

University of Maryland, Baltimore Resilience Assessment

Table of Contents

Background	2
Evolution of Resilience at UMB.....	2
Defining Resilience at UMB.....	3
Process and Outcomes.....	4
Baltimore’s Changing Climate.....	4
Temperature	4
Precipitation.....	5
Heating and Cooling Degree Days.....	6
Strengths/Assets and Vulnerabilities.....	8
Resilience Indicators	8
Assessment Next Steps	10

Background

The University of Maryland, Baltimore (UMB) is a public university that is a part of the University System of Maryland, a public institution that is instrumental to the State of Maryland. It is Maryland's public health, law, and human services university. The 71-acre research and technology complex encompasses 67 buildings located in West Baltimore, a city that has become a model for urban rebirth and vitality. The UMB complex has over 7,800 faculty members and staff, as well as 7,000 students enrolled across seven schools: Dentistry, Law, Medicine, Nursing, Pharmacy, Social Work, and Graduate.

Evolution of Resilience at UMB

A Resilience Subcommittee was established in 2016 by members of UMB's Sustainability Committee after former President Ramsay signed onto Second Nature's Climate Commitment. The Climate Commitment added a resilience component to the University's original commitment to reach carbon neutrality by 2050. The subcommittee completed a UMB Resilience Report in 2017 (Appendix A) and identified projects to create a more resilient campus. Since the original assessment in 2017, UMB has made strides in resilience projects including planning projects for 2 new electrical substations for campus to create redundancy for UMB's power supply and building a recycling center with raised electrical infrastructure for improved flood risk management. UMB's Office of Community Engagement continues to foster UMB's relationship to the west Baltimore community. In 2020, the new Community Engagement Center (CEC) was completed. The newly renovated historic space is approximately seven times larger than the previous CEC and provides a dedicated space for programmatic growth to meet the needs of the surrounding Baltimore neighborhoods.

Since the creation of the original subcommittee, UMB's Office of Emergency Management (OEM) was established in 2018. OEM performs an annual Threat Hazard Identification Risk Assessment & Consequence Analysis (THIRA) (Appendix B), publishes UMB's Emergency Operations Plan, manages the University continuity of operations program, and provides training on the occupant emergency plans that cover topics like campus evacuation to threats such as severe weather, flooding, and utility outages. In addition to the Office of Emergency Management, UMB's Office of Sustainability was established in fall 2021. President Jarrell also re-signed onto the Climate Commitment in fall 2021, indicating support from UMB's new leadership.

In February 2022, the Office of Sustainability created UMB's Sustainability Strategic Plan to outline its goals and tactics in reaching carbon neutrality and building a resilient campus community. A Resilience Working Group was established by UMB's Office of Sustainability (see Appendix C for roster). This reinstated discussions and planning from the Resilience Subcommittee established in 2016 by members of UMB's former Sustainability Committee prior to the Office of Sustainability being created (see Appendix A for members).

Defining Resilience at UMB

Second Nature splits resilience into five dimensions:

Social Equity & Governance

- The systems of governance on campus and in the community, levels of engagement among campus and community members, and the capacity of different groups to adapt and respond to climate change.

Health & Wellness

- The ability of different groups on campus and in the community to fulfill their basic needs.

Ecosystem Services

- The environmental systems and services present in the campus-community.

Infrastructure

- The physical structures built, owned, managed, and/or used by the campus-community.

Economic

- The financial ability of the campus and community to proactively adapt to changing climate conditions and to respond positively to climate change events.

In its 2017 UMB Resilience Report, UMB's former Resilience Subcommittee proposed the following definition of resilience:

“Resilience is the ability of a system or community to survive disruption and to anticipate, adapt, and flourish in the face of change. Based on the University of Maryland, Baltimore’s (UMB) geography, the nature of its built infrastructure, and regional environmental concerns, UMB anticipates having to plan for the following impacts from climate change:

- Increase in heavy precipitation events
- Coastal flooding associated with sea level rise and storm surge
- Increases in temperature extremes”

The report focused on climate resiliency strategies in four key areas:

Flooding and
Hurricane
Preparedness

Redundancy
Planning

Mitigate the Urban
Heat Island Effect

Community
Resiliency
Leadership
Network

UMB's Resilience Working Group adopted a portion of the resilience definition, "Resilience is the ability of a system or community to survive disruption and to anticipate, adapt, and flourish in the face of change," and revised the key areas into three overarching dimensions:

Campus Planning	• Planning and Designing UMB Campus for the future
Hazard Reduction & Readiness	• Proactive effort taken to understand, prepare for, and mitigate the impacts of evolving hazards due to climate change.
Community	• Ensuring UMB acts as a resource to its campus community and the surrounding Baltimore community

Process and Outcomes

- Identifying the University's existing avenues for measuring resilience and projects related to the University's resilience.
- Identifying UMB's strengths and vulnerabilities as they relate to three dimensions that the University has identified: campus planning, emergency response, and community.
- Finding opportunity areas in which the five dimensions outlined by Second Nature - social equity and governance, health and wellness, ecosystem services, infrastructure, and economics - can be bolstered.
- Planning for and designing buildings for climate change.
- Incorporating climate change into UMB's Threat Hazard Identification Risk Assessment & Consequence Analysis.
- Fostering relationships within the surrounding Baltimore community.
- Identifying how UMB can act as a resource to Baltimore City residents during natural disasters or extreme weather events.
- Finding opportunities where UMB can use its institutional power and resources to support Baltimore City in its resilience efforts.

Baltimore's Changing Climate

UMB uses the [Climate Explorer](#) in the [U.S. Climate Resilience Toolkit](#), developed by the National Oceanic and Atmospheric Administration (NOAA). The Climate Explorer tool creates projections for local areas related to temperature, precipitation, growing season, and heating and cooling degree days. The following projections are for the Baltimore region.

Temperature

The Days with Maximum Temperature Above 100 (°F) graph (Figure 1) indicates an estimated average increase of 16 days with a maximum temperature above 100 degrees Fahrenheit in the 2020s to as high as an average of 84 days with a maximum temperature above 100 degrees Fahrenheit in the 2090s when placed in

the higher emissions scenario. There is a projected 27% increase in days with temperatures above 100 degrees each decade based on this tool.

The Baltimore City Health Department (BCHD) issues [Code Red Extreme Heat Alerts](#) when the heat index is expected to reach 105 or higher. Another indicator for a Code Red Day includes a combination of the heat index reaching 95 or higher and poor air quality. The increase in days where the city reaches past 100 degree days not only puts a strain on city residents' health, but also on the city's resources (for opening up cooling centers) and the electrical grid. Urban heat island effect is exacerbated in areas such as Downtown and West Baltimore with sparse tree coverage and green space.

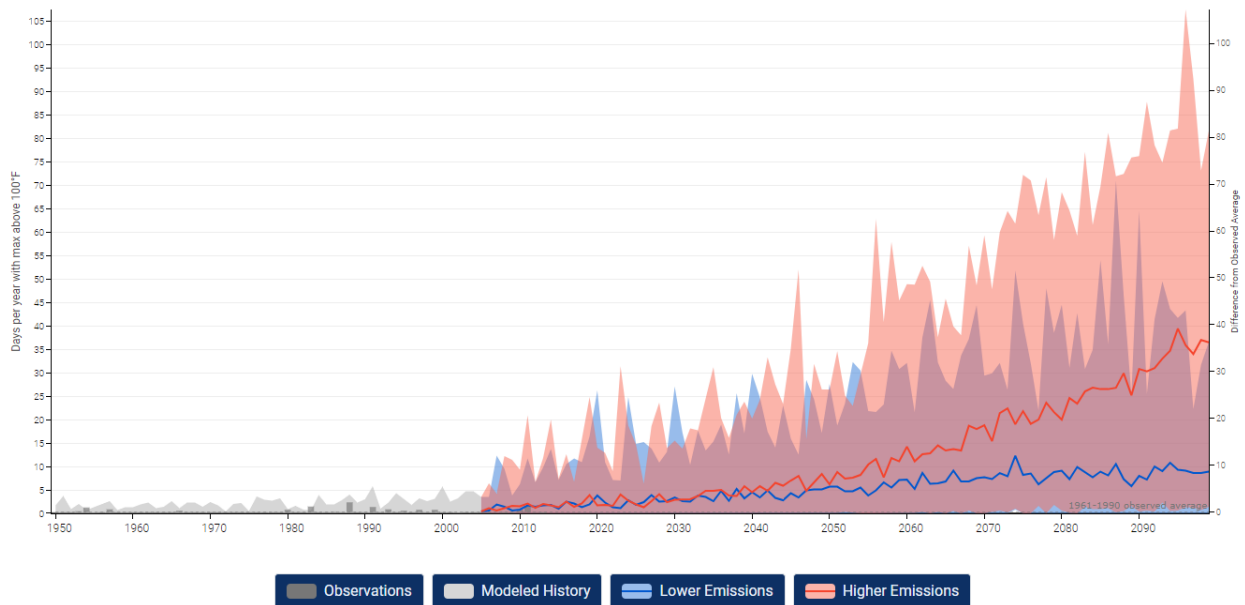


Figure 1: NOAA's Climate Explorer Projection for Days with Maximum Temperature Above 100 (°F) per year

Precipitation

The Climate Explorer projects consistent precipitation ranges from the 2020s to the 2090s for the Baltimore region (Figure 2). The projections do have a large range—anywhere from approximately 30 inches of precipitation annually to 66 inches. Even with consistent annual ranges, heavy precipitation events are projected to increase in frequency, duration, and intensity.

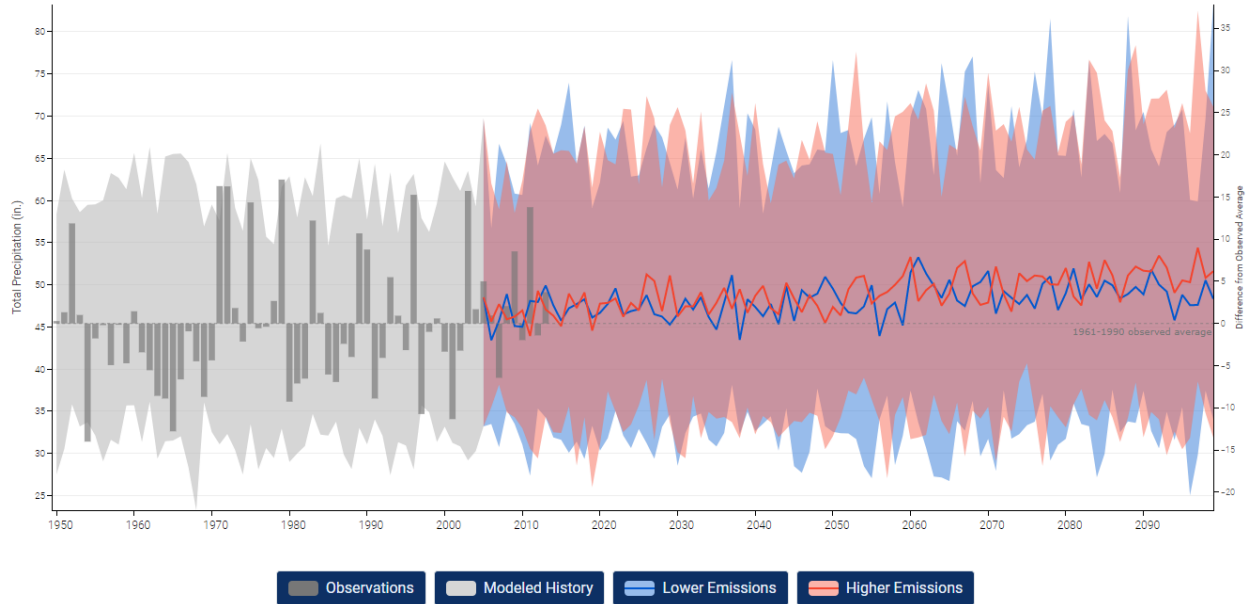


Figure 2: NOAA's Climate Explorer Projection for Annual Total Precipitation (in)

Heating and Cooling Degree Days

According to the National Weather Service:

Degree days are based on the assumption that when the outside temperature is 65°F, we don't need heating or cooling to be comfortable. Degree days are the difference between the daily temperature mean, (high temperature plus low temperature divided by two) and 65°F. If the temperature mean is above 65°F, we subtract 65 from the mean and the result is Cooling Degree Days. If the temperature mean is below 65°F, we subtract the mean from 65 and the result is Heating Degree Days.

The projected number of heating degree days (Figure 3) is expected to decrease for Baltimore over the next several decades. Inversely, the number of cooling degree days will increase over time, consistent with the increased temperature projections (Figure 4). As noted with increased temperature, this will increase UMB's energy demand during the cooling season and may strain the local grid. The longer cooling season also indicates a longer growing season. With annual total precipitation projected to stay the same, droughts may be more likely to occur.



Figure 3: NOAA's Climate Explorer Projection for Heating Degree Days per year

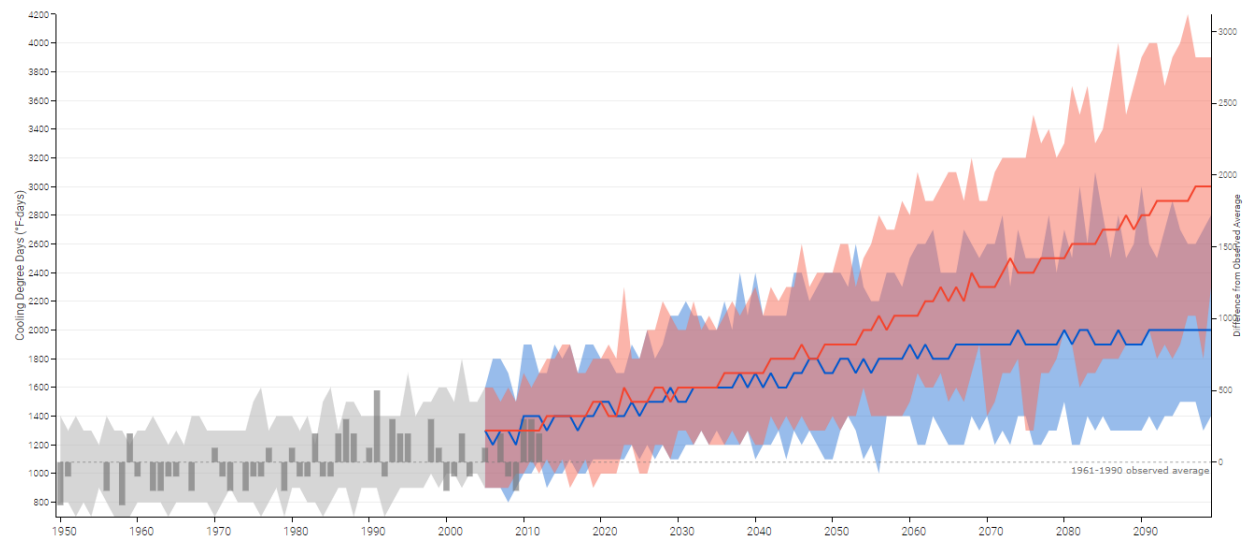


Figure 4: NOAA's Climate Explorer Projection for Cooling Degree Days per year

Strengths/Assets and Vulnerabilities

UMB created an initial assessment of strengths and weaknesses in accordance with the [Campus Evaluation of Resilience Dimensions](#) tool. Resilience working group members (Appendix C) were tasked to complete the assessment after the first working group meeting and the top 3 strengths and opportunities are outlined below.

Strengths from Campus Evaluation of Resilience Dimensions	
Criteria	
Housing & other buildings - structural risks	
Emergency Preparedness	
Energy Stability & Reliability	

Opportunities from Campus Evaluation of Resilience Dimensions	
Criteria	
Education & Curriculum	
Resilience Communication & Awareness	
Food Systems-Equity	

In addition to the Campus Evaluation of Resilience Dimensions, UMB’s Office of Sustainability consulted the Resilience Working Group and considered the University’s THIRA to identify the following climate change hazards, impacts, and exacerbating factors.

UMB Identified Vulnerabilities	
Type	Vulnerability
Hazard	Extreme Heat
	Rainfall Flooding
	Severe Storms (ex. Winter & High Wind)
Impact	Infrastructure Failure
	Poor Air Quality
	Power Outage
Exacerbating Factors	Economic Inequality
	Lack of Green Space
	Political Instability

Resilience Indicators

UMB has identified resilience indicators in each dimension of resilience as defined by Second Nature: 1) Social Equity & Governance, 2) Health & Wellness, 3) Ecosystem Service, 4) Infrastructure, and 5) Economics. These will help track progress towards increased resilience over time. The indicators will be measured qualitatively and/or quantitatively while considering UMB’s overarching categories of resilience: campus planning, hazard reduction & readiness, and community. The indicators represent both the strengths and

vulnerabilities and may change over time, as the campus and community work towards a shared vision of the future and begin to better understand their shared vulnerabilities and risks.

UMB Resilience Indicators			
Social Equity & Governance			
Indicator	Metric	Qualitative/ Quantitative	UMB Dimension(s)
Sustainability courses offered	Number of courses offered	Quantitative	Community
Sustainability integrated into volunteering opportunities	Breadth--ensuring each school and administration has sustainability-related volunteering opportunities	Qualitative	Community
Hazard Analysis	UMB conducts an annual Threat and Hazard Impact Risk Assessment to understand hazards based on the vulnerability and preparedness of UMB and the community	Qualitative	Hazard Reduction & Readiness
Emergency Planning	UMB maintains emergency and continuity plans which support a unified and coordinated structure to sustain emergency program functions and response and recovery from the impacts of hazards	Quantitative	Hazard Reduction & Readiness
Crime	Crime rates	Quantitative	Community
Health & Wellness			
Indicator	Metric	Qualitative/ Quantitative	UMB Dimension(s)
Healthcare access for students and the UMB community	Free or affordable access to healthcare and mental healthcare services	Qualitative	Campus Planning, Community
Healthcare access for Baltimore City residents	Free or affordable access to healthcare and mental healthcare services	Qualitative	Campus Planning, Community
Food insecurity for students and UMB community	Resources to alleviate food insecurity on campus	Qualitative	Campus Planning, Community
Food insecurity for Baltimore City residents	Resources to alleviate food insecurity on campus	Qualitative	Campus Planning, Community
Ecosystem Services			
Indicator	Metric	Qualitative/ Quantitative	UMB Dimension(s)
Urban green space	Number of public green spaces on campus	Quantitative	Campus Planning, Community
Tree canopy	Percent tree canopy coverage	Quantitative	Campus Planning, Community
Air quality	Number of days exceeding National Ambient Air Quality Standard	Quantitative	Community

Stormwater management	Diverse mechanisms like rain gardens, green roofs, native plantings to manage stormwater runoff and mitigate the impacts from flooding	Qualitative	Campus Planning, Community, Hazard Reduction & Readiness
Infrastructure			
Indicator	Metric	Qualitative/ Quantitative	UMB Dimension(s)
Public transportation availability	Percent of campus served by public transportation	Quantitative	Campus Planning, Community
Communication in emergency planning	UMB maintains an Emergency Communications Annex that outlines the roles, responsibilities, and methods for providing timely and accurate information to the UMB community, media, and public during an emergency or crisis. UMB has a notification system capable of providing timely alert and warning messages to students, employees, and registered community guests and visitors.	Qualitative	Hazard Reduction & Readiness
Resilient energy	Multiple substations providing redundancy and protection to UMB's supply	Qualitative	Campus Planning
Multi-modal transportation	Access to diverse alternative modes of transportation like robust bike infrastructure (lanes, parking), carshare programs, discounted transit passes	Qualitative	Campus Planning, Community
Economic			
Indicator	Metric	Qualitative/ Quantitative	UMB Dimension(s)
Green revolving fund	Existence and budget of revolving fund for infrastructure and energy efficiency improvements	Quantitative	Campus Planning
Employment	Unemployment rate for surrounding community	Quantitative	Community

Assessment Next Steps

UMB's Office of Sustainability will report out on the resilience indicators annually to Second Nature and perform a reassessment every three (3) years to update projections, strengths, and vulnerabilities as necessary. The Office of Sustainability will continue building partnerships with campus and community stakeholders to make progress on its Sustainability Strategic Plan. The Resilience Working Group will continue to find opportunities for improving the three UMB resilience dimensions of campus planning, hazard reduction and readiness, and community.

**Appendix A:
University of Maryland,
Baltimore (UMB)
Resilience Report to
Second Nature, 2017**

UMB Resilience Report to Second Nature 2/1/17

First Annual Evaluation of Progress

for UMB Leadership review

Guided by the Campus Sustainability Committee and its Resilience Subgroup, over the past year UMB has achieved the following progress relative to developing a Climate Action Plan to increase Resilience (CAP-R) for our campus and the nearby surrounding communities. These points utilize the enumeration of the Second Nature Resilience Component of the Climate Leadership Commitment:

- **1a. Internal Structure-** UMB's Resilience Subgroup was formed in January of 2016 and has met monthly towards moving these efforts forward.
- **1b. Campus Community Task Force-** Representatives of UMB's Office of Community Engagement (OCE) and School of Nursing (SON) have engaged five groups including Baltimore City to ensure alignment of UMB's CAP-R with their own related initiatives towards facilitating joint actions. See attached first annual evaluation of progress.
- **1c. Campus Community Resilience Assessment-** UMB's Resilience Subgroup has defined what resilience means to our campus and outlined four strategies to address this: Flooding and Hurricane Preparedness, Redundancy Planning, Mitigate the Urban Heat Island effect and defining a Community Resiliency Leadership Network. For these four strategies, we have outlined related objectives and policies. These are captured in the attached spreadsheet which includes current completion and related metrics.
- **1d. Climate Action Plan for Resilience (CAP-R)-** UMB's CAP-R is being developed currently towards a January 2018 projected completion. See above item 1c for progress to date. Additional related details are being addressed over the next year towards expanding the depth of this item.
- **2a. Annual Progress Evaluation-** This document represents UMB's first annual evaluation of progress relative to developing our CAP-R.
- **2b. Report to Second Nature-** UMB's CAP-R and this annual evaluation of progress will be posted to Second Nature's reporting system once approved by UMB Leadership.

This report including attachments are respectfully submitted by UMB's Resilience Subgroup:

Anthony Consoli*, Steve Deck, Mark Drymala, Robyn Gilden, Bill Joyner & Luke Mowbray

**Serves as Chair; contact at aconsoli@umaryland.edu if any questions.*

Attachments:

- "A"- UMB Resilience definition & strategies
- "B"- UMB Resilience progress matrix
- "C"- UMB Resilience Community Engagement Summary & report

**UMB Resilience Subcommittee (RS)
of the Campus Sustainability Steering Committee (CSSC)
February 1, 2017**

RS Members: Anthony Consoli, Steve Deck, Mark Drymala, Robyn Gilden, Bill Joyner, Luke Mowbray
RS Advisors: Terry Morse

Resilience Definition & Strategies – Attachment A

1. **Overview-** to provide a snap shot of what the UMB Resilience Subcommittee (RS) has accomplished over the past year in order to obtain feedback (and additional volunteers) to move forward in meeting the Presidents' Climate Commitment for Resilience.

2. **Resiliency definition proposed for UMB:**

“Resilience is the ability of a system or community to survive disruption and to anticipate, adapt, and flourish in the face of change. Based on the University of Maryland, Baltimore’s (UMB) geography, the nature of its built infrastructure, and regional environmental concerns, UMB anticipates having to plan for the following impacts from climate change:

- *Increase in heavy precipitation events*
- *Coastal flooding associated with sea level rise and storm surge*
- *Increases in temperature extremes*

To address these impacts UMB will focus its climate resiliency strategies on the following areas:

- A. Flooding and Hurricane Preparedness*
- B. Redundancy Planning*
- C. Mitigate the Urban Heat Island Effect*
- D. Community Resiliency Leadership Network*

UMB has developed specific strategies, rough timelines, and metrics for each above item.

3. **Explanation of Strategies “A” to “D”**

Strategy A: Flooding and Hurricane Preparedness

Objective 1: Raise underground electrical infrastructure to the greatest extent practical

Policy 1a: Identify switchgear, substations, and other campus electrical infrastructure that is nearing the end of its useful life and begin the planning process for bringing equipment above grade.

Objective 2: Assess basement sump pumps

Policy 2a: Assess the age and condition of existing sump pumps. Identify basements without existing sump pumps and either relocate utility systems or install new sump pumps.

Policy 2b: Develop a life cycle replacement plan for existing sump pumps.

Objective 2: Assess roof drains

Policy 2a: Assess the age and condition of existing roof drains.

Policy 2b: Develop a life cycle replacement of these likely with roof replacements.

Strategy B: Redundancy Planning

Objective 1: Create redundant electrical supply for the University

Policy 1a: Build 2 new substations (Lombard and Saratoga St) that are fed by separate BGE power sources, and are independently equipped to provide adequate power to campus.

Objective 2: Build redundancy into critical campus communications systems.

Policy 2a: Provide servers in separate locations (601 W Lombard and 300 W Lexington) to create redundant facility control systems (Siemens, Johnson, Square D).

Policy 2b: Strengthen redundancy within fire alarm system through maintaining fiber cable system and backup telephone line communication.

Policy 2c: Geographically separate repeater and backup repeater for radio communications (655 W. Baltimore Street and 220 N Arch St). Objectives & policies being developed

Strategy C: Mitigate the Urban Heat Island effect on campus

Objective 1: Increase tree canopy coverage on campus

Policy 1a: Identify undersized tree pits that can be enlarged and develop an action plan for implementation.

Policy 1b: Increase the number of trees on campus by 10% in the next 5 years.

Policy 1c: Consider swapping columnar trees to species with larger canopies during lifecycle replacements.

Objective 2: Increase the amount of green space on campus

Policy 2a: Identify existing underutilized hardscape that can be converted to green space or pocket parks and develop an action plan for implementation. Incorporate the addition of *pocket parks* into campus master planning.

Objective 3: Improve the reflectivity or *cool* properties of rooftops and surface parking lots

Policy 3a: Identify rooftops on campus that could be improved with a *cool roof* strategy. Strategies could include the addition of solar panels, green roofing systems, or highly reflective paint.

Policy 3b: Identify surface parking lots on campus that could be covered with solar panels, have tree pits installed, or be replaced with permeable paving.

Strategy D: Community Resiliency Leadership Network (CRLN)

Note that below are based on Baltimore City DP3 item PS-3 and research efforts to date.

Objective 1: Identify lead contacts serving West Baltimore neighborhoods adjacent to UMB and coordinate actions to maximize safety and information sharing.

Policy 1a: Solicit recommendations for leader members from OCE, SW Partnership and other community groups.

Policy 1b: Invite these recommended community leaders to meet towards confirming their willingness to participate in this leadership network.

Objective 2: Identify and evaluate plans already in place and work to improve utilization of community based leaders to assist in preparedness and response.

Policy 2a: Research all such plans already in place at UMB and these particular neighboring communities.

Policy 2b: Evaluate their components and look for ways to coordinate efforts among these. Define the role that this community leadership network might play in emergency preparedness and response.

Objective 3: Develop a community group coordination plan & implementation guide.

Policy 3a: Based on results of earlier objectives, prepare a coordination plan and implementation guide.

Policy 3b: Create a structure of regular meetings/communication to keep this effort up to date and readily responsive when the need arises for action in the future.

4. Next steps & Action Items

- A. Schedule goals for components. The following refer to the Resilience Commitment Climate Action Plan components:
- 1b Joint Campus Community Task Force- see report attachment B. Implement steps towards increasing community groups' resilience through 2017.
 - 1c Complete Initial Campus Community Resilience Assessment- draft completed February 2017
 - 1d Complete the CAP-R (Climate Action Plan for Resilience) – targeting mid-June 2017
 - 2a/2b Annual Progress Evaluations- Obtain comments from UMB Leadership towards submitting this first annual progress report to Second Nature.
- B. Next RS Meeting: will be on 2/22 2-3pm. ***Additional volunteers are needed and very welcome to attend. Please contact Anthony.***

UMB Resilience Strategies & Progress Matrix - Attachment B

2/1/2017

STRATEGY COMPONENTS

Strategy Objective Policy

STATUS OF COMPLETION TO DATE

Ex. Cond. Inventory

ID Deficit

Set Goals

Notes/Remarks

A- Flooding & Hurricane Preparedness

1- Raise electrical infrastructure

1a- Identify outdated elements

x of y total	x		Include raising/flood protection as primary goal when completing DM schedule by 2022

see B.1 below re substations

2- Basement Sump Pumps

2a- Assess age/condition: # outdated?

x of y total	x		Replace according to VFA, or earlier, based on priorities/available funding.
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VFA indicates life cycle so no specific date

2b- Develop life/cycle replacement plan

x of y total	x		
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Deferred maintenance funding/priorities being assessed now in conjunction with VFA findings

3- Roof Drains

3a- Assess age/condition: # outdated?

x of y total	x		Replace according to VFA, or earlier, based on priorities/available funding.
--------------	---	--	--

newly suggested so just starting

3b- Develop life/cycle replacement plan

x of y total	x		
--------------	---	--	--

Again; timing of replacement necessity is known but funding/priorities are still in progress

B- Redundancy Planning

1- Create redundant electrical supply

1a- Build 2 new substations, fed separately

1	1		2 new by 2025
---	---	--	---------------

design in 2017; construction start 2018?

2- Build campus communication redundancy

2a- Servers in separate IT locations

1 location	1		2 locations by 2018
Existing is dated	?		Assess need for improvements by 2020
2 locations	0		maintain & monitor

601 W Lombard & 300 W Lexington

2b- Maintain/strengthen fire alarm redundancy

Assessment to be done in near future. 2020 arbitrary

2c- Separate repeaters for radio communications

655 W Baltimore & 220 N Arch

C- Mitigate the Urban Heat Island effect on campus

1- Increase tree canopy coverage on campus

1a- Enlarge undersized tree pits

1b- Increase # of trees on campus by 10% by 2021

109 of 287>32sf	178		enlarge 27 by 2021
~340 current total	maximize		add 34 by 2021
not quantified	TBD		policy; shift away from street

new campus standard 45sf minimum

1c- Swap columnar with larger canopy trees

too modest a goal?

2- Increase the amount of green space on campus

2a- ID underutilized hardscape for conversion

4 locations	sf area		3 new pocket parks by 2021
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CC east; lots n lexington & greene

3- Improve reflectivity of roofs & parking lots

3a- ID roofs to improve & strategies

x of y total are cool	y-x		go light as replaced
all lots are dark			light sealer or white aggregate

create O&M policy & spec for cool roofs

3b- ID parking lots to improve & strategies

create O&M policy & spec for cool paving

D- Community Resiliency Leadership Network

1- ID lead community contacts & coordinate actions

1a- ID who these leaders are

1b- Meet/confirm their willingness to participate

4 groups			
done			

also check city & state as 2 more groups

2- ID/evaluate current plans in place

2a- Research all these current plans

2b- Evaluate these & find coordination opportunities

done			
done			

plans requested from partners;BJ will follow-up

3- Develop a coordinated plan & implementation guide

3a- Prepare a coordinated resiliency community plan

3b- Set method for regular communication & quick response

done			
in progress			

KEY

completed
in progress
no progress

Community Engagement Summary – Attachment C

First Annual Evaluation of Progress

2/1/2017

We have existing relationships with 4 community/institution-based groups; Southwest Partnership, Parks & People, Social Work Community Outreach Service (SWCOS), and Promise Heights. Southwest Partnership is made up of seven neighborhoods and six institutions working together to build sustainable neighborhoods in Southwest Baltimore. The Parks & People Foundation is dedicated to supporting a wide range of recreational and educational opportunities; creating and sustaining beautiful and lively parks; and promoting a healthy natural environment for Baltimore. SWCOS' mission is to serve as a catalyst for inclusive and effective university-community partnerships which build individual, organizational, and community capacity. The vision of SWCOS is that Baltimore and Maryland will become socially and economically more robust through sustained university-community partnerships that foster civic-minded leadership and innovative community-engaged education, service, and research.

Finally, the Promise Heights initiative was established in 2009 by the University of Maryland School of Social Work to improve educational outcomes for youth and ensure families are healthy and successful in the West Baltimore communities of Upton/Druid Heights. In 2012, Promise Heights became a U.S. Department of Education Promise Neighborhood grantee—one of only 50 nationwide—to create a pipeline of integrated and comprehensive services which support children to succeed, thrive, be inspired to stay in school, and aspire to college and career.

After reviewing each organization's master plan and relevant climate change resilience goals, we identified the following opportunities to collaborate:

1. Southwest Partnership has identified streetscaping as an action item in almost every section of their plan. The Parks & People Foundation has identified West Baltimore as an area to focus on to increase tree canopy and strategic community engagement.
 - a. The City has a program to replace missing street trees. *The UMB Resilience subcommittee can help coordinate this resource and also connect groups to funders for new projects.*
2. Community schools are interested in helping parents and students ensure that all families have safety plans in place in case of emergencies and that those plans are understood by all.
 - a. The City has a process to request emergency preparedness workshops and presentations. *The UMB Resilience subcommittee can help the schools in coordinating these educational resources.*

Report by Robyn Gilden SON & Bill Joyner OCE

**Appendix B:
University of Maryland,
Baltimore (UMB) Threat
and Hazard Identification,
Risk, & Consequence
Analysis (THIRA/CA)**

University of Maryland, Baltimore

**Threat and Hazard Identification, Risk
Assessment, & Consequence Analysis
(THIRA/CA)**

Version 3 - 2022 Update

Table of Contents

Record of Change..... 3
Record of Distribution..... 3
Chapter 1: Introduction 4
 1.1 Purpose..... 4
 1.2 Scope 4
 1.3 Situation and Assumptions 4
 1.4 Methodology..... 4
Chapter 2: Assessment & Analysis..... 4
 2.1 Threat and Hazard Identification 4
 2.2 Risk Assessment and Consequence Analysis 8
 2.3 Risk Profile..... 11
 2.4 Top Hazards..... 11
Chapter 3: Plan Development, Evaluation, and Maintenance 12
 Appendix A: Glossary..... 13
 Appendix B: Acronyms..... 14

Figure 1: Consequence Analysis..... 10
Figure 2: UMB Risk Profile 11
Figure 3: Top Hazards 11

Table 1: Hazard Identification and Context 5
Table 2: Hazard Probability..... 8
Table 3: Vulnerability Indicators 8
Table 4: Preparedness Indicators..... 9

Record of Change

Chapter 3 describes the maintenance process, method, and schedule for evaluation and revision of this plan.

Version	Date	Change Made By	Summary
1.0	2019	Emergency Management Team (EMT)	Original plan
2.0	2020	Office of Emergency Management (OEM) with input from EMT members	Annual review; renamed THIRA/CA from Hazard Vulnerability Analysis
2.1	2021	OEM with input from EMT members	Maintenance tasks IAW Chapter 3; addition of 2.3 "2021 Update"
3.0	2022	OEM with input from EMAG and Resiliency Committee	Table 1, Figure 1, and Figure 2 updated based on re-assessment of hazard data. Top Hazards (Figure 3) added.

Record of Distribution

Following the annual review of this plan listed in the Record of Change above, it will be posted to www.umaryland.edu/emergency, and significant changes communicated to the Emergency Management Advisory Group and Emergency Management Team.

Entity	Method of Delivery	Version	Date of Delivery
Emergency Management Team	Briefing	1.0	March 2019
Emergency Management Advisory Group	Briefing	1.0	June 2019
Emergency Management Team	Briefing	2.0	February 2020
Emergency Management Advisory Group	Briefing	2.0	April 2020
Emergency Management Team	Briefing	2.1	June 2021
Emergency Management Advisory Group	Briefing	2.1	June 2021
Emergency Management Team	Email / SharePoint	3.0	July 2022

Chapter 1: Introduction

Building a comprehensive emergency management program depends upon on a firm understanding of hazards and potential consequence faced by UMB.

1.1 Purpose

This THIRA/CA assesses natural, technological, and human-caused hazards based on probability and potential magnitude to create a risk profile for UMB and to identify the top hazards to guide preparedness efforts.

1.2 Scope

This THIRA/CA includes hazards that, when they occur, would require multi-departmental coordination to address the risk or impact to personnel, property, environment, and continuity of operations within the UMB campus boundary.

1.3 Situation and Assumptions

- (a) Mitigation, prevention, emergency operations, recovery, continuity, and resource management planning, the prioritization of trainings, and notification, warning, and public outreach messages are guided by this analysis.
- (b) UMB faces unprecedented challenges as part of the dynamic and interconnected global community, specifically the evolving impacts resulting from climate change. To maximize preparedness efforts, UMB seeks to understand those hazards most likely to impact the university now and in the future.
- (c) While this analysis seeks to be a comprehensive assessment of probable hazards, it does not imply that UMB is limited to only the hazards considered within this analysis.

1.4 Methodology

- (a) OEM developed this THIRA/CA in accordance with requirements established by the Emergency Management Accreditation Program (EMAP).

Chapter 2: Assessment & Analysis

2.1 Threat and Hazard Identification

- (a) The EMT supported development of Version 1.0 by identifying hazards and provide context, providing perceived input on hazard severity, and describing potential consequences. Version 2.0 expanded hazards considered, provided hazard context, and added a consequence analysis.
- (b) Version 3.0 updated probability and magnitude of hazards based on recent mitigation and preparedness efforts and evolving hazards, specifically those influenced by the consequences of global climate change.
- (c) This analysis reflects historical data of hazards affecting UMB and hazards identified by the National Oceanic and Atmospheric Administration (NOAA) Centers for Environmental Information and U.S. Climate Resilience Toolkit, City of Baltimore Disaster Preparedness and Planning Project, Baltimore County Hazard Mitigation Plan, Howard County Hazard Mitigation Plan, State of Maryland Hazard Mitigation Plan, the 2020 Maryland THIRA Report, and University of Maryland Medical Center Hazard Assessment.
- (d) The table below identifies hazards that pose a risk to UMB, based on input from UMB, Maryland, and Federal resources. The table describes the hazard context potential vulnerability to UMB people, property, environment, and operations of UMB.

Threat and Hazard Identification, Risk Assessment, & Consequence Analysis

Table 1: Hazard Identification and Context

Hazard	Hazard Context	Potential Risk and Vulnerability to UMB People, Property, Environment, and Operations
Natural		
Earthquake	Trembling of the ground in Baltimore City caused by the sudden movement of tectonic plates equivalent to a magnitude 4.0 or higher on the Richter scale.	A 2011 earthquake centered in Virginia did impact UMB. However, according to the Maryland Geological Survey , the probability of an earthquake capable of resulting in significant damage to UMB property or harm UMB people is very low.
Flooding	Flooding may impact UMB via several event types, to include <i>rainstorms</i> over the campus where drainage areas cannot accommodate the runoff, and <i>coastal storms</i> that pass over Baltimore City producing substantial storm surge and/or rainfall in a short timeframe.	The State rates Baltimore City as, “high risk” for coastal hazards due to historical frequency and vulnerability of people, property, environment, and continuity of services over a large geographic area, as demonstrated by numerous historical cases. UMB also experiences periods of intense rainfall, which has caused damage to property.
Extreme Heat	A prolonged period (>2 hours) of dangerously high temperatures (>100F).	NOAA data identifies 29 days of extreme heat in Baltimore City between 2010 and 2019. While the MDEM Hazard Mitigation Plan of 2020 identifies Baltimore City at medium-high risk, this is because of population density and vulnerability. The majority of the UMB population perform essential functions indoors and therefore are at low vulnerability. Extreme heat could pose a risk to people and research, but only as a secondary factor following a utility failure. The NOAA Climate Explorer projects extreme heat (greater than 90F) to increase in the timeframe of 2035 and 2064.
High Wind	High Wind may impact UMB because of numerous event types, to include sustained non-convective <i>winds</i> of 40 miles per hour or greater lasting for 1 hour or longer, or gusts of 58 miles per hour or greater occurring within Baltimore City, <i>tornados</i> creating violently rotating column of air in contact with the ground with speeds of approximately 50-200 mph and occurring within Baltimore City, or <i>coastal storms</i> that pass over Baltimore City producing wind speeds (>=>74 miles per hour).	NOAA data identifies 13 high wind events for Baltimore City between 2010 and 2019 resulting in 1 death. NOAA data identifies nine (9) low-pressure events (magnitude EF0 and EF1) occurring in Baltimore City/County between 2010 and 2019. As UMB property is built, inspected, and maintained to comply with building codes, the vulnerability of UMB to a tornado is negligible. The State rates Baltimore City as, “high risk” for coastal hazards due to historical frequency and vulnerability of people, property, environment, and continuity of services over a large geographic area, as demonstrated by historical cases.

Threat and Hazard Identification, Risk Assessment, & Consequence Analysis

Hazard	Hazard Context	Potential Risk and Vulnerability to UMB People, Property, Environment, and Operations
Infectious Disease	A sudden increase in cases of an infectious disease that poses a risk to the health and safety of UMB personnel or disruption to continuity of operations.	The Covid-19 pandemic demonstrated the vulnerability of UMB personnel to infectious diseases. Many UMB faculty and students have frequent patient contact and serve patients overseas, therefore having a limited ability to implement social distancing.
Severe Winter Weather	Precipitation, such as freezing rain, snow, sleet, and ice that result in unsafe conditions on the UMB campus, have the potential to damage UMB property, or disrupt campus operations.	A review of recent National Weather Service watches, warnings, and advisories for the Baltimore area demonstrate a frequent risk from winter weather, specifically between November and March.
Technological		
Hazardous Materials	An uncontrolled release of a chemical, biological, or radiological agent within the UMB Clery boundary with the potential to harm UMB people, property, environment, and/or reputation.	Personnel on UMB property use hazardous materials. Significant training and engineering efforts mitigate an uncontrolled release. Federal requirements by the Centers for Disease Control and Prevention and Department of Energy, along with good judgement dictate ongoing preparedness to address these hazards as the potential for an incident to occur exists and UMB people, property, and environment are vulnerable to potential consequences.
Structure Fire	Fire within a UMB owned or controlled facility, including parking garages, which poses an immediate risk to the safety of occupants or damage of property.	UMB has had fires in offices, lab space, and garages. Fires were suppressed without significant damage, because of fire suppression capabilities. Structure fire is a significant hazard the UMB seeks to mitigate and prevent through educational and engineering efforts.
Utility Outage	Disruption of utility systems and / or commodities that support the UMB campus, to include potable water, gas and electrical power, HVAC, and sewage removal.	Available data indicates a frequency of planned outages and failures (i.e., water main breaks) affecting UMB every year. Utility loss has historically disrupted the performance of research, academics, and business service. Utility service is not owned by UMB, but this hazard has consequences that highlight the importance of UMB continuity of operations planning and preparedness.
Human-caused		
Active Assailant	Individual(s) actively engaged killing or attempting to kill people in a populated area within UMB's Clery boundary.	FBI data of violence in open spaces, health care settings, and educational facilities indicate the prudence of UMB to consider active assailant incidents as a hazard of concern.
Explosions	A rapid uncontrolled volume expansion in which energy is transmitted outward as a shock wave that has the energy to cause property damage, death, or injuries with UMB's Clery boundary.	Throughout UMB buildings exist steam, water, and electrical infrastructure, pressurized gas and liquid cylinders, and stored chemicals that have the potential to explode. <i>Note: Intent is unintentional explosions and excludes malicious activity</i>

Threat and Hazard Identification, Risk Assessment, & Consequence Analysis

Hazard	Hazard Context	Potential Risk and Vulnerability to UMB People, Property, Environment, and Operations
Civil Disturbance	Behavior, by persons outside of UMB buildings, which disrupts the UMB campus and requires intervention to maintain safety due to violence, disorderly conduct, or vandalism.	In 2015, the UMB community experienced the disrupting affects from a multi-day civil disturbance. The location of UMB in an area of the city with social-economic inequality places UMB at a higher vulnerability for future civil disturbance to impact UMB. Physical controls and security force serve to limit vulnerability.
Cyber Disruption	Temporary or permanent loss of IT service or data due to human error, intentional cyber-attack, or physical damage from other hazards.	While UMB cyber resources are transitioning to a resilient cloud environment, vulnerability remains for disruption. Cyber impacts occur from hardware damage and the result of malicious actors. Educational, government, and health care entities have been the target of cyber-attacks. UMB needs secure data and continuity of access to support research, academic, and business operations.
Transportation Disaster	A major crash of a vehicle, such as a truck or aircraft, within the UMB Clery boundary that causes significant damage to UMB property or disrupts campus operations. Minor motor vehicle collisions involving private parties are not within scope of this hazard.	UMMC has a helipad that receives aircraft daily. The Howard Street Tunnel is major railroad infrastructure and Martin Luther King Highway is a major roadway: both parallel the boundaries of campus. A 2001 fire in the Howard Street Tunnel resulted in an impact to the UMB community. Efforts to directly prevent or mitigate this hazard are outside the scope of UMB, and the property potentially involved is not owned by UMB.

2.2 Risk Assessment and Consequence Analysis

- (a) The definitions below establish consistency in how the magnitude of consequences and consequence reduction efforts are assessed for each hazard.

Table 2: Hazard Probability

	Remote	Occasional	Probable	Frequent
Probability	Possible, but not probable within a 10-year period	May occur over the course of several years	Likely to occur	Likely to occur multiple times within a year

Table 3: Vulnerability Indicators

	Low	Moderate	High
Public	Life safety is possible, but not expected to be at risk	Life safety impact most likely to affect a small group of people at UMB (<25)	Life safety impact likely to affect many UMB people
Responders	Response to this hazard is common and manageable by responders	Response to this hazard is uncommon, and may exceed responder capabilities	Response to this hazard is uncommon and likely to overwhelm responders
COOP	Disruption may require some modification of normal activities to continue essential functions	Disruption is likely to require use of continuity plans by one or a few departments / schools	Disruption is very likely to require use of continuity plans by nearly all UMB departments / schools
Property	Damage likely to be repaired within a few days or less	Damage likely to be repaired within 2 weeks	Damage likely to be repaired in a month or longer
Environment	Environmental impacts are possible, but unlikely	Environmental impacts that are UMB responsibility are unlikely to impact clean air and water across the UMB campus	Environmental impacts that are UMB responsibility are likely to impact clean air and water across the UMB campus
Economic Conditions	Consequence of the hazard is possible, but unlikely to cause economic impacts to UMB	Consequence of the hazard may cause hardship, but not lasting economic impacts to UMB	Consequence of the hazard is likely to cause hardship beyond the current fiscal year
Public Confidence	Impact is possible, but unlikely that the hazard's occurrence would be of broad public interest	Occurrence of the hazard may negatively affect confidence in UMB	Occurrence of the hazard is very likely to have lasting negatively impacts on public confidence in UMB

Threat and Hazard Identification, Risk Assessment, & Consequence Analysis

Table 4: Preparedness Indicators

	Low	Moderate	High
Response Plans	An informal/undocumented plan exists among key responders	UMB has developed a hazard-specific plan	UMB has exercised and/or implemented a hazard-specific plan
Engineering	Physical solutions exist in some, but not all UMB buildings that may reduce consequences of this hazard	Physical solutions exist in the majority, but not all UMB buildings that may reduce consequences of this hazard	Unique/robust engineering solutions have been implemented to prevent/mitigate this hazard
Enforcement	Policies/regulations related to preventing/mitigating the hazard are not clearly documented and there is not active enforcement across UMB	Policies/regulations related to preventing/mitigating the hazard are documented, but may not be possible to actively enforce	Policies/regulations related to preventing/mitigating the hazard are documented, and personnel are assigned to actively enforce
Emergency Response	An emergency response capability exists to serve UMB, but not controlled by UMB (ex. provided by Baltimore City, BGE, etc.)	UMB controls an emergency response capability, but would require support from an external entity (ex. Baltimore City)	UMB controls an emergency response capability that is expected to not require external support
Education & Training	Some amount of hazard-specific education and/or training has been made available	Hazard-specific education and/or training is widely available for the target audience	Hazard-specific education and/or training is required of the target audience

- (b) The consequence analysis shown in the figure below identifies how vulnerability and preparedness was measured according to each hazard. The resulting magnitude is vulnerability minus preparedness. Magnitude multiplied by probability results in the total risk ranking.

Threat and Hazard Identification, Risk Assessment, & Consequence Analysis

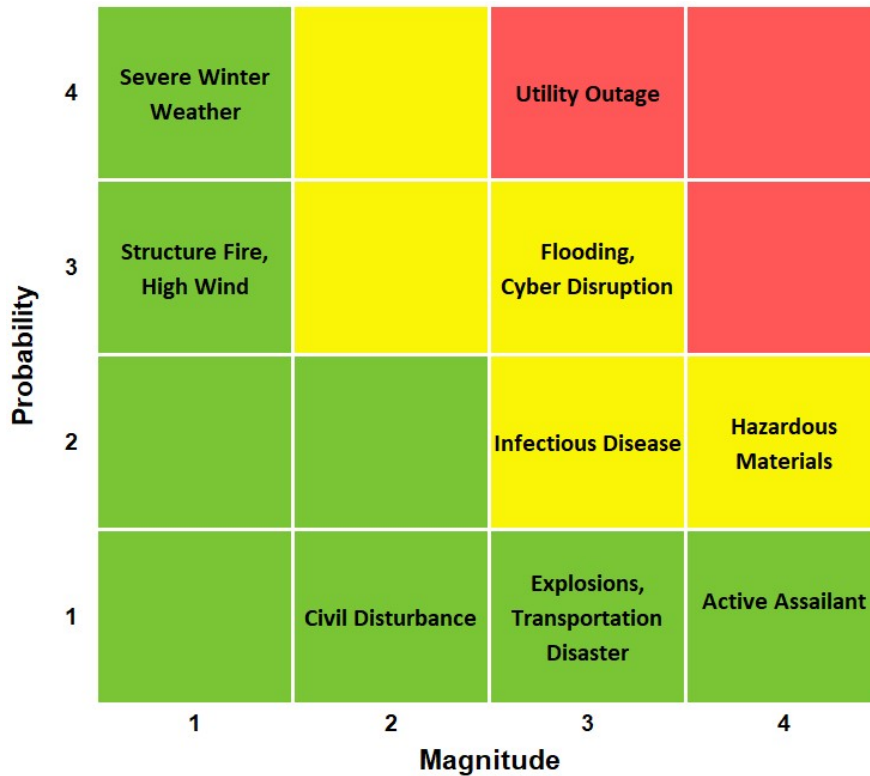
Figure 1: Consequence Analysis

UMB CONSEQUENCE ANALYSIS																
		VULNERABILITY <i>(0=n/a, 1=Low, 2=Moderate, 3=High)</i>							PREPAREDNESS <i>(0=n/a, 1=Low, 2=Moderate, 3=High)</i>					MAGNITUDE <i>(Vulnerability - Preparedness)</i>	PROBABILITY <i>(Remote=1; Occasional=2; Probable=3; Frequent=4)</i>	RISK <i>(Vulnerability x Probability) n/a when Preparedness > Vulnerability</i>
		Public	Responders	COOP	Property	Environment	Economic Condition	Public Confidence	Response Plans	Engineering	Enforcement	Emergency Response	Education & Training			
Natural	Earthquake	1	2	1	1	0	1	1	1	3	3	2	3	-5	1	n/a
	Flooding	3	1	2	2	1	2	0	1	2	2	2	1	3	3	9
	Extreme Heat	1	1	1	0	0	1	1	1	3	3	1	0	-3	3	n/a
	High Wind	2	2	2	1	0	1	0	1	2	1	2	1	1	3	3
	Infectious Disease	3	3	3	0	0	3	2	2	2	3	2	2	3	2	6
	Severe Winter Weather	3	1	3	1	0	1	1	3	3	0	2	1	1	4	4
Technological	Hazardous Materials	2	2	2	2	2	2	3	3	3	2	1	2	4	2	8
	Structure Fire	2	1	2	3	1	1	1	3	3	2	1	1	1	3	3
	Utility Outage	0	1	2	1	1	2	2	1	2	2	1	0	3	4	12
Human	Active Assailant	2	3	2	3	0	2	3	2	3	2	2	2	4	1	4
	Explosion	2	2	2	3	1	2	2	1	3	3	2	2	3	1	3
	Civil Disturbance	3	2	3	1	1	1	2	2	3	2	2	2	2	1	2
	Cyber Disruption	0	3	3	2	0	3	3	2	2	3	2	2	3	3	9
	Transportation Disaster	1	2	2	3	1	2	2	1	3	3	2	1	3	1	3

2.3 Risk Profile

- (a) The risk profile below illustrates the magnitude and probability findings for each hazard. Those hazards listed in Figure 1 but not shown in Figure 2 have a *Preparedness* value greater than the *Vulnerability* value.

Figure 2: UMB Risk Profile



2.4 Top Hazards

- (a) UMB top hazards are those with an overall risk Score of 6 or above, and those with a maximum probability or magnitude ranking.
- (b) The EM Program will use the top hazards to guide development of mitigation, prevention, emergency operations, recovery, continuity, and resource management planning as well as training and exercise priorities. The figure below lists the current UMB Top Hazards:

Figure 3: Top Hazards

		Risk Score
Top Hazards	Utility Outage	12
	Flooding	9
	Cyber Disruption	9
	Hazardous Materials	8
	Infectious Disease	6
	Severe Winter Weather	4 - Frequent
	Active Assailant	4 - High Magnitude

Chapter 3: Plan Development, Evaluation, and Maintenance

Plan Development

The EMT collaborated in development of this plan, and the Baltimore City Office of Emergency Management and the Maryland Emergency Management Agency provided information to support the effort. OEM consulted those schools and departments listed below for input to Version 3.0:

- Community Engagement Center
- Design & Construction
- Environmental Health & Safety
- Environmental Services
- Facilities Operations
- Office of the Chief Business & Finance Officer and Senior Vice President
- Office of Emergency Management
- Office of the Fire Marshal
- Office of Sustainability
- Police Department
- Real Estate Planning and Space Management
- School of Law
- School of Medicine
- Student Affairs/Campus Life

Evaluation

- (a) Annually, the Office of Emergency Management will review the risk assessment to evaluate:
 - If an emerging hazard or completed mitigation projects may alter the assessment of risk and vulnerability.
 - Whether the assessment remains in compliance with USM requirements and accreditation guidelines.
- (b) The EMT will receive the result of this review. When an emerging hazard is identified, objective data will be obtained and the appropriate members of the EMT will be requested to provide input on determining the probability and severity of impact.

Maintenance

- (a) Annually, small formatting changes may be performed to ensure consistency among all plans.
- (b) Beginning in 2022 and every subsequent three years, an extensive re-assessment of historical data for hazards will be done to ensure all appropriate hazards are appropriately identified. These hazards will be re-assessed through the consequence assessment to provide an updated risk profile.
- (c) OEM will document all updated plan revisions in the Record of Changes and ensure the members of the EMT are made aware of and provided access to the most current version.

Appendix A: Glossary

All-hazards: A consistent approach to emergency planning allows for the same process to be followed in responding and recovery, regardless of the hazard.

Continuity of Operations: The continued performance and rapid resumption of essential functions.

Disaster: A serious disruption occurring over a relatively short period of time, affecting the functioning of the university as it causes significant and widespread human, physical, economic, reputational, or environmental loss which exceeds the ability of UMB to cope using existing resources.

Emergency: An unplanned occurrence that requires action by the Emergency Management Program, where without immediate action, harm will befall or has impacted life, property, environment, and/or disrupt campus mission essential functions. The Emergency Management Program seeks to manage the implementation of actions to keep an emergency from escalating into a disaster.

Hazard: A natural, technological, or human-caused source or cause of harm or difficulty.

Impact: The specific effects a threat or hazard scenario would have on a community if the threat or hazard occurred.

Mitigation: Activities intended to reduce the loss of life and property by avoiding or lessening the impact of a disaster.

Preparedness: Activities implemented prior to an emergency that may be used to support and enhance mitigation of, response to, and recovery from disruptions.

Prevention: The capabilities necessary to avoid, prevent, or stop a threatened or actual act of terrorism. In national preparedness guidance, the term “prevention” refers to preventing imminent threats.

Resource: Personnel, equipment, supplies, and facilities available for assignment to incident operations.

Response: Immediate actions to save lives, protect property and the environment, and meet basic human needs.

Risk: The potential for an unwanted outcome resulting from an incident or occurrence, as determined by its likelihood and the associated consequence.

Threat: Synonymous with *Hazard*, but primarily focused on adversarial human-caused incidents.

Vulnerability: A physical feature or operational attribute that renders an entity susceptible to a given hazard.

Appendix B: Acronyms

EMAP	Emergency Management Accreditation Program
EMT	Emergency Management Team
FBI	Federal Bureau of Investigation
THIRA/CA	Hazard Identification, Risk Assessment, and Consequence Analysis
NOAA	National Oceanic and Atmospheric Administration
OEM	Office of Emergency Management
UMB	University of Maryland, Baltimore
USM	University System of Maryland

**Appendix C:
Resilience Working Group
Members, February 2022**

Resilience Working Group Members Roster
(February 2022)

Name	School/Department	Title
Kimia Abtahi	Medicine	Student
Anthony Atalla	Medicine	Student
Halina Bereday	Law	Student
Jeffrey Kahn Blackman	Medicine	Student
Christina Blair	Construction & Facilities Procurement	Construction Contracting Specialist
Anthony Consoli	Design & Construction	University Architect
Bill Crockett	Campus Life Services	Executive Director
Donald De Alwis	Medicine	Student
Cara Dooley	Medicine	Student
Mark Drymala	EVS	Senior Manager
Emily Engelbrecht- Wiggans	Medicine	Office Assistant, Radiology
Sharon Gillooly	Campus Life Services	Senior Media Production Specialist, Faculty Center for Teaching & Learning
Susannah Gilmore	Law	Student
Madison Haas	Community Engagement Center	Program Coordinator
Michelle Hart	Department of Public Safety	Coordinator, Clery Act
Mike Krone	Operations & Maintenance	Assistant Director, Utilities Management
Hayley Markman	Office of Emergency Management	Continuity of Operations Manager
Elisa Medina	Human Resources	Manager, Career Development
Denise Meyer	EVS	Associate Director
Luke Mowbray	Real Estate, Planning, & Space Mgmt	Interim Director
Ashleigh Pagano	Law	Student
Karen Park	A&F Office of the VP	Director, Strategic Projects and Chief of Staff
Aisha Samples	Law	C-DRUM Program Specialist
Michelle Stezelberger	Design & Construction	Acting Associate Director of Project Support
Sanjay Uchil	Medicine	Manager, Applications Development