Menu of Options to Promote Urban Watershed Resilience in Chesapeake Bay Communities

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Prepared for:
Urban Stormwater Workgroup
and
Climate Resiliency Group

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November 1, 2021

This white paper outlines a menu of options to help Bay communities effectively adapt to projected climate change. While the range of climate impacts are broad and will be felt across the watershed and in all sectors, this paper primarily addresses the impacts of future increases in extreme rainfall and sea level, and tools for urban and suburban communities.

Many different local adaptation tools and resources were recommended by watershed stakeholders at a joint meeting of the Urban Stormwater Work Group and the Climate Resiliency Work Group held in October 2021. Time did not allow, however, for a full discussion of the merits of each individual option during the two-day meeting. Consequently, this paper was crafted to flesh out details on the options to enable stakeholders to choose which of them are most applicable to their community/Bay region and receive priority to pursue.

The description of each option concludes with a table that summarizes the initial scope of the proposed product, process and partnerships needed to make them happen, as well as the funds needed to get them done. It is expected that they will be further revised and refined as a result of partnership feedback at future USWG and CRWG meetings. This draft is merely intended to further that process, and help focus the conversation about which priority options are most worthy for the partnership to pursue to respond to the climate directive.

Comments and suggestions are most welcome and can be sent directly to CSN.

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1. Address Unique Needs of Tidewater Communities

Coastal Plain Rising Waters Workshop and Follow-up Actions

Throughout the two-day workshop, one initiative stood out as a short-term product that could be pursued with existing resources. CSN will explore the establishment of a steering committee to plan and conduct a one or two-day workshop in 2022 to address unique issues caused by rising waters in tidewater communities, such as:

- Sea level rise and subsidence
- Higher storm surge
- Blue sky flooding
- Shoreline retreat, saltwater intrusion, higher water tables and ghost forests

The focus of the workshop would be on discussing specific tools and resources to help coastal local governments plan and adapt to changing climate conditions. Discussions would allow for information exchange with experts and community case studies with the goal of identifying next steps and potential future outcomes. Three areas of focus may include:

- Identified impacts and research needs related to shoreline, seagrass and tidal wetland restoration projects.
- Coastal plain-specific stormwater BMP design criteria updates for a group of common practices (i.e., possibly revise CSN Coastal Plain Technical Bulletin), as well as new vegetation and planting guidance for stormwater practices and municipal landscaping.
- Tailored vulnerability assessment tools to help coastal plain watershed managers identify high-risk communities and assets in the face of convergent climate impacts.

2. Community Vulnerability Assessments (4)

A series of vulnerability assessments were recommended to enable communities to determine which of their neighborhoods, municipal assets, ponds or habitats are most vulnerable to extreme flooding in the future, and devise strategies to minimize risk. The assessment methods could be tailored to meet the needs (and resources) of both small and large communities, provide rapid results and fit within municipal budgets.

In general, each community vulnerability assessment would be developed by a panel of subject matter experts to define the general methods and protocols to conduct each kind of community vulnerability assessment. Potential elements of community vulnerability assessments are described below, some of which may be nested or combined to provide a more comprehensive picture of vulnerability:

Option 1: MVN: Most Vulnerable Neighborhoods

An estimated 40% of U.S. urban flood damage occurs outside of FEMA boundaries, so it is important to identify which neighborhoods are most at risk from flooding in the community. This vulnerability assessment is intended to rapidly show which neighborhoods and subwatersheds are most at risk for flooding inside, upstream and adjacent to the FEMA insured floodplain. The risk assessment might look at:

- What existing floodplain mapping layers are available from local, state and federal sources
- Defining priority datasets that determine community risk and vulnerability
- Rapid desktop GIS analysis to look at factors within the subwatershed that may increase future flood risk
- More detailed H&H modeling to identify which individual neighborhoods within these flood-prone subwatershed areas to target
- Analysis to determine the demographic and income characteristics of the neighborhoods at risk to prioritize equity and diversity in community risk management decisions

Key factors that can influence current and future floodplain boundaries in subwatersheds might include proximity to water, age of development, change in IC over last 30 years, past drainage complaints, condition of stormwater detention and flood control of stormwater infrastructure and the past history of stream buffers and floodplain permitting in the subwatersheds.

The intent of this assessment is not necessarily to produce “new” insurance flood maps (which can take 5 to 8 years), but to target the most vulnerable neighborhoods with:

- Outreach to residents about future risks and availability of private flood insurance outside of FEMA insurance boundaries
- Local stormwater and flood control investments in the subwatershed which can that can protect vulnerable neighborhoods
- More detailed flood studies and H&H modeling to design localized flood control strategies for the most vulnerable subwatersheds.

Option 1 at a Glance	
CVA: Most Vulnerable Neighborhoods	
Product	Technical memo outlining the most cost-effective desktop GIS methods to analyze subwatershed factors that elevate future flooding risks for individual neighborhoods. The memo would also recommend more detailed modeling and mapping protocols for the most vulnerable neighborhoods to mitigate those risks.
CBP Lead	CSN/USWG/LGAC
Key Partners	State floodplain management agencies, local flood Managers
Process to Develop	Convene panel of flood mapping and local GIS experts
Scope of Effort	Year, if it goes well
New/Existing Funds?	One or possibly two CVAs can be handled w/ existing funds
Priority Votes	

Option 2 MVMA: Most Vulnerable Municipal Assets

This rapid assessment helps identify which municipal assets are most vulnerable to future flooding, including critical infrastructure, key municipal facilities and public lands. The proposed approach might involve a desktop GIS analysis using the same basic method to identify most vulnerable neighborhoods, but with a narrower focus on the critical municipal infrastructure at greatest risk in the community. The method would focus on potential failures that could cause lengthy interruption of municipal services and/or impact municipal/utility budgets to fix or repair future damages.

The desktop GIS method would predict specific locations in the community where municipal assets are most vulnerable. The method may also prescribe specific follow up investigations to protect, relocate or floodproof the most vulnerable assets.

Some examples of critical infrastructure include:

- Water and sewer lines located in the stream corridor
- Bridges and culverts that cross it
- Stormwater outfalls and roadway embankments
- Other key utility infrastructure

The same GIS methods are also applied to identify the municipal operations and facilities at greatest risk of flooding in the stream corridor, floodplain or shoreline zones. Numerous municipal facilities are often located in or near these zones, including:

- Public works yards
- Waste-water treatment plants
- Pumping stations
- Greenways, trails and parks
- Public buildings (e.g., schools, libraries, and public safety)
- Municipal restoration assets that must be verified for MS4 credit

Once an individual municipal asset is deemed highly vulnerable, it then triggers a site-based follow-up investigation to reduce risks and damages.

Option 2 at a Glance	
CVA: Most Vulnerable Municipal Assets	
Product	Technical memo that outlines desktop GIS methods for identify which specific municipal properties, operations, assets and utilities most vulnerable to future flooding damages. The memo will then outline more specific site investigations to mitigate risk for the most vulnerable municipal assets and utilities.
CBP Lead	CSN/USWG/LGAC
Key Partners	Large and small municipalities
Process to Develop	Convene panel of flood mapping and local GIS experts
Scope of Effort	Year, if it goes well
New/Existing Funds?	One or possibly two CVAs can be handled w/ existing funds
Priority Votes	

Option 3. *MVP: Most Vulnerable Ponds*

Most communities have a large inventory of publicly and privately owned stormwater ponds, as well as farm ponds, roadway embankments, flood controls and small reservoirs. Many of these older legacy ponds are near the end of their design life, due to aging construction materials and poor maintenance history.

This vulnerability assessment systematically assesses which individual ponds and roadway culverts are most at risk of failing during extreme flood events. The assessment involves a combination of desktop GIS analysis along with field inspections of individual ponds/roadways.

Some of the key desktop risk criteria for pond failure due to extreme storms include:

- Dam safety hazard class (i.e., 640 acres CDA + 20 ft embankment height)
- Pond age and engineering standards when constructed
- Contributing drainage area (CDA) and change in impervious cover/upstream plumbing since constructed
- Ownership/maintenance history (any inspections in last 5 years?) and availability of access easements

The pond vulnerability analysis may require some changes to current pond field inspection protocols to identify which individual legacy ponds are most at risk of failing. Many of these individual pond inspections are already required under MS4 permits and/or state dam safety requirements, but the inspection data is not always analyzed to determine which sub-group of ponds in the community require the most urgent (and expensive) pond plumbing retrofits. This assessment may include an update to the CSN pond protocol released in 2019.

Option 3 at a Glance	
CVA: Most Vulnerable Ponds	
Product	Technical memo outlining desktop methods and field inspections to identify which ponds in the local inventory are most vulnerable to failure from extreme storms (e.g., update to the *Pond Protocol*). The memo would also include guidance on how to estimate costs to retrofit the most vulnerable ponds.
CBP Lead	CSN/USWG/LGAC
Key Partners	Dam safety agencies, large and small MS4s, SCDs
Process to Develop	Convene panel of pond and dam safety experts and Ms4 GIS experts
Scope of Effort	Year, if it goes well
New/Existing Funds?	One or possibly two CVAs can be handled w/ existing funds
Priority Votes	

Option 4. MVH: Most Vulnerable Habitats

The last community vulnerability assessment is used to discover which specific stream, shoreline, tidal/non-tidal wetland, riparian forests and other habitats in the community are at most risk from flooding, warming or changes in groundwater/surface waters.

Like other vulnerability assessments, this one would utilize rapid desktop GIS methods to identify and screen the most critical habitats in the community, followed by more intensive field investigations to devise habitat management plans to protect the most vulnerable ones.

The specific list of stream, shoreline or wetland habitats at risk will vary in each locality and region of the Bay, but often may include:

- Degradation of urban streams, floodplains and forest buffers (e.g., benthic habitat, channel incision, floodplain disconnection, riparian degradation, invasive plants)
- Reduced performance of municipal stream, floodplain and shoreline restoration assets (and possible loss of TMDL credit)
- Other conservation areas and buffers adjacent to the stream corridor and waterfront
- Threats to cold and cool-water fisheries vulnerable to future stream warming
- Degradation of tidal and non-tidal wetlands, forests and shorelines due to rising surface waters and groundwater.

This option could also develop guidance on how to improve the resilience of living shorelines, restored wetlands and stream and floodplain restoration projects to future climate change. Experts could craft practical site assessment, design and planting guidelines to improve resilience, as well as defining critical design storms, floodplain elevations and/or tidal water conditions that designers should consider in their project analysis and H&H modeling.

Option 4 at a Glance	
CVA: Most Vulnerable Habitats	
Product	Workshop to scope out a technical memo describing cost-effective GIS desktop methods to identify most vulnerable habitats. The methods would analyze specific subwatershed and stream corridor factors that might influence future habitat conditions, and provide guidance on more specific investigations to craft restoration/mitigations strategies to protect the vulnerable habitats
CBP Lead	SHWG/FWG/WWG and Habitat GIT (CSN liaison)
Key Partners	State and local resource agencies/conservation NGOs, local governments
Process to Develop	Convene panel of habitat and Ms4 GIS experts to develop the habitat assessment protocols
Scope of Effort	2 years
New/Existing Funds?	Would require new funding and staffing from other parts of CBP
Priority Votes	

3. More Resilient Stormwater BMP Design Criteria

Several options were suggested to improve the resilience of current and future stormwater BMPs in communities within the Bay watershed.

Option 5. Statewide Climate-Informed Stormwater Design Supplement

This option would update BMP water quality sizing criteria to reduce runoff bypass, provide practice-specific plumbing improvements (inflow, overflow, bypass) and establish new climate-informed design storm criteria. These updates can promote resilience by ensuring that runoff from extreme storms is safely conveyed through stormwater BMPs and the downstream urban drainage network.

Bay states traditionally have had the authority to set stormwater engineering standards and designate design storm events that local governments must adhere to. Consequently, the process for making these changes can be very long and complex. On the other hand, states may have flexibility to enable communities to adopt more stringent design criteria on their own, but need to be very clear with guidance on which specific local changes would be considered permissible within their jurisdiction.

Option 5 at a Glance	
State-wide Climate Informed Stormwater Design Supplement	
Product	State Stormwater Design Supplement
CBP Lead	No CBP lead, as this is a state prerogative, but perhaps Bay states can coordinate efforts through Management Board
Key Partners	Key stormwater stakeholders in each state including local governments
Process to Develop	Leave process to individual Bay states
Scope of Effort	Multi-year, depending on the scope of engineering changes
New/Existing Funds?	N/A
Priority Votes	

Option 6. Update Local Stormwater Design Specs to Promote Practice Resiliency

Many local governments have the capability to update their local stormwater design and maintenance criteria and ordinances in order to maintain the performance, longevity and resilience of stormwater practices built to serve new or redevelopment projects.

The basic concept would be to develop Bay-wide stormwater design specs that could be adapted to meet the unique needs of each Bay community. The first batch of design specs could focus on popular LID practices such as bioretention, rooftop disconnection, sheet flow to buffer credits and other LID practices.

The new criteria would be developed by urban stormwater experts to promote longevity, boost pollutant removal performance, handle increased extreme rainfall and define more specific maintenance criteria. Some possible areas of emphasis might include:

- New “plumbing” criteria to manage inflows and overflows to on-line LID practices
- Climate-resilient BMP performance enhancements including soil amendments, use of “smart” BMPs, etc.
- Improved modeling guidance to manage extreme storms, provide downstream “flow-ways” and enable disconnection without erosion.
- Climate-informed IDF statistics to define key design storms and outline acceptable protocols for applying H&H models to predict future hydrologic conditions and runoff conveyance at the project site and downstream.
- Establish landscaping and vegetation maintenance criteria to create stormwater plant communities that are best adapted to future climate conditions (extreme rainfall, prolonged droughts, higher air and soil temps and longer growing seasons).

Option 6 at a Glance	
Update Local Stormwater Design Specs to Promote Practice Resiliency	
Product	Series of practice-specific design specifications that locals can adapt to improve their resiliency
CBP Lead	CSN/USWG
Key Partners	State stormwater agencies, local stormwater managers, CBLP, BMP research community
Process to Develop	Expert workshop to define spec issues, CSN to craft draft specs, and solicit external review
Scope of Effort	Multi-year project
New/Existing Funds?	Some seed money available for the first few, but thereafter, new funds would be needed.
Priority Votes	

Option 7. Decision Support Tool to Choose Optimum Design Storms to Manage Different Local Infrastructure Assets

Most communities have the authority to set engineering standards for infrastructure built in their community, ranging from everything from storm drain inlets, streets, storm drain pipes, ditches and open channels, road crossings and culverts, local stream buffers and floodplain analysis, to name just a few.

While local planners and engineers appreciate the new wealth of detail on design storms and flood risk, many are unsure of which specific GCM conditions, storm return intervals, future time horizons, confidence intervals are most appropriate for each class of municipal assets they are managing.

Each class of municipal asset often has a different design life, level of service, public safety risk, life cycle construction costs, replacement cost and maintenance regime. Communities need guidance on how to choose the specific combination of rainfall depths/design storms for each class to cost-effectively manage risk for each class of their municipal assets.

The goal would be to convene climate scientists, modelers, engineers, municipal asset managers and other local stakeholders to develop detailed guidance on the process for deciding which future design conditions to require for different classes of municipal assets. The hope would be a tool or resource that provides scientifically grounded, but easy-to-understand metrics that focus on reducing overall vulnerability in contrast to grounding investment decisions to arbitrary design storms that lack robustness across a wider range of future conditions. It is anticipated that a contractor would facilitate the expert process and develop a decision support tool for local governments in the Bay watershed. The same contractor might also generate new climate-informed IDF curves for storms with less than a year return frequency and/or storm event durations less than one-hour.

Option 7 at a Glance	
Decision Support Tool to Choose Local Resilience Thresholds	
Product	Creation of a local decision support tool to improve local capability to select the most-cost effective risk thresholds for each class of their infrastructure
CBP Lead	CRG, USWG, LGAC, other
Key Partners	Municipal stakeholders and technical contractor
Process to Develop	Expert scoping workshop followed by technical guidance
Scope of Effort	At least 18 months?
New/Existing Funds?	New Funds
Priority Votes	

Option 8: Retrofitting Ponds and Floodplains to Enhance Flood Control Functions.

Several communities have inquired how they can improve the flood control functions of their existing ponds, buffers, floodplains, without sacrificing their important ecological services. This option would look at the feasibility of strategies such as:

- Potential retrofits for detention/retention to control floods in headwaters by modifying the plumbing of detention ponds, and making them "smarter"
- Using existing constrained urban buffers and floodplains to handle extreme floods more actively. This could entail restoration options such as floodplain reconnection, legacy sediment removal and palustrine wetland creation.
- Modifications to existing culverts/crossings to promote fish passage and provide more upstream flood control.
- Other options, as developed by floodplain, wetland or restoration managers.

Option 8 at a Glance	
Guidance of Retrofitting Ponds and Floodplains	
Product	Assess the best engineering/restoration options to improve the flood control functions of ponds, buffers and floodplains
CBP Lead	SHWG/FWG/WWG and Habitat GIT (CSN liaison)
Key Partners	State and local resource agencies/conservation NGOs, local governments
Process to Develop	Convene panel of experts to develop guidance
Scope of Effort	1 to 2 Years
New/Existing Funds?	Would require new funding and staffing from other parts of CBP
Priority Votes	

4. Enhancing Local Floodplain Regulations and Management

A key theme from the workshop was that local governments can promote resiliency by adopting and enforcing floodplain regulations that are more stringent than required under FEMA or state floodplain regulations.

Option 9: Resiliency Checkup: Review of Local Code and Ordinances

The checkup features a comprehensive review of local codes, ordinances and development regulations to reduce the vulnerability of future new and redevelopment projects in the community, with a focus on managing headwater/shoreline flooding risks located outside of current FEMA flood insurance maps. The checkup can help a community:

- Decide whether existing local floodplain management programs should adopt FEMA's Community Rating System Incentives to reduce floodplain insurance premiums in the community
- Conduct smaller scale floodplain modeling for priority MVNs using future buildout IC and climate-informed design storms to notify residents about their flood risks
- Map the vertical and lateral extent of freeboard on local floodplain maps
- Adjust where new land development/redevelopment can occur in or near the 100-year floodplain in the future in development codes
- Assess whether existing stream, shoreline or critical area buffers and floodplain boundaries should be extended outward to promote greater resilience.
- Determine whether supplemental stormwater modeling and BMP design criteria are needed to reduce the impact of development projects going forward.
- Revise other local engineering criteria or ordinances.

Option 9 at a Glance	
Resiliency Checkup: Review of Local Codes and Ordinances	
Product	Series of webcasts targeted toward local planners/engineers and a "Codes and Ordinances Worksheet (COW)" flood resilience checkup document.
CBP Lead	CSN, LGAC, Others?
Key Partners	FEMA, Bay State floodplain management agencies, MASFM and other professional associations
Process to Develop	Work with floodplain managers to provide local governments the best choices to make. Do webcasts and checkup document
Scope of Effort	Could be done over a year
New/Existing Funds?	Webcast portion could be done w/ existing funds, checkup documents would require new funds
Priority Votes	