# Sea Level Rise Strategic Plan Anne Arundel County















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Maryland Chesapeake & Coastal Program Coastal Communities Project

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#### Section 1 – Introduction and Purpose

Located on the western shore of the Chesapeake Bay, Anne Arundel County is almost completely surrounded by tidal and non-tidal waterways and has over 530 miles of shoreline. The rich culture, convenient location between Baltimore and the District of Columbia, and attractive natural setting make the County a unique and desirable place to live. Since its origins through present day, the quality of life in Anne Arundel County has been linked to the Chesapeake Bay and its tributaries. Many of the County's significant cultural resources are located near or on the shoreline. Accordingly, adaptation to the potential coastal impacts of climate change is necessary for the County.

Historical records indicate a relative sea level rise occurring along Maryland's coastal areas at a rate of one foot per 100 years<sup>1</sup>, and it is predicted that this rate will continue into the foreseeable future or possibly accelerate due to a variety of factors. The County is therefore susceptible to the effects of climate change and sea level rise and has a need to better understand the scientific findings to date and their implications for the County. The County's *General Development Plan*, adopted in 2009, includes recommendations to develop a strategic plan for a phased implementation response to avoid or reduce sea level rise impacts to property, infrastructure, and other resources, and to establish policies to guide the relocation, extension or expansion of public infrastructure in at-risk areas.

To this end, the County partnered with the Maryland Department of Natural Resources (DNR) through the Coastal Communities Initiative Program to conduct a study of potential sea level rise impacts and develop adaptation strategies. The project included four major components: 1) a vulnerability assessment to identify potential areas impacted by sea level rise and develop inventories of resources at risk; 2) development of a framework for interagency strategic planning; 3) development of a strategic plan; and 4) public outreach and education to promote public awareness of sea level rise issues.

This Sea Level Rise Strategic Plan is the outcome of that study. The Plan summarizes the State's recent research and planning efforts related to sea level rise; discusses the key findings from the vulnerability assessment and other planning analysis; identifies the major planning issues for Anne Arundel County as related to sea level rise; and recommends future actions to protect resources and minimize impacts.

It is recognized that strategic planning for sea level rise will be an ongoing and transitioning process as more research, analysis and guidance becomes available from State and Federal agencies and the scientific and academic communities. While the intent of this strategic plan is to identify steps that can be initiated by the County in both the near term and longer term, it is anticipated that this plan will be built upon and revised in future years as the topic progresses. It should also be noted that this plan focuses on the potential impacts of sea level rise in the County and does not attempt to address the broader issue of climate change or to address the entire realm of potential consequences related to climate change.

## Section 2 – Summary of Findings from the Maryland Commission on Climate Change

#### Maryland Climate Action Plan

In 2007, Governor O'Malley established the Maryland Commission on Climate Change (MCCC) with the mission of developing a Maryland Climate Action Plan to provide a framework for understanding the anticipated global and regional impacts of climate changes. The Plan was to address the causes of climate change, prepare for the likely consequences and impacts, and establish benchmarks for implementing the Commission's recommendations.

The results of the Commission's work to date have been published in a series of individual reports which collectively form the State's Climate Action Plan. Among these, the

Comprehensive Assessment of Climate Change Impacts in Maryland<sup>2</sup> provides an assessment of historical and projected climate changes across Maryland and identifies the likely impacts to water and land resources, the Chesapeake Bay and coastal ecosystems, and human health. The Comprehensive Strategy for Reducing Maryland's Vulnerability to Climate Change is a two-phase report that presents a mitigation and adaptation strategy to climate change that can be used by local governments and other stakeholders as a



resource for planning for such occurrences in their communities. The Phase I Report<sup>3</sup> establishes broad goals and objectives for reducing the State's vulnerability to sea level rise and coastal storms. The Phase II Report<sup>4</sup> outlines adaptation strategies to reduce the impacts of climate change including sea level rise, increased temperature and changes in precipitation within the key sectors of human health, agriculture, forests and terrestrial ecosystems, bay and aquatic ecosystems, water resources, and population growth and infrastructure.

The MCCC Climate Action Plan provides very helpful guidance for local jurisdictions in the State. In addition to Anne Arundel County, other Maryland counties on the Eastern Shore have used the Climate Action Plan to help complete their own sea level rise planning studies. Each county found different degrees of impact but all acknowledge the need to address changing climatic conditions in their planning efforts now in order to mitigate future impacts. Ongoing work and future resources to be developed by the State and MCCC will continue to provide assistance to local governments in addressing the topic.

#### **Sea Level Rise Projections**

The Maryland Climate Action Plan includes sea level rise projections that are based on models used by the Intergovernmental Panel on Climate Change (IPCC) in its 2007 Fourth Assessment Report. The MCCC selected seventeen specific models from the IPCC Assessment based on how each one replicated both global conditions and observation in Maryland. The model results were averaged in order to provide the most likely projections for sea level rise. Projections were presented using both 'lower' and 'higher' greenhouse gas emissions scenarios. The lower scenario reflects a peak in emissions at mid-century, then a trailing level of emissions through

the end of the century while the higher scenario projects impacts given the current rate of emissions of greenhouse gases through the end of the century.

The model also takes land subsidence into consideration. It has been determined that coastal lands situated along the Chesapeake Bay experience a greater degree of annual sea level rise relative to other areas around the globe due to its coastal geomorphology. Specifically, areas such as Anne Arundel County which lay along the eastern continental shelf continue to subside as a result of post glacial readjustment. In turn, the land slowly sinks (subsidence) relative to sea level. The model used by the MCCC projects land subsidence rates to remain steady from the previous century at about 6 inches over the course of 100 years.

Model results estimated between 2.7 and 3.4 feet of relative sea level rise by the end of 2100 in Maryland. An important caveat exists for the projections; the estimates "...should not be



considered as model forecasts, but as reasonable bases for assessment and planning that take into account the admitted high-end uncertainties in estimating future sea levels."

In light of the projections used in their report, and given the inherent uncertainty regarding how the external variables impact the IPCC sea level rise projections, the MCCC recommended that adaptation measures intent on reducing coastal vulnerability should

plan for at least a 1 foot rise in sea level by the end of 2050, and a 2 foot rise in sea level by the end of 2100. Further, the MCCC also qualifies that planning for up to 4 feet in sea level rise may be warranted depending upon how reliable the IPCC projections are throughout the planning horizon, since it is reasonable to assume that externalities such as greenhouse gas emissions and melting polar ice will influence the IPCC projections.

#### Section 3 – Assessment of Anne Arundel County's Vulnerability to Sea Level Rise

Using the range of sea level rise projections recommended in the State's Climate Action Plan, the County undertook a study to gain a better understanding of its vulnerability to sea level rise in terms of both the locations that may be impacted and the resources that may be threatened. The results were published in 2010 in the *Anne Arundel County Sea Level Rise Phase I Report: Vulnerability Assessment*<sup>5</sup>. The methodology used and the study conclusions are summarized below.

#### **Study Methodology**

For purposes of the study, a County-wide model of sea level rise was provided by the Maryland Department of Natural Resources (DNR). The model was derived using LiDAR-based topographic data along with the State's official shoreline data. Based on a "bathtub" type model that essentially "overlays" projected sea level elevations over land surface elevations,

the model determines land areas that may become inundated with water under various sea level projections. The model projected areas of inundation in two contour intervals, as shown on Map 1. The first interval assumes a rise in sea level between 0 and 2 feet, and the second interval assumes a sea level rise between 2 and 5 feet. These data classification breaks were determined by DNR based upon the available topographic and elevation data and provide generally accepted sea level rise inundation levels that correspond well to the background research and detailed assessments by the MCCC.

The inundation data layers were used to conduct the assessment of resources in the County that may be impacted or vulnerable. The types of resources that were analyzed include land area, principal structures, transportation infrastructure such as roads and bridges, wells, septic systems, utility infrastructure such as water and sewer lines and storm drains, critical facilities, marinas, parks, archaeological sites, historic properties, and cemeteries. The assessment uses a cumulative approach to a 5 foot rise in sea level by assuming that all resources impacted under the 0-2 foot scenario would also be impacted in the 2-5 foot scenario. Thus, for reporting purposes, the results are presented for two planning scenarios, a 0-2 foot scenario and a 0-5 foot scenario.

Some caveats related to this analysis should be noted. First, the inundation layers utilize a base shoreline that is not coincident with the County's digital shoreline, so the degree of horizontal inundation may vary if the inundation layers were recreated using the County base shoreline. In addition, selection of resources based upon their intersection with the sea level rise inundation layers is a simplified method to depict potential impacts, and does not qualify the degree or intensity of impact. Further, this method does not account for the effect shoreline protection measures may have on inundation levels. Finally, the sea level rise models used to create the inundation layers assume uniform rates of sea level rise and land subsidence. These types of sea level rise models do not factor in the ability for wetlands and marshes to absorb the rising waters, nor do they consider the ability for some soils classifications to resist erosion relative to others within the hazard impact zone.

#### Summary of Vulnerability Assessment Results

Vulnerability of resources, as used herein, implies that these resources may be susceptible to adverse effects of sea level rise. Such adverse effects could include more frequent occurrences of flooding, particularly as a result of storm surges, as well as permanent inundation of an area. Adverse impacts may also include increased groundwater elevations in coastal areas, potentially impacting underground infrastructure such as public sewer lines and storm drains, or private well and septic systems. Due to the nature of available models and data used, this type of assessment cannot predict the specific location, degree, frequency or duration of an adverse impact. For the purposes of this planning exercise, resources that fall within the two projected inundation areas are considered "vulnerable".

#### Land and Property Value

Nearly 2,200 acres of land are vulnerable under a 0-2 foot sea level rise. Almost two-thirds of this area (62%) consists of woodlands and open wetlands. Most of the remaining vulnerable land area contains residential uses or is open land. A relatively small amount of land area is used for commercial, industrial or agricultural uses. When the inundation area is expanded under the

0-5 foot scenario, over 6,900 acres of land are potentially impacted. In this scenario, 42 percent of the vulnerable area is woodlands, 24 percent is residential land, 14 percent is open wetland and nine percent is open land, with the remaining land uses comprising smaller percentages.

Type of Land Cover	0-2 ft Inundation	0-5 ft Inundation
Commercial	13	182
Forested Wetland	5	29
Industrial	4	27
Open Land	262	650
Open Wetland	622	964
Pasture/Hay	1	17
Residential 1-acre	24	116
Residential 1/2-acre	44	249
Residential 1/4-acre	66	332
Residential 1/8-acre	68	499
Residential 2-acre	78	381
Residential Woods	20	59
Row Crops	1	37
Transportation	7	70
Utility	1	7
Water	234	383
Woods	743	2,903
Total Acres	2,193	6,905

#### Table 1 - Land Cover (in Acres)

The average, median, and total assessment values of the properties at risk are shown in Table 2. In this analysis, properties include land parcels and subdivided lots. Properties at risk include those that fall fully or partially within the inundation area, as well as both improved and unimproved properties. As seen, the average property value in the vulnerable areas falls within the \$200,000-\$225,000 range. Although the total land area that is vulnerable to sea level rise is a small percentage of the total land in the County (265,770 acres), and a significant portion of it is unimproved woodlands or wetlands, the total value of properties at risk is not insignificant at nearly \$3 billion under the 0-2 foot scenario and over \$4.1 billion in the 0-5 foot scenario.

Table 2 - Properties at Risk and Assessment Values

	0-2 ft Inundation	0-5 ft Inundation
# of Properties at Risk	11,607	18,850
Average Assessment Value	\$223,854	\$202,018
Median Assessment Value	\$143,027	\$133,700
Total Assessment Value	\$2,904,959,889	\$4,135,714,067



#### Principal Structures

Only 140 principal structures were determined to be vulnerable in the 0-2 foot scenario, a relatively small number. The majority of these are residential, primarily single family detached dwellings. A significantly higher number of 2,398 principal structures are vulnerable in the 0-5 foot scenario. Of these, approximately 96% are residential structures, again primarily single family detached homes in the R5, R2 and R1 zoning districts (low to medium density residential zoning).

The principal structures at risk are located all along the shoreline from Pasadena in the north down to South County. Under the 0-5 foot scenario, the Deale peninsula which includes the communities of Deale, Shady Side, Churchton, and Galesville, is particularly vulnerable with over 1,000 structures located in at-risk areas. The Edgewater/Mayo, Annapolis Neck, and Lake Shore peninsulas also have fairly large numbers of structures at risk.

It is noted that critical public safety facilities such as police and fire stations and evacuation centers were included in the analysis but are not seen in the results since no such facilities are located in the inundation areas.

Building Use Type	0-2 ft Inundation	0-5 ft Inundation
Commercial	13	62
Educational	0	2
Other Institutional	2	8
Place of Worship	0	2
Residential	125	2,324
Total	140	2,398

#### Table 3 - Principal Structures at Risk (# of structures)

#### Transportation Infrastructure

Major transportation infrastructure in the County such as freeways and arterial highways does

not appear to be significantly vulnerable to sea level rise impacts, and even local and collector roads were found to be minimally impacted (in terms of total road miles) under a sea level rise of 0-2 feet. Under the 0-5 foot scenario, there are approximately 35 miles of local and collector roads that are potentially at risk. The local roads at risk are found primarily on the Lake Shore peninsula (communities of Bayside Beach, Venice on the Bay, Gibson Island); the Annapolis Neck peninsula (communities of Arundel on the Bay, Oyster Harbor, Bay Ridge); the Mayo peninsula (communities of Turkey



Point, Selby on the Bay, Ponder Cove); the Deale peninsula (communities of Shady Side, Galesville, Churchton, Deale), and in South County (communities of Fairhaven on the Bay, Rose Haven).

Most of the local roads that appear vulnerable are individual segments right along the coast, and their potential inundation would not result in cutting off an entire community. However, individual streets in several areas could eventually require elevation or abandonment, leaving isolated properties with no access. MD 214 is of some concern since its partial inundation could impact access to the lower end of the Mayo peninsula. There are several local roads in the communities of Arundel on the Bay, Oyster Bay, and Shady Side that could become completely inundated.

#### Utility Infrastructure

Many of the areas vulnerable to sea level rise inundation are served by public water and sewer systems owned and maintained by the County. As the areas become inundated, soils become saturated and water tables rise. This can cause infiltration and inflow into water and sewer pipes as well as storm drain pipes, reducing their capacity and resulting in malfunctions of the systems.

Water lines located in vulnerable areas are not concentrated in any specific communities but are scattered along various coastal areas. Public sewer lines within vulnerable areas are also located all along the coastal areas, but there are small concentrations of sewer lines at risk in Glen Burnie along Marley Creek, in Severna Park, along the coastal areas on the Annapolis Neck, Mayo, and Deale peninsulas, and in Rose Haven.

Sewer pump stations that could be vulnerable are located in the Broadneck (6 stations), Annapolis (10 stations), Mayo-Glebe Heights (5 stations), and Broadwater (3 stations) sewer service areas. No public water or sewer treatment facilities are located in the inundation areas, although the Broadwater Water Reclamation Facility which serves the Deale/Shady Side area just borders the five foot inundation area.

Storm drain pipes are found in almost all of the inundation areas along the coastline. The data used in the assessment includes storm drain lines that are maintained by the County as well as privately maintained, but the vast majority (65,897 feet in length) is maintained by the County. However, the County's data on storm drains does not include facilities owned and maintained by the State, the City of Annapolis, or the Federal military complexes in the County such as the Naval Academy.

Facility	0-2 ft Inundation	0-5 ft Inundation
Water Lines (pipe length in feet)	26,684	53,729
Water Hydrants	2	9
Sewer Gravity Lines (pipe length in feet)	12,169	169,202
Sewer Force Mains (pipe length in feet)	21,602	137,663
Sewer Manholes	36	591
Sewer Pumping Stations	1	24
Storm Drain Pipes (pipe length in feet)	22,880	66,212
Stormwater Management Facilities	1	9

#### Table 4 - Public Utility Infrastructure at Risk

#### Private Wells and Septic Systems

There are approximately 40,700 private individual septic systems in the County, and roughly 45,500 private wells serving individual homes or properties. In addition, there are over 500 non-County well systems serving entities other than individual homes, including residential communities, businesses, and mobile home parks. These facilities are also susceptible to impacts of sea level rise, either due to surface inundation or to high water tables associated with a rise in sea level. This may cause septic systems to fail and can result in contaminated wells due to floodwaters and saltwater intrusion. Table 5 indicates the number of properties with private well and septic facilities that are located in vulnerable areas. Septic systems on properties susceptible to sea level rise are concentrated primarily along the coastal portions of the Lake Shore peninsula, the Broadneck peninsula, areas of Crownsville along the Severn River, portions of the Annapolis Neck along the South River, and the coastal areas in South County excepting the Deale/Shady Side peninsula which is served by public sewer.

Private wells at risk are found in general in the same locations with septic systems at risk, with the addition of the Mayo and Deale/Shady Side peninsulas which do not have public water service. The majority of residential properties served by community wells that may be vulnerable are in the Sherwood Forest and Epping Forest communities along the Severn River.

Facility	0-2 ft Inundation	0-5 ft Inundation
Septic systems	5,206	7,238
Private wells	4,718	7,633
Community wells	69	123

Table 5 - Private Wells and Septic Systems at Risk (# of properties)

#### Marinas

The marine industry is an important segment of the local economy in Anne Arundel County given its many miles of shoreline. Based on a recent inventory, there are 221 marinas currently operating in the County including community marinas, commercial marinas, and yacht clubs. The principal services that are provided at marinas are facilities for storing, launching, and hauling boats although other services often include fresh water supply for the docked boats, electric power, repair, fuel, grocery sales, marine supplies, hardware, restaurants, restrooms, tennis, swimming pools, ice, boat sales, boating schools, and sometimes motels.

As would be expected, the majority of marinas are vulnerable to sea level rise under the scenarios analyzed, with 208 marinas vulnerable under the 0-2 foot scenario and all vulnerable under the 0-5 foot scenario.

#### Park Lands

Most of the public park properties vulnerable to sea level rise are County parks. Many are open natural areas, but the vulnerable properties also include active recreation parks with sports fields, public school recreation areas, and public piers. It appears that most of the physical infrastructure on park properties is located outside of the projected inundation areas. Still, future park development plans will need to take into consideration these potentially vulnerable areas.

Of the 59 vulnerable park properties, 12 are located in South County, 11 in Deale/Shady Side, 8 in Edgewater/Mayo, 6 in the Lake Shore area, 5 on the Broadneck peninsula, and the remainder in other communities.

Five State parks were identified as being potentially vulnerable to sea level rise. These are Franklin Point Park, Patapsco Valley State Park, Patuxent River Natural Resource Management Area, Sandy Point State Park, and Severn Run Natural Environment Area. In addition, the federally-owned Smithsonian Environmental Research Center may be affected by inundation.

#### Archaeological and Historic Resources

Anne Arundel County has a rich cultural heritage, and settlement here has long focused on the shorelines. While more recent (modern) development relies upon a network of roadways and there has been increased privatization of large waterfront parcels, historically, the waterfront, and the areas most vulnerable to impacts from sea level rise, have been intensively used by humans for thousands of years. Historic sites and archaeological resources in particular, are non-renewable resources. Once they are destroyed—whether by man-made or natural forces—the information these sites can tell us of our past is also lost forever. This fragile nature of archaeological resources makes the threats to them even more challenging.

A total of 371 archaeological sites are vulnerable under a 0-2 foot sea level rise scenario. The number rises to 422 assuming a 0-5 foot sea level rise. The 422 threatened sites account for nearly 30% of the total sites recorded in the County. Ninety-one of these sites date from the historic period (from the mid-seventeenth- ca. 1650, through the early twentieth century- ca. 1940), and 215 are from the prehistoric period (or, Native American sites that pre-date the arrival of Europeans to Anne Arundel County ca. 1650AD to ca. 8,000 BC). The remaining sites either contain both historic and prehistoric components or date to an unknown time period.

Cultural Affliation	0-2 ft Inundation	0-5 ft Inundation
Prehistoric	192	215
Historic	80	91
Prehistoric & Historic	43	52
Unknown	56	64
Total	371	422

#### Table 6 - Archaeological Sites by Type

Forty-seven recorded structures listed on the Maryland Inventory of Historic Properties (MIHP) may be vulnerable with 0-2 feet of sea level rise, while 74 are vulnerable with up to 5 foot of rise. These sites include historic buildings, bridges, lighthouses, and historic roads and districts, along with several Federal historic resources outside of the County's jurisdiction. Some of the recorded historic sites are historic districts that may contain multiple resources within a confined geographic area. Thus while the table below indicates 12 historic districts may be

vulnerable, the number of individual buildings and landscape features that are within those districts could number in the hundreds and may comprise a much larger threat.

Recorded Historic Sites*	0-2 ft Inundation	0-5 ft Inundation
Structures/Dwellings	12	26
Bridges	8	11
Lighthouses	4	4
Historic Roads	1	2
Historic Districts	12	12
Federal - US Coast Guard & US Navy resources	10	19
Total	47	74

#### Table 7 - Historic Properties by Type

\* Properties are listed on the Maryland Inventory of Historic Properties.

#### Conclusions

The vulnerability study proved very helpful in enabling the County to better understand the level of threat posed by a future rise in sea level. Compared to other nearby jurisdictions such as Dorchester County, which has significantly large land areas that may become inundated, Anne Arundel County is fortunate in that its areas of potential vulnerability to sea level rise are not expansive, and the number of public and private facilities and structures that could be at risk is relatively small. In terms of future development, the vulnerable areas are generally not within the County's planned growth areas.

Nevertheless, the value of properties, infrastructure, and natural resources that could potentially be damaged or rendered unusable is significant, and to this end the County should take preventive planning measures and actions to minimize any damages or loss of important resources. The key planning issues that were identified through the vulnerability assessment are discussed further in the following section.

#### Section 4. Key Issues Related to Planning for Sea Level Rise

The planning analysis has identified several major topics that are the most crucial in terms of future vulnerability to sea level rise in the County. The strategic planning program should consider and recommend adaptation strategies to address these topics.

#### Loss of Ecologically Significant Land

In terms of land cover, some of the most significant impacts of a rise in sea level will be a loss of wooded areas and open wetlands which are valuable components of the coastal ecosystem. Over 1,600 acres of such lands are potentially vulnerable under the 0-2 foot sea level rise scenario, with over 4,500 vulnerable acres under higher levels of sea level rise. While the acreage may

not be large at any one specific location, the benefits of forest and wetlands are significant in terms of their ability to reduce coastal erosion, offer protection against storm surges, and absorb coastal flooding. Further assessment is needed to determine the locations where these environmental features are offering the most protection against sea level rise impacts. In those locations where there is future development capacity on these properties, conservation using protective easements, acquisition, or other mechanisms should be initiated.

There are a significant number of structural shoreline protection features along the County's coastline, including bulkheads, breakwaters, riprap, and similar structures. However, use of such structural mechanisms is being discouraged at the State level in lieu of more environmentally sensitive non-structural mechanisms. The Living Shorelines Protection Act passed in 2008 requires the use of non-structural shoreline stabilization measures except in areas designated and mapped by the State as being more suitable for structural measures. Additional steps required at the State level toward implementation of this legislation are outlined in the State's Climate Action Plan.

#### **Impacts on Private Residential Properties and Property Values**

A majority of the developed land in vulnerable areas is used for residential purposes, being improved with primarily single family detached homes. With a sea level rise of less than two feet, impacts to principal structures may be relatively small. If a rise in sea level between two and five feet should occur, impacts may be much more significant with as many as 2,400 structures that could be vulnerable. Elevation or relocation may be a future solution for some of these structures, but those options may not be feasible for all homes impacted. A serious implication is that as the frequency and/or duration of flooding occurrences may increase, some properties may begin to lose their value and also their resale potential. Through community outreach, the County should encourage public awareness so that all property owners in these areas are informed about the potential implications and can plan accordingly. In addition, the County may need to consider the fiscal impact of decreased property tax revenue should a large number of properties become unusable or decline in value.

Additionally, as further research and information regarding coastal inundation becomes available, it is likely that the insurance industry's response will make living along coastlines more expensive, potentially to a level of public concern. In the future, the difficulty of obtaining affordable homeowner's insurance may discourage residents from continuing to live in these areas and may also discourage new development.

Residences that may be vulnerable are located in most coastal communities, but the majority are located on the Deale/Shady Side peninsula, including communities such as Cedarhurst on the Bay, Avalon Shores, and Columbia Beach. Following the Deale/Shady Side area, the Mayo peninsula will likely be the second most impacted area in the County, where some residences in communities such as Selby on the Bay, Ponder Cove, and Beverly Beach may be vulnerable. Maps 2 and 3 indicate the locations of existing structures in relation to the modeled inundation areas on the Deale/Shady Side and Mayo peninsulas, respectively.

As part of the sea level rise planning project, a community focus group event was held in 2011 with representatives of some of the communities on the Mayo and Deale/Shady Side peninsulas along with County staff. Community feedback appeared to indicate that, while residents in these areas have typically experienced or are aware of instances of coastal flooding due to storm events, few are well informed of the potential implications of future sea level rise. This indicates a further need for public education on this topic within the County.





#### **Impaired Road Access**

Inundation of road facilities, even periodically, can lead to costly maintenance issues as well as dangerous driving conditions. As underlying soils become saturated, road pavement will crack more easily and potholes will occur. Even temporary loss of road access can have significant economic and public health and safety impacts for local citizens.

The primary vulnerability for the County appears to be with local roads serving residential neighborhoods, with the potential exception of MD 214 which could impact the entire lower end of the Mayo peninsula. The total length of road miles is not large and impacts may occur mainly at a neighborhood level but could render some properties inaccessible. Local roads in many coastal communities may be impacted, particularly on the Lake Shore, Annapolis Neck, Mayo, and Deale peninsulas. Individual streets in some of these communities may eventually require elevation or even abandonment.

Strategic planning to minimize these impacts will require identifying those road segments where impairment would have the most severe implications, and determining feasible alternatives which could include road elevation or even improvements to less vulnerable roads in order to provide alternative transportation routes.

#### Impaired Public Utility Infrastructure

Public infrastructure that may be vulnerable to sea level rise impacts includes water, sewer, and storm drain pipelines, sewer pumping stations, and stormwater management facilities. Impacts to public utility infrastructure are difficult to assess. Even if the surface land area is not flooded or permanently inundated, the higher water table associated with a rise in sea level may allow infiltration and inflow causing underground infrastructure, including water supply and sewer lines and storm drains, to malfunction or collapse.

The County's public water supply comes from groundwater sources via 17 well fields. None of the public water supply wells are located in the projected vulnerable areas, but there are public water lines located in vulnerable communities. Sewer infrastructure in vulnerable areas includes sewer gravity lines and force mains, sewer manholes, and pumping stations. In terms of the total quantity of public utility infrastructure, the amount that may be at risk is not large. However, as with road impacts a failure in one pipe segment can impact a large number of properties. Similarly, malfunction of one pumping station can impact entire communities. Also, the public infrastructure at risk is located in a more scattered pattern amongst almost all coastal communities, making planning for retrofits or alternatives more complex.

#### **Private Well and Septic Systems**

Several thousand properties that rely on individual water supply wells and onsite septic systems could be impacted by rising sea level causing septic systems to fail and wells to become contaminated by floodwater and saltwater intrusion. In many cases, these properties are not within a feasible distance for connection to a public utility system, and may not be concentrated enough in density to allow installation of community well or septic systems as a viable alternative. This makes mitigation planning for such situations even more difficult.







There is no public water service on the Mayo or Deale/Shady Side peninsulas, or on the majority of the Lake Shore peninsula except for Gibson Island. In some areas, communities are already experiencing high chloride levels due to saltwater intrusion in private wells, as shown on Map 4 in the Mayo area. More frequent flooding of wells has also been recorded in these areas, often requiring flood-proof well caps and heightened standpipes. Maps 5 and 6 indicate the known extent of submerged well problems in Mayo and Deale/Shady Side.

Potential adaptation strategies include drilling deeper wells in order to penetrate the Magothy Aquifer and avoid saltwater intrusion impacts. However, in some locations such as on the Deale/Shady Side peninsula, this would require drilling very deep wells which is often cost-prohibitive, particularly for an individual property owner. Other strategies may include the requirement of flood-proof well caps or taller standpipes, moving wells to a different location



on a property, or connecting to the public water system if feasible. The location of private wells is of particular importance on the Mayo peninsula due to the public sewer system serving the area. In the Mayo sewer system each property has an onsite septic tank, but instead of leaching into the ground, the effluent is piped or pumped to one of two communal treatment facilities. Water supply wells may become contaminated if located too close to a septic tank, so movement of the wells on these properties would be limited due to proximity to the on-site septic tanks.

Most of the areas vulnerable to sea level rise are located within a public sewer service area, the Lake Shore peninsula being one exception. However, there are in some cases a large number of properties that are not connected to the public system and therefore rely on private septic systems. These may be vulnerable to impacts from either increased groundwater elevations or surface flooding. The County already has a number of communities in which there have historically been problems with failures of private septic systems and is currently involved in strategic planning to determine alternative solutions for the most critical communities. Assessment of communities on septic systems in areas vulnerable to sea level rise should be incorporated into this planning effort.

#### Damage or Loss of Archaeological and Cultural Resources

Over 400 archaeological sites may be susceptible to loss or damage due to sea level rise, as well as over 70 historic properties. This is of particular concern to the County given the extremely high value of some of the archaeological finds discovered to date in the County. Two factors create a high sense of urgency to protect these resources. First, these cultural resources are irreplaceable so once damaged and/or inaccessible, the resource is lost forever. Second, as Anne Arundel County's history is integrally tied to its waterways, many of the County's significant cultural resources are located near or on the shoreline. Strategic planning to prevent loss of these irreplaceable resources is a priority.

Identifying the resources at risk is only a first step, and each resource type will require a varied set of responses to effectively adapt to the potential impacts of coastal climate change. Some resources have already been lost and some are under high impending risk. Yet others are within

the potential inundation zone, but with adequate planning, any potential damages could be mitigated. Protection of cultural resources is complex as they may be damaged by sea level rise if above ground or with limited accessibility near waterways, from shoreline erosion if under ground such as a cemetery, or from the actions of private property owners installing coastal stabilization methods that often results in destruction rather than protection. Policy development will require balanced decision making based on standards for preservation, private property rights, and optimum mitigation options that protect cultural resources while not damaging natural ones.

#### Impacts on the Maritime Industry

The maritime industry has always served an important role in the economy and local character of Anne Arundel County. Boating, sailing, fishing and crabbing have long been symbols of life in the County. However, the maritime industry may be the most vulnerable segment of the local economy since virtually every marina in the County is located in an area of potential inundation. Commercial marinas, community marinas, and yacht clubs as well as community piers and private individual piers may all be subject to impacts. Shoreline changes may impact not only a marina property itself but also the water access to the property.

In addition, changes in fish and shellfish populations due to global climate change impacts may affect the fishing industry which has already been stressed in recent decades due to overfishing, declines in populations, Bay pollution and other factors. While it is beyond the scope of this plan to examine the broad range of potential ecological impacts due to climate change, it is recognized that impacts to the fishing industry will also impact the viability of local marinas even if they are able to adapt to changes in sea level.

Relocation of marinas will be difficult as they must necessarily be located along shoreline areas with good water access and therefore in vulnerable areas. Community outreach targeted to the maritime community will be important in determining how the County and State can assist in adaptation strategies for this segment of the economy.

#### **Shoreline Erosion**

Shoreline erosion has generally been slight along most of the County's coast, according to available data, although many shoreline miles have experienced some degree of erosion. Map 7 indicates shoreline erosion rates as determined by the Virginia Institute of Marine Science. Very small areas of shoreline have experienced moderate to high rates of erosion. Significant areas of shoreline have protection mechanisms in place, although the completeness of the available inventory is uncertain.

Sea level rise will certainly have an impact on low-lying coastal plains, especially as it relates to shoreline erosion. Coastal storm events and their associated storm surge and winds tend to amplify areas currently vulnerable to shoreline erosion. In turn, shoreline erosion that occurs as a result of these storm events will only be amplified by a future rise in sea level. Additional shoreline inventories, assessment, and identification of additional areas in need of future protection will be needed.



## Section 5 – Assessing Development Potential in Vulnerable Areas

Based on the analysis and conclusions to date, the County has determined that its primary focus for sea level rise planning efforts will be more on reducing impacts to existing development and resources, as opposed to determining where and to what extent future development should be limited or restricted. Although the latter may also be necessary in the future as better estimates of development capacity are determined and sea level rise projections are refined, it is currently believed that due to the fairly mature state of development in the County, the relatively low- density zoning in place in most vulnerable areas, as well as existing development regulations that limit development in these areas, future development potential is already limited to a significant degree. While there are certainly a number of infill parcels or lots that can still be developments in these vulnerable areas.

#### **Existing Development Regulations in Vulnerable Areas**

In addition to the County's subdivision code and zoning ordinance which govern land use and development countywide, the State Critical Area regulations as well as FEMA floodplain regulations provide additional controls on future development that may occur within the sea level rise vulnerable areas.

#### Chesapeake Bay Critical Area Regulations

The State Critical Area legislation is implemented at the local level in Article 17 – Subdivision and Development and Article 18 – Zoning in the Anne Arundel County Code as well as on official maps delineating the three Critical Area overlays (RCA, LDA and IDA). These regulations impose restrictions on development in the Critical Area with regard to density limits, permitted uses, buffer setbacks, impervious surface limits, clearing of vegetation, location of septic systems, and methods of stormwater management.

The table below indicates that most of the sea level rise vulnerable areas fall within the Critical Area overlay, primarily in the RCA designation but to a lesser extent in the LDA and IDA designations. Therefore, the existing development restrictions that apply within the Critical Area RCA overlay are currently providing some protection against future development in these vulnerable areas.

The total land area that lies within the County's Critical Area is approximately 49,450 acres. This analysis indicates that approximately four percent of the total Critical Area land area in the County falls within the 0-2 foot inundation area, and approximately 13 percent of the Critical Area falls within the 0-5 foot inundation area. Therefore, much of the County's Critical Area does not appear to be vulnerable to sea level rise impacts, based on the inundation modeling used.

	0-2 ft Inundation	0-5 ft Inundation
Acres of Inundation Inside Critical Area (RCA, LDA, and IDA overlays)	2,079	6,585
Inside RCA Overlay	1,699	4,514
Inside LDA Overlay	333	1,746
Inside IDA Overlay	47	325
Acres of Inundation Outside Critical Area	114	320
Total Acres of Inundation	2,193	6,905

Table 8 - Acres of Potential Inundatio	n in	the	Critical	Area
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This is relevant should the County or State revise current Critical Area regulations or legislation in order to incorporate future sea level rise projections and/or minimize potential impacts. Regulations to reduce sea level rise vulnerability should not negatively impact land values or property owners in areas that are not likely to be vulnerable. However, given that the Critical Area is already an established, codified, and publicly accepted regulatory overlay zone, it may serve well as a mechanism for better adapting coastal areas to a rising sea level.

#### **FEMA Regulations**

Floodplain management is regulated in Article 16 – Floodplain Management, Erosion and Sediment Control, and Stormwater Management in the Anne Arundel County Code as well as on official maps delineating the FEMA floodplain districts.

As shown below, most of the sea level rise vulnerable areas are located within a delineated FEMA floodplain district, primarily the AE zone (tidal and non-tidal 100-year floodplain with known elevation). Therefore, the development and building requirements applied within those districts will to some extent serve to lessen future sea level rise impacts to those properties. As with the Critical Area overlay, the floodplain management ordinance may provide another existing regulatory mechanism that can be used to apply additional protective measures for development within sea level rise vulnerable areas.

	0-2 ft Inundation	0-5 ft Inundation
Area of Inundation Inside FEMA Special Flood Hazard Areas (A, AE, and VE zones)	93 %	89 %
Inside FEMA A Zone	0 %	1 %
Inside FEMA AE Zone	94 %	94 %
Inside FEMA VE Zone	6 %	5 %

Table 9 - Potential Inundation in the FEMA Floodplain

	0-2 ft Inundation	0-5 ft Inundation
Area of Inundation Outside FEMA Special Flood Hazard Areas	7 %	11 %
Total Area of Inundation	100 %	100 %

#### Section 6 – Recommended Actions

#### Goal: Incorporate sea level rise planning into all related County functions.

#### **Recommendations:**

- Establish a sea level rise project team to implement the strategic plan. The team should have representation from the following county agencies: Department of Public Works, Office of Emergency Management, Office of Planning and Zoning, Department of Health, Department of Inspections and Permits, and Office of Community and Constituency Services. The team will be responsible for establishing a work program to implement the recommended actions, monitoring progress, reporting results, and interacting with State agency liaisons.
- Continue to monitor information related to sea level rise planning, data, and resources as it becomes available through State and Federal agencies, other local jurisdictions, and academic research.
- Update the vulnerability assessment when needed as more refined sea level rise projections and resources become available from the State.
- Develop an integrated monitoring system with standardized recording methods to track recent, ongoing and future flooding and/or inundation problems in impacted or vulnerable communities in the county. The system should identify specific locations, types of problems (road flooding, storm drain failures, septic system failures, well problems, flooded properties, etc.), frequency, and duration of these occurrences.
- Account for potential fiscal impacts of sea level rise in future cost/revenue analyses, including impacts on operating and maintenance costs and property tax revenues.
- Incorporate the results and recommendations from the sea level rise planning process into the County's adopted plans as necessary to ensure implementation. These plans could include the General Development Plan; Water and Sewer Master Plan; Hazard Mitigation Plan; Land Preservation, Parks and Recreation Plan; and other plans as appropriate.

## Goal: Protect coastal ecosystems to reduce the impacts of sea level rise, coastal flooding and shoreline erosion.

#### Recommendations:

• Using the Maryland Comprehensive Shoreline Inventory and DNR's Shoreline Conservation and Management Program, identify high priority sites along the County's shoreline for protection and/or restoration.

- Include identified high priority sites in future updates of the County's Land Preservation, Parks and Recreation Plan and General Development Plan.
- Highest priority sites should be targeted for acquisition using Program Open Space or other preservation funds where available and consistent with the purpose of those funding programs.
- Develop an inventory of sites that can be targeted for wetland or forest mitigation projects by private developers where development plans propose off-site mitigation.
- Outreach and promote the establishment of conservation easements on private properties in high priority sites to provide resource protection as well as tax incentives for private property owners.

#### Goal: Reduce sea level rise impacts to existing and future development.

#### Recommendations:

- Determine the remaining development holding capacity within the vulnerable areas, or within the Critical Area or FEMA districts. Incorporate this into the existing development and permit tracking system in order to better assess the number of new lots being approved and permits issued in these areas. This will aid the County in determining whether additional development regulations or restrictions may be required in the future to further reduce the risk and cost of development in vulnerable areas.
- Revise the County's development regulations to discourage the granting of variances and modifications that allow stream and wetland impacts in the Critical Area, unless the applicant can demonstrate that there is no alternative site design possible that would not result in an effective taking of private property.
- Revise the County's development regulations to increase wetland and stream buffer setbacks in the Critical Area in accordance with State Critical Area Commission recommendations, at a minimum.
- Determine whether additional recommendations related to sea level rise vulnerability, both regulatory and non-regulatory, should be incorporated into the development plan review and approval process.
- Assess the feasibility of potential revisions to building code requirements that would minimize sea level rise impacts to existing and future development in the FEMA 100-year non-tidal and coastal high hazard flood zones. These might include increased freeboard elevation requirements, revised standards for foundation design, use of flood-resistant building materials, or other building design criteria.
- Determine the benefits and feasibility of enrolling in FEMA's Community Rating System program to reduce flood insurance premiums for property owners in the County.

## Goal: Reduce potential impacts to public infrastructure serving existing communities and future development.

#### **Recommendations:**

- Identify those road segments in vulnerable areas where flooding has been a known problem and where future impairment would have the most severe impacts, potentially cutting off access to individual properties or entire neighborhoods, and study feasible alternatives that can be put in place in both the short term and longer term to ensure road access.
- Identify those segments or components of the public water and sewer infrastructure systems in vulnerable areas where malfunctions or capacity constraints due to flooding or groundwater infiltration have been a known problem and where future impairment would have the most severe impacts in terms of properties or neighborhoods being served, and determine the range of feasible alternatives that can be implemented in both the short term and longer term to ensure adequate service.
- Assess whether revisions are needed to current design standards for public infrastructure capital projects to reduce future operation and maintenance problems in areas vulnerable to sea level rise impacts.
- It is feasible that at some future point in time, the ongoing costs of maintaining public infrastructure in flood-prone areas may become unsustainable for the County and/or property owners, and abandonment may become the only feasible option. Establish policy directives and develop the criteria that will be used if needed to determine when, where, and under what circumstances public infrastructure in vulnerable areas would be abandoned. Such decisions must necessarily be made far in advance of actual abandonment so that feasible alternatives can be developed and adequate public notice and input can be incorporated.

## Goal: Ensure safe and adequate water supply and wastewater management for communities vulnerable to sea level rise impacts.

#### **Recommendations:**

- Assess whether revisions are needed to current State and local construction or design regulations and standards for private wells and/or private on-site septic systems in vulnerable or flood-prone areas.
- As part of the ongoing study to determine and implement alternatives to on-site septic disposal in problematic areas known for septic system failures, evaluate alternative wastewater treatment solutions for properties on septic systems in areas vulnerable to sea level rise.
- Evaluate the feasibility of new community well systems or connection to the public water system as alternatives for areas that are or may become vulnerable to private well contamination.

## Goal: Protect significant cultural resources from loss or damage due to sea level rise impacts.

#### **Recommendations:**

- Based on the work done in the vulnerability assessment to prioritize all cultural resources based on their significance and level of threat, develop a schedule to complete investigations of all priority sites that have had little or no previous investigation. Commit funding for additional staff resources (county or contractors) to complete all priority investigations.
- Require Phase III level mitigation (excavation) of archaeological sites by contractors, overseen by county staff, when permit or development actions not governed by existing code provisions occur on private or public land located on the prioritized list of vulnerable sites.
- Triggering events for cultural resources review to assess and conduct mitigation should be expanded beyond the current requirements for site development plans. Other triggering actions should include capital projects including all shoreline stabilization and/or armoring projects, and all building and grading permits.
- Protect historic sites and buildings in place where financially and technically feasible using shoreline stabilization measures.
- Develop guidelines and requirements for the potential displacement of vulnerable historic resources when shoreline stabilization is not a feasible strategy for permanent protection.
- Develop a community stewardship program to create a partnership between private property owners of culturally-significant properties and the County for the purpose of monitoring periodic and ongoing occurrences of flooding, inundation and erosion of these properties and ensuring action is taken before significant resources are lost.
- Determine the eligibility of historic properties to use historic preservation tax credit programs to offset costs of elevation or flood-proofing retrofits where those adaptation strategies are appropriate.

### Goal: Ensure that citizens in the County are educated and informed about sea level rise and have access to current information and resources.

#### **Recommendations:**

- Develop a network of community representatives for those communities located in vulnerable areas. Build upon the list of representatives created for the 2011 Community Focus Group session. Use this network for information sharing and updates related to sea level rise planning.
- Provide education and outreach opportunities for business interests, including the maritime industry, which may also be affected by sea level rise impacts.
- Develop and maintain a web site within the County internet system dedicated to sea level rise planning and related resources useful to the public.
- Through the Office of Emergency Management, work with the local community network to assist vulnerable communities in developing action plans and improving emergency preparedness at the community level. In addition to planning for catastrophic events,

promote awareness and preparedness for the longer term or more permanent impacts of sea level rise.

#### **Implementation Schedule**

The schedule below indicates the lead County agency or agencies involved in implementation of the plan recommendations. Many tasks will involve coordination and work efforts among several agencies, and it is the role of the interagency project team to organize and manage the work program among the various agencies. It is also noted that input and assistance from a variety of State agencies may be required, including DNR, MDE, MEMA, and others.

The schedule also indicates the priority assigned to each recommendation as defined below:

**High Priority**: This action is warranted based on current information and the County should initiate implementation in the near term (1 to 3 years).

**Medium Priority**: This action is warranted based on current information and should be implemented within a 5-year timeframe or as resources become available.

**Low Priority**: This action may be warranted in the future based on further study and would be initiated in the longer term (5+ years).

Recommendation	Lead Agencies	Priority		
Goal: Incorporate sea level rise planning into all related County functions.				
Establish a sea level rise project team to implement the strategic plan. The team should have representation from the following county agencies: Department of Public Works, Office of Emergency Management, Office of Planning and Zoning, Department of Health, Department of Inspections and Permits, and Office of Community and Constituency Services. The team will be responsible for establishing a work program to implement the recommended actions, monitoring progress, reporting results, and interacting with State agency liaisons.	Interagency Team	high		
Continue to monitor information related to sea level rise planning, data, and resources as it becomes available through State and Federal agencies, other local jurisdictions, and academic research.	Planning and Zoning	high		
Update the vulnerability assessment when needed as more refined sea level rise projections and resources become available from the State.	Planning and Zoning, Public Works, Health	low		
Develop an integrated monitoring system with standardized recording methods to track recent, ongoing and future flooding and/or inundation problems in impacted or vulnerable communities in the county. The system should identify specific locations, types of problems (road flooding, storm drain failures, septic system failures, well problems, flooded properties, etc.), frequency, and duration of these occurrences.	Emergency Management, Public Works, Health	high		
Account for potential fiscal impacts of sea level rise in future cost/revenue analyses, including impacts on operating and maintenance costs and property tax revenues.	Budget, Public Works	low		

#### Table 9 - Implementation Schedule

Recommendation	Lead Agencies	Priority
Incorporate the results and recommendations from the sea level rise planning process into the County's adopted plans as necessary to ensure implementation. These plans could include the General Development Plan; Water and Sewer Master Plan; Hazard Mitigation Plan; Land Preservation, Parks and Recreation Plan; and other plans as appropriate.	Planning and Zoning, Emergency Management, Recreation and Parks	medium
Goal: Protect coastal ecosystems to reduce the impacts of sea level rise, line erosion.	coastal flooding a	nd shore-
Using the Maryland Comprehensive Shoreline Inventory and DNR's Shoreline Conservation and Management Program, identify high priority sites along the County's shoreline for protection and/or restoration.	Planning and Zoning, Recreation and Parks	medium
Include identified high priority sites in future updates of the County's Land Preservation, Parks and Recreation Plan and General Development Plan.	Planning and Zoning, Recreation and Parks	medium
Highest priority sites should be targeted for acquisition using Program Open Space or other preservation funds where available and consistent with the purpose of those funding programs.	Planning and Zoning, Recreation and Parks	medium
Develop an inventory of sites that can be targeted for wetland or forest mitigation projects by private developers where development plans propose off-site mitigation.	Planning and Zoning, Recreation and Parks	medium
Outreach and promote the establishment of conservation easements on private properties in high priority sites to provide resource protection as well as tax incentives for private property owners.	Planning and Zoning, Recreation and Parks	medium
Goal: Reduce sea level rise impacts to existing and future development.		
Determine the remaining development holding capacity within the vulnerable areas, or within the Critical Area or FEMA districts. Incorporate this into the existing development and permit tracking system in order to better assess the number of new lots being approved and permits issued in these areas. This will aid the County in determining whether additional development regulations or restrictions may be required in the future to further reduce the risk and cost of development in vulnerable areas.	Planning and Zoning, Inspections and Permits	high
Revise the County's development regulations to discourage the granting of variances and modifications that allow stream and wetland impacts in the Critical Area, unless the applicant can demonstrate that there is no alternative site design possible that would not result in an effective taking of private property.	Planning and Zoning	high
Revise the County's development regulations to increase wetland and stream buffer setbacks in the Critical Area in accordance with State Critical Area Commission recommendations, at a minimum.	Planning and Zoning	high
Determine whether additional recommendations related to sea level rise vulnerability, both regulatory and non-regulatory, should be incorporated into the development plan review and approval process.	Planning and Zoning	medium

Recommendation	Lead Agencies	Priority		
Assess the feasibility of potential revisions to building code requirements that would minimize sea level rise impacts to existing and future development in the FEMA 100-year non-tidal and coastal high hazard flood zones. These might include increased freeboard elevation requirements, revised standards for foundation design, use of flood-resistant building materials, or other building design criteria.	Inspections and Permits, Planning and Zoning	medium		
Determine the benefits and feasibility of enrolling in FEMA's Community Rating System program to reduce flood insurance premiums for property owners in the County.	Inspections and Permits, Emergency Management	high		
Goal: Reduce potential impacts to public infrastructure serving existing development.	communities and	future		
Identify those road segments in vulnerable areas where flooding has been a known problem and where future impairment would have the most severe impacts, potentially cutting off access to individual properties or entire neighborhoods, and study feasible alternatives that can be put in place in both the short term and longer term to ensure road access.	Public Works	medium		
Identify those segments or components of the public water and sewer infrastructure systems in vulnerable areas where malfunctions or capacity constraints due to flooding or groundwater infiltration have been a known problem and where future impairment would have the most severe impacts in terms of properties or neighborhoods being served, and determine the range of feasible alternatives that can be implemented in both the short term and longer term to ensure adequate service.	Public Works	medium		
Assess whether revisions are needed to current design standards for public infrastructure capital projects to reduce future operation and maintenance problems in areas vulnerable to sea level rise impacts.	Public Works	low		
It is feasible that at some future point in time, the ongoing costs of maintaining public infrastructure in flood-prone areas may become unsustainable for the County and/or property owners, and abandonment may become the only feasible option. Establish policy directives and develop the criteria that will be used if needed to determine when, where, and under what circumstances public infrastructure in vulnerable areas would be abandoned. Such decisions must necessarily be made far in advance of actual abandonment so that feasible alternatives can be developed and adequate public notice and input can be incorporated.	Public Works, Budget	low		
Goal: Ensure safe and adequate water supply and wastewater management for communities vulner- able to sea level rise impacts.				
Assess whether revisions are needed to current State and local construction or design regulations and standards for private wells and/or private on-site septic systems in vulnerable or flood-prone areas.	Health	low		
As part of the ongoing study to determine and implement alternatives to on-site septic disposal in problematic areas known for septic system failures, evaluate alternative wastewater treatment solutions for properties on septic systems in areas vulnerable to sea level rise.	Public Works, Health	medium		
Evaluate the feasibility of new community well systems or connection to the public water system as alternatives for areas that are or may become vulnerable to private well contamination.	Public Works, Health	medium		

Recommendation	Lead Agencies	Priority
Goal: Protect significant cultural resources from loss or damage due to	sea level rise impac	cts.
Based on the work done in the vulnerability assessment to prioritize all cultural resources based on their significance and level of threat, develop a schedule to complete investigations of all priority sites that have had little or no previous investigation. Commit funding for additional staff resources (county or contractors) to complete all priority investigations.	Planning and Zoning	high
Require Phase III level mitigation (excavation) of archaeological sites by contractors, overseen by county staff, when permit or development actions not governed by existing code provisions occur on private or public land located on the prioritized list of vulnerable sites.	Planning and Zoning	high
Triggering events for cultural resources review to assess and conduct mitigation should be expanded beyond the current requirements for site development plans. Other triggering actions should include capital projects including all shoreline stabilization and/or armoring projects, and all building and grading permits.	Planning and Zoning	high
Protect historic sites and buildings in place where financially and technically feasible using shoreline stabilization measures.	Planning and Zoning	medium
Develop guidelines and requirements for the potential displacement of vulnerable historic resources when shoreline stabilization is not a feasible strategy for permanent protection.	Planning and Zoning	medium
Develop a community stewardship program to create a partnership between private property owners of culturally-significant properties and the County for the purpose of monitoring periodic and ongoing occurrences of flooding, inundation and erosion of these properties and ensuring action is taken before significant resources are lost.	Planning and Zoning	medium
Determine the eligibility of historic properties to use historic preservation tax credit programs to offset costs of elevation or flood-proofing retrofits where those adaptation strategies are appropriate.	Planning and Zoning	medium
Goal: Ensure that citizens in the County are educated and informed abo access to current information and resources.	out sea level rise an	d have
Develop a network of community representatives for those communities located in vulnerable areas. Build upon the list of representatives created for the 2011 Community Focus Group session. Use this network for information sharing and updates related to sea level rise planning.	Community and Constituent Services	high
Provide education and outreach opportunities for business interests, including the maritime industry, which may also be affected by sea level rise impacts.	Community and Constituent Services	high
Develop and maintain a web site within the County internet system dedicated to sea level rise planning and related resources useful to the public.	Community and Constituent Services, Planning and Zoning	high
Through the Office of Emergency Management, work with the local community network to assist vulnerable communities in developing action plans and improving emergency preparedness at the community level. In addition to planning for catastrophic events, promote awareness and preparedness for the longer term or more permanent impacts of sea level rise.	Emergency Management, Community and Constituent Services	medium

#### List of Resources

1. Leatherman, S.P., and C.R. Volonte. 1992. *Future Sea Level Rise Impacts: Maryland's Atlantic Coastal Bays*. Maryland Department of Natural Resources, Annapolis, Maryland.

2. Maryland Commission on Climate Change, 2008. *Comprehensive Assessment of Climate Change Impacts in Maryland*, Report of the Scientific and Technical Working Group.

3. Maryland Commission on Climate Change, 2008. *Comprehensive Strategy for Reducing Maryland's Vulnerability to Climate Change, Phase I: Sea-level Rise and Coastal Storms*, Report of the Adaptation and Response Working Group.

4. Maryland Commission on Climate Change, 2011. *Comprehensive Strategy for Reducing Maryland's Vulnerability to Climate Change, Phase II: Building Societal, Economic, and Ecological Resilience*, Report of the Adaptation and Response and Scientific and Technical Working Groups.

5. Anne Arundel County Office of Planning and Zoning, 2010. *Anne Arundel County Sea Level Rise Strategic Plan, Phase I Report: Vulnerability Assessment*. Publication of the Maryland Chesapeake and Coastal Program, Department of Natural Resources.

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