personal safety and standard of living.

Public Perceptions on Floods			
PERCEIVED CONFIDENCE IN HOWARD COUNTY'S ABILITY TO RESPOND AND RECOVER FROM THIS HAZARD	**PERCEIVED CONFIDENCE IN PERSONAL ABILITY TO PROTECT SELF AND FAMILY FROM THIS HAZARD**	**CONCERN OVER THE IMPACT TO PERSONAL HEALTH AND SAFETY IF THIS HAZARD WERE TO OCCUR LOCALLY**	**CONCERN OVER THE IMPACT TO PERSONAL STANDARD OF LIVING / QUALITY OF LIFE IF THIS HAZARD WERE TO OCCUR LOCALLY**
			
Average: 3.32 *Moderate*	*Average: 2.99* *Moderate - Low*	*Average: 2.98* *Moderately - Low Concern*	*Average: 2.84* *Moderately - Low Concern*

Hurricanes/Tropical Storms

I. OVERVIEW

The Overview section defines the hazard and summarizes the hazard risk profile.

Definition

This section defines the scope of the hazard category. The terminology and characterization established in this section should be consistent throughout all Howard County planning documents.

Hurricanes, tropical storms, and typhoons are collectively known as tropical cyclones. NOAA defines a tropical cyclone as a "warm-core non-frontal synoptic-scale cyclone, originating over tropical or subtropical waters, with organized deep convection and a closed surface wind circulation about a well-defined center. Once formed, a tropical cyclone is maintained by the extraction of heat energy from the ocean at high temperature and heat export at the low temperatures of the upper troposphere."

Risk Profile

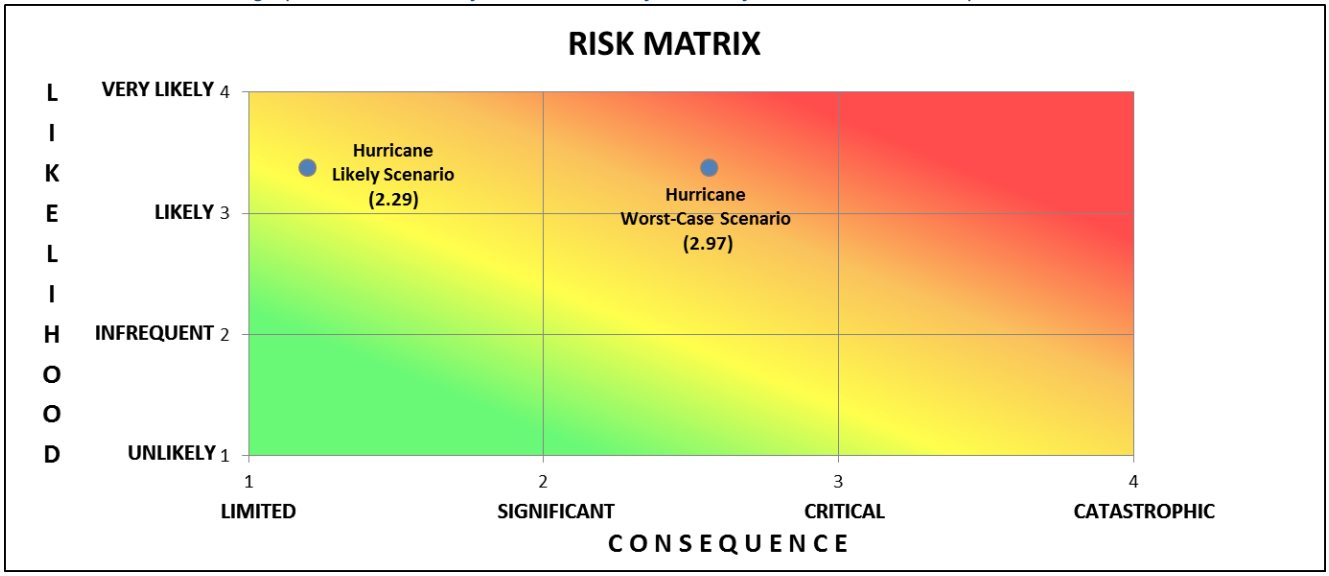
The Risk Profile section presents the Risk Score for the hazard in a range from 1 (lowest risk) to 4 (highest risk). Risk Score is a function of Likelihood and Consequence.

Hurricane/Tropical Storm Risk Profile				
	Risk Assessment Category	**Likely Hazard Scenario**	**Worst-Case Hazard Scenario**	**Weight**
LIKELIHOOD	**Likelihood**	3.375 Likely-Very Likely		50%
CONSEQUENCE	**Impact**	1.25 Limited-Significant	2.83 Significant-Critical	40%
	Warning Time	1 Very Long	1 Very Long	5%
	Duration	1 Short	2 Moderate	5%
	TOTAL RISK SCORE	**2.29**	**2.97**	

**The Likelihood Score reflects the likelihood of any emergency-level hazard event and does not differentiate between Likely and Worst-Case scenarios.*

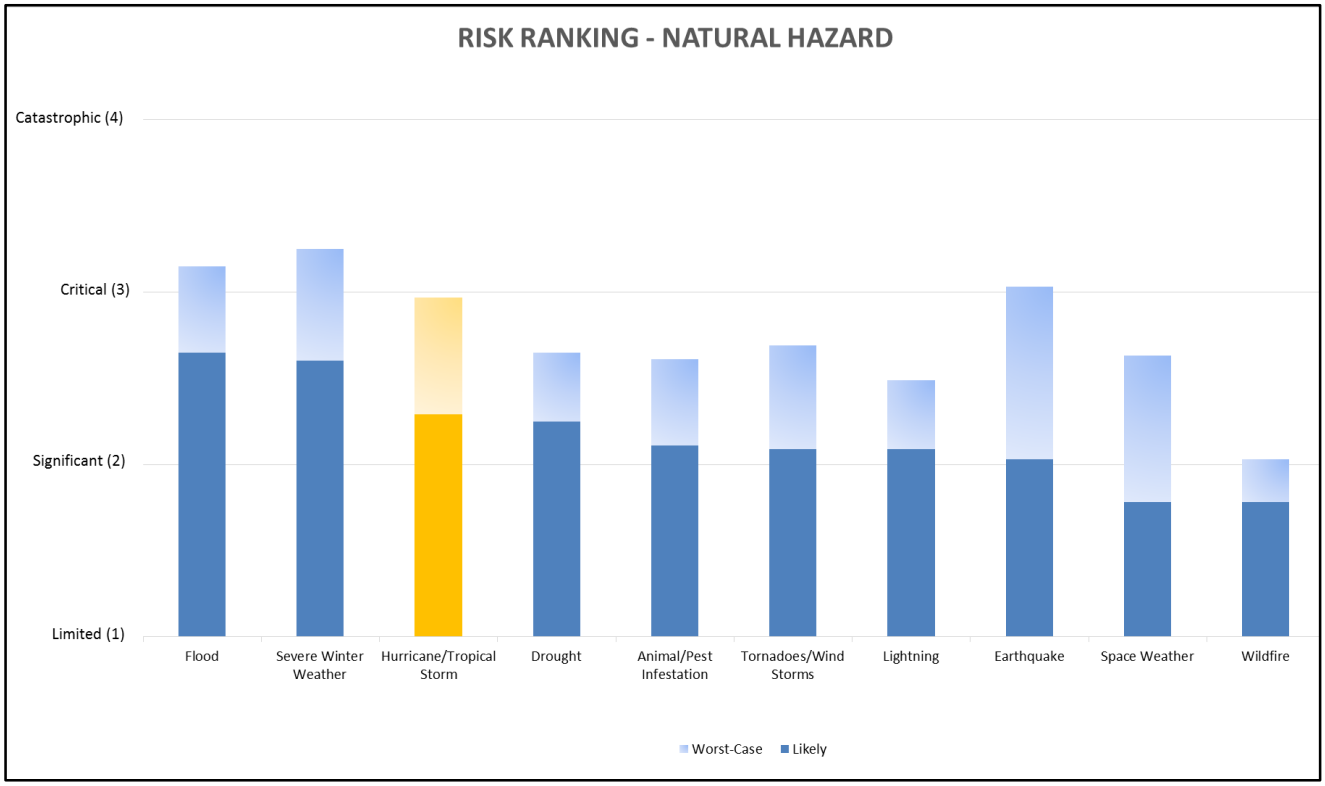
Risk Matrix

The Risk Matrix chart is a graphical illustration of hazard Risk as a function of Likelihood and Consequence.



Risk Ranking

The Risk Ranking chart is a graphical illustration of hazard Risk as it relates to other hazards.



Where no Worst-Case bar is visible, Worst-Case Risk is equivalent to Likely Risk.

II. HAZARD CHARACTERISTICS

The Hazard Characteristics section provides a detailed characterization of the hazard and the local context as it relates to the hazard.

Description of the Hazard

Hurricanes, tropical storms, and typhoons are collectively known as tropical cyclones. NOAA defines a tropical cyclone as a "warm-core non-frontal synoptic-scale cyclone, originating over tropical or subtropical waters, with organized deep convection and a closed surface wind circulation about a well-defined center. Once formed, a tropical cyclone is maintained by the extraction of heat energy from the ocean at high temperature and heat export at the low temperatures of the upper troposphere."[99] Tropical cyclones are among the most devastating naturally occurring hazards in the United States. Hurricanes, the strongest type of the tropical cyclones, generate hazards that can cause extensive damage such as high winds, heavy rainfall, tornadoes, and storm surge. While there is potential for hurricane force winds to occur in Howard County, its inland location removes it from the Atlantic coastline and places it north of the warm Carolina waters. Instead, its location makes the County more vulnerable to tropical storms and tropical depressions.

As a tropical cyclone strengthens, it can be become a tropical depression with wind speeds below 38 mph. As a storm intensifies, it becomes a tropical storm with maximum sustained wind speeds ranging from 39 to 73 mph. A storm of that magnitude is given a name once it reaches tropical storm intensity. Further development can produce a hurricane, which can be described as a well-defined low pressure system with circulation around the "eye" or center of the storm.[100]

Table 6.4.4-1 provides a concise explanation of each of the degrees of tropical cyclones.[101]

[99] *Glossary of National Hurricane Center Terms*, http://www.nhc.noaa.gov/aboutgloss.shtml#TROPCYC (last accessed March 2, 2012).
[100] See generally *NOAA FAQ*, http://www.aoc.noaa.gov/faq.htm#whatisahurricane (last accessed March 2, 2012).
[101] For additional information about hurricanes and tropical storms, see *NOAA's National Hurricane Center*, http://www.nhc.noaa.gov/ (last accessed April 2, 2012).

Table 6.4.4-1

Tropical Cyclone - Wind Speeds Categories

(Source: NOAA)

Category	Wind Speed	Definition
Tropical Depression	< 38 mph	An organized system of strong thunderstorms with a defined surface circulation and maximum sustained winds of 38 mph or less.
Tropical Storm	39 -73 mph	An organized system of strong thunderstorms with a defined surface circulation and a wind speed range from 39 to 73 mph.
Hurricane	74+ mph	An intense tropical low pressure system of strong thunderstorms with a well-defined surface circulation and a sustained wind speed of 74 mph or more. The term hurricane is used for Northern Hemisphere tropical cyclones east of the International Dateline to the Greenwich Meridian.

Local Context

The Local Context section describes community attributes that affect the likelihood of the hazard's occurrence or vulnerability to the hazard's consequences.

Tropical cyclone risk in the United States extends along the entire East Coast (from Florida to Maine), the Gulf Coast, and Hawaii. Based on historical storm tracks, it shows that Southeastern United States and the Gulf Coast are at the greatest risk. As one moves further inland and north along the Atlantic Coast where colder ocean waters persist, the threat of powerful hurricanes diminishes. However, the threat of tropical storms and remnants of hurricanes is still prevalent. The greatest threat for the occurrence of a tropical cyclone is during the Atlantic Ocean/Gulf Hurricane season, which runs from June 1 to November 30 each year. The hurricane/tropical cyclone hazard affects the entire planning area.

III. LIKELIHOOD ANALYSIS

The Likelihood Analysis section characterizes the historical occurrence and future likelihood of the hazard in the planning area.

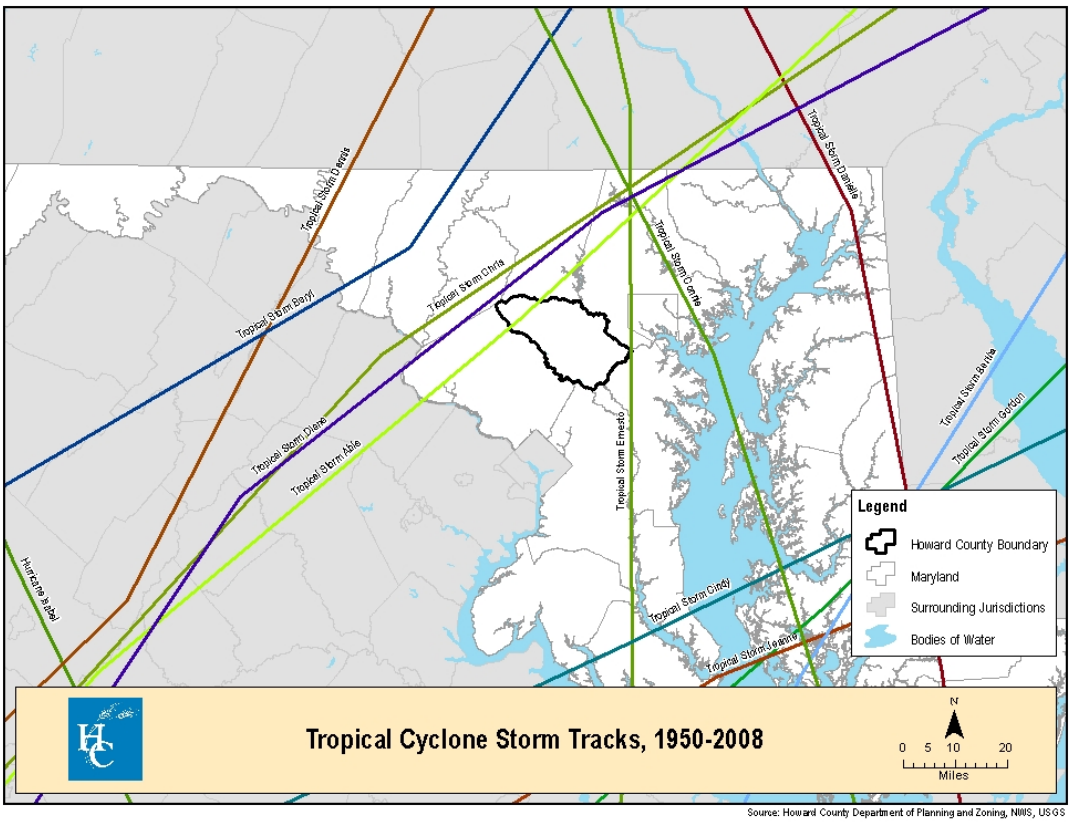
Occurrence of the Hazard

The Occurrence of the Hazard section details the historical occurrence of the hazard in the planning area.

Both SHEDLUS and NCDC database indicate that there have been two tropical storms that have impacted Howard County from 1950 to 2011. In addition to these events, other primary sources indicate that several additional hurricane and tropical cyclone events have occurred during that period of time. According to NOAA's GIS database, there have been 13 named tropical cyclones, with only one storm reaching hurricane strength that passed within 65 miles of Howard County between 1950 and 2008. All of these storms were downgraded to either tropical storms or tropical depressions by the time they reached the Mid-Atlantic region, which is typical for this region. Since that data was collected, three other tropical storms have impacted Howard County (Irene and Lee in 2011 and Sandy in 2012). Although not all of these storms brought significant damage, most brought heavy rain and increased high winds across Howard County.

The figure below shows the storm track for the 13 tropical cyclones that have passed within 65 miles of Howard County over the last 60 years.

Howard County: Storm Tracks, 1950 –2008
(Source: NOAA, National Weather Service, Howard County Department of Planning and Zoning)



Below is a list of notable tropical cyclonic events since 1950 that have significantly impacted Howard County, excluding the aforementioned Tropical Storms David and Hanna. Also, note that Section 6.4.4-4 includes a discussion of Tropical Storms Irene and Lee.

- **October 29, 2012 – Hurricane Sandy:** Hurricane Sandy makes landfall to the north of Maryland, but the size of the storm brings heavy rain and high winds to Howard County. A power outage at a water treatment plant resulted in the release of wastewater. Water contamination became a significant threat to health and the environment for those downstream from the plant. Water mains feeding Howard County from the City of Baltimore failed, and the drinking water supply was limited for a period of 1-2 weeks.
- **September 7, 2011 – Tropical Storm Lee:** On September 7, 2011, the remnants of the storm reached the Maryland area. That afternoon, the combination of a warm front moving across the area and the moisture from the remnants of Tropical Storm Lee produced heavy storms and flooding. With two to three inches of rain falling on already saturated soils, the heavy rains caused flash flooding throughout Maryland. Specific to Howard County, flash flood warnings were issued after heavy rains caused numerous rivers and creeks to rise. According the National Weather Service (NWS), the Little Patuxent River near Savage rose to 13.6 feet on September 7th, its highest level in five years. [102] [103]
- **August 30, 2011 – Tropical Storm Irene:** In Howard County, tens of thousands were left without power in the wake of Hurricane Irene. Initial estimates indicated damage of about $1.9 million in Howard County, where the storm severely damaged two homes and caused significant damage to four others in the Ellicott City area. A total of sixteen homes sustained varying degrees of water damage.[104] The highest rainfall totals in Howard County were around 4-5 inches along the eastern part of the County.
- **September 3, 2006 – Tropical Storm Ernesto:** Tropical Storm Ernesto made landfall on September 1st in North Carolina. The storm maintained its strength as it tracked northward from North Carolina to Virginia, and then into Southern Maryland. Ernesto's center passed just east of Howard County, bringing upwards of five inches of rain and wind guests over 50 mph. Ernesto's winds caused over 44,000 residents in the region to lose power.[105]
- **September 19, 2003 – Hurricane Isabel:** Hurricane Isabel made landfall on September 18th as a Category 2 hurricane. As the storm moved across Southern Virginia, it weakened to tropical storm status. The rain associated with Hurricane Isabel caused isolated flooding, while strong wind brought down power lines and left more than 65,000 homes without power. At one point, 80-90 roads were deemed impassable due to fallen trees. In the end, Hurricane Isabel spared Howard County, but left other Maryland communities suffering substantial damage, particularly areas near the Chesapeake Bay and the Atlantic Ocean.[106]
- **September 16, 1999 – Hurricane Floyd:** The remnants of Hurricane Floyd produced high winds and heavy rains that closed 200 roads and streets countywide. Businesses were threatened by the raging waters of the Patapsco River as its banks overflowed in Ellicott City. Rainfall measurements of 2 to 5 inches were reported throughout the day. County officials reported 17 homes were damaged, 350

[102] Lindsey McPherson, *Heavy Rains Batter County; Flood Warning Extended to Thursday Morning*, Baltimore Sun, September 7, 2001, available at http://www.baltimoresun.com/explore/howard/news/community/ph-ho-cf-flooding-0915-20110907,0,3036295.story.
[103] The highest level ever recorded there previously was 18.38 feet in June 1972 after Hurricane Agnes.
[104] *Maryland Officials Tally Hurricane Irene Losses*, September 2, 2011, WBALTV, available at http://www.wbaltv.com/r/29064770/detail.html.
[105] Desmon, Stephanie and Gadi Dechte, *Ernesto's Wind Gusts Punched Away at Maryland*, Baltimore Sun, September 3, 2006, available at http://articles.baltimoresun.com/2006-09-03/news/0609030063_1_arundel-county-rain-anne-arundel.

[106] *NOAA National Hurricane Center's Tropical Cyclone Report; Hurricane Isabel*. Available at http://www.nhc.noaa.gov/2003isabel.shtml.

basements were flooded, 2 people were rescued, and the Howard Country Fair was shut down for the first time in its 47-year history.

- **September 7, 1999 – Tropical Storm Dennis:** The remnants of Hurricane Dennis tracked across Western Maryland on September 7th. The hurricane brought heavy rains and flooding throughout the County. Strong winds also caused power outages throughout the region.
- **September 22, 1975 – Hurricane Eloise:** The remnants of Hurricane Eloise, coupled with snow from a previous storm, resulted in over 12 inches of rain in four days and caused both the Patuxent and Patapsco Rivers to overflow up to 24 feet above normal. Much of Ellicott City and Elkridge were again flooded, as some businesses had just reopened after recovering from the extensive damage caused by Hurricane Agnes. Mud and debris covered the landscape, and homes and businesses were declared unsafe.
- **June 21, 1972 – Tropical Storm Agnes:** The Howard County FIS estimates the total property damage from the storm to be as high as $41.2 million.[107] The majority of the damage occurred along the Patapsco River in Ellicott City and Elkridge areas. The total damage along the Patapsco River was estimated to be approximately $36 million.[108] Property damages along the Little Patuxent River totaled about $2.4 million[109] and damages along the Patuxent and Middle Patuxent totaled roughly $512,000.[110] An estimated $1.1 million[111] worth of damages occurred to roads and bridges throughout the County. Meanwhile, the SHEDLUS database estimates the total property damage from Tropical Storm Agnes to be roughly $11.17 million.[112] This massive flood caused at least 3 fatalities.
- **August 18, 1955 – Tropical Storm Diane:** Only five days after Connie made landfall, on August 17th, Category 1 Hurricane Diane made landfall near Wilmington, North Carolina. Hurricane Diane was quickly downgraded to a tropical storm as it moved inland. The tropical storm then moved northwest across North Carolina and Virginia before shifting to the northeast over North-Central Virginia. On August 18th, the center of Tropical Storm Diane went through the eastern portion of Frederick County, Maryland, producing winds between 50 and 60 mph. As a result of its proximity, Tropical Storm Diane brought a significant amount of rain and flooding to Howard County.
- **August 15, 1955 – Tropical Storm Connie:** On August 12th, Connie made landfall over the Outer Banks of North Carolina as a Category 1 Hurricane. Hurricane Connie then moved northward across North Carolina. By the time Connie reached Maryland's Eastern Shore on the 13th, it had weakened to a tropical storm. Tropical Storm Connie then moved northwest across the Chesapeake and towards north of Baltimore City; bringing with it 50 mph winds and a substantial amount of rain to the region.
- **October 15, 1954 – Hurricane Hazel:** Hurricane Hazel was listed as a Category 3 storm when it made landfall 250 miles south of Wilmington, North Carolina. Hazel maintained its hurricane force winds as it rapidly progressed up north. From Southern Virginia to Central Pennsylvania, Hazel produced Category 1 hurricane force winds. The storm passed Washington, DC to the west and then near Hagerstown, Maryland. There were reports of peak gusts in an excess of 130 mph in Howard County.
- **September 1, 1952 – Tropical Storm Able:** On the night of August 30, 1952, Hurricane Able made landfall over Beaufort, South Carolina. As the storm moved northward across South Carolina, North Carolina, and Virginia, Able was downgraded to a tropical storm. On September 1st, the center of Tropical Storm Able had moved over the western portion of Howard County. Able brought winds of 35 to 40 mph and gusts up to 50 mph. The peak wind gust at the Washington National Airport was 60 mph.

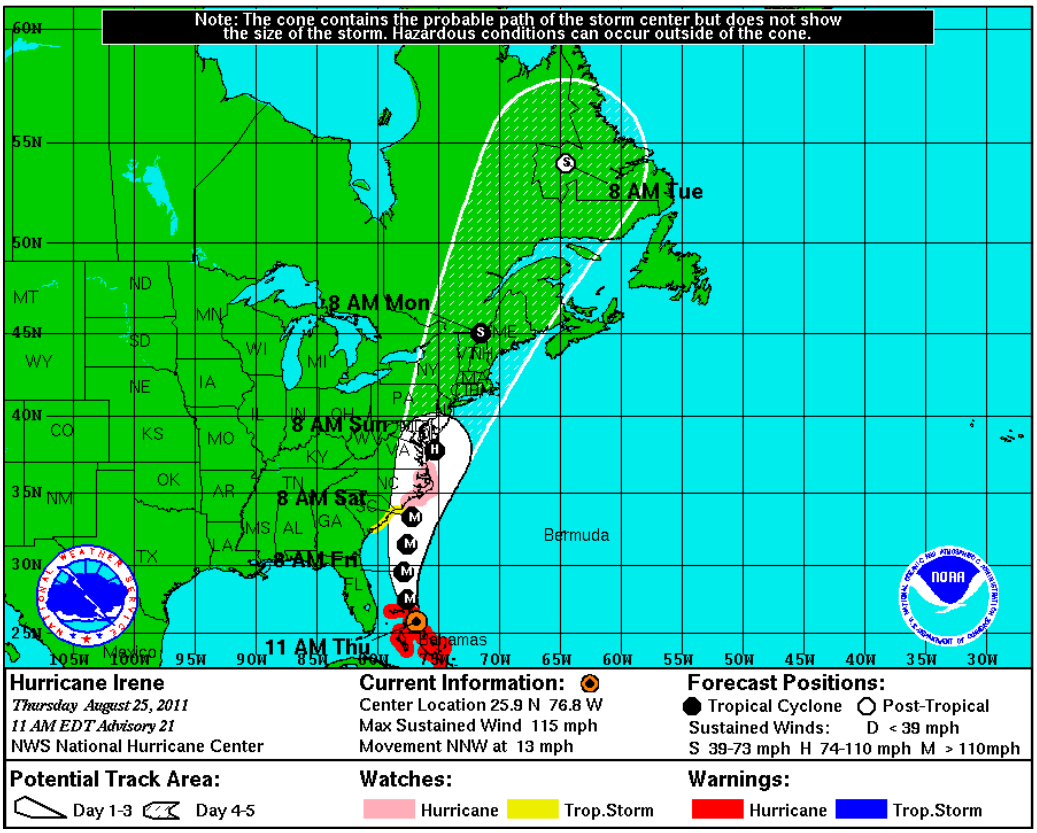
[107] The figure has been adjusted for inflation and is provided in 2010 dollars, based on the Consumer Price Index.
[108] Id.
[109] Id.
[110] Id.
[111] Id.
[112] Id.

The rain associated with the storm caused isolated flooding, while the wind brought down trees and branches and caused power outages to the region.[113]

See Section 6.4.1 for information on Tropical Storm Agnes and Hurricane Eloise, to include their impacts on Howard County.

In late August and early September 2011, Howard County was affected by a downgraded Hurricane Irene, which became a tropical storm by the time it reached Central Maryland. Hurricane Irene originally made landfall on August 27, 2011 as a Category 1 hurricane near Cape Lookout, North Carolina, with maximum sustained winds of 85 mph. The storm followed the Atlantic coastline as a Category 1 storm, which then made a second landfall as a hurricane near Little Egg Inlet, New Jersey the following morning. The path of the storm is shown in the figure below.

Hurricane Irene Actual and Projected Storm Path as of 11 a.m. August 25, 2011
(Source: NOAA)



In Maryland, Hurricane Irene caused tropical storm force winds and torrential rains. More than 700,000 people were left without power across the State. Total damage in Maryland was estimated at approximately $16 million, with the most severe damages occurring on the Eastern and Southern portion of the State. A Presidential Disaster Declaration (FEMA-DR-4034) was declared for 13 of the 24 counties in Southern and Eastern Maryland as a result of this storm.

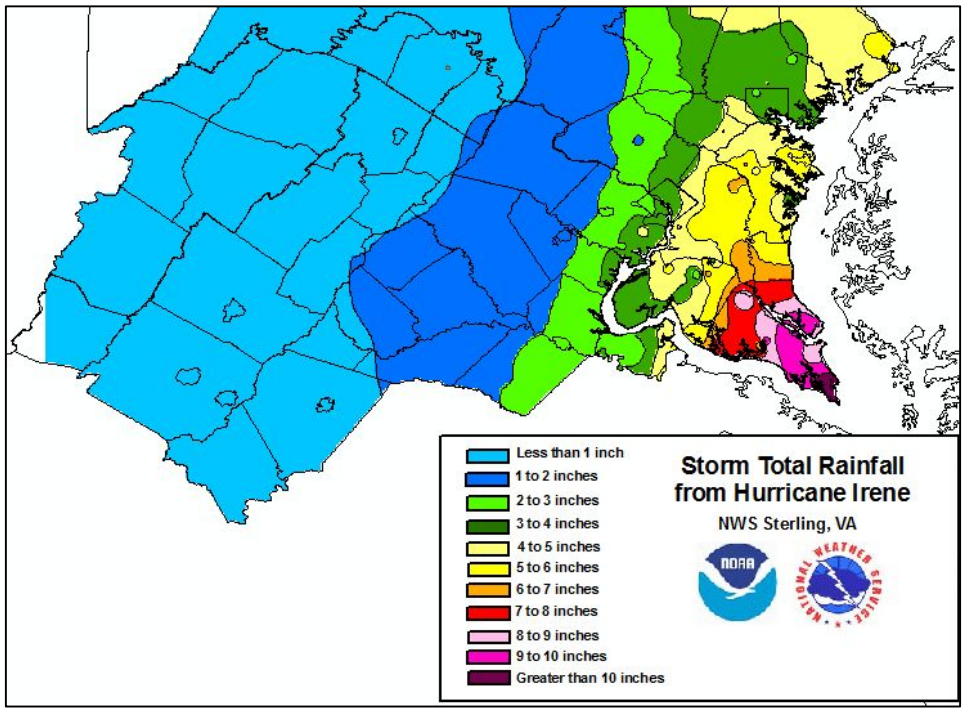
[113] *Monthly Weather Review*, August 1952. Available at http://docs.lib.noaa.gov/rescue/mwr/080/mwr-080-08-0138.pdf.

In Howard County, tens of thousands were left without power in the wake of Hurricane Irene. Initial estimates indicated damage of about $1.9 million in Howard County, where the storm severely damaged two homes and caused significant damage to four others in the Ellicott City area. A total of sixteen homes sustained varying degrees of water damage.[114]

The first two figures below depict the total rainfall and wind speeds for Hurricane Irene. The rainfall figure shows rainfall totals in Howard County were around two inches in the western part of the County, with the rainfall total increasing as one moves eastward. The highest rainfall totals in Howard County were around 4-5 inches along the eastern part of the County. The wind speed figure shows that wind speeds across the majority of Howard County averaged 40-45 mph during the storm.

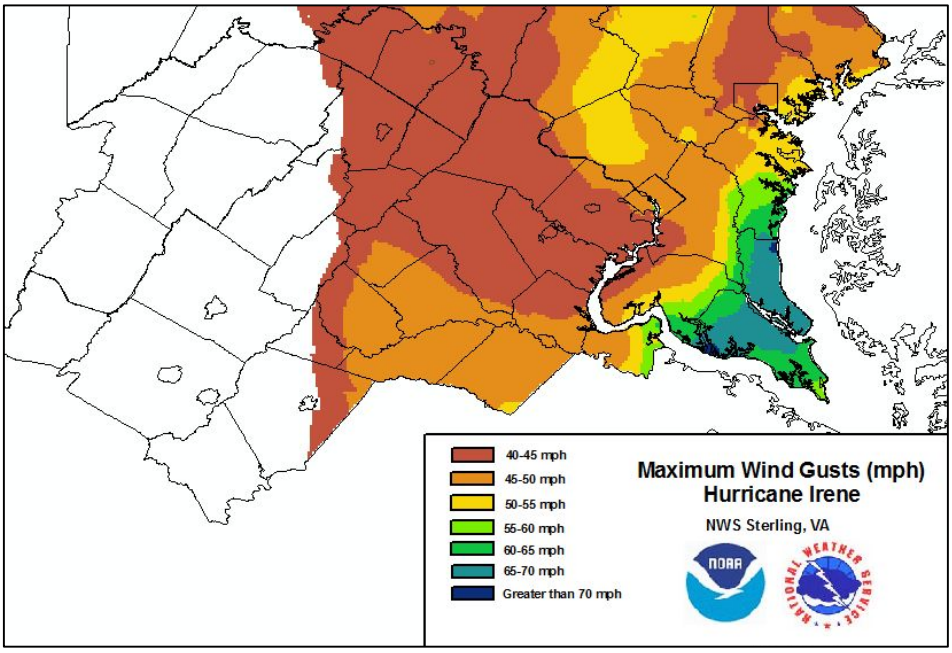
Hurricane Irene also caused widespread power outages throughout the Northeast region. The third figure below shows a Baltimore Gas & Electric (BGE) report showing the number of power outages on August 30th by ZIP code.

Hurricane Irene: Rainfall Totals for Maryland
(Source: NOAA, National Weather Service)

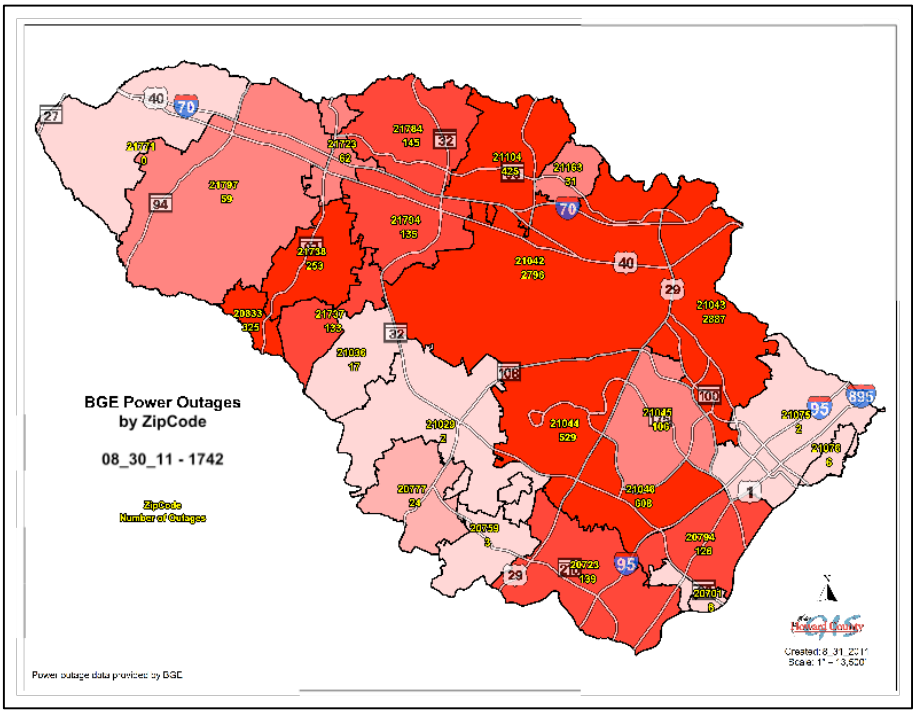


[114] *Maryland Officials Tally Hurricane Irene Losses*, September 2, 2011, WBALTV, available at http://www.wbaltv.com/r/29064770/detail.html.

Hurricane Irene: Wind Speeds for Maryland
(Source: NOAA, National Weather Service)



Howard County Power Outages as of August 30, 2011
(Source: Baltimore Gas & Electric, Howard County GIS)



Tropical Storm Lee made landfall on September 4, 2011 along the Gulf Coast near South-Central Louisiana as a slow moving storm with heavy rains and winds of 45 mph. The storm slowly moved inland, bringing torrential rain and flooding to the Gulf Coast region. The storm continued inland, tracking towards the Mid-Atlantic and Northeast.

On September 7, 2011, the remnants of the storm reached the Maryland area. That afternoon, the combination of a warm front moving across the area and the moisture from the remnants of Tropical Storm Lee produced heavy storms and flooding. With two to three inches of rain falling on already saturated soils, the heavy rains caused flash flooding throughout Maryland. Specific to Howard County, flash flood warnings were issued after heavy rains caused numerous rivers and creeks to rise. According the National Weather Service (NWS), the Little Patuxent River near Savage rose to 13.6 feet on September 7th, its highest level in five years. [115] [116]

The storms and flooding also resulted in numerous road closures. More than 40 road closures were reported in Howard County, including portions of Route 1 and Route 29. Columbia's South Entrance Road, which connects Little Patuxent Parkway to Route 29 Southbound, was closed in the early afternoon of September 7th.

The most significant flooding from Tropical Storm Lee occurred along Main Street in Historic Ellicott City, an area prone to flooding in the past. The swollen Patapsco River and Tiber Creek River both flooded parts of Main Street. Portions of the road on Main Street were covered in rushing water, causing pockets of water that were several feet deep. Several shops closest to the river and creek were flooded, with up to six feet of floodwater in their basements.[117] As a result of the flooding, the Howard County Department of Fire and Rescue Services (DFRS) evacuated the area from the County line to Cocoa Lane (the 8200 through 8500 blocks). The figures below show flooding along Main Street, as well as behind a municipal parking lot adjacent to Main Street.

[115] Lindsey McPherson, *Heavy Rains Batter County; Flood Warning Extended to Thursday Morning*, Baltimore Sun, September 7, 2001, available at http://www.baltimoresun.com/explore/howard/news/community/ph-ho-cf-flooding-0915-20110907,0,3036295.story.
[116] The highest level ever recorded there previously was 18.38 feet in June 1972 after Hurricane Agnes.
[117] *Maryland Historical District: Ellicott City Flooding From Tropical Storm Lee*, http://www.mdhistoricdistrict.com/ellicott-city-flooding-from-tropical-storm-lee/ (last accessed March 24, 2012).

Flooding in the Valley Mede Subdivision
(Source: Howard County Office of Emergency Management)



Tropical Storm Lee: Flooding Along Main Street Ellicott City
(Source: Elkridge Patch)



Tropical Storm Lee: Flooding at a Municipal Parking Lot in Historic Ellicott City
(Source: Baltimore Sun)



As a result of the flooding, a Presidential Disaster Declaration (FEMA DR-4038) was declared on October 5, 2011 for Howard County and several other Maryland counties.

With a total of 10 named tropical cyclones between 1950 and 2010, Howard County experiences a tropical cyclone on average approximately every six years. These 10 events occurred over a period of 60 years which, upon tabulation, equates to an expected 10% annual probability of future tropical cyclone occurrences in Howard County. While clearly it is possible for multiple tropical cyclones to occur in any given year, this result shows that these types of events have a medium probability of occurrence in Howard County.

Future Likelihood of the Hazard for Howard County

The Future Likelihood section anticipates the future occurrence rate of the hazard based on historical likelihood and future trends. This section also addresses factors that may cause the future likelihood to deviate from historical trends.

Future Likelihood of a Hurricane/Tropical Storm Hazard in Howard County	
Historical Average (time period)	13 events every 62 years (1950-2011)
Historical Annual Probability	11-30% chance of annual occurrence
Future Likelihood Expected to Deviate from Historical Likelihood (Yes/No)	No
Future Annual Probability	1-30% chance of annual occurrence
Future Likelihood Score	3.375 (Likely/Very Likely)
Future Likelihood reflects the likelihood of any emergency-level hazard event and does not differentiate between Likely and Worst-Case scenarios.	

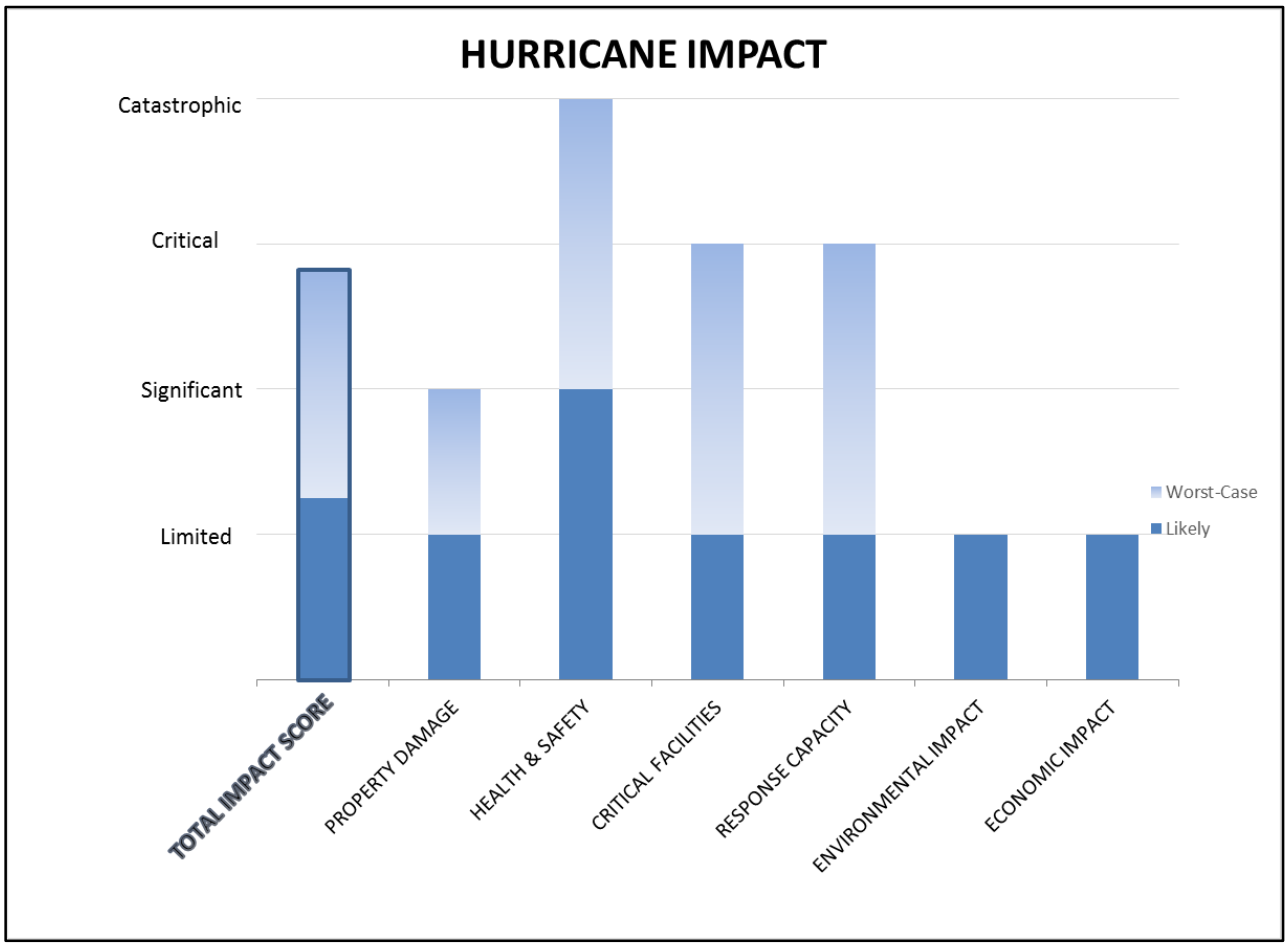
Considerations: An expected increase in rainfall levels and extreme storms may result in a slight increase in the likelihood of flooding.[118]

[118] *Third National Climate Assessment,* U.S. Global Change Research Program (2014). Available at http://nca2014.globalchange.gov/ (last accessed June 26, 2014).

IV. CONSEQUENCE ANALYSIS

The Consequence Analysis section provides a detailed characterization of the anticipated consequences of likely and worst-case hazard events. This section characterizes impacts to property, health & safety, critical facilities, response capacity, the environment, and the economy. This section also characterizes public perceptions of each hazard, the perceived impact to personal safety and standard of living, and public confidence in response capability.

Consequence Analysis Overview



Where no Worst-Case bar is visible, Worst-Case impact is equivalent to Likely impact.

Hurricane/Tropical Storm Warning Time & Duration		
	Likely	**Worst-Case**
WARNING TIME	*Very long warning time.* At least 24 hours.	*Very long warning time.* At least 24 hours.
DURATION	*Moderate.* 24 hours.	*Long-Very Long Duration.* 1 week.

Consequence Analysis: Likely Hazard Scenario

The Consequence Analysis table details the anticipated consequences of the most likely hazard scenario.

HURRICANES OR TROPICAL STORMS Likely		
PROPERTY DAMAGE	*Limited*	• 10% of critical and non-critical infrastructure will be damaged. • Ellicott City, Elkridge, and other low lying areas affected and downed trees and wires with minimal structural damage expected. • Few downed trees and power lines and some flooding across roadways that usually flooded was expected. • Erosion and minor roadbed damage at undersized culverts are expected. • Some structural damage to occupancies and minor flooding is expected.
HEALTH & SAFETY	*Significant*	• *Health*- 0 deaths expected. Heavy rain and flooding are the most common causes of death. • *Health*- 0-5 injuries expected. Scrapes and cuts from debris are the most common causes of injuries.
CRITICAL FACILITIES	*Limited*	• *Utilities* – Hours of critical facilities will be shut down. Trees and branches could cause downed power lines. • *Information/Communication* – Hours-weeks- months of shutdown depending on intensity of damage. • *Transportation* – Road crews shelter in place at height of wind speed will be out of service.
RESPONSE CAPACITY	*Limited*	• *Police* – Local resources adequate. No impact to response capability and continuity of operations. • *Fire & Rescue* – Local resources adequate. Limited impact to response capability. Additional personnel may be required to assist with increased call volume, damage assessment, and Swift Water Team. • *Health* – Local resources adequate. Howard County Health Department operations will not be affected and maintain contact with the EOC. • *Public Works* – Local resources adequate. No impact on response capability and continuity of operations.
ENVIRONMENTAL IMPACT	*Limited*	• Minimal impact with short-term spike in water pollution due to flooding. • Limited environmental impact is expected.
ECONOMIC IMPACT	*Limited*	• Limited amount loss in dollar value. • Some infrastructure impact on economic consequences. • Limited economic impact
TOTAL IMPACT	*Limited - Significant*	• Total Impact Score: 1.25 on a scale of 1 (Limited) to 4 (Catastrophic).
Limited	*Significant*	*Critical*	*Catastrophic*

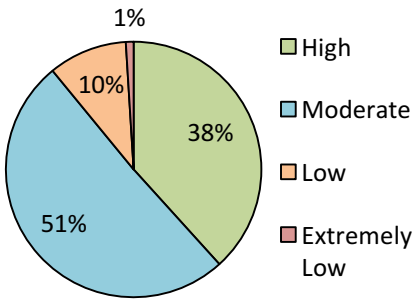
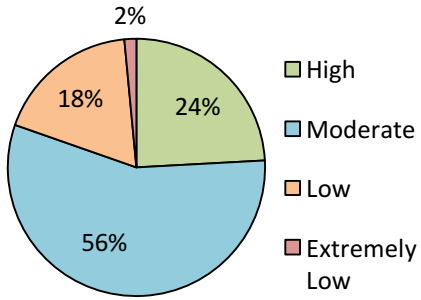
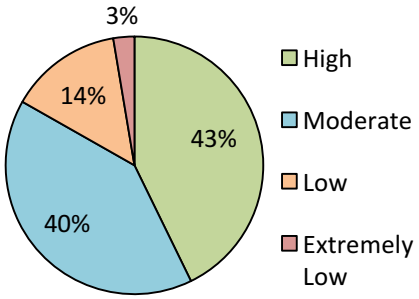
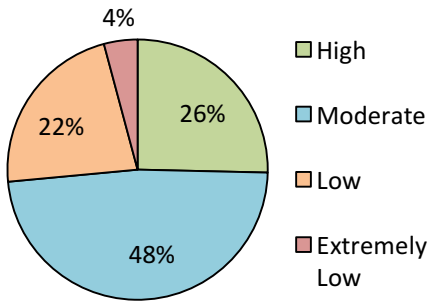
Consequence Analysis: Worst-Case Hazard Scenario

The Consequence Analysis: Worst-Case table details the anticipated consequences of the worst-case hazard scenario.

HURRICANES OR TROPICAL STORMS Worst-Case		
PROPERTY DAMAGE	*Significant*	• Up to 10% of critical and non-critical infrastructure will be damaged. • Ellicott City, Elkridge, and other low lying areas affected and downed trees and wires with significant structural damage expected. • Structure collapse may be significant in lightweight residential construction, damaged vehicles, etc. is expected.
HEALTH & SAFETY	*Catastrophic*	• 0-2 deaths are expected. Heavy rain, flooding, or flying/falling debris is the most common causes of death. • 0-10 injuries are expected. Lacerations or concussions are the most common causes of injuries.
CRITICAL FACILITIES	*Critical*	• *Utilities* – Critical facilities will be shut down for days/months. Phone and electrical/power facilities will be out of service. • *Information/Communications* – Outages expected. • *Transportation* – Roads and bridges will be out of service until cleared and repaired.
RESPONSE CAPACITY	*Critical*	• *Police* – Minimal impact to response capability and continuity of operations. • *Fire & Rescue* – Moderate need for state or federal assistance. Response will be impacted during high winds and post storm. • *Health* – Moderate need for state or federal assistance. A structural assessment of the HD will determine if the normal operations can be performed there. If the facility is declared unstable, plans are in place to maintain essential functions; virtual operations can be performed for administrative duties. • *Public Works* – Moderate need for state or federal assistance with no response during low priority items that impact response capability and continuity of operations.
ENVIRONMENTAL IMPACT	*Limited*	• Minimal impact on air quality and impacts to land resources will be limited to areas that are affected by flooding. • Old and mature trees can be susceptible to wind throw or windsnap altering the canopy coverage and possible causing erosion or mudslides.
ECONOMIC IMPACT	*Limited*	• Downed trees, some structural and roof damage, traffic disruption and limited business closures in economic consequences. • Limited economic impact.
TOTAL IMPACT	*Significant/Critical*	• Total Impact Score: 2.83 on a scale of 1 (Limited) to 4 (Catastrophic).
Limited	*Significant*	*Critical*	*Catastrophic*

Consequence Analysis: Public Perception

The Consequence Analysis: Public Perception table characterizes public perceptions of each hazard. Details include public confidence in personal ability to respond to each hazard, public confidence in Howard County's ability to respond to each hazard, and each hazard's perceived impact to personal safety and standard of living.

Public Perceptions On Hurricanes/ Tropical Storms			
PERCEIVED CONFIDENCE IN HOWARD COUNTY'S ABILITY TO RESPOND AND RECOVER FROM THIS HAZARD	**PERCEIVED CONFIDENCE IN PERSONAL ABILITY TO PROTECT SELF AND FAMILY FROM THIS HAZARD**	**CONCERN OVER THE IMPACT TO PERSONAL HEALTH AND SAFETY IF THIS HAZARD WERE TO OCCUR LOCALLY**	**CONCERN OVER THE IMPACT TO PERSONAL STANDARD OF LIVING / QUALITY OF LIFE IF THIS HAZARD WERE TO OCCUR LOCALLY**
			
Average: 3.26 *Moderate*	*Average: 3.02* *Moderate*	*Average: 3.23* *Moderately Concerned*	*Average: 2.95* *Moderately - Low Concern*

Lightning

I. OVERVIEW

The Overview section defines the hazard and summarizes the hazard risk profile.

Definition

This section defines the scope of the hazard category. The terminology and characterization established in this section should be consistent throughout all Howard County planning documents.

Lightning events are generated by atmospheric imbalance and turbulence due to a combination of conditions. Lightning, which occurs during all thunderstorms, can strike anywhere. Generated by the buildup of charged ions in a thundercloud, the discharge of a lightning bolt interacts with the best conducting object or surface on the ground.

Risk Profile

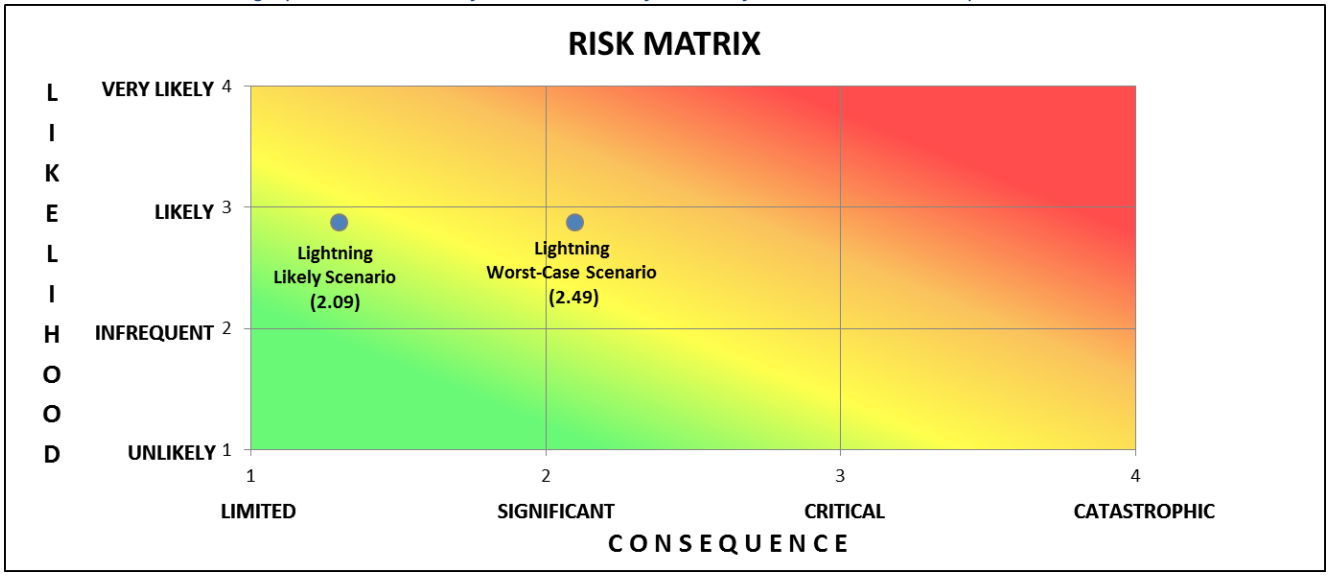
The Risk Profile section presents the Risk Score for the hazard in a range from 1 (lowest risk) to 4 (highest risk). Risk Score is a function of Likelihood and Consequence.

Lightning Risk Profile				
	Risk Assessment Category	**Likely Hazard Scenario**	**Worst-Case Hazard Scenario**	**Weight**
LIKELIHOOD	**Likelihood**	2.875 Infrequent-Likely		50%
CONSEQUENCE	**Impact**	1 Limited	2 Significant	40%
	Warning Time	4 Short	4 Short	5%
	Duration	1 Short	1 Short	5%
	TOTAL RISK SCORE	**2.09**	**2.49**	

**The Likelihood Score reflects the likelihood of any emergency-level hazard event and does not differentiate between Likely and Worst-Case scenarios.*

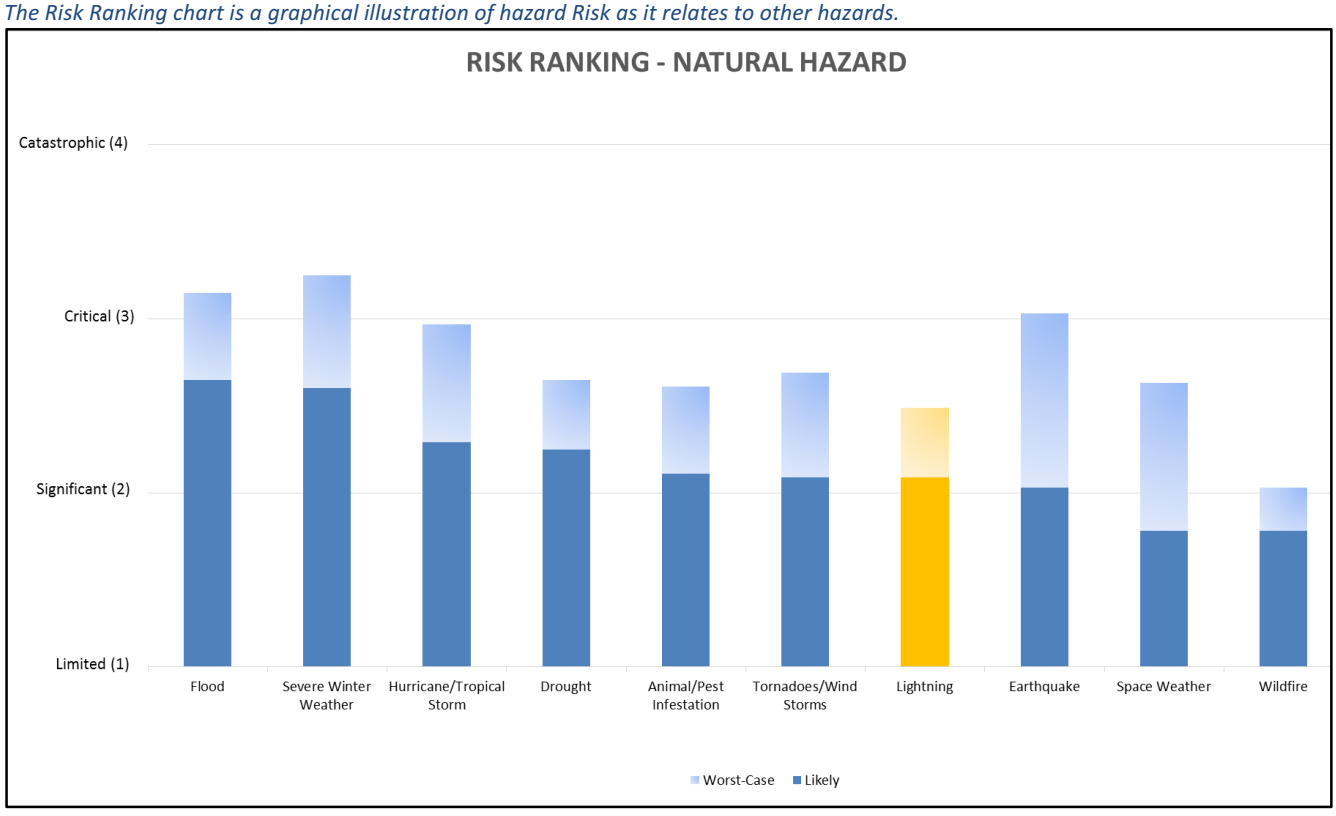
Risk Matrix

The Risk Matrix chart is a graphical illustration of hazard Risk as a function of Likelihood and Consequence.



Risk Ranking

The Risk Ranking chart is a graphical illustration of hazard Risk as it relates to other hazards.



Where no Worst-Case bar is visible, Worst-Case Risk is equivalent to Likely Risk.

II. HAZARD CHARACTERISTICS

The Hazard Characteristics section provides a detailed characterization of the hazard and the local context as it relates to the hazard.

Description of the Hazard

Lightning events are generated by atmospheric imbalance and turbulence due to a combination of conditions. Lightning, which occurs during all thunderstorms, can strike anywhere. Generated by the buildup of charged ions in a thundercloud, the discharge of a lightning bolt interacts with the best conducting object or surface on the ground. The air in the channel of a lightning strike reaches temperatures higher than 50,000 degrees Fahrenheit.[119]

Local Context

The Local Context section describes community attributes that affect the likelihood of the hazard's occurrence or vulnerability to the hazard's consequences.

Individual lightning strikes typically affect a relatively small geographic area. Lightning affects the entire County equally, particularly during the warmer months of the year.

People and property are exposed to damage, injury, and loss of life from lightning in virtually the entire United States. According to the National Weather Service, the United States averaged 55 reported lightning fatalities per year from 1981 to 2010, with 495 people suffering some various degrees of injuries.[120] Most lightning-related deaths and injuries occurred when people were outdoors during summer afternoons and evenings.

Between 1995 and 2005, the NCDC did not identify any injuries or deaths in Howard County resulting from lighting strikes. However, total property damage from lightning strikes was estimated at $935,000.

[119] For additional information about lightning, see NOAA's *Severe Weather*, http://www.noaawatch.gov/themes/severe.php (last accessed April 9, 2012). See also generally *NOAA National Weather Service's Glossary*, http://www.weather.gov/glossary/index.php?letter=l (last accessed March 31, 2012).

[120] *National Weather Service's Lightning Safety*, http://www.lightningsafety.noaa.gov/medical.htm (last accessed March 31, 2012).

III. LIKELIHOOD ANALYSIS

The Likelihood Analysis section characterizes the historical occurrence and future likelihood of the hazard in the planning area.

Occurrence of the Hazard

The Occurrence of the Hazard section details the historical occurrence of the hazard in the planning area.

The NCDC database identified six lightning events in Howard County between 1950 and 2016. Like other hazards, the list appears to only account for events from 1950 onwards. The seven events in the database listed occurred between 1994 and 2006. This indicates additional events outside this period are unlikely captured in the database. Although many more lightning events may have occurred, they were not reported to the NCDC.

Table 6.4.6-1 below summarizes the significant lighting events that have occurred in Howard County between 1994 and 2016.

Table 6.4.6-1
Lighting Events, Howard County, 1994 – February, 2016
(Source: NOAA/NCDC)

Event ID	Location	Date	Event Type	Deaths	Injuries	Property Damage ($)	Crop Damage ($)
5568044	COLUMBIA	7/8/1996	Lightning	0	0	75000	0
5173739	COLUMBIA	8/7/2000	Lightning	0	0	100000	0
5265439	CLARKSVILLE	8/11/2001	Lightning	0	0	100000	0
5314399	CLARKSVILLE	8/3/2002	Lightning	0	0	500000	0
5421712	HANOVER	8/10/2004	Lightning	0	0	55000	0
5515110	ELLICOTT CITY	6/1/2006	Lightning	0	0	100000	0

The event causing the most property damage occurred on August 3, 2002, when a lightning strike destroyed a home in Clarksville along Talon Court. This event caused approximately $602,000[121] in property damage.

Howard County experiences a significant lightning event approximately once every two years. Averaging these seven events over a period of 17 years equates to a 43% annual probability of future lightning occurrences. The probability of lightning impacting Howard County is presumed to be about the same as it has been in the past. Based on historical data, the future probability of lightning strikes is reasonably high with a severe strike impacting the planning area every couple of years. However, the damage associated with these events is usually minor and not widespread.

[121] The figure has been adjusted for inflation and is provided in 2010 dollars, based on the Consumer Price Index.

Future Likelihood of the Hazard for Howard County

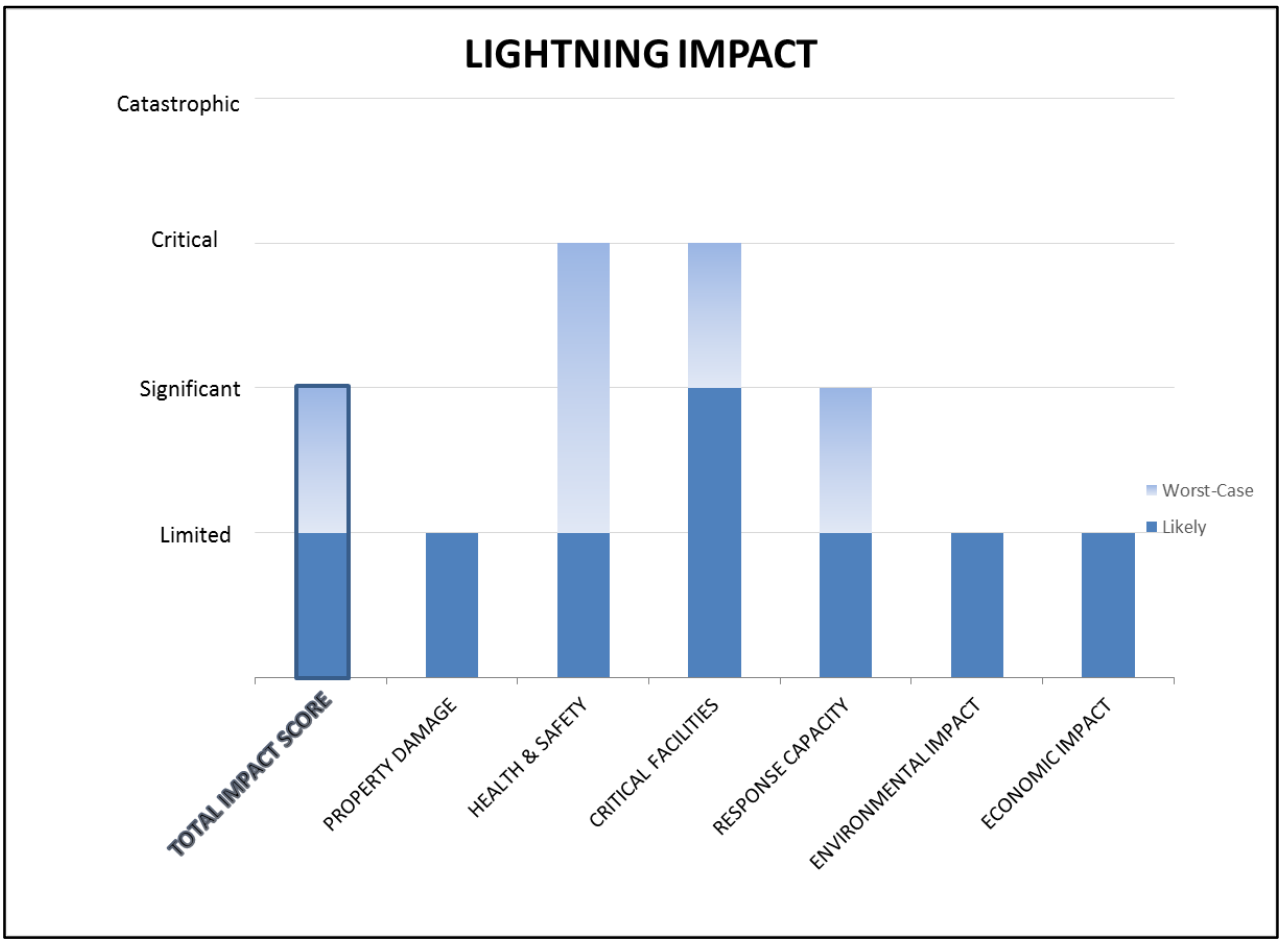
The Future Likelihood section anticipates the future occurrence rate of the hazard based on historical likelihood and future trends. This section also addresses factors that may cause the future likelihood to deviate from historical trends.

Future Likelihood of a Lightning Hazard in Howard County	
Historical Average (time period)	7 events every 17 years (1994-2011)
Historical Annual Probability	43% chance of annual occurrence
Future Likelihood Expected to Deviate from Historical Likelihood (Yes/No)	Yes
Future Annual Probability	1-30% chance of annual occurrence
Future Likelihood Score[4]	2.875 (Infrequent/ Likely)
Future Likelihood reflects the likelihood of any emergency-level hazard event and does not differentiate between Likely and Worst-Case scenarios.	

IV. CONSEQUENCE ANALYSIS

The Consequence Analysis section provides a detailed characterization of the anticipated consequences of likely and worst-case hazard events. This section characterizes impacts to property, health & safety, critical facilities, response capacity, the environment, and the economy. This section also characterizes public perceptions of each hazard, the perceived impact to personal safety and standard of living, and public confidence in response capability.

Consequence Analysis Overview



Where no Worst-Case bar is visible, Worst-Case impact is equivalent to Likely impact.

Lightning Warning Time & Duration		
	Likely	**Worst-Case**
WARNING TIME	*Short-Moderate.* 6 Hours.	*Short-Moderate.* 6 Hours.
DURATION	*Short.* 10 Minutes.	*Short.* 15 minutes.

Consequence Analysis: Likely Hazard Scenario

The Consequence Analysis table details the anticipated consequences of the most likely hazard scenario.

LIGHTNING **Likely**		
PROPERTY DAMAGE	*Limited*	• Up to 0.2% of critical and non-critical infrastructure will be damaged. • Some electrical equipment and panel boxes burned and some structural issues related to fires caused by lightning expected. • Damaged trees and some traffic signals are expected. • Electrical surge damage will be expected. • Possible fires and possible damage to trees and structures are expected.
HEALTH & SAFETY	*Limited*	• 0-3 deaths are expected depending on the time of year. Electrocution is the most common cause of death. • 0-10 injuries are expected. Electrical shock, burns, or seizures are the most common causes of injuries.
CRITICAL FACILITIES	*Significant*	• *Utilities* – Shutdown or interruption of service is unlikely. • *Information/Communications* – Shutdown or out of service is unlikely. • *Transportation* – Motors at pumping station and computers will be out of service.
RESPONSE CAPACITY	*Limited*	• *Police* – Local resources adequate. No impact to response capability or continuity of operations. • *Fire & Rescue* – Local resources adequate. Limited impact to response capability and continuity of operations. • *Health* – Local resources adequate. Clinical and administrative operations can be performed normally as long as the auxiliary power is properly maintained or will be moved to another location. • *Public Works* – Local resources adequate. Minor impact on the response capability and continuity of operations.
ENVIRONMENTAL IMPACT	*Limited*	• Minimal impact. • Could cause loss of canopy coverage or start a forest fire.
ECONOMIC IMPACT	*Limited*	• Limited amount loss in dollar value. • Limited economic consequences.
TOTAL IMPACT	*Limited*	• Total Impact Score: 1 on a scale of 1 (Limited) to 4 (Catastrophic).
Limited	*Significant*	*Critical*	*Catastrophic*

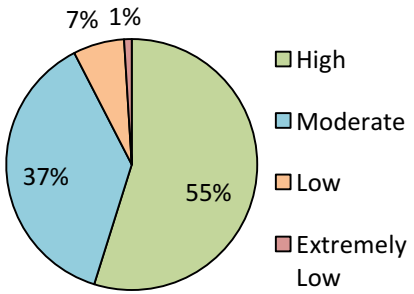
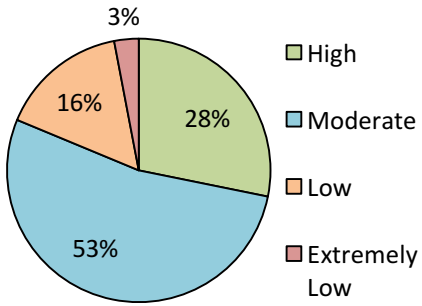
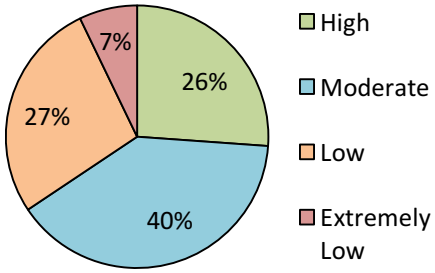
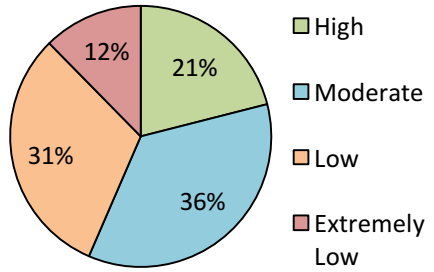
Consequence Analysis: Worst-Case Hazard Scenario

The Consequence Analysis: Worst-Case table details the anticipated consequences of the worst-case hazard scenario.

LIGHTNING **Worst-Case**		
PROPERTY DAMAGE	*Limited*	• Up to 0.5% critical and non-critical infrastructure will be damaged. • Some electrical equipment and panel boxes burned expected. • Some structural issues related to fires caused by lightning. • Damaged trees and some traffic signals are expected. • Damage to trees, occupancies, falling trees, and limbs are expected.
HEALTH & SAFETY	*Critical*	• 0-5 deaths are expected. Electrocution is the most common cause of death. • 10-15 injuries are expected. Electrical shock, burns, or seizures are the most common cause of injuries.
CRITICAL FACILITIES	*Critical*	• *Utilities* – Electrically powered facilities will be out of service temporarily. • *Information/Communications* – No shut down or out of service is expected. • *Transportation* – Shut down and out of service is unlikely.
RESPONSE CAPACITY	*Significant*	• *Police* – Local resources adequate. No impact on response capability or continuity of operations. • *Fire & Rescue* – Mutual aid needed. Limited impact to response capability, but mutual aid may be needed for fires. • *Health* – Mutual aid needed. Clinical and administrative operations can be performed normally as long as the auxiliary power is properly maintained or will be moved to another location. HDOC would be open and communicating with the EOC. • *Public Works* – Local resources adequate. Minor impact on response capability and continuity of operation.
ENVIRONMENTAL IMPACT	*Limited*	• Minimal impact but could cause loss of canopy coverage or start a forest fire. • Limited environmental impact is expected.
ECONOMIC IMPACT	*Limited*	• Transportation impacts in economic consequences. • Limited economic impact.
TOTAL IMPACT	*Significant*	• Total Impact Score: 2 on a scale of 1 (Limited) to 4 (Catastrophic).
Limited	*Significant*	*Critical* / *Catastrophic*

Consequence Analysis: Public Perception

The Consequence Analysis: Public Perception table characterizes public perceptions of each hazard. Details include public confidence in personal ability to respond to each hazard, public confidence in Howard County's ability to respond to each hazard, and each hazard's perceived impact to personal safety and standard of living.

Public Perceptions on Lightning			
PERCEIVED CONFIDENCE IN HOWARD COUNTY'S ABILITY TO RESPOND AND RECOVER FROM THIS HAZARD	**PERCEIVED CONFIDENCE IN PERSONAL ABILITY TO PROTECT SELF AND FAMILY FROM THIS HAZARD**	**CONCERN OVER THE IMPACT TO PERSONAL HEALTH AND SAFETY IF THIS HAZARD WERE TO OCCUR LOCALLY**	**CONCERN OVER THE IMPACT TO PERSONAL STANDARD OF LIVING / QUALITY OF LIFE IF THIS HAZARD WERE TO OCCUR LOCALLY**
			
Average: 3.46 *Moderate*	*Average: 3.06* *Moderate*	*Average: 2.85* *Moderately - Low Concern*	*Average: 2.65* *Moderately - Low Concern*

Severe Winter Weather

I. OVERVIEW

The Overview section defines the hazard and summarizes the hazard risk profile.

Definition

This section defines the scope of the hazard category. The terminology and characterization established in this section should be consistent throughout all Howard County planning documents.

Severe winter weather refers to a weather event that produces forms of precipitation caused by cold temperatures, such as snow, sleet, ice, and freezing rain, while ground temperatures are cold enough to cause precipitation to freeze. Windy conditions may also be present during a winter storm.

Risk Profile

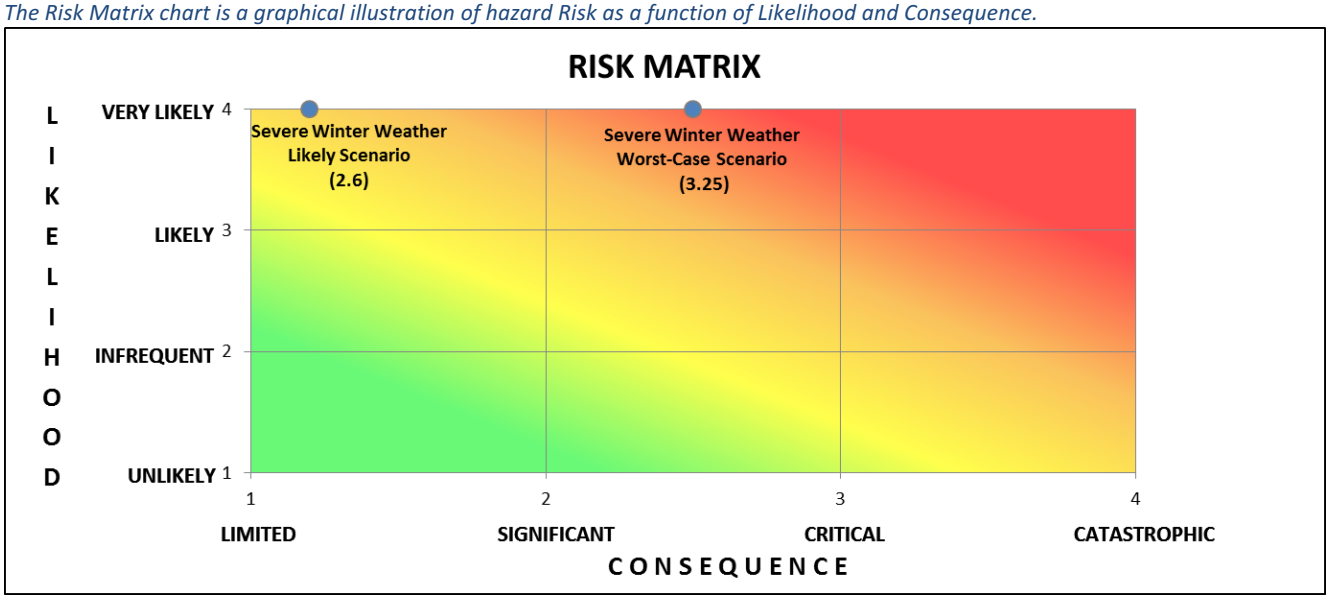
The Risk Profile section presents the Risk Score for the hazard in a range from 1 (lowest risk) to 4 (highest risk). Risk Score is a function of Likelihood and Consequence.

Severe Winter Weather Risk Profile				
	Risk Assessment Category	**Likely Hazard Scenario**	**Worst-Case Hazard Scenario**	**Weight**
LIKELIHOOD	**Likelihood**	4 Very Likely		50%
CONSEQUENCE	**Impact**	1.25 Limited-Significant	2.25 Significant-Critical	40%
	Warning Time	1 Very Long	1 Very Long	5%
	Duration	1 Short	3 Moderate	5%
	TOTAL RISK SCORE	**2.6**	**3.25**	

**The Likelihood Score reflects the likelihood of any emergency-level hazard event and does not differentiate between Likely and Worst-Case scenarios.*

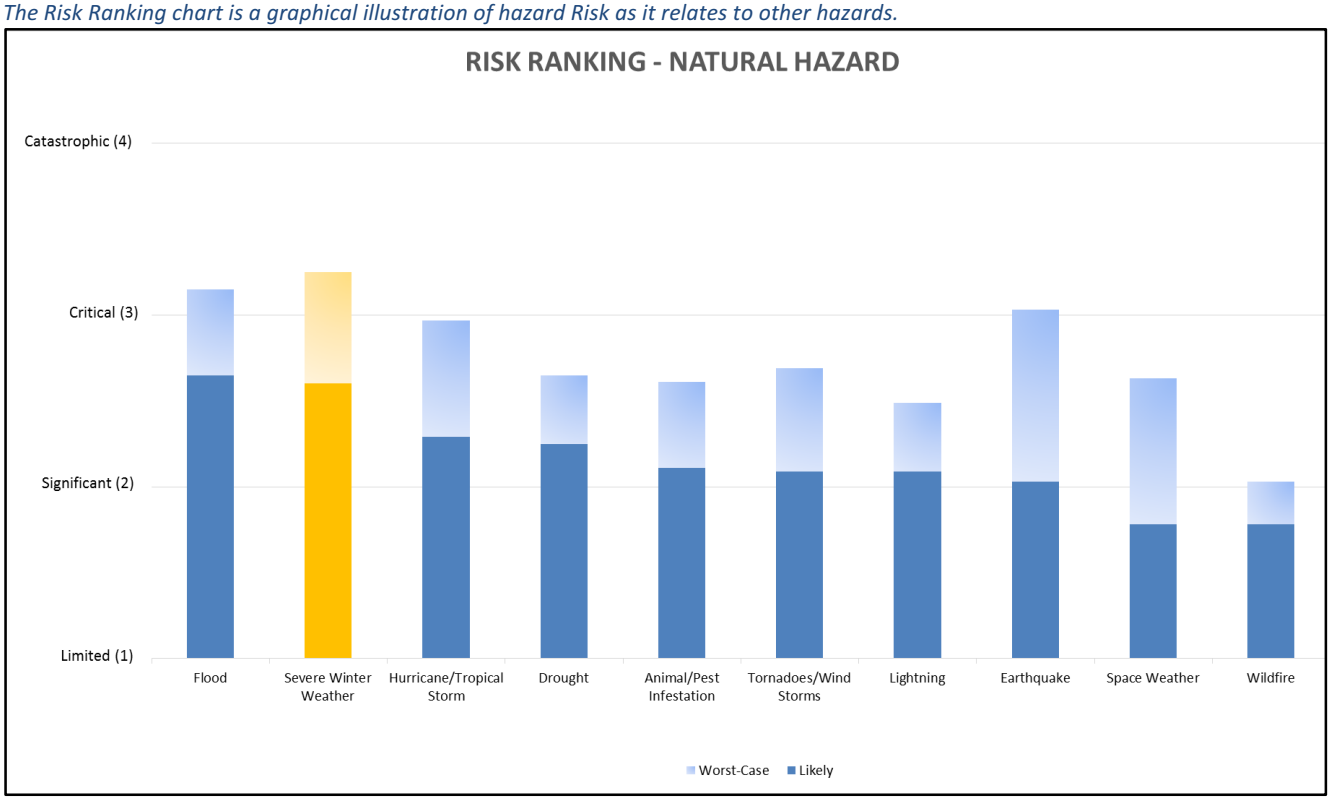
Risk Matrix

The Risk Matrix chart is a graphical illustration of hazard Risk as a function of Likelihood and Consequence.



Risk Ranking

The Risk Ranking chart is a graphical illustration of hazard Risk as it relates to other hazards.



Where no Worst-Case bar is visible, Worst-Case Risk is equivalent to Likely Risk.

II. HAZARD CHARACTERISTICS

The Hazard Characteristics section provides a detailed characterization of the hazard and the local context as it relates to the hazard.

Description of the Hazard

Severe Winter Weather refers to a weather event that produces forms of precipitation caused by cold temperatures, such as snow, sleet, ice, and freezing rain, while ground temperatures are cold enough to cause precipitation to freeze. Windy conditions may also be present during a winter storm. The accumulation of these forms of precipitation can immobilize an entire region, leaving roads impassable, triggering utility outages, causing flooding and storm surge, and may lead to the loss of lives. These impacts may be enhanced with the presence of windy conditions, which can lead to blizzard, whiteout conditions, and drifting of snow.[122]

Local Context

The Local Context section describes community attributes that affect the likelihood of the hazard's occurrence or vulnerability to the hazard's consequences.

Severe winter weather, including snow storms, ice storms, and extreme cold, may affect any part of Howard County during winter. The average annual snowfall for the County is 20-27 inches, which is relatively moderate. Western Maryland counties experience significantly more annual snowfall, while counties closer to the Atlantic Ocean generally have a smaller annual snowfall total.

Generally, the winter storm season for the eastern portion of Maryland runs from November to mid-March, while the western counties experience longer winters. Severe winter weather has occurred as early as October and as late as May in eastern portions of the State. Within Howard County, the risk to people and property from winter weather cannot be distinguished by area.

The particular vulnerabilities for Howard County include the prevalence of old buildings with roof structures that are not up to post-1980 standards. There are also many barns in Howard County which do not require permits and thus may be more vulnerable to damage from winter storms.

The map below shows the average annual snowfall totals for Maryland, Delaware, Washington, DC, Northeast and West Virginia, and Northern Virginia. The map shows the western counties average significantly more snow, upwards of 104 inches a year. Meanwhile, parts of the Eastern Shoreline average between 12-15 inches of snow a year. Howard County averages between 20 and 27 inches of snow per year.

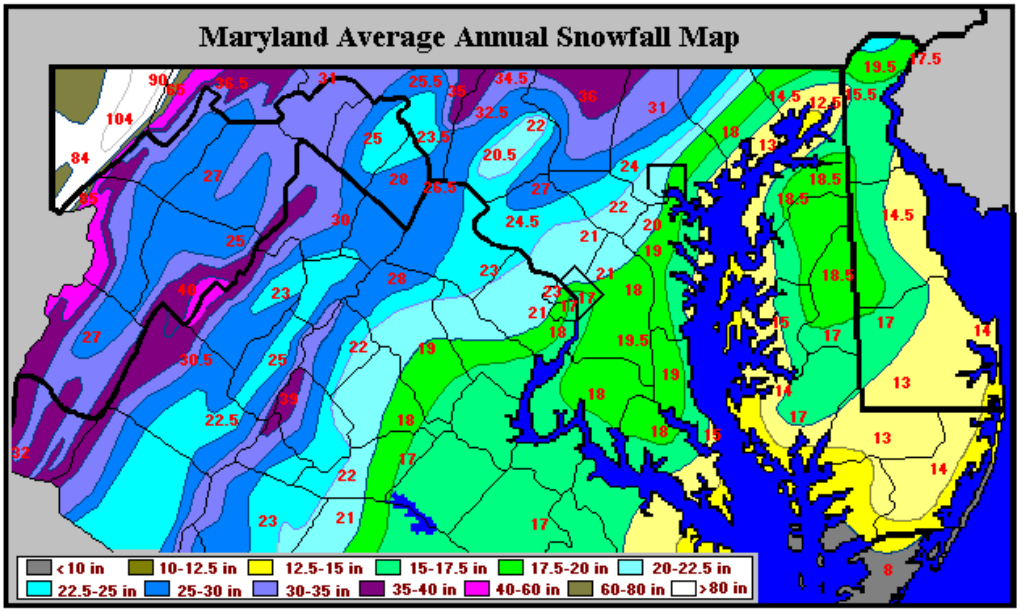
Winter storms are prevalent on a yearly basis for the County, but significant improvements to building codes, maintenance to structures, and weather forecasting has dramatically decreased the threat to people and property. Even with these improvements, a risk of injury or death to individuals during a winter event may still exist, particularly with elderly persons, small children, infants and/or the chronically ill. These groups may be more susceptible and vulnerable to injury or death if they are exposed to the winter event or if they do not have adequate heating in their homes. Also, heavy snow loads may cause possible structural failure or structural damage to buildings and infrastructure.

[122] For additional information about winter storms, see NOAA's *Hydrometeorological Prediction Center*, http://www.hpc.ncep.noaa.gov/wwd/winter_wx.shtml (last accessed November 23, 2011). See also *Winter Weather Basics*, http://www.nssl.noaa.gov/primer/winter/ww_basics.html (last accessed February 21, 2012).

Severe winter storms could also result in increased traffic accidents, impassable roads, and loss of income. On the roadways, snow and ice can reduce visibility and affect automobile traction as bridges may freeze prior to the majority of the roadways. Disruption of the roadways and other transportation methods is a threat to the County's economic well-being, for individuals will not be able to travel to work and the shipment of goods could come to a standstill.

County residents may also be affected physically by severe winter storms. People may injure themselves while walking on ice and snow, or suffer heart attacks as a result from overexertion from shoveling snow. Although rare, carbon monoxide poisoning may occur during winter events when heaters, automobile mufflers or generators are not vented properly.[123] Frostbite and hypothermia may also lead to death or injury.

Maryland Average Annual Snowfall
(Source: NOAA)



[123] In Ellicott City, one died and two were seriously injured from carbon monoxide poisoning when a family used a generator indoors during Hurricane Irene's wake. See *Two Improving in Ellicott City Carbon Monoxide Poisoning that Left One Dead*, http://www.baltimoresun.com/explore/howard/news/ph-ho-cf-co-poisoning-0901-20110830,0,3266348.story (last accessed April 3, 2012).

III. LIKELIHOOD ANALYSIS

The Likelihood Analysis section characterizes the historical occurrence and future likelihood of the hazard in the planning area.

Occurrence of the Hazard

The Occurrence of the Hazard section details the historical occurrence of the hazard in the planning area.

The NCDC database reports Howard County has experienced 137 severe winter weather events between 1969 and 2016 (severe winter weather events include any Avalanches, Blizzards, Cold/Wind Chill events, Extreme Cold/Wind Chill events, Freezing Fog, Frost/Freeze events, Heavy Snow events, Ice Storms, Lake-Effect Snow events, Sleet events, Winter Storms, or Winter Weather events to occur in the jurisdiction).[124] Although the query results start in 1969, the first reported severe winter event was in 1993. Of the 93 severe winter events, only seven resulted in property damage.[125] Table 6.4.2-2 lists the seven winter weather events that resulted in deaths, injuries, property damage, or crop damage for Howard County between 1995 and 2016. Data from the NOAA/NCDC database is derived from a number of sources but may not be the most exhaustive resource for consequence figures. At the time of the search, the NOAA/NCDC database only contained data through the end of 2014.

Although not indicated in the NCDC database, the severe winter storms in December 2009 and February 2010 also resulted in property damage. These two events are described following Table 6.4.2-2

Table 6.4.2-2
Howard County: Severe Winter Weather Events Resulting in Deaths, Injuries, Property Damage, or Crop Damage, 1996 –2014
(Source: NOAA/NCDC)

137 SEVERE WINTER WEATHER event(s) were reported in Howard County, Maryland between 01/01/1950 and 12/31/2011

Event ID	County	Date	Event Type	Deaths	Injuries	Property Damage ($)	Crop Damage ($)
5541132	HOWARD	1/7/1996	Blizzard	0	0	10000	0
5600186	HOWARD	4/10/1997	Frost/Freeze	0	0	0	50000
5633246	HOWARD	3/11/1998	Cold/Wind Chill	0	0	0	2500
5680092	HOWARD	1/14/1999	Ice Storm	0	0	40000	0
5344135	HOWARD	2/14/2003	Winter Storm	0	0	543000	0
5491961	HOWARD	2/11/2006	Heavy Snow	0	0	40000	0
215216	HOWARD	2/5/2010	Winter Storm	0	0	5000	0

2009-2010: More recently, the 2009-2010 winter season brought the highest snowfall on record in the region. Several waves of severe snow events dropped over a foot each of snow in the County. The first low pressure

[124] See *NCDC Storm Events*, http://www4.ncdc.noaa.gov/cgi-win/wwcgi.dll?wwEvent~Storms (last accessed February 27, 2012).
[125] Id.

system arrived on the night of December 18, 2009. The system strengthened on the 19th, as moisture from the South pushed northward while the cold air remained in place. Snowfall totals ranged from 14 to 17 inches across the County. As a result of this event, a Presidential Disaster Declaration (DR-1875) was issued for the State of Maryland on February 19, 2010 for the December storms. Before the Presidential Disaster Declaration was even issued for the December storms, the State was hammered yet again by a line of severe winter storms from February 5th to February 11th, 2010 and produced a snowfall of 10 to 20 inches across the County. Certain parts of the County had even higher localized amounts. As a result of this event, another statewide Presidential Disaster Declaration (FEMA DR-1910) was declared on May 6, 2010 for the February storms.

February, 2010: Snow Covered Streets in Ellicott City, Maryland



Other significant winter storm events that have impacted Howard County are summarized below.

- **January 26, 2011 – January 27, 2011:** A snowfall event produced between 8 to 13 inches of snow across the County. The heavy, wet snow brought trees and power lines down and left thousands without power. Unfortunately, the storm coincided with the evening commute and led to numerous car accidents and roadway shutdowns. There were also several reports of tractor trailers jackknifing due the slick road conditions.
- **February 12, 2008:** A wintery mix of snow and ice produced roughly an inch of snow and between $^{1}/_{10}$ to $^{3}/_{10}$ of an inch of ice. The central and eastern portions of Maryland saw a quick change from snow to ice, which froze just before the evening commute. As road conditions deteriorated, a number of accidents were reported across the region.
- **February 11, 2006 – February 12, 2006:** Storm totals ranged from 14 to 22.5 inches fell across the Washington, DC and Baltimore Metropolitan regions, with Howard County suffering a direct hit from the storm. The highest snowfall total occurred in Columbia Hills, which is located in the north-east part of the County. In that region, snowfall of up to 22.5 inches was recorded. There were numerous reports of downed trees and power outages in the County. NCDC database estimated property damage to be $248,000[126] for the entire storm.
- **February 2003:** The NCDC database indicates that one of the most severe winter storms resulting in property damage and loss of life occurred on February 14, 2003 and lasted until February 18, 2003. The system brought three waves of wintery precipitation to the region. The first line of precipitation started to fall on the evening of the 14th as a mix of light to moderate snow or rain. The next round, on the 16th and 17th, took the form of heavy wet snow and sleet. The event ended with snow showers tapering off on the 18th. When the winter storm ended, snowfall totals ranged from 20 to 32 inches

[126] The figure has been adjusted for inflation and is provided in 2010 dollars, based on the Consumer Price Index.

across the Baltimore Metropolitan area. Estimated regional property damages from the storm were $6.1 million. In Howard County, a stable, a warehouse, a store awning, a tennis bubble dome, a greenhouse, and a shed collapsed under the weight of the snow.

- **December 11, 2002:** A low pressure system produced between 1 and 2 inches of rain. However, the rain turned to ice as temperatures dropped below freezing. In some locations, ice accumulated to ¼ of an inch thick. In Howard County, 22 people were treated for slip and fall injures related to the ice accumulation.
- **January 14, 1999:** An arctic cold front moved over Central Maryland and brought snow to the region. The snow turned to rain while the ground remained below freezing, which in turn created a hazardous condition. Ice accumulations ranged from ¼ to ½ inch. With wind gusting over 40 mph, fallen trees and power outages occurred across the County. At one point, as many as 39,000 households were without power. The Governor of Maryland declared a State of Emergency for Howard County and the surrounding counties.
- **January 7, 1996 – January 13, 1996:** The "Blizzard of '96'" brought between 18 and 30 inches of snow to Howard County on January 8th. On the 9th, an "Alberta Clipper" left an additional 3 to 5 inches of snow throughout the region. A third storm brought another 4 to 6 inches of snow. The County had 2 to 3 feet of snow by the end of the week.
- **February 11, 1983 – February 12, 1983:** The "Blizzard of 1983" was the second greatest snow fall in the region. Over two feet of snow covered the County. During certain periods, snow fell at a rate of 3.5 inches per hour.
- **February 18, 1979**: The "Presidents' Day Storm" brought the second greatest amount of snow fall in the Howard County region, bringing snow of up to 20 inches over the Northern Virginia and Maryland region. At times, snow was falling 2 to 3 inches an hour, and temperatures fell to the single digits.
- **March 29, 1942 – March 30, 1942:** The "Palm Sunday Snowstorm" was the heaviest March snowstorm on record in Maryland. The storm dropped over 20 inches of heavy, wet snow in Howard County.
- **January 27, 1922 – January 28, 1922:** Known as the "Knickerbocker Storm," the nor'easter brought 30 to 32 inches of snow across the County. The high winds also brought blizzard and whiteout conditions across the region.
  January 5, 1912 – February 12, 1912: Known as the "Great Cold Wave" of January 1912, extreme cold was recorded across the region. In Howard County, reports showed that temperatures fell close to 20 degrees below zero.
- **February 1899:** Also known as the "Great Eastern Blizzard of 1899," this February 1899 storm is one of the earliest documented severe winter storm events in the area. The storm produced approximately 20 inches of snow across the region.

With a total of 93 winter storm events between 1993 and 2011, Howard County experiences on average 5.5 winter storm events a year. With 5.5 winter storms occurring per year, there is a 100% annual probability of a winter storm event occurring in Howard County in the future.

Future Likelihood of the Hazard for Howard County

The Future Likelihood section anticipates the future occurrence rate of the hazard based on historical likelihood and future trends. This section also addresses factors that may cause the future likelihood to deviate from historical trends.

Future Likelihood of a Severe Winter Weather Hazard in Howard County	
Historical Average (time period)	93 events over 18 years (1993-2011)
Historical Annual Probability	Near 100% chance of annual occurrence
Future Likelihood Expected to Deviate from Historical Likelihood (Yes/No)	No
Future Annual Probability	30%+ chance of annual occurrence
Future Likelihood Score[4]	4 (Very Likely)
Future Likelihood reflects the likelihood of any emergency-level hazard event and does not differentiate between Likely and Worst-Case scenarios.	

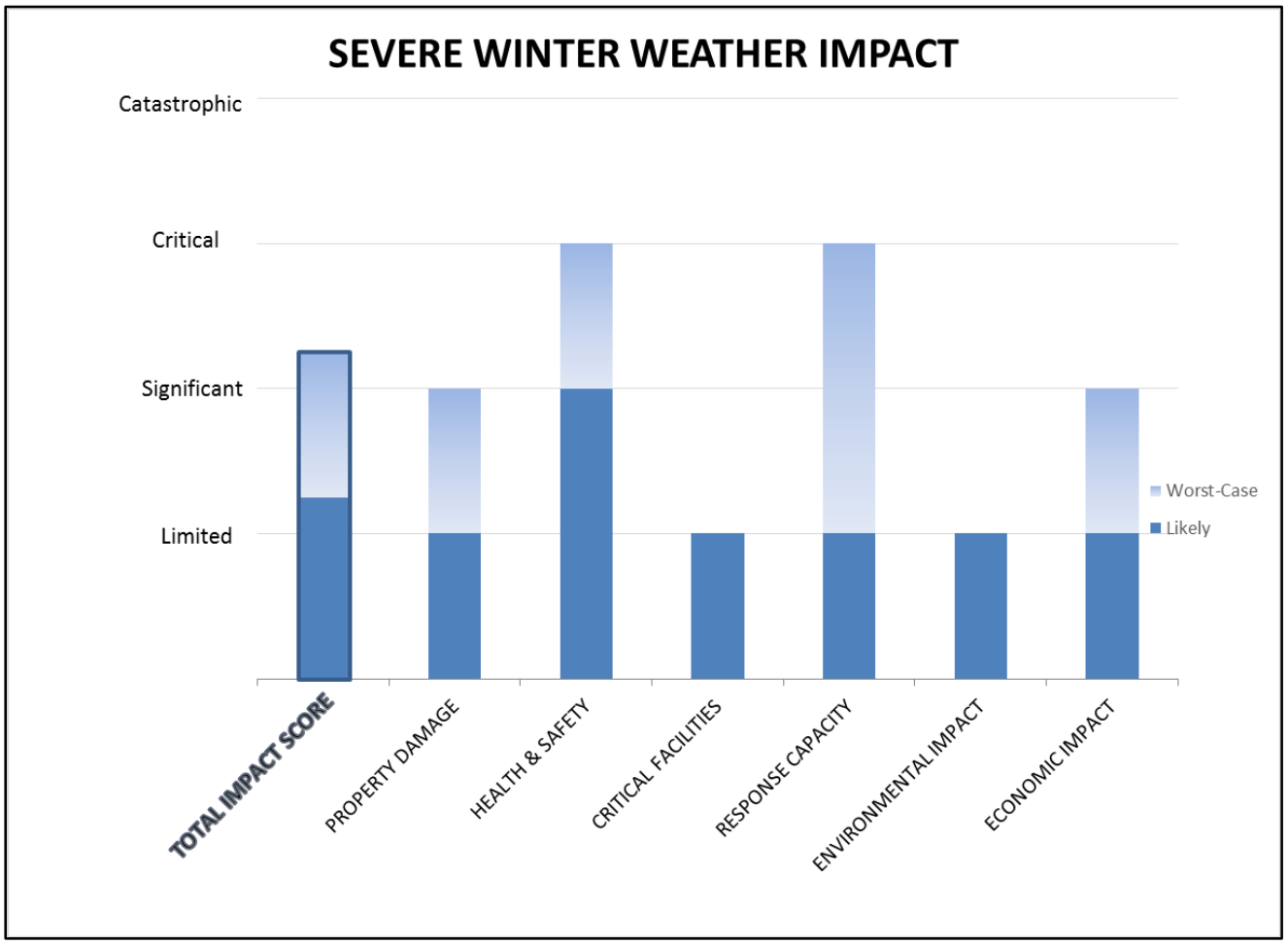
Considerations: An expected increase in extreme storms may result in a slight increase in the likelihood of severe winter weather in Howard County.[127]

[127] *Third National Climate Assessment,* U.S. Global Change Research Program (2014). Available at http://nca2014.globalchange.gov/ (last accessed June 26, 2014).

IV. CONSEQUENCE ANALYSIS

The Consequence Analysis section provides a detailed characterization of the anticipated consequences of likely and worst-case hazard events. This section characterizes impacts to property, health & safety, critical facilities, response capacity, the environment, and the economy. This section also characterizes public perceptions of each hazard, the perceived impact to personal safety and standard of living, and public confidence in response capability.

Consequence Analysis Overview



Where no Worst-Case bar is visible, Worst-Case impact is equivalent to Likely impact.

Severe Winter Weather Warning Time & Duration		
	Likely	**Worst-Case**
WARNING TIME	*Long-Very Long.* 24 hours.	*Long-Very Long.* 24 hours.
DURATION	*Short.* 3 hours.	*Moderate.* 18 hours.

Consequence Analysis: Likely Hazard Scenario

The Consequence Analysis table details the anticipated consequences of the most likely hazard scenario.

SEVERE WINTER STORMS Likely		
PROPERTY DAMAGE	*Limited*	• Up to 2% of critical and non-critical infrastructure will be damaged. • No damage anticipated except icing on some roadways and bridges are expected. • Downed power lines, vehicle accidents, and falling tree limbs are expected.
HEALTH & SAFETY	*Significant*	• 0 deaths are expected. Automobile accidents and hypothermia are the most common causes of death. • 0-5 injuries are expected. Automobile accidents are the most common cause of injuries.
CRITICAL FACILITIES	*Limited*	• *Utilities* – Shutdown unlikely. • *Information/Communications* – Shutdown unlikely. • *Transportation* – No delays or closures likely.
RESPONSE CAPACITY	*Limited*	• *Police* – Local resources adequate. No impact to response capability and continuity of operations. • *Fire & Rescue* – Local resources adequate. Limited impact to response capability. Increased call volume for vehicle accidents. • *Health* – Local resources adequate. Howard County Health Department operations will not be affected. • *Public Works* – Local resources adequate.
ENVIRONMENTAL IMPACT	*Limited*	• Minimal immediate impact. • Repeated use of road salt impacts water resources. • Increased Chloride levels are harmful to aquatic and human life. • Loss of tree limbs and downed trees are likely.
ECONOMIC IMPACT	*Limited*	• Limited amount loss in dollar value. • Traffic delays impact in economic consequences.
TOTAL IMPACT	*Limited - Significant*	• Total Impact Score: 1.25 on a scale of 1 (Limited) to 4 (Catastrophic).
Limited	*Significant*	*Critical*	*Catastrophic*

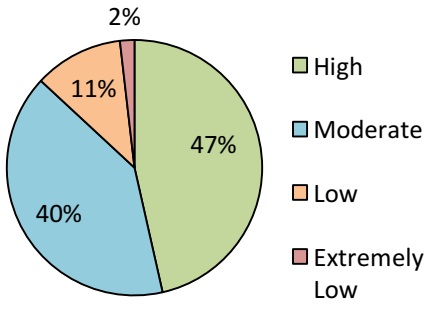
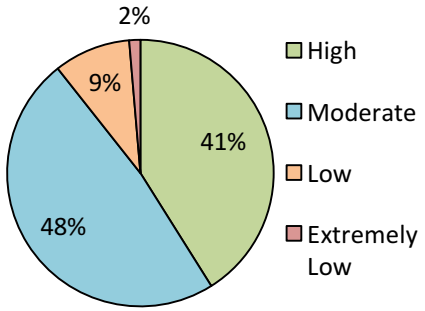
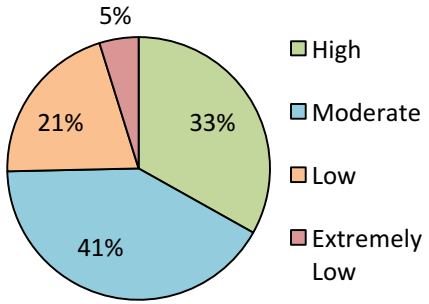
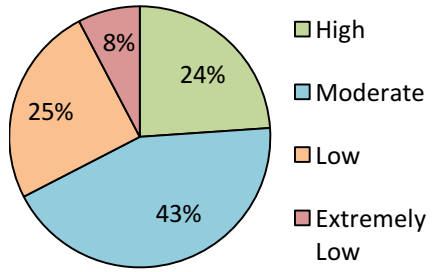
Consequence Analysis: Worst-Case Hazard Scenario

The Consequence Analysis: Worst-Case table details the anticipated consequences of the worst-case hazard scenario.

SEVERE WINTER STORMS **Worst-Case**		
PROPERTY DAMAGE	*Significant*	• Up to 3% of critical and non-critical infrastructure will be damaged. • Some concrete parking garage decks partially collapsed and a few roof failures or creaking and sagging is expected. • Damage to some curbs, storm drains inlets, and mailboxes are expected. • Some roof and interior flooding after and during melting is expected. • Significant impacts on critical and non-critical infrastructure will be damaged. • Structure collapse of occupancies is expected.
HEALTH & SAFETY	*Critical*	• 0-2 deaths are expected. Automobiles, loss of power and heat sources, and overexertion from snow removal are the most common causes of death. • 0-20 injuries are expected. Frost bite, hypothermia, automobile accidents, and overexertion from snow removal are the most common causes of injuries.
CRITICAL FACILITIES	*Significant*	• *Utilities* – Up to 12 hours during the storm and during clean-up, critical facilities will be shut down. All above ground facilities may be out of service until clean up. • Information/Communications – Government, electrical, power, and schools will be out of service. • *Transportation* – 1-2 days shutdown are expected. Government facilities and transit and rails will be out of service.
RESPONSE CAPACITY	*Significant*	• *Police* – Moderate need for state or federal assistance. Low impact to response capability and continuity of operations. May require law enforcement to include additional manpower resources and schedule changes to departmental personnel. • *Fire and Rescue* – Moderate need for state and federal assistance. Impact will be for personnel and operations. • *Health* – Moderate need for state or federal assistance. Howard County Health Department would monitor Web EOC virtually and be in communication with the EOC. • *Public Works* – Significant and long-lasting need for state or federal assistance. Long working hours for crews with minimal breaks.
ENVIRONMENTAL IMPACT	*Limited*	• Minimal immediate impact. • Repeated use of road salt is raising the chloride levels in streams and reservoirs. Increased levels of chloride is harmful to aquatic and human life. • Flooding can occur due to the temperature rising and snowfall melting.
ECONOMIC IMPACT	*Significant*	• Hundreds of millions amount loss in dollar value. • Business closures, loss of productivity, and employment disruption to transportation network are the economic consequences.
TOTAL IMPACT	*Limited - Significant*	• Total Impact Score: 2.25 on a scale of 1 (Limited) to 4 (Catastrophic).
Limited	*Significant*	*Critical*	*Catastrophic*

Consequence Analysis: Public Perception

The Consequence Analysis: Public Perception table characterizes public perceptions of each hazard. Details include public confidence in personal ability to respond to each hazard, public confidence in Howard County's ability to respond to each hazard, and each hazard's perceived impact to personal safety and standard of living.

Public Perceptions on Severe Winter Storms			
PERCEIVED CONFIDENCE IN HOWARD COUNTY'S ABILITY TO RESPOND AND RECOVER FROM THIS HAZARD	**PERCEIVED CONFIDENCE IN PERSONAL ABILITY TO PROTECT SELF AND FAMILY FROM THIS HAZARD**	**CONCERN OVER THE IMPACT TO PERSONAL HEALTH AND SAFETY IF THIS HAZARD WERE TO OCCUR LOCALLY**	**CONCERN OVER THE IMPACT TO PERSONAL STANDARD OF LIVING / QUALITY OF LIFE IF THIS HAZARD WERE TO OCCUR LOCALLY**
			
Average: 3.31 *Moderate*	*Average: 3.14* *Moderate*	*Average: 3.03* *Moderately Concerned*	*Average: 2.84* *Moderately - Low Concern*

Space Weather

I. OVERVIEW

The Overview section defines the hazard and summarizes the hazard risk profile.

Definition

This section defines the scope of the hazard category. The terminology and characterization established in this section should be consistent throughout all Howard County planning documents.

Space Weather describes the conditions in space that affect Earth and its technological systems. Space Weather is a consequence of the behavior of the Sun, the nature of Earth's magnetic field and atmosphere, and our location in the solar system. The active elements of space weather are particles, electromagnetic energy, and magnetic field, rather than the more commonly known weather contributors of water, temperature, and air.

Risk Profile

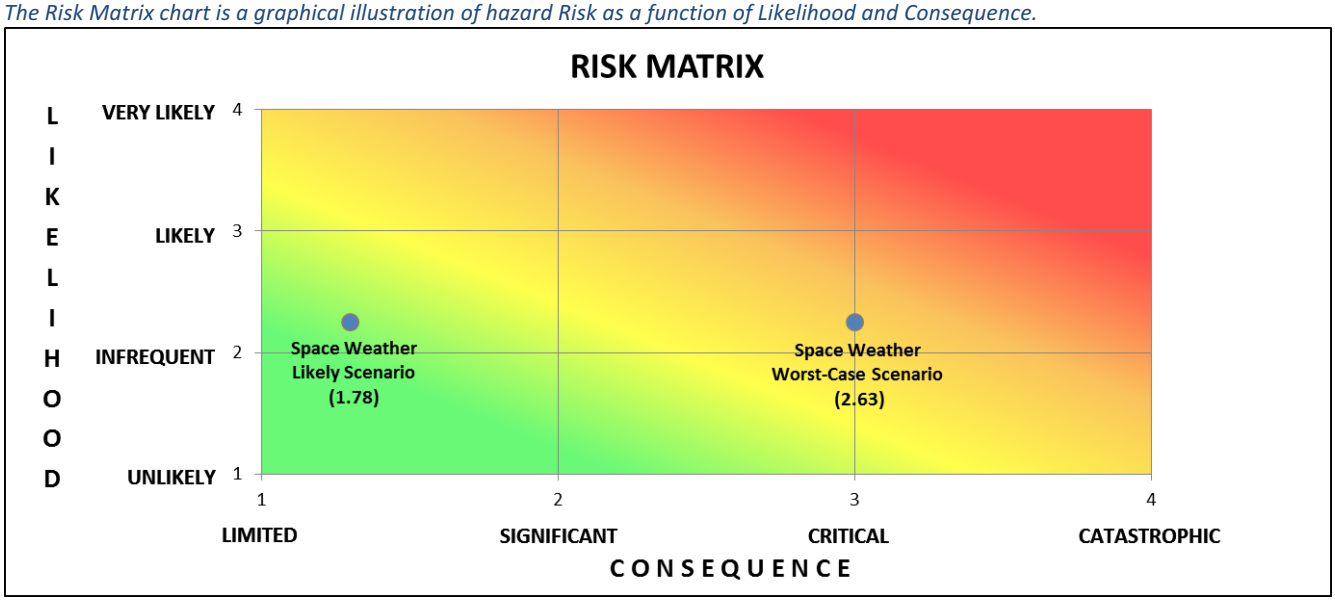
The Risk Profile section presents the Risk Score for the hazard in a range from 1 (lowest risk) to 4 (highest risk). Risk Score is a function of Likelihood and Consequence.

Space Weather Risk Profile				
	Risk Assessment Category	**Likely Hazard Scenario**	**Worst-Case Hazard Scenario**	**Weight**
LIKELIHOOD	**Likelihood**	2.25 Infrequent-Likely		50%
CONSEQUENCE	**Impact**	1 Limited	3.125 Critical - Catastrophic	40%
	Warning Time	4 Short	4 Short	5%
	Duration	1 Short	1 Short	5%
TOTAL RISK SCORE		**1.78**	**2.63**	

**The Likelihood Score reflects the likelihood of any emergency-level hazard event and does not differentiate between Likely and Worst-Case scenarios.*

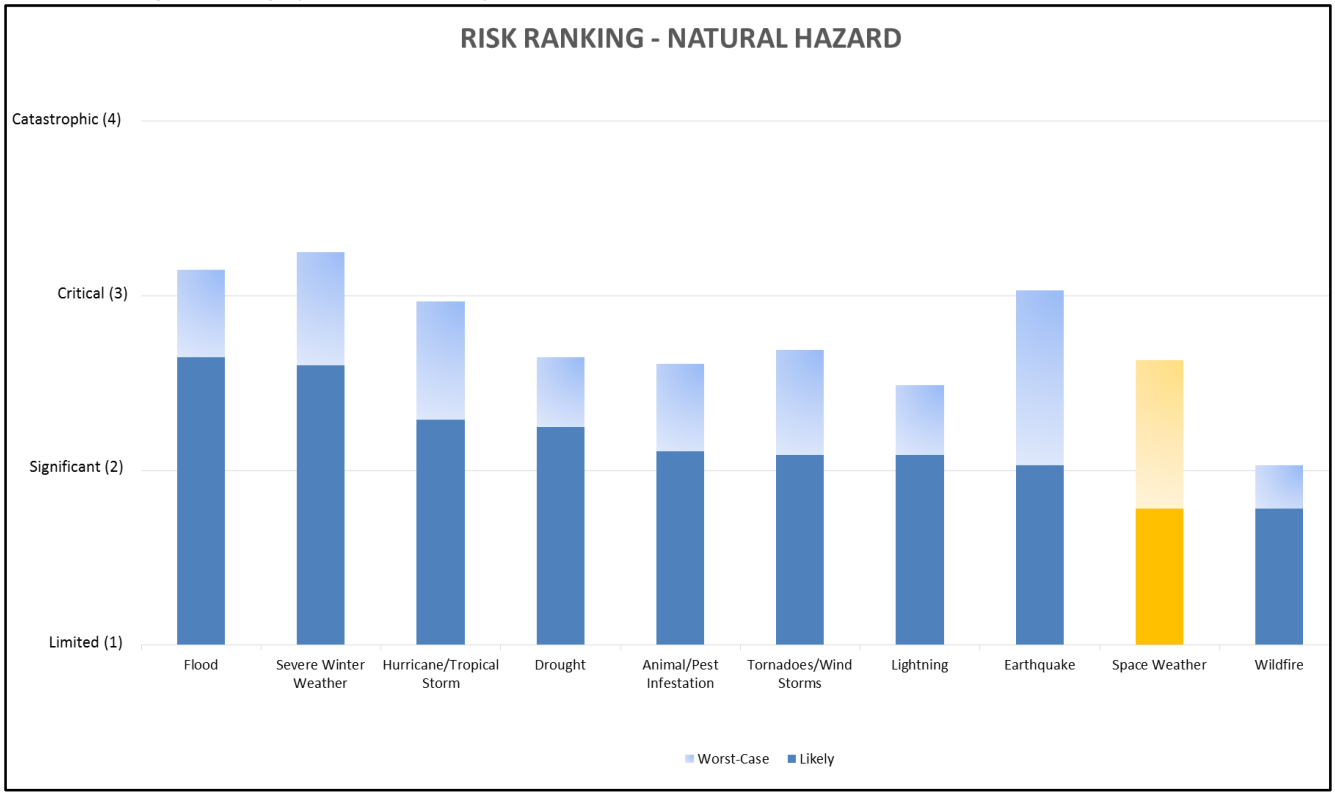
Risk Matrix

The Risk Matrix chart is a graphical illustration of hazard Risk as a function of Likelihood and Consequence.



Risk Ranking

The Risk Ranking chart is a graphical illustration of hazard Risk as it relates to other hazards.



Where no Worst-Case bar is visible, Worst-Case Risk is equivalent to Likely Risk.

II. HAZARD CHARACTERISTICS

The Hazard Characteristics section provides a detailed characterization of the hazard and the local context as it relates to the hazard.

Description of the Hazard

Space weather is generally divided into four components: solar flares, coronal mass ejections, high speed solar wind, and solar energetic particles. The type of space weather that is most relevant to Howard County is the threat of Geomagnetic Storms. A geomagnetic storm is a major disturbance of Earth's magnetosphere that occurs when there is a very efficient exchange of energy from the solar wind into the space environment surrounding Earth. These storms result from variations in the solar wind that produces major changes in the currents, plasmas, and fields in Earth's magnetosphere.[128] The largest storms that result from these conditions are associated with solar coronal mass ejections (CMEs) where a billion tons or so of plasma from the sun, with its embedded magnetic field, arrives at Earth. CMEs typically take several days to arrive at Earth, but have been observed, for some of the most intense storms, to arrive in as short as 18 hours.[129] These storms could cause disturbances in the electric power grid, which could negatively impact homes and businesses in Howard County.

In a geomagnetic storm, Electric Power grid systems could suffer from widespread voltage control problems and possible transformer damage. In a worst-case scenario, such storms could result in complete power grid collapse or blackouts. When magnetic fields move about in the vicinity of a conductor such as a wire, an electric current is induced into the conductor. This happens on a grand scale during geomagnetic storms. By receiving geomagnetic storm alerts and warnings, power companies can minimize damage and power outages.[130]

Besides the risk to the electric power grid, space weather could have other potentially harmful effects on the people of Howard County. Solar Radiation Storms could case the disruption of Satellites in Space, which could disrupt a wide variety of communications systems.

[128] Space Weather Prediction Center, National Oceanic and Atmospheric Administration, *Geomagnetic Storms*, (NOAA), www.swpc.noaa.gov/phenomena/geomagneticv-storms (last accessed March 17, 2016)
[129] Id.
[130] Space Weather Prediction Center, National Oceanic and Atmospheric Administration, *A Profile of Space Weather,* http://www.swpc.noaa.gov/sites/default/files/images/u33/primer_2010_new.pdf, (last accessed March 17, 2016)

Local Context

The Local Context section describes community attributes that affect the likelihood of the hazard's occurrence or vulnerability to the hazard's consequences.

The best- known example of a Space Weather's affect is the collapse of the Hydro- Quebec power network that caused a transformer failure and led to a blackout that lasted nine hours and affected 6 million people (http://www.nasa.gov/mission_pages/sunearth/spaceweather/index.html#q11). Solar storms are a part of space weather and occur when energy blasts off from the sun interacts with the Earth's atmosphere and geomagnetic field (http://www.usatoday.com/story/weather/2015/03/17/solar-geomagnetic-storm/24901903/).

During solar storms, aka geomagnetic storms, the sky is filled with bright auroras in several northern U.S. states including Minnesota, Wisconsin, Montana, the Dakotas, and Washington. Although the sky is beautifully lit up, solar storms can cause a disruption to our daily lives. The electric grid, power to homes and business can be affected, and people who use GPS navigation will also be interrupted. Although the solar storms can last from a few minutes to several hours, the affects linger in the Earth's atmosphere for days and maybe even weeks.

The way solar storms are monitored and observed are not as easy as walking outside and looking in the sky. Scientists utilize a variety of ground- and space- based sensors and imaging systems to view activity at various depths in the atmosphere. Telescopes are used to detect visible light, ultraviolet light, gamma rays, and X rays. Receivers and transmitters are used to detect radio shock wave that is created by when a coronal mass ejection (CME) crashes into the solar wind and produces a shock wave. Particle detectors are used to count ions and electrons, magnetometers record changes in magnetic fields, and UV and visible cameras observe auroral patterns above the Earth.

III. LIKELIHOOD ANALYSIS

The Likelihood Analysis section characterizes the historical occurrence and future likelihood of the hazard in the planning area.

Occurrence of the Hazard

The Occurrence of the Hazard section details the historical occurrence of the hazard in the planning area.

There have been no notable occurrences of Space Weather having an impact in Howard County.

Future Likelihood of the Hazard for Howard County

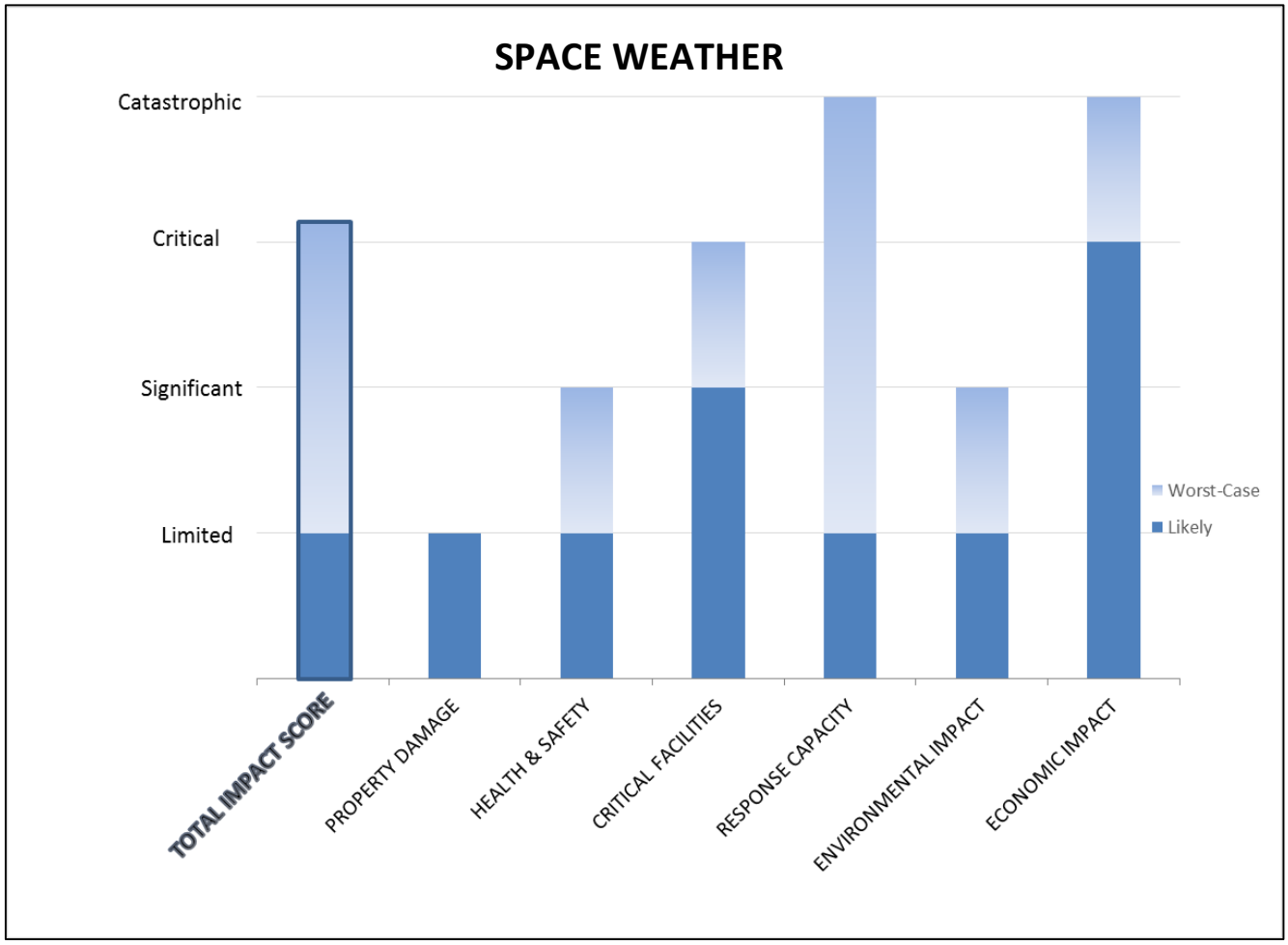
The Future Likelihood section anticipates the future occurrence rate of the hazard based on historical likelihood and future trends. This section also addresses factors that may cause the future likelihood to deviate from historical trends.

Future Likelihood of Space Weather in Howard County	
Historical Average (time period)	No notable occurrences
Historical Annual Probability	0% chance of annual occurrence
Future Likelihood Expected to Deviate from Historical Likelihood (Yes/No)	Yes
Future Annual Probability	1-30% chance of annual occurrence
Future Likelihood Score[4]	2.5 (Infrequent-Likely)
Future Likelihood reflects the likelihood of any emergency-level hazard event and does not differentiate between Likely and Worst-Case scenarios.	

IV. CONSEQUENCE ANALYSIS

The Consequence Analysis section provides a detailed characterization of the anticipated consequences of likely and worst-case hazard events. This section characterizes impacts to property, health & safety, critical facilities, response capacity, the environment, and the economy. This section also characterizes public perceptions of each hazard, the perceived impact to personal safety and standard of living, and public confidence in response capability.

Consequence Analysis Overview



Where no Worst-Case bar is visible, Worst-Case impact is equivalent to Likely impact.

Space Weather Warning Time & Duration		
	Likely	**Worst-Case**
WARNING TIME	*Short.* Less than six hours.	*Short.* Less than six hours.
DURATION	*Short.* Less than six hours.	*Short.* Less than six hours.

Consequence Analysis: Likely Hazard Scenario

The Consequence Analysis table details the anticipated consequences of the most likely hazard scenario.

Space Weather Likely		
PROPERTY DAMAGE	*Limited*	• Up to 1% of critical and non-critical infrastructure will be damaged. • Possibility of critical and high voltage switch gear being destroyed and back-up generators may be worn out. • Possible issues to communication and potential concerns with traffic signals are expected.
HEALTH & SAFETY	*Limited*	• 0 deaths are expected. Lightning and electrocution are the most common causes of death. • 0-1 injuries likely. Lightning and electrocution are the most common causes of death. • *DFRS*- Unknown deaths and causes that are expected. • *DFRS*- Unknown injuries and causes that are expected.
CRITICAL FACILITIES	*Significant*	• *Utilities* – 3-6 hours of shut down of critical facilities. All facilities that require power will be out of service. • *Information/Communication* – Shutdown is unlikely. Some impact on communication and traffic lights are expected. • *Transportation* – 3-6 hours of shutdown is expected.
RESPONSE CAPACITY	*Limited*	• *Police* – Local resources adequate. Low impact to response capability or continuity of operations. May cause law enforcement to loose radio, computer communication for a limited period of time. Land lines will be required for communication. • *Fire & Rescue* – Local resources adequate. Limited impact to response capability. Communication issues will be the most impacted. • *Health* – Mutual aid needed. Administrative duties will be on hold until communication can be restored. Clinical Services can continue to provide services and maintain mutual charts of their patients. • *Public Works* – Local resources adequate. Any responses that have potential failure nodes due to electronic communications are impacted.
ENVIRONMENTAL IMPACT	*Limited*	• Minimal impact on air, water, and land is expected. • Limited environmental impact is expected.
ECONOMIC IMPACT	*Critical*	• Hundreds of millions or more of loss in dollar value. • Business disruption, closure and extended period of electrical, and telecommunications and IT infrastructure damage assessment and repair in economic consequences. • Critical economic impact.
TOTAL IMPACT	*Limited*	• Total Impact Score: 1on a scale of 1 (Limited) to 4 (Catastrophic).
Limited	*Significant*	*Critical*	*Catastrophic*

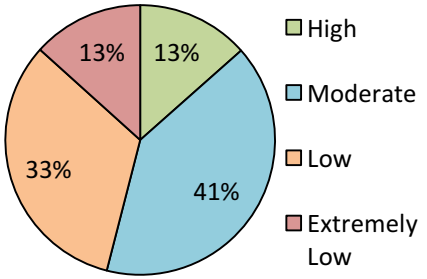
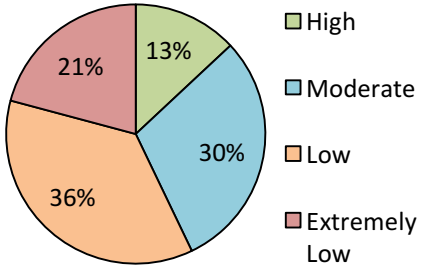
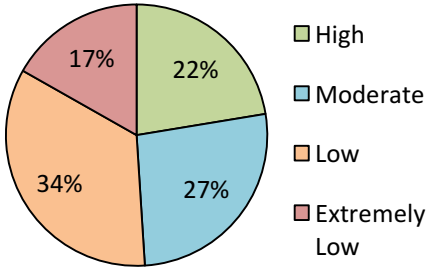
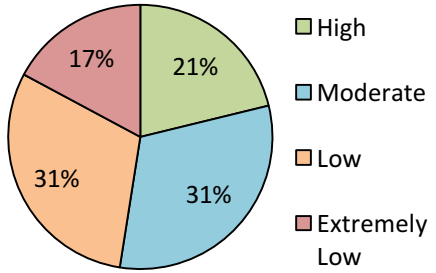
Consequence Analysis: Worst-Case Hazard Scenario

The Consequence Analysis: Worst-Case table details the anticipated consequences of the worst-case hazard scenario.

Space Weather Worst-Case		
PROPERTY DAMAGE	*Limited*	• Less than 5% of critical and non-critical infrastructures will be damaged. • Some traffic signals may be out of service especially along state roadways.
HEALTH & SAFETY	*Significant*	• Unknown deaths expected, but citizens requiring power use for life sustaining interventions would be impacted. Underlying medical conditions are the most common causes of death. • Unknown injuries expected. Underlying medical conditions are the most common causes of injuries.
CRITICAL FACILITIES	*Critical*	• *Utilities* – 3 weeks+ of critical facilities will be shut down. Some buildings may need to be shut down for extended periods of time. • *Information/Communications* – Outages up to to a week or may take longer. • *Transportation* – Nearly all critical facilities will be out of service. No fuel, no food in stores, and no clean water are also expected due to facilities being out of service.
RESPONSE CAPACITY	*Catastrophic*	• *Police* – Moderate need for state or federal assistance. Moderate impact to response capability or continuity of operations. May cause law enforcement to loose radio, computer communication for a limited period of time. Land lines will be required for communication. • *Fire & Rescue* – Significant and long-lasting need for state and federal assistance. Significant COOP issues and access for functional needs communities. • *Public Works* – Significant and long-lasting need for state or federal assistance.
ENVIRONMENTAL IMPACT	*Significant*	• Minimal direct impact on air, water, and land resources, but loss of power and distribution of communications can cause air, water, and land pollution if it disrupts facilities such as pipelines carrying hazardous materials, industrial manufacturing plants, or sewage treatment plants. • Limited-Significant environmental impact is expected.
ECONOMIC IMPACT	*Catastrophic*	• Billions in loss of dollar value. • Loss of electrical, communication, transportation management, and security brings life to a standstill in economic consequences.
TOTAL IMPACT	*Critical – Catastrophic*	• Total Impact Score: 3.13 on a scale of 1 (Limited) to 4 (Catastrophic).
Limited	*Significant*	*Critical* / *Catastrophic*

Consequence Analysis: Public Perception

The Consequence Analysis: Public Perception table characterizes public perceptions of each hazard. Details include public confidence in personal ability to respond to each hazard, public confidence in Howard County's ability to respond to each hazard, and each hazard's perceived impact to personal safety and standard of living.

Public Perceptions on Space Weather			
PERCEIVED CONFIDENCE IN HOWARD COUNTY'S ABILITY TO RESPOND AND RECOVER FROM THIS HAZARD	**PERCEIVED CONFIDENCE IN PERSONAL ABILITY TO PROTECT SELF AND FAMILY FROM THIS HAZARD**	**CONCERN OVER THE IMPACT TO PERSONAL HEALTH AND SAFETY IF THIS HAZARD WERE TO OCCUR LOCALLY**	**CONCERN OVER THE IMPACT TO PERSONAL STANDARD OF LIVING / QUALITY OF LIFE IF THIS HAZARD WERE TO OCCUR LOCALLY**
			
Average: 2.54 *Moderate - Low*	*Average: 2.35* *Low*	*Average: 2.55* *Moderate – Low Concern*	*Average: 2.57* *Moderate – Low Concern*

Tornadoes/Wind Storms

I. OVERVIEW

The Overview section defines the hazard and summarizes the hazard risk profile.

Definition

This section defines the scope of the hazard category. The terminology and characterization established in this section should be consistent throughout all Howard County planning documents.

A tornado is "a violently rotating column of air, pendant from a cumuliform cloud or underneath a cumuliform cloud, and often (but not always) visible as a funnel cloud." Tornadoes are related to larger vortex formations, and therefore often form in convective cells such as thunderstorms or in the right forward quadrant of a hurricane, far from the hurricane eye.

Risk Profile

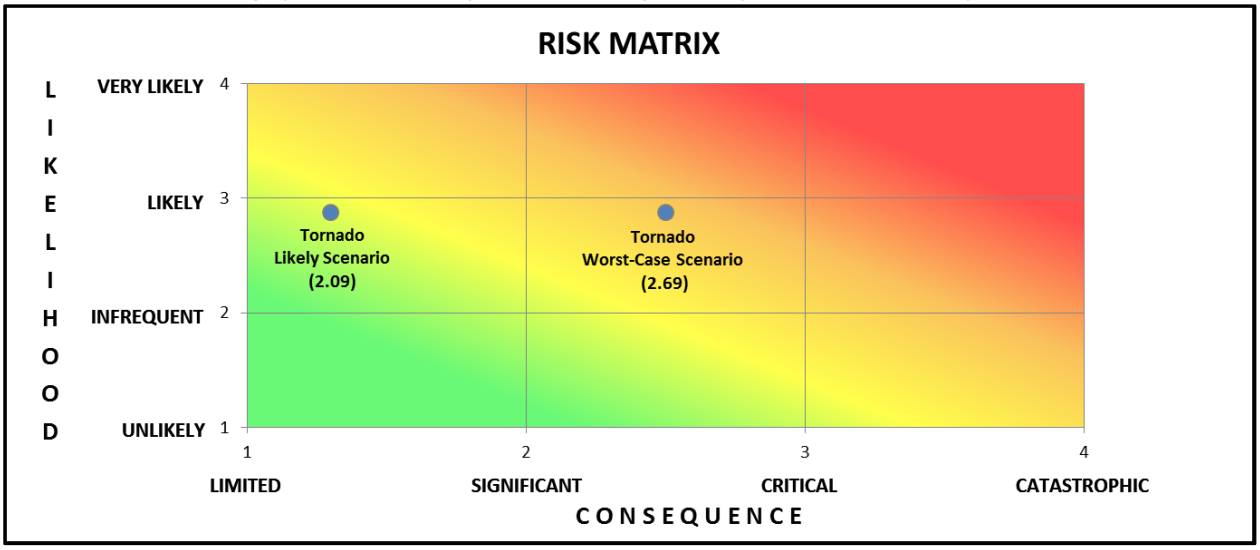
The Risk Profile section presents the Risk Score for the hazard in a range from 1 (lowest risk) to 4 (highest risk). Risk Score is a function of Likelihood and Consequence.

Tornadoes/Wind Storms Risk Profile				
	Risk Assessment Category	**Likely Hazard Scenario**	**Worst-Case Hazard Scenario**	**Weight**
LIKELIHOOD	**Likelihood**	2.875 Infrequent-Likely		50%
CONSEQUENCE	**Impact**	1 Limited	2.5 Significant-Critical	40%
	Warning Time	4 Short	4 Short	5%
	Duration	1 Short	1 Short	5%
TOTAL RISK SCORE		**2.09**	**2.69**	

**The Likelihood Score reflects the likelihood of any emergency-level hazard event and does not differentiate between Likely and Worst-Case scenarios.*

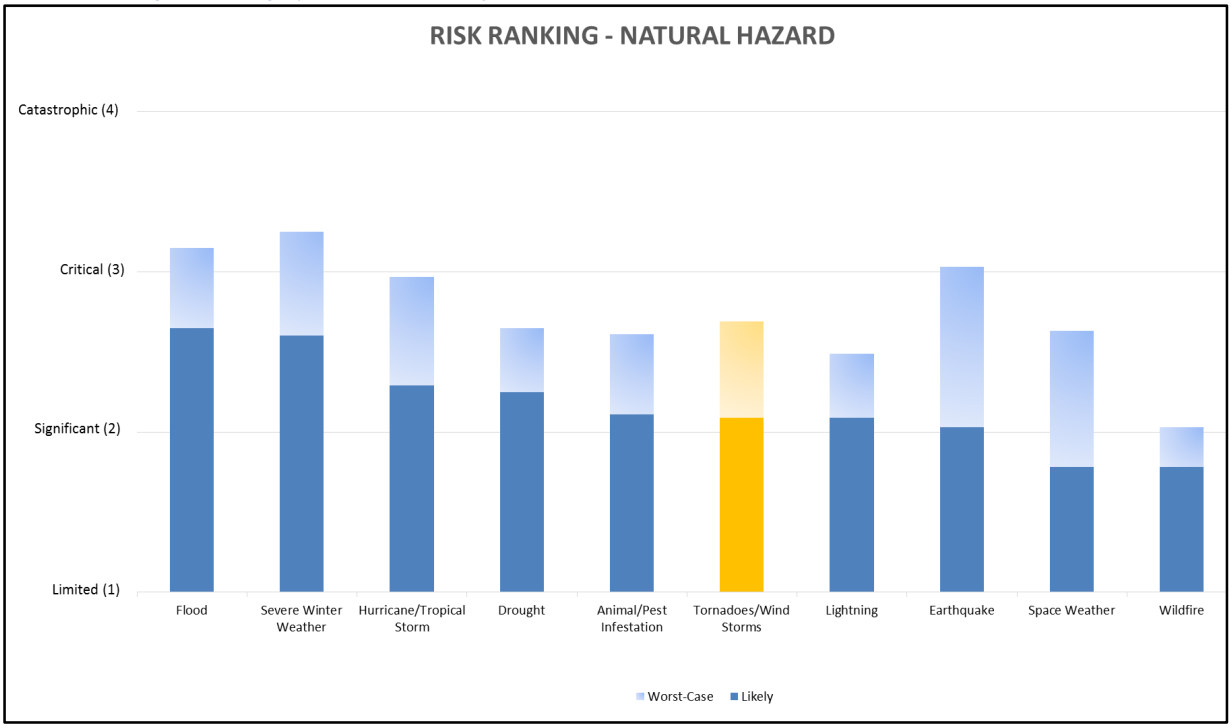
Risk Matrix

The Risk Matrix chart is a graphical illustration of hazard Risk as a function of Likelihood and Consequence.



Risk Ranking

The Risk Ranking chart is a graphical illustration of hazard Risk as it relates to other hazards.



Where no Worst-Case bar is visible, Worst-Case Risk is equivalent to Likely Risk.

II. HAZARD CHARACTERISTICS

The Hazard Characteristics section provides a detailed characterization of the hazard and the local context as it relates to the hazard.

Description of the Hazard

A tornado is "a violently rotating column of air, pendant from a cumuliform cloud or underneath a cumuliform cloud, and often (but not always) visible as a funnel cloud."[131] Most of the time, vortices remain suspended in the atmosphere. When the lower tip of a vortex touches the earth, the tornado becomes a force of destruction.[132] Tornadoes are related to larger vortex formations, and therefore often form in convective cells such as thunderstorms or in the right forward quadrant of a hurricane, far from the hurricane eye. The most destructive tornadoes are formed in the most powerful thunderstorms, known as supercells, which have a well-defined radar circulation called a mesocyclone.[133]

Tornadoes can form any time, with the Nation's season of greatest activity running from March to August. The peak of tornado activity usually occurs in April, May, and June. According, the *2008 State of Maryland Hazard Mitigation Plan*, states that July is the peak month for tornado activity in Maryland. Tornadoes can occur at any time of the day, although they are more likely to occur between 3 p.m. and 9 p.m.

In terms of wind storms events, there are two basic types that may affect Howard County: Mesoscale and Microscale winds. Either type of wind storm events may result in property damage and loss of life. Mesoscale winds are high winds that are long-lasting and occur over a large area. They are typically associated with a cold frontal passages or a Nor'easter. Microscale winds last a short time period and are confided to a small area. Microscale winds are commonly associated with thunderstorms. When a thunderstorm produces winds over 50 knots (roughly 58 mph), that thunderstorm is considered severe.

A downburst, or a sub-set of thunderstorms, is a type of Microscale wind.[134] Downbursts results from a sudden descent of cold air hitting the ground and spreading outward, thus creating a high wind event. A downburst can have devastating effects. According to NOAA, there are two types of downbursts, a microburst and a macroburst. A microburst is a small downburst that brings damaging winds up to 168 mph, over an area of 2 ½ miles, and lasts 5 to 15 minutes. A macroburst is a large downburst that causes tornado-like damage, where winds can reach 134 mph, over an area of 2 ½ miles, and lasts 5 to 30 minutes.[135]

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[131] *Glossary of Meteorology*, American Meteorological Society (2000), available at http://www.spc.noaa.gov/faq/tornado/.

[132] Other definitions stress the destructive nature of tornadoes. For example, the Red Cross describes a tornado as a "violently rotating column of air extending from the base of a thunderstorm down to the ground." *Tornado Safety Checklist*, http://www.redcross.org/portal/site/en/menuitem.86f46a12f382290517a8f210b80f78a0/?vgnextoid=62a7da30df3ea110VgnVCM10000030f3870aRCRD (last accessed March 12, 2012).

[133] For additional information about tornadoes, see *NOAA's Severe Weather*, http://www.noaawatch.gov/themes/severe.php (last accessed April 9, 2012).

[134] See *National Weather Service's Downburst*, http://www.erh.noaa.gov/cae/svrwx/downburst.htm (last accessed April 9, 2012).

[135] For additional information about severe thunderstorms and high winds, see *NOAA's Severe Weather*, http://www.noaawatch.gov/themes/severe.php (last accessed April 9, 2012).

Local Context

The Local Context section describes community attributes that affect the likelihood of the hazard's occurrence or vulnerability to the hazard's consequences.

Compared to the Central United States, the risk of a tornado occurring in Howard County is present but relatively low. From 1950 to 2010, the NCDC database indicates that Maryland has experienced 294 tornadoes, an average of less than 5 per year.[136] Tornadoes can occur at any time, with the greatest frequency during the late spring and early summer months, and during late afternoon and early evening hours. Within Howard County, the risk to people and property from tornadoes cannot be distinguished by area; the hazard has a uniform probability of occurrence across the County. Although the impact of a tornado event will be different in different parts of the County, all people and assets are considered to have the same degree of exposure. This is the same for mesoscale (high wind) and microscale (thunderstorm wind) wind events.

The figure below shows how the frequency and strength of extreme windstorms that vary across the United States. This map is based on a combination of all past occurrences and shows that Central Maryland and Howard County falls within Wind Zone II, where wind speeds can reach as high as 160 mph.

Wind Zones in the United States
(Source: FEMA)



[136] To put these numbers into perspective, a state as large as Texas averages 139 tornadoes annually.

III. LIKELIHOOD ANALYSIS

The Likelihood Analysis section characterizes the historical occurrence and future likelihood of the hazard in the planning area.

Occurrence of the Hazard

The Occurrence of the Hazard section details the historical occurrence of the hazard in the planning area.

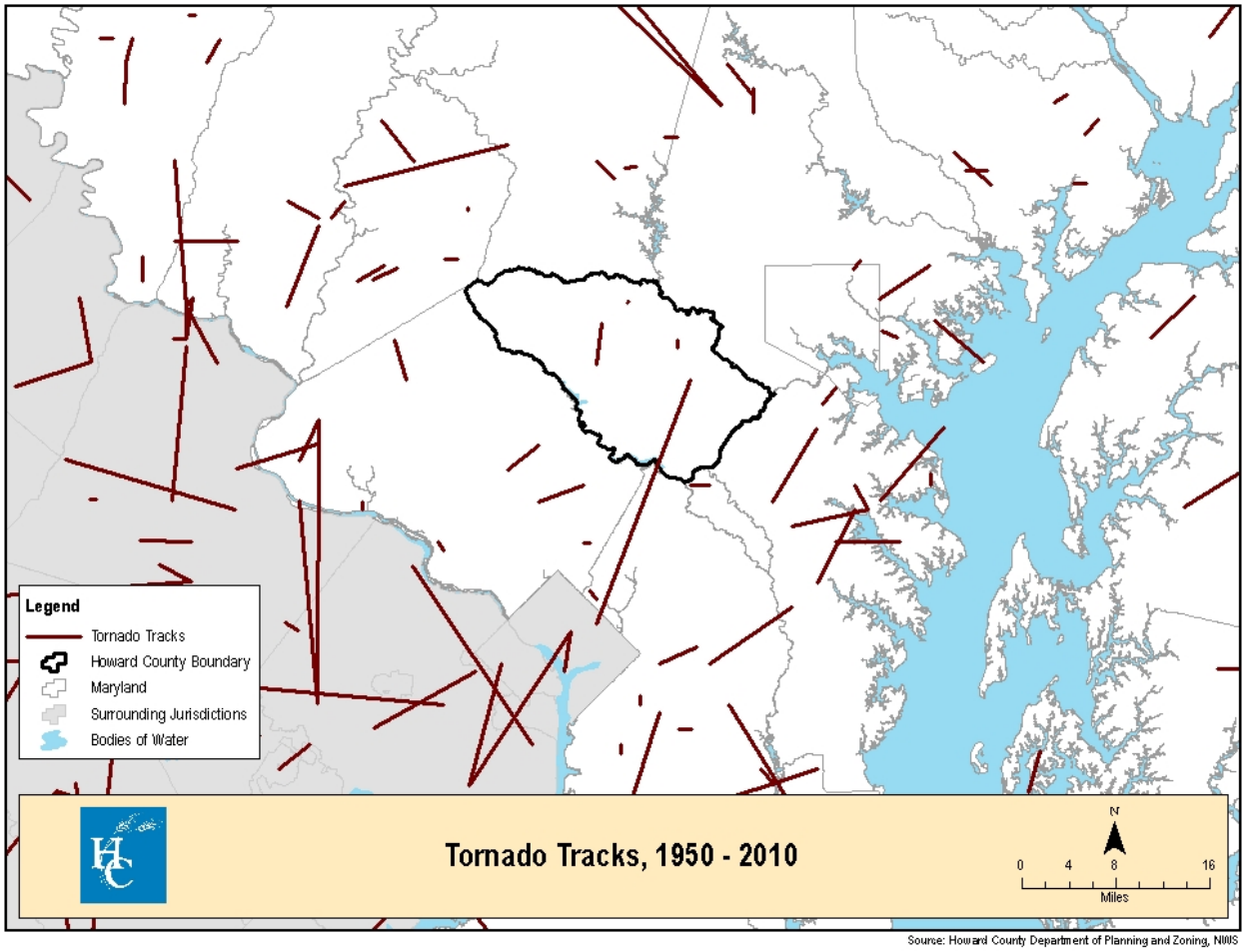
The NCDC database reports that 14 tornadoes have occurred in Howard County between 1975 and 2016. The database indicates there were eight F0s, four F1s, and two F2s tornadoes. Table 6.4.5-4 summarizes the nine tornadoes that have occurred within Howard County.

Table 6.4.5-4
Howard County: Tornado Events 1975 – June 2016
(Source: NOAA/NCDC)

Event ID	Location	Date	Event Type	Tornado Scale	Deaths	Injuries	Property Damage ($)	Crop Damage ($)
10040461	n/a	7/3/1975	Tornado	F0	0	0	0	0
10042106	n/a	7/31/1978	Tornado	F2	0	0	250000	0
10038193	n/a	8/28/1992	Tornado	F1	0	2	2500000	0
10038195	n/a	8/28/1992	Tornado	F0	0	0	2500	0
10329525	West Friendship	7/6/1995	Tornado	F0	0	0	75000	0
5567912	COLUMBIA	8/27/1996	Tornado	F0	0	0	15000	0
5165078	SAVAGE	7/10/2000	Tornado	F1	0	0	50000	0
5270225	NORTH LAUREL	9/24/2001	Tornado	F2	0	0	1000000	0
189029	ALPHA	7/31/2009	Tornado	EF1	0	0	0	0
391766	WATERSVILLE JCT	6/1/2012	Tornado	EF1	0	0	5000	0
391769	SCAGGSVILLE	6/1/2012	Tornado	EF0	0	0	100000	0
546054	SAVAGE	10/15/2014	Tornado	EF0	0	0	0	0
599519	SAVAGE	9/29/2015	Tornado	EF0	0	0	0	0
645695	FLORENCE	6/21/2016	Tornado	EF0	0	0	0	0

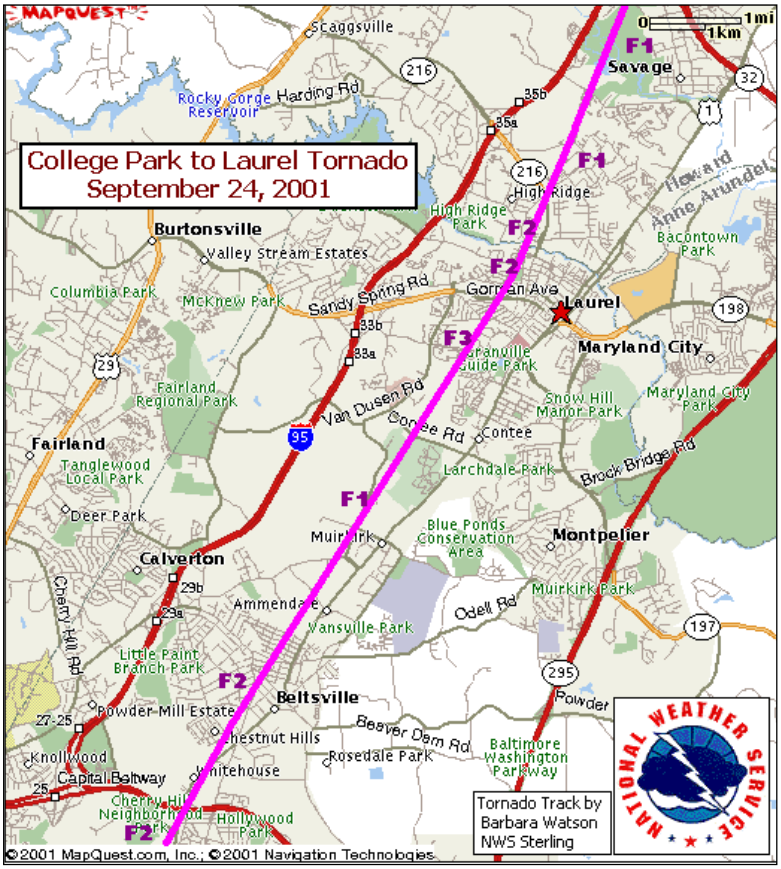
The figure below identifies the tornado tracks for Howard County and the surrounding area between 1950 and 2010.

Tornado Tracks for Howard County and Surrounding Area, 1950- 2010
(Source: NOAA, Howard County Department of Planning and Zoning)



Howard County has experienced two F2 tornadoes since 1975. The July 31, 1978 tornado was estimated to be 40 yards wide and travelled for a length of $^{8}/_{10}$ of a mile, causing $826,000[137] in damage. The tornado of September 24, 2001 originated in Prince George's County as an F3 and travelled north-northeast from Hyattsville, through College Park, and into Laurel. Along its destructive path, the tornado killed two and injured 55. Just before the tornado crossed into Howard County, it weakened from a F3 to an F2 tornado. In Howard County, the tornado caused severe damage to several townhomes in Settler's Landing, a subdivision in North Laurel. As the tornado continued northward, it slowly dissipated and ended one mile east-southeast of Columbia. The tornado traveled a total distance of six miles in Howard County and had a width of 100 yards. Along its destructive path, the tornado uprooted trees, blew off rooftops, and blew out car windows. Many homes were deemed unsafe for a period of time, and one was severely damaged. Property damage in Howard County was estimated at $123.4 million.[138] The tornado caused no fatalities or injures. The figure below shows the College Park tornado track as it moved northeast from Beltsville to Laurel.

September 24, 2001 Tornado Track – College Park to Laurel
(Source: National Weather Service – Baltimore/Washington Office, September 24, 2001 Tornadoes)



[137] The figure has been adjusted for inflation and is provided in 2010 dollars, based on the Consumer Price Index.

[138] Id.

Additional significant tornado events that have impacted Howard County are described below.

- **June 30, 2016 (F0 Tornado):** The tornado traveled nearly 13 miles through western Howard County. There were no injuries or deaths associated, hundreds of trees were knocked down and several homes had serious damage from falling debris. The path of debris was over 500 yards wide at some points.
- **July 10, 2000 (F1 Tornado):** The tornado touched down three miles southeast of Savage. It brought down several trees and power lines. It also blew over two trailers and three semi-tractor trailers. In Howard County, the tornado was 100 yards wide and traveled $^{6}/_{10}$ of a mile before moving into Anne Arundel County. The tornado resulted in $62,600[139] in property damage.
- **August 27, 1996 (F0 Tornado):** A small tornado caused damage to several subdivisions along Frederick Road north of Columbia. A total of four trees were knocked down, including two trees that were blown into a home on Pine Bluffs Drive. The NCDC database estimates that there was $20,600[140] in property damages.
- **July 6, 1996 (F0 Tornado):** A small tornado briefly touched down in a wooded area, just south of Interstate 70 near the Marriottsville Road Exit. The tornado was only 20 yards wide and traveled $^{1}/_{10}$ of a mile. One house between Marriottsville and Ellicott City was heavily damaged by a falling tree. In total, an estimated $103,100[141] in property damage occurred.

With a total of nine tornado events between 1975 and 2011, Howard County experiences, on average, one tornado every four years. Based on this information, it is possible to infer an approximate 26% annual probability of occurrence countywide. Depending on atmospheric conditions, it is possible for any number of tornadoes to occur in any given year. Based on the history of tornadoes in Howard County, there is a high probability of future tornadoes occurring in the Howard County.

The NCDC database reports that 115 thunderstorm wind events have occurred in Howard County between 1969 and 2011. Of the 115 events, six included winds of 60 knots (69 mph) or greater.

[139] Id.
[140] Id.
[141] Id.

Table 6.4.5-7 summarizes the 29 high wind events in Howard County with greater than 60 knot winds.

Table 6.4.5-7
Howard County: Thunderstorm/High Wind Events Over 60 Knots,
Excluding Tornado Winds, 1950 – June, 2016
(Source: NOAA/NCDC)

29 Thunderstorm Wind events were reported in Howard County, Maryland between 01/01/1950 and 2/24/2016.

Event ID	Location	Date	Event Type	Magnitude (Wind speed, knots)	Deaths	Injuries	Property Damage ($)	Crops Damage ($)
10042100		6/29/1978	Thunderstorm Wind	70	0	0	0	0
5297796	ELLICOTT CITY	5/13/2002	Thunderstorm Wind	65	0	0	150000	0
5396541	ELK RIDGE	5/25/2004	Thunderstorm Wind	60	0	0	1000	0
5406302	ELLICOTT CITY	6/1/2004	Thunderstorm Wind	60	0	0	3000	0
189000	ALPHA	7/31/2009	Thunderstorm Wind	65	0	0	0	0
334174	ILCHESTER	7/3/2011	Thunderstorm Wind	61	0	0	5000	0
395293	GLENELG	6/29/2012	Thunderstorm Wind	61	0	0	25000	0
395294	GLENELG	6/29/2012	Thunderstorm Wind	61	0	0	50000	0
395292	REGIONAL, County-Wide	6/29/2012	Thunderstorm Wind (Derecho)	66	0	0	581000	0
584167	EAST LIOAK	6/23/2015	Thunderstorm Wind	61	0	0	3000	0
621659	COOKSVILLE	2/24/2016	Thunderstorm Wind	61	0	0	0	0

The database indicates that there were two thunderstorm wind events that caused over $50,000 in damages. On May 15, 1994, a thunderstorm, with winds exceeding 50 knots, damaged several homes and knocked down numerous trees in the central and eastern portions of the County. The total impact was estimated to be $72,500[142] in property damages. On May 13, 2002, a 75 mph downburst occurred within a 10 square block area northwest of Ellicott City. Numerous trees were brought down and the downburst caused widespread power outages. Two homes were heavily damaged by downed trees. The estimated total property damage for the downburst was $180,600.[143]

[142] Id.
[143] Id.

Additional significant thunderstorm wind events that have impacted Howard County are described below.

- **September 28, 2006:** As a cold front moved into the region during the afternoon, it spawned several thunderstorms. The most intense thunderstorm occurred along the Interstate 95 Corridor. In total, the storms caused an estimated $37,800[144] in property damage.
- **June 1, 2006:** A low pressure trough, combined with upper level moisture and atmospheric instability, caused strong severe thunderstorms to ravage the area. The winds from these storms caused $27,000[145] in damage.
- **August 26, 2003:** A line of severe thunderstorms with winds up to 78 mph moved across the County during the afternoon hours. There were numerous reports of downed trees and power lines throughout the County and caused an estimated $17,700[146] in property damage.
- **July 30, 1996:** A severe thunderstorm moved from east to west across the County. The storm brought down trees and power lines, and caused an estimated $20,600 in property damage and another $2,700 in crop damage. [147]

With a total of 115 thunderstorm wind events between 1969 and 2011, Howard County experiences on average 2.7 thunderstorm wind events per year. With 2.5 storms per year, there is a 100% annual probability of a thunderstorm wind event occurring in Howard County. Based on the history of past thunderstorm and high wind events, there is a high probability of these events occurring in Howard County in the future. Although the probability is high, the impact on life and property in the planning area will probably be minimal as compared to other hazards.

The NCDC database reports there have been 11 high wind events between 1993 and 2011 (excluding the wind events that were related to the remnants of a tropical cyclone). The most destructive high wind event in Howard County occurred on January 14, 2006. Not only did strong winds bring down trees and power lines which left tens of thousands without power for an extended period, it caused an estimated $1.7[148] million in property damages throughout the region.

Other high wind events include:

- **February 10, 2008:** A strong cold front brought wind gusts in excess of 60 mph, with some areas in the region reporting gusts in excess of 40 mph for several hours. In Howard County, the winds caused an estimated $10,100[149] in property damage.
- **March 19, 1996:** A low pressure system over the Ohio Valley produced gusts as high as 58 mph. The winds caused an estimated $103,100[150] in property damage and injured six individuals across the region.
- **February 24, 1996:** With a storm over the Canadian Maritimes and a high pressure ridge over the Southeast United States, a strong wind gradient was created in the Mid-Atlantic. A steady wind of 25 to 35 mph, with gust up to 60 mph, was felt throughout the region. Over 22,000 homes were left without power.

With a total of 11 high wind events between 1993 and 2011, Howard County experiences on average 1.5 high wind events per year. Based on this information, it is possible to infer an approximate 64% annual probability of

144 Id.
145 Id.
146 Id.
147 Id.
148 Id.
149 Id.
150 Id.

occurrence. Also, the past history shows there is a high probability of future high wind events occurring in Howard County.

Future Likelihood of the Hazard for Howard County

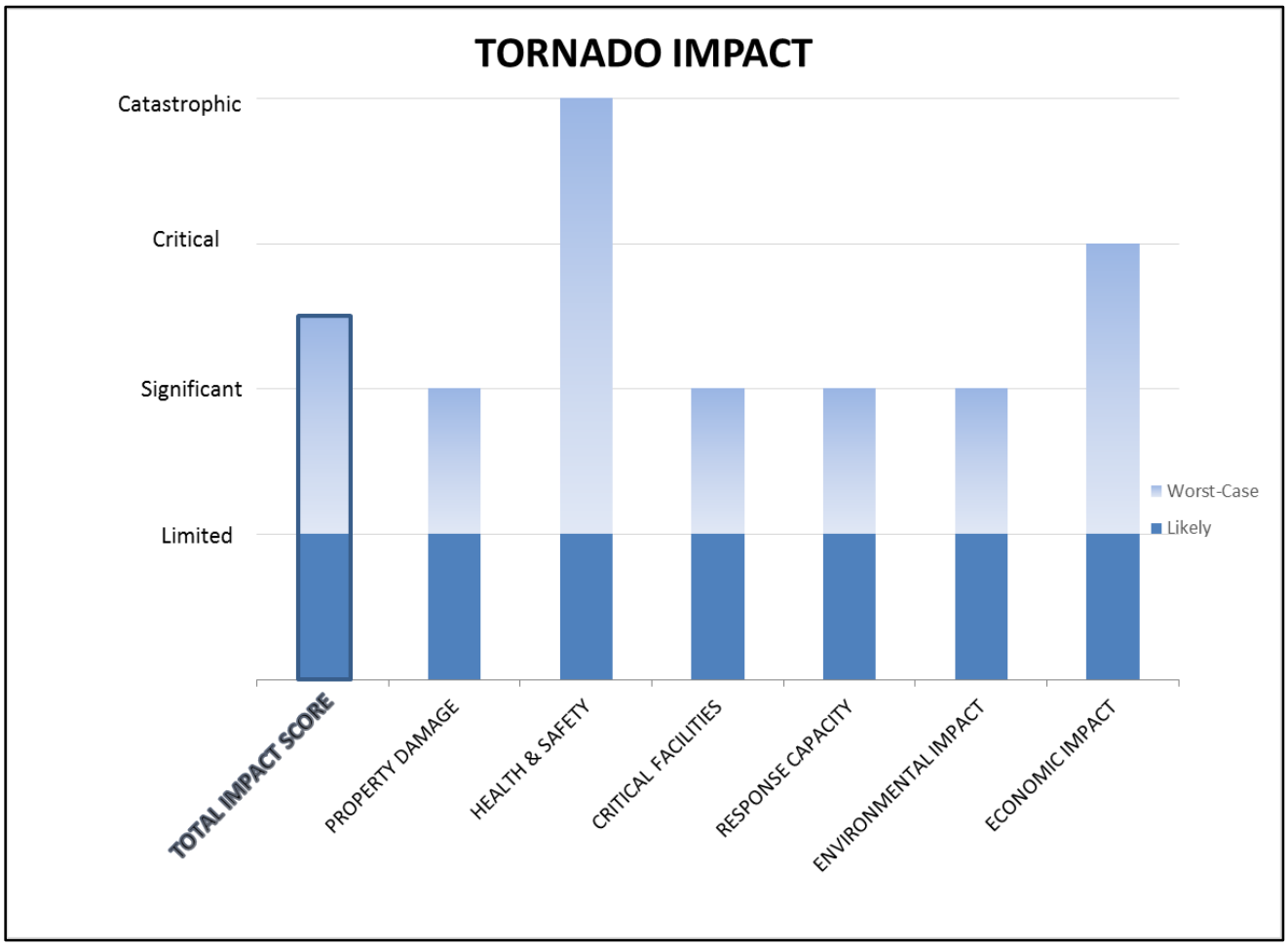
The Future Likelihood section anticipates the future occurrence rate of the hazard based on historical likelihood and future trends. This section also addresses factors that may cause the future likelihood to deviate from historical trends.

Future Likelihood of a Tornado Hazard in Howard County	
Historical Average (time period)	Tornadoes: 1 event every 4 years (1975-2011) Wind Storms: 1.5 events every year. (1993-2011)
Historical Annual Probability	Tornadoes: 26% chance of annual occurrence Wind Storms: 64% chance of annual occurrence
Future Likelihood Expected to Deviate from Historical Likelihood (Yes/No)	No
Future Annual Probability	1-30% chance of annual occurrence
Future Likelihood Score[4]	2.875 (Infrequent/Likely)
Future Likelihood reflects the likelihood of any emergency-level hazard event and does not differentiate between Likely and Worst-Case scenarios.	

IV. CONSEQUENCE ANALYSIS

The Consequence Analysis section provides a detailed characterization of the anticipated consequences of likely and worst-case hazard events. This section characterizes impacts to property, health & safety, critical facilities, response capacity, the environment, and the economy. This section also characterizes public perceptions of each hazard, the perceived impact to personal safety and standard of living, and public confidence in response capability.

Consequence Analysis Overview



Where no Worst-Case bar is visible, Worst-Case impact is equivalent to Likely impact.

Tornado Warning Time & Duration		
	Likely	**Worst-Case**
WARNING TIME	*Short.* From 1 second to 1 minute.	*Short.* From seconds to 5 minutes.
DURATION	*Short.* Seconds to 30 minutes.	*Short. Seconds to 10 minutes.*

Consequence Analysis: Likely Hazard Scenario

The Consequence Analysis table details the anticipated consequences of the most likely hazard scenario.

TORNADOES OR WIND STORMS Likely				
PROPERTY DAMAGE	*Limited*	• Up to 1% of critical and non-critical infrastructure will be damaged. • Some roof shingles and downed trees expected.		
HEALTH & SAFETY	*Limited*	• 0 deaths are expected. Automobile accidents, flying debris, or sheltering in an unsafe location are the most common causes of death. • 0-5 injuries are expected. Automobile accidents, flying debris, or sheltering in an unsafe location are the most common causes of injuries..		
CRITICAL FACILITIES	*Limited*	• *Utilities* – No critical facilities or essential functions will be out of service. • *Information/Communications* – No critical facilities or essential functions will be out of service. • *Transportation – Possible temporary road closures due to downed trees.*		
RESPONSE CAPACITY	*Limited*	• *Police* – Local resources adequate. Low impact to response capability or continuity of operations. • *Fire & Rescue* – Local resources adequate • *Health* – Local resources adequate. Howard County Health Department operations will not be affected. • *Public Works* – Local resources adequate. No impact response capability and continuity of operations.		
ENVIRONMENTAL IMPACT	*Limited*	• Minimal impact and downed trees throughout area is expected. • Limited environmental impact is expected.		
ECONOMIC IMPACT	*Limited*	• Limited amount loss in dollar value.		
TOTAL IMPACT	*Limited*	• Total Impact Score: 1 on a scale of 1 (Limited) to 4 (Catastrophic).		
Limited		*Significant*	*Critical*	*Catastrophic*

Consequence Analysis: Worst-Case Hazard Scenario

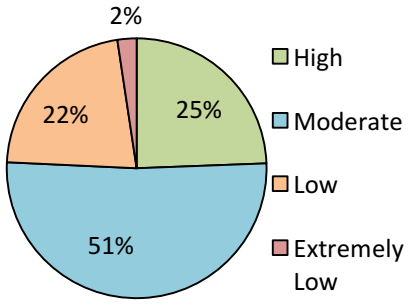
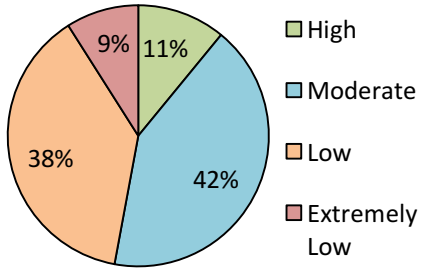
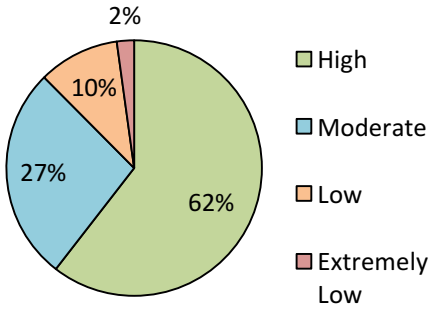
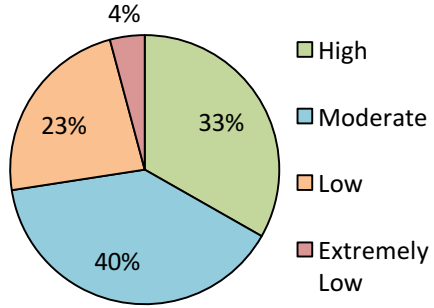
The Consequence Analysis: Worst-Case table details the anticipated consequences of the worst-case hazard scenario.

TORNADOS OR WIND STORMS **Worst-Case**		
PROPERTY DAMAGE	*Significant*	• 5% of critical and non-critical infrastructure will be damaged. • Traffic Signal damage, debris on roadway, downed trees, and significant power line damage are expected. • Some damage to critical and non-critical infrastructures. • Roof damage, glass blown into offices, loose materials blown all over, and buildings blown off site are expected. • Unknown critical and non-critical infrastructure will be damaged. • Significant structural damage, it will be catastrophic since all in the path will be damaged or destroyed.
HEALTH & SAFETY	*Catastrophic*	• 20-50 deaths are expected. Automobile accidents, flying debris, and structure collapse are the most common causes of death. • 200 injuries are expected. Broken/fractured bones, internal bleeding, concussions, respiratory distress/arrest are the most common causes of injuries.
CRITICAL FACILITIES	*Significant*	• *Utilities* – Days to weeks shut down of critical facilities is expected. • *Information/Communications* – Days to weeks shut down of critical facilities is expected. • *Transportation* – 1-2 days of shutdown are expected. Traffic signals, damages to schools, fire stations, and County offices will be out of service.
RESPONSE CAPACITY	*Significant*	• *Police* – Significant and long-lasting need for state or federal assistance. High impact to response capability. Additional manpower will be needed and schedule changes to departmental personnel. Ability to respond and handle minor calls will be affected. Alternate site will be required if building is damaged or destroyed. • *Fire & Rescue* – Moderate need for state or federal assistance. Will require US&R assets and mutual aid response. Damage to utilities expected. • *Health* – Moderate need for state or federal assistance. Howard County Health Department essential services will be operating from an alternate location if the structure is unsafe or damaged. Other services will operate virtually or remotely. • *Public Works* – Moderate need for state or federal assistance. Minimal to critical impact on operations.
ENVIRONMENTAL IMPACT	*Significant*	• Minimal direct impact on air, water, and land resources, although can cause a loss of individual plants and animal. • Downed trees and limbs expected in affected area(s). • Possible air, water, and land pollution if industrial manufacturing plants or sewage treatment plants are damaged causing them to releases gases or untreated liquids.
ECONOMIC IMPACT	*Critical*	• Hundreds of millions in loss of dollar value. • Transportation system, structural and infrastructure impacts on economic consequences.
TOTAL IMPACT	*Significant-Critical*	• Total Impact Score: 2.5 on a scale of 1 (Limited) to 4 (Catastrophic).
Limited	*Significant*	*Critical*	*Catastrophic*

Consequence Analysis: Public Perception

The Consequence Analysis: Public Perception table characterizes public perceptions of each hazard. Details include public confidence in personal ability to respond to each hazard, public confidence in Howard County's ability to respond to each hazard, and each hazard's perceived impact to personal safety and standard of living.

Public Perceptions on Tornadoes

PERCEIVED CONFIDENCE IN HOWARD COUNTY'S ABILITY TO RESPOND AND RECOVER FROM THIS HAZARD	PERCEIVED CONFIDENCE IN PERSONAL ABILITY TO PROTECT SELF AND FAMILY FROM THIS HAZARD	CONCERN OVER THE IMPACT TO PERSONAL HEALTH AND SAFETY IF THIS HAZARD WERE TO OCCUR LOCALLY	CONCERN OVER THE IMPACT TO PERSONAL STANDARD OF LIVING / QUALITY OF LIFE IF THIS HAZARD WERE TO OCCUR LOCALLY
			
Average: 2.98 *Moderate - Low*	*Average: 2.55* *Moderate - Low*	*Average: 3.46* *Moderately Concerned*	*Average: 3.02* *Moderately Concerned*

Wildfire

I. OVERVIEW

The Overview section defines the hazard and summarizes the hazard risk profile.

Definition

This section defines the scope of the hazard category. The terminology and characterization established in this section should be consistent throughout all Howard County planning documents.

Wildfires are uncontrolled forest fires, grassland fires, rangeland, or urban-interface fires which consume natural fuels and spread in response to the environment. Wildfires can be either a natural phenomenon or human-caused. The frequency and severity of wildfires depends on both weather and human activity.

Risk Profile

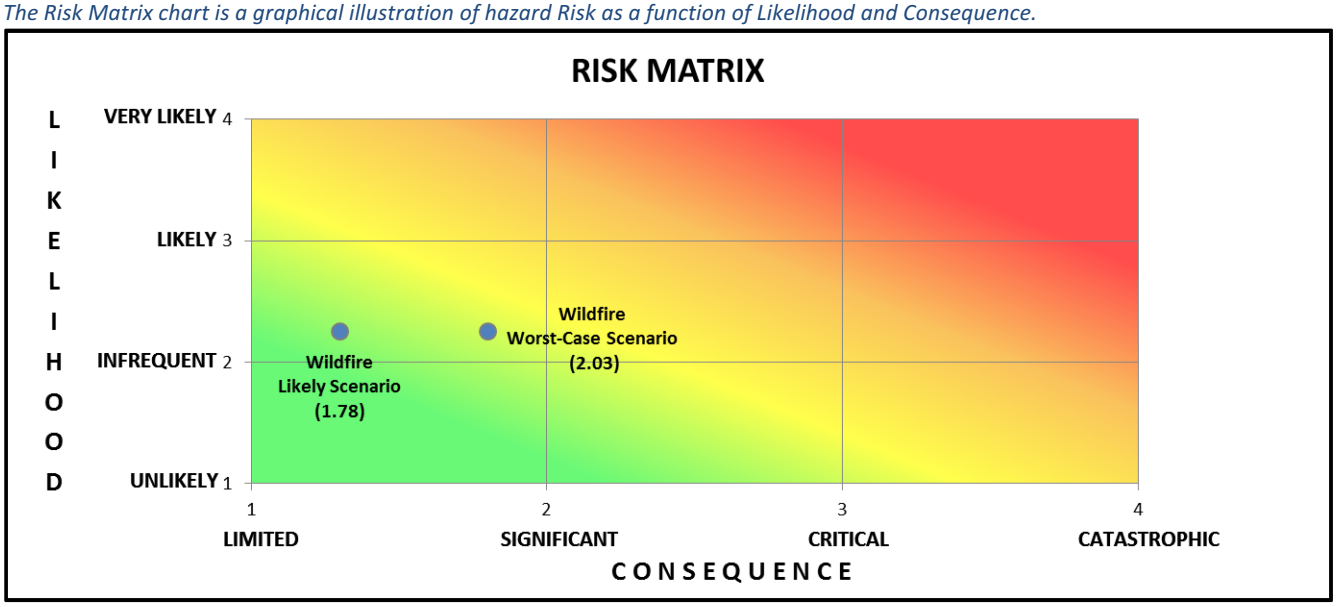
The Risk Profile section presents the Risk Score for the hazard in a range from 1 (lowest risk) to 4 (highest risk). Risk Score is a function of Likelihood and Consequence.

Wildfire Risk Profile				
	Risk Assessment Category	**Likely Hazard Scenario**	**Worst-Case Hazard Scenario**	**Weight**
LIKELIHOOD	**Likelihood**	2.25* Infrequent-Likely		50%
CONSEQUENCE	**Impact**	1 Limited	1.5 Limited-Significant	40%
	Warning Time	4 Short	4 Short	5%
	Duration	1 Short	2 Moderate	5%
	TOTAL RISK SCORE	**1.78**	**2.03**	

**The Likelihood Score reflects the likelihood of any emergency-level hazard event and does not differentiate between Likely and Worst-Case scenarios.*

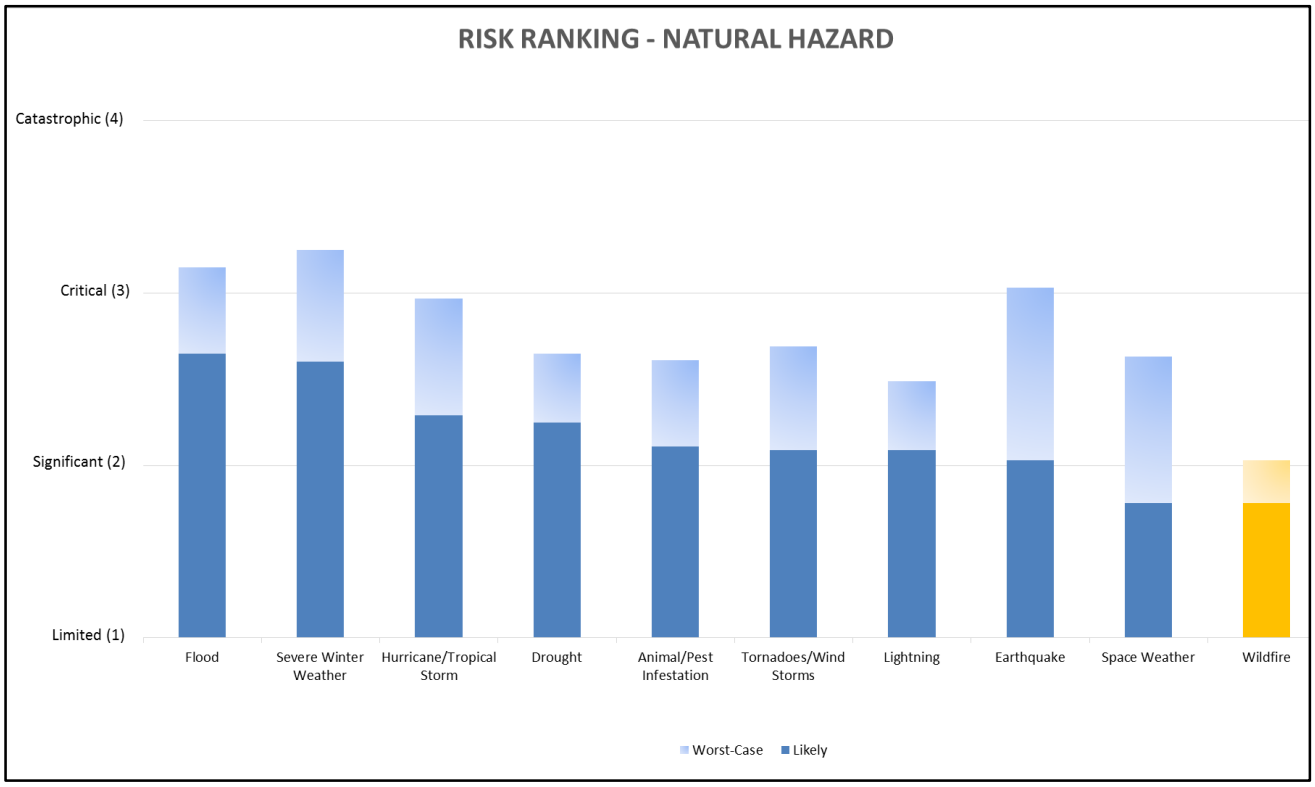
Risk Matrix

The Risk Matrix chart is a graphical illustration of hazard Risk as a function of Likelihood and Consequence.



Risk Ranking

The Risk Ranking chart is a graphical illustration of hazard Risk as it relates to other hazards.



Where no Worst-Case bar is visible, Worst-Case Risk is equivalent to Likely Risk.

II. HAZARD CHARACTERISTICS

The Hazard Characteristics section provides a detailed characterization of the hazard and the local context as it relates to the hazard.

Description of the Hazard

Wildfires are uncontrolled forest fires, grassland fires, rangeland, or urban-interface fires which consume natural fuels and spread in response to its environment.[151] Wildfires can be either a natural phenomenon or human-caused. Wildfires can play a positive or destructive role in the evolution of an ecosystem.

Forest and grassland fires can occur throughout the year. In Maryland, the greatest threat of wildfires occurs during the spring season, in the months of March and April. The length and severity of the burning season largely depends on weather conditions. During the spring, the region experiences low humidity, high winds, below-normal precipitation, and high temperatures, which all contribute to high fire danger. Wildfires can also occur in late fall. Depending on weather conditions, the month of November also generally has a high rate of wildfires.[152]

Local Context

The Local Context section describes community attributes that affect the likelihood of the hazard's occurrence or vulnerability to the hazard's consequences.

The severity in Howard County has been historically very low, and the duration of wildfires has ranged from a matter of hours to several days.

Urban interface fires[153] are becoming increasingly problematic in Maryland. As people continue to live and work near wildland areas, the threat to private property from wildfires increases. This phenomenon is growing in Howard County as suburbanization and population growth continues in the County. Although urban interface fires have the greatest possibility to cause property damage, the potential for wildfires exists throughout the entire planning area. The greatest risk for significant wildfires to occur would be in large, forested areas such as the Patapsco State Park and the Hugh Thomas Wildlife Management Area to the north. The Patapsco River Valley, where Patapsco State Park is located, is characterized by steep slopes exceeding 20% grade. In addition, dense vegetation and hardwoods provide ample fuel for fire. In the southern portion of the County, the Rock Gorge Reservoir Park and the Patuxent Wildland Area are also areas at risk for potential wildfires. The Patuxent Wildland Area is a State-designated wildland, which restricts the ability to reduce fuels or create ingress routes. In addition, the characteristics of the Patuxent Wildland Area are similar to the Patapsco State Park, where dense vegetation and hardwoods provide high fuel loads.

The populated areas considered most at-risk from wildfires are located in the large forested areas, such as Patapsco State Park and the Hugh Thomas Wildlife Management Area in the north. There have been no reported deaths or injuries from wildfires in the planning area.

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[151] See also *NWCG Glossary of Wildland Fire Terminology*, http://www.nwcg.gov/pms/pubs/glossary/w.htm#Wildfire (last accessed April 1, 2012).

[152] For additional information on wildfires, see generally *Maryland's Department of Natural Resources' Wildland Fire Management Page*, http://www.dnr.state.md.us/forests/wfm.asp (last accessed March 12, 2012).

[153] The urban interface is defined as the area where structures and other human development blend with undeveloped wildland. See *Technical Guide to Map and to Characterize Wildland-Urban Interface (WUI)*, http://www.fireparadox.org/technical_guide_wildland_urban_interfaces_print.php (last accessed March 12, 2012).

III. LIKELIHOOD ANALYSIS

The Likelihood Analysis section characterizes the historical occurrence and future likelihood of the hazard in the planning area.

Occurrence of the Hazard

The Occurrence of the Hazard section details the historical occurrence of the hazard in the planning area.

Wildfires incident data shows fires in Maryland occur relatively frequently.

According to the Maryland Department of Natural Resources, Maryland averaged 6,919 natural cover fires per year from 1995-2001.[154] Table 6.4.3-1 summaries the total number of fires and acres for the State of Maryland between 2004 and 2011.

Table 6.4.3-1
Fires and Acres Burned in Maryland from 2004 - 2009
(Source: Maryland Department of Natural Resources)

Year	Total Number of Fires	Total Acres Burned
2004	253	3,149
2005	441	4,344
2006	753	6,074
2007	622	5,102
2008	583	2,339
2009	408	4,853
2010	170	1,503
2011	825	8310

The NCDC[155] indicated there were no wildfire incidents between 1950 and 2011 within Howard County. According to the SHELDUS database[156], two wildfires caused several thousand dollars' worth of damage in 1963. Periodical sources were also consulted to identify past wildfire events for Howard County.

Based on this research, some recent wildfire events are described below.

- **March 30, 1999:** A 10-acre brushfire raged for four hours in the Patapsco Valley State Park. Firefighters were then called to a 5-acre brushfire within an hour after extinguishing the park fire. Firefighters responded to four other fires within eight miles of one another. The high number of fires was due to drought-like conditions.
- **March 23, 2004:** A brushfire on County land near Oakland Mills High School in Columbia burned 10 acres of land. Fueled by dead corn stalks and trees, the fire raced across an open field before firefighters contained it an hour later.[157]

[154] See Wildland Fire Management Fire Statistics for Maryland, http://dnr.maryland.gov/forests/fire/ (last accessed March 3, 2012).
[155] See *NCDC Storm Events*, http://www4.ncdc.noaa.gov/cgi-win/wwcgi.dll?wwEvent~Storms (last accessed February 27, 2012).

[156] See *SHELDUS*, http://webra.cas.sc.edu/hvri/products/sheldus.aspx (last accessed February 28, 2012).
[157] Sentementes, Gus, *Brush Fire Scorches About 10 Acres*, Baltimore Sun, March 24, 2004, available at http://articles.baltimoresun.com/2004-03-24/news/0403240194_1_firefighters-oakland-mills-corn-stalks.

- **February 19, 2011.** High winds with gusts up to 45 mph, high temperatures, and low humidity contributed to the start of eight brushfires, which eventually burned down 20 acres. One of the largest fires occurred near the 3800 block of Manor Lane in Ellicott City. A wildfire was also located on Interstate 95 in the Laurel area between MD 198 and the Capital Beltway closing down both northbound and southbound lanes until the fire was brought under control.

Although wildfire incidents are expected to occur more frequently due to increased human activity in forested areas, no acceptable mechanism exists to assign probability to fire occurrences. As noted, wildfire incidents are directly related to weather patterns and antecedent conditions, and thus its probability of occurrences are dynamic.

Future Likelihood of the Hazard for Howard County

The Future Likelihood section anticipates the future occurrence rate of the hazard based on historical likelihood and future trends. This section also addresses factors that may cause the future likelihood to deviate from historical trends.

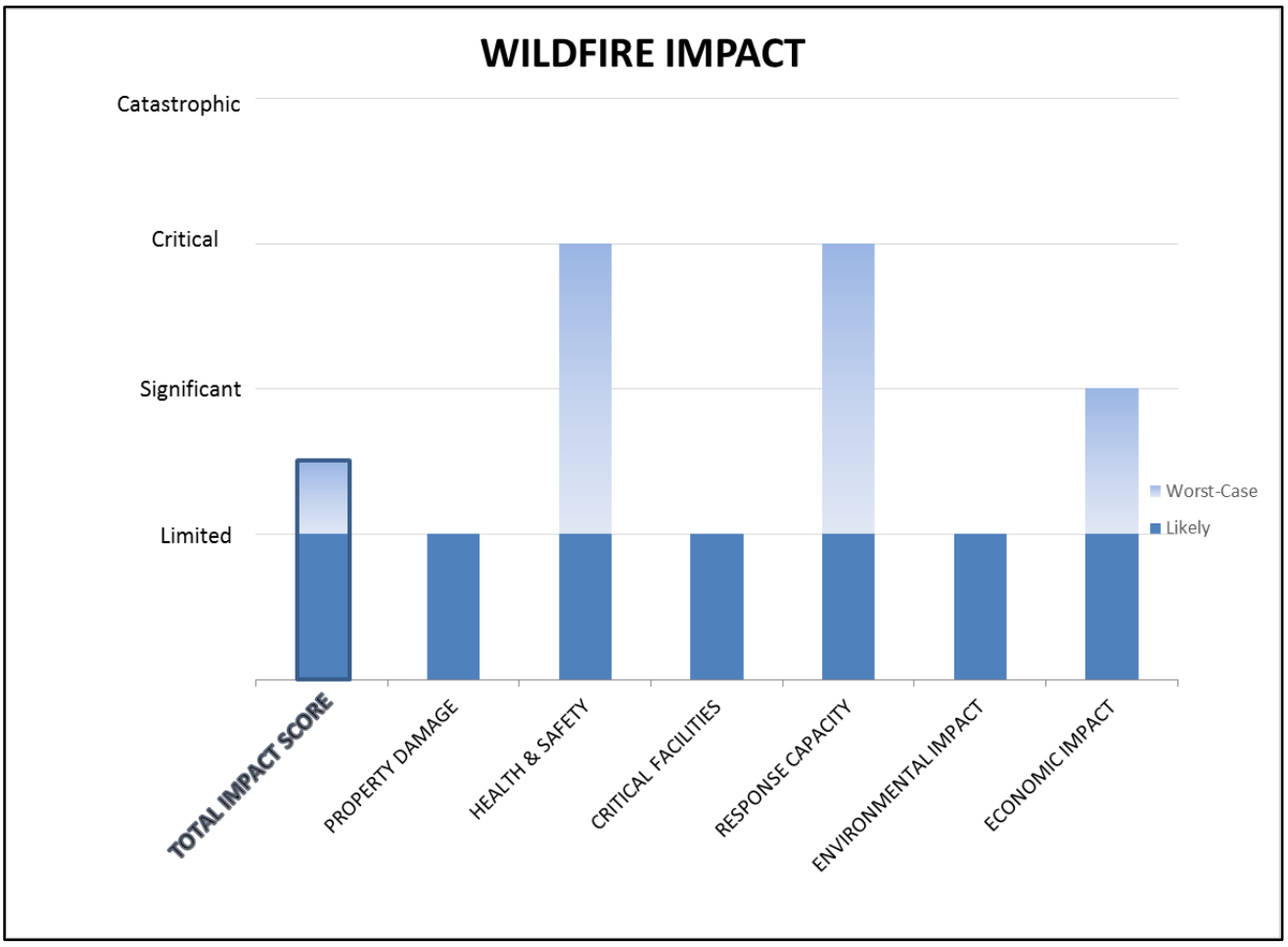
Future Likelihood of a Wildfire Hazard in Howard County	
Historical Average (time period)	6919 events per year (1995-2001)
Historical Annual Probability	Near 100% chance of annual occurrence
Future Likelihood Expected to Deviate from Historical Likelihood (Yes/No)	No
Future Annual Probability	1-30% chance of annual occurrence
Future Likelihood Score[4]	2.25 (Infrequent/Likely)
Future Likelihood reflects the likelihood of any emergency-level hazard event and does not differentiate between Likely and Worst-Case scenarios.	

Considerations: As noted above, wildfire incidents are directly related to weather patterns and antecedent conditions, and thus its probability of occurrences are dynamic.

IV. CONSEQUENCE ANALYSIS

The Consequence Analysis section provides a detailed characterization of the anticipated consequences of likely and worst-case hazard events. This section characterizes impacts to property, health & safety, critical facilities, response capacity, the environment, and the economy. This section also characterizes public perceptions of each hazard, the perceived impact to personal safety and standard of living, and public confidence in response capability.

Consequence Analysis Overview



Where no Worst-Case bar is visible, Worst-Case impact is equivalent to Likely impact.

Wildfire Warning Time & Duration		
	Likely	**Worst-Case**
WARNING TIME	*Short.* No warning time prior to a wildfire.	*Short.* No warning time prior to a wildfire.
DURATION	*Short.* 5-25 minutes.	*Short-Moderate.* 1-12 hours.

Consequence Analysis: Likely Hazard Scenario

The Consequence Analysis table details the anticipated consequences of the most likely hazard scenario.

WILDFIRES Likely		
PROPERTY DAMAGE	*Limited*	• 0% of critical and non-critical infrastructure will be damaged. • Scorched earth and destroyed landscaping expected. • Less than 1% of critical and non-critical infrastructure will be damaged.
HEALTH & SAFETY	*Limited*	• 0 deaths are expected. Smoke and toxic gas is the most common causes of death. • 0-2 injuries are expected. Smoke inhalation and toxic gases are the most common causes of injuries.
CRITICAL FACILITIES	*Limited*	• *Utilities* - Less than 1 hour of shutdown is expected. • *Information/Communications* - Shutdown or out of service is unlikely. • *Transportation* - Possible lane shifts or partial closures will occur. • Some roads or emergency vehicle access needs will be shut down.
RESPONSE CAPACITY	*Limited*	• *Police*- Local resources adequate. No impact to response capability or continuity of operations. • *Fire and Rescue* - Local resources adequate. None- Limited impact to response capability. Traffic issues and increased response times may be impacted. • *Health*- Local resources adequate. Howard County Health Department operations will not be affected and will be communicating with the EOC. • *Public Works* - Local resource adequate with minimal to no impact on response capability and continuity of operations. • *DPW-Gen*- Mutual aid needed (Fire and Rescue, possibly SHA). Some response calls will be rerouted.
ENVIRONMENTAL IMPACT	*Limited*	• Minimal impact with a loss to plant and animal life in the immediate area. • Limited environmental impact is expected.
ECONOMIC IMPACT	*Limited*	• Limited loss in dollar value. • Limited economic consequences.
TOTAL IMPACT	*Limited*	• Total Impact Score: 1 on a scale of 1 (Limited) to 4 (Catastrophic).
Limited	*Significant*	*Critical* / *Catastrophic*

Consequence Analysis: Worst-Case Hazard Scenario

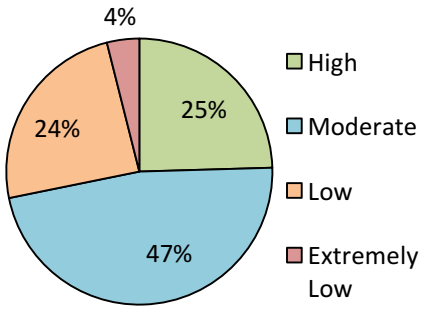
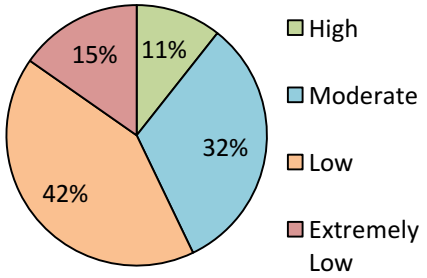
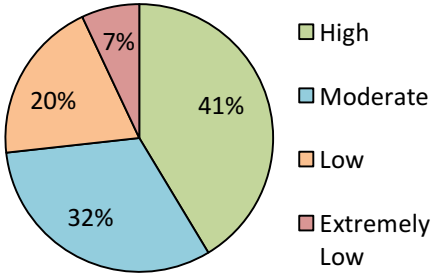
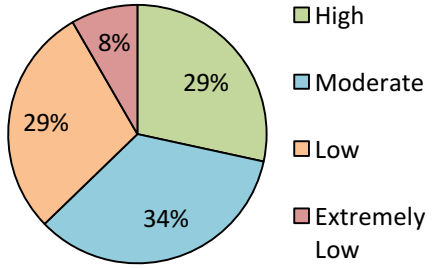
The Consequence Analysis: Worst-Case table details the anticipated consequences of the worst-case hazard scenario.

WILDFIRES Worst-Case		
PROPERTY DAMAGE	*Limited*	• Up to 1% of critical and non-critical infrastructure will be damaged. • Some loss of life, major structural damage, and downed wires are expected. • Mostly private property damage and some County buildings depending on proximity are expected to be damaged. • Structure fires and possible paving damage is expected. • Fire damage occurring to residence and vehicles in the urban/ wild land interface.
HEALTH & SAFETY	*Critical*	• 0-3 deaths are expected. Smoke inhalation and toxic gases are the most common causes of death. • 0-15 injuries are expected. 2nd and 3rd degree burns, smoke inhalation, and toxic gases are the most common causes of injuries.
CRITICAL FACILITIES	*Limited*	• *Utilities* - Less than a day of shut down is expected. • *Information/Communications* - Access to some buildings may be out of service. 6 months shut down for burned structures is expected. • *Transportation* - Possible lane shifts or partial closures will occur. • Some roads or emergency vehicle access needs will be shut down..
RESPONSE CAPACITY	*Critical*	• *Police*-Local resources adequate. No impact to response capability or continuity of operations. • *Fire & Rescue*- Moderate need for state or federal assistance. Limited impact to response capability. Most likely will need assistance from DNR in wild land effort. • *Health*- Moderate need for state or federal assistance. Virtual monitoring and communicating with Web EOC • *Public Works*- Moderate need for state or federal assistance with some impact assisting other departments. • Mutual aid needed. All non-emergency fire and police calls will be delayed.
ENVIRONMENTAL IMPACT	*Limited*	• Minimal impact with a temporary spike in air pollution and a loss of plant and animal life in the immediate area of the burns. • Limited environmental impact is expected.
ECONOMIC IMPACT	*Significant*	• Significant amount loss of dollar value. • Residential and agricultural areas of economic consequences. • *EDC*- Significant economic impact.
TOTAL IMPACT	*Limited - Significant*	• Total Impact Score: 1.5 on a scale of 1 (Limited) to 4 (Catastrophic).

Limited	*Significant*	*Critical*	*Catastrophic*

Consequence Analysis: Public Perception

The Consequence Analysis: Public Perception table characterizes public perceptions of each hazard. Details include public confidence in personal ability to respond to each hazard, public confidence in Howard County's ability to respond to each hazard, and each hazard's perceived impact to personal safety and standard of living.

Public Perceptions on Wildfires			
PERCEIVED CONFIDENCE IN HOWARD COUNTY'S ABILITY TO RESPOND AND RECOVER FROM THIS HAZARD	**PERCEIVED CONFIDENCE IN PERSONAL ABILITY TO PROTECT SELF AND FAMILY FROM THIS HAZARD**	**CONCERN OVER THE IMPACT TO PERSONAL HEALTH AND SAFETY IF THIS HAZARD WERE TO OCCUR LOCALLY**	**CONCERN OVER THE IMPACT TO PERSONAL STANDARD OF LIVING / QUALITY OF LIFE IF THIS HAZARD WERE TO OCCUR LOCALLY**
			
Average: 2.92 *Moderate - Low*	*Average: 2.83* *Moderate - Low*	*Average: 3.08* *Moderately Concerned*	*Average: 2.83* *Moderately - Low Concern*