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EBEI-2: Observation System for Changes in Coastal Areas

Option Description

The Chesapeake Bay is the largest inner-coastal estuary in the Nation, covering over 166 thousand square kilometers, with more than 150 rivers and streams draining into the watershed, and home to about 15 million people. Most of Maryland's communities and economic activities in this low-lying coastal region are particularly vulnerable to storm surges and flooding, events that will be likely be intensified due to rising seal level associated with climate change. Maryland relies upon its coastal areas along the Chesapeake Bay and its Atlantic coast for healthy fisheries, and reliable transport and navigation. Its dependence on infrastructure networks (roads, power grids, etc) intensifies the potential vulnerability of these areas to impacts from climate change-induced natural disasters.

An enhanced ability to observe Maryland's coastal areas will provide key benefits to the state. Under climate change, managing resources in these areas is more important that ever and will require accurate information from an integrated observation system to allow for detection and prediction of the causes and consequences of changes in coastal systems, watersheds and infrastructural resources. This option aims to support and enhance observation systems already in place in Maryland. Specifically, the option aims to strengthen such systems to enable the comprehensive surveillance, monitoring, documentation, and dissemination of rates and locations of sea-level rise in Maryland. This includes the installation of surveillance equipment in coastal sites where current public/private infrastructure is potentially vulnerable to small increases in sea level, the incorporation of long-term coastal monitoring aspects into existing protocols, and the integration of observation activities in regional efforts.

Option Design

The specific objective of this option is to assess how existing observation systems for the Chesapeake Bay can be enhanced to better understand and address long-term sea level rise and its impacts on the built environment. The overall option design is summarized in the bullets below.

- **Targets:** The target for this option is in the form of a detailed assessment regarding the adequacy of MD's current observation system protocols, systems, technologies, and surveillance strategy to address long-term changes in sea level rise in the Bay area. The output of the study should be a series of recommendations regarding how current observation

networks could be reinforced and/or new component addressed to better address changing conditions regarding sea level rise.

- **Timing:** The timing of the study is immediate. It is anticipated that a 3-year period will be needed to complete the study. By the end of this period, there should be a detailed recommended program regarding the additional integrated observations required, supplemental data management and distribution systems (if any), and a set of analytical products that respond to user-specific needs (i.e., commercial, management, recreational, educational, scientific, regulatory, safety, hazard protection, and restoration communities).
- **Parties Involved:** There are several parties that would be involved in the design and oversight of the study. At the state level, it would include the MD Department of Natural Resources, and local national weather services offices. At the regional/national levels, it would include the Chesapeake Bay Observation System, the United State Geologic Survey, and the National Office for Integrated and Sustained Ocean Observations.
- **Other:** NA.

Implementation Mechanisms

This option would be implemented by first preparing a prefeasibility study on the scope, issues, challenges, and likely costs associated with upgrading existing observation systems. On the basis of this study, a terms of reference for the assessment would be prepared and implemented by a qualified organization/consortium. The recommendations of the study would become the input for changes to existing rules/regulations or new legislation to implement the activities identified as necessary to adequately monitor sea level rise.

Related Policies/Programs in Place

There are important observation systems already in place in Maryland to monitor the Chesapeake Bay. The Chesapeake Bay Observing System (CBOS) is an organization that provides integrated data observation, management, and distribution systems and information for use by Chesapeake Bay and coastal communities. It is part of an evolving sub-regional observing system embedded in the Mid-Atlantic Coastal Ocean Observing Regional Association (MACOORA) and the Congressionally-mandated Integrated Ocean Observing System (IOOS).

Estimation of Adaptation Benefits and Costs

- **Estimated Cost:** TBD.
- **Flexibility:** TBD.
- **Adaptive capacity:** TBD.
- **Other:** TBD.

Documentation of Adaptation Benefits and Costs

- **Data Sources:** TBD.
- **Quantification Methods:** TBD.
- **Key Assumptions:** TBD

- **Key Uncertainties:** TBD.

Additional Benefits and Costs

TBD.

Feasibility Issues

TBD.

Status of Group Approval

TBD.

Barriers to Consensus

TBD.

EBEI-3: Adaptation of Vulnerable Coastal Infrastructure

Option Description

The viability of coastal infrastructure in Maryland will be affected in the coming decades by sea level rise associated with climate change. The identification of potential adaptation options of vulnerable coastal infrastructure is a key initial response strategy that will ultimately contribute to the minimization of potential impacts of climate change on public sector infrastructure (e.g., roads, bridges, airports, wastewater treatment facilities, landfills, administrative buildings, marinas, etc) as well as private sector infrastructure (e.g., residential properties, marinas, yacht clubs, boat yards, retail buildings, power stations, etc). The assessment of adaptation options is a key basis upon which to better understand how Maryland can implement a program to reduce, at least cost, the adverse effects on its varied built environment and infrastructure.

Adaptation options for protecting Maryland's built environment include changes in processes, practices, or hard/soft protection structures to reduce anticipated damages from sea level rise or enhance adaptive responses associated with increased climatic variability. In some cases, the assessment of adaptation options will reveal that there are opportunities for adaptation that may offer multiple benefits. While a range of adaptation options are possible to protect vulnerable coastal infrastructure, there is a current lack of information which impedes successful action. In the current Maryland context, a comprehensive assessment of the range of adaptation options is needed in order to inform policy dialogue regarding strategic ways to address climate change impacts on infrastructure.

Hence, this option involves a comprehensive adaptation assessment for all public and private properties located in coastal zones susceptible to sea level rise. The assessment should include an evaluation of existing and future unprotected reaches of shoreline with respect to existing infrastructure. The results of this study will provide timely and critical information on strategies for addressing rising sea level and associated storm surge threats from climate change. The conclusions drawn from the assessment will be used to design new policies and improve measures to address the vulnerability of coastal infrastructure.

Option Design

The specific objective of this option is to assess the range of potential processes, practices, and structures for adapting vulnerable infrastructure to long-term sea level rise and its related impacts on the built environment. The overall option design is summarized in the bullets below.

- **Targets:** The target for this option is in the form of a detailed assessment regarding an assessment of coastal adaptation options to address long-term changes in sea level rise in the Bay area. The output of the study should be a series of recommendations regarding the costs of various options, the degree to which they reduce exposure to risk, and how current practices/processes should be reinforced to better address changing conditions regarding sea level rise.

- **Timing:** The timing of the study is immediate. It is anticipated that a 3-year period will be needed to complete the study. By the end of this period, there should be a detailed set of conclusions and recommendations regarding immediate next steps required.
- **Parties Involved:** There are several parties that would be involved in the design and oversight of the study. At the state level, it would include the MD Department of Natural Resources, the Maryland Association of Counties, the Maryland Transportation Authority, and the Maryland Department of Housing and Community Development. At the national level, it would include the US Climate Change Science Program.
- **Other:** NA.

Implementation Mechanisms

This option would be by first preparing a detailed terms-of-reference for the adaptation assessment, followed by carrying out the study by a qualified organization/consortium. The recommendations of the study would become the input for changes to existing rules/regulations or new legislation to implement the activities identified as necessary to adequately protect vulnerable infrastructure from sea level rise.

Related Policies/Programs in Place

TBD.

Estimation of Adaptation Benefits and Costs

- **Estimated Cost:** TBD.
- **Flexibility:** TBD.
- **Adaptive capacity:** TBD.
- **Other:** TBD.

Documentation of Adaptation Benefits and Costs

- **Data Sources:** TBD.
- **Quantification Methods:** TBD.
- **Key Assumptions:** TBD
- **Key Uncertainties:** TBD.

Additional Benefits and Costs

TBD.

Feasibility Issues

TBD.

Status of Group Approval

TBD.

Barriers to Consensus

TBD.

EBEI-6: Assessment of Coastal Zone Adaptation Options and Evaluation of Shoreline Protection Structures

Option Description

It is estimated that 31% of Maryland's coastline is experiencing some level of erosion *(Shoreline Erosion Task Force, 2000)*. Caused primarily by wind driven waves, erosion is a natural process exacerbated by manmade events and sea level rise (SLR). As the rate of SLR increases, the state's erosion control infrastructure will become further taxed. New and existing shoreline erosion control SEC structures must be an integral part of any future plan(s) to deal with the eroding effects of SLR.

Over the years, and with varying degrees of success, different types of SEC structures have been built along the state's shorelines in an effort to dissipate the erosive action of wave energy. It is estimated that X% of the state's shoreline currently has some type of SEC structure. The design and construction of SEC structures is site specific. The variety of SEC structures employed is a function of the state's varied coastal conditions. Shorelines exposed to high levels of wave energy, such as those directly on the bay, are subject to greater rates of erosion and consequently require more robust erosion control structures, than shorelines exposed to lower levels of wave energy and which erode at a slower rate, such as those on many of the bay's tributaries.

Within the industry, SEC structures are generally classified as either "structural" or "non-structural". Structural options include bulkheads, revetments, breakwaters, groins, and similar "hard" structures for high energy applications. Non-structural, or "soft" options, which are preferred by regulatory agencies, include beach replenishment, wetland restoration and marsh creation, among others, for lower energy applications. In some cases, a hybrid approach is used that combines both hard and soft elements.

Because SEC structures have a fixed elevation, they are at risk of becoming submerged as the sea level rises, compromising their effectiveness and potentially creating sub-aqueous hazards. Left unaddressed, SLR will result in a topping of SEC structures, exposing new shorelines to eroding waves.

The specific objectives of this policy initiative are as follows:

1. Conduct an inventory of current SEC alternatives and evaluate the "pros" and "cons" of each
2. Evaluate the suitability of each alternative, or type of SEC structure, to accommodate SLR
3. Modify existing and/or create new design and construction standards and protocols for SEC structures – both new and retrofit, to accommodate projected SLR
4. Locate, quantify, and evaluate the *installed base* of SEC structures for purposes of modify/replace/abandon decision making

5. Evaluate the vulnerability of riparian buffer zones in which significant infrastructure is located to accommodate projected levels of SLR
6. Integrate these policy recommendations into existing SEC plans and protocols at the state and local level as required

Related to, but not a specific objective of this policy initiative, is determining the optimal location and type of future SEC structures. In the public sector, this responsibility lies with designated authorities. Rather, the objective with respect to the public sector is to supplement the existing body of work on SEC structures with data on their installed base (quantity, location, and type), and design and construction standards for retrofitting them, *as needed*, to accommodate SLR. Alternatively, existing structures would be replaced or abandoned.

For property owners in the private sector, the primary deliverable would be design and construction standards for installing new SEC structures and/or retrofitting existing ones.

Option Design

The overall objective of this policy initiative is to better understand the impact of sea level rise (SLR) on the performance of shoreline erosion control (SEC) structures so that they can be designed, constructed, maintained, and situated for optimum effectiveness and environmental stewardship. The overall option design is summarized in the bullets below.

- **Targets:**

There are five key targets associated with this option, as outlined below:

1. Survey existing shoreline to determine inventory of SEC structures – quantity, location and type (assess condition?)
2. Work with engineering community to modify and/or create new design and construction standards for SEC structures
3. Distribute modified/new design and construction standards to engineering, contractor, and property owner communities (e.g. *SHORE EROSION CONTROL GUIDELINES For Waterfront Property Owners* published by the DNR)
4. Perform cost/benefit analyses as required
5. Work with county administrations to address the most severe erosion problems first, i.e. the approximately 221 miles of shoreline eroding at a rate in excess of four feet per year *(Maryland Geological Survey, 2003)*

- **Timing:** TBD.
- **Parties Involved:** There are several parties that would be involved in the implementation of this option, as outlined below.

1. MD Department of Natural Resources, specifically their Shore Erosion Control (SEC) Program
2. Maryland's Coastal Program
3. MD Department of Environment
4. Army Corps of Engineers

5. Center for Coastal Resources Management
6. County Administrations
7. Engineering, Contracting, and Property Owner Communities

- **Other:** NA.

Implementation Mechanisms

This option would be implemented by focusing on three key steps. First, integrate the identification and structural assessment of installed SEC structures into the data collection, reporting, and distribution process of the Comprehensive Coastal Inventory Program managed by the Center for Coastal Resource Management. Second, update the design and construction standards and protocols for SEC structures – both new and retrofit, to accommodate projected SLR *(e.g. SHORE EROSION CONTROL GUIDELINES For Waterfront Property Owners)* – distribute this information to the engineering, construction, and property owner communities. Finally, enforce these design and construction standards by appropriate agencies.

Related Policies/Programs in Place

Numerous state and federal agencies work with local governments to implement and manage various erosion-related initiatives, among them:

1. The *Shore Erosion Control (SEC) Program*, Department of Natural Resources, provides assistance to Maryland property owners in resolving shoreline erosion problems along the Chesapeake Bay and its tributaries.
2. The *Comprehensive Coastal Inventory (CCI) Program*, Center for Coastal Resources Management at the Virginia Institute of Marine Science, collects, reports, and distributes information on Maryland's shoreline features including SEC structures.
3. The *Living Shorelines Stewardship Initiative (LSSI)* is a collaborative effort by various public and private entities to promote the use of "living shorelines" (i.e. vegetated buffers) to waterfront property owners.
4. *Strategic Shore Erosion Assessment (SSEA)*, part of the Maryland Coastal Program, helps various government agencies prioritize SEC projects for public assistance and identify key environmental features of selected sites, among other services.

Estimation of Adaptation Benefits and Costs

- **Estimated Cost:** TBD.
- **Flexibility:** TBD.
- **Adaptive capacity:** TBD.
- **Other:** TBD.

Documentation of Adaptation Benefits and Costs

- **Data Sources:** TBD.
- **Quantification Methods:** TBD.

- **Key Assumptions:** TBD
- **Key Uncertainties:** TBD.

Additional Benefits and Costs

TBD.

Feasibility Issues

TBD.

Status of Group Approval

TBD.

Barriers to Consensus

TBD.

EBEI-8: Building Code Revisions, including New Design standards and codes to facilitate retreat, avoid SLR risks and increase resilience

Option Description

Strengthening existing building codes for new infrastructure and structures in vulnerable coastal areas will involve a number of major activities. These include evaluating existing codes with respect to their proven effectiveness in past storm events, identifying causes of failure, and implementing changes to codes to improve performance in the future. In addition to past performance, codes should be reviewed and strengthened by taking into account future increased hazards caused by sea level rise and the associated possible increase in storm frequency and intensity caused by climate change. Standards for marine-related structures such as piers and wharves should be included in this review.

In addition to the overall evaluation and strengthening of codes, the entire development process must begin to recognize the potential impacts of sea level rise and climate change. Design professionals must look for ways to mitigate future impacts, and local governments must increase plan review, inspection and enforcement efforts.

This effort is ongoing at several levels. FEMA regularly publishes a "Summary Report on Building Performance" after major natural disasters (such as Hurricane Andrew and Hurricane Katrina). These reports study the damage resulting from the event, identify areas of strength and weakness in building design and construction, and recommend improvements. The International Code Council also studies code effectiveness and regularly makes improvements to its codes.

Option Design

The specific objective of this option is to assess how existing observation systems for the Chesapeake Bay can be enhanced to better understand and address long-term sea level rise and its impacts on the built environment. The overall option design is summarized in the bullets below.

- **Targets:** All construction-related codes should be evaluated for their effectiveness in protecting against the future effects of climate change and sea level rise. This will include the following issues:
  - *Elevation of buildings* – FEMA and local governments should mandate freeboard for all construction in coastal flood hazard zones. Freeboard is an elevation above a design high water level (base flood elevation). For example, the bottom of the lowest horizontal structural member should be elevated a minimum of two feet (or more) above the base flood elevation. This is especially pertinent with regard to sea level rise, since base flood elevations will be higher in the future. The required freeboard should relate to the amount of sea level rise expected, potential wave height, and the expected life of the structure.
  - *Foundation design* – Certain types of foundations are more effective in flood situations than others. Deep pile or column foundations are desired if significant erosion is possible

in oceanfront locations as well as bay locations where the following conditions exist: erodibility of the soil; exposure to "damaging" waves (greater than 1.5 feet high); potential for velocity flow; potential for floodborne debris; and required resistance to wind forces. These locations include FEMA identified V-zones as well as A-zones.

- *Long-duration flood impacts* – Long-duration flooding, which may be a result of sea level rise in the future, can cause extensive damage to interior contents and building materials. Moisture entrapment within walls and floors can impact structural integrity as well as cause biological and chemical contamination. Elevation will avoid this problem, as will the use of flood resistant building materials above the minimum elevation.
- *Debris impact* – Substantial damage can be caused by floating or wind-driven debris in a flood or storm event. Current codes and construction standards should be evaluated with regard to debris resistance.
- *Building envelope* – Building envelope is the entire exterior surface of a building, including walls, windows, doors and roofs. All parts of the building envelope must provide protection from wind, wind pressure, and windborne debris. Building codes are very specific regarding these issues, but they should continually be reviewed and improved as needed.

- **Timing:** This is primarily an ongoing effort. Codes are currently in place, and should be implemented and enforced by everyone involved in the design and construction process. FEMA and the code agencies continually evaluate the effectiveness of the code requirements, especially after a major event such as a hurricane or flood. These events provide essential information regarding the performance of code complaint structures and reveal areas in need of improvement. Training of enforcement personnel should also be an ongoing effort.
- **Parties Involved:** All parties involved in the design and construction process should be involved in this effort, including the International Code Council, design professionals such as architects and engineers, building materials manufacturers, the Federal government (FEMA, National Weather Service, NOHH, Corps of Engineers), state government (MEMA, DOE, DNR), and local governments. Property owners also need to be aware of potential hazards and know how to evaluate the strengths and weaknesses of their properties.
- **Other:** NA.

Implementation Mechanisms

Implementation of this option will initially involve an evaluation of existing codes and regulations with specific regard to the threats associated with climate change and sea level rise. This will involve looking many years into the future and trying to predict these impacts. If deficiencies are found, changes to codes, regulations and laws will be necessary. Enforcement of these codes is usually the responsibility of local governments; funding assistance is needed to ensure that an adequate number of trained code officials and inspectors are available.

Related Policies/Programs in Place

Codes are currently in place to regulate construction. The International Building Code is the primary building code. FEMA's flood insurance program is the primary source of flood

protection regulations. State and local governments often compliment these general programs with more site-specific regulations.

Estimation of Adaptation Benefits and Costs

- **Estimated Cost:** TBD.
- **Flexibility:** TBD.
- **Adaptive capacity:** TBD.
- **Other:** TBD.

Documentation of Adaptation Benefits and Costs

- **Data Sources:** TBD.
- **Quantification Methods:** TBD.
- **Key Assumptions:** TBD
- **Key Uncertainties:** TBD.

Additional Benefits and Costs

TBD.

Feasibility Issues

TBD.

Status of Group Approval

TBD.

Barriers to Consensus

TBD.