



ANNAPOLIS, MARYLAND

NATURAL HAZARD MITIGATION PLAN UPDATE

2012

The information and conclusions contained in this report are intended for use by government officials in emergency preparedness and mitigation planning activities only. They should not be applied in any other context or for any other purpose. They are not intended for use by non-government entities. Anyone seeking to use the information contained in this report is advised to contact the City of Annapolis Office of Emergency Management beforehand for guidance and technical assistance.

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Glossary of Acronyms

AQI -- Air Quality Index
BGE -- Baltimore Gas and Electric
CBRNE -- Chemical/Biological/Radiological/Nuclear/& Explosive Incidents
CCTV -- Closed-Circuit Television
CIP -- Capital Improvements Program
DEP -- Department of Economic Planning
DMA 2000 -- Disaster Mitigation Act of 2000
DNEP -- Department of Neighborhood and Environmental Programs
DNR -- Department of Natural Resources
DPW -- City of Annapolis, Department of Public Works
DPZ -- Department of Planning and Zoning
EAP -- Emergency Action Plan
E911 -- Enhanced 911 Capability
FAA -- Federal Aviation Administration
FEMA -- Federal Emergency Management Agency
FIRM -- FEMA Insurance Rate Map.
HACA -- Housing Authority of the City of Annapolis
HAZUS -- Hazards United States
LEPC -- Local Emergency Planning Commission and Local Fire Departments.
MDE -- Maryland Department of the Environment
MEMA -- Maryland Emergency Management Agency
MLT -- Multi-Hazard
MNRP -- Maryland's Natural Resources Police
NFIP -- National Flood Insurance Program
NOAA -- National Oceanic and Aeronautical Administration
NCDC -- NOAA's National Climate Data Center
NHC -- National Hurricane Center
NWS -- National Weather Service
OEM -- Office of Emergency Management
RDD -- Radiological Dispersion Devices
SERC -- State Emergency Response Commission
USEPA -- U S Environmental Protection Agency
VHF -- High Frequency Radio

1.0 INTRODUCTION

To support better mitigation planning in order to prepare for and minimize the impacts of disasters in the future, Congress enacted the Disaster Mitigation Act of 2000 (DMA 2000). In 2002, the Federal Emergency Management Agency (FEMA) issued regulations to implement requirements for mitigation planning by states and communities. FEMA is the lead agency supporting implementation of the DMA 2000 requirements and will make funds available to support efforts to meet these requirements.

To be eligible for FEMA funds, state and local entities were required to prepare DMA 2000 Hazard Mitigation Plans for natural hazards. The City of Annapolis met that requirement in 2005. The purpose of the plan is to assess the communities' vulnerabilities to natural hazards, man-made and terrorism hazards, and prepare a long-term strategy to address these hazards and prevent future damage and loss of life of Annapolis city residents. In 2009, an update was made to the Annapolis Hazard Mitigation Plan. The update was the outcome of participation from state, county and municipal officials; residents; business owners; and other agencies. This plan is a living document and will be updated accordingly as additional information becomes available.

1.1 Specific Jurisdictions Represented in this Plan

Multiple agencies have assets in The City of Annapolis. This plan applies only to the City of Annapolis assets. Mitigation plans have been prepared by Anne Arundel County, the State of Maryland, St. John's College, and the U.S. Naval Academy. All of these jurisdictions share responsibility in mitigating risks to their assets within the City of Annapolis.

2.0 PLANNING PROCESS

In compliance with DMA 2000 requirements, public participation was sought and encouraged throughout the mitigation planning process. In 2004, a Hazard Mitigation Planning Committee was formed that was comprised of various City of Annapolis staff, Anne Arundel County and State of Maryland staff, and representatives from the US Naval Academy. A series of regular committee meetings resulted in the development of a coordinated effort by the City of Annapolis, Anne Arundel County and State of Maryland for the 2005 *Annapolis Hazard Mitigation Plan*. The public involvement elements of the planning process were addressed through a series of working sessions, public hearings, and review and comment periods. Ultimately, the plan was adopted by the Annapolis City Council. Additional information on man-made hazards and flood mitigation were added to the plan in 2006 and 2007.

An essential element of the first *Annapolis Hazard Mitigation Plan* had been the inclusion of considerations for hazard mitigation in development of all City of Annapolis planning processes. In fact, the Office of Emergency Management (OEM) was formed as a part of the initial hazard mitigation planning process which had been initially led by the Annapolis Planning Department. OEM led mitigation plan additions in 2006 and 2007. OEM participation in weekly department head meetings since its formation has led to incorporation of hazard mitigation elements in all new plans and programs in the City of Annapolis since 2006.

Planning began for the preparation of the updated *Annapolis Hazard Mitigation Plan* in the summer of 2008. A series of meetings were held with OEM, MEMA, a variety of consultants, and multiple City of Annapolis departments. In 2009, the consultant began revisions to the document under the direction of OEM and the Department of Neighborhood and Environmental Programs (DNEP). During the update, the following changes were made to the *Annapolis Hazard Mitigation Plan*

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I Introduction	1 Introduction
II. Overview	3 City of Annapolis Profile
2.1 Population Demographics	3.1 Population Demographics
2.2 Housing Demographics	3.2 Housing Demographics
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2.1 Planning Committee Involvement

In 2004, a multi-agency planning committee was actively involved in identifying and discussing assets and hazards within the City of Annapolis. Discussion and debate were held on the City of Annapolis vulnerabilities to natural hazards and recommendations were generated on how to reduce and prevent potential damage from these hazards. The same organizations were involved with the plan update.

At the direction of planning committee members, the consultant began the update process by reviewing all relevant city plans completed since the initial *Annapolis Hazard Mitigation Plan* was prepared. Plans reviewed included:

- Local Comprehensive Plan
- Sustainability Plan
- Capital Improvements Plan
- Evacuation Plan
- Historic Preservation Plan
- Transportation Improvement/Retrofit Program
- Mutual Aid Agreement

Most of these plans are available on the City of Annapolis website at www.annapolis.gov. Upon completion of a draft updated *Annapolis Hazard Mitigation Plan*, review and comment were sought from the Planning Committee membership. Organizations represented on the Planning Committee include:

- City of Annapolis Fire Department
- Anne Arundel County Police
- City of Annapolis Planning and Zoning Department
- City of Annapolis Department of Neighborhood & Environmental Programs
- City of Annapolis Department of Public Works
- City of Annapolis Police Department
- City of Annapolis Office of Emergency Management
- City of Annapolis Harbormaster
- Maryland Emergency Management Agency
- Federal Emergency Management Agency

The Planning Committee members reviewed the Plan and presented their comments at the Committee's April 19, 2012 meeting. The Plan was subsequently updated to in response to the members' feedback.

2.2 Public Involvement

Public involvement with hazard mitigation planning has been a part of all planning activities in the City of Annapolis since 2006. Public involvement has been conducted in the development of the following plans:

- Local Comprehensive Plan
- Sustainability Plan
- Capital Improvements Plan
- Evacuation Plan
- Historic Preservation Plan
- Transportation Improvement/Retrofit Program
- Mutual Aid Agreement

As in 2004 and 2005, the public involvement specific to the update of the *Annapolis Hazard Mitigation Plan*, was addressed through a series of working sessions, public hearings, and review and comment periods on the plan update. The vehicles used were two of Annapolis' public commissions – Planning and Environmental. Both commissions have representatives appointed by City Council members representing each Council District. Both have regularly scheduled, publicized and well attended monthly meetings. The Planning Committee believed that seeking comment through the Commissions would be the best way to obtain informed comment on the document.

The first public meeting on the plan update was held June 3, 2010 during a regularly scheduled Planning Commission meeting. The plan was publicized as an agenda item in the public notice of the meeting on the City of Annapolis web site and in the local newspaper. The Commission provided comments, reviewed and approved the following goals:

- Goal 1.0 – Continued operation and continuity of government
- Goal 2.0 – Minimize effects each of the hazards identified for Annapolis
- Goal 3.0 -- Create awareness among residents of these potential hazards and how they can protect themselves and their properties from damaging events
- Goal 4.0 -- Protect existing community assets in the City of Annapolis from damage caused by these hazards
- Goal 5.0 – Protect the Chesapeake Bay tributaries surrounding City of Annapolis to the maximum extent practicable
- Goal 6.0 -- Ensure hazard mitigation goals are consistent with goals and objectives of other plans in Annapolis and Anne Arundel County

The second public hearing on the plan update was held on July 16, 2012 during a Public Safety Committee meeting of the Annapolis City Council. The meeting was advertised in press releases, on the City Council agenda, and on the Office of Emergency Management website. At the meeting, staff from the Office of Emergency Management reviewed details of the plan update and responded to public questions and comments.

A public comment period on the plan update was held from July 16-30, 2012; whereby the plan was posted on the City of Annapolis web site and the library held copies for review. Based on comments received during that public comment period, and from MEMA and FEMA, a final plan was provided to the Annapolis City Council for adoption.

2.3 Agency Review

The Maryland Emergency Management Agency (MEMA) will serve as the State of Maryland review agency and clearinghouse. The following agencies will also receive a draft of the plan for review and comment once the City of Annapolis has adopted the Plan:

- Federal Emergency Management Agency (FEMA), Region III
- Maryland Department of Natural Resources (DNR)
- Maryland Department of the Environment (MDE)

3.0 CITY OF ANNAPOLIS PROFILE

As characterized by the Annapolis *Hazard Identification and Risk Assessment* of 2002, The City of Annapolis is located in Anne Arundel County, MD on a peninsula between two tributaries of the

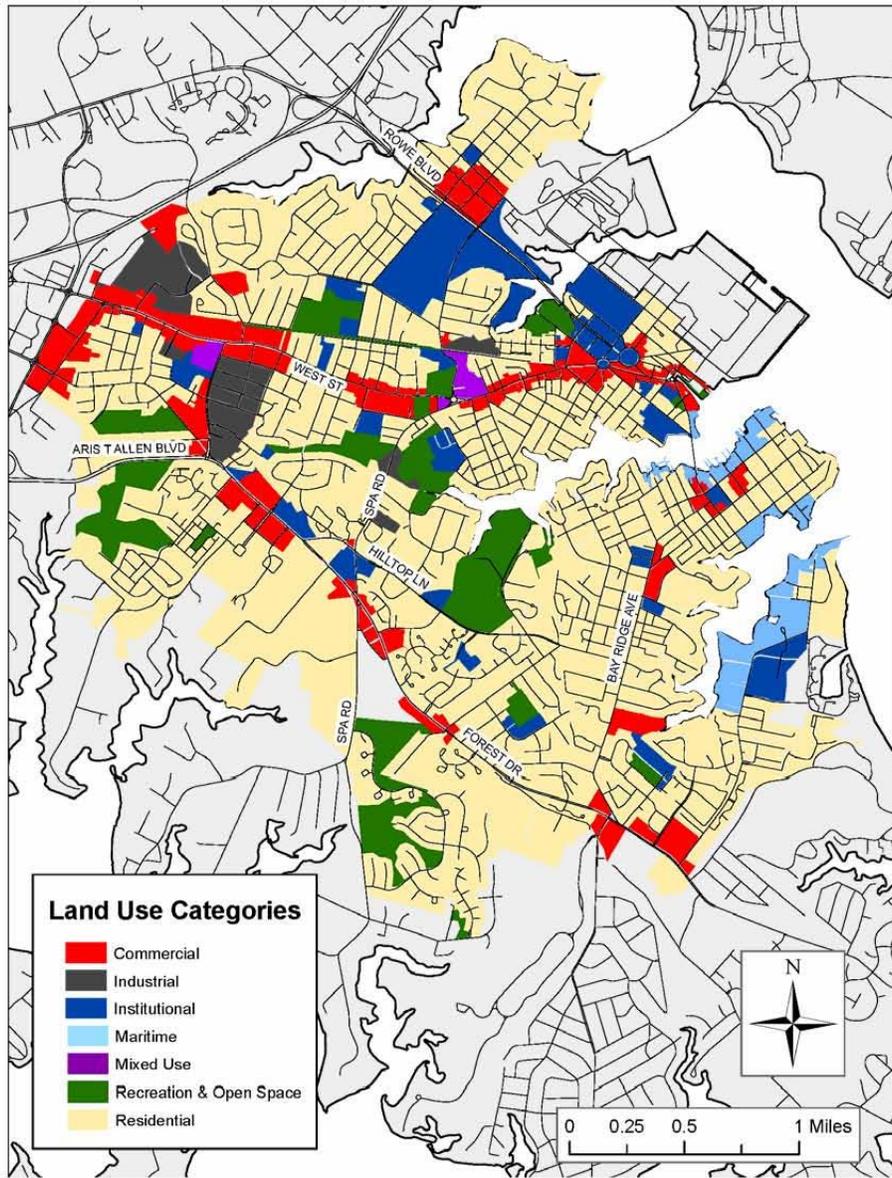
Chesapeake Bay, the Severn and South Rivers. Historically, the City of Annapolis functioned as a port City, state capital, and freestanding center for a predominantly agricultural region. In recent decades, the City of Annapolis has been increasingly affected by its location within the commuter



sheds of the metropolitan areas of Baltimore to the north and Washington, DC to the west. Because of this location, increasing numbers of residents choose to live in the City of Annapolis or the adjacent Anne Arundel County and commute to jobs in the Baltimore or Washington region. Completion of a series of highway improvements in recent years, including widening of US Route 50/301 and construction of Interstate 97 and Aris T. Allen Boulevard (Route 665) have reduced travel times to these metropolitan areas and helped spur development in Anne Arundel County. With the exception of relatively recently annexed areas along Forest Drive, the City of Annapolis has experienced less development than Anne Arundel County because of the lack of vacant land.

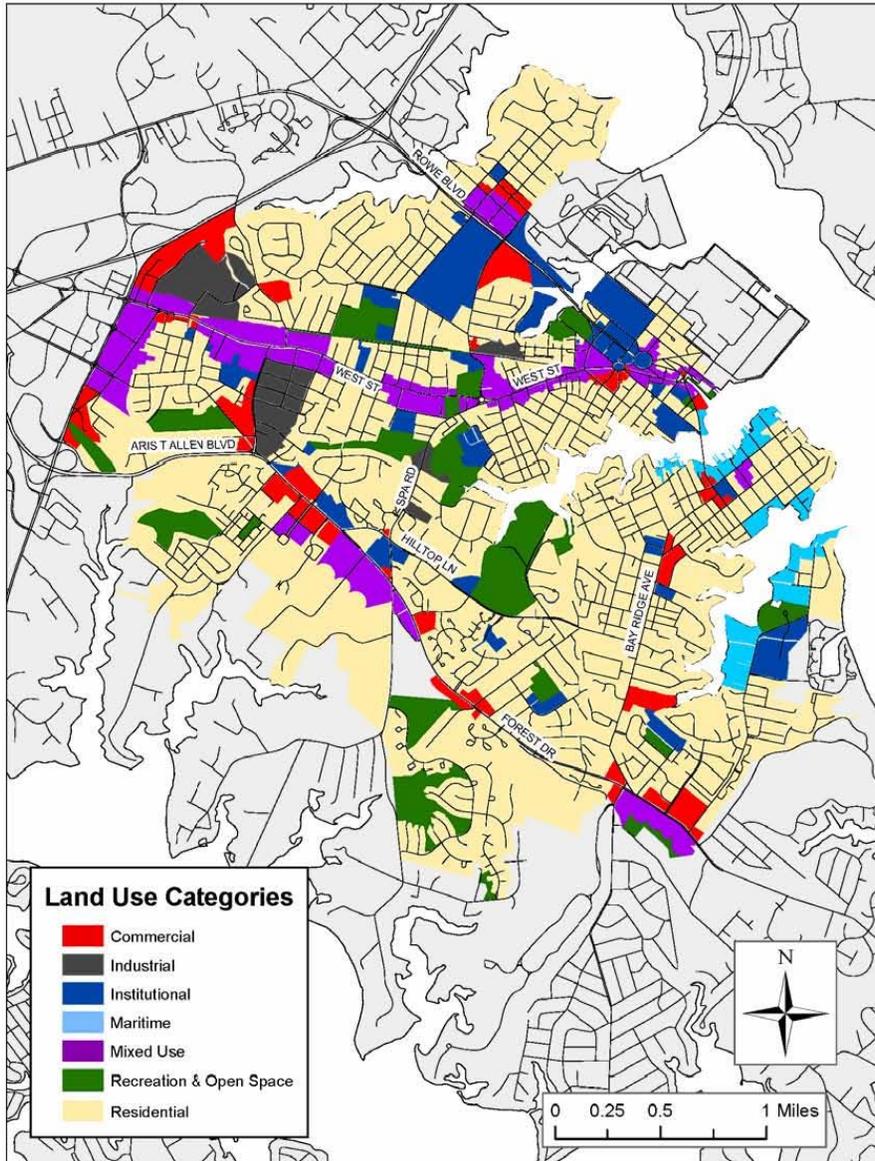
The geographic context of the City of Annapolis can best be characterized as a cul-de-sac, due to the City of Annapolis' location on a peninsula surrounded on three sides by water. Rowe Boulevard and other local arterials provide access to the regional highway system to the northwest of the City of Annapolis, which converges at Parole.

Figure 3-1 Present Land Use



Source: City of Annapolis Comprehensive Plan (2009)

Figure 3-2 Future Land Use



Source: City of Annapolis Comprehensive Plan (2009)

3.1 Population Demographics

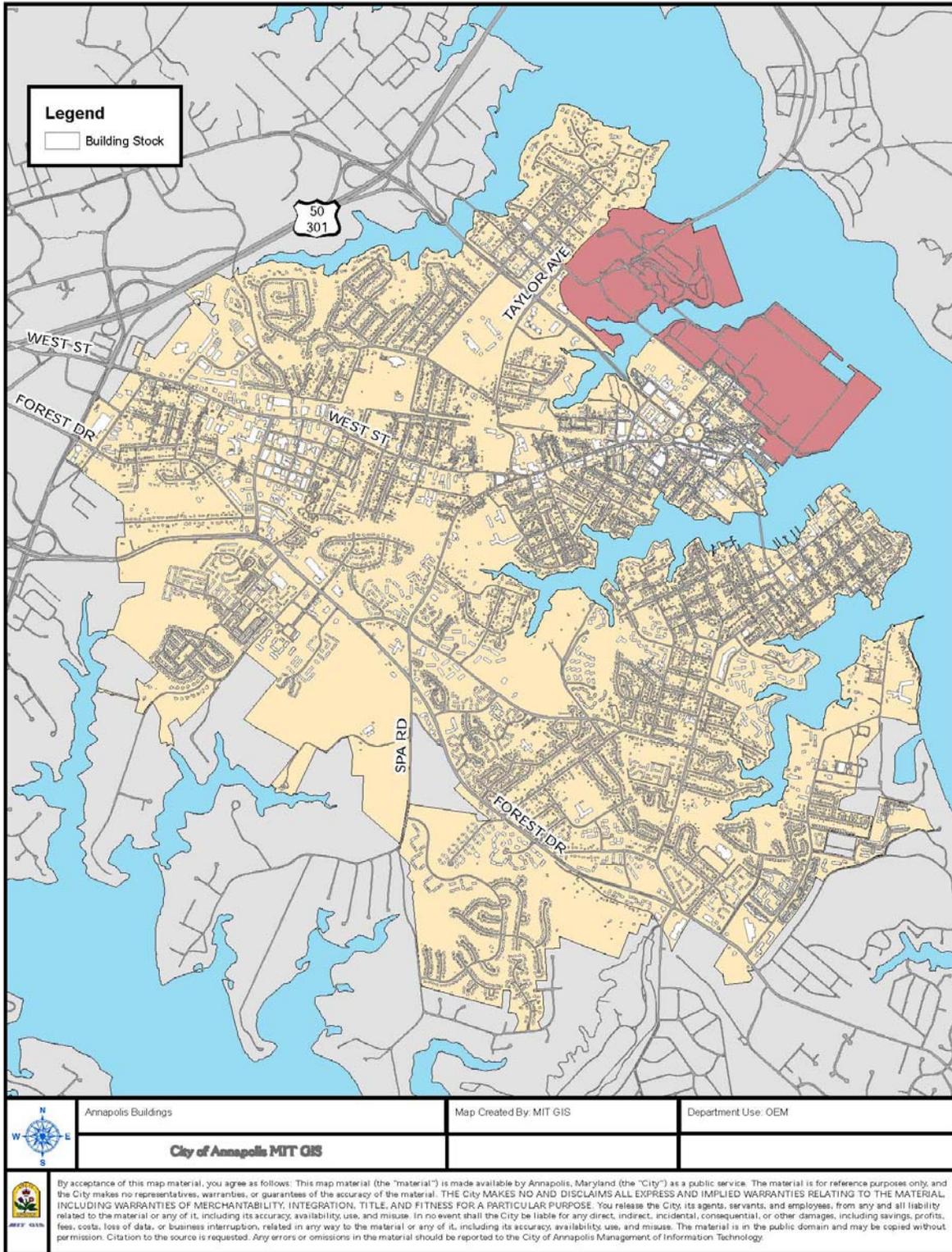
The City of Annapolis population was estimated at 38,394 in 2010, an increase of approximately 7.1% from the 2000 population of 35,838. Since much of the City of Annapolis is developed, the population of the City of Annapolis is projected to continue growing at a modest pace for the foreseeable future. In addition, the City of Annapolis derives significant economic benefit from a healthy tourism industry, the state capital, and the presence of two colleges within the City of Annapolis' limit. On certain days during any year, the City of Annapolis population may swell by an additional 10,000 to 50,000 people.

The City of Annapolis demographics indicate that the City of Annapolis is widely diverse in many aspects. Based on 2010 demographic profile data, the City of Annapolis population has a median age of 36.0 years old. The population is approximately 60% Caucasian and 37% identified themselves as minorities. The largest minority groups include African Americans at 26% and Latinos at 16.8%. It is conceivable that an unmeasured number of undocumented individuals reside in the City of Annapolis, a population that receives City of Annapolis services and benefits from infrastructure, but may not be accounted for in quantitative analyses presented in this plan.

3.2 Housing Demographics

The 2010 Census determined that there are 17,845 housing units in the City of Annapolis. Approximately 89% of the housing units were occupied at the time of the Census. In the City of Annapolis, the vacancy rate of homeowner units is 3.8%, and the vacancy rate for rental units is 7.3%. Fifty-four and one half percent (54.5%) of the housing stock is owner occupied and 45.5% is rental occupied. One of the unique features of the City of Annapolis that will play an important role in the education of the public on loss prevention is the location of a substantial number of public housing units within the City of Annapolis. Further, to support the tourism and secondary learning industries described above, the City of Annapolis has several pockets of large hotel space and student dormitories. Both of these housing features will also need to be addressed in mitigation plans.

Figure 3-3 Building Stock



3.3 Economic Demographics

The City of Annapolis income profile, from the 2010 Census, is as follows:

Median Income of Households:	\$70,229
Per capita income:	\$41,124

According to the Census, the median value of owner-occupied housing units is \$425,100. The City of Annapolis is also a vibrant business community with county, state and federal government offices. Approximately 18,500 people work in the City of Annapolis – excluding those who work in education or public administration.

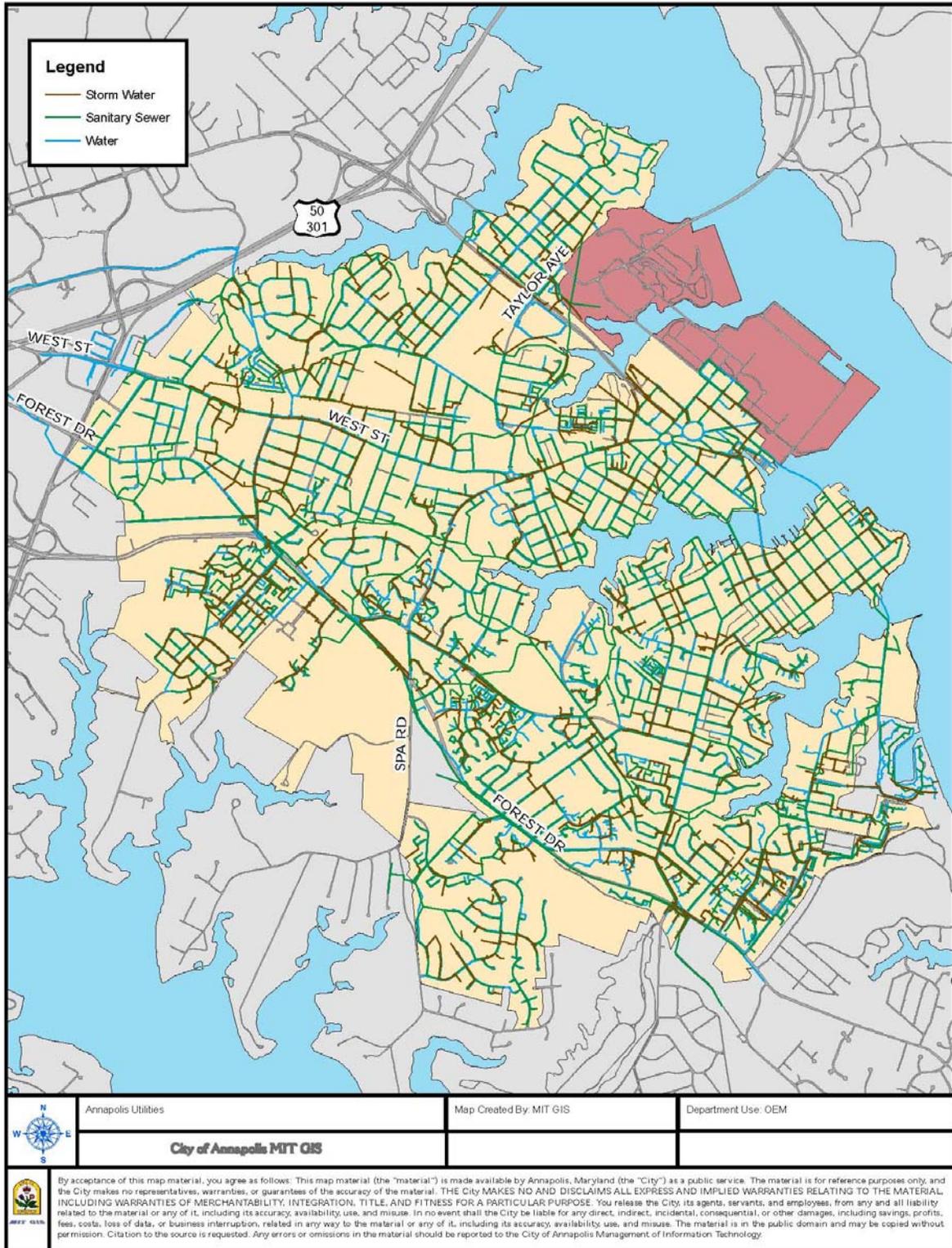
3.4 Critical Facilities and Other Essential Services within Annapolis City Limits

The City of Annapolis provides essential services such as water, fire and police to its residents. Much of this is conducted in close coordination with Anne Arundel County.

Public utilities serving the City of Annapolis include water, sanitary sewer, storm water drainage, and solid waste. The City of Annapolis manages these utilities with exception of the wastewater treatment facility, which is the responsibility of Anne Arundel County Department of Public Works.

The City of Annapolis is served by a municipal police force consisting of 116 sworn officers and 67 civilian personnel. The City of Annapolis is divided into seven (7) areas for patrol by car and downtown area is divided into sections for foot patrol. The Fire Department is served by a municipal fire and rescue force of approximately 128 firefighters, 6 of whom are civilian personnel. The Annapolis Fire Department provides fire and disaster protection, emergency health care, rescue, and related services for the City of Annapolis as well as adjacent parts of Anne Arundel County.

Figure 3-4 Annapolis Utilities



4.0 RISK ASSESSMENT

This chapter contains the hazard profile, loss estimates, and vulnerability assessment, as well as detailed information about each natural hazard.

4.1. Hazard Profile

To adequately assess the risk of those hazards selected, the previously prepared *Hazard Identification and Risk Assessment for Natural Hazards* was used as the primary reference. That research was conducted recently enough to be considered accurate. Where appropriate, information was updated in reliance on the Annapolis Watershed Management Plan, the Annapolis Flood Mitigation Plan, and the draft updated Anne Arundel County Hazard Mitigation Plan. The assessment was reviewed and approved by the City of Annapolis government.

4.1.1. Hazard Identification

The City of Annapolis is at risk from a broad range of natural hazards. Below is a list of natural hazards that are known to threaten the United States:

<u>Natural Hazards With the Potential To Affect Annapolis</u>	<u>Natural Hazards Not Considered Based on Low Probability of Impact in Annapolis</u>
<ul style="list-style-type: none">• Coastal Storm• Coastal Erosion• Drought• Earthquake• Extreme Heat• Flood<ul style="list-style-type: none">○ Coastal/Tidal Flooding○ Rainfall Generated○ Flash Flooding• Freezing Rain/Icing• Heavy Snowfall• Severe Winter Storm• Windstorm<ul style="list-style-type: none">○ Hurricane○ Tornado○ Severe Thunderstorms or Tornado○ Frontal Passage	<ul style="list-style-type: none">• Avalanche• Expansive Soils• Land Subsidence• Landslide• Tsunami• Volcano

Many of those natural hazards can only occur in areas with certain geographic features. To focus mitigation resources to the maximum extent possible, the City of Annapolis eliminated from its planning process:

1. Hazards unlikely to occur within the City of Annapolis
2. Hazards unlikely to cause significant economic damage to the City of Annapolis and its residents.

Other highly unlikely hazardous events are addressed by Anne Arundel County and the State of Maryland planning processes. This document focuses on mitigation plans for damages from hazards that might reasonably be expected to impact the City of Annapolis – not necessarily all those hazards that could affect the City of Annapolis. For a more thorough description of all hazards, see the Anne Arundel County Hazard Mitigation Plan Update (2010).

4.1.2. Data Gaps

A noticeable data gap in the risk assessment concerns the transitory nature of the City of Annapolis population. As described in Section 3, the City of Annapolis is home to State of Maryland offices, including the State Legislature; Anne Arundel County offices; St. John’s College; the U.S. Naval Academy; Annapolis City government offices; retail establishments; commercial services for boating; and hospitality/tourism. Each of these factors puts greater numbers of individuals at risk from hazards at different times during the year. (For example, Navy football games during hurricane season). All of these considerations are addressed in the mitigation plans described in Section 5 of this document.

4.1.3. Natural Hazards

According to NOAA’s National Climate Data Center (NCDC) database, from 1950-2011, Anne Arundel County experienced 60 flood events, 2 hurricanes, 3 tropical storms, 19 tornadoes, 41 thunderstorm and high wind events, 41 lightning events, and 56 hail storms. Many of these events caused property damage, injuries, and deaths.

Below is selected information on a variety of natural hazards: It has been developed in reliance on other documents prepared for the City of Annapolis, and information made publicly available by the Federal Emergency Management Agency (FEMA). This information was the basis of the valuation of damage from multiple events in the City of Annapolis. Guidance requires each hazard’s location, extent, probability, and past events to be stated. It can be assumed that the probability of occurrence for most hazards (except flooding) is the same probability as in Anne Arundel County and that the location (other than flooding) would be within the boundaries of The City of Annapolis.

4.1.3.1. Extreme Heat

Episodes of extreme heat typically are characterized by high temperature and high humidity. Extreme heat can cause water

shortages, fire hazards, excessive energy demands and damage to infrastructure.

Location: When the air temperature is above 90 degrees F and the relative humidity is high, the body is under great stress to maintain its normal temperature. When this situation occurs, heat exhaustion can result followed by heat stroke. Prolonged temperatures near 100 degrees during the day with little cooling at night have caused distress among at-risk populations in the City of Annapolis who do not live in air-conditioned housing.

Extent: The climate in the City of Annapolis is considered temperate and rarely do extreme weather impacts cause significant disruption within the City of Annapolis. With its temperate climate, these variations rarely cause significant disruption in the City of Annapolis. The potential for extreme heat events is uniform for all of Anne Arundel County. All people and assets are considered to have the same degree of exposure.

Probability: The City of Annapolis' average monthly temperatures and precipitation are moderate in severity, with average precipitation well distributed throughout the year. Only approximately 2% of the time does the maximum temperature rise 10 degrees above normal and 1% of the time does the maximum temperature rise 15 degrees above normal.

Past Events: For the 2012 Plan update, data from the NCDC database was used to identify past extreme heat events for Anne Arundel County. This data indicated that between 1950 and 2011, there were 21 extreme heat events that affected Anne Arundel County. These events occurred between 1995 and 2008. The database provides no indication as to why there are no events prior to 1995, although presumably occurrences follow the same pattern and frequency as shown in the NCDC list.

4.1.3.2. Flooding

Authorized under Section 553 of the National Flood Insurance Reform Act of 1994, the Flood Mitigation Assistance Program supports local governments in funding cost-effective actions that reduce or eliminate the long-term risk of flood damage to buildings, manufactured homes, and other insurable structures, as well as reduce or eliminate claims under the National Flood Insurance Program (NFIP) through mitigation efforts.

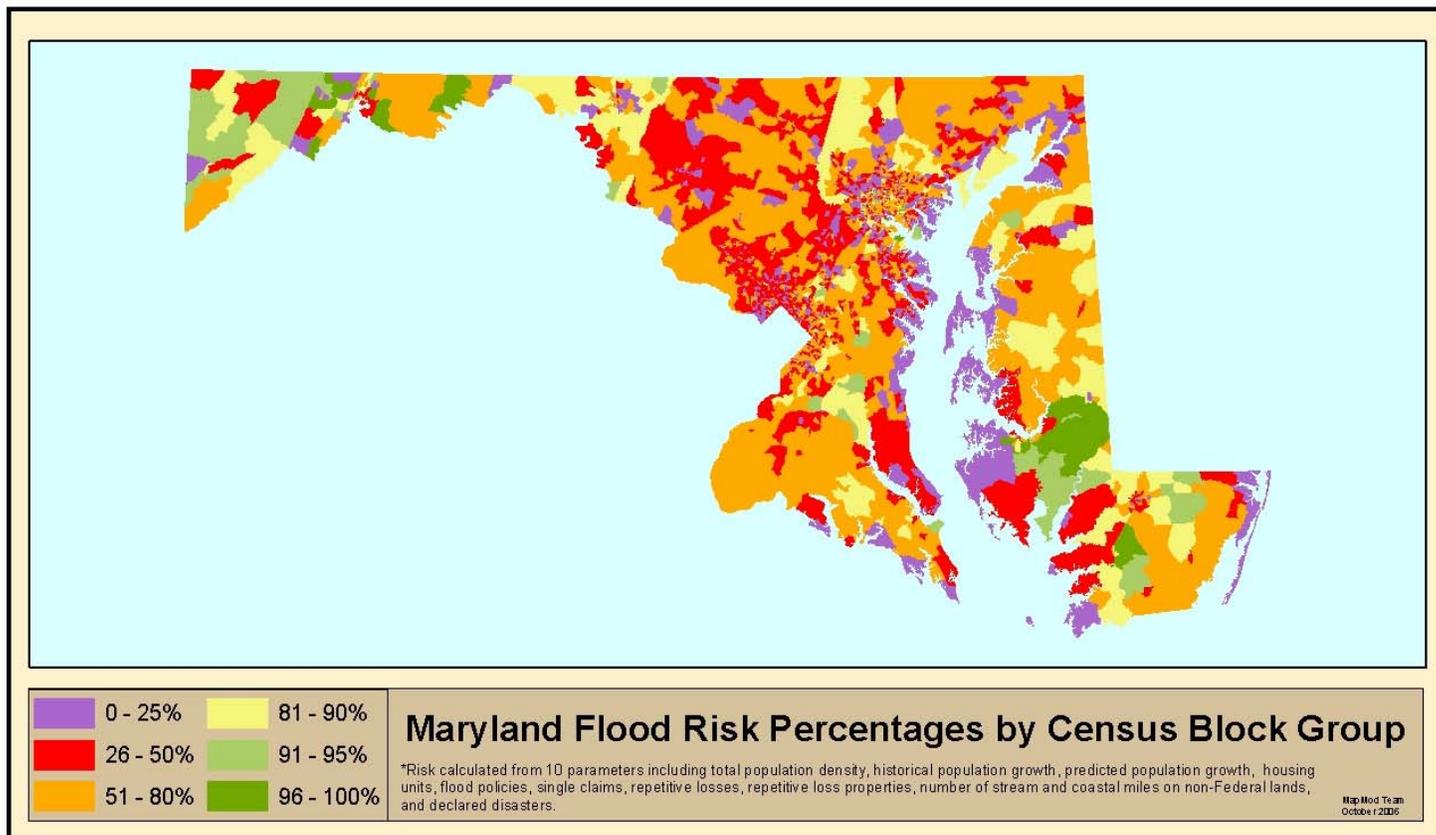
The City of Annapolis is surrounded by water on three sides, making it susceptible to flooding associated with meteorological events. Therefore a flood mitigation plan is crucial to the well being of the city's residents, business owners and government.

As defined by NFIP guidelines, a flood is "a general and temporary condition of partial or complete inundation of normally dry land areas from the overflow of inland or tidal waters or the unusual and rapid accumulation or runoff of surface waters from any source." The term "flood stage" refers to the level at which waters begin to rise above riverbanks – it does not account for tidal influence. High water is generally not considered to be a problem until it begins to adversely affect people or their property. There are three general classifications of flooding:

- Nontidal Flooding - flooding from rivers, streams, etc. with gravity flow downstream
- Tidal Flooding - flooding by slowing rising water from tides and storm surges
- Coastal High Hazard Flooding - flooding from static tidal flooding with the addition of waves of at least three feet

In a 100-year floodplain, there is a one percent chance of flooding each year but floods may occur more frequently than once a century. Regulated by local floodplain ordinances adopted by communities that are in the NFIP, only the outer edge of the 100-year floodplain has that one percent risk. The risk rises for sites closer to the flooding source and at lower elevations. Areas within the mapped 100-year floodplain may flood more frequently and to greater depths than others, and a floodplain line shown on a map is not absolute. The flood map modernization efforts for the State of Maryland have resulted in the generation of Figure 4-1 below, depicting risk from flood by census block. Note that FEMA is currently revising the 100-year floodplain. It will be included in the next Mitigation Update after it is finalized.

Figure 4-1



4.1.3.2.1. Description of the Existing Flood Hazard

From the first recorded flood on May 11, 1860 in Baltimore City to the devastating floods caused by the tidal surge of Hurricane Isabel in September 2003, Maryland has been subject to its share of major flooding events. The state is prone to three types of flooding: nontidal flooding (flooding in the non-tidal portion of rivers and streams), tidal flooding (flooding from tides and storm surges), and coastal high-hazard flooding (the addition of wave action to tidal flooding).

As sea level rise has become an issue studied by the Maryland Department of Natural Resources (DNR) and the US Environmental Protection Agency (USEPA), it seems appropriate to note that the change in sea level in Annapolis has increased by .22 feet in the last epoch (19 year spans). However, the Federal Government (US EPA) has generated the graphics presented below that indicate a possible change in flood scenarios due to impending

sea level changes. Consequently, changing global conditions may add a fourth type of flood risk in the City of Annapolis necessitating implementation of mitigation measures (Figures 4-2 and 4-3).

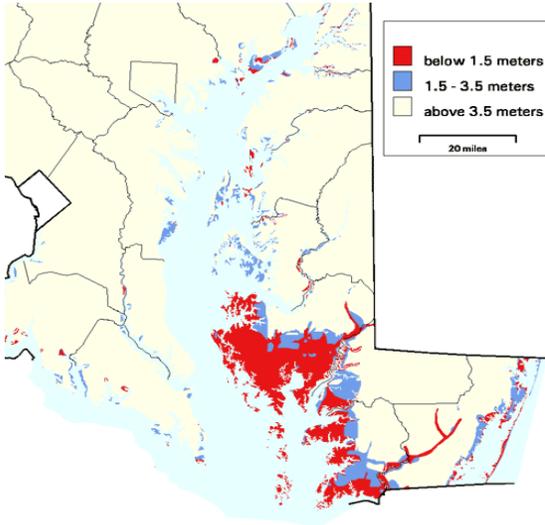


Figure 4-2

Land areas to be impacted by sea level rise in three categories – red if sea level rise is less than 1.5 meters, blue if between 1.5 and 3.5 meters and yellow if over 3.5 meters. (US EPA)

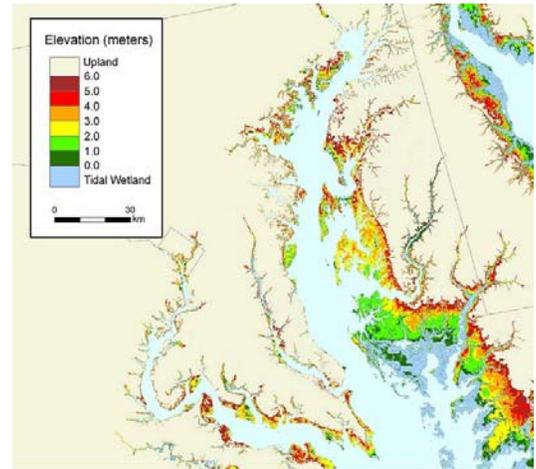


Figure 4-3

Projected elevation in sea level as a result of global warming. Recorded in meters (US EPA)

Since it is regulated by local flood ordinances adopted by communities in the NFIP, the 100-year floodplain – which has a one percent chance of flooding in any given year -- receives the most attention with regard to flood mitigation. In the City of Annapolis, the 100-year floodplain lies at the seven-foot elevation. Rarely have floodwaters in the City of Annapolis reached that level.

Below is a list of the significant flooding events in Annapolis as identified by the Maryland Department of the Environment and the City of Annapolis Department of Planning and Zoning:

1954

October 14-16 -- Hurricane Hazel dumped heavy rains on North Branch of the Potomac River, causing flooding from Cumberland to Washington DC. Winds of over 100 mph were reported on Eastern Shore. The tide elevation in Annapolis was 5.34’.

1955

August -- Hurricanes Diane and Connie, which arrived a week apart, produced a high tide of 4.81'.

1972

June 21-24 -- Hurricane Agnes, the worst non-tidal flood in 36 years and regarded as the 100-year flood in many places, flooded many parts of the state. The tide elevation in Annapolis was 3.04'.

1974

December 1 -- Storms and tidal surges caused damage statewide, especially on the Western Shore of the Bay. The tide elevation in Annapolis was 4.10.

1979

Sept. 5-6 -- Hurricane David floods Rock Creek, Jones Falls, and East Branch Herbert Run. The recurrence interval was 50 - to more than 100-year. The tide elevation in Annapolis was 4.46'.

March 28-29 -- Statewide flooding and intense coastal erosion, especially along lower Chesapeake Bay, caused two deaths.

1985

Nov. 4-7 -- Hurricane Juan, combined with stationary front, caused flooding statewide, especially in the Potomac River basin. One death and \$5 million in nontidal and \$16 million in tidal damages were recorded. The recurrence interval was 2 - to more than 100-year. High tide in Annapolis was 4.5'.

1991

October 31 --- Halloween flooding event for the costume party at the bars---Annapolis tide reached 3.6' resulting in patrons building sand bag bridges from bar to bar at dock space.

1996

Sept. 6 -- Remnants of Hurricane Fran triggered widespread flooding in Western Maryland, especially George's Creek, causing \$1.7 million in damages. In Annapolis, tides reached 5'.

1999

Sept. 16 -- Hurricane Floyd produced widespread flooding on Eastern Shore, especially in northern portions. Damages were calculated at \$14 million, and some places saw greater than 500-year flood. In Annapolis, tides were very close to the predicted astronomical tide and did not exceed 1.5'.

2003

Sept. 18-19 -- The remnants of Hurricane Isabel caused widespread tidal surge flooding, especially in the middle portion of the Bay. High tide in Annapolis was 7.35', which is considered greater than the 100-year flood event. See Figure 4-4.

2005

October 8 – Remnants of Tropical Storm Tammy caused widespread storms and resulting flooding.

2006

June 27, - Double digit rainfall resulting from a four-day cold front produced flash flood in Annapolis caused approximately \$30,000 in property damage.

2008

May 12, 2008, wide spread showers and thunderstorms produced a flood that caused \$100,000 in property damage in Annapolis.

Although there were significantly more storms during the past 150 years, the events of concern here are those that produced flooding. The City of Annapolis Department of Public Works, relying on NOAA data to measure hourly water-level height at the United States Naval Academy, identified only one event in the past six years that had resulted in water levels greater than the four-foot elevation line. That was Hurricane Isabel, a greater than 100-year flood. Therefore the committee determined that the four-foot elevation line would be selected as the mitigation elevation.

Figure 4-4. Flooding in downtown Annapolis, September 19, 2003 (source: Annapolis.gov)



4.1.3.3. Hurricane

Tropical cyclones are among the most powerful and destructive meteorological systems on earth. In addition to very high winds, they are accompanied by a variety of destructive phenomena including heavy rain, lightning, tornadoes, and storm surge. They are identified in three categories: tropical depressions, tropical storms, and hurricanes.

Hurricanes are defined as tropical cyclones with maximum sustained surface wind speed exceeding 74 mph. For coastal areas, the storm surge caused by a hurricane typically is the most dangerous and damaging phenomenon. It is defined as an abnormal local rise in sea level that accompanies a tropical cyclone. The end result is that water is pushed onto a coastline (as described in flooding above). The most notable storm surge in recent City of Annapolis history was that caused by Hurricane Isabel in September 2003.

Probability: Because of its location, hurricanes and their effects are relatively rare in the Chesapeake Bay. On any given year there is an approximately 20% chance of a tropical cyclone (greater than or equal to 39 mph sustained) passing within 75 miles of the City of Annapolis, and only an approximately 3% chance of a hurricane passing within 75 miles of the City of Annapolis.

Location: Tropical cyclones have the potential to pass both to the west and to the east of the City of Annapolis and the Chesapeake Bay. The most dangerous storms for City of Annapolis are those that pass very close to the west with southeasterly winds that cause storm surges up the Severn River. The majority of storms affecting the City of Annapolis, however, approach from the southwest and pass to the east.

For the purposes of this plan, any tropical cyclone approaching within 180 nautical miles of the City of Annapolis is considered a potential threat. This is because the City of Annapolis would have to respond to such a threat by activating its Emergency Plan.

Extent: The tropical cyclone season for the City of Annapolis area lasts from early June to the beginning of November. The highest rate of occurrence is from the beginning of August to late October.

Previous Occurrences: Historically, all hurricanes affecting the City of Annapolis have occurred in this interval. The 87 tropical storms and hurricanes have passed within 180 miles of City of Annapolis over 115 years (1886-1999). Of the 87 total storms passing the City of

Annapolis, 26 were of hurricane strength at their closest point. In some years, no tropical cyclones pass within 180 of the City of Annapolis while in other years up to five have passed by the City of Annapolis. Most storms pass the City of Annapolis (near 39°N) after recurvature. The Eastern Shore of Maryland provides enough natural protection, combined with the limited size of the Chesapeake Bay, to prevent the few passing storms from generating high winds or large storm surges in the City of Annapolis area. Most tropical cyclones affecting the City of Annapolis area make landfall far to the south on the Atlantic seaboard or pass well to the southeast of the Chesapeake Bay entrance.

The primary approach axis for storms during June-July is overland from the southwest after making landfall in the Gulf of Mexico or along the Atlantic coast. This primary approach axis shifts far to the east during the following months of August-September. Although the majority of tropical cyclones still make landfall before reaching the Chesapeake Bay, storms tend to travel much farther up the Atlantic coast before encountering land during August-September allowing them to maintain wind intensity.

NCDC database indicates that three tropical storms occurred in Anne Arundel County between 1950-2011. The first event, Hurricane Floyd, occurred in September 1999, and the second, Hurricane Isabel, occurred in September 2003. Both events were downgraded to tropical storms by the time they reached the Mid-Atlantic region.

Additionally, in late August 2011, Hurricane Irene made landfall and impacted much of the mid-Atlantic region. The storm caused serious injuries and deaths, damaged homes and businesses, hammered shorelines, disrupted travel, and caused over \$10 billion worth of damage in the United States. Though the flooding in Annapolis was not as disruptive as Hurricane Isabel, many homes and businesses experienced flooding from the massive amounts of rainfall in the weeks during and after the storm.

Location: The most dangerous storms for the City of Annapolis Harbor, Naval Station Annapolis, and the U.S. Naval Academy are those that cause surges up the Severn River resulting in flooding. Storm surges in the City of Annapolis are produced when winds from the south retard the Severn River outflow. The effects of a storm are further amplified by heavy rainfall and resulting runoff. Storms passing to the west of the City of Annapolis provide southerly wind fields over the Chesapeake Bay that creates surges up the Severn

River. Flooding of the inner basin of the City of Annapolis Harbor can occur whenever a storm surge of three feet or greater is experienced at the mouth of the Severn River. In addition, storm surges of three feet or greater cause the Farragut and Dewey seawalls at the US Naval Academy to become questionable moorages.



U.S. Naval Academy Seawall



Annapolis City Dock

Slow moving storms (23 mph) traveling northward would cause the greatest storm surges in the City of Annapolis area. Faster moving storms (46 mph), although moving in the same direction, have smaller surge effects on the City of Annapolis. Category two tropical storms or greater passing in close proximity to the City of Annapolis have a reasonable chance of causing flooding in the harbor and making the seawalls at the U.S. Naval Academy unusable for moorage.

Probability: It has been over 100 years since a hurricane has entered the Chesapeake Bay with an orientation that would bring it near the City of Annapolis, although hurricanes passed within 75 miles of the City of Annapolis in 1954 and 1983. NOAA estimates such an event would result in a 100-year frequency type of hurricane, where wind speeds reach 90-100 mph. While this occurrence is rare, there should be no doubt that such an event would cause significant wind and flood damage within the City of Annapolis that might well severely disrupt the City of Annapolis and take several years from which to recover. Many historic structures might well be damaged beyond repair, permanently changing the character of the City of Annapolis and causing significant damage to the City of Annapolis's tourism industry. Based on approximately 60 years of historical data from the NHC, the probability of future tropical storms impacting Maryland and Anne Arundel County is moderate, averaging approximately one event every five to six years.

4.1.3.4. Severe Thunderstorm

Severe thunderstorms can generate torrential rainfall, high winds, frequent lightening, and hail. The National Weather Service (NWS) uses wind speed and hail size to define "official" severe thunderstorms. A thunderstorm is declared severe by the NWS if wind gusts reach 57.5 mph or stronger or if hail size is three quarters of an inch or bigger. Hailstones are balls of ice that grow as they are held up by thunderstorm updrafts while super cooled water drops hit and freeze onto them. The faster the updraft, the bigger the stones can grow.

When updrafts are strong, intense downdrafts, or downbursts, can occur. These downbursts often create gusty winds of nearly 60 mph, and on some occasions gusts have been recorded as high as 160 mph. These winds can smash buildings and easily uproot trees, and are often mistaken for tornadoes. Large hailstones can cause severe damage to plants, automobiles, and also pose a threat to people caught outside in a storm. Heavy rain and flash flooding from severe thunderstorms also pose a serious threat to life and property. Lightning is a very serious threat from any thunderstorm. Whether it is severe or not, officials recommend people know and obey lightning safety rules when a thunderstorm is near.

Microbursts are similar to downbursts - but smaller. A microburst only affects a path of 2.5 miles or less and lasts less than 10 minutes. Downbursts can affect a much larger area and for a longer period of time. Often wind damage that is blamed on tornadoes is actually done by winds coming down from a shower or thunderstorm. Such "microburst" winds can reach more than 150 mph.

Average annual precipitation varies from 40-44 inches and is fairly evenly distributed throughout the year. Most precipitation in the colder half of the year is the result of low pressure systems moving northeast along the coast. In the summer, precipitation occurs in the form of showers and thunderstorms. Thunderstorms occur on average of 31 days per year.

Probability: The City of Annapolis has a moderate probability of thunderstorm occurrence when compared to other parts of the U.S. that experience thunderstorms. The City of Annapolis can expect approximately 50 thunderstorm events per year.

Past Events: During the period 1950-2011, the City of Annapolis experienced three thunderstorms that met the hailstone size criteria of ¾" in diameter. In addition, the City of Annapolis experienced 11

thunderstorms that produced wind, which exceeded the Severe Thunderstorm threshold of 58 mph.

If one considers 60 years of data as a predictor of severe thunderstorms in the City of Annapolis, it would appear a severe thunderstorm impacts the City of Annapolis approximately once every 5 years. This equates to moderate risk when compared to other communities located east of the Rocky Mountains.

Extent: Finally, weather fronts pass through the City of Annapolis area throughout the year. While cold front passage in the spring, summer, and fall is often associated with lines of thunderstorms, winter passage of cold fronts is often accompanied by high winds that can occur over a regional area. The high winds are normally predictable and forecast by the NWS by the issuance of either a High Wind Watch or Warning.

Location: Normally, winds associated with frontal passages can result in trees being downed and possibly cause scattered power outages. Rarely do they cause wide spread sustained disruption within the City of Annapolis. Other impacts can be the banning of high-profile vehicles from the Bay Bridge causing temporary disruption to the flow of traffic over the bridge.

Cold front passage normally results in wind blowing primarily from the Northwest to the Southeast. Since the City of Annapolis is located on the western shore of the Chesapeake Bay, this prevailing wind direction has the beneficial result of not causing Bay waters to back up into the estuaries that dissect the City of Annapolis.

4.1.3.5. Tornado

Tornado intensity is measured using the Fujita Scale. The intensity of each tornado is determined by the NWS through a field investigation conducted by meteorologists.

Past Events: While the City of Annapolis has not experienced a direct strike from a tornado in recent times, a significant risk from tornadoes exists within the City of Annapolis. Compared with other States, Maryland ranks number 33 for frequency of tornadoes, 37 for number of deaths, 33 for injuries and 35 for cost of damages. When we compare these statistics to other States by the frequency per square mile, Maryland ranks number 15 for the frequency of tornadoes,

number 30 for fatalities, number 28 for injuries per area and number 27 for costs per area. (Based on data from 1950 – 1995)

From 1950 through 2011, Anne Arundel County was the second most tornado prone county in the State of Maryland. Between 1950-2011, 21 tornadoes struck Anne Arundel County. The most severe was an F3. Deaths from tornadoes in Anne Arundel County were limited to 3 people during that 61-year period.

Extent: Time of day has a strong correlation to the probability of a tornado.

While a tornado can occur at anytime of the day, the vast majority of tornadoes strike in the late afternoon and evening. Furthermore, stronger tornadoes tend to occur later in the day. This is why schools are rarely in session when tornadoes occur. It is normally those in after school activities that are often at risk when schools are struck by tornadoes.

Probability: In summary, the occurrence of tornadoes in Anne Arundel County can be expected about once every three years with an intensity of probably no more than F2.

Location: If occupants of the City of Annapolis take proper shelter during a Tornado Warning, they successfully can weather a tornado striking within the City of Annapolis. Tornadoes are some of the most extreme weather events known to occur on earth and the broad generalization that the City of Annapolis has a minimal tornado risk must be taken with some caution.

4.1.3.6. Severe Winter Weather

While the City of Annapolis generally experiences relatively mild winters, severe winter weather impacting the City can take the form of heavy snowfall, a Nor'easter, or freezing rain/ice storms. Nearly the entire United States is considered at risk for severe winter storms. When these storms occur in the South, unprotected pipes are especially vulnerable. Disruption in water service and decreases in water pressure cause a cascading problem for emergency responders. Heavily populated areas are particularly impacted when severe winter storms disrupt communication and power due to downed lines from high winds and icing. Debris associated with heavy icing may impact utility systems and transportation routes.

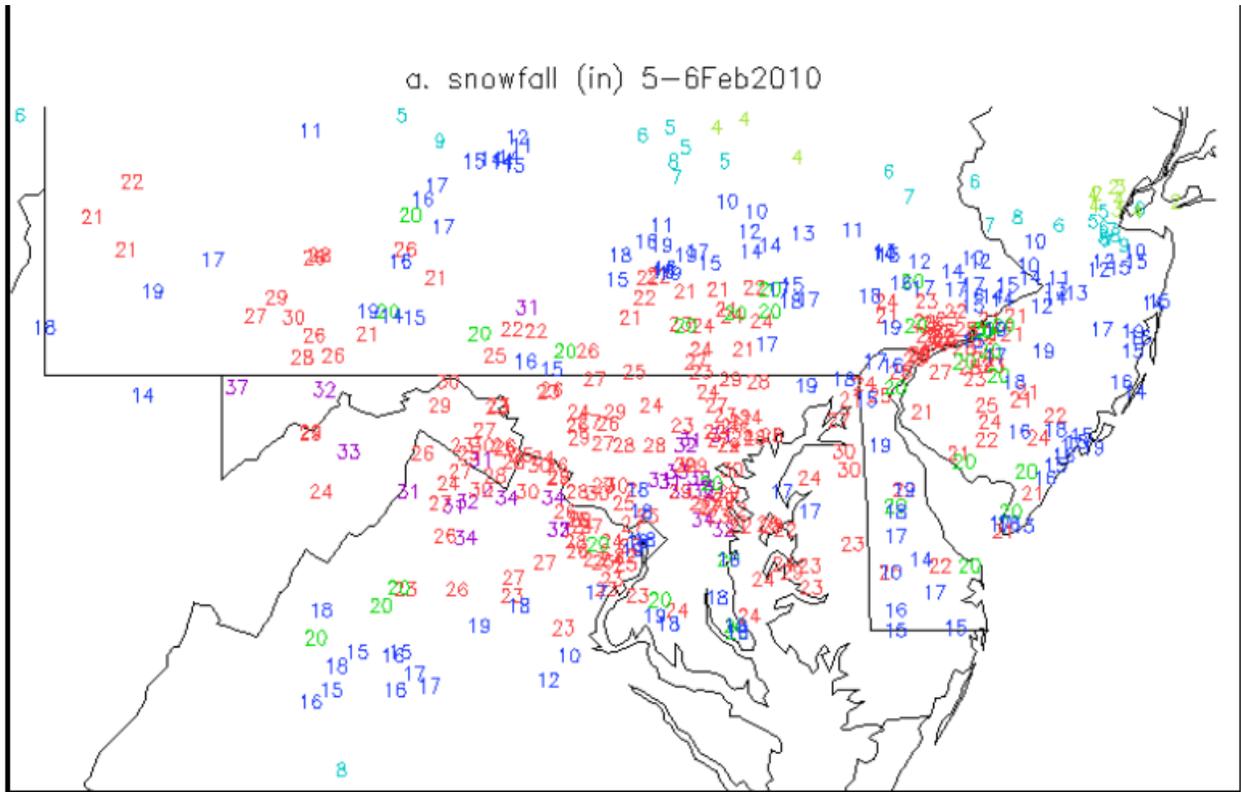
Past Events: The NCDC database shows four deaths and 16 injuries from 68 winter storms between 1950 and 2009 in Anne Arundel County. Of the 68 winter storms, three resulted in injuries.

Based on records kept, the City of Annapolis receives only a moderate snowfall as shown in Figure 4-5. With respect to heavy snowfall, the City of Annapolis' averages are somewhat deceiving in that the City of Annapolis will often go several years with little measurable snow, only to be followed by a single heavy or extremely heavy snowfall. As an example, the snowfall during the 2010-2011 winter season set a seasonal total at BWI, Airport of over 45.5 inches.

<i>November</i>	<i>Trace</i>
December	.6
January	1.7
February	6.6
March	7.6
Seasonal total:	16.5

The single events that produce the greatest snowfalls in the City of Annapolis are a result of coastal storms forming off the coast of North Carolina or Virginia and track northeast along the coast. These storms are often referred to as Nor'easters and have resulted in record-setting snowfall. As Figure 4-6 demonstrates, the City of Annapolis can exceed its average annual snowfall from one coastal storm event. In these events, the City of Annapolis received approximately 22 inches of snow from the Blizzard of 1996 and the 2003 President's Day Storm showed very similar results with the City of Annapolis again receiving 23" of snow. In the intervening six years, the City of Annapolis experienced minimal snowfall until one winter storm in December 2009 and two severe storms in February 2010 resulted in widespread power outages, closed roads, and significant need for snow removal. The two disasters were declared to provide the state and counties reimbursement funds primarily for snow removal under Public Assistance Category B. Figure 4-6 shows the storm totals for this record-breaking snow event. Values are color coded with cyan for 1-10 inches, blue for 10-20 inches, red for 20-30 inches and purple for values over 30 inches. In Anne Arundel County, storm totals ranged from 22-33 inches.

Figure 4-6
February 5-6, 2010 Mid-Atlantic Snowfall Totals
 (Source: NWS, The Historic Mid-Atlantic Snow Storm of February 5-6 2010 (Draft))



4.1.3.7. Nor'easter

Similar to a hurricane, a Nor'easter is a counter-clockwise turning spawned by a Jet Stream that dips far south allowing cold arctic air to meet warm air. The warm air rises over the cold creating instability up high and an area of low pressure below. Larger temperature differences create greater turbulence. Once the system is formed, the earth's rotation causes the air to circle around the center. This creates the northeast wind, hence it's name Nor'easter.

During the October to April Nor'easter season, February is the busiest month. What Nor'easters do not achieve in wind-speed (as compared with hurricanes), they achieve in duration (up to a week) and size (up to 1000 miles or more in diameter). Nor'easters can be the cause of significant tidal flooding damage in the City of Annapolis.

4.1.3.8. Freezing Rain and Ice

Freezing rain/ice storms can also cause significant disruption. Ice coatings can render roadways impassable, cause trees and power lines to snap, and are known to fill emergency rooms with patients with numerous injuries from falls and traffic accidents.

There were approximately 80 hourly observations of freezing rain at BWI airport over the eight-year period of 1982 to 1990. The level of reported freezing rain averages out to only 10 hours of freezing rain per year.

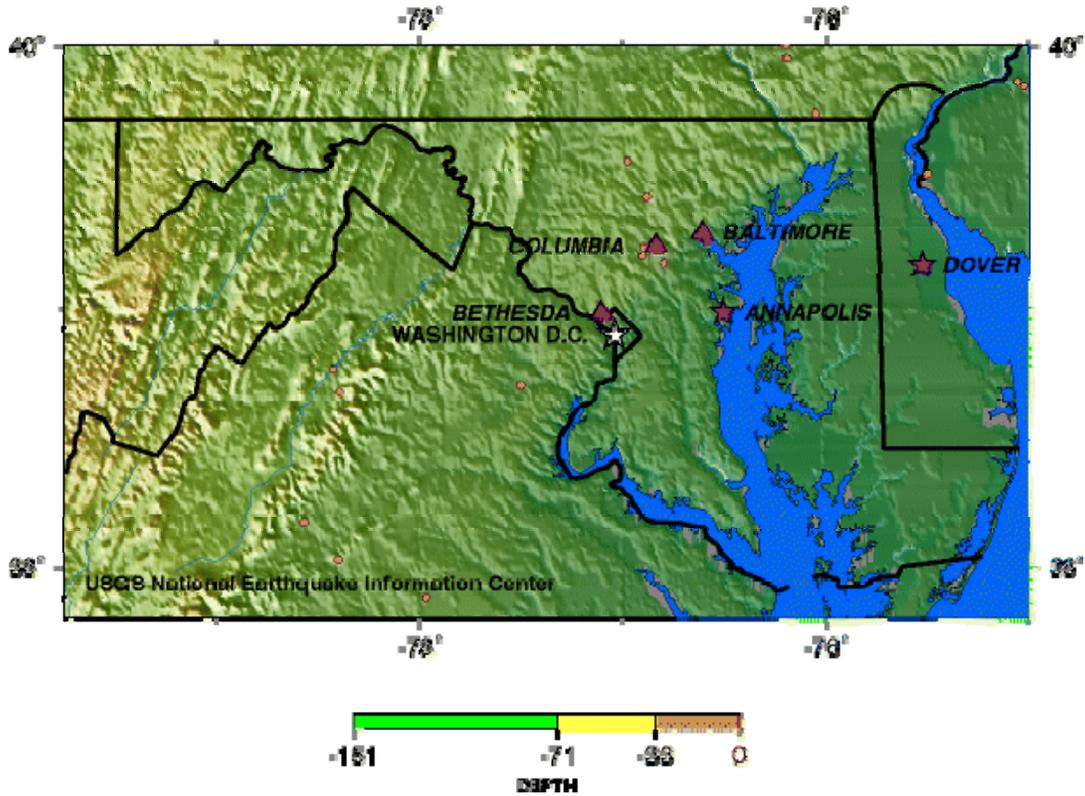
The City of Annapolis does not have a significant history of freezing rains and ice storms thus the City of Annapolis has a moderate risk from freezing rain and ice storms.

City of Annapolis temperatures do not vary significantly from normal daily highs and lows. As an example, only approximately 2% of the time does the minimum temperature drop 10 degrees below normal and 1% of the time does the minimum temperature drop 15 degrees below normal. With its temperate climate, these variations rarely cause significant disruption in the City of Annapolis.

4.1.3.9. Earthquakes

The U.S. Geological survey defines an earthquake as “both sudden slip on a fault, and the resulting ground shaking and radiated seismic energy caused by the slip, or by volcanic or magmatic activity, or other sudden stress changes in the earth.” Numerous “earthquake hazards” may result in Maryland from an earthquake occurring within the State or in another State (i.e. surface faulting, ground shaking, landslides, liquefaction, tectonic deformation, tsunamis, and seiches). Though strong earthquakes are unusual in Maryland, the State occasionally experiences perceptible earthquakes. According to Lamont-Doherty Cooperative Seismographic Network, between 1970 and 2011, the Chesapeake Bay Region experienced 37 earthquakes ranging from 0.1 to 4.1 magnitudes. Other earthquakes outside the region are often felt inside the region, depending on the severity of the earthquake and the density of the area. Recently, on August 23, 2011, a 5.8 magnitude earthquake struck Mineral, Virginia, approximately 125 miles SW of the City of Annapolis and was felt throughout the City. Some structures sustained minor damage.

Seismicity of Maryland 1990 - 2006



4.2 Vulnerability Assessment

The Office of Emergency Management designated 16 sites in the city of Annapolis as critical infrastructure Phase 1 facilities. These sites include water, sanitary sewer, storm water drainage, solid waste, public service and government buildings, and police/fire facilities. To ensure the health and safety of the citizens of Annapolis, the Annapolis Office of Emergency Management conducted critical infrastructure vulnerability assessments. Each infrastructure site was visited, investigated, and given a thorough vulnerability assessment by way of a two hundred point vulnerability checklist including aspects such as: barriers, access controls, lighting, intrusion detection, camera/video surveillance, mail/package control, fuel supply storage, contingency planning, visitor control, and parking/traffic security. Data from the above listed criteria was entered into the computer program "Risk Watch." This program analyzes raw data and calculates the most cost effective means for reducing risk unique to a specific facility. This data can be utilized for predicting the likelihood of naturally occurring disasters to which Annapolis is prone, such as hurricanes, flooding, extreme heat/cold emergencies, terrorist threats, and earthquakes.

Security and continuity of operations are essential elements concerning each and every critical infrastructure site. An increase in threat capabilities and methodologies, and therefore potential infrastructure vulnerabilities, has resulted in a subsequent need for enhanced vulnerability mitigation and overall threat deterrence. Emphasis is given to providing the most effective means of improvement where most needed, while utilizing the most cost effective means possible. In accordance with this, most entrances that may be accessible to the public in the city of Annapolis are securely locked, or are equipped with a uniformed guard and all critical infrastructure facilities are equipped with adequate outdoor lighting. An analysis of the above mentioned critical infrastructure sites has revealed that threat deterrent criteria such as bomb detection, fire detection/alarms, computer systems security, and the effective use of landscape and vegetation rank highest in threat mitigation for the city of Annapolis, according to "Risk Watch." The greatest areas of improvement are in: intrusion detection, camera/video surveillance, mail/package control, and fuel supply storage. Areas which also have the ability to be enhanced are: visitor control, parking/traffic security, and contingency planning. The overarching vulnerability noted is intruder detection and deterrence.

The City of Annapolis recently invested in a range of equipment to bolster protection of its Phase 1 critical infrastructure facilities. Annapolis acquired three mobile generators in addition to transfer switches for the Public Works facility on Spa Road and the Pip Moyer Community Recreation Center. Thirteen more cameras are soon to be utilized at critical infrastructure sites. A fence has also been constructed at the Police Department to enhance security for law enforcement personnel, vehicles, and equipment.

Several additional enhancements are currently planned or underway in response to these findings. A new security system is planned for City Hall that would allow guarded, controlled access to public areas, while at the same time only permit access to sensitive, non-public areas to personnel with coded identification badges. Several additional projects, which would provide transfer switches to additional Phase 1 facilities, will be carried out as soon as the funding is available. Once the transfer switches are in place, City personnel will be able to restore power to critical infrastructure facilities by using the existing mobile generators.

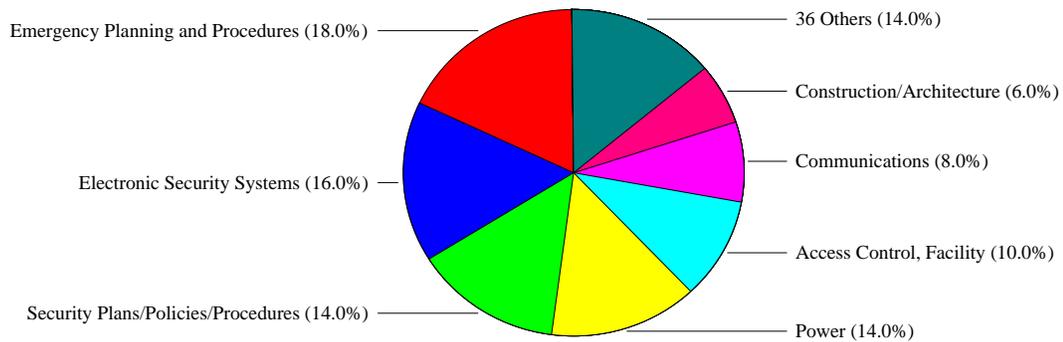
The full vulnerability report for each phase facility is included below. The Office of Emergency Management has completed critical infrastructure vulnerability assessments of Phase 1 facilities. The next step is to conduct the similar assessments and analyses of Phase 2 facilities, which include several pumping stations, the Roger W. "Pip" Moyer Community Recreation Center, Market House, the Maritime Museum, historic buildings, and parking garages.

4.2.1 Phase 1 Facilities

Each Phase 1 facility listed below includes a description and a pie chart indicating the prevalence of each area of vulnerability, as determined from a set of 200 vulnerability questions. Listed below are the evaluation criteria as demonstrated by the corresponding pie charts. The criteria are: Emergency Planning and Procedures, Electronic Security Systems, Security Plans/Policies/Procedures, Construction/Architecture, Communications, Facility Access Control, Power, Fire Suppression/Smoke Evacuation, Security Plans/Policies/Procedures, Computer Systems Security, HVAC Systems, Fuel Supplies/Storage, Fire Detection/Alarm Systems, Vehicle Controls, and Others. All facilities are similarly affected by each of the potential hazards that could impact Annapolis.

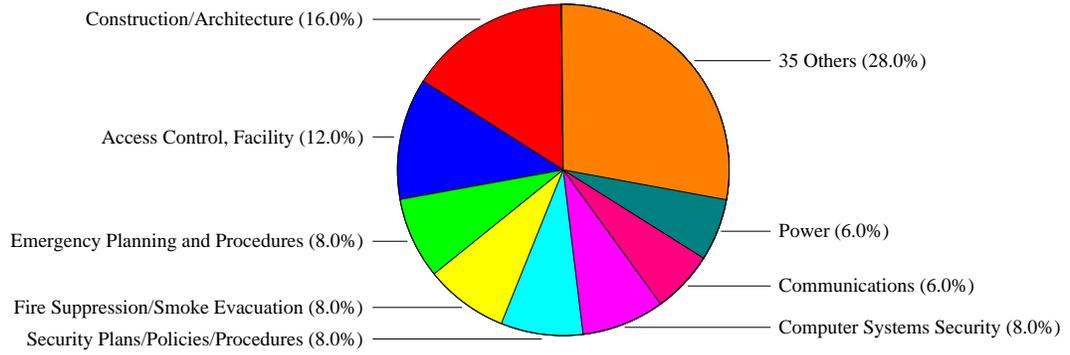
City Hall:

Located at 160 Duke of Gloucester Street in downtown Annapolis, the Annapolis City Hall is home to the Department of Neighborhoods and Environmental Programs (DNEP), Office of Finance, and the Annapolis City Council which is comprised of the Mayor of Annapolis and eight Aldermen and Alderwomen. The role of the City Council is to take legislative action and hold public hearings within City Hall.



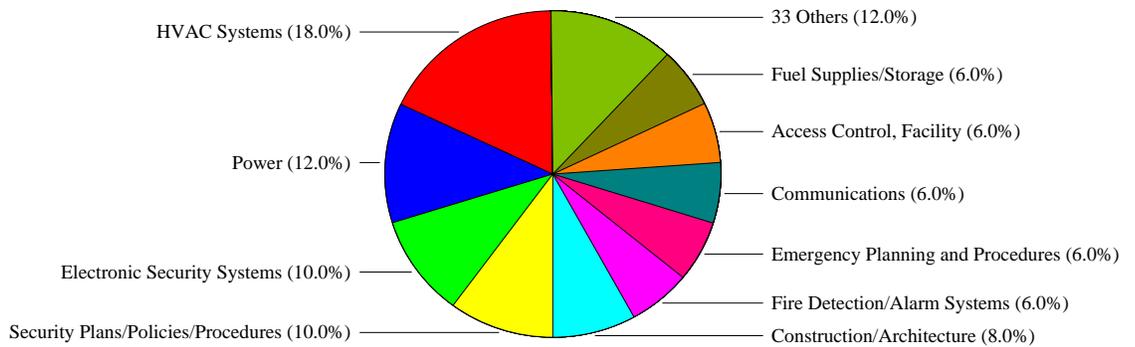
Eastport Fire Station:

Eastport Fire Station is located at 914 Bay Ridge Avenue in Eastport. This fire station services all of Eastport and is equipped with an Advanced Life Support Unit for medical emergencies.



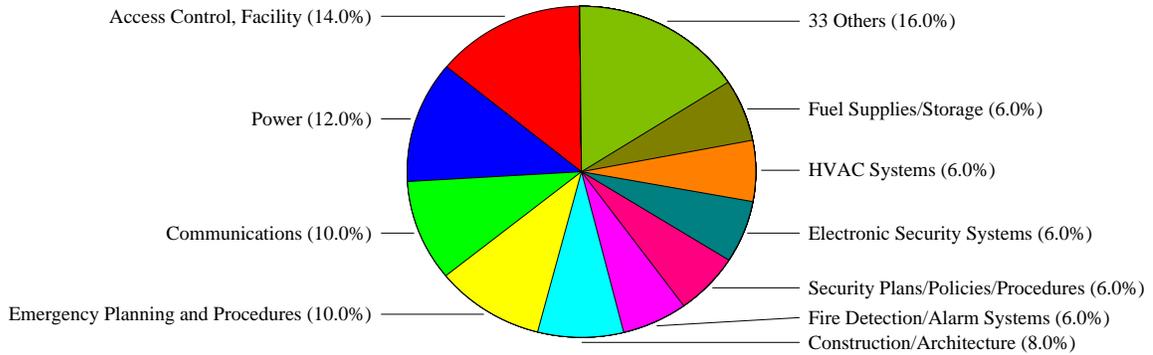
City of Annapolis Fire Headquarters:

The City of Annapolis Fire Headquarters is located at 1790 Forest Drive.



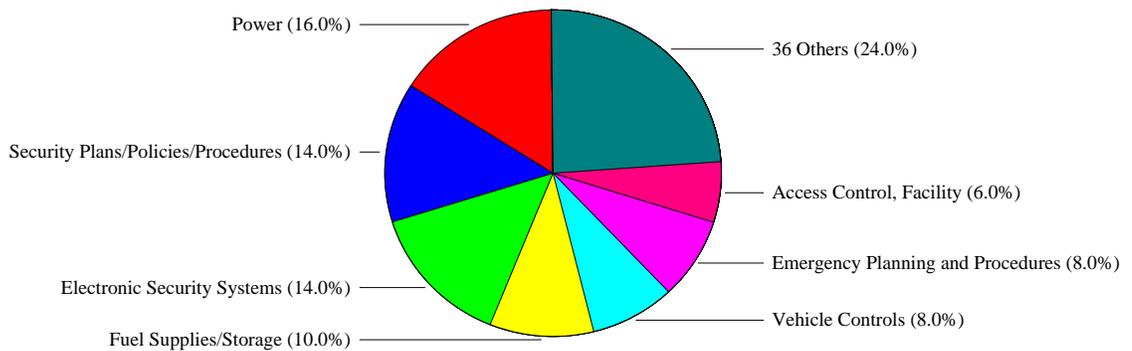
145 Gorman Street:

145 Gorman Street is located next to City Hall in downtown Annapolis. This leased facility contains the Department of Planning and Zoning, Procurement, the City Clerk, Human Resources, and the Office of Law.



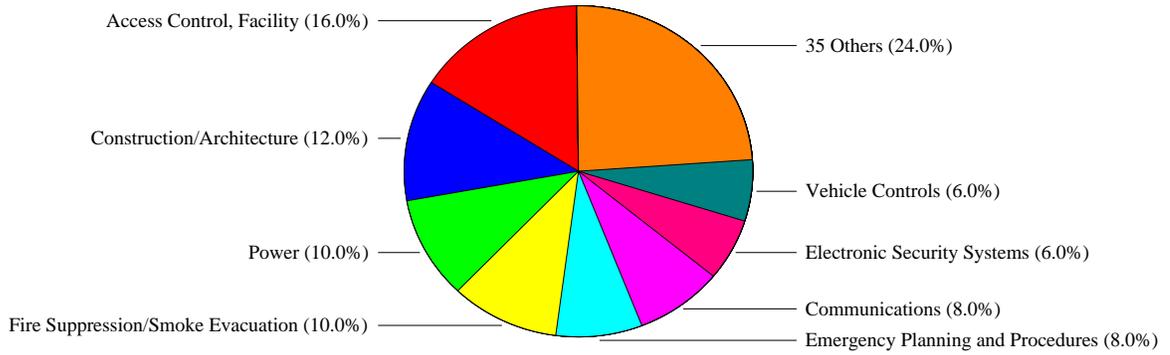
Harbormaster:

The Office of the Annapolis Harbormaster is located at 1 Dock Street in downtown Annapolis. The role of the Harbormaster is to ensure the safe and environmentally sound utilization of the Annapolis Harbor as well as the safety of the boating public.



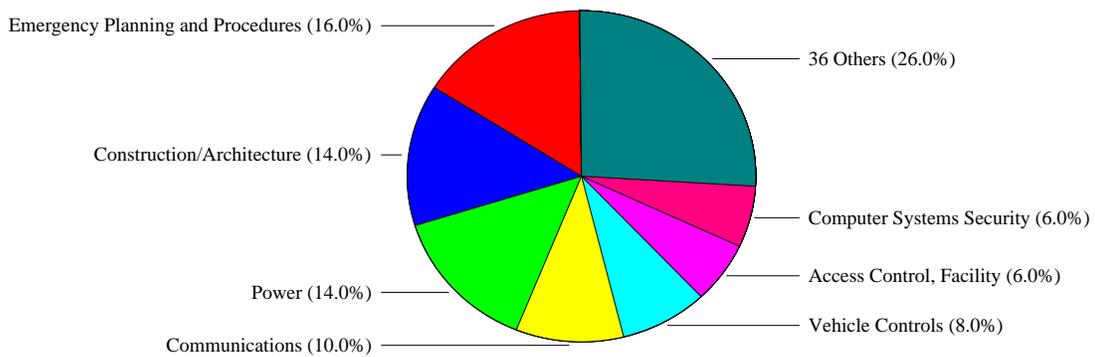
Hillman Garage:

The Hillman garage is the primary parking garage located in downtown Annapolis. It is accessible from Main Street and is located next to 145 Gorman Street and City Hall.



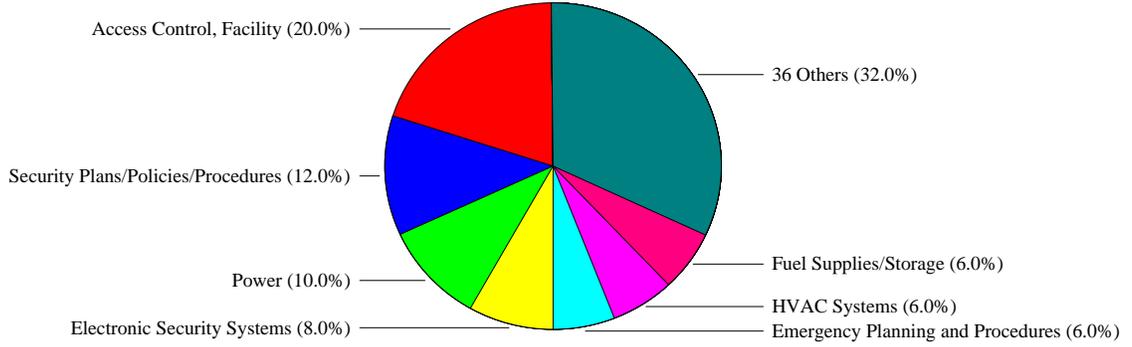
Management Information Technology (MIT):

MIT is located across from the Annapolis City Hall at 161 Duke of Gloucester Street and is a subdivision of the Finance Department. It maintains a central processing computer installation to support the many functions of the Finance Department. MIT is responsible for providing Management Information Technology services to all City Departments.



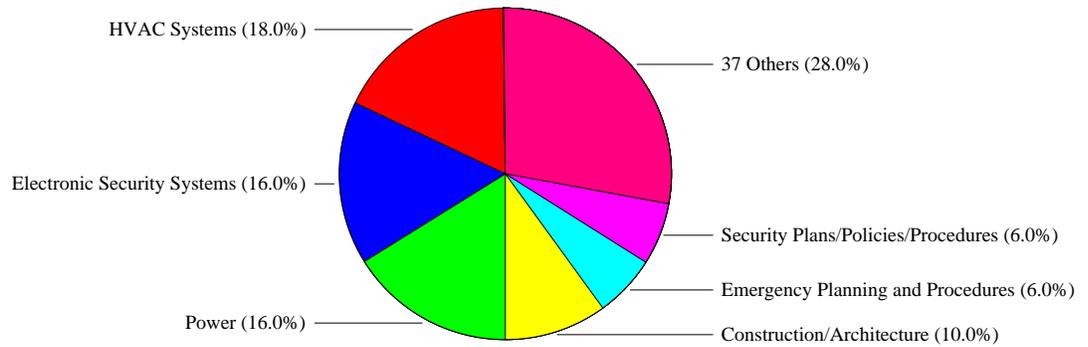
Police Station, City of Annapolis:

The City of Annapolis Police Station is located at 199 Taylor Avenue and shares the facility with the Annapolis Office of Emergency Management.



Public Works, City of Annapolis:

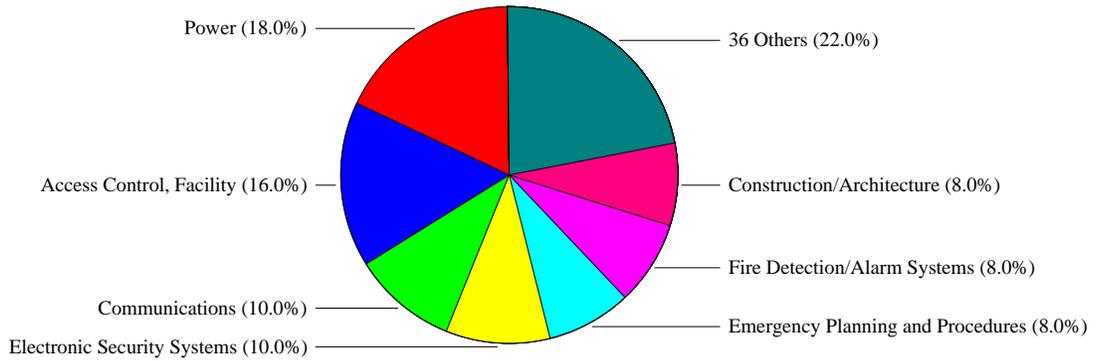
City of Annapolis Public Works has facilities at 935 and 937 Spa Road. 935 Spa Road houses Public Works Services; The City fuel pumps are located at 937 Spa Road.



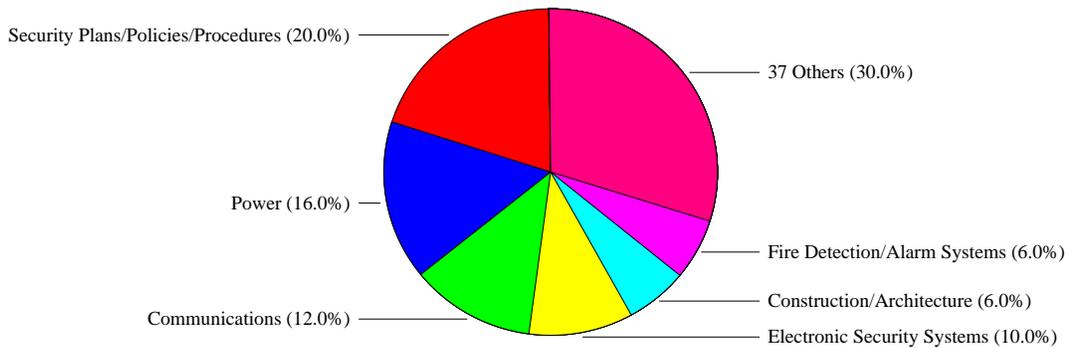
Pumping Stations:

Within the City of Annapolis are 26 sewage pumping stations. City of Annapolis pumping stations are actually “lifting” stations in that the sewage water is actually “lifted” by the station and is then gravity fed downhill to the treatment plant.

Second Street Pumping Station:

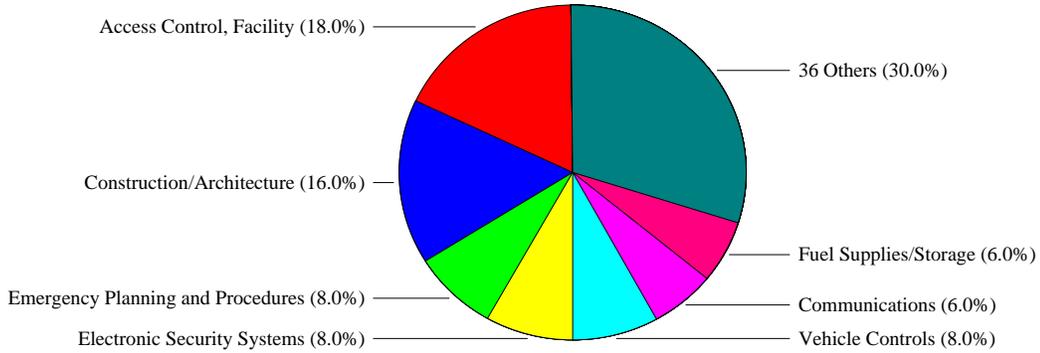


Sample of 10 Other Pumping Stations:



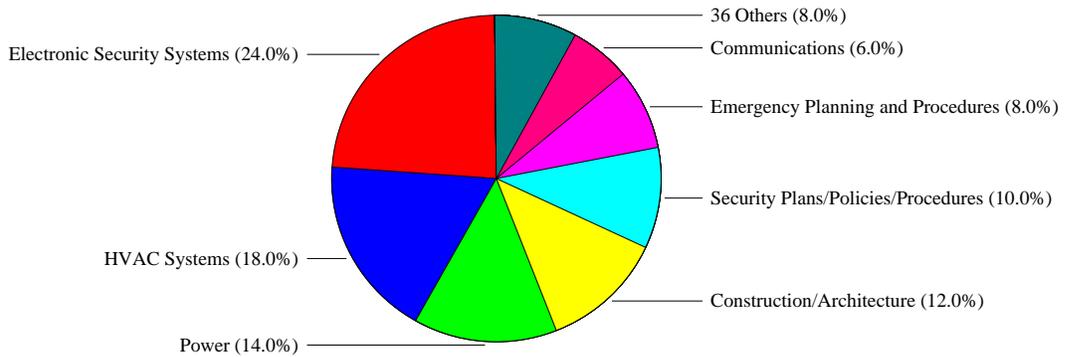
Taylor Avenue Fire Station:

The Taylor Avenue Fire Station is located at 620 Taylor Avenue and is one of three operational fire stations within the City of Annapolis; the others being the Eastport Fire Station and the City of Annapolis Fire Headquarters.



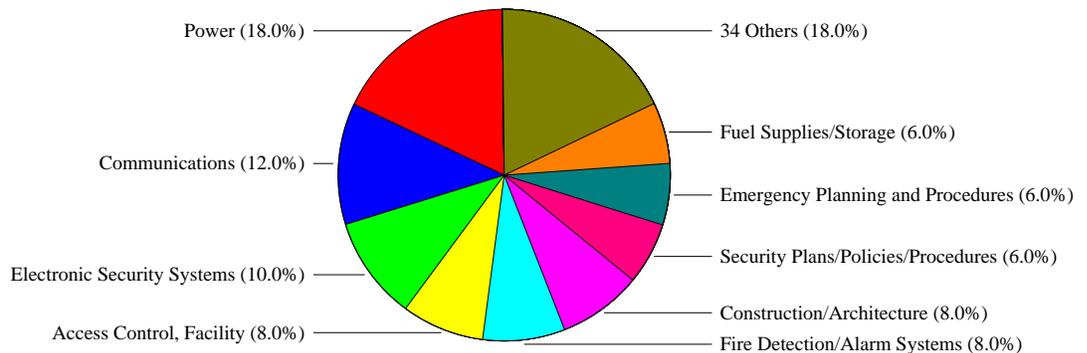
Transportation:

The City of Annapolis Department of Transportation is located at 308 Chinquapin Round Road. This service provides the citizens of Annapolis with safe and reliable public transportation throughout the City as well as providing for emergency transport services in the event of a major disaster.



Water Treatment Plant:

The City of Annapolis water treatment plant is located at 260 Defense Highway. This plant is staffed 24 hours a day, is well secured, and provides safe drinking water for the residents of Annapolis.



Of the above listed charts, several patterns have been observed regarding the fourteen total sites evaluated:

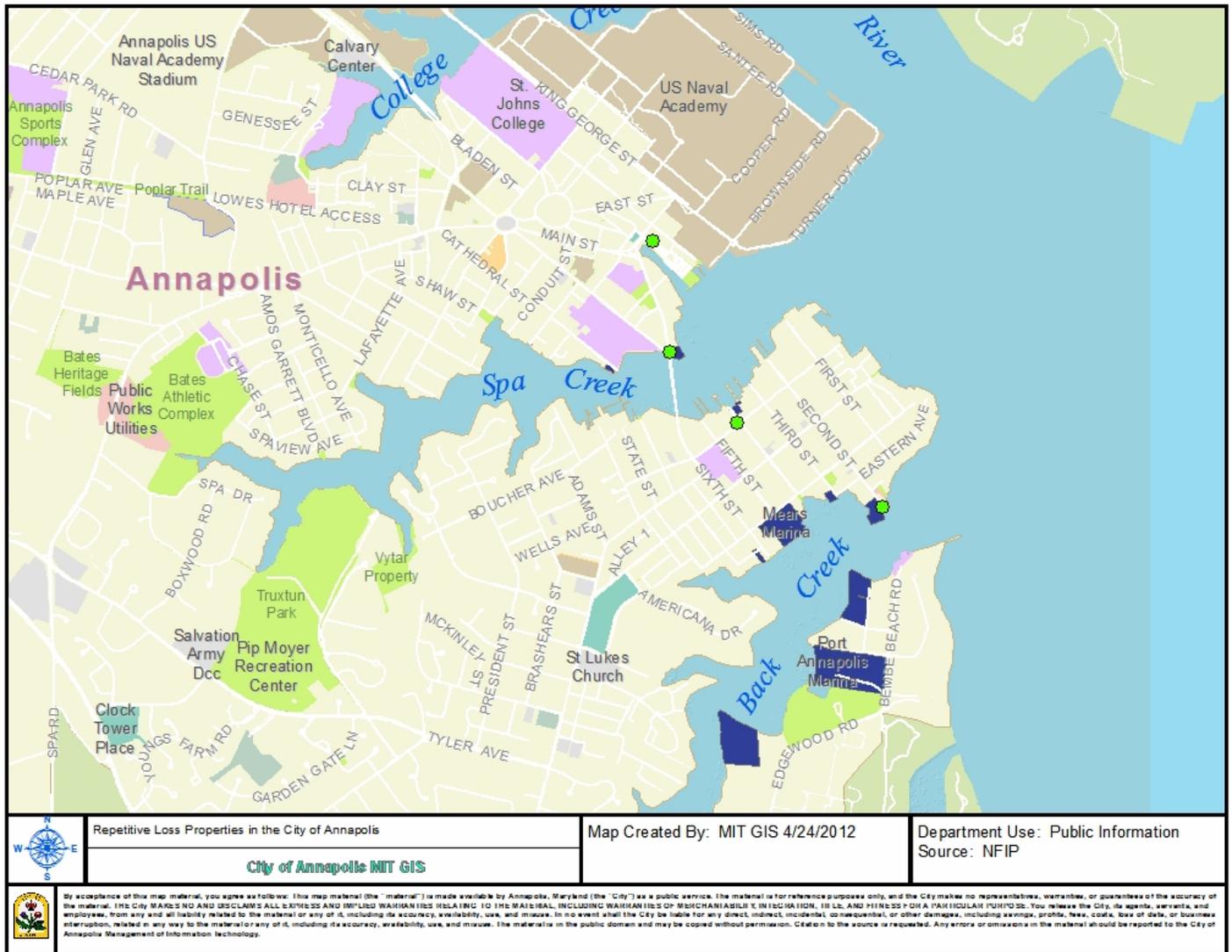
- Eight sites have an “Electronic Security Systems” discrepancy of at least 10%.
- Twelve facilities have a “Power” discrepancy of at least 10%.
- “Electronic Security Systems” and “Transportation” contain the largest single discrepancy at 24%.
- “Emergency Planning/ Procedures” and “Power” are listed the most frequently with thirteen facilities listing them.
- “145 Gorman Street” and “Annapolis City Fire Headquarters” are the facilities containing the most number of discrepancies listed overall with eleven.
- “Fire Suppression/Smoke Evacuation” and “Computer Systems Security” are the discrepancies listed the least number of times with two apiece.

4.3 Process for Estimating Losses

The Office of Emergency Management estimates losses by analyzing National Flood Insurance Program data on properties located in the City of Annapolis. As of September 30, 2011, four properties in Annapolis were designated as “repetitive loss.” These properties filed insurance claims of a minimum amount of \$1,000 each within a 10 year span. The dates of losses surrounding these properties mostly correspond to major storms, such as Tropical Storm Isabel, and other significant flooding events. The general locations of these properties are illustrated in Figure 4-7 below. No properties in Annapolis qualified as “severe repetitive loss,” defined as

filing at least four claims of \$5,000 each, or at least two claims with the cumulative amount exceeding the market value of the building.

Figure 4-7
Repetitive Loss Properties in the City of Annapolis



5.0 MITIGATION STRATEGY

This section identifies and presents the results of the analyses of a comprehensive range of specific mitigation actions and projects that have been considered to reduce the effects of each natural hazard that poses a significant risk to the City of Annapolis. The process for new, or updated, mitigation strategies is based on criteria such as availability of resources, cost of projects, time needed, and staff availability. The prioritization process also places an emphasis on the use of a cost-benefit review to maximize benefits.

5.1. Process for Developing Mitigation Plans

The Annapolis Hazard Mitigation Plan is designed to help the City of Annapolis achieve a series of overarching goals. Those goals are listed below. Each goal is then intended to be achieved through the implementation of the plan elements described in previous mitigation plans and in section 5.3 below.

- Goal 1.0 – Continued operation and continuity of government
- Goal 2.0 – Minimize effects each of the hazards identified for Annapolis
- Goal 3.0 -- Create awareness among residents of these potential hazards and how they can protect themselves and their properties from damaging events
- Goal 4.0 -- Protect existing community assets in the City of Annapolis from damage caused by these hazards
- Goal 5.0 – Protect the Chesapeake Bay tributaries surrounding City of Annapolis to the maximum extent practicable
- Goal 6.0 -- Ensure hazard mitigation goals are consistent with goals and objectives of other plans in Annapolis and Anne Arundel County

In previous versions of the Annapolis Hazard Mitigation Plan, a series of actions were correlated to these goals and presented in a table. In updating those previous plans, the Planning Committee reviewed the mitigation action table and noted which activities have been completed. Upon review, it is apparent that a significant number of those projects focus on preparedness, rather than “sustained actions taken to reduce or eliminate long-term risk to people and property from hazards and their effects” as hazard mitigation is defined in the Local Multi-Hazard Mitigation Planning Guidance of July 1, 2008. Consequently, this document presents the preparedness and mitigation activities that are continuing to be implemented or have yet to be implemented from previous versions of the Annapolis Hazard Mitigation Plan. Also included are new mitigation activities identified by the City of Annapolis.

5.2. General Mitigation Plans

Of the General Mitigation activities presented in previous versions of this plan, one activity continues to be implemented in an ongoing fashion. The one remaining activity is a preparedness effort known as:

Project B: Develop a public awareness campaign that will be a long-term initiative providing consistent educational opportunities to advance the community's knowledge and skills. Outreach activities could include the following:

- Displays in public buildings or shopping malls
- Articles and special sections in newspapers
- Radio and TV (public access) news releases and interview shows
- Property protection video for cable TV programs or to loan to organizations
- Presentations at meetings of neighborhood groups, realtors, bankers, or other special interest groups
- Presentations at community association meetings
- Training sessions from related organizations, such as the American Red Cross
- Website with hyperlinks to other sources of information
- Newspaper inserts, tax and utility bill inserts
- Classroom curriculum on disaster preparedness and safety

5.3. Specific Mitigation Plans

Based on the specific hazards identified, previous plans then listed a series of mitigation actions targeted to each specific hazard. Below is an update on the status of those plans and descriptions of other actions that have since been identified by the City of Annapolis:

5.3.1. Extreme Heat

Beginning in 2010, the Office of Emergency Management developed and activated the City of Annapolis Code Red Heat Alert Plan (CRHA). The CRHA Plan is used to provide cooling relief to vulnerable populations in the City of Annapolis during an extreme heat event. An extreme heat event is defined as a day in which the heat index is anticipated to reach or exceed 105 degrees. The Roger "Pip" Moyer Recreation Center serves as the primary cooling center.

The CRHA Plan was updated in 2011. The Office of Emergency Management also assisted the Housing Authority of the City of Annapolis to draft its own heat plan and to open additional cooling centers when necessary. The Anne Arundel County Department of Aging and Disabilities now provides transportation to the Pip Moyer Recreation Center when it is in use as a cooling center. The CRHA Plan was activated multiple times in 2010 and 2011.

One project identified in previous mitigation plans specific to extreme heat is in development. It is a project known as:

Project I: Using tools already developed by other governments in the State of Maryland, customize and distribute brochures and other educational materials on summer weather tips – in both English and Spanish.

5.3.2. Flooding

The Office of Emergency Management completed the City of Annapolis Flood Plan in 2010. The Plan presents strategies for mitigation, response, and recovery to problems caused by flooding. It includes resources the City of Annapolis possesses to mitigate the damage caused by floods and to facilitate a response effort in the case of a flood impacting the City. The Flood Plan describes various City departmental roles in anticipation of, during, and following a flood, including alert and notification steps, activation of the EOC, possible evacuation and sheltering operations, damage assessment, and inspection for re-entry. The Flood Plan is part of the City of Annapolis Emergency Operations Plan.

The one project identified in previous mitigation plans specific to flash flooding still has yet to be implemented. It is a project known as:

Project J: Using tools already developed by other governments in the State of Maryland, customize and distribute brochures and other educational materials on flood hazards – in both English and Spanish.

Of the five projects identified in previous plans as relating specifically to coastal/tidal flooding, four have been implemented and one has been eliminated. The eliminated project was to make mitigation grant funding available to private residences. That project has since been proven to be impossible.

Of the many projects identified in the 2007 Flood Mitigation Appendix, the following projects listed in section 5.3.2.2 remain planned for action in 2012.

5.3.2.1 Strategy for Reducing Flood Risk

In March 2011, The City of Annapolis Department of Neighborhood and Environmental Programs received a study entitled, Flood Mitigation Strategies for the City of Annapolis, MD: City Dock and Eastport Area. This detailed study examined the nature and extent of flooding in Annapolis and accounted for future projected impacts. It included an analysis of several flood mitigation strategies and the benefits and costs of each.

Based on the Flood Mitigation Strategies study, the Planning Team found two options to be most feasible and subject to swift implementation. First, the Office of Emergency Management has submitted a plan to the Maryland Emergency Management Agency that would install seven check valves at flood prone storm drains at the lowest points in the City. When minor flooding of approximately 3.5 feet above Mean Lower Low Water (MLLW) occurs in the City, Chesapeake Bay waters frequently back up through the storm drains in the following locations: City Dock; the intersection of Compromise and Newman Streets; Memorial Circle; and Second Street near the Maritime Museum. In these areas, high tides commonly carry water from the Chesapeake Bay back through storm drains and onto streets and parking lots. The check valves will ensure that minor flooding will not inundate these locations. The valves will prevent tidal

waters from backing up through the storm drains while allowing rainwater to pass through at the same time. The proposed valve sizes are: four 15", one 24", one 36", and one 39".

The valve locations are high priority sites where vehicle and foot traffic are both substantial. The valves will prevent damaging effects of minor and moderate flooding. For example, when the storm drain at Newman and Compromise Streets floods, Compromise Street must be shut down, thereby severing the primary artery to Eastport. Similarly, Memorial Circle serves as the core of downtown and carries heavy amounts of traffic. Once submerged, it causes a major disruption to traffic and local businesses. In addition, when the storm drains back up at City Dock, lower-lying businesses suffer the effects and much of the area's limited parking capacity is unusable. The City will also save on the costs of supplying sandbags, which it routinely provides to the community during flooding events.

The second flood mitigation project entails providing vigorous community and business education. This is another cost effective strategy for reducing flood risk. Specific mitigation steps for some properties are presented in section 5.3.2.2 below.

5.3.2.1.1 Description of the Planning Process

A team of City of Annapolis employees, complemented by contractor assistance, developed this plan. The team was responsible for establishing goals, assessing the hazard and identifying mitigation options.

5.3.2.1.2 Public Involvement

A public meeting was held on July 16, 2012 before the Public Safety Committee of the Annapolis City Council. The meeting was advertised in press releases, on the City Council agenda, and on the Office of Emergency Management website. At the meeting, staff from the Office of Emergency Management presented the findings and proposals of the Planning Committee. Members of the public were invited to ask questions and provide comments.

5.3.2.1.3 Task Force and Planning Team

In 2012, a Planning Team from the City of Annapolis convened to discuss the scope and scenarios for development of a flood mitigation plan. The Office of Emergency Management chairs the Planning Team with strong participation by the Department of Public Works. The Harbormaster and Department of Neighborhood and Environmental Programs also reviewed the draft flood mitigation plan.

5.3.2.1.4 Flood Plain Management Goals

Determining tolerable risk for a specific property includes consideration of the investment involved, potential danger to life, access to safe areas in the event of a flood and a host of other factors. Even when all the conceivable influencing factors are considered, there is no straightforward answer. For example, the amount of risk that's tolerable for a residence is ultimately a personal decision and may hinge on noneconomic considerations, such as the

proximity of the owner's home to work, the value placed on living on the water or a desire to remain near relatives and friends.

The Planning Committee agreed upon the following flood mitigation goals:

- Protection of Human Health
- Limitation of Economic Damages to the City of Annapolis
- Preservation of the Architectural Character and Historical Significance of the City of Annapolis

The following flood mitigation plans were developed with those goals as primary evaluation criteria for mitigation options.

5.3.2.2. Preliminary Plans for Selected Projects

Street ends and commercial structures in the vicinity of City Dock will be best protected from floodwaters by proper sandbagging techniques, installation of protective plastic around doors, windows and foundations, and through private purchase of generators to provide electric support in the event of electricity outages resulting from flooding.

For many of the docks throughout The City of Annapolis, the best mitigation measure is installation and proper maintenance through the setting of docks/piers at six to seven feet above high tide levels.

Similarly, for sea walls and bulkheads and the grassy lawns behind them that protect much of the shoreline of The City of Annapolis, the best mitigation measure is proper maintenance of those bulkheads to ensure erosion and rot do not compromise the structures.

Proper maintenance is also the preferred mitigation measure for utility poles that are found within the four-foot elevation. Maintenance is the responsibility of the utility companies that those poles serve.

Flooding may damage trees that are within the four-foot elevation. Proper maintenance through trimming and mulching may protect those important tree canopies from wind and erosion that often accompany floods.

There are several sheds and boat houses that are peppered along the shorelines of Spa and Back Creeks in The City of Annapolis. The mitigation measure is any structure over 120 sq. feet will have to meet new building requirements, those that are existing or under 120 sq. feet will get a letter from the City warning them of vulnerability.

Both the Annapolis Yacht Club and the Eastport Yacht Club have boatlifts that are identifiably within the four-foot elevation. The best mitigation measures for those pieces of equipment will be proper maintenance.

Several marinas are situated within the four-foot elevation. Two that are most notably at risk are Petrini's and Sarle's on the south side of Spa Creek. Proper maintenance of those facilities docks, ramps, lifts and sheds are essential to mitigation of damage from flood.

5.3.3. Hurricanes

Of the two projects identified in previous mitigation plans regarding specific hurricanes, only half of one has been implemented. Those that have yet to be implemented are projects known as:

Project P: Using tools already developed by other governments in the State of Maryland, customize and distribute brochures and other educational materials on hurricane preparedness, shelter locations and use, boater safety – in both English and Spanish. English of Annapolis web site. Spanish versions are not yet available versions have been prepared and are available on the City

Project Q: Offer training programs to residents and property owners on mitigation measures such as window boarding and flood damage prevention.

5.3.4. Severe Thunderstorm

Project R specific to severe thunderstorms has been implemented by using tools already developed by other governments in the State of Maryland. Brochures and other educational materials on severe weather tips have been customized and distributed in both English and Spanish.

5.3.5. Tornado

Project R specific to tornados has been implemented by using tools already developed by other governments in the State of Maryland. Brochures and other educational materials on severe weather tips have been customized and distributed in both English and Spanish.

5.3.6. Severe Winter Weather

Of the six projects identified as specific to severe winter weather, only one has yet to be implemented. That project is known as:

Project U: Provide public education (on safe driving and driving only if it is required; also stock up on food, water, batteries, and other supplies) to prepare people for the storm.

The following projects have been implemented:

Project S ensures that residents are forewarned and prepares the City with supplies to face winter storms.

Project T ensures that adequate quantities of salt and sand are stocked to expedite road clearing.

Project V protects utilities, including underground pipelines, and avoids other disruptions of utilities that may be impacted and interrupted from exposure to hazards such as hail, icy conditions, high winds, etc.

Project W ensures that vegetation that lies in close proximity to utilities are examined and trimmed on a regular basis by BGE and, wherever possible, power lines are installed underground.

Project X seeks to increase community awareness and introduces the concept of buffers (pruning back overhanging branches from trees) and windbreaks (planting tall trees to reduce wind velocity or low shrubs to trap snow) to protect against winter storms and winds.

6.0 PLAN MAINTENANCE

This plan is the City of Annapolis's road map for:

- Evaluating hazards
- Identifying resources and capabilities
- Selecting appropriate actions
- Developing and implementing mitigation measures to eliminate or reduce future damage from those hazards in order to protect the health, safety, and welfare of the residents in the community

This plan also identifies procedures for keeping the plan current and updating it at least once every five years, as prescribed by the Disaster Relief & Emergency Assistance Act (42 U.S.C. §§ 5121-5207).

6.1 Monitoring and Evaluating the Plan

Monitoring, evaluating, and updating the plan are critical to maintaining its relevance. Effective implementation of mitigation activities paves the way for continued momentum in the planning process. It also gives direction for the future.

Office of Emergency Management will oversee the progress made on the implementation of the identified action items and update the plan, as needed, to reflect changing conditions. City Staff involved with other planning efforts in The City of Annapolis will be asked to participate in this process.

Evaluation of the plan includes not only checking on whether or not mitigation actions are implemented but also assessing their degree of effectiveness. This is done through a review of the qualitative and quantitative benefits (or avoided losses) of the mitigation activities. These are then compared to the goals and objectives that the plan was intended to achieve. Office of Emergency Management also evaluates mitigation actions to see if they need to be modified or discontinued in light of new developments.

6.2 Public Involvement

Office of Emergency Management involves the public during the evaluation and update of the plan through annual public education activities and participation, including annual public meetings. The public is notified through a newspaper advertisement. The City of Annapolis website serves as a means of communication by providing information about mitigation initiatives.

6.3 Updating the Plan

Throughout the hazard analysis and vulnerability assessment, descriptions of missing or inadequate data indicate some areas in which the City of Annapolis could improve its ability to identify vulnerable structures. As the City of Annapolis works to increase its overall technical capacity and implement their comprehensive planning goals, it will also attempt to improve their ability to identify assets vulnerable to hazards.

The plan will be updated every five years, as required by the DMA 2000, or following a disaster. The Office of Emergency Management oversees the update of the plan. The updated plan accounts for any new developments in the City of Annapolis or special circumstances (post-disaster). Issues that come up during monitoring and evaluation, which require changes in mitigation strategies and actions, are incorporated in the plan.

**Attachment A
Sign In Sheets from Mitigation Planning Committee Meetings**

Hazard Mitigation Planning Update Planning Committee Meeting - April 19, 2012 REGISTRATION/SIGN IN				
Attendee	Department/Agency	Email	Phone	
1	MATT STAVICK			
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Sign In 12-01-11 OEM

~~John Mounser~~

FRANK BAPT DARP

Virginia Buzell P+Z

Sam Purcell DPW

Robin Clark OEM

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John Bower Fire

Dave Marshall OEM

Al Pesay OEM