Calvert County Flood Mitigation Plan

Prepared for:

Calvert County Office of Planning & Zoning

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Executive Summary

Mitigation is the effort to reduce loss of life and property by lessening the impact of disasters. Mitigation is key to reducing the impacts of flood events within Calvert County, Maryland, including but not limited to flooding, flash flooding, tidal flooding, and dam failure events.

In 2023, the Calvert County Department of Planning & Zoning contracted a consulting agency to conduct a comprehensive flood study and mitigation plan for the entire county to be used in conjunction with the 2023 Calvert County Hazard Mitigation Plan. The flood study was successfully completed in February of 2024 and revised based on input from the local planning team and the public. The flood study and mitigation plan assesses Calvert County's flooding vulnerability based on historic information, areas of previous concern, and future trends for flooding in the county.

The planning process for the 2024 Calvert County Flood Study and Mitigation Plan consisted of the following:

- Review of community information for Calvert County including land use/land cover, population demographics, and community locations.
- Examination of past flooding and flash flooding events.
- Examination of average precipitation data (rainfall and snowfall) for Calvert County.
- Development of dam failure profiles for Calvert County.
- Development of HAZUS scenarios for the entirety of Calvert County and specific Calvert County census tracts.

Throughout the planning process, stakeholders in Calvert County were given the opportunity to review and provide information for the flood study and mitigation plan. A list of these stakeholders and those that participated in the planning process, as well as a schedule that outlines the process, is in the introduction section of this report.

The Calvert County Flood Study and Mitigation Plan reflects the current conditions in Calvert County at the time of the writing of this report. All analyses were conducted with the goal of reducing the vulnerability of Calvert County to flooding hazards, and to reduce the vulnerability of Calvert County structures, critical infrastructure, community lifelines, and functional needs facilities. This document will be used to assist in future updates of the Calvert County Hazard Mitigation Plan and the development of sound mitigation strategies for the county and incorporated municipalities. This document can be used as a guide to flooding, flash flooding, tidal flooding, and other flooding items for risk assessment in Calvert County.

This document will work with hazard mitigation principles to break the cycle of damage to facilities, reconstruction, and repeated damage. Hazard mitigation principles can be used for studies such as this, as well as larger, multi-jurisdictional hazard mitigation plans.

Section 1: Introduction

The Calvert County Department of Planning & Zoning, in an effort to further understand the flooding impacts that can occur within Calvert County, initiated the process of conducting a countywide flood study in conjunction with the Calvert County 2023 Hazard Mitigation Update.

The Board of Commissioners of Calvert County were successful in securing grant funding to offset the cost of the countywide flood study and mitigation plan and the 2023 hazard mitigation plan. The commissioners assigned the Calvert County Department of Planning & Zoning with the primary responsibility to oversee the process of the Calvert County Flood Study and Mitigation Plan. MCM Consulting Group, Inc. was selected to complete the Calvert County Flood Study and Mitigation Plan. A local planning team at Calvert County was developed and was comprised of Calvert County employees, stakeholders for the project, and MCM Consulting Group, Inc. employees. This flood study and mitigation plan will offer a solid foundation for future Calvert County mitigation planning.

Scope

This Calvert County Flood Study and Mitigation Plan examines the flooding risk and vulnerability for Calvert County, determines the areas of the county where flooding events would be the most impactful, and offers future solutions to minimize the impact of flooding, flash flooding, tidal flooding, and other flooding impacts. The Calvert County Flood Study will result in a disaster resilient community through multiple actions and analyses.

The Calvert County Flood Study and Mitigation Plan includes:

- An initial Hazards-United States (HAZUS) scenario and secondary HAZUS scenarios utilized to determine the potential damage from a probabilistic flooding event (1% annual chance flood) within Calvert County and its census tracts.
- An examination of past flooding, flash flooding, and tidal flooding events in Calvert County including warnings and advisories.
- An examination of dam failure flooding impacts for Calvert County and the vulnerability of county assets to those events.
- A review of mitigation actions and mitigation project opportunities to potentially be used during the next hazard mitigation planning period.

Planning Team

The Calvert County Flood Study and Mitigation Plan planning team consisted of staff members from Calvert County government and MCM Consulting Group, Inc. staff members. Each member of this local planning team is listed in *Table 1 – Calvert County Flood Study and Mitigation Plan Planning Team* and actively participated in the planning process and/or provided

valuable information utilized in the flood study. *Table 2 – Flood Study Timeline* lists all meetings and milestones that occurred in the Calvert County Flood Study and Mitigation Plan.

Table 1 - Calvert County Flood Study and Mitigation Plan Planning Team

Calvert County Flood Study Planning Team		
Name	**Organization**	**Position**
Harry "Ray" Alvey	Calvert County Technology Services	GIS Mapping Technician
Tamara Blake-Wallace	Calvert County Department of Planning & Zoning	Planning Commission Administrator
Kara Buckmaster	Calvert County Division of Emergency Management	Emergency Management Specialist
Amalia Pleake-Tamm	Calvert County Department of Planning & Zoning	Environmental Planner III
Ron Marney	Calvert County Department of Planning & Zoning	Environmental Planning Regulator
Siarah Newsome	Calvert County Public Safety	Public Safety GIS Analyst
Kevin Shaver	Calvert County Department of Public Works	Project Engineer II
Calvin Strozier	Calvert County Technology Services	GIS Analyst
Michael Rearick	MCM Consulting Group, Inc.	Director of Operations
Valerie Zents	MCM Consulting Group, Inc.	Senior Consultant
Adam Leister	MCM Consulting Group, Inc.	Senior Consultant
Daniel Becker	MCM Consulting Group, Inc.	Consultant
Ashley Thoirs-Lawrence	MCM Consulting Group, Inc.	Project Coordinator
Alyssa Rusnock	MCM Consulting Group, Inc.	Project Coordinator

Table 2 - Flood Study Timeline

Calvert County Flood Study Timeline		
Date	**Meeting**	**Description**
10/11/2023	Flood Study Planning Team Kickoff Meeting	Kickoff meeting with initial planning team including Calvert County.
10/11/2023 – 10/13/2023	Initial GIS Data Request	Initial GIS data request to Calvert County.
10/11/2023 – 10/18/2023	Download FEMA info for Calvert County	Downloading of flood information and FEMA depth grids for Calvert County.
11/15/2023	Flood Study Planning Team Meeting	Planning team meeting to discuss ongoing flood study development.

Calvert County Flood Study Timeline		
Date	**Meeting**	**Description**
12/12/2023	Flood Study Public Meeting	Public meeting to present information on the flood study to the public and solicit public input into process.
12/13/2023	Flood Study Planning Team Meeting	Planning team meeting to discuss ongoing flood study development and public input from previous public meeting.
01/18/2024	Flood Study Planning Team Meeting	Planning team meeting to discuss ongoing flood study development and planning for public meeting.
01/18/2024	Flood Study Public Meeting	Public meeting to present information on the flood study to the public and to solicit input into planning process.
01/31/2024 – 02/14/2024	Planning Team Review of Draft Flood Study	Planning team review of draft flood study.
02/14/2024 – 02/21/2024	Updating of Draft Flood Study with Planning Team Comments	Updating of the draft flood study with planning team comments including any issues related to flooding, flash flooding, and tidal flooding.
03/18/2024	Flood Study Planning Team Meeting	Public meeting to present the final flood study and mitigation plan to the public.

Section 2: Community Profile

Calvert County covers approximately 345 square miles and is situated in southcentral Maryland. The county is bordered by Anne Arundel County to the north, Prince George's County to the northwest, Charles County to the west, and St. Mary's County to the south. Calvert County lies within the Atlantic Coastal Plan physiographic province. The county is 14th in terms of population within the State of Maryland. There is a total of 213 square miles of land and 132 square miles of water in Calvert County. Calvert County is the smallest county in the state.

Community Facts

Native populations lived in the areas of Calvert County as early as 12,000 years ago and the first indigenous peoples to live in the area of Calvert County were the Piscataway Native Americans. These Native Americans were displaced by the colonists in Calvert County due to disease and violence. Calvert County, Maryland was founded in 1654 and was originally named Charles County, after King Charles I of England. Charles County was abolished in 1654 and Calvert County was established in the same area. The Puritan Assembly changed the name of the county to Patuxent County on October 20, 1654. The Calvert County name, named for the Calvert family, was restored to the county in 1658 and has remained to this day. The Calvert family name is derived from the traditional family name of the Barons of Baltimore and the proprietors of the Colony of Baltimore.

The county seat of Calvert County was previously located in Calvertown on the north shore of Battle Creek, until the county seat was moved in 1722 to the area that would become Prince Frederick. The courthouse for Calvert County in Prince Frederick was completed in 1732.

Calvert County has two incorporated municipalities, and seven Town Centers that have specific boundaries and are used for zoning and development. Town Centers in Calvert County do not have a central, incorporated government, but do allow for the preservation of rural areas and natural areas in the county from development.

The following incorporated municipalities and unincorporated Town Centers are located in Calvert County:

- **Municipalities (2):** Town of Chesapeake Beach, Town of North Beach
- **Town Centers (7):** Dunkirk, Huntingtown, Lusby, Owings, Prince Frederick (County Seat), St. Leonard, and Solomons

Population and Demographics

The total population for Calvert County is 92,783 based on the 2020 Decennial United States Census by the United States Census Bureau. The total population change for Calvert County

from 2010 to 2020 was an increase of 4,046 or a percent change of 4.56% from 2010. The most populous municipality in the county is the Town of Chesapeake Beach, located in the northeast corner of the county. The municipalities in the county had population changes of 10.48% for the Town of Chesapeake Beach and 8.49% for the Town of North Beach.

Based on information provided in the American Community Survey for Calvert County from 2021, the racial composition of the county is 79.3% White, 12.4% Black or African American, 4.3% Hispanic or Latino, 0.1% American Indian and Alaska Native, 2.1% Asian, 0.1% native Hawaiian or Pacific Islander, and 5.6% two or more races. The median age of Calvert County is 40.5 years of age, which is higher than the Maryland median age of 39.3 years old and the median age of the United States at 38.8 years old. The percentage of Calvert County under the age of 5 years old is 5.2%, under the age of 18 is 23.4%, between the ages of 18 and 64 years old is 56.4%, and the individuals 65 years and older is 15%.

The median household income for households in Calvert County is $120,295.00 and the poverty rate of Calvert County is 4.9% of the total population. The poverty rate for the State of Maryland as a whole is 10.3%. There are approximately 7,750 veterans in Calvert County. Minimal information was available at the time of this writing on Calvert County statistics for veteran information, but the ACS estimates that 2.1% of veterans in the county are unemployed. This equates to approximately 163 veterans.

There was a total of 35,421 housing units in the county in 2020. Of these housing units, there are an estimated 32,558 households within the county, with an average size of 2.81 persons. The estimated owner-occupied housing rate of Calvert County is 84.7%.

Land Use, Cover, and Development

Calvert County has a wide range of land cover and land use. The county is broken down into different land cover types. The county has a large amount of forested land, and this land is located primarily in the central and southern areas of the county. This forested land also includes state parks and natural areas. The most prominent state park in Calvert County is the Calvert Cliffs State Park, located near Lusby. Other, smaller parks in Calvert County that are forested include the Dunkirk District Park, Flag Ponds Nature Park, Hallowing Point Park, Jefferson Patterson Park, Ward Farm Park and Kings Landing Park. Forested areas make up approximately 45.6% of the county's land area.

There are also two land trusts located in Calvert County, and these include the American Chestnut Land Trust and the Cove Point Natural Heritage Trust.

Wetlands are also a prominent land cover in Calvert County, Maryland. Wetlands make up approximately 2% of the land area in Calvert County, but do provide a large amount of environmental benefits and natural resource protection. A prominent example of a wetland in

Calvert County is the Battle Creek Cypress Swamp Sanctuary. The sanctuary is a large area of cypress swamp and was designated a national natural landmark in 1965.

Development in Calvert County is heaviest in the northeastern and southern portions of the county. Residential areas, including the incorporated municipalities and the Town Centers, make up 33.6% of the total land area in Calvert County. Low density residential land has the largest percentage based on the information provided. Industrial land makes up less than 1% of the total land areas and institutional land accounts for 1.2% of the land area. Development from 2018 to 2023 has occurred around the Town Centers and communities in Calvert County. The Calvert County Comprehensive Plan outlines that development in Calvert is "concentrated in existing population and business centers, growth areas adjacent to these centers, or strategically selected new centers". (Calvert County Comprehensive Plan, 2022) This focuses on growth in the two incorporated municipalities and seven Town Centers. Future development will continue to be focused in these areas of Calvert County, but development could occur in more areas.

Farming

Calvert County is home to a large number of farms that account for the vast cropland, pastures, or grasses throughout the county. As of the 2017 United States Department of Agriculture (USDA) National Agricultural Statistics Service (NASS), Calvert County has approximately 280 farms with approximately 25,152 acres of land in those farms. The average size of a farm in Calvert County is 90 acres. Calvert County does not represent a statistically measurable percentage of the State of Maryland's agricultural sales. Approximately 50% of the farms in Calvert County are cropland, 34% are woodland, 8% is pastureland, and 7% is other use. Calvert County farms are split by shares of sales by type with 90% of sales related to crops and the remaining 10% related to livestock, poultry, and other products.

Table 3 – Calvert County Farms by Size illustrates the number of farms and their respective size, including the percentage of the total for each value. There are certain farms percentages that also point to what kind of farms are located in Calvert County. Approximately 97% of the farms in Calvert County are family farms and are family owned. Additionally, 18% of the farms in Calvert County hire farm labor, and 10% of the total farms in the county sell directly to consumers.

Table 4 – Livestock Inventory in Calvert County illustrates the approximate number of each type of livestock within the farms of Calvert County. Layer poultry make up the largest number of livestock within the county, followed by cattle and calves. Pullets were the least populous of livestock within the county with a total of only 38 as of the 2017 data, the most recent data to be released. This information can be used to determine the environmental impacts on farms from flooding, flash flooding, and potential tidal flooding.

The data in this section is based on the 2017 United States Department of Agriculture (USDA) National Agricultural Statistics Service publications, which are released every five years. This

data is set to be updated and distributed on February 13, 2024. This data was delayed due to the COVID-19 pandemic from 2019 to 2022.

Table 3 - Calvert County Farms by Size

Calvert County Farms by Size		
Farm Size (Acres)	**Number of Farms**	**Percent Total**
1 to 9	83	30%
10 to 49	105	38%
50 to 179	64	23%
180 to 499	18	6%
500 to 999	6	2%
1000+	4	1%
Source: USDA, NASS, 2017		

Table 4 - Livestock Inventory in Calvert County

Calvert County Livestock Inventory	
Type of Livestock:	**Count of Livestock:**
Broilers and other meat-type chickens	670
Cattle and calves	1,217
Goats	595
Hogs and pigs	112
Horses and ponies	412
Layers	1,556
Pullets	38
Sheep and lambs	193
Turkeys	43
Source: USDA, NASS, 2017	

Figure 1 - Calvert County Basemap

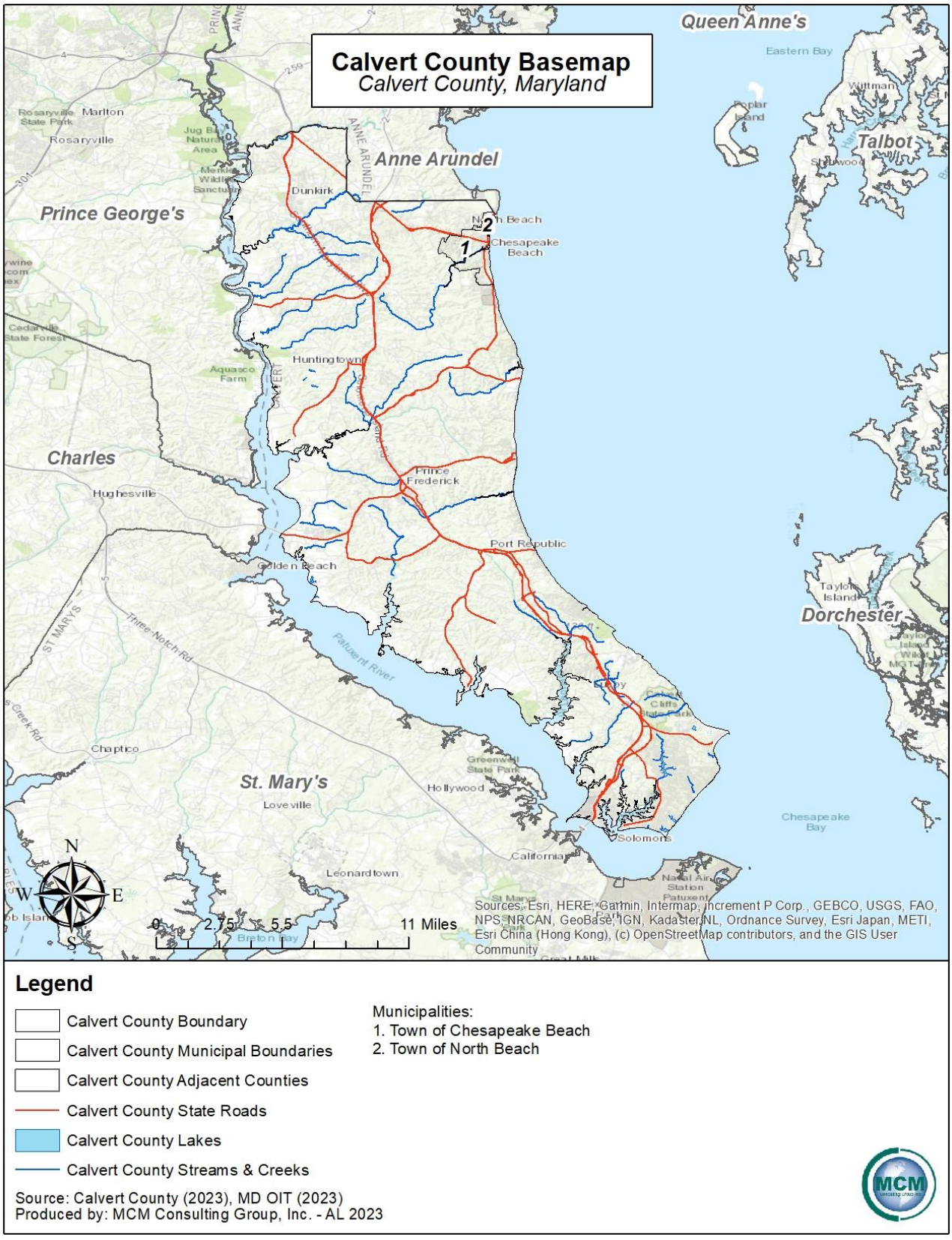


Figure 2 - Calvert County Population Density

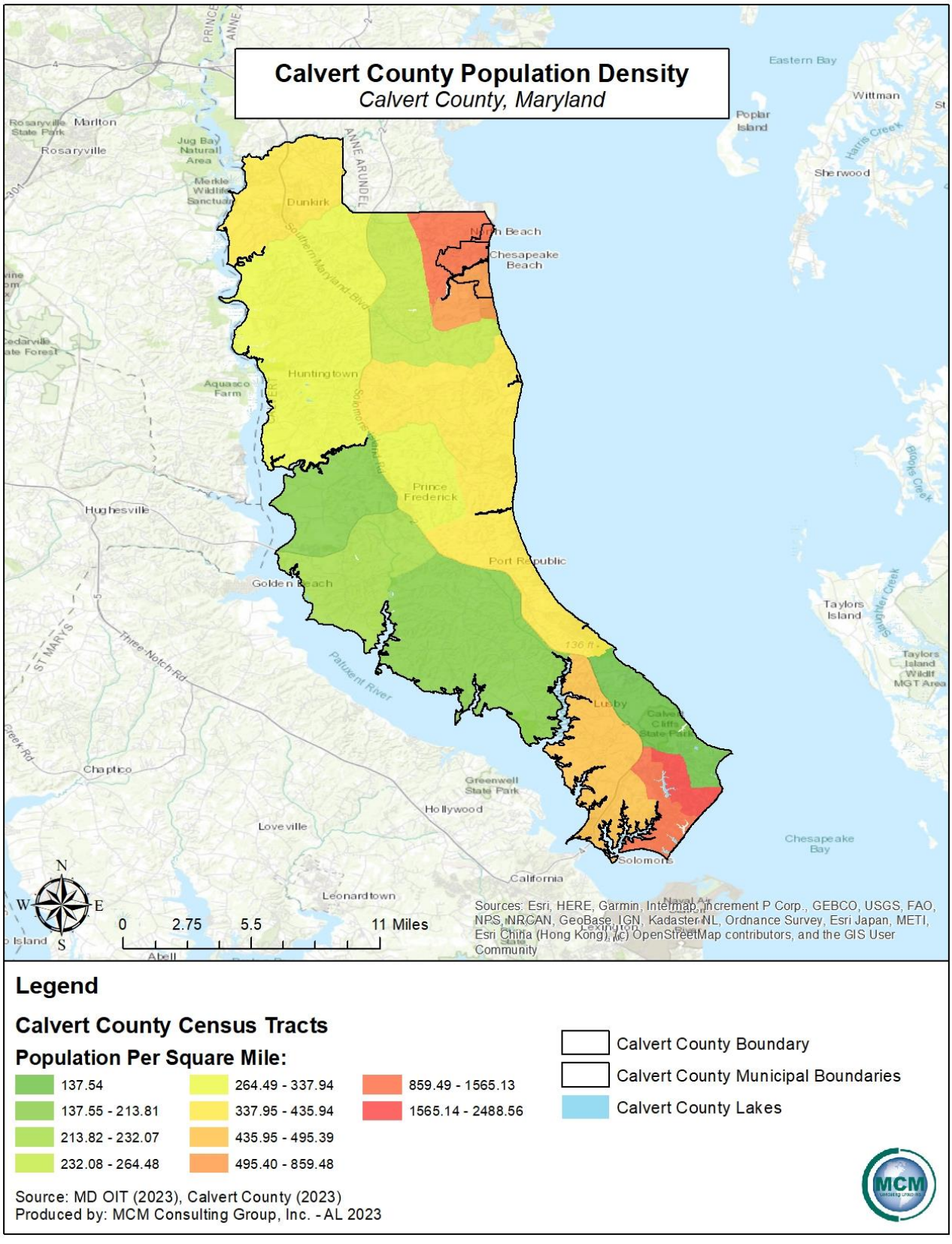
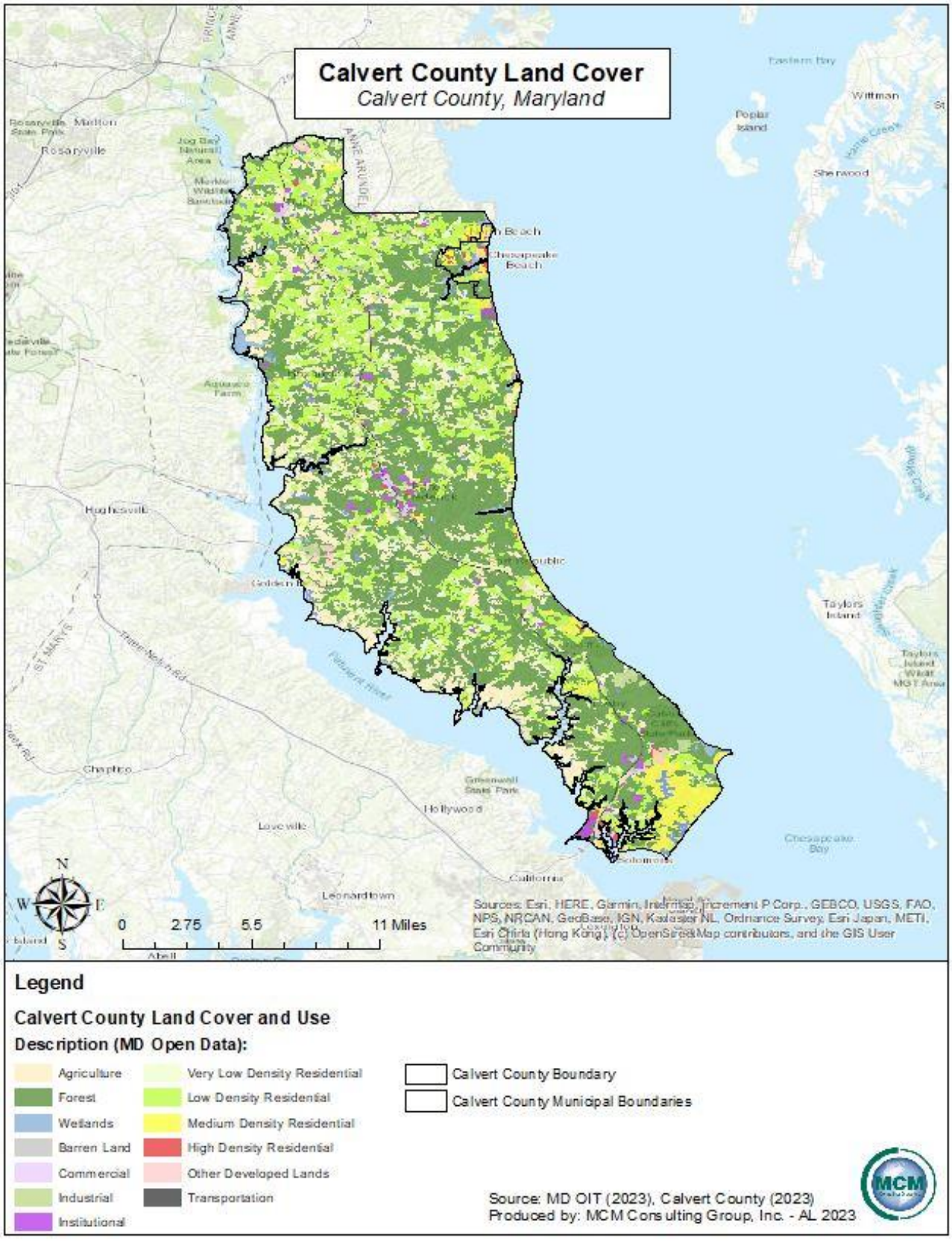


Figure 3 - Calvert County Land Cover



Section 2: Risk Assessment and Vulnerability Assessment

Risk Assessment – Past Flooding Occurrences

Flooding Events:

Calvert County, Maryland has experienced numerous flooding, flash flooding, tidal flooding, or nuisance flooding events. The flooding and flash flooding were caused by a variety of heavy storms, tropical storms, weather depressions, or significant volume rain events. A summary of past flooding and flash flooding historical events for Calvert County from January 1996 to December of 2023 is found in *Table 5 – Calvert County Past Flood Occurrences* and *Table 6 – Calvert County Past Flash Flood Occurrences*. Details for each event can be found in NOAA's National Center for Environmental Information (NCEI) database. Local past occurrences of flooding and flash flooding were solicited from the public during local meetings.

Table 5 - Calvert County Past Flood Occurrences

Calvert County Past Flood Occurrences			
Location	**Date**	**Event Type**	**Property Damage***
Along Chesapeake Bay	09/06/1996	Storm Surge Flood	$750,000.00
Coastal Zone	10/08/1996	Flood	$10,000.00
Calvert County	01/14/2005	Flood	$0.00
Long Beach	05/12/2008	Flood	$0.00
Lower Marlboro	09/09/2011	Flood	$0.00
Owings	09/09/2011	Flood	$0.00
Randle Cliff Beach	05/02/2016	Flood	$0.00
North Beach	05/02/2016	Flood	$0.00
North Beach	07/01/2016	Flood	$5,000.00
Bowens	05/27/2018	Flood	$0.00
Prince Frederick	05/27/2018	Flood	$0.00
Sunderland	07/22/2018	Flood	$0.00
Chaneyville	07/22/2018	Flood	$0.00
Randle Cliff Beach	07/22/2018	Flood	$0.00
Bowens	07/22/2018	Flood	$0.00
Huntingtown	07/22/2018	Flood	$0.00
Dunkirk	07/22/2018	Flood	$0.00
Barstow	08/11/2018	Flood	$0.00
Prince Frederick	10/11/2018	Flood	$0.00
Chaneyville	10/11/2018	Flood	$0.00
Randle Cliff Beach	07/31/2019	Flood	$0.00
Chaneyville	08/04/2020	Flood	$0.00
Port Republic	08/04/2020	Flood	$0.00
Prince Frederick	08/04/2020	Flood	$0.00
Stoakley	08/04/2020	Flood	$0.00
Chesapeake Ranch Est	07/09/2021	Flood	$0.00
Dares Beach	08/20/2021	Flood	$0.00
Mt Harmony	05/22/2022	Flood	$0.00

Calvert County Past Flood Occurrences			
Location	**Date**	**Event Type**	**Property Damage***
		Total:	$765,000.00
Source: NWS NCEI, 2023 *Property damage dollar estimates are pulled directly from the NWS NCEI for Calvert County. They should not be considered authoritative.			

Table 6 - Calvert County Past Flash Flood Occurrences

Calvert County Past Flash Flood Occurrences			
Location	**Date**	**Event Type**	**Property Damage***
Prince Frederick	06/20/1996	Flash Flood	$0.00
Countywide	01/28/1998	Flash Flood	$5,000.00
Countywide	02/04-05/1998	Flash Flood	$230,000.00
Countywide	09/16/1999	Flash Flood	$500,000.00
Countywide	07/26/2000	Flash Flood	$0.00
Chesapeake Beach	06/26/2006	Flash Flood	$0.00
North Beach	08/22/2009	Flash Flood	$0.00
Owings	08/22/2009	Flash Flood	$0.00
North Beach	09/30/2010	Flash Flood	$0.00
Appeal	09/30/2010	Flash Flood	$0.00
Stoakley	09/30/2010	Flash Flood	$0.00
Randle Cliff Beach	09/08/2011	Flash Flood	$0.00
North Beach	09/08/2011	Flash Flood	$0.00
Appeal	08/26/2012	Flash Flood	$0.00
North Beach	06/18/2013	Flash Flood	$0.00
Lower Marlboro	06/18/2013	Flash Flood	$0.00
Solomons	06/30/2013	Flash Flood	$0.00
North Beach	05/29/2016	Flash Flood	$0.00
Appeal	07/06/2017	Flash Flood	$0.00
Dares Beach	08/14/2021	Flash Flood	$0.00
		Total:	$735,000.00
Source: NWS NCEI, 2023 *Property damage dollar estimates are pulled directly from the NWS NCEI for Calvert County. They should not be considered authoritative.			

Areas of Past Flooding Concern:

There are large portions of Calvert County that see varying degrees of flooding, flash flooding, tidal flooding, or nuisance flooding every year. The Calvert County local planning team and the public from Calvert County have outlined areas of past flooding concern within the county that have significant impact on life safety, property damage, and economic impact. These areas include but are not limited to the following areas:

- Breezy Point
- Neeld Estates

- Broomes Island
- Cove Point
- Solomons Island
- Areas of Calvert County adjacent to cliffs along the bayside

Areas of past flooding concern were also solicited from the public of Calvert County during two public meetings. These meetings were held on December 13th, 2023, and January 18th, 2024. The areas of public concern matched the areas of concern that were presented by the Calvert County local planning team for this process. Specifically, the public was concerned about areas surrounding Cove Point, Solomons Island, Broomes Island and Breezy Point.

Neeld Estates, located near Breezy Point, was an area of specific concern for both the public and the local planning team. Neeld Estates sits near the eastern edge of Calvert County over the Chesapeake Bay. Residents of Neeld Estates fostered discussion during the December 13th, 2023, and January 18th, 2024, public meetings concerning localized road and yard flooding issues, as well as septic issues. Many of the residents in Neeld Estates are reliant on septic fields, and the exposure of septic tanks and septic fields are of particular concern. Ground sinking was also identified as a significant issue during the public meetings and was noted as an area of concern. Specific areas around Neeld Estates that are of particular concern include the Bay Boulevard, Beach Drive, and Ridge Road. Localized flooding occurs in the general area on a regular basis, and these issues are not limited to one specific street or household. During the January 18th, 2024, public meeting, residents of Neeld Estates stated that Beach Drive flooded four times in 2023. Also, Bay Boulevard at Neeld Estates has seen septic fields and ground sinking by up to one foot. This presents a particular area of concern in Neeld Estates. This is also adjacent to Plum Point.

Cove Point concerns were discussed during the public meetings, including beach accretion in the area. Specific pipe blockage with sand and beach deposits were discussed in detail, and those concerns will be addressed in potential inspections in the problem areas. These inspections are performed based on customer service requests. The areas of Cove Point identified as an issue for this item includes areas around Beacon Court.

Areas that are prone to flooding can be seen in *Figure 4 – Calvert County Flood Prone Areas*. The data was provided by the Calvert County GIS Department in the Calvert County Office of Technology. The data is symbolized based on point type and those point types are beach, bridge, community, and road. Within that data, there are eight points that are considered community points, five points that are classified as beach points, seventeen bridge points, and thirty-five road points. All of these locations that were provided by the county are evenly distributed around the county, and a significant number of these points match areas of public concern for flooding, flash flooding, and tidal flooding.

Calvert County and the local jurisdictions utilize MyCoast, a flooding community science app and website, to document coastlines and coastal or tidal flooding events that can impact a

municipality, local area, or jurisdiction. MyCoast partners with other agencies in the United States including the United States Geological Survey (USGS), the National Oceanic and Atmospheric Administration (NOAA), and the National Weather Service (NWS). Local citizens are able to register for MyCoast and then submit flooding reports for coastal flooding and tidal flooding. Those reports are collated and presented with information on potential damage and imagery from those events. There are three major tools that are able to be used on the MyCoast website. Those tools are the high-tide flooding tool, the storm reporter tool, and the coastal damage tool. The sorting of events is based on user provided data and what information is available at the time of reporting. As part of this flood mitigation plan process, the public was encouraged to submit events in their jurisdiction to MyCoast during the December and January meetings. For Calvert County, there were a total of 141 reports submitted for the county in MyCoast. Those events were then collected and are presented in the table below. This table (*Table 7 – MyCoast Reports for Calvert County (10/23 to 02/24)*) presents information from MyCoast.

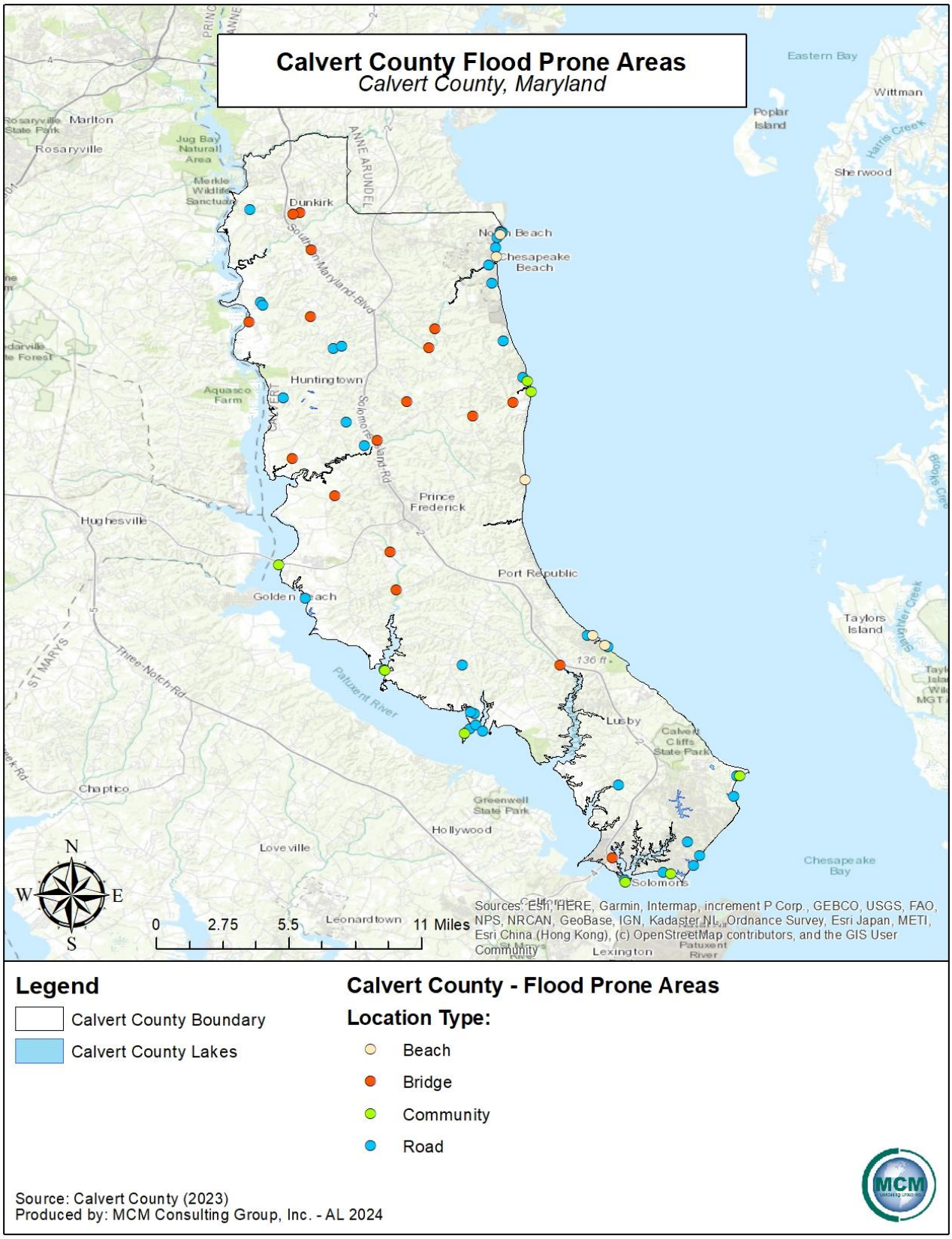
Table 7 - MyCoast Reports for Calvert County (10/23 to 02/24)

MyCoast Reports for Calvert County, Maryland (10/23 to 02/24)			
Date	**Infrastructure Impacts/Damage**	**Location**	**Type**
10/12/2023	N/A*	Neeld Estates	Tidal
11/22/2023	Erosion (Moderate)*	Beach Drive	Coastal
12/11/2023	No Damage Reported*	Beacon Way	Coastal
12/18/2023	No Damage Reported*	Beach Drive	Coastal
12/18/2023	No Damage Reported*	Bayside Boulevard	Coastal
12/28/2023	N/A*	Calvert Avenue	Tidal
01/08/2024	N/A*	Solomons Island	Tidal
01/09/2024	Street/Road (Impassable)*	Bay Boulevard	Coastal
01/09/2024	N/A*	Neeld Estates	Tidal
01/09/2024	N/A*	Neeld Estates	Tidal
01/09/2024	N/A*	Neeld Estates	Tidal
01/09/2024	N/A*	Neeld Estates	Tidal
01/09/2024	N/A*	North Beach	Tidal
01/09/2024	N/A*	North Beach	Tidal
01/09/2024	N/A*	North Beach	Tidal
01/09/2024	N/A*	Broomes Island Road	Tidal
01/10/2024	No Damage Reported*	Broomes Island Road	Coastal
01/10/2024	No Damage Reported*	Broomes Island Road	Coastal
01/10/2024	No Damage Reported*	Lighthouse Boulevard	Coastal
01/10/2024	N/A*	Flag Ponds Parkway	Tidal
01/10/2024	N/A*	Flag Ponds Parkway	Tidal
01/10/2024	N/A*	Duncans Pond	Tidal
01/10/2024	N/A*	Neeld Estates	Tidal
01/10/2024	N/A*	Neeld Estates	Tidal

MyCoast Reports for Calvert County, Maryland (10/23 to 02/24)			
Date	**Infrastructure Impacts/Damage**	**Location**	**Type**
01/10/2024	N/A*	Neeld Estates	Tidal
01/10/2024	N/A*	Chesapeake Beach	Tidal
01/10/2024	N/A*	Chesapeake Beach	Tidal
01/11/2024	N/A*	Solomons Island	Tidal
Source: MyCoast, 2024 Note: * Denotes flooding is present in the images attached to event.			

Information from MyCoast is also used by the Maryland Department of Natural Resources to review areas of flooding concern in each county in Maryland. Recommendations for future integration can be found below, in the recommendations section of this flood study and mitigation plan for Calvert County, Maryland.

Figure 4 - Calvert County Flood Prone Areas



Average Historic Precipitation Statistics for Calvert County:

The National Weather Service and the National Oceanic and Atmospheric Administration publishes large amounts of open-source precipitation data for Calvert County over the past twenty-four years. As seen in the table below, 2018 was the wettest year on record with a yearly average of 63.46 inches of rainfall. June is the wettest month on record for the period from 2000 to 2023, with an average rainfall of 4.89 inches. August is the second wettest month of the twenty-four-year period with an average rainfall of 4.88. The years 2002, 2003, 2004, 2005, 2006, 2008, 2009, 2010, 2012, 2013, 2015, 2016, 2017, 2018, 2020, 2022, and 2023 have had months on record with over 6 inches of precipitation.

The rainfall data presented in *Table 8 – Calvert County Rainfall Data (Average Rainfall Per Month)* below is based on information collected from the National Weather Service for the local areas near Calvert County. The records for the weather gauges in Solomons, Maryland were not complete, so information from neighboring Patuxent River was used to supplement the information. Information in the table below, highlighted light blue, was from the Solomons, Maryland weather gauge. The Solomons, Maryland weather gauge had a high proportion of information listed as missing. Data in this report runs through December of 2023, and does not include information for 2024.

Based on Calvert County's climate, it is understood that the late spring and early summer months will have the most rainfall as thunderstorms move across the region based on local weather patterns. The winter months and early spring tend to have precipitation in the form of snow or ice, because of the colder temperatures associated with the climate in the northern hemisphere.

Table 8 - Calvert County Rainfall Data (Average Rainfall Per Month)

Calvert County Annual Precipitation													
Year	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Yearly Average**
2000	M	M	M	M	M	M	M	M	M	0.64	M	M	
2001	1.98	2.3	3.98	1.97	3.75	4.37	4.89	4.85	1.61	0.81	0.22	2.93	
2002	2.8	0.83	5.31	3.1	1.92	2.26	2	2.99	3.52	7.41	5.25	4.33	
2003	1.63	6.42	4.02	3.35	7.55	4.56	5.63	6.26	8.36	3.99	5.16	M	
2004	2.65	M	1.72	7.23	2.88	4.35	11.2	8.78	4.92	0.82	5.58	2.65	

Calvert County Annual Precipitation													
Year	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Yearly Average**
2005	1.46	2.35	4.56	4.11	4.53	2.91	5.97	5.95	0.84	8.24	3.76	3.8	**4.04**
2006	M	0.84	0.03	M	1.69	13.43	1.62	1.49	8.38	5.5	4.13	1.39	**3.85**
2007	2.62	1.86	1.7	3.45	1.59	3.9	0.79	3.19	0.79	4.46	1.13	3.87	**2.45**
2008	1.47	2.57	2.45	2.93	5.63	9.34	4.25	3.29	3.08	1.05	3.96	3.78	**3.65**
2009	1.85	0.40	2.52	3.25	4.6	5.05	1.76	4.94	4.16	8.03	7.84	7.16	**4.30**
2010	M	2.66	5.17	2.33	1.86	1.87	2.07	3.69	14.47	4.24	1.39	1.95	**3.79**
2011	1.71	1.81	5.94	3.46	3.41	8.00	4.02	11.4	5.11	2.32	3.30	2.69	**4.43**
2012	1.39	2.05	3.13	3.47	2.61	1.39	1.98	7.52	3.81	10.3	0.57	4.14	**3.53**
2013	3.64	1.70	3.25	4.50	2.59	7.12	8.11	3.94	1.15	4.63	2.86	5.43	**4.08**
2014	2.93	3.83	2.82	4.32	4.68	2	3.65	2.51	2.41	2.67	2.92	3.35	**3.17**
2015	4.41	2.29	2.72	4.96	1.91	11.6	3.90	3.54	2.49	3.08	4.05	4.10	**4.09**
2016	1.38	3.85	1.41	2.17	5.77	2.89	3.30	2.36	8.45	4	0.48	2.54	**3.22**
2017	2.25	1.27	4.46	1.82	4.78	2.4	7.2	3.64	M	3.49	1.97	0.64	**3.08**
2018	3.04	4.13	2.98	3.5	8.72	3.28	7.6	4.17	6.6	6.6	8.33	4.51	**5.29**
2019	2.05	4.45	2.91	3.62	3.47	4.65	5.57	2.69	0.26	4.50	1.39	M	**3.23**
2020	2.67	3.67	2.76	3.59	2.62	5.70	3.67	13.4	5.78	M	6.05	6.6	**5.14**

Calvert County Annual Precipitation													
Year	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Yearly Average**
2021	2.28	4.06	4.08	3.21	3.48	5.37	M	7	1.91	2.79	0.43	0.93	**3.23**
2022	3.50	1.02	4.60	2.44	6.66	3.71	7.91	1.65	2.83	4.55	2.8	5.67	**3.95**
2023	1.81	2.85	0.90	6.63	1.6	2.38	4.8	2.79	4.57	1.41	2.72	M	**2.95**
Monthly Average	**2.36**	**2.60**	**3.19**	**3.61**	**3.84**	**4.89**	**4.63**	**4.88**	**4.34**	**4.15**	**3.32**	**3.62**	
Note: M: Data is missing. This could be the result of data not meeting a quality check, equipment failures, or observer was not present at a manual station. (NCEI, Storm Events Database, 2023).													

The following *Figure 5 – Total Average Rainfall for Calvert County (2000 – 2023)* illustrates the total average amount of rainfall for each year from 2000 through 2023. The calendar year 2018 continues to have the highest amount of rainfall when viewed from this perspective as well. The year 2003 had the next highest total for average rainfall after 2018. The year 2017 can be viewed as the year with the least amount of precipitation in the form of rain. The year 2000 has incomplete records and cannot be considered a valid record for analysis.

Monthly rainfall averages can also be examined to complete a more holistic view of rainfall data for Calvert County. Data for each month from January to December, from 2000 to 2023, was compiled and then an average value was calculated from those values. This data can be seen in *Figure 6 – Monthly Rainfall Average (Compiled 2000 – 2023)*. This data shows that January has the lowest monthly average for rainfall data with an average of 2.36 inches of rain based on the twenty-four occurrences of rainfall in January. As seen above in other analysis of rainfall data, June is the wettest month when the monthly average is examined. June's monthly rainfall average from 2000 to 2023 was 4.89 inches of rain. This is followed by August, with 4.88 inches of rain for a monthly average, and then July, with a total of 4.63 inches of rain for a monthly average.

Figure 5 - Total Average Rainfall for Calvert County (2000 – 2023)

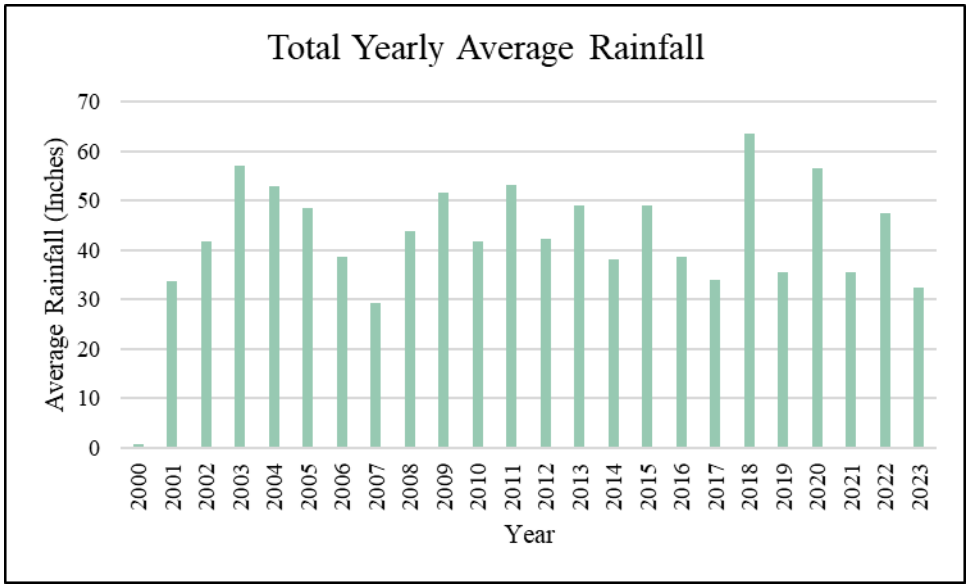
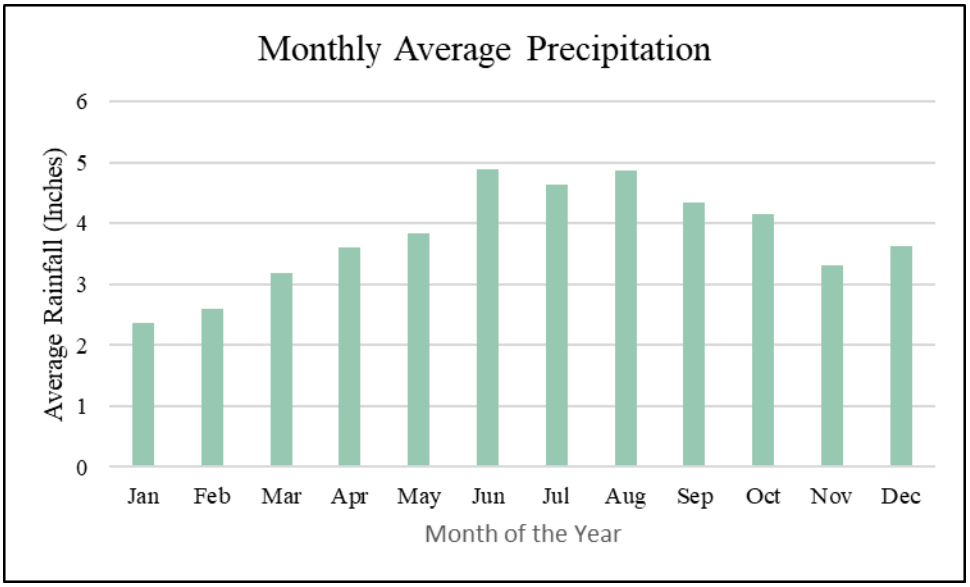


Figure 6 - Monthly Rainfall Average (Compiled 2000 - 2023)



Risk Assessment - Dam and Levee Failure Impacts

Dams

A dam restricts the flow of water or underground streams and often creates reservoirs for water storage. The reservoirs created by these barriers not only suppress floods but also provide water for activities such as irrigation, human consumption, industrial use aquaculture, and navigability.

Dam failures occur usually as a secondary effect of massive amounts of rainfall and flooding, causing too much water to enter the spillway system. This type of failure occurs with little to no warning. Spring thaws, severe thunderstorms, and rainfall are also contributing factors to potential dam failures. Depending on the size of the body of water where the dam is constructed, additional water may come from distant upstream locations. Water contributions may also come from dam failures in adjoining counties that are along the same riverine or water features.

FEMA considers the following to be the most frequent causes of dam failures:

- Overtopping caused by floods that exceed the capacity of the dam
- Deliberate acts of sabotage
- Structural failure of materials used in dam construction
- Movement and/or failure of foundation supporting the dam
- Settlement and cracking of concrete or embankment dams
- Piping and internal erosion of soil in embankment dams
- Inadequate maintenance and upkeep

Poor engineering or poor maintenance may also cause dam failure. The Maryland Department of the Environment (MDE) issues permits for dams after technical reviews. The local dam owners are primarily responsible in the State of Maryland for inspections. Inspection results are characterized as either safe or unsafe.

The National Inventory of Dams (NID) is a registry that captures information about structures that are greater than or equal to 25 feet in height or impound 50-acre-feet or more of water (an acre-foot is equal to 325,851 gallons of water); it includes structures above 6 feet in height where failure would potentially cause damage downstream. The dams are classified in terms of hazard potential as “high”, “significant”, or “low”, with high-hazard and significant hazard dams requiring emergency action plans (EAPS). There are two high-hazard dams and six low-hazard dams in Calvert County that are either publicly and privately owned and have been reported to the Maryland Department of the Environment. There are also ten dams with a hazard classification of significant-hazard. The State of Maryland also lists small ponds in the inventory of dams in Calvert County that are also possible to cause a hazard if certain events and changes occur. Those municipalities or Town Centers not listed do not have high-hazard dams. *Table 9 – Calvert County Dam Inventory* illustrates the dams located in Calvert County.

Table 9 - Calvert County Dam Inventory

Calvert County Dams							
Dam Name	**River**	**Owner Name**	**Year Completed**	**Dam Height (feet)**	**Drainage Area (acres)**	**Hazard**	**EAP**
Calvert Gateway	Hall Creek	Village Ltd Partnership	2000	16	25.6	Significant	Yes
Chesapeake Ranch Estates Dam	Mill Creek	Chesapeake Ranch Estates	1965	46	1856	High	Yes
Cove Point LNG Main Dam	Wilbur Creek	BHE GT&S A Berkshire Hathaway Energy Company	1974	74	128	Significant	Yes
Cove Point LNG Secondary Dam	Wilbur Creek	BHE GT&S A Berkshire Hathaway Energy Company	1974	38	128	Significant	Yes
Ferry Landing Woods Pond	Patuxent River	Ferry Landing Woods Civic Association	1981	22	128	Low	No
Lake Karylbrook Community Pond (Keren Drive)	Fishing Creek	Calvert County Department of Public Works	1990	30	160	Significant	Yes
Lake Ridge Community Pond Dam (Alta Drive)	Fishing Creek	Lake Ridge Homeowners Association, Inc	1969	28	192	Significant	Yes
Prince Frederick Wwtp Pond Two	Parker Creek	Calvert Department of Public Works	2002	65	64	Low	No
Queensberry Drive Playground Dam	Hunting Creek	Queensberry Community Association, Inc.	1981	28	172.8	Significant	Yes
Queensberry Drive Swim Pond	Hunting Creek	Queensberry Community Association, Inc.	2001	19	76.8	Significant	Yes

Calvert County Dams							
Dam Name	**River**	**Owner Name**	**Year Completed**	**Dam Height (feet)**	**Drainage Area (acres)**	**Hazard**	**EAP**
Running Hare Vineyard Lake	Battle Creek Cypress Swamp	Running Hare Vineyard	1970	20	320	Low	No
Shores of Calvert Lower Dam	Patuxent River	Shores of Calvert Assn	1972	15	64	Low	No
Shores of Calvert Upper Dam	Patuxent River	Shores of Calvert Assn	1972	25	211.2	Significant	Yes
Starkey Pond	Morsell Creek	Tom Starkey	1950	11	192	Low	No
Stoneleigh Community Pond	Cocktown Creek	Calvert County Department of Public Works	1978	24	64	Significant	Yes
Sunderland Railroad Embankment Pond	Fishing Creek	John Ireland	1850	25	128	Low	No
Twin Lakes Upper Pond	Cocktown Creek	Twin Lakes Community Association, Inc.	1970	15	38.4	Significant	Yes
Victoria Station Community Lake	Graham Creek	Victoria Station Homeowners Association	1986	27	192	High	Yes
Source: National Inventory of Dams, USACE, 2023							

Dam Failure Vulnerability

Property and populations located downstream from any dams are vulnerable to dam failures. Maryland hazard classification for dams follows similar methods as that of the Federal Emergency Management Agency (FEMA). Maryland classifies a dam as having either a high, low, or significant classification. The Code of Maryland Regulations (COMAR 26.17.04.05) breakdown by dam classification and number of dams in Maryland can be found in *Table 10 – Dam Classification*.

Table 10 - Dam Classification

Dam Classification				
Dam Size Classification				
Hazard Class	**Category**	**Description**	**Number of Dams in Maryland**	**Number of Dams in Calvert County**
High	I	Failure would likely result in loss of human life, extensive property damage to homes and other structures, or cause flooding of major highways such as State roads or interstates. High Hazard dams are referred to as "Category I" dams in the Code of Maryland Regulations (COMAR 26.17.04.05) and "Class C" ponds by the US Natural Resources Conservation Service (NRCS).	81	2
Significant	II	Failure could possibly result in loss of life or increase flood risks to roads and buildings, with no more than 2 hours impacted and less than six lives in jeopardy. These are referred to as "Category II" dams in COMAR and "Class B" by NRCS.	114	10
Low	III	Failure is unlikely to result in loss of life and only minor increase to existing flood levels at roads and buildings is expected. These structures are referred to as "Category III" dams in COMAR and "Class A" by NRCS.	240	6
Source: State of Maryland, Maryland Department of the Environment, COMAR 26.17.04.05				

Dam failures can cause significant environmental effects, as the resulting flood from a dam failure is likely to disperse debris and hazardous materials downstream that can damage local ecosystems. Debris carried downstream can block roads, cause traffic accidents, disrupt traffic patterns, and delay the delivery of essential services along major traffic corridors. Debris flow can also cause landslide along steep slopes and embankments with low slope stability. The economic and financial impact from damage and recovery ranges from minimal to severe, depending on the magnitude of damage the scale of failure event.

Emergency action plans are developed by the owners of high-hazard and significant hazard dams. These plans are then disseminated to first responders and other planning partners within the county. Vulnerable populations are those residents and businesses located downstream from a high-hazard dam within the inundation area. The emergency action plan identifies a call list to

notify downstream at-risk populations. Emergency action plan exercises are held based on state regulations.

The characteristics of the dams in Calvert County are different when compared with one another. The Shores of Calvert Upper Dam, located in Dunkirk, has the largest drainage area with a total of 211.1 acres. The dams that were constructed most recently are the Prince Frederick Wastewater Treatment Plan Pond Two, and the Queensbury Drive Swim Pond, located in Prince Frederick. They were constructed in 2002 and 2001, respectively. The dam that is the oldest in the county is the Sunderland Railroad Embankment Pond, which was constructed in 1850. The Cove Point Long Main Dam is the tallest in the county with a height of 74 feet. The Calvert County Department of Public Works owns the most dams in Calvert County with a total of three. These dams are the Lake Karylbrook Community Pond, the Prince Frederick Wastewater Pond Two, and the Stoneleigh Community Pond. The dams in Calvert County are owned by a mix of public and private owners and vary in almost every aspect. The county dams are distributed relatively evenly throughout the county and municipalities, with an even mixture of high and low hazard dams in the municipalities and Town Centers.

The characteristics of the two high-hazard dams in Calvert County vary greatly. The Victoria Station Community Lake Dam was constructed in 1986 and the Chesapeake Ranch Estates Dam was constructed in 1965. The Chesapeake Ranch Estates Dam is higher than the Victoria Station Community Lake Dam. The heights are 46 feet and 27 feet, respectively.

FEMA's Resilience Analysis and Planning Tool (RAPT) can be used to look at specific vulnerability information in relation to vulnerable populations around high-hazard dams. This tool can overlay areas of interest around certain features to determine what types of populations are within certain distances of those features. In the table below, a 2-mile distance was calculated around each high-hazard dam in Calvert County. Those locations were then used to determine how many people or households are vulnerable to a dam failure based strictly on distance. Some of the indicators used for this analysis were total population, households without vehicles, households with limited English, and housing units that are mobile homes. This information can be found in *Table 11 – Calvert County High-Hazard RAPT Data*.

Table 11 - Calvert County High-Hazard Dam RAPT Data

High-Hazard Dam Vulnerability Data				
Dam	**Total Population**	**Households without a vehicle**	**Households with limited English**	**Housing units that are mobile homes**
Chesapeake Ranch Estates Dam (Chisolm Trail)	14,201	337	38	86

High-Hazard Dam Vulnerability Data				
Dam	**Total Population**	**Households without a vehicle**	**Households with limited English**	**Housing units that are mobile homes**
Victoria Station Community Lake	4,010	173	4	8
Total	**18,211**	**510**	**42**	**94**
Source: RAPT, ACS, 2017-2021, Table B08201, Table S1602, and Table DP04				

An analysis was also conducted for high priority infrastructure within 2-miles of high-hazard dams in Calvert County. The information in the table below illustrates which infrastructure was located in that vulnerability zone. This information can be found in *Table 12 – Calvert County High-Hazard Dam RAPT Infrastructure Locations*.

Table 12 - Calvert County High-Hazard Dam RAPT Infrastructure Locations

High-Hazard Dam Vulnerability Data – Infrastructure				
Dam	**Hospitals**	**Nursing Homes**	**Fire Stations**	**Public Schools**
Chesapeake Ranch Estates Dam (Chisolm Trail)	0	2	1	4
Victoria Station Community Lake	0	1	0	4
Source: RAPT, Homeland Infrastructure Foundation-Level Data, 2024				

As seen in *Table 13 – Detailed Infrastructure from FEMA RAPT*, each high-hazard dam in Calvert County protects certain infrastructure that is within 2 miles. The table below outlines these locations in greater detail.

Table 13 - Detailed Infrastructure from FEMA RAPT

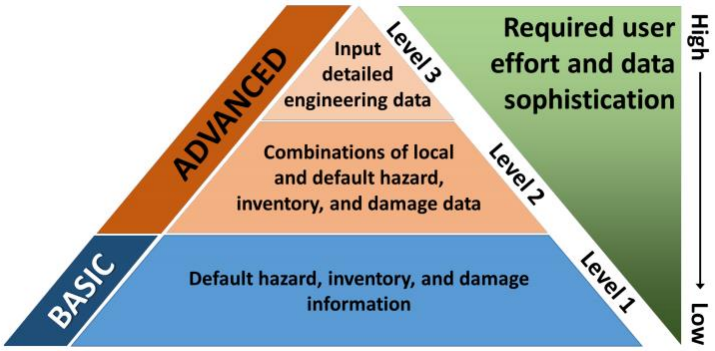
High-Hazard Dam Vulnerability Data – Infrastructure Names	
Dam	**Infrastructure Details**
Chesapeake Ranch Estates Dam (Chisolm Trail)	Two Nursing Homes: 1. Hermitage at St. John's Creek 2. Solomons Nursing and Rehab Center One Fire Station: 1. Solomons Volunteer Rescue Squad and Fire Department Four Public Schools: 1. Patuxent High School

High-Hazard Dam Vulnerability Data – Infrastructure Names	
Dam	**Infrastructure Details**
	2. Mill Creek Middle School 3. Patuxent Appeal Elementary School 4. Dowell Elementary School
Victoria Station Community Lake	One Nursing Home: 1. Caribbean Breeze Assisted Living III Four Public Schools: 1. Northern High School 2. Northern Middle School 3. Mount Harmony Elementary School 4. Sunderland Elementary School
Source: RAPT, Homeland Infrastructure Foundation-Level Data, 2024	

Risk Assessment - HAZUS Loss Estimations

An important part of any flood study is the loss estimation scenarios that can be run by FEMA's HAZUS-MH (Multi-Hazard) software. HAZUS-MH is a free software that was developed by FEMA to estimate the damage from specific hazard events including flooding, coastal storms/tsunamis, earthquakes, and hurricanes. HAZUS is built onto ESRI's ArcMap products and utilizes those GIS resources built into the program. The scenarios that are created and executed with HAZUS can be used to determine potential mitigation actions and the areas where these mitigation actions could take place. HAZUS has three different types of scenarios that can be seen in *Figure 7 – HAZUS Scenario Types*.

Figure 7 - HAZUS Scenario Types



As illustrated above, the three types of HAZUS scenarios are broken down into three categories based on the amount of user expertise and the time required to complete the scenario and subsequent processing effort. The most basic HAZUS scenario is a level one scenario, which incorporates default hazard data, default inventory features, and default damage information. A level one scenario most commonly utilizes standard digital elevation models (DEMs) that can be found at the United States Geological Survey web download page. There were no level one scenarios that were executed for the Calvert County Flood Study. A level two scenario is a combination of local depth grid data, which replaces the DEM data in a level one scenario, and can include local and default hazard data. All of the scenarios that were executed for the Calvert County Flood Study were level two scenarios.

Level two scenarios are the industry standard for hazard mitigation planning and were utilized in the hazard mitigation planning period for Calvert County in 2023. A level three scenario is the most detailed and the most time consuming of the HAZUS scenarios and is based on detailed engineering data that can be obtained from local sources. A level three scenario requires the highest level of user data and effort and is not standard practice for hazard mitigation planning due to time and feasibility constraints.

Each HAZUS scenario has the ability to generate multiple reports which are used to understand the impact of certain hazards events. The reports for the Calvert County Flood Study were

generally concerned with a flooding event with a 1% annual chance of occurrence. The majority of the useful information for loss estimations is found in the HAZUS Global Flood Risk Factor Report that can be generated from the HAZUS software after successful floodplain delineation. Five HAZUS scenarios were executed for Calvert County and the results of the loss estimation are listed below. The HAZUS scenario based on the entire county is listed first, and then each census tract scenario is listed.

Technical Information:

HAZUS needs approximately 7 GB worth of space on a computer in order to run and a version of ArcMap based on the version of HAZUS that is being used.

- HAZUS 4.2 utilizes ArcMap 10.5.1
- HAZUS 5.0 utilizes ArcMap 10.8.1

HAZUS also requires that a Spatial Analyst Extension be activated within the ArcMap software in order to perform processing required to analyze flooding hazards. All scenarios found within this document were performed using HAZUS 4.2.3.

Risk Assessment - Calvert County (Entire County) HAZUS Scenario

A level two HAZUS scenario was completed for the entire county, and the loss estimates concern the entire general building stock data for Calvert County. The entire study region for the entire county contains approximately 217 square miles and has approximately 2,965 census blocks based on the completed 2010 United States Census. Census information from 2020 was not included in the HAZUS software because of delays in that information being released caused by the COVID-19 pandemic. There were 34,304 buildings in the region that were used in the HAZUS scenario from the General Building Stock. Based on the Global Flood Risk Report generated for the HAZUS scenario, 108 buildings will be at least moderately damaged.

Losses for the entire county can be broken down into two major categories: economic loss figures and business interruption figures. The building losses are estimates for cost to repair or replace the damage caused to the building and its contents. The business interruption losses are losses associated with the inability to operate a business because of damage sustained during the flooding scenario. Economic loss figures, which can be seen in *Table 14 – Calvert County Building Economic Loss Figures*, illustrates the type and breakdown of economic loss from a 1% annual chance flood. *Table 15 – Calvert County Business Interruption Economic Loss Figures* illustrates the dollar amounts of business interruption for specific categories of businesses in Calvert County.

Table 14 - Calvert County Building Economic Loss Figures

HAZUS Building Economic Loss Figures					
	Residential	**Commercial**	**Industrial**	**Other**	**Total**
Building:	$25,030,000.00	$590,000.00	$200,000.00	$90,000.00	$25,910,000.00
Content:	$13,700,000.00	$1,930,000.00	$320,000.00	$760,000.00	$16,710,000.00
Inventory:	$0.00	$20,000.00	$30,000.00	$0.00	$50,000.00
Subtotal:	**$38,730,000.00**	**$2,540,000.00**	**$550,000.00**	**$850,000.00**	**$42,670,000.00**
Source: HAZUS, 2023					

Table 15 - Calvert County Business Interruption Economic Loss Figures

HAZUS Business Interruption Economic Loss Figures					
	Residential	**Commercial**	**Industrial**	**Other**	**Total**
Income:	$140,000.00	$4,380,000.00	$10,000.00	$690,000.00	$5,220,000.00
Relocation:	$10,690,000.00	$500,000.00	$0.00	$150,000.00	$11,340,000.00
Rental Income:	$3,270,000.00	$380,000.00	$0.00	$10,000.00	$3,660,000.00
Wage:	$340,000.00	$3,660,000.00	$10,000.00	$2,170,000.00	$6,180,000.00
Subtotal:	**$14,440,000.00**	**$8,920,000.00**	**$20,000.00**	**$3,020,000.00**	**$26,400,000.00**
Source: HAZUS, 2023					

Based on the level two scenario for the entirety of Calvert County, 38% of the estimated losses were related to business interruption of the region. Approximately 93.5% of the buildings in this scenario are associated with residential housing. This also accounts for 88.3% of the total building value in the scenario.

Table 16 – Expected Building Damage by Occupancy shows the potential structures by occupancy type that will be damaged by certain damage levels from the scenario. Residential building occupancy makes up a large majority of the damage to buildings. There are only five buildings with a residential occupancy to be listed between 41 and 50 in terms of damage level.

Table 16 - Expected Building Damage by Occupancy

Expected Building Damage by Occupancy						
Occupancy	**Damage Levels**					
	1 - 10	**11 - 20**	**21 - 30**	**31 - 40**	**41 - 50**	**>50**
	Count (%)	**Count (%)**	**Count (%)**	**Count (%)**	**Count (%)**	**Count (%)**
Agriculture	0	0	0	0	0	0
Commercial	0	0	0	0	0	0
Education	0	0	0	0	0	0
Government	0	0	0	0	0	0
Industrial	0	0	0	0	0	0
Religion	0	0	0	0	0	0
Residential	49 (31)	66 (42)	24 (15)	13 (8)	5 (3)	0
Total:	**49**	**66**	**24**	**13**	**5**	**0**
Source: HAZUS, 2023						

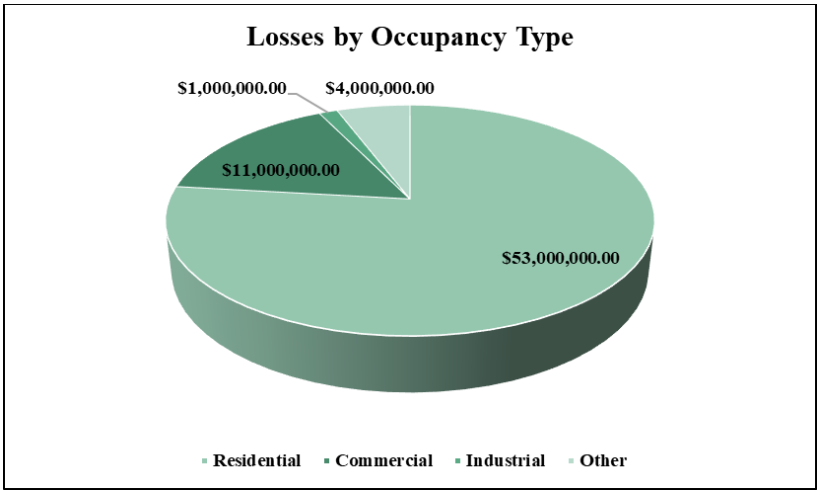
Table 17 – Building Exposure by Occupancy Type for the Calvert County illustrates the total amount of replacement value for different types of buildings within the study region for the level two scenario. *Figure 8 – Occupancy Type for the Calvert County* illustrates the information provided in the below table in pie graph format.

Table 17 - Building Exposure by Occupancy Type for Calvert County

Building Exposure by Occupancy Type for Study Region		
Occupancy	**Exposure***	**Percent Total**
Residential	$3,440,790.00	90.0%
Commercial	$236,246.00	6.2%
Industrial	$75,298.00	2.0%
Agricultural	$8,664.00	0.2%
Religion	$44,348.00	1.2%
Government	$3,693.00	0.1%
Education	$15,446.00	0.4%
Total:	$3,824,485.00	100%

Building Exposure by Occupancy Type for Study Region		
Occupancy	**Exposure***	**Percent Total**
Source: HAZUS, 2023 *Dollar figures are in thousands of dollars.		

Figure 8 - Loss by Occupancy Type for Calvert County



With the level two scenario, HAZUS also assesses the damage to essential facilities. *Table 18 – Expected Damage to Essential Facilities from HAZUS* illustrates these values based on infrastructure information that can be found in the FEMA General Building Stock. This table illustrates the total number of emergency operation centers, fire stations, hospitals, police stations, and schools that could be damaged by a 1% annual chance flood. Based on this scenario, no infrastructure locations will be moderately or substantially damaged from the recurrence interval. HAZUS also provides an estimate of the number of hospital beds in order to determine the impact of the scenario on the capability of hospitals to treat patients during the scenario. At the beginning of the scenario, Calvert County had an estimated seventy-six hospital beds and at the end of the scenario, all seventy-six of those hospital beds were available for use.

The building damage states are listed below:

- Slight Damage: Slight damage is when a building is damaged with a percentage of between 1-10%
- Moderate Damage: Moderate damage is when a building is damaged with a percentage of between 11-50%
- Substantial Damage: Substantial damage is when a building is damaged with a percentage of between 51-100%

All damage levels listed above are from the HAZUS Flood Technical Manual distributed by FEMA.

Table 18 - Expected Damage to Essential Facilities from HAZUS

Expected Damage to Essential Facilities				
Classification:	**Total Number:**	**At Least Moderate Damage:**	**At Least Substantial Damage:**	**Loss of Use:**
Emergency Operation Centers	1	0	0	0
Fire Stations	8	0	0	0
Hospitals	1	0	0	0
Police Stations	3	0	0	0
Schools	32	0	0	0
Source: HAZUS, 2023				

Table 19 – Utility System Dollar Exposure illustrates the economic dollar figure damage for utility lines. This data shows that the wastewater and electric power utility systems will be particularly vulnerable to the scenario.

Table 19 - Utility System Dollar Exposure

Utility System Dollar Exposure						
Facility Type	**Potable Water:**	**Wastewater:**	**Oil Systems:**	**Natural Gas:**	**Electric Power:**	**Communication:**
Facility Losses:	$0.00	$782,925.00	$0.00	$0.00	$957,213.00	$99.00
Pipeline Losses:	$0.00	$0.00	$0.00	$18,176.00	$0.00	$0.00
Total:	**$0.00**	**$782,925.00**	**$0.00**	**$18,176.00**	**$957,213.00**	**$99.00**
Values are in thousands of dollars. Source: HAZUS, 2023						

Figure 10 – Calvert County HAZUS Extent Map illustrates the scenario flood extent and the exposed essential facilities and structures within the study region. This map was generated using the HAZUS software, and gives a comprehensive view of which parts of the county were exposed to the flooding scenario. Areas outlined in red are the flooding scenario and areas in orange and yellow are highly populated areas. Unlike the level one scenario, the most basic, the level two uses depth grids instead of riverine reaches to execute its analysis. This can be seen in the map below, where, unlike in a level one scenario, all of the water bodies that could contribute to the flooding are cross hatched in red, meaning that they were used in the scenario.

HAZUS can also be utilized to determine the amount of debris that might occur from a given event and these estimates can be helpful in determining the potential environmental impacts from

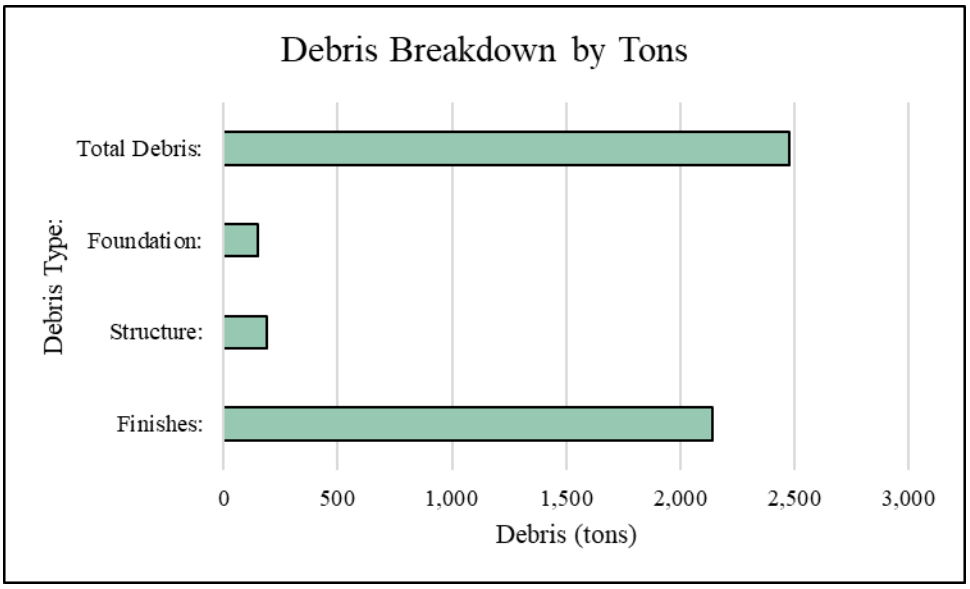
a scenario and the needed recovery in cleanup after a potential 1% annual chance flood. The HAZUS scenario that was completed for Calvert County broke down debris for the scenario into four categories: total debris, finishes, structure, and foundation. The values can be found in *Figure 9 – HAZUS Estimated Debris and Debris Breakdown*. Breakdown numbers are related in tons.

The debris breakdown categories are as follows, as defined by FEMA in the HAZUS reports:

- **Structure:** Structure materials include building materials used to construct a building and its framework including but not limited to wood, brick, etc.
- **Finishes:** Finishes are materials that are used in the internal construction and finishing of a building. These materials can include drywall and insulation.
- **Foundation:** Foundation materials are materials such as concrete, slab concrete, and rebar that are used in the construction of the foundation of a building or residence.

Please refer to the discussion above for all HAZUS debris breakdown graphs and analysis below.

Figure 9 - HAZUS Estimated Debris and Debris Breakdown



HAZUS provides an estimate of 100 trucks hauling debris at twenty-five tons per load to clean up the debris from this scenario. The following scenarios listed below illustrate debris generation on smaller scales for the different focus areas throughout the county.

HAZUS calculates certain values that relate to social impacts for Calvert County. HAZUS calculates the number of individuals who will either be seeking shelter from a 1% annual chance flood within the county; the total estimated number of persons seeking shelter for Calvert County is approximately fifty-five persons, and the total number of displaced persons is estimated to be 1,796 persons. Approximately 599 households could be displaced from the scenario.

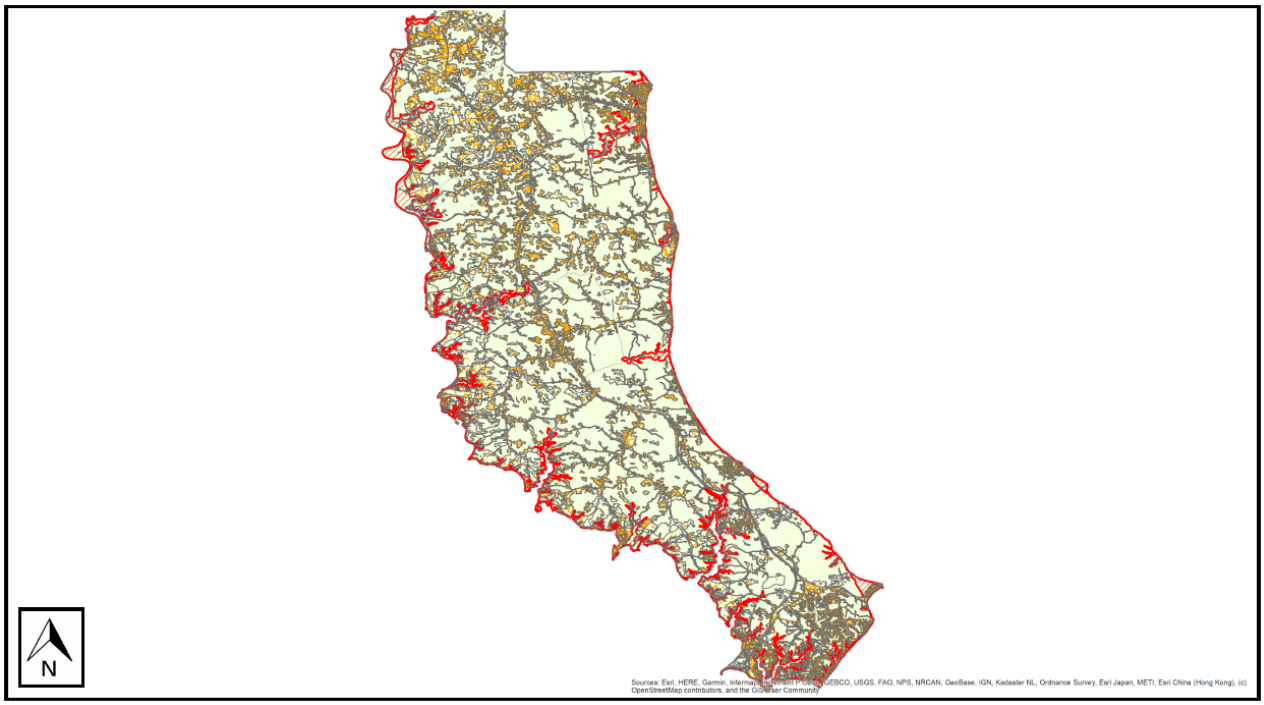
Finally, HAZUS can be used to determine the amount of economic loss concerning vehicles in Calvert County. *Table 20 – Economic Dollar Loss for Vehicle Exposure (Day)* illustrates the dollar amounts associated with three different vehicle types based on potential losses during daylight hours in Calvert County. These vehicle types are cars, light trucks, and heavy trucks.

Table 20 - Economic Dollar Loss for Vehicle Exposure (Day)

Economic Dollar Loss for Vehicle Exposure				
	Vehicle Type			
Dollar Loss:	**Cars:**	**Light Trucks:**	**Heavy Trucks:**	**Total:**
	$400,407,551.00	$277,655,145.00	$75,373,103.00	**$753,435,799.00**
Source: HAZUS, 2023				

As seen in the above table, the total economic loss associated with the scenario at the county level for vehicles during the day is over $753 million. That is a very high economic exposure value, especially when considered along with the replacement value for buildings and the business interruption that can occur with a 1% annual chance flood.

Figure 10 - Calvert County HAZUS Extent Map



Source: HAZUS, 2023

Risk Assessment - Calvert County (Census Tract 24009860502) HAZUS Scenario

A level two HAZUS scenario was completed for Calvert County, specifically census tract 24009860502 and the areas around Breezy Point and Neeld Estates based on generalized building stock information and localized depth grid information published for Calvert County by FEMA. Losses for census tract 24009860502 can be broken into two major categories: economic loss figures and business interruption figures. Economic loss figures, which can be seen in *Table 21 – Calvert County (Census Tract 24009860502) Building Economic Loss Figures,* illustrates the type and breakdown of economic loss from a 1% annual chance flood. *Table 22 – Calvert County (Census Tract 24009860502) Business Interruption Economic Loss Figures* illustrates the dollar amounts of business interruption for specific categories of businesses in the scenario region.

Table 21 - Calvert County (Census Tract 24009860502) Building Economic Loss Figures

HAZUS Building Economic Loss Figures					
	Residential	**Commercial**	**Industrial**	**Other**	**Total**
Building:	$2,830,000.00	$20,000.00	$20,000.00	$0.00	$2,870,000.00
Content:	$1,610,000.00	$100,000.00	$30,000.00	$0.00	$1,740,000.00
Inventory:	$0.00	$0.00	$0.00	$0.00	$0.00
Subtotal:	**$4,440,000.00**	**$120,000.00**	**$50,000.00**	**$0.00**	**$4,610,000.00**
Source: HAZUS, 2024					

Table 22 - Calvert County (Census Tract 24009860502) Business Interruption Economic Loss Figures

HAZUS Business Interruption Economic Loss Figures					
	Residential	**Commercial**	**Industrial**	**Other**	**Total**
Income:	$10,000.00	$270,000.00	$0.00	$0.00	$280,000.00
Relocation:	$1,330,000.00	$20,000.00	$0.00	$0.00	$1,350,000.00
Rental Income:	$390,000.00	$10,000.00	$0.00	$0.00	$400,000.00
Wage:	$30,000.00	$260,000.00	$0.00	$0.00	$290,000.00
Subtotal:	**$1,760,000.00**	**$560,000.00**	**$0.00**	**$0.00**	**$2,320,000.00**
Source: HAZUS, 2024					

Based on the level two scenario for census tract 24009860502 in Calvert County, 33% of the estimated losses were related to business interruption of the region. The total residential occupancies that made up the total losses was equivalent to approximately 89.44%. Approximately 96.14% of the buildings associated with the study region are related to residential housing.

With the level two scenario, HAZUS also assess the damage to essential facilities. There are no essential facilities that are expected to be significantly or moderately damaged by the scenario run for census tract 24009860502. Of the estimated 1,348 buildings in this study region,

approximately eleven buildings will be moderately damaged. No buildings will be completely damaged based on this scenario.

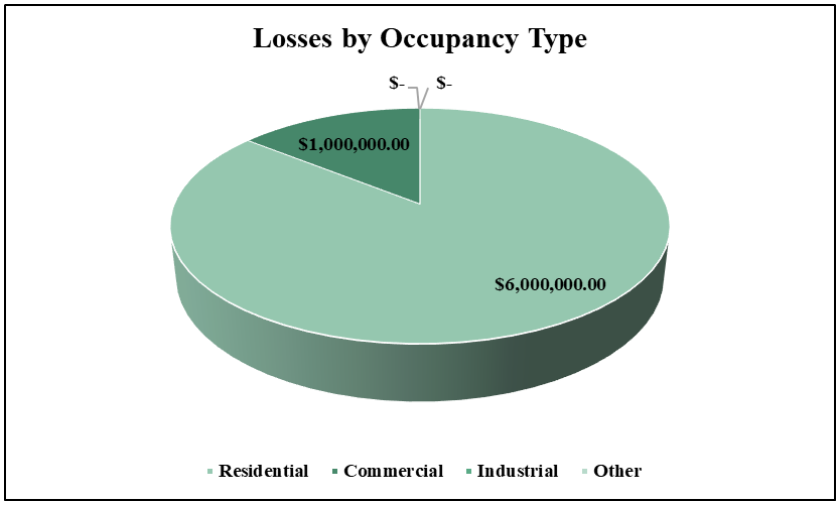
Table 23 – Building Exposure by Occupancy Type for the Study Region (Census Tract 240098690502) illustrates the total amount of replacement value for different types of buildings within the study region. *Figure 11 – Building Exposure by Occupancy Type for the Study Region (Census Tract 240098690502)* illustrates the occupancy type in pie graph form.

Table 23 - Building Exposure by Occupancy Type for the Study Region (Census Tract 240098690502)

Building Exposure by Occupancy Type for Study Region		
Occupancy	**Exposure***	**Percent Total**
Residential	$254,143.00	96.5%
Commercial	$7,611.00	2.9%
Industrial	$1,481.00	0.6%
Agricultural	$158.00	0.1%
Religion	$0.00	0%
Government	$0.00	0%
Education	$0.00	0%
Total:	$263,393.00	100%

Source: HAZUS, 2024
*Dollar figures are in thousands of dollars.

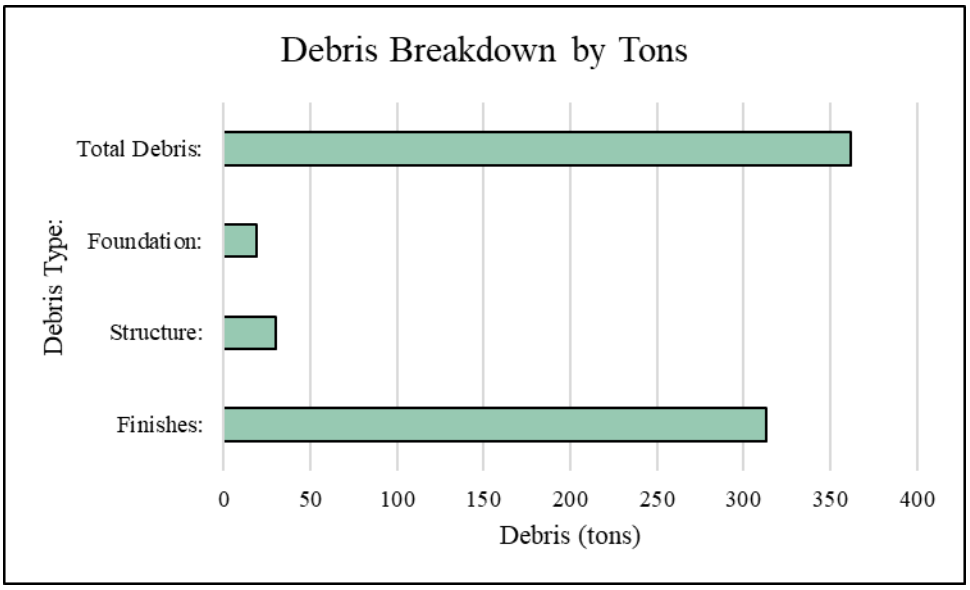
Figure 11 - Building Exposure by Occupancy Type for the Study Region (Census Tract 240098690502)



HAZUS also determines the amount of debris that might occur from a given event and these estimates can be helpful in determining the potential environmental impacts from a scenario and the needed effort in cleanup after a 1% annual chance flood. The HAZUS scenario that was completed for census tract 24009860502 broke down the debris that could be generated from the scenario into four categories: total debris, finishes, structures, and foundations. The values can be

found in *Figure 12 – HAZUS Estimated Debris and Debris Breakdown (Census Tract 24009860502)*. These breakdown numbers are related in tons of debris.

Figure 12 - HAZUS Estimated Debris and Debris Breakdown (Census Tract 24009860502)



A discussion on the attributes of debris breakdown categories can be found in the narration above in the section for the HAZUS scenario for the entire county. Of the total debris breakdowns, the following percentages for each category are listed below:

- Finishes: 86.46%
- Structure: 8.29%
- Foundation: 5.25%

HAZUS estimates that approximately fifteen trucks hauling debris at 25 tons per load would be required to clean up the debris generated from this level two scenario.

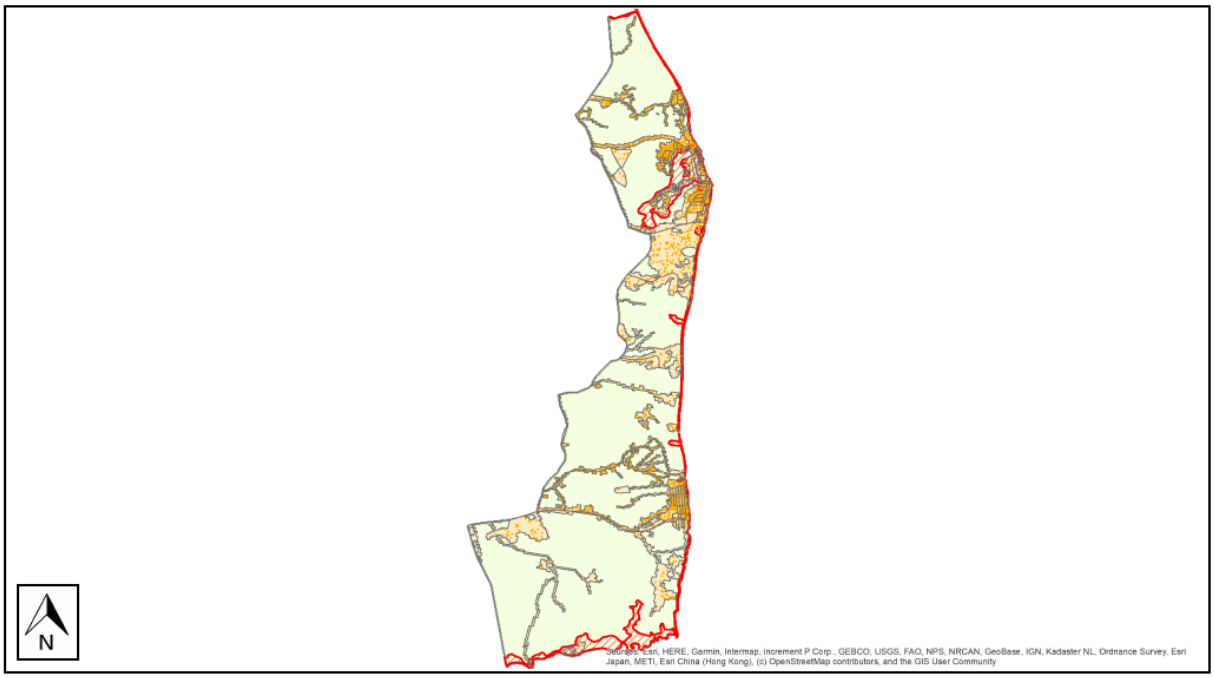
Direct economic loss figures for transportation in Calvert County illustrates the economic loss for transportation assets such as bridges, tunnels, and other transportation facilities. This breakdown for census tract 24009860502 can be found in *Table 24 – Direct Economic Loss for Transportation (Census Tract 24009860502)*. Values represented in the table below are in thousands of dollars. The data is broken down into seven categories, and these are highway, railway, light rail, bus, ports, ferries, and airports. For this census tract, highway damage is of primary concern.

Figure 13 – Calvert County (Census Tract 24009860502) HAZUS Extent illustrates the scenario flood extent and the exposed locations and structures within the region. This map was generated using the HAZUS software, and gives a comprehensive view of which parts of the county were exposed to the flooding scenario. Areas outlined in red are the flooding scenario and the areas in orange and yellow are highly populated areas.

Table 24 - Direct Economic Loss for Transportation (Census Tract 24009860502)

Direct Economic Loss for Transportation							
	Highway:	**Railway:**	**Light Rail:**	**Bus:**	**Ports:**	**Ferries:**	**Airport:**
Segments:	$115,696.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Bridges:	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Tunnels:	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Facilities:	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Source: HAZUS, 2024							

Figure 13 - Calvert County (Census Tract 24009860502) HAZUS Extent



Source: HAZUS, 2024

Risk Assessment - Calvert County (Census Tract 24009860900) HAZUS Scenario

A level two HAZUS scenario was completed for Calvert County, specifically census tract 24009860900 and the areas around Solomons and Solomons Island based on generalized building stock information and localized depth grid information published for Calvert County by FEMA. Losses for census tract 24009860900 can be broken into two major categories: economic loss figures and business interruption figures. Economic loss figures, which can be seen in *Table 25 – Calvert County (Census Tract 24009860900) Building Economic Loss Figures,* illustrates the type and breakdown of economic loss from a 1% annual chance flood. *Table 26 – Calvert County (Census Tract 24009860900) Business Interruption Economic Loss Figures* illustrates the dollar amounts of business interruption for specific categories of businesses in the scenario region.

Table 25 - Calvert County (Census Tract 24009860900) Building Economic Loss Figures

HAZUS Building Economic Loss Figures					
	Residential	**Commercial**	**Industrial**	**Other**	**Total**
Building:	$1,610,000.00	$170,000.00	$40,000.00	$20,000.00	$1,840,000.00
Content:	$890,000.00	$570,000.00	$90,000.00	$220,000.00	$1,770,000.00
Inventory:	$0.00	$10,000.00	$10,000.00	$0.00	$20,000.00
Subtotal:	**$2,500,000.00**	**$750,000.00**	**$140,000.00**	**$240,000.00**	**$3,630,000.00**
Source: HAZUS, 2024					

Table 26 - Calvert County (Census Tract 24009860900) Business Interruption Economic Loss Figures

HAZUS Business Interruption Economic Loss Figures					
	Residential	**Commercial**	**Industrial**	**Other**	**Total**
Income:	$90,000.00	$1,180,000.00	$0.00	$440,000.00	$1,710,000.00
Relocation:	$440,000.00	$90,000.00	$0.00	$130,000.00	$660,000.00
Rental Income:	$170,000.00	$70,000.00	$0.00	$10,000.00	$250,000.00
Wage:	$230,000.00	$940,000.00	$0.00	$1,060,000.00	$2,230,000.00
Subtotal:	**$930,000.00**	**$2,280,000.00**	**$0.00**	**$1,640,000.00**	**$4,850,000.00**
Source: HAZUS, 2024					

Based on the level two scenario for census tract 24009860900 in Calvert County, 57% of the estimated losses were related to business interruption of the region. The total residential occupancies that made up the total losses was equivalent to approximately 40.6%. Approximately 92.91% of the buildings associated with the study region are related to residential housing.

With the level two scenario, HAZUS also assess the damage to essential facilities. There are no essential facilities that are expected to be significantly or moderately damaged by the scenario run for census tract 24009860900. Of the estimated 3,175 buildings in this study region, no

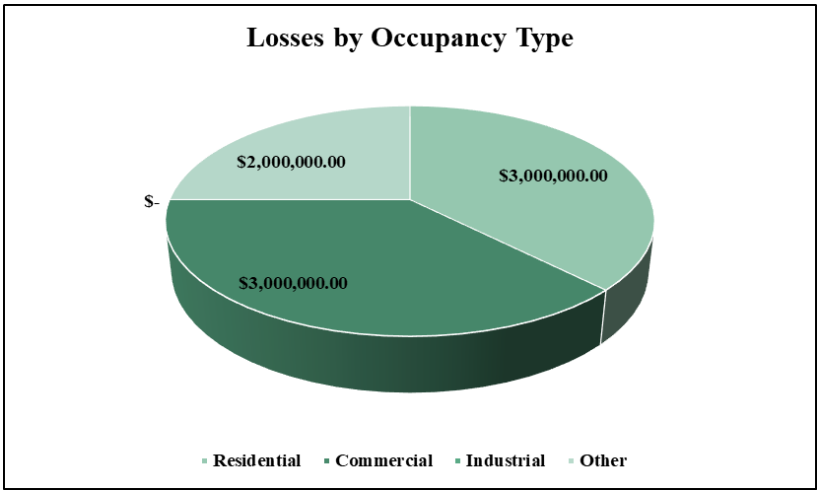
buildings will be moderately damaged. No buildings will be completely damaged based on this scenario.

Table 27 – Building Exposure by Occupancy Type for the Study Region (Census Tract 240098690900) illustrates the total amount of replacement value for different types of buildings within the study region. *Figure 14 – Building Exposure by Occupancy Type for the Study Region (Census Tract 240098690900)* illustrates the occupancy type in pie graph form.

Table 27 - Building Exposure by Occupancy Type for the Study Region (Census Tract 240098690900)

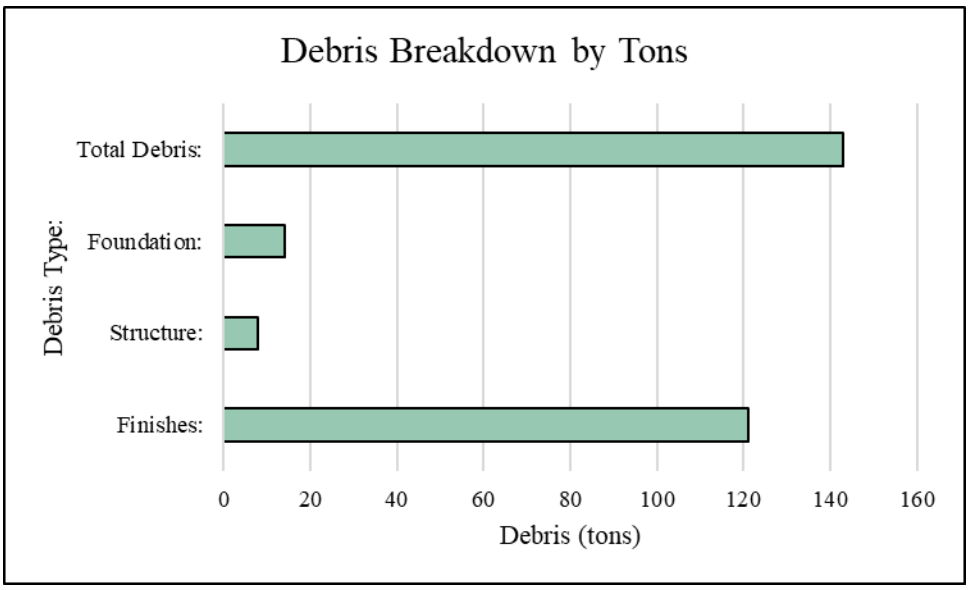
Building Exposure by Occupancy Type for Study Region		
Occupancy	**Exposure***	**Percent Total**
Residential	$479,666.00	83.9%
Commercial	$63,748.00	11.2%
Industrial	$12,627.00	2.2%
Agricultural	$1,895.00	0.3%
Religion	$6,378.00	1.1%
Government	$78.00	0%
Education	$7,269.00	1.3%
Total:	**$571,661.00**	**100%**
Source: HAZUS, 2024 *Dollar figures are in thousands of dollars.		

Figure 14 - Building Exposure by Occupancy Type for the Study Region (Census Tract 240098690900)



HAZUS also determines the amount of debris that might occur from a given event and these estimates can be helpful in determining the potential environmental impacts from a scenario and the needed effort in cleanup after a 1% annual chance flood. The HAZUS scenario that was completed for census tract 24009860900 broke down the debris that could be generated from the scenario into four categories: total debris, finishes, structures, and foundations. The values can be found in *Figure 15 – HAZUS Estimated Debris and Debris Breakdown (Census Tract 24009860900)*. These breakdown numbers are related in tons of debris.

Figure 15 - HAZUS Estimated Debris and Debris Breakdown (Census Tract 24009860900)



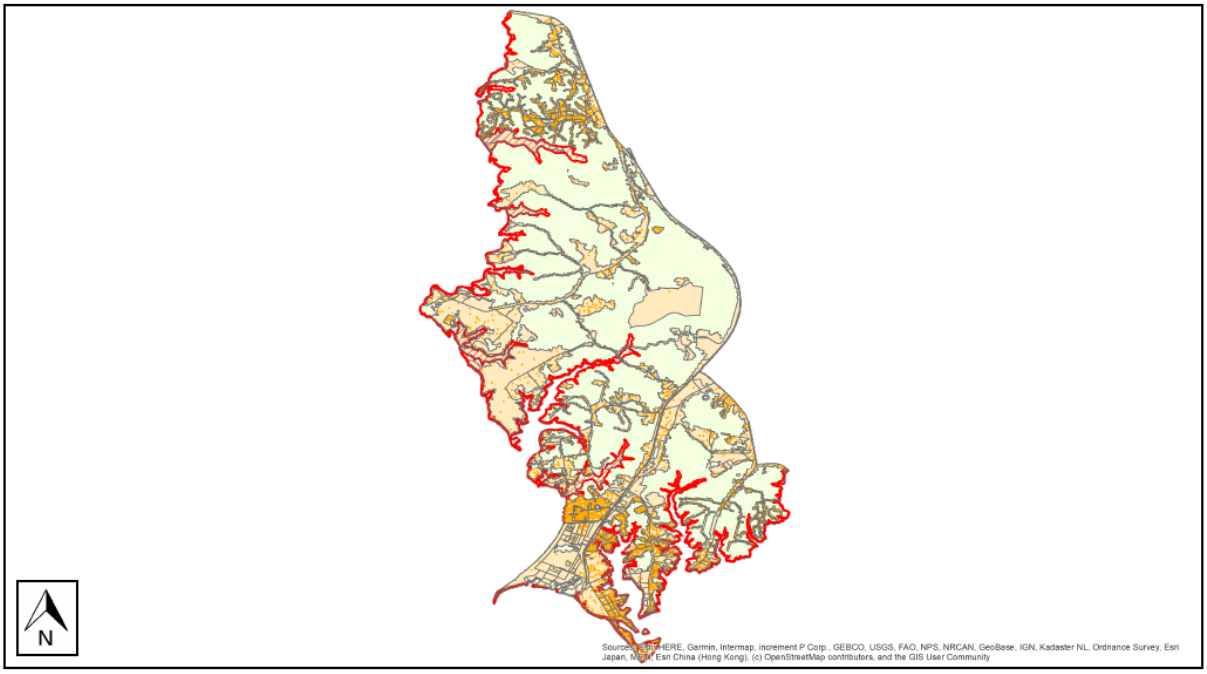
A discussion on the attributes of debris breakdown categories can be found in the narration above in the section for the HAZUS scenario for the entire county. Of the total debris breakdowns, the following percentages for each category are listed below:

- Finishes: 84.62%
- Structure: 5.59%
- Foundation: 9.79%

HAZUS estimates that approximately six trucks hauling debris at 25 tons per load would be required to clean up the debris generated from this level two scenario.

Figure 16 – Calvert County (Census Tract 24009860900) HAZUS Extent illustrates the scenario flood extent and the exposed locations and structures within the region. This map was generated using the HAZUS software, and gives a comprehensive view of which parts of the county were exposed to the flooding scenario. Areas outlined in red are the flooding scenario and the areas in orange and yellow are highly populated areas. This extent map illustrates that there were no failed reaches and that a localized flood depth grid was used for this scenario

Figure 16 - Calvert County (Census Tract 24009860900) HAZUS Extent



Source: HAZUS, 2024

Risk Assessment - Calvert County (Census Tract 24009861001) HAZUS Scenario

A level two HAZUS scenario was completed for Calvert County, specifically census tract 24009861001 and the areas around Cove Point based on generalized building stock information and localized depth grid information published for Calvert County by FEMA. Losses for census tract 24009861001 can be broken into two major categories: economic loss figures and business interruption figures. Economic loss figures, which can be seen in *Table 28 – Calvert County (Census Tract 24009861001) Building Economic Loss Figures*, illustrates the type and breakdown of economic loss from a 1% annual chance flood. *Table 29 – Calvert County (Census Tract 24009861001) Business Interruption Economic Loss Figures* illustrates the dollar amounts of business interruption for specific categories of businesses in the scenario region.

Table 28 - Calvert County (Census Tract 24009861001) Building Economic Loss Figures

HAZUS Building Economic Loss Figures					
	Residential	**Commercial**	**Industrial**	**Other**	**Total**
Building:	$2,340,000.00	$50,000.00	$10,000.00	$2,390,000.00	$4,790,000.00
Content:	$1,330,000.00	$80,000.00	$10,000.00	$1,410,000.00	$2,830,000.00
Inventory:	$0.00	$0.00	$0.00	$0.00	$0.00
Subtotal:	**$3,670,000.00**	**$130,000.00**	**$20,000.00**	**$3,800,000.00**	**$7,620,000.00**
Source: HAZUS, 2024					

Table 29 - Calvert County (Census Tract 24009861001) Business Interruption Economic Loss Figures

HAZUS Business Interruption Economic Loss Figures					
	Residential	**Commercial**	**Industrial**	**Other**	**Total**
Income:	$0.00	$390,000.00	$0.00	$0.00	$390,000.00
Relocation:	$1,610,000.00	$100,000.00	$0.00	$0.00	$1,710,000.00
Rental Income:	$480,000.00	$70,000.00	$0.00	$0.00	$550,000.00
Wage:	$0.00	$170,000.00	$0.00	$0.00	$170,000.00
Subtotal:	**$2,090,000.00**	**$730,000.00**	**$0.00**	**$0.00**	**$2,820,000.00**
Source: HAZUS, 2024					

Based on the level two scenario for census tract 24009861001 in Calvert County, 43% of the estimated losses were related to business interruption of the region. The total residential occupancies that made up the total losses was equivalent to approximately 86.96%. Approximately 93.6% of the buildings associated with the study region are related to residential housing.

With the level two scenario, HAZUS also assess the damage to essential facilities. There are no essential facilities that are expected to be significantly or moderately damaged by the scenario run for census tract 24009861001. Of the estimated 594 buildings in this study region,

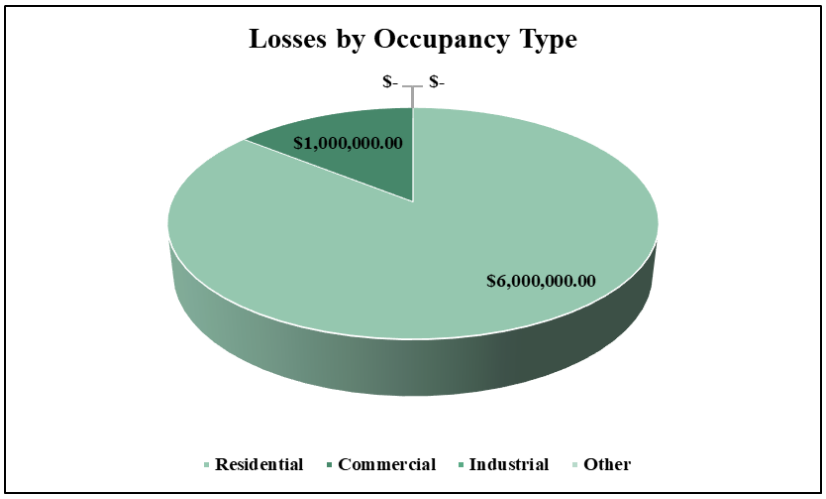
approximately twenty-one buildings will be moderately damaged. No buildings will be completely damaged based on this scenario.

Table 30 – Building Exposure by Occupancy Type for the Study Region (Census Tract 240098691001) illustrates the total amount of replacement value for different types of buildings within the study region. *Figure 17 – Building Exposure by Occupancy Type for the Study Region (Census Tract 240098691001)* illustrates the occupancy type in pie graph form.

Table 30 - Building Exposure by Occupancy Type for the Study Region (Census Tract 240098691001)

Building Exposure by Occupancy Type for Study Region		
Occupancy	**Exposure***	**Percent Total**
Residential	$170,921.00	82.6%
Commercial	$28,405.00	13.7%
Industrial	$2,240.00	1.1%
Agricultural	$142.00	0.1%
Religion	$2,485.00	1.2%
Government	$0.00	0%
Education	$2,688.00	1.3%
Total:	**$206,881.00**	**100%**
Source: HAZUS, 2024 *Dollar figures are in thousands of dollars.		

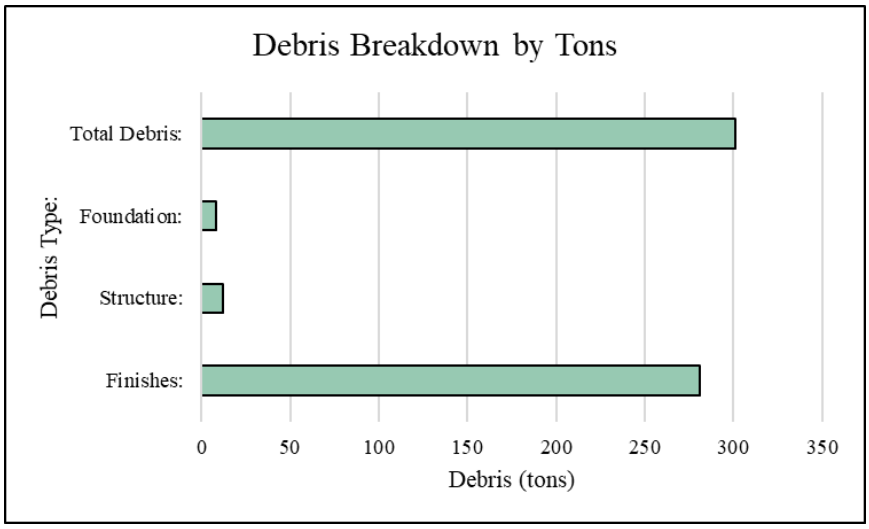
Figure 17 - Building Exposure by Occupancy Type for the Study Region (Census Tract 240098691001)



HAZUS also determines the amount of debris that might occur from a given event and these estimates can be helpful in determining the potential environmental impacts from a scenario and the needed effort in cleanup after a 1% annual chance flood. The HAZUS scenario that was completed for census tract 24009861001 broke down the debris that could be generated from the scenario into four categories: total debris, finishes, structures, and foundations. The values can be

found in *Figure 18 – HAZUS Estimated Debris and Debris Breakdown (Census Tract 24009861001).* These breakdown numbers are related in tons of debris.

Figure 18 - HAZUS Estimated Debris and Debris Breakdown (Census Tract 24009861001)



A discussion on the attributes of debris breakdown categories can be found in the narration above in the section for the HAZUS scenario for the entire county. Of the total debris breakdowns, the following percentages for each category are listed below:

- Finishes: 93.36%
- Structure: 3.99%
- Foundation: 2.65%

HAZUS estimates that approximately six trucks hauling debris at 25 tons per load would be required to clean up the debris generated from this level two scenario.

Figure 19 – Calvert County (Census Tract 24009861001) HAZUS Extent illustrates the scenario flood extent and the exposed locations and structures within the region. This map was generated using the HAZUS software, and gives a comprehensive view of which parts of the county were exposed to the flooding scenario. Areas outlined in red are the flooding scenario and the areas in orange and yellow are highly populated areas. This extent map illustrates that there were no failed reaches and that a localized flood depth grid was used for this scenario.

Figure 19 - Calvert County (Census Tract 24009861001) HAZUS Extent

Source: HAZUS, 2024

Risk Assessment - Calvert County (Census Tract 24009860801) HAZUS Scenario

A level two HAZUS scenario was completed for Calvert County, specifically census tract 24009860801 and the areas around Broomes Island based on generalized building stock information and localized depth grid information published for Calvert County by FEMA. Losses for census tract 24009860801 can be broken into two major categories: economic loss figures and business interruption figures. Economic loss figures, which can be seen in *Table 31 – Calvert County (Census Tract 24009860801) Building Economic Loss Figures*, illustrates the type and breakdown of economic loss from a 1% annual chance flood. *Table 32 – Calvert County (Census Tract 24009860801) Business Interruption Economic Loss Figures* illustrates the dollar amounts of business interruption for specific categories of businesses in the scenario region.

Table 31 - Calvert County (Census Tract 24009860801) Building Economic Loss Figures

HAZUS Building Economic Loss Figures					
	Residential	**Commercial**	**Industrial**	**Other**	**Total**
Building:	$6,100,000.00	$210,000.00	$50,000.00	$30,000.00	$6,390,000.00
Content:	$3,160,000.00	$560,000.00	$60,000.00	$220,000.00	$4,000,000.00
Inventory:	$0.00	$10,000.00	$10,000.00	$0.00	$20,000.00
Subtotal:	**$9,260,000.00**	**$780,000.00**	**$120,000.00**	**$250,000.00**	**$10,410,000.00**
Source: HAZUS, 2024					

Table 32 - Calvert County (Census Tract 24009860801) Business Interruption Economic Loss Figures

HAZUS Business Interruption Economic Loss Figures					
	Residential	**Commercial**	**Industrial**	**Other**	**Total**
Income:	$0.00	$450,000.00	$0.00	$90,000.00	$540,000.00
Relocation:	$1,680,000.00	$120,000.00	$0.00	$0.00	$1,800,000.00
Rental Income:	$490,000.00	$90,000.00	$0.00	$0.00	$580,000.00
Wage:	$0.00	$450,000.00	$0.00	$210,000.00	$660,000.00
Subtotal:	**$2,170,000.00**	**$1,110,000.00**	**$0.00**	**$300,000.00**	**$3,580,000.00**
Source: HAZUS, 2024					

Based on the level two scenario for census tract 24009860801 in Calvert County, 26% of the estimated losses were related to business interruption of the region. The total residential occupancies that made up the total losses was equivalent to approximately 81.68%. Approximately 91.61% of the buildings associated with the study region are related to residential housing.

With the level two scenario, HAZUS also assess the damage to essential facilities. There are no essential facilities that are expected to be significantly or moderately damaged by the scenario run for census tract 24009860801. Of the estimated 2,484 buildings in this study region,

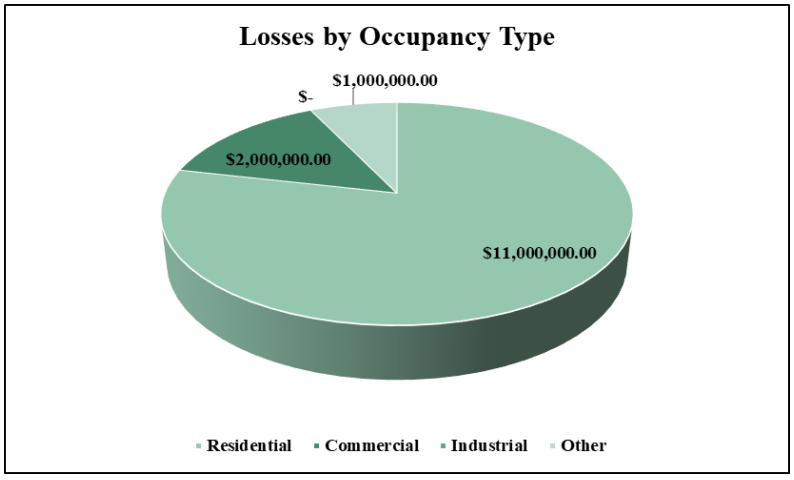
approximately thirty-three buildings will be moderately damaged. No buildings will be completely damaged based on this scenario.

Table 33 – Building Exposure by Occupancy Type for the Study Region (Census Tract 24009860801) illustrates the total amount of replacement value for different types of buildings within the study region. *Figure 20 – Building Exposure by Occupancy Type for the Study Region (Census Tract 24009860801)* illustrates the occupancy type in pie graph form.

Table 33 - Building Exposure by Occupancy Type for the Study Region (Census Tract 24009860801)

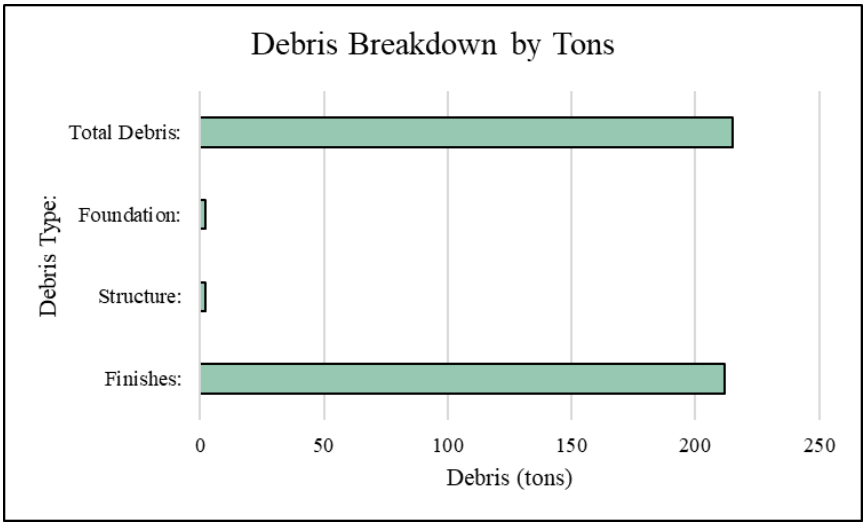
Building Exposure by Occupancy Type for Study Region		
Occupancy	**Exposure***	**Percent Total**
Residential	$389,100.00	94.2%
Commercial	$16,509.00	4.0%
Industrial	$5,234.00	1.3%
Agricultural	$1,068.00	0.3%
Religion	$589.00	0.1%
Government	$67.00	0%
Education	$341.00	0.1%
Total:	**$412,908.00**	**100%**
Source: HAZUS, 2024 *Dollar figures are in thousands of dollars.		

Figure 20 - Building Exposure by Occupancy Type for the Study Region (Census Tract 24009860801)



HAZUS also determines the amount of debris that might occur from a given event and these estimates can be helpful in determining the potential environmental impacts from a scenario and the needed effort in cleanup after a 1% annual chance flood. The HAZUS scenario that was completed for census tract 24009860801 broke down the debris that could be generated from the scenario into four categories: total debris, finishes, structures, and foundations. The values can be found in *Figure 21 – HAZUS Estimated Debris and Debris Breakdown (Census Tract 24009860801)*. These breakdown numbers are related in tons of debris.

Figure 21 - HAZUS Estimated Debris and Debris Breakdown (Census Tract 24009860801)



A discussion on the attributes of debris breakdown categories can be found in the narration above in the section for the HAZUS scenario for the entire county. Of the total debris breakdowns, the following percentages for each category are listed below:

- Finishes: 99%
- Structure: 1%
- Foundation: 1%

HAZUS estimates that approximately nine trucks hauling debris at 25 tons per load would be required to clean up the debris generated from this level two scenario.

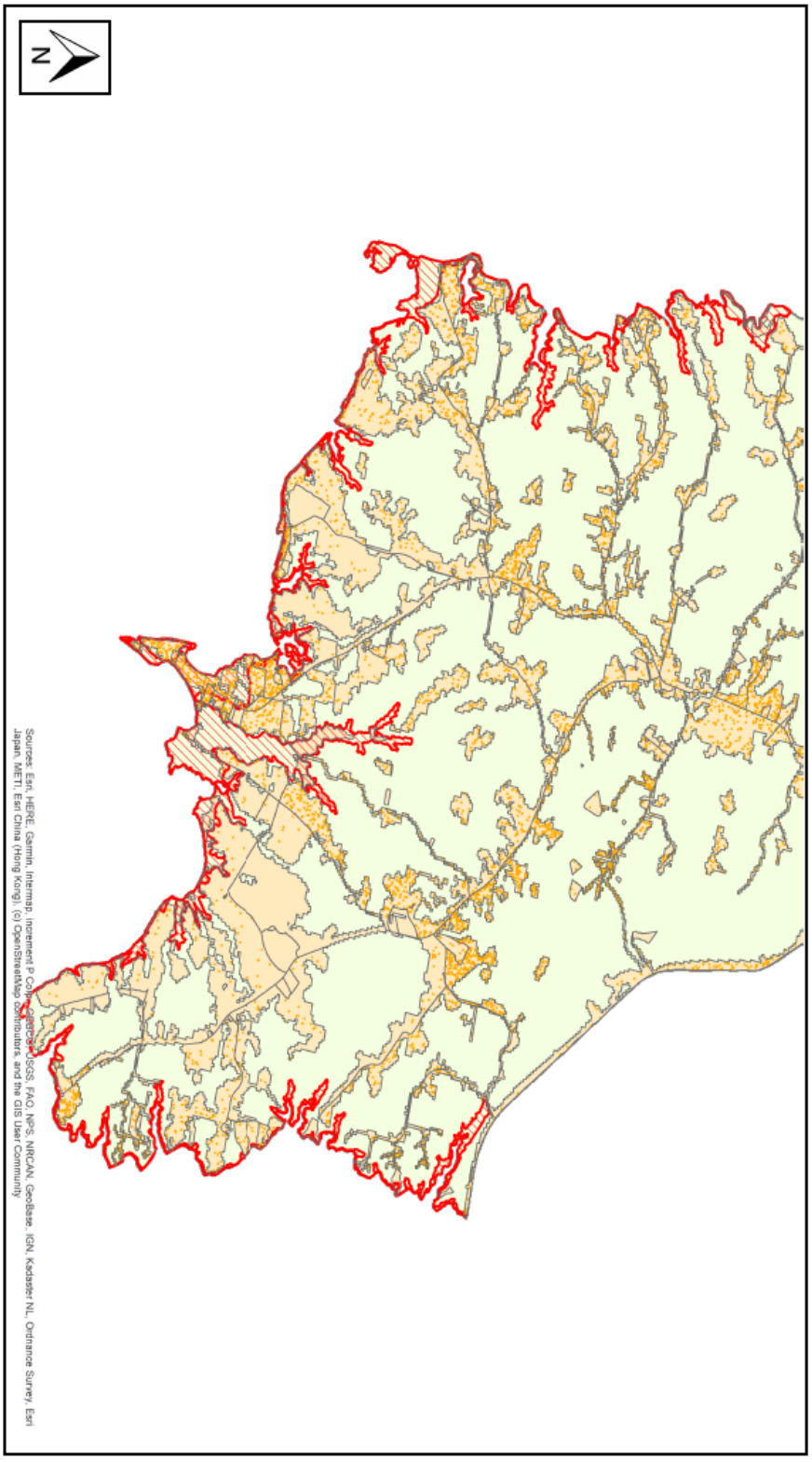
Figure 22 – Calvert County (Census Tract 24009860801) HAZUS Extent illustrates the scenario flood extent and the exposed locations and structures within the region. This map was generated using the HAZUS software, and gives a comprehensive view of which parts of the county were exposed to the flooding scenario. Areas outlined in red are the flooding scenario and the areas in orange and yellow are highly populated areas. This extent map illustrates that there were no failed reaches and that a localized flood depth grid was used for this scenario.

Direct economic loss figures for transportation in Calvert County illustrates the economic loss for transportation assets such as bridges, tunnels, and other transportation facilities. This breakdown for census tract 24009860801 can be found in *Table 34 – Direct Economic Loss for Transportation (Census Tract* 24009860801*).* Values represented in the table below are in thousands of dollars. The data is broken down into seven categories, and these are highway, railway, light rail, bus, ports, ferries, and airports. For this census tract, highway damage is of primary concern. There is also an estimated damage value for ports based on this census tract. This is due to port facilities on Broomes Island.

Table 34 - Direct Economic Loss for Transportation (Census Tract 24009860801)

Direct Economic Loss for Transportation							
	Highway:	**Railway:**	**Light Rail:**	**Bus:**	**Ports:**	**Ferries:**	**Airport:**
Segments:	$155,696.00	$0.00	$0.00	$0.00	$0.00	$0.00	$155,696.00
Bridges:	$1,125.00	$0.00	$0.00	$0.00	$0.00	$0.00	$1,125.00
Tunnels:	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Facilities:	$0.00	$0.00	$0.00	$0.00	$5,767.00	$0.00	$5,767.00
Source: HAZUS, 2024							

Figure 22 - Calvert County (Census Tract 24009860801) HAZUS Extent



Source: HAZUS, 2024

Risk Assessment - HAZUS Conclusions

Table 34 – HAZUS Scenario Building Loss Figures (Total) illustrates the dollar values for each HAZUS scenario for Calvert County Flood Study and Mitigation Plan and charts them against the total value. Calvert County would see a significant amount of damage from a 1% annual chance flood event, and that damage would require a long effort for cleanup, recovery, and remediation. With an estimated debris generation of 2,480 tons (4,960,000 pounds) of debris, the impact on the environment in and around Calvert County would be high.

The losses from the HAZUS scenarios run for the county depend on the study regions building concentration and building value. Therefore, areas where water features such as rivers, streams, creeks, lakes, and coastal areas are closer to developed areas or modernized areas are at greater vulnerability to heavy and debilitating losses. The developed areas of Calvert County are at extreme risk of flooding, including coastal, tidal, and depending on the location, riverine flooding. The entire building economic loss figure for Calvert County is $43,670,000.00. Rural and less developed areas are less vulnerable to a large flooding event due to the lower concentration of tight urbanization or development. These locations would still result in losses, but those losses would not be compounded by close proximity to one another.

HAZUS is useful for understanding the impacts of a potential event, but HAZUS does not determine the number of flooding occurrences that can happen in any given year. A 1% annual chance flood event can occur more than once in a calendar year and can occur more than once every 100 years. As climate change continues to advance, scenarios similar to those presented in this report could become more common in Calvert County. HAZUS scenarios and the software will become more useful as losses are examined in more granular study regions.

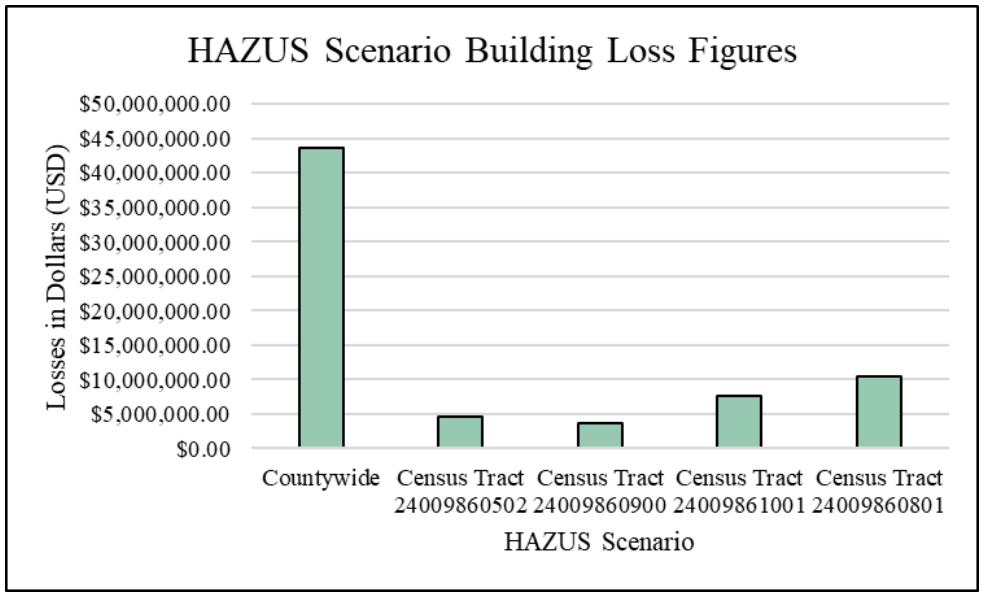
A potential development path for future HAZUS applications in Calvert County would be inclusion of engineering information into the software and the general building stock to try to complete a level three scenario. This type of scenario is not standard practice for HAZUS runs for hazard mitigation planning but could be useful to understand the impacts of flooding events on different types of structures at greater detail.

Smaller HAZUS scenarios could be developed at the census block level, but the usefulness of those scenarios would depend on where they were located and what specific infrastructure was located at those locations. Smaller areas being used as HAZUS study regions could result in more granular detail, but also areas of no data being processed. If this development path is chosen for Calvert County, areas along the coast should be chosen due to direct impacts from coastal and riverine flooding.

Figure 23 – HAZUS Defined Regions in Calvert County illustrates which census tracts of Calvert County were used as study regions. The four census tracts that were used as study regions are outlined in red. Three of these study regions are found south of Prince Frederick, Maryland, but

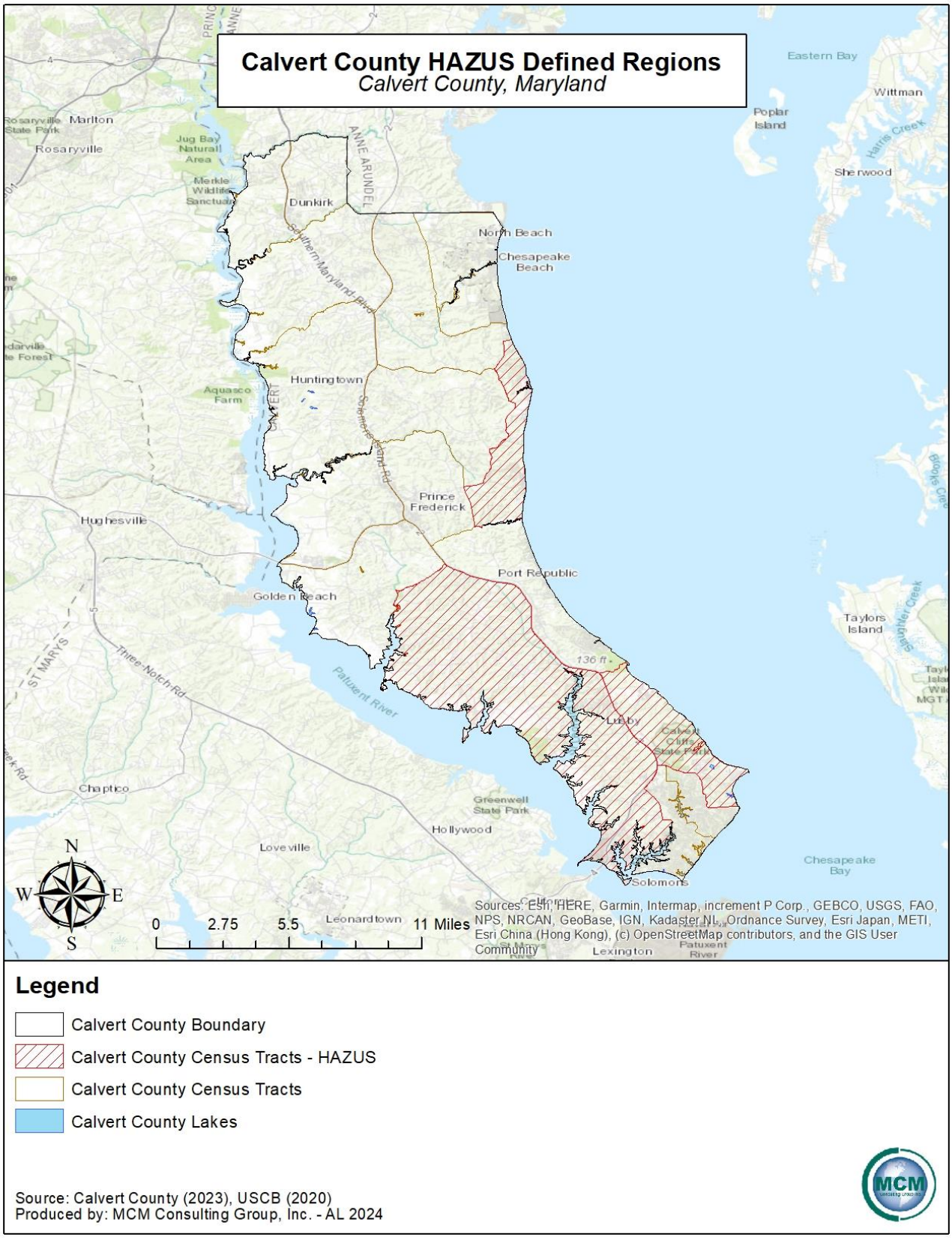
the fourth census tract is located north of Prince Frederick. This accounts for the areas of flooding concern that were determined by the local planning team with assistance of the public. The areas in Calvert County that were not utilized as study regions can still be used for future planning and modeling.

Table 35 - HAZUS Scenario Building Loss Figures (Total)



Additional documentation on HAZUS can be found in the appendices following this report. The HAZUS documentation is sorted by HAZUS scenario for Calvert County. This includes the global flood risk reports and the satellite reports generated by the software during the course of this project.

Figure 23 - HAZUS Defined Regions in Calvert County



Vulnerability Assessment - Future Flooding Trends

Riverine and Stream Flooding:

A large portion of Calvert County is vulnerable to stream and riverine flooding events. Calvert County can expect to experience some degree of flooding every calendar year. Flooding, regardless of the degree, puts the entire population at some level of risk, whether through flooding of homes, businesses, places of employment, roadways, sewer systems, and water infrastructure. Flooding can cause significant power outages and poor road conditions that can lead to heightened transportation accident risk.

Critical infrastructure, community lifelines, and functional needs facilities are the most vulnerable buildings and services when riverine and stream flooding is considered. Critical facilities and community lifeline facilities are locations that are needed to maintain public safety, including fire departments, police stations, emergency medical services (EMS) stations, and hospitals and facilities that, if damaged, would present an immediate threat to life, public health and safety.

The Federal Emergency Management Agency (FEMA) provides community lifeline descriptions for seven different categories. These descriptions are:

- **Safety and Security:** Law Enforcement/Security, Fire Service, Search and Rescue, Government Service, Community Safety
- **Food, Water, Shelter:** Agriculture, Shelters for homeless, displaced, and unsheltered persons, Food Banks
- **Health and Medical:** Medical Care, Public Health, Patient Movement, Medical Supply Chain, Facility Management
- **Energy:** Power Grid, Fuel
- **Communications:** Infrastructure, Responder Communications, Alerts, Warnings and Messages, Finance, 911 and Dispatch
- **Transportation:** Highway/Roadway/Motor Vehicle, Mass Transit, Railway, Aviation, Marine
- **Hazardous Materials:** Facilities, HazMat, Pollutants, Contaminants

Climate change will also increase the risk of flooding across Calvert County, the State of Maryland, the United States, and the world. Warmer temperatures that can result from climate change will mean more precipitation throughout the year that will fall as rain, as opposed to falling as snow. Snow melting can occur gradually over hours and days, while heavy rain can increase river and stream depth in as little as minutes. Warmer air also has the potential to carry more moisture than colder air, so the rainfall that occurs will be heavier and more intense. This adversely can also make winter storms more intense in the winter months, resulting in greater snow load that could melt and contribute to river and stream rise. Also related to climate change

is the strengthening of hurricanes and tropical storms, some which have the potential to affect Calvert County.

Flash Flooding:

Flash flooding is a common occurrence in Calvert County and can continue to occur anywhere in the county. A large portion of flash flooding occurs in populated areas that have an increase in impervious ground cover. Flash flooding will continue to occur in Calvert County and parts of the county experience some degree of flash flooding every year.

Areas that are prone to flash flooding in Calvert County include, but are not limited to:

- Dares Beach
- Owings Town Center
- Town of Chesapeake Beach
- Town of North Beach

The above locations were the locations with the most reports on flash flooding based on the National Centers for Environmental Information (NCEI) Storm Event Database. Those areas are not the only areas of the county where flash flooding can occur. Flash flooding can be mitigated by increased awareness of stormwater issues in urban areas and at areas where construction of culvert locations restricts the flow of water.

Flash flooding will continue to be a large issue when there is a heavy amount of rain in Calvert County or in counties that are adjacent to Calvert County and contribute water to Calvert County areas. Flash flooding, although typically seen only in spring and summer months, could occur in the future as climate change continues. Also, flash flooding can occur in winter when the ground is frozen and runoff cannot penetrate the water table or the topsoil, causing flash flood conditions in narrow locations, valleys, and tight natural spaces. Significant winter storms can also cause flash flooding when rapid warmups result in heavy rainfall over ground covered in snow and ice. This presents an impervious surface, where water will run off and over an area but not allow for water penetration into the ground. Climate change will also result in increased heavy rainfall and torrential rainfall. With increased, heavy rainfall, the amount of water runoff and flash flooding will increase, and more property could be damaged, and citizens, visitors, and populations put at increased vulnerability.

Tidal Flooding:

Tidal flooding vulnerability is expected to increase in Calvert County due to climate change. Tidal flooding is already a common occurrence and with climate change factors, that frequency will likely increase. Increased coastal erosion along the Chesapeake Bay will result in less coastal areas able to accept water in high tide events. Areas around Neeld Estates and Breezy Point historically had beaches and coastlines, but the changing nature of the climate has resulted in less beach area and more flooding events. Sea level rise could also contribute to greater tidal

flooding events. Most of the coastline of Calvert County, including the towns of Chesapeake Beach and North Beach, Breezy Point, Broomes Island, and Neeld Estates sit at or near sea level, making their vulnerability to tidal flooding great.

Section 3 - Mitigation Actions, Project Opportunities, and Preventative Measures

Mitigation Actions

As part of Calvert County's flood study, mitigation actions that are related to flooding, flash flooding, and tidal flooding were reviewed and examined to determine what the status of each action was and whether the mitigation actions were still valid. *Table 36 – 2024 Calvert County Floody Mitigation Plan - Mitigation Action Review – Table 1, Table 37 – 2024 Calvert County Flood Mitigation Plan – Mitigation Action Review – Table 2,* and *Table 38 – 2024 Calvert County Flood Mitigation Plan – Mitigation Action Review – Table 3* illustrates the action items from different planning mechanisms in Calvert County. The process will also be used for future hazard mitigation efforts, in conjunction with Calvert County hazard mitigation plan updates.

Each of the mitigation actions should be reviewed at the start of future hazard mitigation plan updates. This is the standard procedure at the start of the mitigation action plan creation for a hazard mitigation plan update. This process will ensure that the local planning team is made up of the required stakeholders and county employees that could have potentially changed since the previous planning period. Also, a review of the mitigation actions with required stakeholders is crucial, as some mitigation actions are related specifically municipal and agency stakeholders.

Table 36 - 2024 Calvert County Floody Mitigation Plan - Mitigation Action Review – Table 1

Calvert County Mitigation Actions Review Worksheet						
Existing Mitigation Actions *(2004 HMP)*	***Status***					***Review Comments***
	No Progress/ Unknown	**In Progress/Not YetComplete**	**Continuous**	**Completed**	**Discontinued**	
1. Encourage uninsured property owners in known flood hazard areas to purchase flood insurance through the NFIP.			X			**Previous 2011 Comment:** High Priority **2024 Comment:** No comment.

Calvert County Mitigation Actions Review Worksheet						
Existing Mitigation Actions *(2004 HMP)*	***Status***					***Review Comments***
	No Progress/ Unknown	**In Progress/Not YetComplete**	**Continuous**	**Completed**	**Discontinued**	
2. Ensure municipal compliance with local stormwater management plans.			X			**Previous 2011 Comment:** High Priority **2024 Comment:** No comment.
3. Store the community's FIRMs and FIS in an easily accessible location and make them available for public inspection. Conduct routine inspections, regular maintenance and annual tests on all emergency communications equipment, public awareness systems, and high alert sirens to ensure unhindered operation during an emergency.					X	Previous 2011 Comment: High Priority **2024 Comment:** FIRMS is stored Digitally – emergency communications systems are tested regularly. Wireless alerts are available. Everbridge.
4. Coordinate with the local municipalities or the DOT on the potential feasibility of replacing, removing, or enlarging bridge and culvert stream crossings that are unable to pass the 10-year frequency flood flow.			X			Previous 2011 Comment: Medium Priority **2024 Comment:** Capital projects in progress to pass the 100-year frequency flood flow. Enhancing culverts 2.1.3 to 10-year. Environmental planning DPW, to facilitate the projects and explore other avenues of financial. DOT state and local may need to focus on county funded roads
5. Ensure continued contractor compliance with approved erosion and sediment control plans and continue to work with local farmers to implement best practices.			X			Previous 2011 Comment: Medium Priority **2024 Comment:** No comment.
6. Preserve the highest priority for undeveloped floodplain areas via fee simple acquisition and/or permanent easement and retain as public open space for passive recreational uses. Less critical floodplain areas may be preserved/protected via local ordinances.			X			Previous 2011 Comment: Medium Priority **2024 Comment:** No comment.
7. Elevate known flood-prone structures in accordance with the general guidelines.		X				Previous 2011 Comment: Medium Priority **2024 Comment:** Grant funding or local ordinance

Calvert County Mitigation Actions Review Worksheet						
Existing Mitigation Actions *(2004 HMP)*	***Status***					***Review Comments***
	No Progress/ Unknown	**In Progress/Not YetComplete**	**Continuous**	**Completed**	**Discontinued**	
8. Relocate and/or acquire known flood -prone structures with the general guidelines.	X					Previous 2011 Comment: Medium Priority **2024 Comment:** 2023 actions?

Table 37 - 2024 Calvert County Flood Mitigation Plan – Mitigation Action Review – Table 2

Calvert County Mitigation Principles Review Worksheet						
Existing Mitigation Actions *(2010 Comprehensive Plan)*	***Status***					***Review Comments***
	No Progress/ Unknown	**In Progress/Not Yet Complete**	**Continuous**	**Completed**	**Discontinued**	
1. Establish a comprehensive approach to environmental planning with special emphasis on watershed planning.	No status update provided.					**2024 Comment:** The local planning team decided to keep this action.
2. Protect environmentally sensitive areas such as floodplains, wetland, and water way buffers from development impacts.	No status update provided.					**2024 Comment:** The local planning team decided to keep this action.
3. Preserve stream valleys to maintain the natural functions and to provide greenways throughout the county.	No status update provided.					**2024 Comment:** This action is similar to mitigation action #2 from the 2010 Calvert County comprehensive plan.
4. Establish greenways systems along stream valleys to preserve the lowlands.	No status update provided.					**2024 Comment:** This action is similar to mitigation action #2 from the 2010 Calvert County comprehensive plan.

Calvert County Mitigation Principles Review Worksheet						
Existing Mitigation Actions *(2010 Comprehensive Plan)*	***Status***					***Review Comments***
	No Progress/ Unknown	**In Progress/Not Yet Complete**	**Continuous**	**Completed**	**Discontinued**	
5. Require and maintain sufficient buffers from all perennial and intermittent streams to provide environmental protections.	No status update provided.					**2024 Comment:** The local planning team decided to keep this action.
6. Reforest stream buffers wherever possible.			X			**2024 Comment:** No comment.
7. Consider altering the 50 foot buffer requirements.		X				**2024 Comment:** The local planning team was unsure when this item will be passed.
8. Continue to direct development out of the floodplain.	No status update provided.					**2024 Comment:** The local planning team stated that this was part of the ordinance process
9. For development in the floodplain, ensure that construction practices minimize damage to property and the environment during flooding.	No status update provided.					**2024 Comment:** No comment.
10. Require vegetation in floodplain to remain except when it is required to be removed for stormwater management.			X			**2024 Comment:** The local planning team decided to keep this action.

Table 38 - 2024 Calvert County Flood Mitigation Plan – Mitigation Action Review – Table 3

Calvert County Mitigation Actions Review Worksheet						
Existing Mitigation Actions *(2023 HMP)*	***Status***					***Review Comments***
	No Progress/ Unknown	**In Progress/Not YetComplete**	**Continuous**	**Completed**	**Discontinued**	
1.1.5 Implement FEMA's Integrated Public Alert and Warning System (IPAWS) for sudden onset hazards such as tornados, thunderstorms, or flash floods.			X			**2024 Comment:** No comment.
2.1.1 Ensure reconstruction activities are compliant with NFIP substantial damage/improvement requirements and existing codes.			X			**2024 Comment:** The local planning team stated that this action is more defined than the other two documents and their respective actions.
2.1.2 Continue to provide technical assistance to local residents in applying for hazard mitigation assistance for acquisition/demolition, elevation, and localized flood risk reduction.			X			**2024 Comment:** The local planning team decided to keep this action.
2.1.3 Continue to coordinate with the county, municipality and/or the Maryland Department of Transportation on the potential feasibility of replacing, removing, or enlarging those bridge and culvert stream crossings that are unable to pass the 10-year frequency flood flow.			X			**2024 Comment:** The local planning team commented that the threshold for this action is 400 acres for the 100-year flood flow. Another action will be added to capture this parameter.
2.2.1 Support the identification and implementation of stormwater management projects for flood risk reduction.			X			**2024 Comment:** The local planning team decided to keep this action.
3.1.3 Continue to ensure county and municipal compliance with local Stormwater Management Plans.			X			**2024 Comment:** The local planning team decided to keep this action.

Calvert County Mitigation Actions Review Worksheet						
Existing Mitigation Actions *(2023 HMP)*	***Status***					***Review Comments***
	No Progress/ Unknown	**In Progress/Not YetComplete**	**Continuous**	**Completed**	**Discontinued**	
5.2.1 Continue a community-specific stormwater maintenance program consisting of routine inspections and subsequent debris removal.			X			**2024 Comment:** The local planning team stated that this action is ongoing but that there is relevant verbiage that should be added to reflect the status of these inspections and requests. This verbiage should include the following: "Responding to citizen service requests…" Another additional verbiage update should include the following: start a community education program specific to stormwater management and debris clearing."
5.3.1 Develop a presentation for structural retrofitting and actions homeowners can take to address protection in the event of a flooding hazard event.			X			**2024 Comment:** The local planning team decided to keep this action.
6.2.1 Identify natural resources that provide natural mitigation such as wetlands, buffers, etc. and make them a priority for conservation.	No status update provided.					**2024 Comment:** The local planning team stated that this is identified in the 2004 and 2010 documents and that an additional action should be crafted stating: "continue to protect natural resources"
6.2.2 Give high priority to undeveloped floodplain areas, forested wetlands, and emergent wetlands for natural preservation.	No status update provided.					**2024 Comment:** The local planning team decided to keep this action.

Project Opportunities

As part of this mitigation plan for flooding, all project opportunities that are directly or indirectly related to flooding, flash flooding, tidal flooding, or other flooding events are listed. A majority of the project opportunities listed below are directly from the Calvert County 2023 Hazard Mitigation Plan, therefore, there has not been time to review the project opportunities for completion. Newly developed project opportunities for the next hazard mitigation plan update could concern flood mitigation including but not limited to replacing and resizing culverts, streambank stabilization and clean up, creek bed dredging, and bridge replacement/improvement next to streams, creeks, and waterways. Specific coastal project opportunities could include placement and development of sea walls, beach and sand replacements and rejuvenation, and shore stabilization. This information can be seen in *Table 39 – Calvert County Flood Mitigation Plan – Project Opportunities*.

Table 39 - Calvert County Flood Mitigation Plan - Project Opportunities

Calvert County Project Opportunities – Flood Mitigation Plan								
Organization	**Community Rank**	**Project Name**	**Description**	**Hazard**	**Total Cost**	**Schedule**	**Funding**	**Local Champion**
Calvert County Division of Emergency Management	N/A	RL/SRL Acquisitions	Acquisition and demolition of high-risk flood properties both in and out of the SFHA (due to riverine and stormwater flooding).	All Flood Hazards	Unknown	2023-2028	FMA and Calvert County	Calvert Division of Emergency Management

Calvert County Project Opportunities – Flood Mitigation Plan								
Organization	**Community Rank**	**Project Name**	**Description**	**Hazard**	**Total Cost**	**Schedule**	**Funding**	**Local Champion**
Calvert County Division of Emergency Management	N/A	Stormwater Mitigation	Work with DPW to assess stormwater infrastructure; identify high-priority locations and infrastructure in need of upgrading and improvement. Work collaboratively to develop sub-applications for HMA funding.	Flash Flooding	To be determined.	2023-2028	BRIC/FMA and Calvert County	Calvert Division of Emergency Management
Calvert County Department of Planning & Zoning	N/A	Flood Risk Reduction Education	Properties within the 100 yr. floodplain will be contacted by the county to learn about flood-risk reduction strategies.	All Flood Hazards	N/A	2023-2028	N/A	Department of Planning & Zoning
Calvert County Department of Planning & Zoning	N/A	Flood Risk Reduction Education	Properties identified as "repetitive loss" will be contacted by the county to learn about flood-risk reduction strategies.	All Flood Hazards	N/A	2023-2028	N/A	Department of Planning & Zoning

Preventative Measures and Recommendations

Preventative Measures

1. Calvert County Division of Emergency Management will review debris removal and disposal plans with stakeholders to ensure proper planning in the event of a 1%-annual chance flood.
2. Calvert County Division of Emergency Management will review the estimated number of displaced persons from a 1%-annual change flood event and plan for sheltering and safety for those individuals.
3. Calvert County Division of Emergency Management will review all evacuation procedures for the county, in preparation for flooding and storm events that could cause severe coastal and tidal flooding.
4. As discussed in the hazard mitigation plan update, Calvert County will review repetitive loss and severe repetitive loss properties, and where agreed upon by all parties, perform acquisitions, elevations, demolitions, and demolitions/reconstructions for those structures.
5. Local citizens and local jurisdictions should continue to review grants and projects related to flooding that they can apply for, and work with the Calvert County Division of Emergency Management on applications.

Recommendations

1. Calvert County will continue to coordinate with Calvert County Environmental Health regarding holding tanks for septic near sea walls and flooding events exposing those holding tanks.
2. Calvert County will review engineering level data that is available to the county to conduct a HAZUS scenario using specific and measurable building information in areas of concern outlined in this report and from public feedback.
3. Local citizens and local jurisdictions will monitor their homes and communities for flooding issues, and should report those issues as they arise.
4. Local citizens and local jurisdictions will continue to review coastal and tidal flooding events and report those findings to MyCoast for Calvert County and Maryland.
5. The flood mitigation plan for Calvert County should continue to be integrated into the larger hazard mitigation plan for the county. This plan will be an appendix to the 2023 Calvert County Hazard Mitigation Plan, but more significant plan integration can occur during the next hazard mitigation plan update.
6. Calvert County government will review continued MyCoast information with the Maryland Department of Natural Resources. This will allow additional conversation on specific flooding areas submitted by the public.
7. The Calvert County local planning team, for hazard mitigation planning, should continue to look at mitigation actions and mitigation items related to flooding mentioned in this

report to continue the process of active planning. This should include the Calvert County Department of Planning & Zoning, the Calvert County Division of Emergency Management, and the Calvert County Department of Public Works.

Conclusions

Calvert County has had a significant number of recorded flooding, flash flooding, and tidal flooding. The county will continue to see some degree of flooding each year, whether events are reported to the county, local jurisdictions, or the National Weather Service. With increased awareness of the locations of where flooding events occur, Calvert County can utilize mitigation efforts to better prepare and respond to said flooding events. This flood study and mitigation plan has looked at the community demographics of Calvert County, has examined past flooding events, areas of past flood concern, utilized HAZUS software to review potential losses for specific flood events, and has reviewed the previous mitigation actions and project opportunities submitted during other hazard mitigation planning processes.

Conclusions that can be drawn from the past flooding occurrence section of this report include the realization that flooding, flash flooding, and tidal flooding will occur to some degree on an annual basis. A majority of the flooding that has impacted Calvert County has been riverine flooding due to the Patuxent River, streams, and creeks and tidal flooding along the Patuxent River and Chesapeake Bay areas of the county. Flash flooding has been reported in areas of Calvert County and has been moderate, with some level occurring every year. By reviewing this information, a baseline can be established for expected flooding events in the future. For more information on the past flooding events, please refer to that section in the above report.

Dam failure impacts will continue to be a factor in Calvert County's planning for and examination of flooding events. With two high-hazard dams in Calvert County, continued planning, mitigation review, and maintenance on infrastructure will be paramount to protecting the citizens and property of Calvert County. Dam failure is a danger during large rain events where heavy rains can increase the amount of water running into and around impoundments, dam features, and levee walls and areas. Calvert County currently examines dams within the county that qualify as high-hazard dams. For more information on dam failures, and the vulnerability to Calvert County populations, please refer to the above section on dam failures.

Conclusions for the HAZUS section of this report can be found in the HAZUS conclusion section above. Please refer to the HAZUS section and the HAZUS conclusion section for more information.

Future flooding trends must be examined to understand the future of flooding in Calvert County. By examining the past flood occurrences, trends can be seen in greater detail. As discussed in the future flooding trends section of this report, flooding is likely to increase in future years,

especially with the increased change in climate and weather. For more information, please refer to the future flooding trends section of this document.

Each of the mitigation actions from different planning mechanisms that relate to flooding, flash flooding, and tidal flooding, or some aspects of flooding were reviewed with members of the Calvert County local planning team. The results of those reviews can be found in the mitigation action review section above. Comments for each of those actions is listed as well for each action. By reviewing these mitigation actions, Calvert County is well prepared to conduct a similar review during upcoming hazard mitigation plan updates or annual reviews of hazard mitigation plans. These reviews can also be utilized to help determine edits and changes to the mitigation action plan.

In conclusion, Calvert County is taking valid steps to mitigate the risk of flooding, flash flooding, and tidal flooding events, but should continue to review, adjust, and implement mitigation action measures in the coming years. Calvert County government should continue to work with the public to identify areas of primary and secondary concern for flood events. By looking at all of the aspects of flooding in this report, Calvert County can better understand what type of mitigation actions would be best suited to address flooding occurrences and trends both now and in the future.