2. IDENTIFICATION OF CRITICAL VULNERABILITIES

2.1 SEA LEVEL SCENARIOS AND CRITICAL VULNERABILITIES DEFINED

Sea Level Scenarios Overview

The focus of the current report is on areas that are projected to be impacted by an increase in water level. Water level increase is driven by: (1) relative sea level rise (SLR) from climate change, and (2) major flood stage (MFS) from storm events. Both of these factors are described in the following sections. Areas that are predicted to be impacted are those areas where the existing topography overlaps with the predicted water elevation (geographic information system [GIS] analysis Section 2.2). Predicted water elevations are calculated as the summation of water level at mean higher high water (MHHW) in terms of the North American Vertical Datum of 1988 (NAVD88) and different combinations of water level increases from SLR and MFS and are termed sea level scenarios (**Table 2-1**). A range of elevations is presented for the year 2050 and year 2100. The range in elevations for the years 2050 and 2100 presented in this report represent potential bounds for water level increases.

Reference Sea Level (MHHW)

To calculate the sea level scenarios presented in this report, a reference sea level was needed as sea levels change within a day (e.g., tides). This reference sea level is MHHW in NAVD88. The water in the Northern Chesapeake Bay has two high tides and two low tides that continue in a cycle. The MHHW is the average of the highest tides within each tidal day (two high tides and two low tides) calculated over 19 years (National Tidal Datum Epoch). Therefore, sea level scenarios include the highest sea level within a tidal day.

Relative Sea Level Rise from Climate Change

In the context of this report, relative SLR refers to projected water level increases estimated from climate change for the Maryland Coast. The projections for SLR were selected from Boesch et al. (2018) for the years 2050 and 2100. In Boesch et al. (2018), a probabilistic model developed by Kopp et al. (2014) was used to estimate probabilities associated with specific rises in sea level. The SLR predictions for Maryland account for local increases in sea level from: (1) thermal expansion, (2) melting of glaciers, (3) melting of ice from Greenland, (4) melting of ice from Antarctica, (5) vertical land movement, and (6) alterations in ocean dynamics (Boesch et al. 2013, 2018). The predominant factor driving the rate and extent of SLR is greenhouse gas emissions. Three different greenhouse gas emission scenarios, listed from lowest to highest emissions are: (1) emissions that decline now and become net zero this century, Paris Agreement; (2) emissions that stabilize now and decline after 2050, Stabilized Emissions; and (3) emissions that continue to increase, Growing Emissions (Boesch et al. 2018). After 2050, the probabilistic model predicts greater increases in sea level with higher emissions.

To capture some of the uncertainty associated with SLR predictions, a range of water level increases is presented in the current report. The low SLR prediction for the range presented in

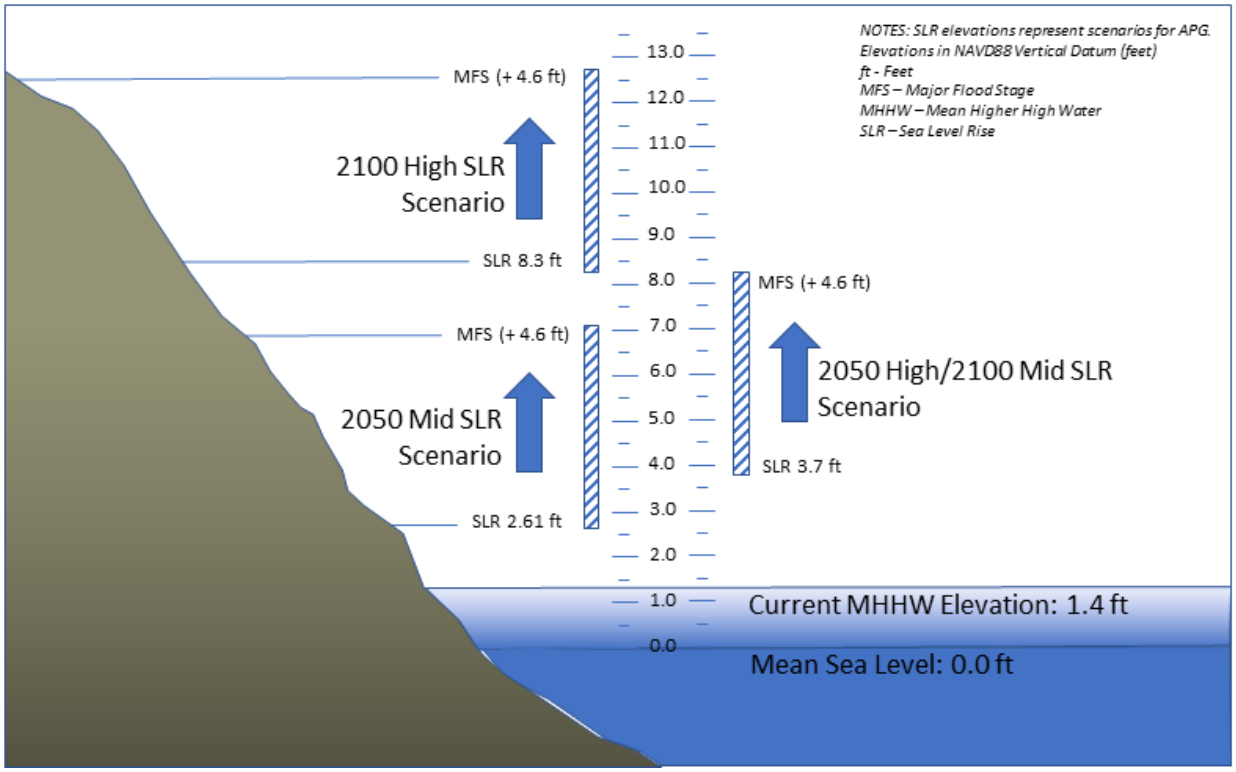
this report is likely to occur while the high SLR prediction represents a possible "worst" case scenario. For 2050, water level increases of 1.2 ft and 2.3 ft were used in the sea level rise scenarios (**Table 2-1**). Based on the probabilistic models (Boesch et al. 2018), there is a 50% probability that SLR will meet or exceed 1.2 ft by 2050, the central estimate in terms of possible SLR. The high SLR presented in this report represents the 1% probability that SLR will meet or exceed 2.3 ft in 2050. For 2100, water level increases of 2.3 ft and 6.9 ft were used in the sea level rise scenarios (**Table 2-1**). An increase of 2.3 ft in sea level rise is within the range of predicted central estimates (50% probability SLR meets or exceeds) for SLR based on stabilized emissions (2.4 ft) and Paris Agreement emissions (2.0 ft). The predicted 1% probability sea level rise for 2050 and the central estimate for 2100 result in the same increase from relative sea level rise in this report. The high SLR prediction for 2100 is an increase in sea level of 6.9 ft and has a 1% probability that sea level will meet or exceed that elevation based on the growing emissions scenario. The increases in sea level from climate change are predicted to result in a "new normal" and, therefore, are anticipated to result in relatively permanent flooding with the exception of tides.

Flooding from Storm Events

The water level increases from flooding that are used throughout this report are the 2019 major flood stages. The major flood stages are determined by National Oceanic and Atmospheric Administration (NOAA) and the National Weather Service and are different for each county (**Table 2-1**). Major flooding is defined as extensive inundation of structures and roads resulting in significant evacuations of people (U.S. Department of Commerce 2010). Major flood stages occur infrequently. For example, in Havre de Grace, major flooding is projected to occur every 20 to 25 years. The major flood stage is calculated for each county based on flooding impacts to the existing (2019) infrastructure. This calculation uses the topography of the area at the current (2019) sea level as well as the location and density of existing infrastructure. In this report, the major flood stage provides an estimate of water inundation from a storm event, although the flood stages are anticipated to change with SLR from climate change in the future.

Table 2-1 Sea Level Rise Scenarios

Year	MHHW Elevation (ft)	Relative SLR Scenario Range	Water Level Increase (ft) from SLR	Predicted MHHW Elevation with SLR (ft)	MFS Water Level Increase (ft)	Predicted MHHW Elevation with SLR and MFS (ft)
APG – Reference NOAA Tide Station/Gauge = 8574070/HDGM2 Havre de Grace **MHHW referenced to the NAVD88 Vertical Datum**						
2050	1.4	Mid	1.2	2.6	4.6	7.2
		High	2.3	3.7		8.3
2100	1.4	Mid	2.3	3.7	4.6	8.3
		High	6.9	8.3		12.9
Harford County – Reference NOAA Tide Station/Gauge = 8574070/HDGM2 Havre de Grace **MHHW referenced to the NAVD88 Vertical Datum**						
2050	1.4	Mid	1.2	2.6	4.6	7.2
		High	2.3	3.7		8.3
2100	1.4	Mid	2.3	3.7	4.6	8.3
		High	6.9	8.3		12.9
Cecil County – Reference NOAA Tide Station/Gauge = 8573927/CHCM2 Chesapeake City **MHHW referenced to the NAVD88 Vertical Datum**						
2050	1.6	Mid	1.2	2.8	4.3	7.1
		High	2.3	3.9		8.2
2100	1.6	Mid	2.3	3.9	4.3	8.2
		High	6.9	8.5		12.8
Kent County – Reference NOAA Tide Station/Gauge = 8573364/TCBM2 Tolchester Beach **MHHW referenced to the NAVD88 Vertical Datum**						
2050	0.81	Mid	1.2	2.0	3.8	5.8
		High	2.3	3.1		6.9
2100	0.81	Mid	2.3	3.1	3.8	6.9
		High	6.9	7.7		11.5



The following reference is provided to compare the predicted water level increase from sea level scenarios outlined above (**Table 2-1**) relative to a historic event that caused significant flooding in the area. Hurricane Isabel occurred in 2003 and created the most significant coastal flooding to impact the Project Area since 1933 (National Weather Service 2013). Although the damage caused by the energy produced from the storm may not be comparable to SLR from climate change, the example is provided with the intent of comparing increases in water levels. During and following Hurricane Isabel, sea levels in Kent County recorded at the Tolchester Beach NOAA Tide Station were approximately 6.2 ft (referenced to MHHW). For Kent County, the predicted elevation with SLR and MFS in both 2050 and 2100 would exceed the water level increase from Hurricane Isabel for three of the four scenarios (exception of 5.78 ft predicted elevation). In Kent County, the highest elevation predicted in 2100 (11.5 ft) would exceed the measured water level increase from Hurricane Isabel by approximately 5.3 ft.

2.2 GEOGRAPHIC INFORMATION SYSTEM ANALYSIS AND QUALITY CONTROL/QUALITY ASSURANCE PROCESS

A GIS analysis was used to predict areas that will be impacted based on the aforementioned sea level rise scenarios in APG, and Harford, Cecil, and Kent counties. The process for data collection analysis and quality assurance (QA)/quality control (QC) is described in the following sections.

Data Collection and Analysis

The light detection and ranging (LiDAR) Digital Elevation Model (DEM) raster dataset for APG was obtained directly from the military installation. The LiDAR DEM raster datasets for Harford, Cecil, and Kent counties were obtained from MD iMAP, Maryland's mapping and GIS data portal. Areas of missing data coverage for APG were substituted with U.S. Geological Survey (USGS) National Elevation Dataset DEM raster datasets. All DEMs were projected in horizontal coordinate system World Geodetic System (WGS) 1984 Universal Transverse Mercator (UTM) 18N Meter to comply with Spatial Data Standards for Facilities, Infrastructure, and Environment (SDSFIE) data formatting, and vertical coordinate system NAVD88 U.S. foot. Cell size was set to 5 ft by 5 ft. The LiDAR DEMs provided the most accurate, best available topographic data for mapping the current MHHW boundary and modeling sea level rise and flood stage scenarios. The current MHHW and scenario boundaries were visually reviewed against aerial imagery and edited as needed to more accurately represent the interface between hydrologic and terrestrial boundaries.

General categories for infrastructure and environment (listed in Sections 2.2 and 2.3) data layers were obtained from MD iMAP, APG, county GIS departments, and U,S, Fish and Wildlife Service (USFWS), to ensure that the most accurate and best available data were used. All layers were projected in horizontal coordinate system WGS 1984 UTM 18N Meter to comply with SDSFIE data formatting. Data inventory figures are provided in Appendix A (**Figures A-2 through A-8**). The figures contain tables that include the GIS layers shown on the figures that indicate the type, name, date, source, and description of each layer.

Quality Assurance/Quality Control (QA/QC)

To ensure data quality and accuracy for estimating the areal coverage of the projected sea level rise scenarios, three QA/QC procedures were followed: survey-grade global positioning system (GPS) field verification of vertical positions, external comparison of spot elevations, and a 10% QA review of the data feature layers. Each of these procedures is detailed below. These procedures were followed to verify that the DEM employed for SLR extent estimates was accurate to within <1 ft in the vertical (horizontal extents were constrained to a 5-ft by 5-ft cell size based on the DEM with the lowest resolution), and resulting GIS SLR scenarios, infrastructure, and environmental layers reflected assumed conditions. Additionally, as part of the SDSFIE data deliverable process, all GIS data were fully attributed with appropriate metadata completed according to Federal Geographic Data Committee metadata standards. Data layers were projected to WGS84 UTM Zone 18N.

Field Verification

Using a real-time kinematic differential survey-grade GPS, 10 point locations randomly assigned from within the study areas were imported into the GPS unit. Each point was attributed with elevations acquired from the DEM. A field stakeout procedure was followed whereby EA Engineering, Science, and Technology, Inc., PBC navigated to the imported point locations and compared the actual GPS elevations found at each location with the values imported from the

DEM. Accuracy tolerances were maintained to within 1 ft horizontal (X, Y) and 2–4 inch vertical (Z). Horizontal projection was verified in the North American Datum of 1983 Maryland State Plane. Vertical projection was verified in NAVD88. A QC check was also conducted for the real-time kinematic GPS unit by cross-checking elevations on two National Geodetic Survey Monuments with known vertical positions.

External Comparisons of Spot Elevations

A secondary elevation check was completed via desktop by plotting 10 random points within the study area and exporting their associated elevations from the DEM as a .kml file. The .kml file was then imported into Google Earth where the elevation values could be compared with the elevations reported in Google Earth. This check was a coarse check to ensure there were no omissions or unit of measure mis-matches in the data and, therefore, vertical tolerances were within feet rather than inches.

10% Feature Layer Accuracy

A QC check was completed for each SLR scenarios and a minimum of 10% of the features produced for the analysis of each category—Infrastructure and Environmental layers. These checks were to ensure that the point or polygon from each QC'd feature that fell within an SLR scenario was reported correctly.

2.3 CRITICAL INFRASTRUCTURE VULNERABILITIES FOR ABERDEEN PROVING GROUND

Critical vulnerabilities for APG include mission-critical areas that are anticipated to be impacted by relative SLR and storm events. The following general categories were assessed in terms of their locations relative to impacts from SLR and MFS.

- Military ranges/training areas
- Airfields
- Buildings
- Roads
- Railroads
- Electrical Substations
- Wetlands and Critical Area Buffers.

For APG, figures were provided for each area anticipated to be impacted (**Figures 2-1 through 2-113**). Military ranges within APG are outlined in red and a white call out box identifies each range. In addition to the name of the military range, the call out box also specifies the total acreage for the range and the land area that is anticipated to be impacted by the indicated SLR and MFS. The impacted area presented for the "Major FS" on the range call out box is the summation of the predicted impacted areas from SLR and flooded areas from MFS. Buildings and electrical substations that are anticipated to be impacted by high SLR and MFS (i.e., predicted elevation of 12.9 ft). The name and location of the building are included in Table B-1

(Appendix B). The buildings that are anticipated to be impacted by high SLR and MFS are included on all figures (**Figures 2-1 through 2-113**).

The areas that are predicted to be impacted for APG can be ranked to prioritize areas that require a plan for mitigation. Areas can be prioritized by: (1) the percent of a range that is anticipated to be impacted, (2) ranges that are anticipated to be in use for a short or long period of time relative to the time scale for SLR (approximately 30 and 80+ years), and (3) the criticality of the ranges, buildings, electrical substations, and roads/railroads.

In 2050, the mid SLR scenario is anticipated to result in the greatest impacts to the military range, Spesutie Island-Central with 59% of the area impacted (**Table B-2**). The other military ranges decrease in terms of impacts from 39% to 0% for the mid SLR scenario. Three buildings on Mulberry Point (**Figure 2-19**), Pooles Island (Lighthouse) (**Figure 2-79**) and SI Range 14 are predicted to be impacted for the mid SLR scenario as well. There is a substantial increase in flooding is predicted when MFS is added to the mid scenario in 2050. For the mid SLR and MFS scenario, there are 14 military ranges that are anticipated to have 50% or more of the total area impacted (**Table 2-2**). In addition, 100 buildings and 1 electrical substation are anticipated to be impacted by flood waters (**Table 2-2**). For the high SLR and MFS scenario in 2050 (new elevation of 8.3 ft), 134 buildings and 1 electrical substation are anticipated to be impacted (**Table 2-2**).

Assuming that the mid SLR scenario in 2100 is reached, acres of 4 military ranges is anticipated to be impacted by 50% or more during MHHW (**Table B-2**). The impacted ranges are Spesutie Island-Central (**Figure 2-8**), Spesutie Island-South (**Figure 2-8**), Spesutie Island-West (**Figure 2-4**), and J Field (**Figure 2-76**). During MHHW, 12 buildings are predicted to be impacted (**Table 2-2**). Similar to the mid SLR scenario for 2050, storm events that result in a major flood stage are anticipated to result in a relatively large increase in flooded areas. Fifteen military ranges (**Table 2-4**) are predicted to be impacted by 50% or more and 134 buildings and 1 electrical substation may be flooded (**Table 2-2**). For the 2100 high SLR scenario, the acres of 25 military ranges (**Table B-2**) are predicted to be impacted by greater than 50%. In addition, 213 buildings and 4 electrical substations are anticipated to be impacted (**Table 2-2**). **Tables 2-2 and 2-3**, identify military ranges anticipated to be impacted by 50% or more for the specified year and scenario.

As a result of flood events, changes in overlying water levels can alter the biogeochemistry of soils and sediments. An understanding of the impacts' alterations in biogeochemistry of soils and sediments used to sequester contamination may be beneficial to prevent mobilization of contaminants.

Table 2-2 Operational Range Impacts for Sea Level Rise Scenarios – APG

SLR Scenarios	2050 Mid SLR (1.2 ft above MHHW)		2050 High/2100 Mid SLR (2.3 ft above MHHW)		2100 High SLR (6.9 ft above MHHW)	
Impacted Area	Permanent Flooding	MFS	Permanent Flooding	MFS	Permanent Flooding	MFS
Military Range/Training Area (acres)	3,896	10,555	5,360	11,592	11,641	15,835
Number of Buildings	3	100	12	134	135	213
Number of Electrical Substations	0	1	0	1	1	4

Table 2-3 Military Ranges with Predicted Impacts greater than or equal to 50% Ranked from Highest to Lowest. Predicted Percent Impact for mid SLR and MFS in 2050.

Range Name	Predicted Percent Impact in 2050	Range Type
Maxwell Point	98%	RDTE RANGE
PAWS Testing	96%	RDTE RANGE
P Field	92%	RDTE RANGE
Carrolls Island	92%	Light infantry maneuver training area
Pooles Island	90%	RDTE RANGE
J Field	77%	RDTE RANGE
Spesutie Island-West	75%	RDTE RANGE
Edgewood Impact Area	73%	RDTE IMPACT AREA
Spesutie Island-Central	67%	RDTE RANGE
Spesutie Island-South	64%	RDTE RANGE
Spesutie Island-East	60%	RDTE RANGE
H Field	58%	RDTE RANGE
New Bombing Field	56%	RDTE RANGE
Graces Quarters	52%	Amphibious Forces maneuver training area
Note: RDTE = Research, Development, Test, and Evaluation.		

Table 2-4 Military Ranges with Predicted Impacts greater than or equal to 50% Ranked from Highest to Lowest. Predicted Percent Impact for mid SLR and MFS in 2100.

Range Name	Predicted Percent Impact in 2100	Range Type
Maxwell Point	98%	RDTE RANGE
PAWS Testing	97%	RDTE RANGE
P Field	93%	RDTE RANGE
Carrolls Island	93%	Light infantry maneuver training area
Pooles Island	93%	RDTE RANGE
J Field	83%	RDTE RANGE
Spesutie Island-West	77%	RDTE RANGE
Edgewood Impact Area	76%	RDTE IMPACT AREA
New Bombing Field	70%	RDTE RANGE
Spesutie Island-Central	67%	RDTE RANGE
Spesutie Island-South	64%	RDTE RANGE
Spesutie Island-East	63%	RDTE RANGE
H Field	62%	RDTE RANGE
Graces Quarters	57%	Amphibious Forces maneuver training area
Briar Point	56%	RDTE RANGE
Note: RDTE = Research, Development, Test, and Evaluation.		

2.4 CRITICAL INFRASTRUCTURE VULNERABILITIES FOR HARFORD, CECIL AND KENT COUNTIES

The focus of this report are areas where predicted impacts from SLR and flooding from storm events intersect with critical land uses. To further focus efforts for Harford, Cecil, and Kent counties, vulnerabilities were identified. Critical vulnerabilities are areas and infrastructure that are necessary for human health and safety, industry, culture, and the environment and are anticipated to be impacted by an increase in water level from SLR and flooding from storm events. The following general categories were assessed to determine if there is overlap between their location and predicted water levels for each of the scenarios (**Figures 2-114 through 2-155 [Harford County], Figures 2-156 through 2-237 [Cecil County], and Figures 2-238 through 2-279 [Kent County]**).

General Land Use Types

- Agriculture
- Commercial
- Industrial
- Institutional
- Residential.

Infrastructure Categories

Transportation

- Airport
- Transportation station – Bus station
- County-owned bridge
- State-owned bridge.

Communication and Utilities

- Utility station – Electric
- Communications tower
- Wastewater treatment plant
- Water treatment plant
- Energy plant.

Emergency Response

- Fire station
- Hospital
- Police station.

Miscellaneous

- Correctional facility
- Long-term care assisted living
- School
- Veterans services.

Cultural

- Recreation area
- Library
- Place of worship
- Surveyed historic resource
- Historic district or easement.

Environmental Categories

- Federal or State protected land
- DNR land
- Sensitive species project review area (SSPRA)
- Critical habitat of local significance
- Forest conservation easement
- Forest conservation project
- USFWS wetland
- Maryland wetland of special State concern.

The figures created for each of the counties have an overview map at an appropriate scale to view the entire county. Additional figures were created on a smaller scale (e.g., town) and were selected to highlight areas with relatively high densities of critical vulnerabilities. In terms of critical infrastructure vulnerabilities, these figures target areas that have multiple buildings that are predicted to be impacted. For the figures displaying critical environmental vulnerabilities, smaller scale figures were used to highlight environmental categories with relatively high percent impacts for the respective county and captured multiple environmental categories (e.g., USFWS wetlands and Maryland wetlands of special State concern). The figures at a smaller scale represent areas that could be the focus for development of an adaptation plan. Areas excluded from the smaller scale figures also are predicted to be impacted by water level increases in low-lying areas along water bodies (e.g., rivers, creeks, and Chesapeake Bay). An example of areas that are predicted to be impacted are marinas and boating areas that serve as locations for recreation and tourism for the counties.

Harford County

The mid SLR scenario results in a total of 720 acres of shoreline in Harford County that are impacted during MHHW in 2050 (**Table 2-5**). When MFS is added to mid SLR in 2050, the

impacted acreage increases by 1,160 acres resulting in a total impacted area of 1,880 acres of shoreline (**Table 2-5**). Areas included in the 1,880 acres of shoreline are low-lying areas in Joppatowne, Edgewood, Abingdon, and East of Aberdeen. More specifically, in Joppatowne and West of Joppatowne, along the Gunpowder River, and Big Gunpowder Falls are areas that are likely to be impacted (**Figure 2-120**). Historic districts and easements are among the impacted areas for the mid SLR and MFS scenario. Within the impacted area are 84.13 acres of historic districts and 3.09 acres of historic easements (**Table 2-5**). During MFS, water levels begin to impact recreation areas (0.31 acre) and utility stations (0.87 acre) (**Table 2-5**). Importantly for Harford County, 6 surveyed historic sites are anticipated to be flooded with 5 of the 6 sites located in Havre de Grace (1 in Edgewood) (**Table 2-5**). These historic sites are identified in **Figures 2-115 through 2-118** and their addresses are listed in **Table B-3**.

In 2100, for the mid SLR and MFS scenario the impacted acreage increases to 2,076 acres (**Table 2-5**). Of this impacted area, 109.05 acres is historic districts, 3.13 acres is historic easements, and 1.03 acres is utility stations. For the high SLR and MFS scenario, approximately 50 more acres within the historic district become impacted. A library, a long-term care assisted living building, 3 places of worship, and 10 surveyed historic resources are anticipated to be flooded (**Table 2-5**). Ten of the 15 total buildings that are anticipated to be flooded for the high SLR and MFS scenario are in Havre de Grace, 3 are in Joppatowne, 1 is in Abingdon and 1 is in Edgewood (**Figure 2-118 and 2-122)**.

There are numerous environmental resources that will be impacted by water level increases in 2050 and 2100 for the mid SLR and MFS scenarios. These resources include State Protected Land, DNR Land, SSPRA, Critical Habitats of Local Significance, Forest Conservation Easements, USFWS and Maryland Wetlands of Special State Concern (**Figure 2-132 through 2-155**). The greatest acreage of impact is USFWS wetlands (789 acres in 2050 and 851 acres in 2100) (**Table 2-6**).

Table 2-5 Critical Infrastructure Impacts for Sea Level Rise Scenarios – Harford County

SLR Scenarios	2050 Mid SLR (1.2 ft above MHHW)		2050 High/2100 Mid SLR (2.3 ft above MHHW)		2100 High SLR (6.9 ft above MHHW)	
Impacted Area (acres)	**Permanent Flooding**	**MFS**	**Permanent Flooding**	**MFS**	**Permanent Flooding**	**MFS**
Total Impacted Acreage	720	1,160	1,114	962	2,066	1,144
Parcels – Agriculture	56	45	76	33	108	36
Parcels – Commercial	20	128	53	118	172	137
Parcels – Industrial	51	88	83	72	155	61
Parcels – Institutional	282	445	405	397	805	339
Parcels – Residential	44	155	81	152	236	308
Historic District	5.50	78.6	14.4	94.7	110	53.6
Historic Easement	0.03	3.06	0.07	3.06	4.53	0.00
Recreation Area	0.00	0.31	0.00	0.32	0.33	0.53
Utility Station	0.00	0.87	0.00	1.03	6.01	0.62
Number of Structures						
Airports	0	0	0	0	0	0
Communications Towers	0	0	0	0	0	0
Correctional Facilities	0	0	0	0	0	0
Fire Stations	0	0	0	0	0	0
Hospitals	0	0	0	0	0	0
Libraries	0	0	0	0	0	1
Long-Term Care Assisted Living	0	0	0	0	0	1
Places of Worship	0	0	0	0	0	3
Police Stations	0	0	0	0	0	0
Schools	0	0	0	0	0	0
Surveyed Historic Resources	0	6	0	8	2	10
Transportation Stations	0	0	0	0	0	0
Veterans Services	0	0	0	0	0	0

Table 2-6 Environmental Infrastructure Impacts for Sea Level Rise Scenarios – Harford County

SLR Scenarios	2050 Mid SLR (1.2 ft above MHHW)		2050 High/2100 Mid SLR (2.3 ft above MHHW)		2100 High SLR (6.9 ft above MHHW)	
Impacted Area (acres)	**Permanent Flooding**	**MFS**	**Permanent Flooding**	**MFS**	**Permanent Flooding**	**MFS**
Federal Protected Land	0	0	0	0	0	0
State Protected Land	74	98	108	80	188	60
DNR Land	132	203	192	173	366	79
Sensitive Species Project Review Area	183	262	269	211	492	327
Critical Habitat of Local Significance	71	153	122	132	255	172
Forest Conservation Easement	29	19	41	9	49	4
USFWS Wetland	364	425	526	325	756	195
Maryland Wetland (Special State Concern)	19	28	28	29	57	20

Cecil County

Substantial flooding Southwest of Elkton along Big and Little Elk creeks in Cecil County is predicted for each SLR scenario. For the mid SLR scenario, a total of 1,434 acres in 2050 and 2,291 acres in 2100 are predicted to be impacted by SLR alone (**Table 2-7**). Buildings are not impacted for either of these years from SLR. The addition of MFS to the mid SLR scenario increases impacted areas to 4,133 acres in 2050 and 4,884 acres in 2100 (**Table 2-7**). In Cecil County, there are a number of historic districts that are predicted to be impacted by increasing water levels from SLR and MFS. The impacts to historic districts and easements generally increase as predicted water levels increase. Impacted historic districts and easements are in Port Deposit, Charlestown, Northeast, Elkton, Chesapeake City, and Fredricktown (**Figures 2-157 through 2-160**). For the mid SLR and MFS scenario in 2050, there is a place of worship in Northeast, a communications tower in Chesapeake City, and a Wastewater Treatment Plant (WWTP) in Port Deposit that are predicted to be flooded (**Figure 2-159**). In 2100, Harbour View WWTP in Chesapeake City may be flooded. For the high SLR and MFS scenario in 2100, a fire station and a place of worship in Port Deposit, the Northeast Library, a police station in Northeast, and Port Herman WWTP are predicted to be impacted (**Figure 2-160, Figure 2-168, Figure 2-180, Table B-4**).

Adaptation plans for the WWTPs in Port Deposit and the Harbour View WWTP are in preparation (Cecil County, Maryland 2018; EnviroProjects 2018).

For each of the SLR scenarios, Federal and State Protected Lands, SSPRAs, Forest Conservation Easements, USFWS wetlands, and Maryland Wetlands of Species State concern will be impacted by flooding to some extent (**Figure 2-213 through 237**). The specific environmental infrastructure impacted by inundation is summarized in **Table 2-8**. Impacted SSPRAs include areas where federally and state-listed species may be located.

Table 2-7 Critical Infrastructure Impacts for Sea Level Rise Scenarios – Cecil County

SLR Scenarios	2050 Mid SLR (1.2 ft above MHHW)		2050 High/2100 Mid SLR (2.3 ft above MHHW)		2100 High SLR (6.9 ft above MHHW)	
Impacted Area (acres)	**Permanent Flooding**	**MFS**	**Permanent Flooding**	**MFS**	**Permanent Flooding**	**MFS**
Total Impacted Acreage	1,434	2,699	2,291	2,593	5,049	2,905
Parcels – Agriculture	501	1,011	793	965	1,826	1,169
Parcels – Commercial	43	183	89	194	293	150
Parcels – Industrial	0	1	0	2	2	6
Parcels – Institutional	244	355	415	353	791	273
Parcels – Residential	295	648	478	628	1,150	668
Historic District	2.62	34.3	11.6	45.2	63.4	85.1
Historic Easement	70.9	150	157	99.8	265	101
Number of Structures						
Airports	0	0	0	0	0	0
Communications Towers	0	1	0	1	1	1
Correctional Facilities	0	0	0	0	0	0
Energy Plants	0	0	0	0	0	0
Fire Stations	0	0	0	0	0	1
Hospitals	0	0	0	0	0	0
Libraries	0	0	0	0	0	1
Long-Term Care Assisted Living	0	0	0	0	0	0
Places of Worship	0	1	0	1	1	1
Police Stations	0	0	0	0	0	1
Schools	0	0	0	0	0	0
Veterans Services	0	0	0	0	0	0
Wastewater Treatment Plants	0	1	0	2	3	3
Water Treatment Plants	0	0	0	0	0	0

Table 2-8 Environmental Infrastructure Impacts for Relative Sea Level Rise – Cecil County

SLR Scenarios	2050 Mid SLR (1.2 ft above MHHW)		2050 High/2100 Mid SLR (2.3 ft above MHHW)		2100 High SLR (6.9 ft above MHHW)	
Impacted Area (acres)	**Permanent Flooding**	**MFS**	**Permanent Flooding**	**MFS**	**Permanent Flooding**	**MFS**
Federal Protected Land	22	115	70	88	162	403
State Protected Land	519	900	862	880	1,796	807
Sensitive Species Project Review Area	887	857	733	1,641	702	887
Forest Conservation Easement	331	180	317	517	329	331
USFWS Wetland	871	1,484	605	2,111	318	871
Maryland Wetland (Special State Concern)	131	213	35	250	21	131

Kent County

In Kent County, considerable impacts to agricultural and residential land within, surrounding, and south of Rock Hall is predicted for each SLR scenario (**Figures 2-251 through 2-254**). As early as 2050 for the mid SLR scenario, 1,608 acres of agricultural land is anticipated to be impacted (**Table 2-9**). During an MFS for the mid SLR scenario, the impacted acreage is anticipated to be 6,427 acres. For the high SLR and MFS scenario, 12,702 acres of agricultural land will be impacted in 2100 (**Table 2-9**). Low-lying agricultural areas along Langford Creek, Chester River, and Comegys Bight are also anticipated to be impacted for the high SLR and MFS scenario (**Figure 2-250**). In addition to agricultural areas, part of the historic district of Chestertown along Chester River and West of Chester River along Radcliffe Creek is likely to be impacted for each SLR scenario (**Figures 2-248 through 2-250**). Several long-term assisted living facilities are also impacted when the predicted water elevation is 6.88 ft and greater (**Table 2-9**).

Environmental impacts to wetlands, SSPRAs and Federal and State Protected Land along water bodies South of Rock Hill are predicted to result from each SLR scenarios. The surface area of Eastern Neck Island is predicted to decrease by approximately half as a result of the high SLR and MFS scenario in 2100. On Eastern Neck Island, up to 1,264 acres (**Table 2-10**) of the National Wildlife Preserve may be impacted. Flooding is likely to occur for SSPRAs for federally and state-listed species for the range of SLR scenarios (**Figure 2-255 through 2-279**).

Table 2-9 Critical Infrastructure Impacts for Sea Level Rise Scenarios – Kent County

SLR Scenarios	2050 Mid SLR (1.2 ft above MHHW)		2050 High/2100 Mid SLR (2.3 ft above MHHW)		2100 High SLR (6.9 ft above MHHW)	
Impacted Area (acres)	**Permanent Flooding**	**MFS**	**Permanent Flooding**	**MFS**	**Permanent Flooding**	**MFS**
Total Impacted Acreage	2,818	7,467	5,444	6,679	13,499	5,698
Parcels – Agriculture	1,608	4,819	3,354	4,323	8,612	4,090
Parcels – Commercial	57.2	215	111	197	336	170
Parcels – Industrial						
Parcels – Institutional	574	598	855	387	1,292	205
Parcels – Residential	259	1,046	530	1,067	1,865	881
Historic District	9.32	31.2	20.0	25.7	49.5	23.2
Historic Easement	97.2	95.0	144	68.5	224	51.9
Number of Structures						
Airports	0	0	0	0	0	0
Fire Stations	0	0	0	0	0	0
Hospitals	0	0	0	0	0	0
Libraries	0	0	0	0	0	0
Long-Term Care Assisted Living	0	0	0	1	2	3
Places of Worship	0	0	0	0	0	0
Police Stations	0	0	0	0	0	0
Schools	0	0	0	0	0	0
Wastewater Treatment Plants	0	0	0	0	0	0
Water Treatment Plants	0	0	0	0	0	0

Table 2-10 Environmental Infrastructure Impacts for Sea Level Rise Scenarios – Kent County

SLR Scenarios	2050 Mid SLR (1.2 ft above MHHW)		2050 High/2100 Mid SLR (2.3 ft above MHHW)		2100 High SLR (6.9 ft above MHHW)	
Impacted Area (acres)	**Permanent Flooding**	**MFS**	**Permanent Flooding**	**MFS**	**Permanent Flooding**	**MFS**
Federal Protected Land	530	509	786	311	1,136	128
State Protected Land	3.64	19.9	8.68	17.0	26.9	11.8
DNR Land	28.4	58.6	58.2	52.5	121.7	61.4
Sensitive Species Project Review Area	629	1,600	1,268	1,196	2,629	738
Forest Conservation Easement	0	0	0	0.35	1.75	13.7
USFWS Wetland	2,126	2,742	3,589	1,583	5,356	680
Maryland Wetland (Special State Concern)	16.0	348	189	181	374	12.6