



# Sustainable Shorelines and Community Management Project Phase I Report

October 1, 2008 – September 30, 2009  
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Grant Year 2008, Task 12.06



**Virginia Coastal Zone**  
MANAGEMENT PROGRAM

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# Introduction

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The Sustainable Shorelines and Community Management Project is a collaborative planning effort between the localities, major landholders, and universities in Northern Virginia that border the tidal Potomac River. The project regionalizes planning efforts for relative sea level rise and storm surge, along Northern Virginia's approximate 100 miles of tidal shoreline.

Phase I, of this three phase project, is an inventory of existing data resources and policies for natural and man-made resources to support in the identification of data gaps, and to understand current local shoreline management plans and regulations. Additionally, a project workgroup consisting of representatives from local, state, and federal governments, college and universities, and other stakeholders assisted in highlighting and collecting relevant data and providing review and critic of draft products.

This report fulfills the product requirements set forth in the 2008 Virginia Coastal Zone Management Program Grant, Task 12.06 (NOAA Grant #NA06NOS4190466) for:

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Draft vulnerability maps of the following localities are provided on CD-ROM:

- Alexandria, City of
- Arlington County
- Dumfries, Town of
- Fairfax County
- Occoquan, Town of
- Prince William County
- Quantico, Town of

## Product 1

# Summary of Workgroup Formation, Meetings, and Outcomes

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NVRC and the Virginia/Chesapeake NEMO programs coordinated a workgroup comprised of staff representatives from localities, military installations, universities, major land managers, including the National Park Service, DCR – Mason Neck State Park, and the Fish and Wildlife Service – Mason Neck Wildlife Refuge, and others major stakeholders. Individual meetings were held with organizations who might be interested in participating due to their vested interest in the Potomac River shoreline.

Four meetings were held throughout the year. The workgroup engaged in discussions and work sessions facilitated by Virginia/Chesapeake NEMO to identify areas of concern within their respective jurisdictions on maps of the Potomac River shoreline and review and provide feedback on vulnerability maps, as well as draft content for the Policy Inventory Report.

The workgroup shaped the products of Phase I to meet the needs of local land use decision makers. Between meetings the group communicated through a private Chesapeake Watershed Network group, to house meeting materials, including presentations and handouts for easy access. When interviewed individually regarding the workgroup progress the general sentiment was positive and members felt as though the project will be reflective of their needs and usable to guide land use.

At the September workgroup meeting, a discussion on the final draft Policy Inventory Report revealed additional interest by the workgroup members in understanding the legal authority Virginia's local governments have and what may currently prohibit the integration of adaptation strategies into their plans and policies.

A secondary outcome of the workgroup is a continuing forum for the members to learn from each other's experiences. For example, after hearing a presentation by CH2M Hill at one of the workgroup meetings, Arlington County is riding a City of Alexandria's contract to develop new regional stormwater curves for the county, based on projected climate change impacts.

Meeting agendas and summaries are below.



# Northern Virginia Sustainable Shoreline and Community Management Project

## Workgroup Meeting Summary

James House at Mason Neck State Park  
February 10, 2009  
10 a.m. – 12:30 p.m.

### Agenda

**I. Welcome and Introductions**

*Mark Gibb, Executive Director, Northern Virginia Regional Commission (NVRC)*

**II. Project Overview**

*Laura Grape, Senior Environmental Planner, NVRC*

**III. Climate Change: Status, Trends, Adaptation**

*Tom Smith, Natural Heritage Director, Virginia Department of Conservation and Recreation*

**IV. Discussion**

*Virginia/Chesapeake Network for the Education of Municipal Officials (NEMO)*

- a. What changes are you seeing along the shorelines?
- b. What areas are your localities/organizations most concerned about?
- c. What pressure are you receiving to deal with climate?

**V. Sustainable Shoreline and Community Management Project**

*Laura Grape, Senior Environmental Planner, NVRC*

**VI. Wrap Up and Next Steps**



**In attendance:**

<b>Name</b>	<b>Organization</b>
Jeff Harn	Arlington County – Department of Environmental Services
Noel Kaplan	Fairfax County – Department of Planning and Zoning
Michael Willingham	Virginia Tech
Fred Krimgold	Virginia Tech
John Bigger	Virginia Tech
Craig Perl	City of Alexandria – Transportation & Environmental Services
Claudia Hamblin-Katnik	City of Alexandria – Transportation & Environmental Services
Mike Hudson	Fort Belvoir
Sybille Vega	Fort Belvoir
Randy McBride	George Mason University
Lauryn Sacha	Virginia Department of Conservation and Recreation
Tom Dombrowski	Prince William County
Clay Morris	Prince William County
Patty Dietz	Prince William County
Sam Martin	Virginia Tech , Ecos360, llc.
Laura Grape	Northern Virginia Regional Commission
Samantha Ference	Northern Virginia Regional Commission
Marshall Popkin	Northern Virginia Regional Commission
Mark Gibb	Northern Virginia Regional Commission
Jonathan Doherty	Chesapeake NEMO
Todd Janeski	Virginia NEMO
Amy Handen	Chesapeake NEMO

**Invited, but unable to attend:**

<b>Name</b>	<b>Organization</b>
John Muse	Virginia Department of Transportation
Iris Tharpe	Town of Quantico
Claudia Cruise	Town of Occoquan
Greg Weiler	US Fish & Wildlife Service – Mason Neck Wildlife Refuge
Bruce Frizzell	Quantico Marine Corps Base
Doug Curtis	National Park Service – Center for Urban Ecology
Brent Steury	National Park Service – George Washington Memorial Parkway

## **Summary**

### **Purpose of the Meeting**

The purpose of this meeting was to communicate the objectives of the project, as well as to hear from localities what the pressures and needs are in regards to planning and development along their tidal shorelines. The meeting clarified that this project will be to prepare specifically for adaptation to sea level rise and storm surge, as there is an increasing need for it in Northern Virginia.

### **Welcome and Introduction**

Mark Gibb, Executive Director of the Northern Virginia Regional Commission (NVRC), welcomed everyone to the first Workgroup meeting for the Sustainable Shorelines and Community Management Project. Mr. Gibb noted the significant commitments the localities and other organizations are taking to reduce greenhouse gas emissions. However, aspects of the climate will continue to change regardless of the current efforts. Sea level rise is one example. Sea level rise and increased storm surges are the focus of this project. This is a project of interest amongst the elected community as well.

Mr. Gibb introduced Project Manager Laura Grape, Senior Environmental Planner with NVRC.

### **Project Overview**

Ms. Grape provided a brief overview of the project and introduced the project partners, including the Virginia and Chesapeake Network for Educating Municipal Officials (NEMO), the National Oceanic and Atmospheric Administration (NOAA) and the Virginia Coastal Zone Management Program (Virginia CZM).

The Virginia CZM focal area for the next three years is adapting to the influences of climate change at the local level. Virginia CZM chose to utilize the eight Planning District Commissions within Virginia's Coastal Zone for this effort. Northern Virginia, the Middle Peninsula, and Hampton Roads are addressing the issue of sea level rise and storm surge.

Ms. Grape noted through the first phase of the Sustainable Shorelines and Community Management Project, the impacts of sea level rise and storm surge will be better understood across the region. Subsequent phases will focus on the development of adaptation strategies to better plan and prepare our existing and future communities.

Ms. Grape introduced Tom Smith, Natural Heritage Director with the Virginia Department of Conservation and Recreation.

### **Climate Change: Status, Trends, Adaptation**

*(Slides Available)*

Tom Smith, Natural Heritage Director with the Department of Conservation and Recreation explained the impacts of climate change in Virginia. He emphasized findings from the Intergovernmental Panel on Climate Change (IPCC), as well as recommendations made by the Governors Commission on Climate Change.

Mr. Smith noted a few key findings from the IPCC's 2007 assessment. The projected future changes in the physical climate system were detailed as well as the likelihood of the prediction. The probability that "heat waves, heat extremes and heavy precipitation events will increase." is considered very likely (90-99% probability). It is with high confidence (8 out of 10 chance) that the IPCC finds "Climate change is

strongly affecting many aspects of systems related to the cryosphere, emerging evidence shows changes in hydrological systems, water resources, coastal zones and oceans. In addition to the many mitigation efforts that the GCCC recommended, there were several specific to adaptation. Recommendation 14C states “Local governments in the coastal area of Virginia should include projected climate change impacts, especially sea level rise and storm surge, in all planning efforts, including local government comprehensive plans and land use plans. Local governments should revise zoning and permitting ordinances.”

## **Discussion**

Jonathan Doherty, Program Manager with Chesapeake Network for Educating Municipal Officials (NEMO) facilitated a discussion focusing on current changes that jurisdictions are seeing along their coastlines, as well as the types of pressures each are facing to adapt. Responses included:

*Fairfax County* – The County is receiving more mitigation questions than adaptation questions. Some questions are specific about reducing emissions, and coincide with Chairman Connelly’s Cool Counties initiative. There has not been much pressure or thought regarding adaptation yet.

*Prince William County* – The County has just begun their GreenInitiative program, and is seeing successes in wetlands and stream restoration. There was agreement that the County sees the economic downturn as a relief from the demands of a thriving construction period, and a chance to prepare for future development with a respect to climate change impacts. They are also dealing with the degenerating creeks and waterways. The increasing need for dredging and the overwhelming growth of hydrilla is limiting access.

*Arlington County* – The County mentioned the impacts of flooding in 2006, and how that has sparked the board to have an increased interest in future needs for the stormwater network, hydrological modeling, impacts on aging infrastructure, and a stormwater master plan. It is also noted that there is increased pressure to incorporate human safety factors into modeling.

*City of Alexandria* - The City has made several commitments through their Ecocity program. The City has also participated in the Chesapeake Inundation Prediction System (CIPS) project over the last three years, including a street level modeling exercise for storm surge impacts in the Old Town area. The Old Town area is of utmost concern and pressure due to its economic contribution to the City. Some initiatives are also underway to look at the engineering design as it relates to increased storm intensity and events.

*VA Department of Conservation and Recreation* – Representation from Leesylvania State Park – The major issue at the forefront is determining how the parks continue to provide the customer/public with the same opportunities, while taking into consideration the loss of land and damages at the shorelines. There have been some successes in implementing adaptation strategies (breakwaters, etc.) however, these techniques are expensive and it’s unsure how long they will last. The representative stated a need for “overwhelming guidance” on how to plan for development.

*Department of Conservation and Recreation* – The Department has responded to the increased risks by limiting the coastal projects they are engaging in because the expense is outweighed by the likelihood of loss and/or damage.

Workgroup members were invited to identify area of concern and highlight them with markers on maps designated with FEMA's 100-year floodplains and distinguished the areas below the 10 foot contour line<sup>1</sup>. The 10 foot contour line was selected as it was the highest resolution data NVRC has for the region. Most features were communities located within the broad area of vulnerability. Prince William County was particularly concerned about development and storm events in the watersheds causing pronounced impacts in the tidal areas. Water Treatment Facilities and other infrastructure were also highlighted as areas of concern.

### **Sustainable Shoreline and Community Management Project**

*(Slides Available)*

Laura Grape, Senior Environmental Planner with the Northern Virginia Regional Commission further explained the goals of the project and outlined each phase. The scope of the project could potentially reach years in the future, and the products will be living documents that will need to be revisited as additional data and research becomes available.

Should funding persist, the project will take place in three phases over three years. Phase I will include a broad data and vulnerability assessment, as well as review of existing policies at the local level. Phase II will be a period of data collection, assessment refinement, and strategy development. Phase III will be a process of strategy refinement and implementation, examples of which may include amendments to policy, integration of strategies into comprehensive plans, etc. Phase I has several goals that characterize the work and products of the workgroup. These include, inventorying the existing data resources, identifying additional data needs, conducting a broad vulnerability assessment, and compiling existing planning policies and tools.

Ms. Grape also detailed some of the more specific data and projections for the Northern Virginia area. Additionally, she noted that though this project is not focused on mitigation, there will be interaction and cooperation with projects specifically addressing it.

Ms. Grape's presentation prompted a discussion that raised several topics and data needs. The needs included the importance of mapping critical infrastructure, the mean high and low water levels plotted data sets, the availability of LIDAR, and the comparison of vulnerability models and the data needed to run them. The group determined that all of the jurisdictions have 2ft and 5 ft contour data, which will be valuable in refining the maps.

### **Wrap Up and Next Steps**

The project team explained the use of the Chesapeake Watershed Network as the primary tool for continued discussion and collaboration throughout the project. Meeting materials, including presentations and handouts will be housed on this site. The project team will be continuing communication and research efforts through the Chesapeake Watershed Network and a public website.

The next meeting will be on May 26, 2009, at the James House at Mason Neck State Park.

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<sup>1</sup> After the meeting, it was revealed that the elevation highlighted on the maps was incorrectly designated at the 30 foot contour line. NVRC has reproduced the maps, which are available on the project's Chesapeake Watershed Network website.



# Northern Virginia Sustainable Shoreline and Community Management Project

## Workgroup Meeting Summary

James House at Mason Neck State Park

May 26<sup>th</sup>, 2009

10 a.m. – 12:30 p.m.

### Agenda:

#### VII. Welcome and Introductions

#### VIII. Overview of Vulnerability Assessment

*Laura Grape, Senior Environmental Planner*

*Northern Virginia Regional Commission (NVRC)*

#### IX. Discussion

*Chesapeake/Virginia Network for the Education of Municipal Officials (NEMO)*

Discussion objectives:

- a. Confirm selection of focal areas based on Sea Level Rise and Storm Surge (SLR/SS) scenarios
- b. Review resource categories and project impacts for each focal area
- c. Identify appropriateness and completeness of resource categories
- d. Identify resource impacts and gaps (areas where more data or analysis is needed)
- e. Summarize patterns of resource impacts and gaps across focal areas
- f. Identify most appropriate SLR/SS scenario(s) on which to base future analysis and planning.

#### X. Case Study: Worcester County, MD Sea Level Rise Response Strategy

*Gwen Shaughnessy, Coastal Planner*

*Maryland Department of Natural Resources – Chesapeake and Coastal Program*

#### XI. Next Steps



**In attendance:**

<b>Name</b>	<b>Organization</b>
Jeff Harn	Arlington County – DES
Craig Perl	Alexandria T&E/S
Lauryn Sacha	DCR – State Parks
Mary Ann Welton	Fairfax County - DPZ
Claudia Hamblin-Katnik	City of Alexandria T&ES
Greg Weiler	U.S. FWS – Mason Neck Wildlife Refuge
Gwen Shaughnessy	Maryland DNR
Laura Grape	Northern Virginia Regional Commission
Marshall Popkin	Northern Virginia Regional Commission
Sam Ference	Northern Virginia Regional Commission
Orient Au-Vang	Northern Virginia Regional Commission
Todd Janeski	Virginia NEMO
Jonathan Doherty	Chesapeake NEMO
Amy Handen	Chesapeake NEMO

**Summary**

The workgroup convened to discuss progress in assessing vulnerability of the region to inundation from sea level rise and flooding from storm surge. Additionally, the workgroup reviewed maps depicting the inland range of four scenarios across the region. A dialogue formed regarding specifics of how to begin tailoring the data and analysis to be most useful for long-range planning purposes. Gwen Shaughnessy, Coastal Planner with Maryland Department of Natural Resources presented a case study on the Worcester County Sea Level Rise Response Strategy. The approach in Worcester County and other parts of Maryland are similar in scope to the Northern Virginia Sustainable Shorelines Community Management Project.

**Overview of Vulnerability Assessment**

Laura Grape, Senior Environmental Planner with the Northern Virginia Regional Commission welcomed the workgroup and outlined the meeting agenda. She reviewed the progress since the February meeting, including the hiring of a summer intern, confirmation of various GIS shapefiles, and the acquisition of LiDAR for the region. Laura introduced Northern Virginia Regional Commission’s new intern, Orient Au-Vang, a graduate student at Virginia Tech who will support the project this summer. Mr. Au-Vang’s role will focus on researching policy/adaptation strategies and recommendation developed across the mid-Atlantic region, other parts of the United States, and Europe.

Ms. Grape announced that Chesapeake NEMO acquired LiDAR data for the entire Potomac tidal area from a contact from the Department of Defense. She noted this gain brings the project ahead of where it was expected to be, but comes with its own set of challenges. She presented the gaps and inconsistencies associated with overlaying the different shape files with the LiDAR data.

Ms. Grape presented the four scenario definitions that were applied to model different variations of sea level rise. She explained the broad analysis of the four different scenarios, and identified the number of parcels and acreage of tidal wetlands susceptible to inundation.

The four scenarios are defined as:

Scenario	Definition	Rate
Steady State 2100	The observed historic trend rate at Washington, D.C. gage <i>(NOAA Tides and Currents, Station 8594900)</i>	1 foot by 2100
Accelerated 2100	The projected rate based on historical data and predicted global warming trend <i>(IPCC and GCCC)</i>	2.5 feet by 2100
Steady State 2100 + Storm Surge	The observed historic rate, plus 10 feet of storm surge	11 feet
Accelerated 2100 + Storm Surge	The projected rate based on global warming trend, plus 10 feet of storm surge	12.5 feet

Storm surge values based on surge caused by the September 2003 Tropical Storm Isabel, which created a surge characteristic of a Category Two Hurricane in the Chesapeake and Potomac Region. Source: National Weather Service, *Service Assessment Hurricane Isabel, September 18 – 19, 2003*. May 2004

An analysis conducted by NVRC to determine the number of properties affected by each of the scenarios and the amount of tidal freshwater marsh affected by the scenarios, revealed:

	Steady State 2100	Accelerated 2100	Steady State 2100 + Storm Surge	Accelerated 2100 + Storm Surge
<b>Total Number of Parcels Affected</b>	1,869	2,678	7,083	8,135
<b>Acres Tidal Freshwater Marsh* Inundated</b>	1,959 (90%)	2,031 (94%)	2,121 (98%)	2,129 (98%)

\* 2,168 acres = total acreage of tidal freshwater marsh in the Northern Virginia region

NVRC intends to continue refining the vulnerability assessment and scenarios, using factors that are relevant to the workgroup members for their planning purposes. The subsequent workgroup discussion supported this effort.

### Discussion

Jonathan Doherty, Program Manager with Chesapeake Network for the Education of Municipal Officials (NEMO) facilitated the workgroup discussion. The primary objective of the discussion was to receive feedback on the four scenarios and the resource categories.

Regarding the inundation scenarios, discussion topics included:

- Questions about whether climate change may impact the relationships between weather patterns, storm frequency, storm surge, and sea level rise. It was agreed the scientific basis for understanding this is not as clear and there are concerns with how to accommodate it for future planning. Also, Gwen noted through her experience, the most defensible and accepted approaches use historic data, rather than attempting to predict the intensity of future storms.
- Greg Weiler stated that the US Fish and Wildlife Service is using a 0.5m, 1m, and 1.5m rise for their Sea Level Affecting Marshes Model (SLAMM) analysis. However, for planning purposes, each refuge is using what they believe is reasonable or defensible.
- Mary Ann Welton mentioned an overview of the Virginia Governors Commission on Climate Change recommendations and the potential impacts of sea level rise along the county’s shorelines was presented to the Fairfax County Board of Supervisor’s Environmental Committee in March 2009. Impacts up to an elevation of five feet were mapped and the use of a 2050 projection of 1.0 – 1.6 rise in sea level was recommended. Laura noted this rate correlates with the Accelerated 2100 rate used in the Sustainable Shorelines and Community Management project.
- Workgroup members recommended including a presentation of worst case scenarios across the region, including high rate of sea level rise, and storm surge from a category 4/5 hurricane, at spring high tide. The workgroup consensus was that though this was useful for “shock and awe” they anticipate jurisdictions may use a more conservative scenario for planning purposes.

Regarding the resource categories, discussion topics included:

- The workgroup confirmed that the Data Resources/Impacts table appropriately categorizes the resources of highest concern. It was suggested that the extent of hardened shorelines be added to the table. Laura mentioned that VIMS submitted a proposal to the Virginia Coastal Zone Management Program to conduct an inventory of the shoreline characteristics across the region, over the next year.
- The workgroup agreed that human risk and financial impacts are two of the best ways to present the ramifications of the different scenarios. Workgroup members suggested documenting impacts to structural facilities such as, wastewater treatment plants and stormwater facilities as the amount of population served and the number of outfall submerged, respectively. Resources and data needs will continue to be added through an online discussion on the Chesapeake Watershed Network.

**Case Study: Worcester County, MD Sea Level Rise Response Strategy**

Gwen Shaughnessy, Coastal Planner with Maryland Department of Natural Resources – Chesapeake and Coastal Program, gave an overview of the Worcester County project. She noted the many similarities between their approach and the Sustainable Shorelines project. Essentially, the two projects share a single challenge to make broad data relevant at a local level. In partnership with the USGS and Maryland DNR, Worcester County modeled several scenarios against LiDAR topographic data.

The scenarios used in the Worcester County analysis, include (Table 1.1. of the Worcester County Sea Level Response Strategy):

Scenario	2025	2050	2100
Steady State	x		
Average Accelerated			

<b>Worst Case*</b>	x	x	x
<b>Steady State and Category 3 Storm Surge</b>	x		
<b>Average Accelerated and Category 3 Storm Surge</b>	x	x	x

\*According to the Worcester County Sea Level Response Strategy, the Worst Case scenario was chosen as a precautionary inundation zone for pre-planning in Worcester County. The strategy states, “If possible without unacceptable opportunity costs, limiting development within this worst case inundation zone is a wise decision for the overall good of the community and environment.”

Ms. Shaughnessy believed that the most effective analysis for Worcester County was the breakdown of financial losses associated with the different inundation and flooding scenarios.

The county developed potential response options for four major categories including:

- Existing development,
- Future development,
- Infrastructure and public facilities, and
- Natural systems.

Response options include:

- Protect in place – structural vs. non-structural options
- Accommodate – rolling easements, elevating or floodproofing homes, etc.
- Retreat – property acquisition, relocation programs, etc

The county’s Sea Level Response Strategy is not a public document yet, but is available to the Sustainable Shorelines workgroup for discussion purposes. Ms. Shaughnessy also said that Maryland is working first on incentives for local governments to prepare for sea level rise, but is moving towards state-wide legislation requiring strategy development. The Worcester County Sea Level Response Strategy is available on the Maryland DNR website, along with strategies developed for Somerset and Dorchester Counties, Maryland.

- Worcester County Sea Level Rise Inundation Model:  
[http://www.dnr.state.md.us/bay/czm/wc\\_slr\\_model\\_final\\_report\\_nov2006.pdf](http://www.dnr.state.md.us/bay/czm/wc_slr_model_final_report_nov2006.pdf)
- FTP site with Dorchester & Somerset County Sea Level Rise Guidance:  
<http://www.dnr.state.md.us/bay/csc/login.asp>  
(login: Maryland; password: CoastSmart)

### Next Steps

Laura wrapped up the meeting with a reminder that the project will be progressing between meetings on the Chesapeake Watershed Network. The presentations, meeting summary and draft maps will be placed on the Network, as well. NVRC will work to acquire the shapefiles for the SLOSH (Sea, Lake, and Overland Surge from Hurricanes) model outputs across the region for a more accurate representation of potential storm surge. As the vulnerability assessment continues to be refined, the project will advance toward collecting established policies and recommendations that may be useful to the workgroup members as we begin looking at recommendations for the Northern Virginia region. Orient Au-Vang will present the results of his research at the next workgroup meeting in July.

The next meeting will be held on July 28, 2009. The meeting location has yet to be determined.



# Northern Virginia Sustainable Shoreline and Community Management Project

## Workgroup Meeting Summary

NVRC Chesapeake Conference Room

July 28, 2009

10 a.m. – 12:30 p.m.

### Agenda:

#### **I. Welcome and Introductions**

#### **II. Vulnerability Assessment Discussion**

*Laura Grape, Senior Environmental Planner  
Northern Virginia Regional Commission*

Review of efforts to date, seek consensus on inundation scenarios and direction of impacts analysis.

#### **III. Draft Policy Review and Consistency Report**

*Orient Au-Vang, Intern  
Northern Virginia Regional Commission*

Discussion of draft policy review and consistency report findings, including summary of sea level rise response strategies and recommendations from across the United States and abroad, and a comparison of local policies in Northern Virginia.

#### **IV. Communication and Outreach Strategy**

*Chesapeake/Virginia Network for the Education of Municipal Officials (NEMO)*

Coordination of a strategy for communicating results from the first phase to elected officials and the public during Fall 2009.

#### **V. Next Steps**

Next meeting, September 29, 2009 – James House at Mason Neck State Park



**In attendance:**

<b>Name</b>	<b>Organization</b>
Jeff Harn	Arlington County – DES
Craig Perl	Alexandria T&E/S
Mary Ann Welton	Fairfax County - DPZ
Camylyn Lewis	Fairfax County
Claudia Hamblin-Katnik	City of Alexandria T&ES
Patty Dietz	Prince William County
Greg Weiler	U.S. FWS – Mason Neck Wildlife Refuge
Lauryn Sacha	DCR – State Parks
Shep Moon	Virginia CZM
Beth Polak	Virginia CZM
John Muse	VDOT
Tara Ajello	CH2M Hill
Laurens van der Tak	CH2M Hill
Phil Pasteris	CH2M Hill
Randy McBride	George Mason University
Laura Grape	Northern Virginia Regional Commission
Marshall Popkin	Northern Virginia Regional Commission
Sam Ference	Northern Virginia Regional Commission
Orient Au-Vang	Northern Virginia Regional Commission
Amy Handen	Chesapeake NEMO

**Summary**

The workgroup convened to discuss the following topics: a review of the sea level rise scenarios, a case study managed by CH2M Hill on behalf of the City of Alexandria that focuses on whether the City’s storm sewer infrastructure will be able to handle the impacts of projected climate change, an overview by NVRC intern, Orient Au-Vang, of existing policies throughout the U.S. and the region designed to account for sea level rise and storm surge, and a brief discussion of project outreach strategies.

**Overview of Vulnerability Assessment and Sea Level Rise Scenarios**

Laura Grape, Senior Environmental Planner with the Northern Virginia Regional Commission, welcomed the workgroup and outlined the meeting agenda. She reviewed the progress since the May meeting, including the acquisition of LiDAR for the entire region. Meeting participants introduced themselves.

Ms. Grape discussed what has been accomplished vis-à-vis the vulnerability assessment. NVRC has collected data on the most vulnerable areas in the region and performed the assessment to 10 meter contour intervals. LiDAR data was utilized to gain a better understanding of the specific number of affected parcels and impacted wetlands. Lastly, NVRC studied the affected zone types by jurisdiction.

Ms. Grape presented the three scenario definitions that were applied to model different variations of sea level rise.

The three scenarios are defined as:

Scenario	Definition	Sea Level Rise Rate	SLR with 10 feet of Storm Surge
<b>Steady State 2100</b>	Observed historic trend at Washington, D.C. gage. <i>(NOAA Tides and Currents, Station 8594900)</i>	3.2 mm/year (1 foot by 2100)	11 feet
<b>Average Accelerated 2100</b>	Average projected sea level rise rate for the Chesapeake Bay region. (2.3-5.2 ft by 2100) <i>(IPCC, 2007; STAC, 2008; and GCCC, 2008)</i>	11.6 mm/year (3.8 feet by 2100)	13.8 feet
<b>Worst Case 2100</b>	Highest projected rate for the mid-Atlantic and Chesapeake Bay regions. <i>(STAC, 2008; and GCCC, 2008)</i>	16 mm/year (5.2 feet by 2100)	15.2 feet

Ms. Grape noted that sea level rise projections to 2100 vary due to uncertainty surrounding the degree to which the polar ice sheets may melt. If the ice sheets melt entirely, eustatic sea levels may rise by up to 13 meters. NVRC completed additional projections based on ‘worst case scenarios,’ including a study of the five largest storm events that affected the region during the 20<sup>th</sup> century. Each of the storms was adjusted for 2003 sea levels and for the average accelerated rate for 2100.

Ms. Grape invited workgroup members to provide additional input on the various scenarios. The conversation primarily centered on looking at scenarios with shorter time horizons.

- Camylyn Lewis (Fairfax County) suggested that timeframes in the 10-25 year range might be more relevant to the general public. Randy McBride (George Mason University) noted that a 30-year timeframe might be useful to the general public, given that that is the length of most standard mortgages, while Shep Moon (VACZM) pointed out that shorter time horizons likely would prompt greater responses from elected officials. Claudia Hamblin-Katnik suggested the inclusion of scenarios on 10-, 30-, 50-, and 100-year time horizons.
  - Craig Perl (City of Alexandria) expressed concerns regarding the validity of the methods used to determine the ‘Average Accelerated Rate.’
    - Dr. Hamblin-Katnik suggested that other studies be consulted for determining an estimated accelerated rate of sea level rise.

Ms. Grape asked the workgroup to consider the scenario timeframe that would be most useful in planning efforts.

- Patty Dietz (Prince William County) stated that local plans are updated roughly once every ten years. Laurens van der Tak (CH2M Hill) noted that the 75- to 100-year lifespan of most structures dictates the importance of keeping a long-term view as well.

In short, the workgroup expressed confidence in the steady state and worst case scenarios, but concerns over the defensibility of the average accelerated rate. The group encouraged the development of shorter term time horizons, which are more useful to the general public and functional with typical planning horizons.

- Lauryn Sacha (VADCR) stated that inclusion of both best case and worst case scenarios is helpful. Dr. McBride emphasized the importance, however, of not focusing planning efforts on the extremes.

### **CH2M Hill Presentation on Updating Storm Sewer Infrastructure in the City of Alexandria**

Phil Pasteris (CH2M Hill) discussed his company's efforts to review the impacts of climate change on the storm sewer infrastructure for the City of Alexandria. CH2M Hill has studied the historical design criteria, and data from the last 30 years, in order to produce revised precipitation projections.

- New Intensity-Duration-Frequency (IDF) Curves have been generated that incorporate data from 1948-2008; the IDF curves model future precipitation changes based on emissions and global ocean circulation models. Precipitation is projected at 1-11% greater for the 5-60 minute window, and 17-29% greater for the 2-24 hour window. Mr. Pasteris also noted that return periods are projected to decrease as well; i.e., a storm that used to occur once every ten years may now return once every eight years.
- Based on the revised precipitation models, sea level in Washington, DC, may rise by 1.8 to 2.4 feet by 2100.

### **Sea Level Rise and Storm Surge Policies**

Orient Au-Vang (NVRC Intern) presented his research on existing policies related to sea level rise and storm surge. Mr. Au-Vang's presentation first summarized existing policies in other parts of the United States, including: King County, WA, New York City, North Carolina, Delaware, Somerset County, MD, and the San Francisco Bay Area. Mr. Au-Vang distributed a handout with a table displaying the planning efforts and strategies for land use, critical infrastructure, ecosystems, physical structures, and health and welfare that are employed by each jurisdiction listed above. The second half of the presentation provided an inventory of relevant existing policies throughout Northern Virginia and potential opportunities for supplementing them.

- Ms. Grape noted that the content of Mr. Au-Vang's presentation will be consolidated into a draft report that will be delivered to the work group in August.
- Dr. McBride suggested that the report include a summary of ongoing efforts in Louisiana, as the current situation in that state represents the potential worst case scenario for Northern Virginia.
- Dr. Hamblin-Katnik pointed out that the City of Alexandria's Eco-City Charter is available online.

### **Community Outreach Strategy Discussion**

Amy Handen (Chesapeake NEMO) led a brief discussion regarding outreach strategies for potential work products.

- Ms. Handen suggested that messages may include: definitions, clear descriptions of the scenarios, and data sources. Other work group members added the following: information on the zones at greatest risk of inundation, jurisdiction-specific maps (including shp files), and effective techniques utilized by other jurisdictions.
- Messages may be delivered via presentation, a briefing packet, or executive summary.
  - The workgroup suggested that the first presentation be to the NVRC commissioners, followed by the local planning commissions and local managers.

- Ms. Sacha noted that any changes to park plans first would need to be vetted through a public meeting.
- Outreach products will be developed with the idea that they will be completed by January 2010.

**Next Meeting**

The workgroup will meet next on September 29 at 10 a.m., at the James House at Mason Neck State Park.



# Northern Virginia Sustainable Shoreline and Community Management Project

## Workgroup Meeting Summary

James House at Mason Neck State park

September 29, 2009

10 a.m. – noon

### **I. Welcome and Introductions**

### **II. Brief Review of Phase I**

*Northern Virginia Regional Commission (NVRC)*

### **III. Draft Policy Inventory and Local Consistency Report Dialogue**

*Chesapeake/Virginia Network for the Education of Municipal Officials (NEMO)*

### **IV. Vulnerability Assessment**

*NVRC*

### **V. Next Steps – Phase II**



This project was funded by the Virginia Coastal Zone Management Program at the Department of Environmental Quality through Grant #NA08NOS4190466 of the U.S. Department of Commerce, National Oceanic and Atmospheric Administration, under the Coastal Zone Management Act of 1972, as amended.

**In attendance:**

<b>Name</b>	<b>Organization</b>
Jeff Harn	Arlington County – DES
Todd Janeski	Virginia NEMO
Mary Ann Welton	Fairfax County - DPZ
Camylyn Lewis	Fairfax County
Greg Weiler	U.S. FWS – Mason Neck Wildlife Refuge
Lauryn Sacha	DCR – State Parks
Greg Weiler	U.S. FWS – Mason Neck Wildlife Refuge
John Muse	VDOT
Laura Grape	Northern Virginia Regional Commission
Amy Handen	Chesapeake NEMO
Sam Ference	Northern Virginia Regional Commission

**Summary**

The workgroup convened to address several topics including the Draft Policy Inventory and Local Consistency Report, the progress of the vulnerability assessments, and the transition into Phase II of the project.

**Overview of Vulnerability Assessment and Sea Level Rise Scenarios**

Laura Grape, Senior Environmental Planner with the Northern Virginia Regional Commission welcomed the workgroup and outlined the meeting agenda. Meeting participants introduced themselves. Ms. Grape summarized the purpose and scope of the project and reviewed the progress since the July meeting.

Samantha Ference, Regional Planner with the Northern Virginia Regional Commission presented an overview of the Draft Policy Inventory and Local Consistency Report. She explained the format, and a few of the most important components of the document.

Ms. Grape opened up a discussion on the report. Todd Janeski and Amy Handen of NEMO prompted the group to evaluate the report for effectiveness, formatting, and content. The prompt initiated a few general comments. Noel Kaplan of Fairfax County noted the document would benefit from a more neutral tone. He also suggested including the State legislation on jurisdictional authority to implement policies to address sea level rise. The group identified a few additional guidance points for the report, including a summary of the State’s efforts, an educational component that addresses the implications of protect, accommodate, retreat strategies, as well as the positive and negative implications of the different scenarios. Also, it was recommended that each jurisdiction critically review and edit their sections for accuracy. The group discussed the intended audience of the report, and how best to engage them. The group liked the executive summary and discussed the possibility of rearranging the content to be more topic based. The EPA Climate Ready Estuaries document was referenced as a well-organized example.

Ms. Grape prompted the workgroup about the potential upcoming survey to assess waterfront property owners’ opinions regarding the inundation risks. The group resonated that the most important component that could result from the survey would be an educational component.

Ms. Grape updated the workgroup of the progress made in the vulnerability assessment. She first reviewed data gaps that are necessary to fill. NVRC has begun and secondary round of analysis with the

complete LiDAR data. Four different scenarios were used to evaluate the impacts, including a one foot, three foot, five foot, and 10 foot rise in sea level to help visualize a range of possibilities. The 1 foot rise is an estimate of projected sea level rise based on the observed rate since 1924 at the Washington, D.C. NOAA Tides & Currents. The 3 foot rise is a representation of an average accelerated rate and the 5 foot rise corresponds to a worst case scenario for sea level rise as determined by the Scientific and Technical Advisory Committee on the Chesapeake Bay. A 10 foot scenario was modeled to show the possible inundation zones due to storm surge. This scenario is based on historic flooding that occurred in the Northern Virginia region over the past century.

The analysis improved understanding of the specific number of affected parcels and impacted wetlands. For example, this analysis shows that with consistent sea level rise of the 1 foot scenario, 1,869 parcels will be affected, and 1,959 acres of tidal freshwater marsh will be inundated. Ms. Grape then showed the group the images of the preliminary vulnerability assessments, including a few enlarged “hot spot” areas. The group confirmed the powerful effect of the visualizations and reaffirmed the need to continue to identify and assess “hot spots” as well as to break out the economic impacts on market and non-market costs based on the scenarios. The group decided to continue to inform the process of choosing the “hot spots”.

In addition to the PDF format already available on the Network, Ms. Grape will post the Draft Policy Inventory and Local Consistency Report to the workgroup in MS Word format for review and easier edited for accuracy. Final responses by workgroup members are due by October 23<sup>rd</sup>.

An overview of the next 12 months was provided to the workgroup members. Over the next year, the group will refine the modeling and mapping effort, continue understanding of existing policy strengths and limitations as the group moves forward with developing and integrating adaptation strategies, as well as initiate an outreach and education strategy. An economic analysis will take place, as well.

### **Next Meeting**

The next workgroup will take place in early-December 2009.

## Product 2

# Report on Northern Virginia Shoreline Inventory and Data Gaps

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### Overview

Although the topography along Northern Virginia's shoreline is more bluff like, the low-lying areas that do exist have been repeatedly inundated by flooding and storm surge. These areas were highlighted by the workgroup members during their February meeting and correspond to concentrated areas of population or services. They include:

- Arlington County
  - National Airport
  - Arlington County Pollution Control Plant
- City of Alexandria
  - Old Town Alexandria & Waterfront
  - Indigo Landing
- Fairfax County
  - Dyke Marsh
  - Belle Haven and New Alexandria
  - Little Hunting Creek
  - Hallowing Point
  - Mason Neck State Park & Wildlife Refuge
- Prince William County
  - Occoquan Bay Wildlife Refuge
  - Leesylvania State Park
  - Developments along Neabsco and Powells Creeks
  - Quantico

The September 1992 Tidal Shoreline Erosion in Northern Virginia Report states two areas along the Potomac River where extreme rates of erosion (>15 feet/year) occur. These include the airfield at Quantico and Dyke Marsh, to the south of Little Hunting Creek. Most of the other locations identified by the workgroup members are in areas that experience moderate erosion (<3 feet/year) and did not have hardened shorelines in 1992. However, between the period of time when the shoreline situation reports were conducted by the Virginia Institute of Marine Sciences in the late-70's and the Tidal Shoreline Erosion study was conducted, approximately 12.6 miles of Northern Virginia's shorelines were converted from natural to armored states. In 1992, approximately 20% of Northern Virginia's shorelines were hardened.

## GIS Data Audit and Gaps

NVRC conducted a GIS data audit to determine available data and where gaps in data may exist to support the formation of base project file for which to conduct the risk and vulnerability assessment. At the February workgroup meeting, the members identified the following as high priority data to support the assessment:

### Land Use

- Land use basics - Underutilized plan for future growth
- Special intensive planning areas (ex. Crystal City / Potomac Yards)

### Elevations

- Mean High/Mean Low Tidal Elevations
- LiDAR
- GIS 2'-5' Contours (Prince William, Arlington, Fairfax)

### Infrastructure

- Map of critical infrastructure and elevations
- Map of critical community facilities (schools, etc.)
- Combine Sewer Systems

### Natural Resources

- Rare Threatened Endangered Species
- State/Heritage data

Since February, NVRC, with assistance from Chesapeake/Virginia NEMO acquired LiDAR data collected at MSL from the Department of Defense for the entire study area filling the largest gap and limitation in conducting the vulnerability assessment. However, the data did not contain metadata or reference to a vertical datum. Due to the high resolution nature of the LiDAR data, it does not match up exactly with locally produced layers, which could produce inconsistencies in representing impacts. Additional gaps or inconsistencies in data across the region include the location of:

- Wells
- Septic Systems
- Storm Drainage Network
- Underground Utilities
- Shoreline Erosion\*
- Boat ramps
- Marinas

\*Priority data gap

Acquiring underground utility information poses as challenge as much of it is unavailable for security reasons.

Shoreline erosion was identified by the workgroup members as a priority data gap as information is not available as GIS data layers. However, the Virginia Institute of Marine Sciences (VIMS) and the Northern Virginia Regional Commission conducted two studies in the late-70's and in 1992, respectively to identify areas of erosion. The VIMS Shoreline Situation Reports are available online at: [http://ccrm.vims.edu/gis\\_data\\_maps/shoreline\\_inventories/index.html](http://ccrm.vims.edu/gis_data_maps/shoreline_inventories/index.html), while the Tidal Shoreline Erosion in Northern Virginia report is available only in hardcopy.

### Scenario Development - ongoing

Relative sea level rise rates along the mid-Atlantic coast of the United States vary between 1.75 mm and 4.42 mm per year (Zervas, 2001). The National Oceanic and Atmospheric Administration (NOAA) maintains twelve Tide and Current gauges in the Chesapeake Bay that capture this data (Figure 1).



Figure 1. A comparison of relative sea-level rise rates across the Chesapeake Bay reveal an increase as one moves closer to the mouth of the Chesapeake Bay. The rates may increase due the Chesapeake Bay impact crater, the inner basin of which is presumed to be in the southern tip of Virginia's Eastern Shore (USGS 1997). The base map includes the locations of the NOAA Tides and Current gauges along the Chesapeake Bay (Google Earth, 2009, NOAA).

Station 8594900, in operation in Washington, D.C., since 1924, is the closest gauge to Northern Virginia. The scenarios selected for this study represent the historic trends for the Washington, D.C. gauge, the average rate of relative sea level rise projected for the Chesapeake Bay region, and the highest rate projected for the region, based on global sea level rise (Table 1).

Table 1. Sea level rise scenarios used for the Sustainable Shorelines and Community Management Project.

Scenario	Definition	Rate
Steady State 2100	The observed historic trend rate at Washington, D.C. gage (3.16 mm/year) <i>(NOAA Tides and Currents, Station 8594900)</i>	3.2 mm/year (1 foot by 2100)
Average Accelerated 2100	The average sea level rise rate projected for the Chesapeake Bay region. (2.3-5.2 ft by 2100) <i>(IPCC, 2007; STAC, 2008; and GCCC, 2008)</i>	11.6 mm/year (3.8 feet by 2100)
Worst Case 2100	The highest rate projected for the mid-Atlantic and Chesapeake Bay regions. <i>(STAC, 2008)</i>	16 mm/year (5.2 feet by 2100)

The scenarios are based on data from existing gauges and comprehensive reports for the mid-Atlantic region. The Steady State 2100 scenario represents the historic rate of relative sea level rise observed at the NOAA Tide and Current gauge located in Washington, D.C. (Station 8594900) between 1924 and 2006; during that time period, mean sea level rose 3.16 millimeters/year with a 95 percent confidence interval of +/- 0.35 mm/yr. This is equivalent to approximately 1 foot over 100 years (Figure 2, NOAA, 2009).

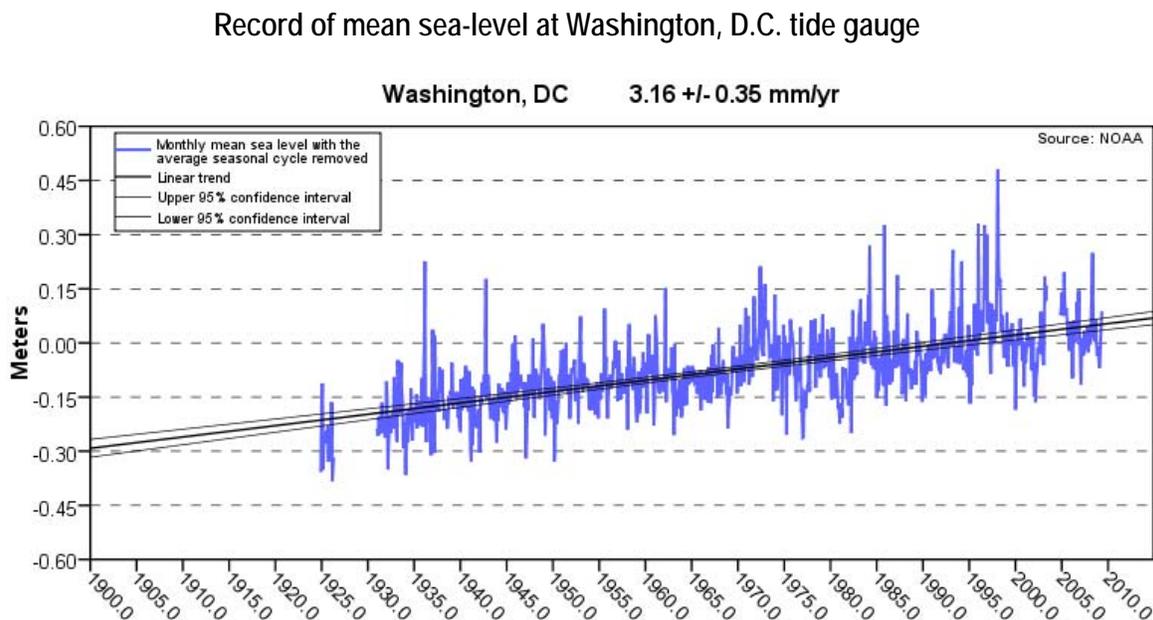


Figure 2. Monthly mean sea level at Washington, DC tide gauge from 1924 to 2006. The blue line represents observed data (NOAA 2009).

The Average Accelerated and Worst Case scenarios represent the enhanced rates of sea-level rise in the Chesapeake Bay. The Virginia Governor’s Commission on Climate Change’s Adaptation and Sequestration Workgroup recommends that, at a minimum, Virginia should plan for a 3.6°F increase in air and water temperatures, and at least a 2.3 foot rise in sea level by 2100 (7mm/yr). The full range of sea level rise expected across the Bay region is estimated to be between 2.3 – 5.2 feet (7-16mm/yr), with great local variability as a result of subsidence (GCCC, 2008). This range is based on the Chesapeake Bay Program’s Scientific and Technical Advisory Committee’s (STAC) September 2008 report, which based projections on a study conducted by Stefan Rahmstorf of the Potsdam Institute for Climate Impact Research, Germany in 2007. In this study, Rahmstorf uses a model which relates global sea level rise to global mean surface temperature. When applied to the IPCC future warming scenarios (Nakicenovic and Swart, 2000), Rahmstorf’s model projects a global sea level rise of 700 to 1,400 mm by 2100. When added to the Chesapeake Bay local component that includes subsidence, the region may see relative sea-level increases of 700 to 1,600 mm by 2100 (Pyke, 2008).

## Product 3

# Report on Local and Regional Policy Consistency

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Northern Virginia localities have various planning tools in place that address environmental concerns, particularly Chesapeake Bay preservation. Though these tools contain policies, goals or actions that indirectly relate to the influences of climate change they do not clearly seek to adapt to relative sea level rise or storm surge. In addition to meeting state requirements, some jurisdictions have developed more extensive environmental strategies. The existing mandated and non-mandated strategies could serve as a framework for adapting sea level rise specific policies to support local government's role in protecting the health, safety, and welfare of their citizens.

The Governor's Commission on Climate Change Report (December 2008) contains two recommendations to support local government efforts. They include:

*14T. State and local agencies should establish policies such as rolling easements, tax incentives, or mandatory setbacks to discourage new development in vulnerable coastal areas. Person purchasing or developing in vulnerable coastal areas or floodplains should have ready access to accurate data on the current and future vulnerability of their property.*

*14U. The General Assembly should require local governments whose jurisdictions encompass Virginia's shorelines to develop integrated shoreline management plans in coordination with VMRC. Such planning efforts would integrate adaptation and response strategies for coastal erosion, sea level rise adaptation, and coastal storm surge into existing state and local policies.*

Each Northern Virginia jurisdiction has a consistent planning framework and develops goals and objectives tailored to specific communities and interests. The intent of this inventory is to provide a solid understanding of the structure, which localities may consider integrating adaptation measures for their vulnerable areas and support their movement toward an integrated shoreline management plan as recommended by the Governor's Commission on Climate Change.

Virginia Code §15.2-2223 requires that all local governing bodies adopt a Comprehensive Plan for physical development within its jurisdiction. The code further requires jurisdictions to update their plans on a five-year cycle in order to be responsive to current conditions and/or changes in community goals.

Each Plan integrates consistent policies or planning tools that include state mandated ordinances for Chesapeake Bay Preservation, erosion and sediment control, stormwater management, floodplain management, water quality management, and open space and recreation. Although these plans have some distinction in their language, requirements, the ultimate goals are for the most part consistent. A general description of the comprehensive plan element goals is presented in Table 1. Table 2 provides the specific document references for each jurisdiction as they relate to environmental impacts.

Table 1: General description of plan or policy element.

Management Goal	General Description
Chesapeake Bay Preservation	Protect and enhance the water quality of the Chesapeake Bay, while accommodating for economic development.
Water Quality	Control or limit land uses and development intensities in waterways' buffer areas
Erosion & Sedimentation Control	Reduce the harmful effects of on-site soil erosion and siltation as a result of land disturbance activities that would impact adjacent properties or ecological features.
Floodplain	Prevent the loss of life and property, protect sensitive environmental features, and prevent land activities and developments from interfering with drainage way capacity and flow. These ordinances regulate uses and activities within designated floodplain limits.
Open Space & Recreation	Provide opportunities for recreation, protect cultural resources, protect environmentally sensitive features, and improve the livability of communities.

### The Chesapeake Bay Preservation Act

The Chesapeake Bay Preservation Act is established to protect and enhance the water quality of the Chesapeake Bay, while accommodating for economic development. The state requires Tidewater Virginia jurisdictions to incorporate the act into their local plans.<sup>2</sup> State-designated tidewater jurisdictions are required to establish Resource Protection Areas (RPA) and Resource Management Areas (RMA). Among the requirements of the RPA is that there be at least a 100-foot buffer landward of tidal shores, tidal wetlands, non-tidal wetlands connected by surface flow to tidal wetlands, and “water bodies with perennial flow that have an intrinsic water quality value...”<sup>3</sup> RMA lands are those not included in the RPA. RMA includes lands that “if improperly used or developed, have a potential for causing significant water quality degradation or for diminishing the functional value of the Resource Protection Area.” Floodplains; highly erodible soils, including steep slopes; highly permeable soils; and non-tidal wetlands not included in the RPA are included in the Resource Management Areas and “shall encompass a land area large enough to provide significant water quality protection...”<sup>4</sup> Local governments are to ensure that development or redevelopment within the RPA and RMA meets the act’s criteria. Some of those criteria include preserving existing vegetation to the extent practicable, not disturbing more land than necessary for the proposed use, minimizing impervious cover, and requiring a review process for activities that disturb more than 2,500 square feet of land.<sup>5</sup>

Those are the minimum requirements; however, there are some variations in each jurisdiction’s ordinance language and requirements. Fairfax County has established its Chesapeake Bay Preservation Ordinance as a separate chapter in the County Code (Chapter 118) and reference the Bay Ordinance in the County’s Zoning Ordinance. The other Northern Virginia jurisdictions with Bay programs have established Chesapeake Bay Areas Overlay Districts with in their zoning ordinances.

<sup>2</sup> Moore, D. Principal Environmental Planner, Chesapeake Bay Local Assistance. E-mail 4 Aug. 2009.

<sup>3</sup> State of Virginia (2008, Sept.). Chesapeake Bay Act: Chapter 20 Chesapeake Bay Preservation Area Designation and Management Regulations: Revision September 4, 2008. (9VAC10-20-80).

<sup>4</sup> State of Virginia (2008, Sept.). (9VAC10-20-90).

<sup>5</sup> State of Virginia (2008, Sept.). (9VAC10-20-120).

Table 2: Reference information for plan or policy elements by jurisdiction.

Management Goal	Jurisdiction						
	Alexandria	Arlington	Dumfries	Fairfax Co	Occoquan	Prince William	Quantico
Chesapeake Bay Preservation	Zoning Ordinance Art. XIII Environmental Management	Ordinance Chap. 77 Chesapeake Bay Preservation, Chesapeake Bay Preservation Plan	Ordinance Div. 12 Chesapeake Bay Preservation Area-OD	Zoning Ordinance Chap. 118 Chesapeake Bay Preservation, Chesapeake Bay Supplement	Town Code Chap. 66 Art. II Div. 7 Chesapeake Bay Preservation-OD	Code of Ordinance Art. V Part 504 Chesapeake Bay Preservation Area-OD	Comprehensive Plan Vol. A Sect. J Chesapeake Bay Preservation Areas, Vol. B Part III Sect. D Chesapeake Bay Protection Ordinance
Water Quality	<i>Water Quality Management Supplement</i>	<i>Chesapeake Bay Preservation Ordinance Guidance Manual</i> Sect. 6 Water Quality Impact Assessment	Ordinance Div. 12 Chesapeake Bay Preservation Area-OD Sect. 70-452 Water Quality Impact Assessment	<i>Chesapeake Bay Supplement</i> , Zoning Ordinance Art. 7-800 et seq. Water Supply Protection-OD (this will be discussed in further detail under the "Differences Between Local Policies" section of this report)	Town Code Chap. 66 Art. II Div. 7 Chesapeake Bay Preservation-OD and Art. II Div. 7 Sect. 66-201	<i>Design and Construction Standards Manual</i> Sect. 742.04 et seq. Water Quality Impact Assessment Elements	<i>Town of Quantico Comprehensive Plan</i> Vol. A Natural Resources and Water Quality Supplement, Vol. B Part 2 Sect. D Water Quality Protection and Improvement Plan
Erosion & Sedimentation Control	Zoning Ordinance Art. XIII Environmental Management	Chesapeake Bay Preservation Ordinance Guidance Manual Section 3.4 Erosion and Sediment Control Plan, Ordinance Chapter 57 Erosion and Sediment Control	Ordinance Div. 12 Chesapeake Bay Preservation Area-OD	Chesapeake Bay Supplement, Public Facilities Manual, Zoning Ordinance Art. 2-603 Erosion and Sedimentation Control Regulations, Fairfax County Comprehensive Plan: Environment Appendix I	Town Code Chap. 18 Art. II Erosion and Sediment Control	Code of Ordinance Chap. 8 Environment, Design and Construction Standards Manual Sect. 750 et seq. Erosion and Sediment Control	Comprehensive Plan Vol. A Sect. G Shoreline Erosion, Vol. B Part III Sect. E Erosion and Sediment Control Ordinance
Floodplain	Zoning Ordinance Art. VI Sect. 6-300 Floodplain District	<i>Watershed Management Plan</i>	Ordinance Div. 12 Chesapeake Bay Preservation Area-OD, Ordinance Art. III Div. 9 Floodplain Districts FP-1	Zoning Ordinance Art. 2-900 et seq. Floodplain Regulations; Zoning Ordinance Art. 2-602 Drainage, Floodplains, Wetlands and Resource Protection Areas, <i>Chesapeake Bay Supplement, Public Facilities Manual</i>	Town Code Chap. 26 Art. II Floodplain Management, <i>Design and Construction Standards Manual</i> Sect. 730 et seq. Floodplain Management <sup>6</sup>	Code of Ordinance Art. V Part 501 Flood Hazard-OD, <i>Design and Construction Standards Manual</i> Sect. 730 et seq. Floodplain Management	Zoning Ordinance Art. X Floodplain-OD, <sup>7</sup> <i>Town of Quantico Comprehensive Plan</i> Vol. A Sect. E Flood Hazard Areas
Open Space & Recreation	Zoning Ordinance Art. VI Sect. 6-100 et seq. Public Open Space and Community Recreation Zone (POS), Art. VI Sect. 6-200 et seq. Waterfront Park and Recreation Zone (WPR), <i>Alexandria Open Space Plan</i> , <sup>8</sup> <i>City of Alexandria Recreation, Parks and Cultural Activities</i> <sup>9</sup>	<i>Comprehensive Plan: Public Spaces Master Plan</i>	Has addressed the open space and recreation element in various zoning districts under Ordinance Art. III Division Districts.	<i>Fairfax County Comprehensive Plan: Parks and Recreation Plan</i>	Town Code Chap. 66 Art. II Div. 4 Sect. 66-114 Area Regulations and Div. 4A Sect. 66-122 Area Regulations	<i>Comprehensive Plan: Parks, Open Space and Trails</i>	Zoning Ordinance Art. V Park and Recreation Zone, <sup>10</sup> <i>Town of Quantico Comprehensive Plan</i> Vol. B Part II Sect. E Potomac Riverfront Park Plan

<sup>6</sup> Prince William County Planning Office (2006, June). *Prince William County Design and Construction Standards Manual*.

<sup>7</sup> Northern Virginia Planning District Commission (1993).

<sup>8</sup> Rhodeside & Harwell, Inc. (2002). *Master Plan: Alexandria Open Space Plan*.

<sup>9</sup> Leon Younger and PROS (2003). *Strategic Master Plan: The City of Alexandria Recreation, Parks and Cultural Activities*.

<sup>10</sup> Northern Virginia Planning District Commission (1993).

### **Erosion and Sedimentation Control**

Local jurisdictions have erosion and sediment control ordinances, as required by the Chesapeake Bay Preservation Act and Virginia Erosion and Sediment Control Law. The intent behind the sediment and erosion control ordinances is to reduce the harmful effects of on-site soil erosion and siltation as a result of land disturbance activities that would impact adjacent properties or ecological features.

Sediment and erosion control ordinances relate to sea level rise and storm surge planning in several ways. When sediments build up in municipal storm sewer systems, it could decrease the sewer systems' capacity during more severe storm events. And when activities disturb land, they also compromise the land and its vegetation's abilities to absorb flood water during storms, thereby exacerbating the flooding problems. Land disturbing activities and the destruction of their associated vegetation also destabilize the soil, which worsen the sediment and erosion control problem.

### **Floodplain Management**

Floodplain management ordinances are intended to prevent the loss of property, to protect sensitive environmental features, and to prevent land activities and developments from interfering with drainage way capacity and flow. Each Northern Virginia locality has flood maps developed by the Federal Emergency Management Administration (FEMA) depicting the extent of the current 100-year floodplain. These maps are in each localities comprehensive plan.

### **Water Quality**

The purpose of the Chesapeake Bay Preservation Act is protecting the bay's water quality and the designated water systems that drain to the bay. The act's requirements are applicable to all designated tidewater jurisdictions.

Since water quality ordinances control or limit land uses and development intensities in waterways' buffer areas, those ordinances may relate to sea level rise and storm surge planning, as well. Buffer areas for tidal waters are more vulnerable to sea level rise and tidal surges; as such, controlling or limiting land uses and development intensities around those areas could serve multiple purposes. Furthermore, as water levels rise, the buffers that protect water quality will have to move further upland to accommodate the new water levels.

### **Open Space and Recreation**

Each jurisdiction also has an open space and recreation plan. The City of Alexandria and Arlington, Fairfax, and Prince William counties have the open space and recreation element as part of their comprehensive plans and open space requirements for developments in various districts. The towns of Dumfries, Occoquan, and Quantico have incorporated open space and recreation into zoning ordinances.

## Planning Initiatives by Northern Virginia Jurisdiction

This section highlights some of the additional strategies, plans and policies that local jurisdictions are employing. As such, amending policies to address sea level rise and storm surge may be consistent with the adopted policy goals and recommendations.

### Arlington County

In February 2003 the county amended its Chesapeake Bay Preservation Ordinance to include natural streams and open man-made channels that are more than 100 feet long and connected to the RPA.<sup>11</sup> Additionally, the county no longer allows exemptions from county review for a proposed land disturbance of less than 2,500 square feet, within a RPA.<sup>12</sup> Amendments to the RMA include a reduction in the allowable impervious surface from 38 percent to 16 percent (for pollution removal requirement)<sup>13</sup> for proposed developments in the RMA.

Arlington County's *Public Space Master Plan* has several priorities and recommendations that relate to planning for the sea level rise and storm surge challenge. In Chapter 5, Priority 2 – Develop a Land Acquisition Policy points to the fact that “There is a clear need for a multifaceted approach to land acquisition that can respond to the impacts of growth and community needs and improve the ability to acquire high priority properties” and to “secure properties viewed as critical for protection or for public space development.”<sup>14</sup> To accomplish Recommendation 2.4–Pursue the Use of Easements to Protect Natural Areas and Heritage Resources, one of the action plans is to “Favor the use of easements for the linking of natural areas and parks, the preservation of wildlife corridors, Resource Protection Areas, and other environmentally sensitive areas such as land associated with the Potomac River and its tributary streams.”<sup>15</sup> Green infrastructure also includes natural systems. Communities can capitalize on those systems’ abilities to absorb adverse effects such as flooding and tidal surges. In Recommendation 2.7–Develop and Implement a Green Infrastructure Plan, some of the guiding principles are “Embrace green infrastructure as the framework for conservation” and “Finance the protection and management of green infrastructure as a primary public investment.”<sup>16</sup>

Furthermore, the county also has in its comprehensive plan the on-going sustainability policy. Though much of the policy is focused on Smart Growth and its impact on greenhouse gas emission,<sup>17</sup> there are opportunities to incorporate sea level rise and storm surge planning which would be consistent with the county’s sustainability goals.

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<sup>11</sup> Arlington County Department of Environmental Services (2001, Feb.). *Arlington County Comprehensive Plan: Chesapeake Bay Preservation Plan*. Chapter 66 Sect. 61-5.

<sup>12</sup> Arlington County Department of Environmental Services (2001, Feb.). Chapter 66 Sect. 61-19.

<sup>13</sup> Arlington County Department of Environmental Services (2001, Feb.). Chapter 66 Sect. 61-10.

<sup>14</sup> Arlington County Dept. of Parks, Recreation and Cultural Resources (date not shown). p.42.

<sup>15</sup> Arlington County Dept. of Parks, Recreation and Cultural Resources (date not shown). p.48.

<sup>16</sup> Arlington County Dept. of Parks, Recreation and Cultural Resources (date not shown). p.49.

<sup>17</sup> Arlington County Department of Community Planning, Housing and Development (2006, Dec.). *Five-Year Review of Arlington County's Comprehensive Plan*. p.46, 51.

## Fairfax County

The county has a few unique planning tools that could provide a suitable framework for sea level rise planning.

The Environmental Quality Corridor (EQC) is a planning tool that includes additional criteria beyond the Chesapeake Bay Preservation ordinance. The EQC includes 100-year floodplains, adjacent slopes of 15% or more, connected wetlands, and slope based on minimum buffer areas; additional criteria that augment the requirements for stream valley habitats and buffers can also be recommended by the planning staff.

The Residential-Conservation District (R-C) is intended to “protect water courses, stream valleys, marshes, forest cover in watersheds, aquifer recharge areas, rare ecological areas, and areas of natural scenic vistas; to minimize impervious surface and to protect the quality of water in public water supply watersheds;” and to facilitate agricultural and low density residential uses. The allowed maximum density for conventional subdivisions is 1 dwelling unit per 5 acres and for cluster subdivisions is 0.22 dwelling unit per acre (before proffer).<sup>18</sup>

The purpose of the Water Supply Protection Overlay District is to promote the “public health, safety, and welfare through the protection of public water supplies from the danger of water pollution.” The regulation encourages land uses and developments within the district that are compatible with water quality protection. The underlying uses do not change; however, there is a separate review and approval process to ensure that water quality protection requirements are met.<sup>19</sup>

Chap. 116 Wetlands Zoning Ordinance is essentially a living shorelines and no-net-loss of wetlands policy. The ordinance regulates the uses and development of wetlands, which also include a number of creeks, streams, and rivers flowing into the Chesapeake. Certain water dependent, recreational, agricultural, and natural resources conservation are some of the activities and uses that are permitted. In general, uses and activities are permitted if they do not obstruct the flow of tides, alter the natural contours of wetlands, or cover additional wetlands.<sup>20</sup>

Under the *Comprehensive Plan: Chesapeake Bay Supplement*, the “Appendix 1: Guidelines for Tidal Shoreline Erosion Control Measures” is intended to protect properties that are at risk from tidal erosion. There are three criteria for shoreline stabilization methods, and the recommended methods are based on the severity of shoreline erosion rates.

Another related policy is the Coastal Primary Sand Dunes and Beach Protection Ordinance, which is now being written. Though it will be a stand-alone policy, the Dunes and Beach Protection Ordinance will work hand-in-hand with the existing Wetlands Zoning Ordinance. The proposed ordinance is pending the Board of Supervisors actions.<sup>21</sup>

Fairfax County has a number of policy objectives relevant to the sea level rise and storm surge planning. The intent of the *Comprehensive Plan: Environmental* Objective 3 is to “Protect the Potomac Estuary and the Chesapeake Bay from the avoidable impacts of land use activities in Fairfax County.” Tidal areas can

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<sup>18</sup> Fairfax County Department of Planning and Zoning (2009, June). Art. 3 Sect. 3-C01 and Art. 3 Sect. 3-C08.

<sup>19</sup> Fairfax County Department of Planning and Zoning (2009, June). Art. 7 Sect. 7-801.

<sup>20</sup> Fairfax County Department of Planning and Zoning (2009, June). Chap.116 Sec. 116-1-1 to Sec. 116-1-3.

<sup>21</sup> Welton, M.A. Fairfax County Department of Planning and Zoning. Phone interview. 13 August 2009.

have unstable soils in that those areas can be flooded on a regular basis and are subject to accelerated rate of erosion. Objective 6 intends to “Ensure that new development either avoids problem soil areas, or implements appropriate engineering measures to protect existing and new structures from unstable soils.” Objective 7 seeks to “Minimize the exposure of new development to the potential of flood impacts.” Objective 9 is to “Identify, protect and enhance an integrated network of ecologically valuable land and surface waters for present and future residents...” The intent of Objective 11 is to “Promote the use of open space/conservation easements as tools to preserve environmental resources.”<sup>22</sup> Furthermore, the *Comprehensive Plan: Chesapeake Bay Supplement* also echoes some of those planning objectives.

### City of Alexandria

The City of Alexandria has several policies that guide the uses and developments along its waterfront. And the city also has the *Eco-City Charter*, which outlines how the city plans to address climate change, sea level rise and storm surge issues.

The intents of the *Alexandria Waterfront Plan* are to guide the uses and development along the designated waterfront area. Floodplain management issues are also discussed in the plan. The city is updating the plan to respond to current conditions and citizens’ vision.

The intent of the Public Open Space and Community Recreation Zone (POS) is to “preserve and enhance” city-owned open space and recreation areas and the natural and developed amenities in those areas. Permitted uses include passive and active recreation.<sup>23</sup>

The Waterfront Park and Recreation Zone (WPR) is intended to enhance the city’s waterfront by providing for parks, open spaces and recreational opportunities that are linked by a pedestrian promenade. WPR accommodates the traditional waterfront uses such as public buildings, restaurants, and marinas. The last two are allowed by permit. Among other things, each developer is to provide 25% of the project’s land as “open and usable space.”<sup>24</sup>

The *Environmental Action Plan 2030* establishes goals and action plans that would advance Alexandria’s efforts to prepare for future environmental challenges and become more environmentally friendly. The plan also has goals and actions that must be taken to prepare the city for the Potomac River’s water level rise as result of climate change. Those goals and actions will be discussed later in this report.

The City of Alexandria also has a number of priorities and goals that relate to sea level rise and climate change. In its *Goals & Objectives: Adopted 1992 Master Plan*, one of the objectives for community facilities such as stormwater infrastructure is “Construction within the 100 year flood plain should either be prohibited or should be constructed in such a manner so as not to interfere with the flood plain capacity.”<sup>25</sup> And one of the goals for parks and recreation is “To preserve and enhance the public open spaces and recreational areas by protecting the natural and developed amenities they possess and by encouraging development which respects and is consistent with those amenities.”<sup>26</sup>

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<sup>22</sup> Fairfax County Department of Planning and Zoning (2007). *Fairfax County Comprehensive Plan: Environment*. p.10-16.

<sup>23</sup> City of Alexandria Department Planning and Zoning (2009, March). *Code: City of Alexandria, Virginia*. Art. VI Sect. 6-100.

<sup>24</sup> City of Alexandria Department Planning and Zoning (2009, March). Art. VI Sect. 6-200 et seq.

<sup>25</sup> City of Alexandria (1992). *Goals & Objectives: Adopted 1992 Master Plan: Alexandria, Virginia*. p.13.

<sup>26</sup> City of Alexandria (1992). p.19.

In 2002 the *Alexandria Open Space Plan* reflects the 1992 goals. Several of the recommendations to achieve Goal 3 Review and Complete Implementation of the Potomac Riverfront Plan are “High priority should be given to protecting and creating continuous public access to and along the Potomac River” and “Strive to restore the 100-foot RPA buffer along the shoreline as opportunities to do so arise.” There are several recommendations and strategies to advance Goal 4 Protect, Expand, and Connect Stream Valleys, and Other Environmentally Sensitive Areas.

- “Strive to achieve more than the 100-foot wide buffers for the purpose of protecting natural resource areas.”
- “Curtail or eliminate the granting of encroachments in stream valley RPA’s and adjacent areas. Enhance identified RPA’s with natural area buffers.”
- “Require the restoration of RPA’s when sites are redeveloped.”<sup>27</sup>

The city’s 2003 *Strategic Master Plan: The City of Alexandria Recreation, Parks & Cultural Activities* reiterates some of those same goals and strategies that have been underscored in the other plans.

The *Environmental Action Plan 2030* establishes several goals and action plans to advance the city in planning for Potomac River water level rise and climate change. The mid-term actions (2012-2020) to prepare for Global Climate Change and Other Emerging Threats are to

- “Gather and publish environmental performance metrics to identify trends in water quality, average sea level, air quality metrics, energy use, and temperature.”
- “Update the flood management program to take into account anticipated rises in Potomac River levels and increased intensity of storm-related flooding.”
- “Continue to support the work of City and Health Department emergency planners in developing plans that take into account climate change-related emergencies...”<sup>28</sup>

The city has already begun to address some of those topics by hiring consultants to assess the impacts of sea level rise and climate change on municipal stormwater infrastructure.

### Prince William County

Prince William County has a unique ordinance that concentrates developments to protect environmentally sensitive and hazardous areas. The General Regulations in Art. III Sect. 32-300.60 Suburban Cluster Development states that “The proposed cluster development shall be designed so as to protect natural vegetation and the topographic features of the site and concentrate construction so as to minimize the intrusion of manmade improvements upon the surrounding area.” Following are some of the other criteria.

- The ordinance requires that at least 30% of the gross acreage be committed to open space.

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<sup>27</sup> Rhodeside & Harwell, Inc. (2002). *Master Plan: Alexandria Open Space Plan*. p.55-59.

<sup>28</sup> City of Alexandria (2009, June). *Environmental Action Plan 2030*. Environmental Policy Commission. p.53

- “No portion of any residential lot shall be platted in the Chesapeake Bay Resource Protection Area..., any non-tidal wetland area, any 100-year floodplain, perimeter buffers, any major utility easement or right-of-way for existing above-ground utilities, ...or on slopes greater than 15 percent adjacent to a perennial stream...”
- “No street shall be located in any wetland area (tidal or upland) or in any 100-year floodplain except for necessary crossings or access points.”

Prince William County has policy goals that are relevant to sea level rise and storm surge planning as well. As part of the *Comprehensive Plan: Environment* EN-Policy 5, the action strategy for residential use is to “Preclude the development of habitable structures within 100-year floodplains. The allowable dwelling unit density for a property in the Urban and Suburban Area shall be calculated based on the area outside the floodplain, the Chesapeake Bay RPAs,” and other requirements. For non-residential uses, “The intensity of development is to be evaluated on the basis of other relevant environmental resource action strategies, the compatibility of the proposed uses with surrounding existing uses” and other relevant factors.<sup>29</sup>

Other strategies within the *Comprehensive Plan: Environment (EN)* document relate to the sea level rise and storm surge element. The intent of EN-Policy 6 is to limit the amount of impervious surface. An action strategy identified in EN-Policy 6 is to minimize the amount of development impervious surface and encourage the use of low-impact development techniques to reduce runoff.<sup>30</sup> Additionally, the intended purpose of EN-Policy 10 is to ensure high quality public drinking water sources. One of the action strategies is “Where not otherwise required as part of the Chesapeake Bay Preservation Act for designated RPAs, require a minimum 100-foot setback from shorelines of public water sources for development-related ground disturbance activities.”<sup>31</sup>

In addition, the *Comprehensive Plan: Parks, Open Space and Trails (OS)* section serves two main purposes: “to protect and preserve environmentally sensitive land, habitat connectivity, and water resources, and areas of archaeological, historical and/or cultural significance;” and to provide opportunities for recreation.<sup>32</sup> OS-Policy 5 seeks to increase the amount of open space. Several of the strategies are to

- “Actively seek to acquire easements or fee interest in property – through land purchases, grants, proffers, and donations – that is suitable for protected open space, including existing open spaces, or where an environmental constraints analysis shows that by-right development would result in substantial community impacts.”
- “Consider open space acquisition as a regular component of the capital improvement program.”<sup>33</sup>

### Town of Quantico

A portion of the Town of Quantico is located in the FEMA-designated 100-year floodplain limit next to the Potomac River. The town has prevented development from occurring in most of that area<sup>34</sup> and designated it as Park and Recreation Zone.

<sup>29</sup> Prince William County (2008, March). *Prince William County Comprehensive Plan: Environment*. p.ENV-7 to ENV-8.

<sup>30</sup> William County (2008, March). p.ENV-8.

<sup>31</sup> Prince William County (2008, March). p.ENV-10.

<sup>32</sup> Prince William County (2008, Feb.). *Prince William County Comprehensive Plan: Parks, Open Space and Trails*. p.POS&T-1.

<sup>33</sup> Prince William County (2008, Feb.). p.POS&T-27.

<sup>34</sup> Iris Tharp. Mayor of the Town of Quantico. Phone interview. June 2009.

## Conclusion

Planning for relative sea level rise and storm surge is a complex issue that requires support from various sectors and agencies. Though most Northern Virginia jurisdictions do not have policies or plans that directly target sea level rise and storm surge, there are a number of related policies that indirectly address sea level rise impacts. Despite variations in language, requirements, and variance, many policies address the same issues. A presentation made to the Fairfax County Board of Supervisors Environmental Committee, by Fairfax County Department of Public Works and Environmental Services – Land Development Services, in March 2009, provides recommendations for how the county may move forward in addressing rising water levels based on a 1 – 1.6 ft rise by 2050. Staff recommendations include:

- Base adaptation strategy on YR 2050 projection of a 1.0 - 1.6 ft. rise in sea level.
- Incorporate sea level rise in the design of all new buildings requiring SE approval.
- Evaluate the impact of sea level rise during the design of planned flood protection projects in coastal areas.
- Investigate larger freeboard and/or setback for proposed construction in areas influence by tidal flooding (Zoning Ordinance Amendment).
- Inventory public facilities in vulnerable areas and evaluate impacts.
- Acquire tools to perform a more detailed analysis of impacts of sea level rise on floodplain elevations in coastal areas.

With the Sustainable Shorelines and Community Management Project, most of these recommendations will be addressed, particularly as they relate to the vulnerability assessment. Staff's recommendations, which are based primarily off of the GCCC's recommendations, may be applicable to the other localities in the region, since they have a number of goals and objectives that are consistent with planning for rising sea levels and tidal surge. However, the enabling and legislative authority for localities to integrate adaptive measures for sea level rise and storm surge into their existing planning framework needs to be explored further.