ENVIRONMENTAL RESOURCES MANAGEMENT

REPORT

Regulatory Response to Sea Level Rise and Storm Surge Inundation

City of Annapolis, Maryland

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I. Background

A. Project Description

In September 2011, the City of Annapolis contracted with ERM and WBCM to develop planning and regulatory responses to the impacts of sea level rise in the City. This report reviews sea level rise projections impacting Annapolis area, describes potential impacts of sea level rise, summarizes potential municipal responses to the increased flooding risks, and provides recommendations on revisions that should be considered to the City's code. This report does not include specific draft code language. The City would need to develop code language for those revisions that it wishes to implement.

The City will present the planning and regulatory response to sea level rise at a public meeting. A power point presentation summarizing and illustrating the key points of this report will be made and will be made available on the City's web site.

B. Sea Level Rise Projections

This report considers projections of sea level rise for Annapolis and establishes a recommended level for the city to use in evaluating regulatory changes. Three sources of sea level rise projections are considered:

1. ***Sea Level Rise Studies, City Dock and Eastport Areas:*** WBCM June 2010 and March 2011**.** WBCM's studies of sea level rise for the City Dock and Eastport areas, completed June, 2010, used National Oceanic and Atmospheric Administration (NOAA) data specific to Annapolis collected on a daily basis since 1996. (The NOAA website provides verified data beginning in 1996.) This data, when projected through 2050, results in an expected sea level rise of 0.5 feet by 2050. WBCM's study maps the larger area expected to be impacted by a 100-year flood based on the projected 0.5-foot increase in sea level rise. Current Federal Emergency Management Agency (FEMA) Flood Insurance Rate Maps designate the areas with elevation 7.8 feet or below in the 100-year or base floodplain[1]. With a 0.5-foot increase in sea level, areas at elevation 8.3 feet or below will be in the base floodplain.

   WBCM's study notes that the impacts from climate change and sea level rise will be more than only an increase in the area within the base floodplain. The frequency of storms that result in flooding is expected to increase as well as the frequency and extent of minor flooding from normal high tides. The study states that: "Minor nuisance flooding around the City Dock (currently) begins to occur when tides rise above elevation 1.9 feet. At that level, water begins to flow out of the existing storm drain system even during sunny days. Projecting to the year 2050, the occurrence of nuisance flooding is expected to more than double."

2. ***Climate Action Plan:*** State of Maryland 2008. Maryland is experiencing a greater rise in sea level than many other parts of the world due to naturally occurring regional land subsidence. The Maryland Commission on Climate Change, Scientific and Technical

[1] See Glossary

Working Group (STWG), assessed the Intergovernmental Panel on Climate Change 4th Assessment Report (2007) and three scientific reports that incorporated acceleration of ice loss, along with regional land subsidence variables to provide a conservative estimate that by the end of this century, Maryland's coasts may experience an average relative sea-level rise of 2.7 feet under a lower-greenhouse gas emissions scenario, and as much as 3.4 feet under the higher-emissions scenario. The Climate Action Plan states that "Relative sea-level rise as little as 0.6 ft (probably unlikely because this is scarcely above the 20th century rate) to much as 1.3 ft could be experienced along Maryland's coast by the middle of the century. By the end of the century, accelerated melting could produce a relative sea-level rise of 2.7 ft under the lower emissions scenario to 3.4 ft under the higher emissions scenario."

3. ***Final Flood Damage Reduction Analysis For The United States Naval Academy:*** U.S. Army Corps of Engineers Baltimore District, February 2006**.** The Naval Academy has chosen to base its flood protection measures on the current FEMA 500-year flood, which has an elevation of 9.98 feet.

For purposes of this report, the consultants have used WBCM's projected sea level rise of 0.5 feet by 2050. This projection was chosen because it is based on local sea level measurements, specific to Annapolis, captured daily over the past 15 years. This report uses the closer time frame of the next 40 years, rather than the Maryland DNR's 100-year projections, to reflect the time frame within which buildings are likely to be renovated, and to allow for the City's regulatory response to change over time.

Maryland Commission on Climate Change sea rise projections for Maryland's coastline are higher because they are based on models of global climate and ice melt trends. The models that predict greater sea level rise must be considered seriously, given the City's vulnerability to flooding. This report strongly recommends that the City of Annapolis frequently review actual sea level rise data and updated projections (at least every 6 years as part of the Comprehensive Plan update), and consider further revisions to codes and plans as appropriate.

If the City of Annapolis would prefer to base its response to sea level rise on the projected rise of 1.5 ft. by 2050, the new base flood elevations used in the recommended code changes in Section II of this report could be adjusted accordingly. Such a response would result in areas at elevation 9.3 feet or below being in the projected base floodplain.

C. Impacts of Sea Level Rise

1. Maryland's 2008 Climate Action Plan notes several potential impacts of sea level rise, including shore erosion, inundation, coastal flooding, higher water tables, and salt water intrusion into fresh water sources. Increased coastal flooding will be of major importance to Annapolis, while the other impacts will affect the City less.

   a. **Shore erosion** will impact Annapolis to a limited extent only. The city's less sheltered shores are protected by hardened shorelines such as riprap, jetties and seawalls (Annapolis Comprehensive Plan p.128).

b. **Inundation**, the gradual submergence of land areas, is of most immediate concern in the lower Eastern Shore and bay islands that have a very gradual increase in elevation above sea level (Maryland Climate Action Plan, Chapter 5, pp. 5-7). Based on a projected sea level rise of 0.5 feet, inundation is less of a concern than flood damages. However, areas near the City Dock could experience inundation if greater sea level rise occurs, and Annapolis should periodically review projections based on new data.

c. **Coastal flooding** will occur with greater frequency and severity. Sea level rise increases the height of storm waves, enabling them to reach further inland, and heightens the risk of damage to properties and infrastructure.

d. **Higher water tables and salt water intrusion**: As sea level rises, the groundwater table may rise and salt-water will begin to intrude into fresh water aquifers. Annapolis land is served by the City's municipal water supply. The depth of the City's water supply wells (300 to 1000 feet) and the inland location of the municipal water supply in Waterworks Park will help to protect the water supply from salt water intrusion. As with other potential impacts of rising sea level, Annapolis should monitor impacts on groundwater and its municipal water supply. Section D.2 below notes the types of public improvements recommended by WBCM and used in other jurisdictions to protect city pump stations and improve storm drain effectiveness during flooding.

Of the potential impacts listed above, coastal flooding is the major concern for Annapolis at this time. The City's currently defined 100-year floodplain and adjacent areas can expect more frequent and more severe flood events.

2. Annapolis' response to sea level rise must take into account the city's built environment:

a. Annapolis has very little vacant buildable land. The Comprehensive Plan states that 97 percent of developable land has been built upon. Future development will be infill of scattered vacant lots and the redevelopment of small geographic areas.

b. The waterfront is particularly important to the character and economic vitality of Annapolis. While maritime uses occupy 1% of the city, the maritime industry is estimated to have a $200 million economic impact on the city (Comprehensive Plan p. 16).

c. The city's historic core, which is partially located within the current 100-year floodplain, has great value. As noted in the Comprehensive Plan:

> "The city's historic core, a largely intact pre-industrial colonial city, is designated a National Historic Landmark for possessing exceptional value in illustrating the heritage of the United States. Annapolis boasts the largest collection of 18th century buildings in America. Many are open to the public where their beauty and architectural style are major attractions."

The Maryland Climate Action Plan and sea rise studies conducted for lower Eastern Shore counties evaluate three possible responses to sea level rise: protect, retreat/relocate, and abandon. Given the importance of the historic district and the waterfront, and the recreational and economic needs for waterfront access, the Annapolis response to sea level rise must focus on protecting existing structures and infrastructure. If sea level rise increases as projected in the Maryland Climate Action Plan over the next 100 years (up to

3.4 feet), Annapolis will need to evaluate structural flood protection methods such as floodwalls or address the possibility of retreating from some of its waterfront land (see illustrations in WBCM 2010, 2011.

D. Planning for Sea Level Rise

1. Comprehensive Plan

Two policies of the Annapolis Comprehensive Plan (2009) address sea level rise:

Chapter 3: Land Use and Economic Development; Policy 10:

Evaluate risks from sea level rise in decisions involving land use along the waterfront. The parts of the established downtown which are prone to severe flooding and may be expected to be impacted by sea level rise should be the subject of a study to determine the costs and benefits of public decision-making in mitigating property damage. Refer to Figure 7-7 and Policy 3 in Ch. 7 – Environment for further treatment of the City's policy position on sea level rise. Notwithstanding this, land use in areas that are prone to flooding should be evaluated carefully when land use changes are proposed.

Chapter 7: Environment; Policy 3.4:

Develop a strategy for sea level rise as part of the City's adaptation and response to threats from climate change. This planning effort should be coordinated with the City's Hazard Mitigation Plan and be prepared in coordination with State efforts, as well as the Federal government, U.S. Naval Academy, and County Government. It should delineate impacted areas, inventory potentially affected populations, assets, and resources, and develop legislative and regulatory responses. It should also address such issues as a post-disaster plan, public education on the risks of sea level rise, and coordination with other government agencies on research needs related to sea level rise. See Policy 10 in Ch. 3 – Land Use & Economic Development for the City's policy regarding waterfront land use.

2. Capital Projects and Management

The recommendations in Part II of this study address revisions to the city floodplain and development codes to respond to the increased flooding expected from sea level rise. These code revisions, if implemented, would require private property owners seeking building permits or change-in-use permits to better protect their properties from flood damages. To place these recommendations in context, following are other components of preparing for sea level rise that the city should evaluate in its cycle of comprehensive plan, neighborhood plan, and capital program updates:

a. Public flood protection projects. WBCM's studies of the City Dock and Eastport areas describe potential public projects that would reduce the amount of flooding in the city floodplain areas. These include barriers to coastal floodwaters such as temporary flood walls, temporary dams, and improvements to the drainage system such as installation of backflow preventers on the city storm drain outflows into the bay. Annapolis has no current capital projects to implement such flood protection measures.

b. Public projects to make infrastructure more resilient when flooding occurs. WBCM's sea rise studies identified improvements within the two study areas to reduce the impact of

flooding on public roads, parking areas and utilities. These improvements include floodwalls around pump stations, flap or duckbill valves for storm drain outfalls and permanent or temporary pumps to discharge storm drainage systems over floodwalls. Similar studies of other parts of the city could result in similar recommendations. The City's infrastructure could be made more resilient during flooding by such means as using more durable base materials for roads to withstand periodic flooding; raising road elevations; implementing drainage improvement projects; flood-proofing city utilities; raising the elevation of low-lying utility equipment (such as pumping stations); providing backflow preventers for sewer and storm drain connections; and moving city facilities that would be important in emergency operations (fire, police) out of flood-prone areas.

c. Education, management and planning. Preparation for more frequent flooding can include mapping streets that would be affected by flooding; establishing and publicizing evacuation routes; determining where emergency shelters will be located; providing educational materials on floodproofing buildings; mapping operations in the flood area that store hazardous materials; and other operational details. Many of these should be covered and periodically updated in the city's Hazard Management Plan and publicized broadly.

d. Ongoing comprehensive and neighborhood planning. The impacts of sea level rise should be incorporated into city planning for areas that may be impacted by coastal flooding. Annapolis already has made progress in this area through the City Dock and Eastport studies and this report. Future planning efforts can continue to evaluate the need and options for protecting historic structures and waterfront areas; identify public utility structures and equipment that may be endangered by floods; review needs for drainage and road improvements to allow access to flooded areas; and revisit the code sections reviewed in this report.

e. Periodic review of current and projected sea levels. These should be reviewed on the same cycle as the city's comprehensive plan; i.e., approximately every six years.

II. Recommended Code Revisions

Code Chapter	Current Text	Issues	Options and recommendations
Definitions Chapter 17.04	17.04.080 - Base flood elevation. "Base flood elevation" means an elevation 7.2 feet above mean sea level 17.04.340 - Elevation certificate. "Elevation certificate" means the official form as prepared and distributed by the Federal Emergency Management Agency, using mean sea level as established by the National Geodetic Vertical Datum of 1929. 17.04.570 - Mean sea level. "Mean sea level" is as defined by the National Geodetic Vertical Datum of 1929.	These definitions differ from the base flood elevation (100-year flood elevation) shown on FIRM maps. Current base flood elevation is 7.78 feet. Elevations should be measured from the points established by the North American Vertical Datum of 1988 (NAVD 88) rather than the National Geodetic Vertical Datum 1929 (NGVD 29). Mean sea level under NGVD 29 is at elevation -0.08 feet. Current mean sea level based on NAVD 88 is at elevation 0.72 feet. See Appendix 2 of this report for a diagram illustrating the current elevations. Appendix 3 illustrates the result of updating these definitions while retaining the elevation requirements currently in this Floodplain Ordinance. The city enforces the floodplain ordinance using benchmarks that establish the elevation of 8 feet above mean sea level. These stations, if based on these definitions, may be using out-of-date sea level information.	Update definitions for base flood elevation, elevation certificate and mean sea level. Ensure that the benchmarks used by city staff to establish distance above mean sea level are accurate.

Code Chapter	Current Text	Issues	Options and recommendations
Floodplain Ordinance Chapter 17.11	17.11.120 - Construction below base flood level. If the construction, reconstruction or modification of any structure constitutes less than a substantial improvement, the elevation of the lowest floor shall be at or above eight feet above mean sea level. Those parts of the improvement below the elevation of eight feet above mean sea level shall be dry-floodproofed as specified by the U.S. Army Corps of Engineers in its publication EP1165 2 314 entitled "Flood-proofing Regulations." Routine maintenance and repairs shall be excepted. 17.11.130 - Lowest floor elevation. The elevation of the lowest floor, as defined in this title, of all new or substantially improved structures within the one-hundred-year flood shall be at or above eight feet above mean sea level. Basements as defined in this title are prohibited in the floodplain. 17.11.180 - Electric systems. A. All electric water heaters, electric furnaces, generators, heat pumps, air conditioners and other permanent electrical installations shall be permitted only at or above eight feet above mean sea level. B. No electrical distribution panels shall be permitted at an elevation less than ten feet above mean sea level. 17.11.190 - Plumbing. Water heaters, furnaces and other permanent mechanical installations shall be permitted only at or above eight feet above mean sea level. 17.11.200 - Storage. No materials that are buoyant, flammable or explosive or which, in times of flooding, could be injurious to human, animal or plant life shall be stored below nine feet above mean sea level.	These provisions require elevation or floodproofing 8 to 10 feet above mean sea level. The current FEMA base flood elevation (BFE) for Annapolis is 7.8 feet; the projected flood elevation in 2050 is 8.3 feet. Mean sea level in Annapolis is at elevation 0.7 feet (based upon NAVD88). If the definitions are updated to reflect these figures, elevating up to “8 feet above mean sea level” will protect structures up to 8.7 feet (0.7 feet plus 8 feet.) This provides protection higher than the projected 2050 base flood elevation of 8.3 feet. Freeboard is an additional height requirement above the base flood elevation (BFE) that provides a margin of safety and makes the structure eligible for a lower flood insurance rate. While not required by the NFIP standards, FEMA encourages communities to adopt at least a one-foot freeboard. The Maryland Climate Change Plan recommends a minimum standard of a 2 -foot freeboard above the 100-year flood level for coastal communities (Maryland *Climate Action Plan*, EBEI-8).	Option 1: No revision. These requirements require elevation and floodproofing higher than the 8.3-foot base flood elevation projected through 2050. Option 2: Revise the current language to measure required height using elevation rather than sea level. This is familiar to surveyors and engineers and is a static measurement, unlike “mean sea level” which changes and needs to be re-evaluated periodically. Implement FEMA’s freeboard recommendation, and build in greater elevation to account for expected sea level rise, by requiring the lowest floor elevation to be a minimum of 1.0 feet above the FEMA base flood elevation. Require electrical distribution panels and storage of hazardous materials at to be at least 3 feet above the BFE. Option 3: Adopt Maryland’s recommended 2-foot freeboard standard by requiring elevation of 2 feet above the FEMA base flood elevation for the first floor and electrical/plumbing equipment currently required to be 8 feet above mean sea level. This would protect up to an elevation of 10 feet, sufficient to account for a base flood elevation of 9.8 feet that would result from a sea level rise of 1.5 feet by 2050 as projected by the Maryland Commission on Climate Change.

Code Chapter	Current Text	Issues	Options and recommendations
Floodplain Ordinance Chapter 17.11	17.11.280. Plans and Specifications D.4. If a variance is being applied for under the provisions of Article IV of this chapter, certification by a registered professional engineer or architect that the structure will be dry-floodproofed in accordance with the specifications of the U.S. Army Corps of Engineers in its publication EP1165-2-314 entitled "Flood-proofing Regulations" at or above nine feet above mean sea level.	This provision requires dry floodproofing for structures for which a variance is requested from the minimum first floor elevation. By requiring an extra foot of floodproofing, this provision complies with the National Flood Insurance Program (NFIP). The minimum National Flood Insurance Program (NFIP) requirement is to floodproof a building *to the BFE*. However, when it is rated for flood insurance, one foot is subtracted from the floodproofed elevation. Therefore, a building has to be floodproofed *to one foot above the BFE* to receive the same favorable insurance rates as a building elevated to the BFE. (From NFIP guidance document.)	These are parallel to options 1-3 in the row above and would consistently require dry floodproofing one foot higher than the first floor elevation requirement. Option 1: no revision Option 2: Require floodproofing at least 2 feet above the BFE. Option 3. Require floodproofing at least 3 feet above the BFE.
Floodplain Ordinance Chapter 17.11	17.11.370 Grounds for Variances A. Variances may be issued by the director for: 1. New construction of or substantial improvements to nonresidential structures or any portions which will be floodproofed; 2. Functionally dependent uses which cannot perform their intended purpose unless they are located or carried out in close proximity to water. A functionally dependent use includes only docking facilities that are necessary for the loading and unloading of cargo or passengers, and ship building and ship repair facilities, and does not include long-term storage or related manufacturing facilities; or 3. Reconstruction, rehabilitation or restoration of structures listed in the National Register of Historic Places or State Inventory of Historic Places.	Retaining the integrity of historic structures is of key importance; thus, the broad variance provision for historic structures is necessary. However, with flooding expected to increase in frequency, protection of these structures to the extent possible is desirable.	Consider qualifying the variance provisions for historic structures: o Clarify that when interior alterations are made to historic structures, the electrical and plumbing systems should be relocated to the elevations required by sections 180 and 190 above. o Require floodproofing to the extent feasible while preserving the historic building exterior. Materials that can survive flooding should be used for interior renovations; when windows or doors are replaced, use floodproofing installation to the extent consistent with historic preservation goals.

Code Chapter	Current Text	Issues	Options and recommendations
Zoning Code Chapter 21.50	Maritime zoning districts: bulk requirements and permitted uses Bulk Regulation Tables for the Waterfront Maritime Districts, including: o 21.50.280.WMM o 21.50.290. WMC o 21.50.300. WMI o 21.50.310 WME.	Periodic studies have been completed of the maritime industry in Annapolis, focusing on the industry's economic contribution to the City. Some of the studies have recommended revisions to the Maritime zoning districts to allow more intensive development of structures. The benefits to the maritime industry will need to be balanced with the increased risk of substantial damage to buildings and infrastructure from flooding, since the maritime zoning districts are in the floodplain.	Reconsider the recommendations of maritime industry studies in light of the probability of increased frequency and severity of flooding in the Waterfront Maritime Districts.
Zoning Code Chapter Division IV Overlay District Regulation	21.54. Critical Area Overlay Zone	The area of Annapolis within the Critical Area Overlay Zone will increase if required by State legislation (as sea level rises the landward extent of tidal water will increase). Revisions to the state-mandated boundaries of the Critical Area are likely based on new surveys and sea level rise.	Evaluate the impact of any proposed expansions of the Critical Area on the Annapolis zoning map and regulations.
Zoning Code Division IV Overlay District Regulations	Chapter 21.56 Historic Overlay District Article 1 Approval of Exterior Changes The code requires a certificate of approval from the Historic Preservation Commission for exterior alterations. Only "routine maintenance" is exempt from this requirement.	No timely process is provided for emergency approval of repair work if the repair work requires exterior alterations of a structure within the Historic District.	Consider providing a process for approval of emergency repairs following flooding, fire or other disaster. The process could allow administrative review and approval or provide for an emergency meeting of the Historic Preservation Commission.
Zoning Code Division IV Overlay District Regulations	Issue not currently addressed	Property owners in the historic district may wish to install storm protection measures such as temporary or permanent flood walls (especially if a comprehensive public flood wall project does not happen for many years). Such structurrs would not alter the exterior of a historic structure, but could be visible additions to the overlay district	Address the possibility of property owners using storm protection measures such as temporary or permanent flood walls. These would need to be approved by the Historic Preservation Commission if located in the Historic Overlay District.

Code Chapter	Current Text	Issues	Options and recommendations
Zoning Code various sections	Height standards for most zoning districts range from 30 to 48 feet. The historic overlay district requires a maximum cornice height of 22 to 35 feet.	If the first floor elevation is revised upwards due to sea level rise, the useable building height is reduced. However, the heights allowed by the Annapolis zoning ordinance are sufficiently high to allow adequate useable building area.	In future revisions to the Zoning Ordinance, evaluate height limits if problems are encountered due to the need for higher first floor elevations.

Code Chapter	Current Text	Issues	Options and recommendations
Zoning Code Chapter 21	Add a new overlay zoning district.	Add a "Coastal Floodplain Overlay Zone" on zoning maps, covering an area that includes the City's current base floodplain and areas projected to be within the base floodplain by 2050, using the 8.3-foot elevation projected in the WBCM study. Apply this overlay zone only to the current and projected base floodplain in areas affected by coastal tides and floods; not to the city's inland floodplains along rivers and streams. The floodplain ordinance, being closely tied to FEMA regulations, cannot easily be revised to regulate the areas not currently in the base floodplain but expected to be by 2050. The zoning ordinance is the other ordinance that lends itself to requirements that apply to a mapped district. The Maryland Climate Change Plan recommends creation of districts that add to the FEMA-delineated base floodplain for areas anticipated to experience increased flooding by 2050 (Maryland *Climate Action Plan*, EBEI-8). Include requirements in this overlay zone that parallel those in the floodplain district. However, provide standards used by FEMA for coastal flooding areas, typically applied to areas of greater hazard due to wave action. FEMA designates all of the Annapolis floodplain as "AE" areas; FEMA uses the designation "VE" for coastal areas where floods are expected to have waves higher than 3 feet. NFIP guidance to local jurisdictions recommends the following: > NFIP regulations apply the same minimum requirements to both coastal AE zones and riverine AE zones. FEMA has concluded that these standards may not provide adequate protection in coastal AE zones subject to wave effects, velocity flows, erosion, scour, or combinations of these forces. Wave tank studies have shown that breaking waves considerably less than the 3-foot criteria used to designate VE zones can cause considerable damage. FEMA's *Coastal Construction Manual*, FEMA-55 (May 2000) and other recent FEMA publications have introduced the concept of Coastal AE Zone to encourage use of V-zone construction methods and standards in these areas. For example, pile or column or other open foundations are more likely to withstand wave impacts than other types of foundations. If your community contains Coastal AE Zones, you are encouraged to revise your ordinances to apply all or some of the VE zone standards to these areas. Apply "VE" area coastal floodproofing standards, as provided in FEMA regulations, within the Coastal Floodplain Overlay Zone. State that for lots within both the overlay zone and the floodplain district, the more stringent requirements apply. Review boundaries regularly to compare with flood history and new projections.	

Code Chapter	Current Text	Issues	Options and recommendations
Title 15, Harbors and Waterfront Areas.	Issue not currently addressed	Bulkheads and piers are installed at varying heights as determined by the property owner. There are no minimum height requirements.	Reduce storm damage by requiring that the top of bulkheads and piers generally have a minimum elevation of 8.3 feet. Allow flexibility where this elevation is not feasible given the elevation of the specific property.
Subdivision Ordinance 20.20.010 Required Improvements	B.Culverts, Storm Drains, and Drainage Structures—Erosion Control. Culverts, storm drains and drainage structures shall be constructed in, under or along streets and alleys, and bulkheads, groins or other erosion control features along streams, rivers and other watercourses and their embankments, as required by the director to prevent frequent and probable damage from stormwater, or to prevent frequent occurrence of a flow of stormwater on streets as to present a hazardous condition for moving vehicles and pedestrians, to maintain the flow of stormwater in its natural channels or to protect the shoreline from erosion. "Frequent," as used in this section, is intended to designate a probable frequency of not less than once in ten years when averaged over a long period. Protection against erosion of natural channels or watercourses on adjoining property and adequate shore erosion control is required.	During coastal flood events, water in storm drains can be forced backwards, flooding areas that they are intended to drain.	Require that for storm drains within the current or projected 100-year floodplain, backflow preventers be installed.

III. Summary of Recommended Actions in Other Jurisdictions

Like Annapolis, other east coast jurisdictions are responding to projected sea level rise by evaluating possible courses of action. These courses of action include the need for additional analysis and planning as well as for capital projects and regulatory changes. Following is a summary of the recommended responses for selected jurisdictions, focusing on recommended revisions to regulations. For the jurisdictions reviewed for this report, the actions have not yet been implemented through code revisions.

A. Maryland Jurisdictions

1. **Sea Level Rise: Technical Guidance for Dorchester County, October, 2008**

   Nearly 60% of Dorchester County lies in the current 100-year floodplain, with most of that area being tidal floodplain. The grave impacts of sea level rise in Dorchester County have resulted in strongly worded recommendations in its report. The report recommends that the Economic Development staff work with companies in sea level risk areas in relocation efforts. It also notes the potential of amending forest conservation requirements to address forest habitat that would manage the level of groundwater, serve as protective buffers to salt marshes and nontidal wetlands, and prohibition of forest harvest on areas with high water tables that lie adjacent to salt marsh.

   Following are recommendations for a "Sea Level Risk Overlay Zoning District for Dorchester County:

   - Prohibit new subdivisions
   - Prohibit expansion of footprints on existing developed lots
   - Restrict major renovations of structures to cosmetic repairs, re-roofing, and replacement of appliances
   - Prohibit use of bermed infiltration ponds for development on unimproved lots
   - Restrict septic disposal facilities to state of the art facilities whose integrity would not be compromised by storm surge
   - Require well heads to be raised above the base food elevation plus a height to accommodate wave action on storm surge
   - Require a minimum two-foot freeboard above base flood elevation
   - Until federal agencies can update their maps, assume the 100-year flood elevation to be equivalent to the Category Two storm surge elevation, which will vary depending on the waterway
   - Provide for the closure of inundated roads where an alternate route exists
   - Provide for the termination of maintenance for roads that serve only a few occupied residences
   - Provide for the termination of maintenance on roads where the cost to maintain exceeds the Fair Market Value of the properties it serves
   - Initiate participation in the National Flood Insurance Program (NFIP) Community Rating System; implement provisions for a buy-out program

- Identify properties for potential buy-out. Rank them in order of level of immediate risk.
- Assess forest loss and identify reforestation sites outside the sea level risk zone
- Assess wetland losses and identify suitable areas to accommodate sea level encroachment and conversion to new wetlands
- Strongly participate with Corps of Engineers projects to restore and/or create barrier islands which act as buffers to the wetlands and mainland behind them.
- Prohibit investment on new infrastructure in the SLR District
- Abandon, relocate, raise, or seal any infrastructure that will sustain damage by inundation

2. **Somerset County Rising Sea Level Guidance, March 2008**

Following is a summary of recommended code revisions for Somerset County:

- Re-delineate the landward boundary of Conservation Zone to coincide with the 2050 inundation area and reduce the allowed density (retain current zoning for existing villages).
- Require planning for certain roads to anticipate more frequent flooding.
- Regulate the areas projected to be within the 100 year flood plain as a "Floodplain Planning Zone."
- Require structural use of perimeter wall foundations and piling/column foundations (avoids drainage problems, facilitates potential future relocation of buildings).
- Require the lowest floor of all new buildings and substantially-improved buildings to be at least 2 feet higher than the currently required Base Flood Elevation. This will result in NFIP flood insurance savings.
- Within the predicted 2050 inundation area, require proposed central package treatment systems to be designed and installed to recognize anticipated flooding and groundwater conditions.
- Require subdivision sketch, preliminary and final plats to show the "Floodplain Planning Zone."
- Modify Sec. III.C.2(c)(11) to require that preliminary plats delineate the 'floodplain planning zone'.
- For roads that will be frequently inundated, identify requirements for elevated roads or for low water crossings (i.e., design them to be low to avoid blocking drainage, but require owners to acknowledge access limitations). Also improve road bedding as groundwater levels rise; removal of more unsuitable material to bear the placement of thicker fill materials may be required. Require more underdrains/crossdrains to allow for drainage.

3. **Worcester County Sea Level Rise Guidance Document, 2008**

This document reports that Worcester County recently amended its Floodplain Law to require a 2-ft above base flood elevation requirement for the lowest horizontal structural member of the structure. This is the FEMA standard for V-type or higher hazard floodplains. Its guidance document contains the following concepts:

- An overlay zoning district requiring sea level rise-related elevation and flood proofing requirements.
- Public education to encourage retrofitting of structures that do not meet floodproofing or elevation, standards, based on continued remapping of flood probabilities, combined with financial assistance or incentives and stringent rebuild policies.
- A post-disaster redevelopment ordinance or plan with rebuild policies that require flood retrofits in areas projected for sea level rise inundation or surge from sea level rise.
- Designation in the overlay zoning district of areas where septic tanks and hazardous materials must be removed to prevent pollution of coastal waterbodies. A progression of this district based on sea level rise rates in conjunction with a grace period could be used to give property owners advance notice of the requirement. • Require removal of old tanks as a condition of property transfer or utility hook up.
- Down-zoning of flood-prone areas to encourage retreat, so that any redevelopment would be less dense. Non-conforming uses could be restricted from expanding or rebuilding.
- Prohibition on rebuilding in projected sea level rise inundation areas that have been designated for retreat. The zoning regulations could include a non-conforming structure rule that limits substantial improvements.
- Subdivision design standards requiring that the size and shape of subdivided parcels be based on projected sea level rise such that development can potentially be accommodated. Deep lots would be necessary to accommodate setbacks for coastal lots.
- Subdivision standards that add shoreline protection prohibitions or rolling easement requirements. (Rolling easements require retreat from eroding shorelines after a given period of time.)

4. **Anne Arundel County Background Report on Sea Level Rise, General Development Plan 2008**

This background report found that the County's General Development Plan should recommend an integrated planning strategy that, at a minimum, addresses potential threats in at-risk areas and proposes a phased implementation response to achieve avoidance or reduction of impacts, under the following categories:

- Land use, zoning, and population density regulations to reduce population and investments at risk;
- Public and market-based incentives/disincentives to reduce property damage and threats to human health;
- Planning for community infrastructure such as roads, schools, public safety and medical facilities, water and wastewater systems, gas, electrical and communications utilities to ensure public safety; and
- Maintenance of existing and future natural resource lands, wildlife habitat, and agricultural lands to minimize impacts from storm surge.

Anne Arundel County is currently developing a more specific sea level rise strategy.

5. **Town of Queenstown 2010 Community Plan**

This plan identifies the approximate area that would be affected by the storm surge from a Category III hurricane. Models indicate that the storm surge would be 9 to 12, feet, impacting an area larger than the FEMA flood maps, which identify areas with storm surges as high as 10 feet. The town has identified potential flood zones based on a 12-foot storm surge using fine-scale topography. Future development would be directed outside these areas.

B. Jurisdictions Outside Maryland

1. Portsmouth Virginia Floodplain Management Plan and Repetitive Loss Plan: September, 2010

This plan was produced for Portsmouth's participation in the Community Rating System, a voluntary program under the National Flood Insurance Program that encourages communities to complete an assessment of the local floodplain management program. In exchange for undertaking this process, the citizens will pay reduced flood insurance premiums and are also better prepared to take advantage of other federal and state funding and grant programs.

Although the report addresses sea level rise only in general terms, it does state that the City has, in the past 4 years, enacted Freeboard requirements, created a new definition for substantial damage to facilitate insurance claims and reduce future claims, and prohibited certain materials from being stored in flood hazard zones.

The report also provides a summary of actions, primarily non-regulatory, that are used by the City of Portsmouth to protect its infrastructure and citizens during flooding. The report includes:

- A list of streets that routinely flood
- A list of government facilities in flood-prone areas.
- Areas where flooded roads would hamper evacuation and emergency services to an area of the city.
- Lists of "Repetitive Loss" structures under the NFIP.
- A list of utility facilities that need to be raised to an elevation of 9.5 feet to protect water and sewer utility system from damage and interruption of services due to flood damages.

The report contains recommendations for city actions:

- Map commercial operations that store hazardous materials and that are in flood hazard areas.
- Prepare evacuation policies that include actions for disabled individuals; require all applications for nursing homes and similar facilities to have an emergency operations plan
- Increase the ability of the school system to provide shelters/temporary housing for flood victims
- Provide protection from surge flooding for certain areas.
- Continue with existing storm drainage evaluation and planning underway under the direction of the City Engineer.
- Implement measures that reduce street flooding during rain events.
- Identify and fund drainage improvement projects.
- On a five year basis determine the rate of sea level rise using the most accurate information available and amend plans accordingly.

- Prepare and adopt an overlay zoning district that addresses sea level rise.

2. The City of Lewes Hazard Mitigation and Climate Adaptation Action Plan: June, 2011

Key recommendations of this plan from Lewes, Delaware include:

Zoning Code

Review, and when appropriate, adopt the following specific suggestion for regulations that exceed the National Flood Insurance Program (NFIP) minimums.

- Create a freeboard standard for homes in the floodplain.
- Create stricter flood regulations for critical facilities (hospitals, fire stations, hazardous materials storage sites, etc.).
- Create specific development prohibition in floodplain areas. Examples include the prohibition of new sheds in the floodplain and prohibiting the expansion of the footprint of existing homes.
- Create a floodplain setback – requiring that homes be built a minimum distance from the floodplain, river channels or shorelines.
- Protect of flood storage capacity – using land development criteria and low density zoning to reduce the damage potential within the floodplain and help maintain flood storage and conveyance capacity.

Planning Regulations

- The 100 year flood standard for setting floor elevations is neither adequate not is it sustainable. Regulate development to future risk level, not past. Update flood maps to include future flood risks
- All new construction and substantial improvements have lowest floor elevated at least 1 to 2 feet of freeboard above FEMA's 100 year flood elevation.
- New lots should not be created in the floodplain.
- Limit new development in the floodplain – no new subdividing, infilling existing lots allowed but to higher standards.
- New structures should be set back adequately from eroding shorelines to allow for dune and beach preservation over the lifetime of the structure, taking into account expected erosion rates.
- Adopt a No Adverse Impact approach to regulation to reduce or eliminate practices which increase flood risk to adjacent properties.

Risk Management and Flood Mapping –recommended changes

- Utilize best available technology to map risk and plan development accordingly.
- Use new technologies to more easily visualize risk.
- Manage flood risk to future levels, not current or past. Stop using floodplain maps which depict current or past risk to design future construction.
- Evacuation and street flooding should be incorporated into subdivision design.
- Roads servicing new development should be located above the base flood elevation

Appendix 1 Glossary

Base Flood: A flood that has a 1.0 percent chance of being reached or exceeded in any single year. Also called the “one-hundred year flood” or the “one-percent annual chance flood.”

Base floodplain: The land area covered by the floodwaters of the base flood floodplain. On NFIP maps, the base floodplain is called the Special Flood Hazard Area (SFHA).

Base Flood Elevation (BFE): The computed elevation to which floodwater is anticipated to rise during the base flood.

Dry Floodproofing: Use of materials and design that prevent water from entering the structure. Only effective where flood levels are low (i.e., below 3 ft) and there is little flow velocity (FEMA, 1998).

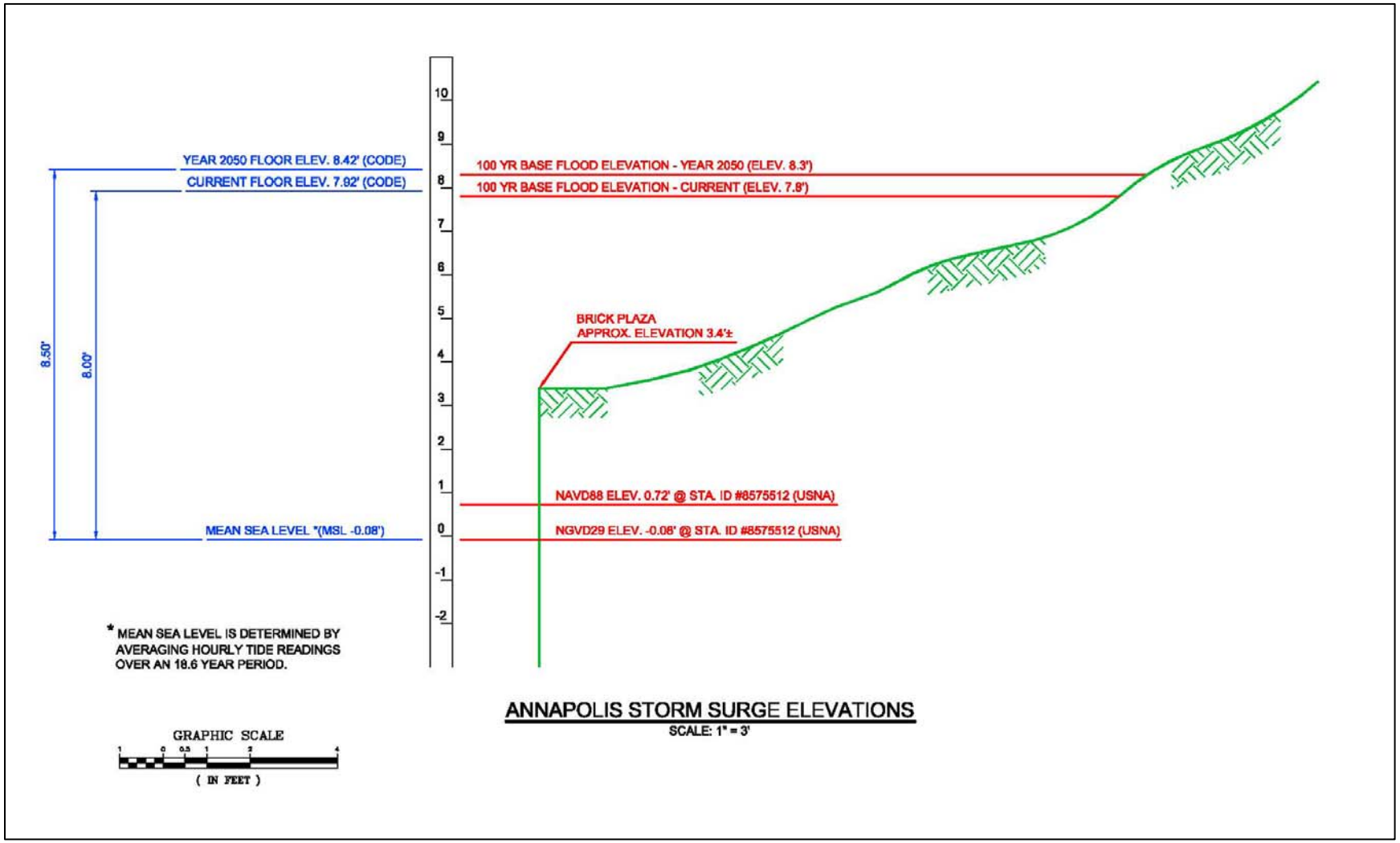
Freeboard: An additional height requirement above the base flood elevation (BFE) that provides a margin of safety against extraordinary or unknown risks. Freeboard elevations reduce the risk of flooding and make the structure eligible for a lower flood insurance rate.

Storm Surge: increased water levels that occur when storms bring air pressure changes and strong winds that “pile” water up against the shore.

Wet Floodproofing: Use of materials and design that allow water to enter the structure but not damage structural components or service equipment.

Appendix 2 Floodplain Ordinance Requirements

This diagram shows the current Floodplain Ordinance requirement that the first floor be at least eight feet above sea level (§17.11.130) based on the NGVD 29 datum referred to in the Floodplain Ordinance definitions. This requirement places the first floor at an elevation of 7.92 feet, only just above the FEMA current base flood elevation of 7.8 feet, but below the projected 2050 base flood elevation of 8.3 feet.



Appendix 3 Floodplain Ordinance Requirements with Updated Sea Level

This diagram shows application of the current Floodplain Ordinance if the definitions in the Ordinance are updated to refer to the current measurement of Mean Sea Level, using the NAVD 88 datum for measurement. A first floor placed 8 feet above mean sea level as required by §17.11.130 would be at elevation 8.72 feet, above FEMA's current base flood elevation of 7.8 feet and slightly above the projected 2050 base flood elevation of 8.3 feet.