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Hampton Roads Sea Level Rise Preparedness and Resilience Intergovernmental Pilot Project

Phase 2 Report:
Recommendations, Accomplishments and Lessons Learned

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October 2016

Acknowledgments

The Hampton Roads Sea Level Rise Preparedness and Resilience Intergovernmental Pilot Project Phase 2 Report: Recommendations, Accomplishments and Lessons Learned was developed through a collaborative process that included the active participation of the Working Group and Advisory Committee Chairs, the Steering Committee, and other key stakeholders.

This report is presented with gratitude and appreciation to the community of stakeholders working collaboratively to prepare for sea level rise and recurrent flooding in Hampton Roads and build a more resilient Virginia, not all of whom are mentioned below. Thank you to all of our partners who not only assisted with the development of this report but more importantly have dedicated countless hours to the IPP project and other parallel initiatives whether as part of their professional duties or out of a sense of responsibility. Your hard work each day advances our shared mission of a resilient nation, Commonwealth, and Hampton Roads.

A very special thank you to the current and past members of the IPP Steering Committee, Federal Liaisons, Conveners, Working Group and Advisory Committee Chairs, and several key advisers and supporters:

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Executive Summary

After two years, the Hampton Roads Sea level Rise and Resilience Intergovernmental Planning Pilot Project (Intergovernmental Pilot Project or IPP), convened at Old Dominion University, has come to a successful close. Although the conclusion of the project is different than originally imagined by the drafters of the IPP Charter, the process in and of itself brought hundreds of stakeholders together, built lasting and ongoing relationships, and produced many workable recommendations for the region that can be accomplished by a variety of partnerships. The key deliverables include a whole of government mitigation and adaptation planning process and an integrated regional recommendation, both which can serve as a template for other regions. Additionally the IPP demonstrated a new role for an urban campus to act as a community convener, matching focused research and curriculum development with public service across the university and the region.

Initiated in June 2014, the IPP was an effort to use the knowledge, skills and expertise of all regional stakeholders to create a framework or template for intergovernmental strategic planning that could be used outside the region; and, to implement that integrated strategy in Hampton Roads, Virginia, creating an effective and efficient method for planning holistically for sea level rise and recurrent flooding. This "Whole of Government and Community" effort would not have been successful without the hundreds of stakeholders and volunteer leaders from across all levels of government, academia, and the community who participated out of a sense of duty to their community and commitment to the collaboration.

Knowing water knows no jurisdictional bounds, a high level of intergovernmental collaboration is necessary to develop integrated regional solutions and implement effective sea level rise preparedness and resilience strategies. Additionally, the wider community in Hampton Roads recognizes that they too will be affected by not only sea level rise itself, but also the adaptation strategies implemented in preparation.

Phase 1 of the project, from June 2014 through June 2015, saw the drafting and signing of a Charter, the recruitment of a steering committee, a host of events, and the development of working group and advisory committees comprised of subject matter experts. Phase 2, from June 2015 through June 2016, included heavy discussion with regard to ongoing strategies for intergovernmental collaboration as well as research, a number of case studies carried out by committees and working groups, and the careful development of recommendations for the region.

The IPP concludes successfully with a series of recommendations from each working group and committee as well as a final resolution drafted by the Legal Working Group and containing the consensus views of steering committee members. Though the recommendations vary in specificity and subject area, a few themes are clear. In order to move forward regionally, local stakeholders need to maintain, institutionalize and build relationships with each other in order to facilitate effective collaboration and information sharing. Institutionalizing these relationships and partnerships is key, as people shift positions throughout their careers. Additionally, while more data is needed, the methods by which that data is integrated and shared are equally important. Further, some form of the Whole of Government and Community approach that focuses on the watershed as opposed to jurisdictional boundaries is essential to accomplishing the recommendations set forth in this report.

The IPP has been a success because of the dedicated volunteers committed to a resilient Hampton Roads. During the last two years, this project advanced regional adaptation through the evaluation and recommendation of a future governance structure, the development of working group and committee recommendations, building public awareness, building awareness of the need for federal agency involvement locally and building relationships among numerous organizations involved in the Pilot Project. All of this work, which in pieces may be specific only to a unique circumstance or area, when taken as a whole, brings foundational change. It builds on previous work accomplished by other leaders in the Hampton Roads region and should be leveraged in the future to accelerate regional adaptation.

1. Introduction & Background

1.1. Sea Level Rise and Flooding in Hampton Roads, Virginia

Hampton Roads, Virginia, for purposes of the Hampton Roads Sea Level Rise and Resilience Intergovernmental Planning Pilot Project (Intergovernmental Pilot Project or IPP) was defined as the seventeen localities within the borders of the Hampton Roads Planning District Commission. The Steering Committee and stakeholders recognize that this creates an artificial political boundary, one which the water does not recognize. However, for the purposes of this two-year-long experiment, the steering committee agreed to limit the area considered. In order to consider living with the water in Hampton Roads, the region must join together and act innovatively and proactively.

The Phase 1 of the IPP report contains a careful detailing of the region, its localities, and the economy, which is largely reliant on the heavy defense presence in the area. In short, the region is one of the nation's most vulnerable to coastal hazards, with CoreLogic estimating that the total homes vulnerable to all categories of hurricanes regionally as 385,084.[1] Additionally the region faces a high relative rate of sea level rise due to the convergence of multiple factors in the mid-Atlantic region.[2]

[1] Howard Botts, et al. (2016). *2016 CoreLogic Storm Surge Report*, CORELOGIC .

[2] Ezer, T., & Atkinson, L. P. (2014). Accelerated flooding along the US East Coast: on the impact of sea-level rise, tides, storms, the Gulf Stream, and the North Atlantic oscillations. *Earth's Future, 2*(8), 362-382.

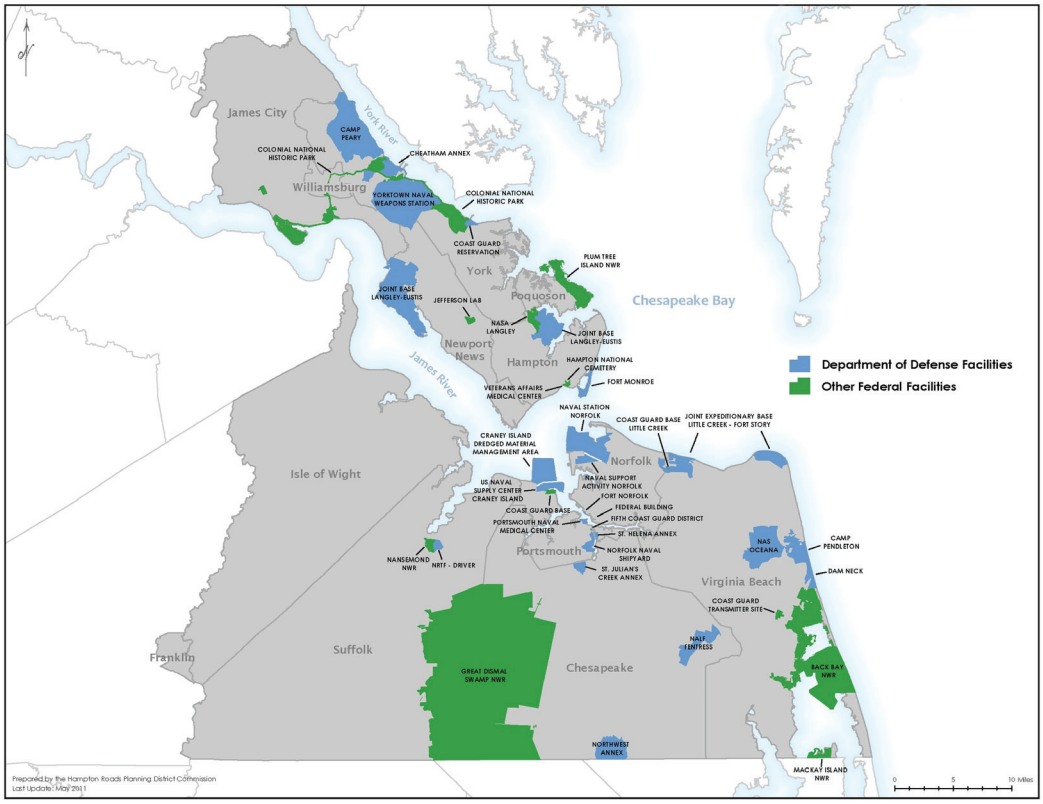


Figure 1-1. Hampton Roads Region Municipalities and Federal Facilities, Image Courtesy of the Hampton Roads Military and Federal Facilities Alliance

The Virginia Institute of Marine Science (VIMS) Recurrent Flooding Study for Tidewater Virginia (2013) report commissioned by the Virginia General Assembly highlighted the cities of Virginia Beach, Portsmouth, Norfolk, Chesapeake, Hampton, and Poquoson as confronting significant challenges related to sea level rise, assuming a 1.5-foot rise in sea level and a 3-foot storm surge. The study found that in these localities the percentage of the total land area vulnerable to flooding ranged from 11% to 69%.[3]

The region has a population of over 1.7 million, many of whom depend on the waterways indirectly for employment or for recreation, as well as a high concentration of valuable commercial, industrial, and military assets benefiting from their direct access to water-dependent assets. Along with other federal facilities, Naval Station Norfolk, the largest naval base in the world, and the Port of Virginia, which generates $60 billion in annual spending,[4] are key economic drivers in the region. Supporting industries including shipbuilding and repair, defense contracting, rail transport and truck transport play a key role economically. Commercial and recreational fishing, outdoor recreation, tourism and the associated real estate development, and many other industries take advantage of the shorelines, wetlands, and beaches. Institutes of higher

[3] Virginia Institute for Marine Science (VIMS). (2013). *Recurrent Flooding Study for Tidewater Virginia,* available http://ccrm.vims.edu/recurrent_flooding/Recurrent_Flooding_Study_web.pdf.

[4] Roy L. Pearson, *The Fiscal Year 2013 Virginia Economic Impacts of the Port of Virginia*, WILLIAM & MARY, RAYMOND A. MASON SCHOOL OF BUSINESS (Dec. 26, 2014) http://www.portofvirginia.com/pdfs/POV%20Econ%20Impact%20Study%202014.pdf.

education in the area, also economic drivers, boast strengths in water-related programs and research. These industrial, commercial, residential, and environmental assets and pillars of the economy are key to the region's success, but are at risk from the rising level of the very waters that drew them to Hampton Roads. However, if the region continues to act proactively with regard to these risks, there are many opportunities to develop new economies as the region adapts.

1.2. Other Coastal Resilience Initiatives

Throughout the course of the IPP many exciting initiatives and developments occurred throughout Hampton Roads and in the Commonwealth of Virginia with regards to sea level rise and resilience. The IPP and its stakeholders worked hard to ensure that efforts were not duplicated and that any IPP efforts supported other initiatives where possible. In fact, in most cases IPP participants were leaders in these other efforts. Below is a list of exciting and interesting sea level rise and resilience initiatives, but by far is not an exhaustive list of all of the activity in the region:

- The Commonwealth was awarded more than $120.5 million through the Housing and Urban Development National Disaster Resilience Competition. These funds will build resilience in the Ohio Creek Watershed area of Norfolk and provide seed funding for a Coastal Resilience Laboratory and Accelerator.
- HRPDC has reinvigorated its work through its Coastal Resilience Committee. Local county and city administrators have appointed deputy administrators to serve on the committee and allocated funds for a coastal resiliency planner position.
- Hampton Roads Adaptation Forums have continued to be hosted by ODU and HRPDC and are now sponsored by private sector partners. The forums bring practitioners together quarterly for day-long workshops, presentations, and networking.
- The City of Norfolk launched its Resilience Strategy and is moving forward with its Vision 2100 process.
- Research has continued and expanded at ODU, VIMS, VCPC and other academic institutions on subjects from subsidence, housing recovery, data integration, and storm surge modeling and more.
- ODU, Hampton University, Virginia Sea Grant, and Wetlands Watch successfully collaborated on the Chesterfield Heights and other resilient design projects engaging students in developing innovative adaptation strategies.
- The Commonwealth Center for Recurrent Flooding Resilience (CCRFR) was established by 2016 General Assembly Authorization (HB 903) & Climate Change & Resiliency Update Commission Priority. The CCRFR will leverage the complementary strengths of ODU, VIMS, and VCPC to enable short- and long-term decision making by assisting with the integration and coordination of federal, state, local, and nongovernmental data, evaluating best practices, developing and testing innovative interventions, engaging stakeholders throughout Virginia, providing outreach, training, technical and non-technical services as requested.

1.3. Intergovernmental Pilot Project

1.3.1. Background

The IPP was a two-year project officially launched in June 2014 with a goal of using a Whole of Government and Whole of Community approach to resilience planning. A dual purpose initiative, the IPP worked to meet the needs of local stakeholders to build relationships and develop a process for collaborative planning and with federal stakeholders to create a model for Whole of Government resilience planning in one of the more complex and federally saturated regions in the nation.

The White House and Department of Defense each initiated three regional pilots following President Obama's Executive Order, "Preparing the United States for the Impacts of Climate Change." The Hampton Roads Intergovernmental Pilot Project was the only geographic location on both lists, and the only pilot convened by a university across a region as varied as Hampton Roads. Furthermore, this initiative was the only one exploring the Whole of Government/ Community model and addressing coastal resiliency with a focus on regional resilience and local mitigation and adaptation to address national security concerns and economic impacts.

MISSION: The mission of the IPP is to establish in Hampton Roads a regional Whole of Government & Whole of Community organizational framework and procedures that effectively coordinate SLR Preparedness & Resilience Planning.

VISION: A regional Whole of Government and Whole of Community approach to sea level rise preparedness and resilience planning in Hampton Roads that also can be used as a template for other regions.

The IPP utilized the Whole of Government highlighted in the 2010 National Security Strategy[5] to improve integration and collaboration across federal, state, and local governmental agencies in Hampton Roads to more effectively leverage limited resources in order to plan for sea level rise and coastal flooding. Because this was a cross-jurisdictional issue as floodwaters do not adhere to political boundaries, the application of the Whole of Government approach to sea level rise preparedness and resilience planning could benefit the region greatly.

The IPP has been a success based on the leadership of the volunteers working in the working groups and committees for two years. During the last two years, the Pilot Project has advanced regional adaptation through the evaluation and recommendation of a future governance structure, the development of working group and committee recommendations, building public awareness, building awareness of the need for federal agency involvement and building relationships between numerous organizations involved in the Pilot Project. This work builds on work of others in the region, and in turn, can be a launching point for implementing strategies and partnerships. It builds on previous work accomplished by other leaders in the Hampton Roads Region and can be leveraged in the future to accelerate regional adaptation. According to Ekstorm & Moser, on whom the IWG and PIC based their strategies, at early stages in the

[5] See *National Security Strategy, 2010*, available https://www.whitehouse.gov/sites/default/files/rss_viewer/national_security_strategy.pdf. See also, Presidential Policy Directive (PPD-8): National Preparedness, available http://www.dhs.gov/presidential-policy-directive-8-national-preparedness.

adaptation process "merely advancing or continuing the process can be used as a proxy for success."[6]

In a diverse region of 17 localities, the Whole of Government process does not come easily. The conveners of the IPP aimed to build bridges between levels of government and within the region and increase understanding and collaborative processes during the two-year experiment. Though the Whole of Government concept was the initial goal of the White House and Department of Defense pilots, the Whole of Community concept was added to bring regional ownership to the process. The IPP two-year process was an iterative one, with input gathered from all interested stakeholders in a manner that allows for adaptive management in response to changing information and conditions.

Over the course of the IPP, countless volunteer hours were logged via participation in events, working group and advisory committee meetings, and more. Participation in the IPP was completely voluntary for Steering Committee members and working group and committee members. While some organizations, agencies, and localities tasked staff members with participation, others have simply volunteered their time and expertise. Additionally, over the course of the IPP many graduate students conducted research on the IPP itself or participated in working groups and committees.

Old Dominion University (ODU) acted as the convener of the IPP and supported the IPP during the course of two years by supporting faculty and staff who dedicated time to the effort. William & Mary Law School's Virginia Coastal Policy Center and the Virginia Institute of Marine Science also provided expert support throughout the duration of the project.

Importantly, the IPP was not funded by federal partners. ODU, as the convening organization, supported the project with significant staff time, communications support, the underwriting of various IPP events, and support of faculty where possible. Grants from a private foundation supported the Phase 2 work of the Infrastructure Working Group, Private Infrastructure Advisory Committee, Public Health Working Group, and Citizen Engagement Committees, making possible their detailed case studies. Because of limited funding the IPP held to its two-year schedule and the project ended during the summer of 2016.

1.3.2. Structure & Partnerships

The IPP structure consisted of a Steering Committee charged with directing the overall strategic direction for the pilot. The Steering Committee was informed and supported by a set of working groups and advisory committees. Steering Committee membership included private industry, state and local representatives as well as non-voting federal liaisons. Because one of the goals of the IPP was to propose a strategy for effective local planning, federal liaisons were active participants but not voting members of the committee.

Over the course of the two-year pilot project, many original steering committee members left their positions in the Navy or other employment due to the natural course of their work. For example, many military posts change command every two years. Where possible, steering committee members briefed their replacements prior to departure, which aided the group with

[6] Moser, Susanne C., and Maxwell T. Boykoff, eds. *Successful Adaptation to Climate Change: Linking Science and Policy in a Rapidly Changing World.* New York: Routledge, 2013.97-113. Print.

the transition. However, these frequent transitions highlighted the need to incorporate the relationships developed during the IPP process into their scope of work not just between federal and state/local partners, but among all community leaders. The steering committee in place at the close of the IPP was as follows:

Steering Committee

Randy Keaton - *Chair*	Deputy Executive Director, Hampton Roads Planning District Commission
Shawn Talmadge – *Deputy Chair*	Homeland Security and Resiliency Staff Director, Commonwealth of Virginia
Mayor Kenneth Wright	Former Chair, HRPDC; Mayor, City of Portsmouth
Kit Chope	VP, Sustainability Director, Virginia Port Authority
Angela Navarro	Deputy Secretary of Natural Resources, Commonwealth of Virginia
Timothy Fortune	Engineering Manager, Newport News Shipyard, Huntington Ingalls
Jim Utterback	Virginia Department of Transportation, Hampton Roads Director
Heather Wood	Consultant to the Port, Kennedy Jenks
Sharon Baxter	Director, Division of Environmental Enhancement, Virginia DEQ
Christine Morris	Chief Resiliency Officer, City of Norfolk
Phil Davenport	Director of Public Works, City of Virginia Beach

Federal Liasons

RADM John C. Scorby	Commander Navy Region Mid-Atlantic
COL Jason Kelly	USACE, Commander Norfolk District
CAPT George Bonner	Commanding Officer USCG Shore Infrastructure Logistics Center
Andrew Lawrence	USCG District 5
CAPT Dean Vanderley	Commanding Officer NAVFAC Mid-Atlantic
COL Caroline Miller	Commander Joint Base Langley-Eustis

Convener

CAPT Ray Toll (Ret.)	Director for Coastal Resilience Research, Old Dominion University

Working Group and Advisory Committee Chairs

Roy Hoagland	W&M VCPC, Chair, Legal Working Group
RADM Ann Phillips (Ret)	Chair, Infrastructure Working Group
Dr. Michelle Covi	ODU/VASG, Co-Chair Citizen Engagement Working Group
Chris Bonney	HRCCE, Co-Chair Citizen Engagement Working Group
Dr. Steve Becker	ODU, Chair Public Health Working Group
Carol Considine	ODU, Chair Private Infrastructure Advisory Committee
Dr. Larry Atkinson	ODU, Co-Chair Science Advisory Committee
Dr. Carl Hershner	VIMS, Co-Chair Science Advisory Committee
Dr. Chip Filer	ODU, Chair Economic Impacts Advisory Committee

Initial workgroups and advisory committees evolved slightly throughout the two-year process, and some groups started at different times or were more active than others. This is not a surprising result from a stakeholder initiative led by mostly volunteers.

The initial structure of the IPP, including the following working groups and advisory committees, with changes occurring over time as noted in parentheses:

1. Legal Working Group
2. Infrastructure Working Group
3. Land Use Planning Working Group (Dissolved December 2015)
4. Citizen Engagement Working Group
5. Public Health Working Group (Added in April 2015)
6. Economic Impacts Advisory Committee (Started Fall 2015)
7. Private Infrastructure Advisory Committee
8. Municipal Planning Advisory Committee (Never Initiated)
9. Senior Advisory Committee (Inactive)
10. Science Advisory Committee

The Legal, Infrastructure, Land Use Planning, and Citizen Engagement Working Groups were formed by the Charter, while the Public Health Working Group was formed at a meeting of the Steering Committee in April 2015 after acknowledgment of a planning gap. Advisory Committees were convened as well, to provide key information to the Working Groups and Steering Committee. Figure 3 shows the basic organizational structure with primary communication relationships between Steering Committee, Working Groups, and Advisory Committees. The structure of the IPP at its close is as follows:

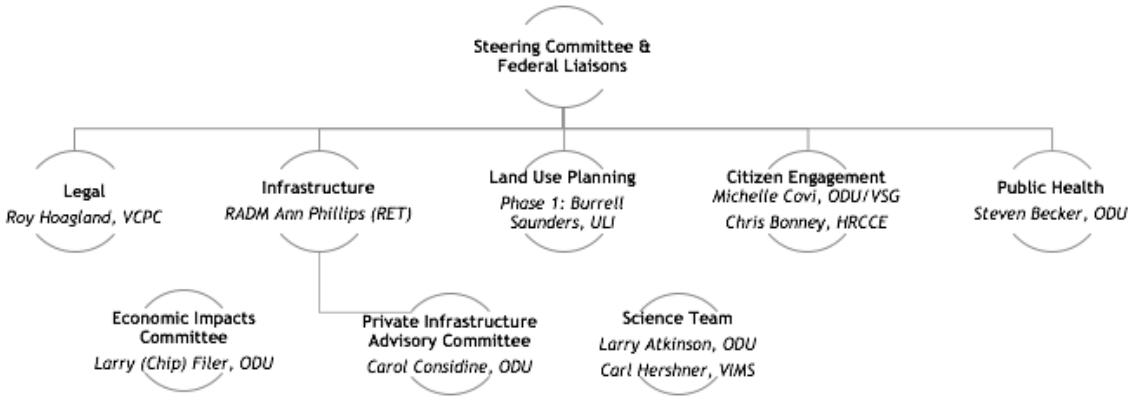


Figure 1-2 IPP Structure

The chairs of the working groups and advisory committees worked together regularly, sharing information and strategies. Additionally, members of the Legal Working Group and the Science Advisory Committee regularly attended other's meetings to answer questions where appropriate. Each active committee's strategy is summarized in this report and closely detailed in independent reports available in the Appendices for reference.

1.3.3. Phase 1

1.3.3.1. Summary

Beginning in June 2014, Old Dominion University convened the Hampton Roads Sea Level Rise Preparedness and Resilience Intergovernmental Pilot Project (Intergovernmental Pilot Project or IPP). The IPP was an effort to use the knowledge, skills and expertise of all regional stakeholders to create a framework or template for intergovernmental strategic planning that can be used outside the region; and to implement that integrated strategy in Hampton Roads, Virginia, creating an effective and efficient method for planning holistically for sea level rise and recurrent flooding.

Shortly after the official launch of the project, on June 30, 2014, political leaders met at ODU to discuss a bipartisan approach to flooding resilience as a part of the Pilot Project. With active stakeholders from the Department of Defense, federal agencies and the White House as well as the Commonwealth of Virginia and many localities across Hampton Roads, Virginia, the IPP was truly a Whole of Government effort. Knowing water knows no jurisdictional bounds, that level of intergovernmental collaboration is necessary to develop integrated regional solutions and implement effective sea level rise preparedness and resilience strategies. Additionally, the wider community in Hampton Roads recognizes that they too will be affected by not only sea level rise itself, but also the adaptation strategies implemented in preparation. As such, many academic and community partners actively participated, ensuring that this was a Whole of Community project as well.

Thus, IPP stakeholders include representatives from private industry, infrastructure, nonprofits, the real estate community, and vulnerable communities. Furthermore, while the IPP was conceived in Hampton Roads, the IPP recognizes that sea level rise affects the entire Commonwealth, and a successful "Whole of Government and Community" approach must eventually include regions beyond Hampton Roads and reach across Coastal Virginia and the Commonwealth as a whole.

The IPP was completely un-funded, except as supported by ODU and via stakeholders' donated time. It existed not as an entity, but as an attempt to bring together the community, and leveraging and building upon other initiatives including the Secure Commonwealth Panel's Subcommittee on Sea Level Rise, Urban Land Institute's Resilient Region Reality Checks, the City of Norfolk's experience with 100 Resilient Cities and the work of NOAA and NASA scientists, and more.

1.3.3.2. Deliverables

In October 2014, the Steering Committee signed the Charter and formation of the various working groups and advisory committees commenced. By July 2015, every working group and committee established by the Charter had a tentative chair or co-chairs except for the Economic Impacts Advisory Committee. Essential to the energy and support behind Phase 1 of

the IPP were the letters sent to federal agencies by United States Senator Tim Kaine in October 2014 encouraging participation in the Hampton Roads IPP project. Throughout the fall and winter, agencies responded with support and designated points of contact.

For the remainder of Phase 1, IPP stakeholders worked diligently to follow the intent of the Charter with limited staffing and funding while responding to the challenges of stakeholder engagement.

The Legal Working Group established several operating principles for consideration by the Steering Committee and worked to develop a "Legal Primer Version 1," which details federal, state, and local laws and regulations related to planning for sea level rise, serving as a reference document for the Steering Committee and the other working groups (See Appendix D-3).

All active working groups and committees developed action plans and/or a scope of work, and briefed the Steering Committee and Senior Advisory Committee on their efforts and requested feedback in March 2015. Though timelines were altered from the original Charter schedule, the focus remained on adapting to lessons learned in Phase 1 in the pursuit of establishing a regional entity focused on collaborative resilience planning, and many objectives remain the same.

At the conclusion of Phase 1, as a self-check to assess progress, challenges, and redefine goals half-way through the two-year pilot project, the Steering Committee, federal liaisons, working group and advisory committee chairs, and key stakeholders took part in a daylong strategic planning session. A facilitator led the group members as they worked to define a concrete path forward and ensure that knowledge from the first year was incorporated into the second phase of the project. As a result of this workshop, the project adapted as necessary to work toward proposing a Whole of Government and Whole of Community process for sea level rise preparedness and resilience in Hampton Roads that could also be used as a template elsewhere.

1.3.4. Phase 2

1.3.4.1. Summary

At the end of the IPP leadership's strategic planning session, Jim Redick, Emergency Manager for the City of Norfolk, and Randy Keaton were elected chair and co-chair of the Steering Committee. The group developed and held to a monthly meeting schedule, and established a timeline for completion of the project. In November of 2015, Jim Reddick stepped down as chairman, and the group elected Randy Keaton of the HRPDC Chair and Shawn Talmadge of the Secretary for Public Safety and Chief Resilience Officer as co-chair, continuing with the existing processes for meetings and timeline structure. In this way they were able to respond to questions and ideas from working group and advisory chairs as well as address key strategic questions posed by the Legal Working Group.

The working groups and advisory committees, having accomplished the bulk of the stakeholder engagement for the IPP during Phase 1, started case studies where applicable and then worked to develop recommendations carefully over the course of the second year of the project. Although the Charter initially planned on the addition of advisory committees during Phase 2, this was not initiated due to funding challenges, staffing constraints, and because of the logistical difficulties of bringing more groups into the project halfway through.

Though small feats when compared to the great efforts of the working groups, committees, and Steering Committee, Phase 2 was marked with two important events. First, in November, Secretary of State John Kerry visited Norfolk prior to attending the 2015 United Nations Climate Change Conference in Paris, France. During his visit he spoke with leadership at Naval Station Norfolk about the challenges faced on base from flooding and gave a speech at Old Dominion University stating that "unprecedented cooperation at all levels of government and the Pilot Program housed right here at Old Dominion University is the perfect example of the type of coordinated effort we need to deploy from sea to shining sea." Additionally, midway through Phase 2, ODU hosted a large event to serve as a check-in and establish a network of regions so that IPP stakeholders could not only hear updates about activities in Virginia but also across the country; this event is discussed in Section 3.

1.3.4.2. Deliverables

According to the Charter, the goal of the second phase was to use the findings of the Steering Committee to draft a Memorandum of Understanding (MOU) among the members of the IPP establishing "an intergovernmental planning coordination organization that will commence operations upon conclusion of the Pilot Project." Though the Steering Committee considered developing an MOU, the group decided that they were not yet ready to take that step and the groundwork was not in place to start a new entity. As such they took a more measured approach and worked closely with the LWG to consider first, what types of authorities would be useful for collaborative planning, and second, how those goals could be accomplished.

In addition to other issues, the LWG and Steering Committee carefully discussed the key issues as detailed in the Charter: (1) Authority, (2) Structure, (3) Governance, (4) Scope of Planning, (5) Resources, and (6) Execution. After careful consideration, analysis of a matrix of authorities and strategies for collaborative planning, and consideration of the recommendations of the other working groups and advisory committees, the Steering Committee opted to move forward with a resolution that addressed both short-term realities and long-term goals as opposed to an MOU. This resolution is available in Appendix C-1. Moreover, each working group and advisory committee developed overall recommendations as they related to their area of expertise. These recommendations are available in a summary chart in Section 4.1 as well as in each committee's report.

1.3.4.3. Process for Developing Final Report and Recommendations

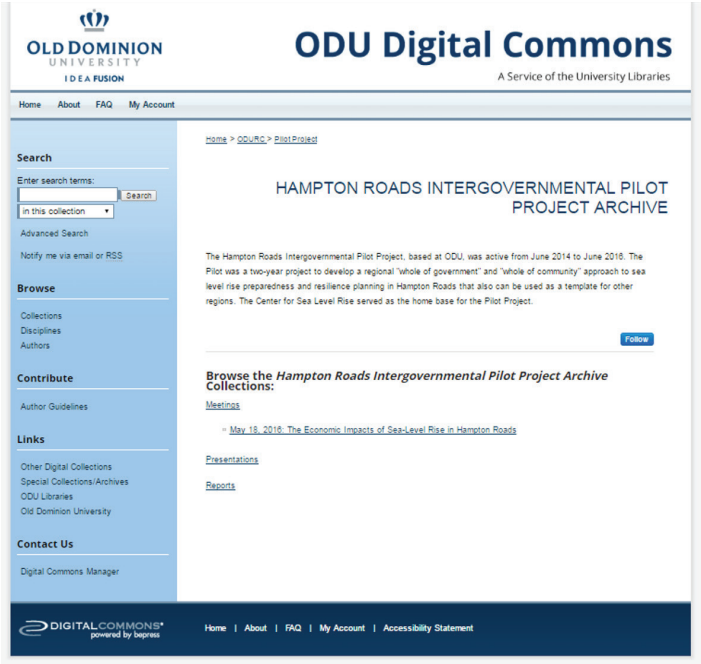
Throughout the IPP process the Steering Committee, working groups and advisory committees, with ODU as the convener, have maintained various communications strategies to ensure interested stakeholders were informed during the two-year pilot project. Each working group or committee was formed in a unique manner as appropriate for that sector and as determined feasible with limited time and resources. This is detailed in the respective committee and working group sections and in more depth in the independent Committee Reports where applicable.

Members of the Steering Committee, working group and advisory committee chairs, and the convener have all spoken at various conferences and smaller community events or meetings as well as offering and partaking in countless check-in and update phone calls and meetings with stakeholders throughout Hampton Roads, Richmond, and Washington, D.C.

The process for compiling this report was no different. First the Steering Committee agreed to a tentative schedule for working group and advisory committee submissions, as well as a template for those submissions and a tentative outline for the report. Each working group and advisory group worked together to compile recommendations and submit the requested information, sending multiple drafts out to committee members for comment and approvals and discussing the reports in meetings as necessary.

The report compilers then input that information into this report and included any additional information, resources, or reports in the Appendices for reference. Throughout the compilation process, working group and advisory committee chairs were offered the opportunity to comment, revise, and discuss, and provided input to the process and the content of the report to ensure it accurately reflected the many hours of work from volunteers across the region.

In an effort to increase usability, the body of this final report serves as a summary of more detailed stand-alone working group and committee reports as well as the overall IPP process. For a more detailed study of each committee and working group's actions, please refer to the independent committee reports, as they contain a wealth of information and represent many hours of stakeholder investment. The full body of each committee final report, including member lists, case studies, literature reviews, pertinent information, deliverables, etc., are located in the Appendices. Additionally, all IPP resources are archived permanently on ODU's Digital Commons and available at http://digitalcommons.odu.edu/odurc_pilot/. We welcome you to explore this wealth of resources.



2. Working Group and Committee Reports

2.1. Legal Working Group

2.1.1. History, Objectives & Strategy

The Legal Working Group assembled members by contacting every HRPDC jurisdiction and requesting each jurisdiction assign an attorney. The various military organizations volunteered to participate from the beginning and several private practitioners also volunteered later. The Legal Working Group was chaired by Roy Hoagland, then Director, now Co-Director, of the Virginia Coastal Policy Center at William & Mary Law School. William & Mary law students also provided essential support through the IPP process.

The group's primary function was to respond to the needs of the other working groups, advisory committees and the Steering Committee. Through thorough research and legal analysis, it produced the Legal Primer (See Appendix D-3) as a reference for use by the IPP partners. It also shared the extensive knowledge and expertise of its membership to guide the Steering Committee in fulfilling its Charter obligations and in producing a strategic plan for its early work. Most significantly, the group's evaluation of the various structural options of the IPP successor entity (See Section 3.3 and Appendix D-4) and production of the final Resolution of the Steering Committee (See Appendix C-1) provided the necessary closure for the IPP.

2.1.2. Actions & Accomplishments

The planned deliverables of the Legal Working Group are as follows and can be found in the Appendices:

1. Legal Primer
2. Memo to Steering Committee Re: IPP Outcomes- Final Structure
3. Chart of Potential IPP Steering Committee Successor Entity Structure Options and Features
4. Resolution of the Steering Committee and Federal Government Liaisons of the Hampton Roads Sea Level Rise Preparedness and Resilience Intergovernmental Pilot Project

2.1.3. Lessons Learned

The main purpose of the Legal Working Group was to use the knowledge and expertise of its members to respond to the needs of the Steering Committee and the other working groups. In doing such, the group found a repeated need to seek clear goals and decisive leadership on the part of the Steering Committee to effectively perform its duties. In addition, the group learned that more inclusive and formalized clarification of charges, roles and strategic planning at the initiation of the IPP would have enabled the group to produce helpful, accurate and useful materials in a more timely and efficient manner.

2.1.4. Recommendations

Due to its unique role in the IPP process, the LWG did not provide recommendations in the same manner as the other groups. Throughout the IPP the LWG provided nonbiased information to the Steering Committee in the form of a memo analyzing potential organizational structures and a chart of potential entity structures and features. The LWG provided resources deliverables and information throughout the process, and provided the resolution at the request of the Steering Committee based on its consensus decisions.

2.2. Infrastructure Working Group

2.2.1. History, Objectives & Strategy

The IWG was chaired by Ann C. Phillips, RADM, USN (Retired). The IWG worked to follow direction from the Charter to determine its initial goals and objectives. The IWG first developed a Mission Statement, shown below, and then, developed Objectives/Deliverables for Phase 1 and 2 of the Pilot project, which are included in the IWG Final Report.

Infrastructure Working Group MISSION STATEMENT

"The Infrastructure Working Group, in supporting the Hampton Roads Sea Level Rise Preparedness and Resilience Intergovernmental Planning Pilot Project Steering Committee, will review critical infrastructures in the Hampton Roads region, determine which are most suited to and will be most positively affected by adaptation planning, and make recommendations to the Steering Committee for intergovernmental coordination of that planning. The IWG will further coordinate with the Private Infrastructure Advisory Committee, to formulate recommendations to coordinate with privately owned infrastructure planning."

As a part of the formation of the Charter, a preliminary list of potential committee and working group members was developed and as working group and committee chairs came onboard, they were provided the tentative list of group membership and contact information. No organization on the initial list declined to participate, but often there were several different participants or names offered until the final representative sorted itself out with time, or the appropriate job title or focus could be identified.

The initial participation list for the IWG did not include any representatives from cities or municipalities, which was evaluated as a clear shortfall by the group. Initially the objective was that every city with any sea level rise impact would have representation, but this was not feasible, so an effort was made to ensure representation from the cities with the most near-term impact, and also that diversity of locale was represented within the IWG, in that cities from both the "Peninsula" and from the "Southside" of Hampton Roads were included.

Norfolk International Airport declined to participate throughout the project. They were initially contacted by the PIC Chair during Phase I, and then contacted again, by the PIC, IWG and Legal Working Group during Phase II once the study area had been defined, which included their property, and they again declined participation or even to accept a brief on the project. While this did not unduly impact the Pilot outcome it did present the unique circumstance of a public entity, under supervision of several federal, state and local agencies, most of whom were study participants (FAA, DOT, DHS, VDOT, City of Norfolk) vulnerable to sea level rise and storm surge impact over time, declining to participate in a regionally sponsored project to understand and better define collaborative efforts to mitigate, adapt, plan, and prepare for sea level rise impact.

The following is a summary of critical infrastructure sectors and their members included on the IWG:

- Government Facilities: Naval Facilities Engineering Command, Joint Base Langley-Eustis, Navy Region Mid Atlantic, Joint Expeditionary Base Little Creek/Fort Story, U.S. Army Corps of Engineers, City of Norfolk, City of Virginia Beach, City of Hampton, City of Newport News
- Sector Specific Agencies: DHS, DOT, DOE, HRPDC, HRTPO, HRSD, VDOT
- Transportation Systems: Port of Virginia on Steering Committee, VDOT, HRTPO on IWG
- Water and Wastewater Systems: HRSD, Cities of Norfolk, Virginia Beach, Hampton, Newport News

The first phase of the pilot project for the IWG focused on gathering and understanding the body of work in the form of studies and other documentation that addressed sea level rise in the Hampton Roads region, or was related to sea level rise in the region, or was related to sea level rise in other regions in a manner that may be useful to the IWG in determining and discovering deliverables as aligned with the goals and objectives of the pilot project. As studies were determined to be of particular interest, the IWG arranged opportunities to learn more about their specific objectives through on-site briefs, or through phone briefs or other contact with the authors of the work in question. The IWG was also looking for methodologies used in other projects that might be of use in making decisions for this project, and so also investigated areas of interest in that regard as such opportunities presented themselves. Once study and

methodology reviews were completed, the IWG turned its attention to understanding how to best select critical infrastructure, or critical infrastructures that would be suitable for a Phase II case study.

During Phase II of the Pilot, the IWG selected sea level rise scenarios for study that were suitable for consideration for the potential study areas once selected, and that represented feasible challenges to sea level rise, and resiliency and adaptation planning for the Hampton Roads region. Using the methodology from the DOT-sponsored Gulf Coast II study, the IWG created its own matrix of selection criteria to select an appropriate study area and solicited input from within the working group for areas that might be suitable and that were vulnerable to sea level rise impact under the scenarios chosen. The IWG then weighted those scenarios and selected the area that received the highest overall value. The area chosen was Little Creek/Pretty Lake which included the cities of Norfolk, Virginia Beach and the Department of Defense Joint Expeditionary Base Little Creek/Fort Story. In coordination with the PIC, the IWG then worked to identify critical infrastructure within the study area selected (using DHS Critical Infrastructure Taxonomy Criteria – see Appendix E-6 IWG reference list) and evaluated dependencies and interdependencies of this infrastructure using a matrix developed by the PIC and adopted by the IWG. Once dependencies and interdependencies were evaluated, the IWG considered challenges and impediments to adaptation planning and made recommendations to facilitate intergovernmental coordination of that planning.

2.2.2. Actions & Accomplishments

The IWG was tasked to conduct a thorough review of existing studies related to sea level rise impact in the Hampton Roads region, and to consider other relevant studies that while not specific to Hampton Roads, might contribute to gaining better insight and understanding of the challenges related to whole of government and community sea level rise adaptation planning. They were further tasked, initially, to identify and prioritize sea level rise-vulnerable critical infrastructures in the Hampton Roads region, determine those critical infrastructures with the greatest impact to the most municipalities, and federal, state, and local agencies, and to then make recommendations to the Steering Committee as to which of those infrastructures might be best suited to adaptation planning (for Phase II) at a regional level to ensure future resiliency. By the end of Phase 1 of the Project, the IWG determined that identification and prioritization of all critical infrastructures vulnerable to sea level rise within the Hampton Roads region, while essential for future regional planning, was beyond the scope of the working group's ability in the time and circumstances of the Pilot. Instead, the group focused on selection of infrastructure, or infrastructures that best defined the objectives of the Charter, to identify impediments to and determine solutions and recommendations for whole of government and community planning.

2.2.2.1. IWG Case Study Selection Process

Early in the study review process, the IWG, with the help of IWG representatives from the Department of Transportation, identified the "Impacts of Climate Change and Variability on Transportation Systems and Infrastructure: The Gulf Coast Study, Phase 2" (referred to as the Gulf Coast II Study) as relevant to both of these tasks. Of particular interest was the methodology matrix, referred to as a Criticality Assessment tool used by U.S Department of Transportation,

Mobile Metropolitan Planning Organization and the South Alabama Regional Planning Commission (SARPC) and supporting engineering firms to determine which transportation infrastructures were most critical and most vulnerable to, in this case, storm surge along the Mobile, Alabama, Gulf Coast.

The IWG initially attempted to use the GC II matrices exactly as designed but modified for the Hampton Roads region in the selection of the case study area for Phase II of the Pilot project, but, decided that a full modification of the matrices, while essential for future regional planning and infrastructure criticality prioritization, was far too complex for the scope of the pilot project. Instead, the IWG designed a similar, but much simplified, version of the GC II matrix for use in determining selection of an appropriate critical infrastructure case study area. The IWG matrix (See Figure 2-1) used some of the criteria selected by the GC II study, and then added in its own recommendations, most specifically to include an area that stressed the whole of government and community planning challenges by including more than one city or municipality and at least one federal or state agency in the study area.

After assessing the criticality and vulnerability of a number of locations in the Hampton Roads region, using the criteria outlined in the matrix, three areas that scored highly in the evaluation were voted on by the IWG members for a final case study location selection. The Little Creek/Pretty Lake area was selected as most suitable for the Pilot's objectives (See map in Figure 2-2).

2.2.2.2. IWG SLR Scenarios Selection Process

Once the IWG selected the critical infrastructure area of Little Creek/Pretty Lake, it next turned to the selection of sea level rise scenario curves to consider the impact of sea level rise and storm surge under varying conditions on the study area. One of the challenges to making such a determination is which curves to use, as NOAA and U.S. Army Corps of Engineers, both using National Climate Assessment (NCA) Data (from year 2014), have generated scenario curves with very different projected sea level change predictions. Further, the Virginia Institute of Marine Science (VIMS), also using the latest NCA data, but modifying it for Hampton Roads' specific sea level rise and subsidence measurements, has also developed its own set of scenario curves - specific to this region, which closely trend with the NOAA curves (See NOAA curves 2014 and VIMS 2015 curves in Figure 2-3). In addition, cities and municipalities within the Hampton Roads region have worked with engineering firms, and have developed scenario curve interpretations that, while using the same data as the federal and VIMS curves, interpret the potential timelines to achieve the projected scenario elevations in different ways, in large part due to planning considerations for their individual cities. While aware of these different interpretations by cities and municipalities, the IWG chose to use the VIMS NCA-based projections, modified for the Hampton Roads region, as in keeping with the best available science, and initially selected a series of three specific timeframes (near, medium, far) and then selected sea level rise scenario curves within those timeframes to use to evaluate the impact on critical infrastructure within the Little Creek/Pretty Lake study area. In addition to the scenario projections for sea level rise, the IWG also added the consideration of the further impact of a 100-year flood on the area, or the additional depth of water projected by a flood with a 1% chance of occurring, being equaled or exceeded in any given year for these scenarios.

Assessing Criticality and Vulnerability - Hampton Roads, Virginia

Infrastructure Planning Working Group, Hampton Roads Intergovernmental Planning Pilot Project

Final Version 13 July 2015

Factor Weights	Screen	Screen	Screen	2	1	1	2	2	3	1	2	
	Feasibility	Data Availability	More than 1 Agency (Ownership &/or Regulation)	More than 1 Municipality (Location)	At least 1 Private Utility	Lack of Redundancy	Known Problem Area	Evacuation Route	National Security Impact	Votes (7/13/15 End of Meeting)	Regional Economic Impact	Score
Little Creek and upstream lakes	1	1	1	1	1	0	1	0	0	7	0	12
HRBT & Approaches	0	1	1	1	1	0	0	1	1		1	0
Hampton Blvd. (NIT, NOB, ODU; Lafayette River Br approaches)	1	1	1	0	1	0	1	0	1	4	1	12
Sentara/Fort Norfolk/Brambleton/Mid-Town Tunnel Area	1	1	1	0	1	0	1	1	0	1	1	8
Atlantic Ave and/or Larkin in VB	1	1	0	0	1	1	1	0	0		1	0
Port Access to NIT (& VIG & PIT off of Hampton)	1	1	0	0	1	0	1	0	1		1	0
Elizabeth River Shipyards (incl'g PNSY)	1	0	1	1	1	0	1	0	1		1	0
Wetlands as it relates to fishing industry	0	1	1	1	1	1	1	0	0		1	0
Surry Nuclear Power Plant	0	0	1	0	1	1	0	0	1		1	0
Newport News Reservoir	1	1	0	1	1	1	1	0	0		1	0
Newport News Shipbuilding (HII)	1	0	1	0	1	1	1	0	1		1	0
Langley	1	0	1	0	1	1	1	0	1		1	0
NOB	1	0	1	0	1	1	1	0	1		1	0
Airport (ORF)	1	0	1	0	1	0	1	0	0		1	0
Norfolk & Portsmouth Beltline	1	0	1	1	1	0	0	0	0		1	0
										12		

Figure 2-1 Infrastructure Working Group Evaluation Matrix

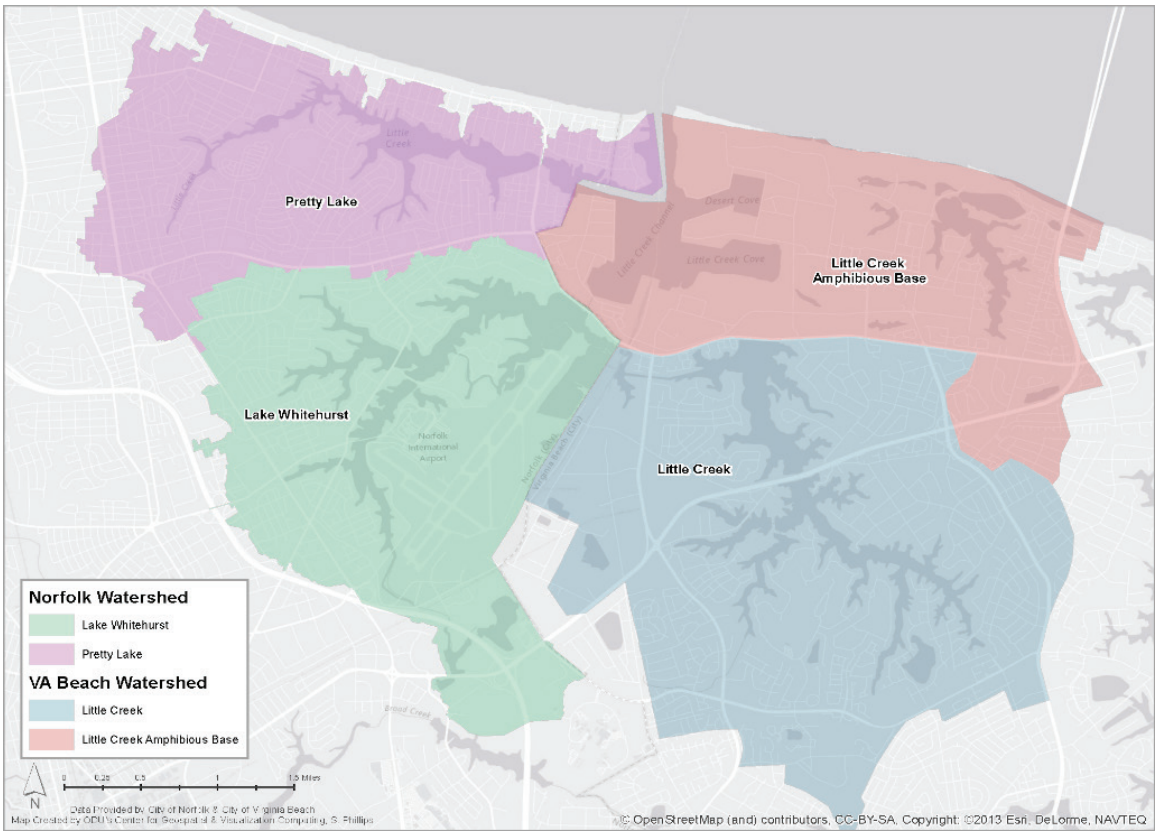


Figure 2-2 Little Creek/Pretty Lake Case Study Area

After evaluation by planning departments in several of the cities participating in the Pilot project, there was concern that the scenarios selected, and the timeframes chosen, portrayed sea level rise elevations that exceeded those under current use by those cities, and in particular exceeded levels they used to address sea level rise planning with their constituents. The cities requested that the IWG consider modification of the scenarios selected to more closely align with those in current use by the cities, and specifically requested any timeframes related to those scenarios be removed. Faced with the potential of study participants withdrawing from the project over this disagreement in projection timeframes and scenario levels, the IWG agreed to modify the scenarios used to evaluate the Little Creek/Pretty Lake study area to include ranges acceptable

to all participating cities, and to remove discussion of timeframes for specific scenario events. The final language chosen and scenario curves used are provided below:

"The Infrastructure Working Group and Private Infrastructure Advisory Committee will evaluate the impacts of relative sea level rise scenarios of 1.5 feet and 3 feet on selected infrastructure in Phase II of the pilot. In addition, they will consider the impact of a '100-year flood' or the flood having a 1% chance of being equaled or exceeded in any given year on these two scenarios."

Virginia Beach SLR/RF Analysis
8638610, Sewells Point, VA
NOAA's Published Rate: 0.01457 feet/yr
All values are expressed in feet relative to LMSL

Year	USACE Low NOAA Low	USACE Int NOAA Int Low	NOAA Int High	USACE High	NOAA High
1992	0.00	0.00	0.00	0.00	0.00
1995	0.04	0.04	0.05	0.05	0.05
2000	0.12	0.12	0.13	0.14	0.15
2005	0.19	0.20	0.24	0.25	0.28
2010	0.26	0.29	0.35	0.38	0.43
2015	0.34	0.38	0.49	0.53	0.61
2020	0.41	0.48	0.63	0.70	0.81
2025	0.48	0.58	0.79	0.88	1.04
2030	0.55	0.68	0.97	1.09	1.29
2035	0.63	0.79	1.15	1.31	1.57
2040	0.70	0.90	1.36	1.55	1.88
2045	0.77	1.02	1.57	1.81	2.21
2050	0.84	1.14	1.81	2.09	2.56
2055	0.92	1.27	2.05	2.39	2.95
2060	0.99	1.40	2.31	2.70	3.35
2065	1.06	1.54	2.59	3.04	3.79
2070	1.14	1.68	2.87	3.39	4.24
2075	1.21	1.82	3.18	3.76	4.73
2080	1.28	1.97	3.49	4.15	5.24
2085	1.35	2.12	3.83	4.56	5.77
2090	1.43	2.28	4.17	4.99	6.33
2095	1.50	2.44	4.53	5.43	6.92
2100	1.57	2.61	4.91	5.90	7.53

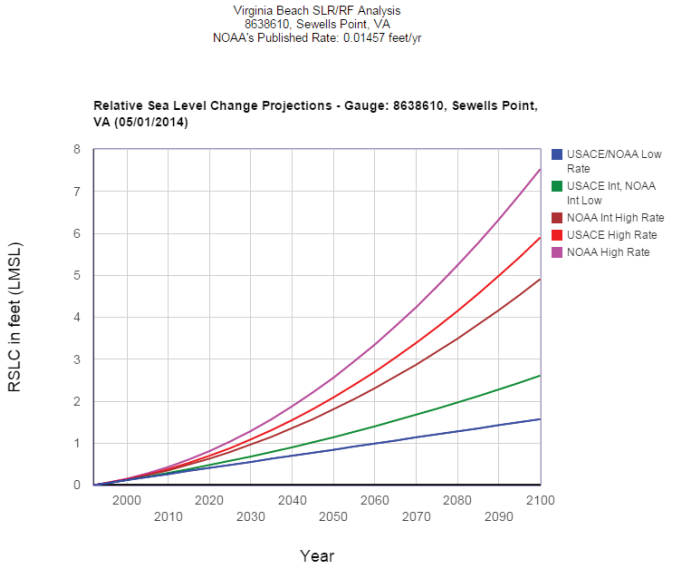


Figure 2-3 USACE and NOAA Relative Sea Level Rise Projections at Sewell's Point, 1 May 2014.

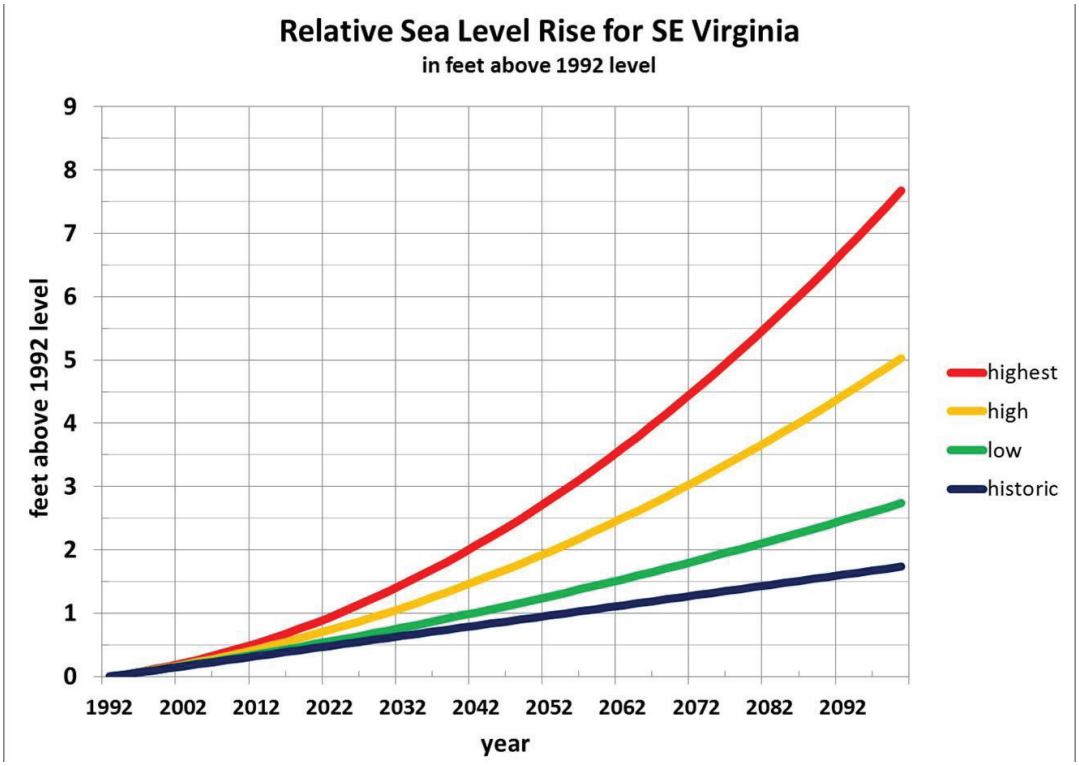


Figure 2-4 VIMS Relative Sea Level Rise Projections for Southeast Virginia

2.2.3. Case Studies

2.2.3.1. Pretty Lake - City of Norfolk Work – Understanding Criticality and Infrastructure Dependencies/Interdependencies

The Pretty Lake Study was completed by the City of Norfolk with the assistance of local engineering firms in 2012, and identified adaptation and engineering solution strategies to a 10% level of engineering effort for adapting the Pretty Lake area to reduce storm surge and flooding impact. Use of this region and study was suggested by a City of Norfolk Senior Stormwater Engineer, who was not a part of the IWG at the time, but was later asked to and did join the working group. As the IWG evaluated the study area, it decided to expand it to include the Navy base at Little Creek and the surrounding watersheds, including Virginia Beach watersheds 1 and 31 and Norfolk watersheds of Pretty Lake and Lake Whitehurst. This expanded area, Little Creek/Pretty Lake, became the case study area used in Phase II of the Pilot.

2.2.3.2. Gulf Coast II - Prioritization Methodologies for Criticality Assessment

The IWG spent two meeting sessions reviewing and taking briefs about the Gulf Coast II study completed by DOT in 2011 (ref GC 2 Study, Task 1), and Gulf Coast Study, Phase 2, by representatives from USDOT, Parsons Brinckerhoff, and ICF International. Of particular interest was the methodology used by U.S Department of Transportation, Mobile Metropolitan Planning Organization and the South Alabama Regional Planning Commission (SARPC) and supporting engineering firms to determine which transportation infrastructures were most critical and most vulnerable to, in this case, storm surge along the Mobile, Alabama, Gulf Coast. DOT and study engineering firms were given a list by the Mobile Metropolitan Planning Organization planning district of over 2,000 transportation infrastructures deemed critical, as developed by local, regional, state and federal inputs evaluating against socioeconomic, operational and health and safety criteria. They then worked through a detailed process of determining specific categorization criteria by which they developed a Criticality Assessment tool -- a matrix and methodology to prioritize which were the most vulnerable critical transportation infrastructures, and then, using DOT's 11-step Engineering Assessment Process, recommended adaptation modifications for those infrastructures.

2.2.3.3. NACCS – Validation of Pretty Lake Engineering Work, and Understanding Adaptation Strategies

The USACE North Atlantic Coast Comprehensive Study, a post-Hurricane Sandy study, provided a comprehensive review of the vulnerability of coastline along the Atlantic Coast to storm surge, and impending sea level rise. This study not only reviewed vulnerabilities, but also made suggestions for adaptation strategies in a broad sense for the full scope of coastline considered within the study confines. In addition, it selected several areas for specific review, one of which was Norfolk, Virginia, and in Appendix D of the NACCS (see IWG References, Appendix E-6), validated work done by the City of Norfolk for a number of critical infrastructure areas within the city, including the Pretty Lake area selected by the IWG for Phase II of the Pilot Project.

2.2.3.4. Little Creek/Pretty Lake Case Study

The IWG selection of the Little Creek/Pretty Lake case study area and the selection of the

scenarios used for evaluation have been described in Sections 2.2.2.1 and 2.2.2.2 of this report. The evaluation of infrastructure dependencies and interdependencies in the case study area can be found in the Private Infrastructure Advisory Committee section of this final report. In addition, a Little Creek/Pretty Lake Case Study Technical Report is included in Appendix X and includes a detailed overview of the Little Creek/Pretty Lake Case Study selection process and scenario selection process, a detailed description of the dependency/interdependency methodology and matrices used, as well as the outcomes and impacts to the study area.

2.2.4. Lessons Learned

The IWG participants repeatedly discussed the importance of community planning and managing the perception of the community. Planning should include high-level perspective, and be reasonable, manageable and executable. Perception of planning in logical steps does matter to get long-range planning started and accepted by an informed community. It is important to recognize that there are many solutions, whether engineering-based or science-based. Engineering-based solutions are not the answer to every SLR problem, therefore they should not be the only type of solution considered. Other key lessons include:

Adaptive redevelopment:

The cities and municipalities included in the Pretty Lake Study area and in the IWG felt that adaptive redevelopment was a key factor to long-range planning to prepare for sea level rise and ongoing recurrent flooding. Portions of the public infrastructure will undergo renewal as the infrastructure ages. It is essential that policies and standards are implemented so that during reconstruction and renewal, the new infrastructure is resilient into the future. This may mean that some infrastructure is reinforced, constructed at higher elevation, relocated or reconfigured.

Planning processes and prioritization:

As highlighted studies reviewed by the IWG, there is a difference between vulnerabilities and criticalities, and any future planning prioritization must consider both aspects. Some things that are vulnerable and important are not critical. It may be easier to measure or quantify vulnerability through a scientific or engineering assessment; criticality, on the other hand, can be more subject to individual perceptions and values, and involves some subjective judgments. Such values, whether they are on behalf of a government, community group or individual, are difficult to quantify, but may be nonetheless essential. These include military preparedness and emergency response capabilities.

Dependencies/Interdependencies:

As they completed the matrices, participants gained considerable insight that, even with their years of professional experience, was new to them. Entire systems must be understood to be able to understand how specific segments are impacted. It is difficult for every city representative to have that level of knowledge in a large city; collaboration among and between managing departments and regions is essential.

Collaboration:

The IWG emphasized the criticality of regional collaboration among all of the Hampton Roads localities and entities, as SLR does not recognize government boundaries. For future sea level

rise planning processes to work, representatives from each affected government entity must be at the table, working collectively to achieve standardization in planning actions, to review, de-conflict and prioritize strategies, standards, and future development policies and procedures.

2.2.5. Recommendations

1. This region should undertake development and formation of a functional process and organization to facilitate regional collaboration, including the local governments, regional, state, tribal and federal agencies, and other entities, that face the most imminent impact from and have the greatest interest in sea level rise. This organization might ultimately be evolved to be considered a "commission, board or council" under Virginia law. It should have authority to foster collaboration among federal, tribal, state and local agencies, with support from academia, and should serve as a collaborative agency to oversee regional matters of importance in facilitating regional sea level rise planning and actions.
2. Federal civil agencies and military branches and localities in the Hampton Roads region must have a way to work together directly, particularly as to determination and processes for approval of authorities and appropriations for funding. This process should begin as an MOU or set of MOUs between federal agencies and local governments or a regional entity representing them. When authority for federal collaboration with local governments is unclear or too restrictive to support effective planning, federal agency or branch headquarters should issue guidance providing their respective field offices and personnel with the authority needed to collaborate effectively with local governments. If a federal agency or branch determines that its ability to collaborate is constrained by federal statute, legislation should be sought to provide that agency authority to collaborate with local governments. Certain existing intergovernmental programs, such as the National Ocean Council and collaboration in the areas of homeland security and emergency management, provide models for legislation authorizing intergovernmental collaboration.
3. The region should establish and adopt a definitive set of regional sea level rise planning scenarios and standards, including a minimum base floor elevation and a standard vertical datum set. The affected local governments and regional, state, tribal, and federal agencies will then be able to work from the same set of scenarios in regional and local planning efforts to address sea level rise and recurrent flooding impacts, adaptation and mitigation.
    - The necessity for planning scenario development and use in decision making for planning is as stated in the April 2016 SERDP report : "Regional Sea Level Scenarios For Coastal Risk Management: Managing The Uncertainty Of Future Sea Level Change And Extreme Water Levels For Department Of Defense Coastal Sites Worldwide." SERDP, April 2016. "This report and its accompanying scenario database provide regionalized sea level and EWL scenarios for three future time horizons (2035, 2065, and 2100) for 1,774 DoD sites worldwide. The decision-making paradigm must shift from a predict-then-act approach to a scenario-based approach. The primary purpose of this report and its associated scenario database is to enhance and increase the efficacy of screening-level vulnerability and impact assessment for DOD coastal sites worldwide containing permanent or enduring assets." (Page ES-1 and ES-2.) With the significant federal presence in Hampton Roads, federal processes and

standards should be accounted for and considered when developing regional procedures and standards so that there is not inadvertent conflict resulting in negative impacts on regional planning efforts over time.

- Federal government leadership and input could make achieving federal standards clearer and simpler for regional efforts.
- A definitive set of regional sea level rise scenarios is essential for addressing planning issues that overlap jurisdictional boundaries, particularly as to land use planning and critical infrastructure design, planning, project prioritization, and construction.

4. Regional identification, evaluation, and prioritization of critical infrastructure vulnerability to sea level rise impact within the next 30, 50, and 75 years should be undertaken. This work should include development of models and methods to understand and incorporate economic impact of adaptation, replacement, or relocation of such infrastructure, along with other relevant social and cultural factors.
5. The IWG noted that the National Climate Assessment (NCA) was updated in 2014 and that it is updated every four years, with updates potentially forthcoming every two years. The IWG recommends that a Science Advisory Committee be established with responsibility for (i) reviewing the NCA and VIMS projections, and the projections used by federal agencies for their own planning (in particular those of DOD and DOT, as they have a considerable stake in the region's sea level rise challenges), and (ii) recommending to the regional planning organization what SLR curves should be used for regional planning. This IPP final report should acknowledge that there will be SLR scenario updates and that these updates should be incorporated into regional planning efforts – in addition to a collaborative decision as to which curves will be used regionally for planning purposes, and that planning scenarios will be updated on a timeline sufficient to address changes to these curves based upon best available science.

2.3. Citizen Engagement Working Group

2.3.1. History, Objectives & Strategy

The Citizen Engagement Working Group (CEWG) was formed in late 2014 to complement the IPP's Whole of Government approach with the perspective of the Whole of Community; that is, anyone in the Hampton Roads region who was not, or did not represent a municipal, state, regional or federal agency or branch of the Department of Defense. Over the course of the project the definition of "community" evolved to include all stakeholders, governmental and otherwise.

The working group chairs sought to complement the IPP by including in the working group a wide variety of non-governmental stakeholders from throughout the Hampton Roads region, including individuals and representatives of community, business, civic and social organizations and non-governmental institutional stakeholders. Almost all participants were volunteers.

The CEWG met on its own and in conjunction with other groups and events between December 2014 and June 2016. The group was co-chaired by Chris Bonney, a marketing researcher and

former chair of the Hampton Roads Center for Civic Engagement, and Michelle Covi, PhD, Assistant Professor of Practice with Old Dominion University and part of the Virginia Sea Grant extension program.

2.3.2. Actions & Accomplishments

The CEWG adopted the following objectives:

1. Create a partnership between the Whole of Community and the Whole of Government.
2. Develop engagement and communications strategies that enhance the capacity of Hampton Roads communities to:
    a. Plan for flooding emergencies.
    b. Prepare for sea level rise contingencies.
    c. Strengthen social capital and resilience.
3. Create a flexible and scalable template that can be customized for different communities.

Because the working group lacked both the human and funding resources necessary to commission its own original research, the CEWG adopted an expert opinion approach that sought initially to focus on:

- Integration of the perspective of the non-governmental community into the IPP
- Providing opportunities for the non-governmental community to contribute to the IPP
- Development of recommendations for future citizen engagement working groups.

The CEWG engaged in a number of investigations through briefings from invited experts in community, governmental, and environment engagement. In addition, group members conducted several case studies through partnerships with outside groups, including participation in the Hampton Roads Chapter of the Urban Land Institute's March 2015 Sea Level Rise conference and a foundation-funded research study conducted by several academic members of the CEWG in the neighborhoods adjacent to the Little Creek Naval Amphibious Base.

2.3.3. Lessons Learned and Case Studies

2.3.3.1. Best Practices of Contemporary Civic Engagement

The typical civic engagement process includes:

- Stating the Issue
- Identify the Stakeholders
- Determination of Information Needs
- Information Distribution
- Issue Framing to Create Alternate Solutions
- Deliberation about Solutions
- Quantitative Measurement of Citizen Solution Preference
- Communication of Conclusions

2.3.3.2. Citizen Engagement and Sea Level Rise in Hampton Roads

Carefully considering and implementing best practices of civic engagement reveals a distinction between the best practices of good civic engagement process and the way that the sea level rise issue has been addressed in Hampton Roads, particularly in the way that discussion of the implications, challenges and solutions to sea level rise in Hampton Roads prior to the formation of the CEWG did not include serious or sincere citizen engagement. The following methods of citizen engagement were outlined from this discussion:

- Structured and facilitated small group conversation, e.g., deliberative dialogue, house party, book club, etc.
- Virtual town hall-type online interactive communication with government.
- Residents developing a neighborhood plan, for emergencies and/or long-term adaptation.
- Interested volunteers framing the regional problem and creating options for community-wide discussion.
- Activities, e.g., citizen science-like observing and recording seasonal changes, telling one's personal story to urge official action, rallies and public demonstrations, shoreline protection, recycling and using renewable energy, etc.

2.3.3.3. Resilient Region Reality Check (March 17, 2015)

The Hampton Roads Resilient Region Reality Check event was held on March 17, 2015, at Old Dominion University. The event was built on three key themes: a region-wide, multi-sector, and whole-of-community approach that is oriented toward actions to address SLR and flooding. This event was a collaboration between the Urban Land Institute Hampton Roads (HRULI), Old Dominion University (ODU), and the Community Engagement Working Group of the Hampton Roads Sea Level Rise Preparedness and Resilience Intergovernmental Planning Pilot Project.

Approximately 130 residents and stakeholders across government, nonprofit, business, and civil society sectors within the Hampton Roads region participated in the event. The event focused on encouraging discussion concerning three items:

- How flooding affects citizens?
- What can citizens do about flooding?
- What resources are needed to address flooding?

For each question, participants were also asked to discuss and identify two regional priorities. From these discussions, six key themes arose:

1. The impacts of sea level rise and flooding are multifaceted;
2. Sea level rise and flooding need to be incorporated into planning and decision making;
3. Land use planning plays an important role in building resilience;
4. Regional collaboration and regionally adopted solutions are needed;
5. Financial and non-financial resources are needed;
6. Civic engagement and outreach are important.

In an end-of-the-day prioritization activity, all attendees were asked to rank the top priorities, selecting from a list of discussion items that had surfaced during this event. Across attendees, the following top priorities appeared:

1. Pursue regional collaboration;
2. Revise zoning and land use;
3. Pursue public education/outreach;
4. Reduce carbon emissions;
5. Pursue natural solutions (e.g., coastal engineering, wetlands preservation).

2.3.3.4. Little Creek/Pretty Lake Research Study

The demonstration project used the Action-Oriented Stakeholder Engagement for a Resilient Tomorrow (ASERT) framework, to facilitate discussion of, knowledge about, and action to adapt to flooding and SLR. The foundation of this engagement framework is the presentation of relevant and accessible information, dialogue and two-way communication, and deliberative and participative mechanisms. The goal of the project is to demonstrate the efficacy of the engagement framework as a tool for facilitating community resilience building through engagement. The ASERT framework incorporates several key principles:

- An inclusive process that engages stakeholders across multiple social dimensions and across the whole-of-community spectrum
- A strong emphasis on surfacing local context and knowledge
- Integrated engagement where social and cultural factors are integral to the process of engagement
- Explicit consideration of change mechanisms, such as structured conversations, deliberative dialogue, and participatory mechanisms.

Conclusions from this initiative included:

1. Residents of the neighborhoods surrounding Little Creek Base identified several cultural and social elements in their community as assets, such as parks, churches, community centers, restaurants, and shops. Residents also identified the base itself as an important asset to the community that should be protected, as well as the Norfolk Airport and several other roads and bridges. The inability to access these important places and flooded streets in general is a major challenge.
2. Property losses such as vehicular loss and damage to residential properties were identified as being widespread throughout the community.
3. Preferred adaptation solutions among focus group participants included natural solutions such as beaches and dunes, flood warning and preparedness, and floodplain policy management.
4. In post-group evaluations, participants responded that they found both the participatory mapping and focus group discussions valuable. Residents were extremely grateful to have the opportunity to have their needs and concerns heard, but wanted more specific action items that they could implement for resilience.

2.3.3.5. Other Case Studies

The CEWG heard presentations from representatives of several organizations and municipalities that both regularly engage various stakeholders in Hampton Roads and are committed to resilience. Those interested in more details with regard to citizen engagement strategies should consult the full CEWG report, which contains detailed case studies. The following case studies were considered by the CEWG:

- *The Hampton Roads Transportation Planning Organization (HRTPO)*

  The HRTPO is Southeast Virginia's regional transportation planning agency. As such, HRTPO communicates with a wide variety of regional stakeholders, ranging from elected municipal leaders, city and county managers, state and federal agencies and, increasingly, "grassroots" citizens. Here, the CEWG considered HRTPO's engagement strategy with Hampton Roads' citizens who are most vulnerable to social and economic disruption by natural conditions and local planning decisions.

- *City of Hampton Waterways Project*

  The City of Hampton, Virginia, has been recognized as one of the nation's leading municipalities in terms of engagement with its citizens. The CEWG considered, for example, the strategies used during a year-long waterways planning project. The goal of Hampton's civic engagement initiatives has been to make local government process and decision making more transparent and to engage more citizens in this process.

- *Wetlands Watch: Chesterfield Heights Project*

  The Chesterfield Heights Project (funded by Virginia Sea Grant) is a collaboration among Wetlands Watch, an environmental advocacy group, the architecture faculty at Hampton University, and Old Dominion University engineering faculty, to address the needs of a historic, low/middle income neighborhood in Norfolk. Bounded by the Elizabeth River and Interstate 264, Chesterfield Heights is a mostly African-American neighborhood of roughly 500 single-family homes, some of which have been divided into smaller dwelling units. Most of the neighborhood is no more than a few feet above mean high water level. The project sought to engage the neighborhood in a discussion of how it could adapt to increasing frequent tidal flooding and overall rising waters. Residents were introduced to landscape, hardscape and nature-based design solutions that could make residences in the neighborhood more resilient.

- *Lynnhaven River NOW*

  Lynnhaven River NOW is a watershed protection group in Virginia Beach. One of their main goals is to educate and engage the community in restoring and protecting the Lynnhaven River. They have a number of restoration projects and try to engage a variety of groups including property owners, children, faith communities and private businesses. The programs have been very successful in improving water quality and educating the community.

- *Mothers Out Front*

  Virginia Organizing Hampton Roads Environmental Justice team has been leading a

collaboration of organizations including the League of Women Voters and others to bring attention to climate change and sea level rise issues in the Hampton Roads area. They are using a program developed by Mothers Out Front, a Boston-based group that uses house parties among social networks to spread information and encourage engagement in climate issues.

- *Southeast Care Coalition Project*

  Through a long-term effort of capacity building, empowerment and relationship building between the Southeast Community and the City of Newport News, this project seeks to create solutions that become cornerstones in the foundation for greater community resiliency. The main objective is to create the relationships and dialogue between city and community that will enable a positive collaboration for an evacuation plan before it is needed in a future crisis.

2.3.4. Recommendations

The CEWG study led the committee to believe that the optimum strategy for addressing sea level rise and identifying and implementing adaptation solutions does not lie in identifying separate Whole of Government and Whole of Community strategies, but rather in developing a single "whole of region" strategy that unites science, academia, engineering, planning, governance, and citizen/stakeholder participation in a collaborative environment.

The following steps are recommended:

1. Recognize that sea level rise is a serious issue that touches the entire region and that engagement on a piecemeal basis or on the basis of governmental purview, municipal boundaries, local political will or current levels of stakeholder interest is not a viable long-term strategy.

   Rising waters do not observe municipal boundaries. Even those living in Hampton Roads municipalities not impacted directly by rising waters may be impacted by the economic ripple effect of rising waters. Therefore, addressing sea level rise and recurrent flooding on the basis of political boundaries or current perceived vulnerability is not an efficient or effective way to address this regional environmental challenge.

2. Identify a respected regional entity to "own" and be responsible for being the thought leader on sea level rise in Hampton Roads and for convening Whole of Community deliberations regarding sea level rise.

   At the conclusion of the IPP no single entity will "own" thought leadership or responsibility for convening the region on issues related to sea level rise. Therefore, an entity having these characteristics must be identified:

   - Geographic scope as large as the issue and not bounded by municipal or other political boundaries within the region.
   - A record of dealing effectively with issues of a regional nature.
   - Welcoming to both "grassroots" and "grasstops."
   - Credible organizer and convener of science, government, academia, citizen and other stakeholders.

- Trustworthiness.
- Perceived impartiality.
- Knowledge of the best practices of civic engagement.
- Access to experienced civic engagement facilitators.
- Experience communicating to the entire region.

3. Use the best practices of civic science—including good facilitation process and good methods for information dissemination and feedback—to engage all stakeholders in sea level rise deliberation and decision making from the very start.

   Creating successful civic engagement partnerships depends on the presence of conditions that must be specifically developed, rather than left to chance:

   - There must be clearly defined goals and expectations.
   - Goals must reflect not only the needs of the governmental factors or entities, but also the priorities of citizens.
   - The process must be open to all who have exposure to the impacts of sea level rise.
   - Participants in the process must have respect for and trust in each other.
   - Collaborations between citizens and government require respect for all parties involved.
   - There must be confidence in the collaborative process and that its outcome will be given respect.

4. Create benchmark and ongoing internal and external tracking metrics for assessing the performance and effectiveness of the engagement program and its impact on the ability of the Hampton Roads region to rise to the challenge of sea level rise.

   To assure stakeholders, funders and other participants that the engagement of the entire region in addressing the challenge of rising waters is proceeding in an efficient and responsible manner, it will be necessary to establish internal and external benchmark and tracking metrics that monitor factors such as:

   - Levels of participation and inclusiveness.
   - Perceived levels of respect and trustworthiness in the process.
   - Perceived levels of success in meeting the challenge of sea level rise.
   - Awareness and understanding of the issues and implications of sea level rise among the general population.
   - Awareness and knowledge of information and resources available for mitigating and adapting as waters rise.

2.4. Public Health Working Group

2.4.1. History, Objectives & Strategy

As noted in the Phase 1 Report, the Public Health Working Group (PHWG) was formed in April 2015, at a meeting of the Steering Committee. The working group is chaired by Steven M. Becker, PhD, Professor of Community and Environmental Health, College of Health Sciences, Old Dominion University. The aim of the Public Health Working Group is to make public health an integral part of sea level rise planning, adaptation and resilience efforts in the region.

Specific areas of focus include analyzing potential public health impacts of sea level rise in Hampton Roads; identifying ways to incorporate public health issues into planning, adaptation and resilience efforts; engaging the public health community in sea level rise projects; identifying special areas of expertise that public health can contribute (e.g., public health emergency preparedness, health and environmental risk communication, health-related community outreach, epidemiology, industrial hygiene, and working with vulnerable/special needs populations); identifying new and innovative ways of incorporating sea level rise issues into public health education and training in the region; and developing new and innovative solution-oriented projects to address public health aspects of sea level rise locally and around the nation.

Upon the formation of the committee in April 2015, area health agencies, including health departments, public health higher education programs, and public health research organizations, were contacted and invited to participate in the newly established Public Health Working Group.

2.4.2. Actions & Accomplishments

The PHWG's initial activities have been focused in three broad areas: (1) working to integrate sea level rise preparedness and resilience issues into graduate public health education in the region, (2) creating new linkages and collaborations for information exchange, practice and research on sea level rise and public health, and (3) assessing the public health implications of sea level rise in the region.

2.4.2.1. Integrating Sea Level Rise Preparedness and Resilience Issues into Graduate Public Health Education

Members of the Public Health Working Group have been working with faculty at area institutions of higher education to better integrate sea level rise issues into graduate public health education.

2.4.2.1.1. Curriculum

The effort began with the foundational course in environmental health that is taken by all first-year students in the Master of Public Health (MPH) program jointly offered by Eastern Virginia Medical School (EVMS) and Old Dominion University (ODU). The three-credit course, entitled Principles of Environmental Health (ENVH 600/MPH 613), now includes a two-part module on climate and sea level rise issues. Topics include health impacts of sea level rise, storm surge and coastal flooding; vulnerable populations; challenges for public health and healthcare system preparedness; and implications for public health planning and training. Additional content on sea level rise and health will be added to other courses in the 2016-2017 academic year. Furthermore, ODU is in the process of adding faculty positions specifically focused on climate and health. These will be based in the School of Community and Environmental Health in the

College of Health Sciences. Thus, in the near future, entire courses should be available on climate, sea level rise and health.

2.4.2.1.2. Practicum

A particularly innovative step to create links between public health professional education and sea level rise was taken in 2016 when a "community practicum" focusing specifically on sea level rise was created. All second-year MPH students are required to complete a 3-credit graduate course entitled Community Practicum (MPH 750). The practicum is intended to provide students with an in-depth supervised experience in an approved organization. Under the guidance of an on-site preceptor and an academic adviser, students work on real-world public health issues using the knowledge and skills gained in academic courses.

The 2015-2016 academic year saw the completion of the first community practicum on sea level rise. MPH student Christina Gumina was based with the IPP, where she worked under the direction of practicum supervisor Emily E. Steinhilber, Esq. (Assistant Director of Coastal Resilience Research) and academic adviser Dr. Steven M. Becker (Chair of the Public Health Working Group). Ms. Gumina's multi-part project involved carrying out an overall literature review on public health impacts of sea level rise, focusing on a smaller subset of those impacts, and relating the findings to the Hampton Roads area. Ms. Gumina also attended committee and working group meetings, in a similar manner to the legal liaisons, to provide a public health perspective. In addition, the practicum paper offered a series of recommendations for follow-up work on public health and sea level rise. The paper is included as an appendix to this report (see Appendix G-2).

Figure 2-5 Assessing the Public Health Implications of Sea level Rise in the Region

2.4.2.2. Creating New Linkages & Collaborations for Practice and Research on Sea level Rise and Public Health

Another major area of emphasis for the Public Health Working Group involved the creation of new linkages and collaborations for practice and research. A notable example of this effort involved a special program that was held at ODU in March 2016. Co-sponsored by the Public Health Working Group, the program featured a special six-person delegation from the U.S. Environmental Protection Agency (EPA).

The delegation discussed a new interactive mapping tool for better understanding links between the environment and human health. Called EnviroAtlas, the tool enables users to access, view, and analyze local and regional environmental data to better understand how individual and community decisions can affect sustainability and resilience. Users can access, view, and analyze hundreds of local and regional environmental data layers to better understand the potential impacts of various decisions on sustainability and resilience. EnviroAtlas covers the contiguous U.S. at 30-meter and watershed resolutions, and selected urbanized areas at 1-meter and census block group resolutions. EnviroAtlas will include the greater Norfolk area as a featured community in 2017.

Although the initial focus of the tool has been on basic environmental features and health, future additions will include climate change metrics, land use scenarios, runoff and recharge metrics, and flood plain information. As such, EnviroAtlas has enormous potential to be helpful in understanding links between ecosystem services (benefits provided by nature and valued by people), flooding and related sea level rise issues, and human health.

2.4.2.3. Assessing the Public Health Implications of Sea level Rise in the Region

Because some of the most serious impacts of sea level rise are those affecting public health, and because these impacts are likely to be an important focus of concern across a wide variety of sectors involved in a Whole of Government/Whole of Community approach, public health issues need to be an integral part of sea level rise adaptive planning efforts. Toward this end, the Public Health Working Group has been carrying out a case study of potential SLR public health impacts and issues in the Pretty Lake Watershed. This work is being carried out as part of a broader project funded by the Blue Moon Fund. To date, the project team has been working to identify the range of potential public health impacts associated with SLR alone (1.5' and 3.0' sea level rise) and with storm surge situations (1.5' sea level rise + 100-year storm surge and 3.0' sea level rise + 100-year storm surge).

Potential public health impacts are being identified by drawing on the scholarly literature about SLR and public health, consulting documents about the watershed, utilizing infrastructure maps and other map products of the area, and via actual visits to parts of the Pretty Lake Watershed. An example of an SLR alone impact is a significantly increased problem with pools of standing water, which can enable the rapid growth of mosquito populations and result in the spread of infectious diseases. An example of an SLR + Storm Surge public health impact is water from flooding causing the growth of mold, resulting in an increase in allergic reactions and asthma. In addition to such traditional public health concerns, the case study is devoting attention to less-known potential impacts. This includes contamination of the environment with hazardous

materials that are found in a surprising number of facilities and locations, and that may be released under certain circumstances. Once the analysis of public health impacts has been completed for the Pretty Lake Watershed case study, key insights will be expanded to include the Hampton Roads region more generally.

2.4.3. Recommendations

The following conclusions and recommendations are provided by the PHWG:

1. Some of the most serious impacts of sea level rise are those affecting public health.
2. Consequently, there will be a continuing need for public health issues to be an integral part of current and future sea level rise adaptive planning efforts.
3. In the Hampton Roads region, it will be essential to continue and further expand the activities and the membership of the Public Health Working Group.
4. One important area of focus needs to be on understanding potential public health impacts of sea level rise, and the implications of those impacts for planning, training, preparedness, practice, and decision making.
5. Another area of focus should deal with how public health expertise in such areas as health and environmental risk communication, health-related community outreach, working with vulnerable/special needs populations, epidemiology, industrial hygiene, and public health emergency preparedness can best contribute to broader sea level rise adaptation efforts.
6. Research on the public health dimensions of sea level rise will be a continuing area of emphasis. In this regard, new tools such as EnviroAtlas have the potential to improve our understanding of environment-health relationships, and to enhance sea level rise adaptation planning efforts.
7. Preparing the next generation of public health professionals to grapple with sea level rise issues will also be vital. Curricular innovations, new practicum sites, new courses, and related initiatives such as those described above all have a role to play in contributing to this effort.

2.5. Land Use Working Group

In accordance with the Charter, the Land Use Working Group (LUWG) was to recommend which land-use related plans, programs, and policies in Hampton Roads require adaptation planning and to formulate recommendations for intergovernmental coordination. In consultation with the Municipal Planning Advisory Committee, the working group was to address land use planning, floodplain management, local government comprehensive plans, zoning, building codes and other plans, programs, and policies it identifies in the course of its work.

As detailed in the Phase 1 report, under the leadership of Burrell Saunders of the Urban Land Institute Hampton Roads and Saunders + Crouse Architects, the group initially developed an extensive work plan, which would have extended well beyond the duration of the IPP with the support of Urban Land Institute and university partners. This work plan aimed to address the ways in which we live, work, and do business in Hampton Roads and sought to (1) raise awareness, (2) define the approach, (3) explore the value proposition, and (4) advance the state of practice and policy. This work plan is attached in Appendix G.

The Land Use Working Group was dissolved during the course of Phase 2 of the IPP. Although land use planning is a critical component of regional resilience planning, the group never fully coalesced, and formally ceased when the Phase 1 chair, Burrell Saunders, resigned effective December 2015. The Steering Committee discussed this resignation in its next meeting and decided not to replace him. The group noted that land use planning is a key function of localities, and as such should be left to the individual localities; consequently, the steering committee was uncomfortable moving forward with such a committee.

While the Land Use Working Group as a part of the IPP ceased work prematurely, localities should still continue to work together using the best available science to incorporate resilient strategies into their zoning codes, building codes, comprehensive plans and other plans where appropriate. Moreover, collaborative Whole of Government initiatives in other geographical areas may benefit from an active land use committee where this region did not.

2.6. Science Advisory Committee

2.6.1. History, Objectives & Strategy

The initial meeting of the Science Advisory Committee (SAC) was on December 10, 2014, at a Federal Emergency Management Agency National Exercise Division event. Membership in the committee was not restricted and continued to grow over the next year under the leadership of Dr. Larry Atkinson, Slover Professor of Oceanography, ODU, and Dr. Carl Hershner, Director of the Center for Coastal Resources Management, VIMS. The SAC was co-chaired by Larry Atkinson, Old Dominion University, and Carl Hershner, Virginia Institute of Marine Science.

The original scope of work as defined by the Charter was as follows:

The Science Advisory Committee is responsible for providing the Executive Steering Committee with critical information based on relevant scientific research of interest to the IPP. Topics will include information on global mean sea level rise, local relative sea level rise, vertical land motion, dynamical ocean change, ocean fingerprinting, extreme water levels, decision frameworks, risk management, and uncertainty management in addition to any other scientific inquiries made by the Executive Steering Committee. Additional work includes providing updates on the activities of Federal agencies relevant to Hampton Roads, to other stakeholders, and developing a plan for and a mechanism to provide integrated information on science observations and information. The Science Advisory Committee will also develop a 'roadmap' or 'framework' for summarizing sea level rise knowledge, integrating information, and identifying gaps in sea level rise observation.

The SAC quickly evolved to being a coordinating organization between the various stakeholders in the region and federal agencies. It should be noted that the active members of this committee had jobs that specifically included activities directly related to goals of the committee; they were in general not volunteers.

2.6.2. Actions & Accomplishments

Teleconferences were scheduled approximately monthly. A framework for topics of discussion was developed following the first conference call, but requests for additional topics were accepted

as the project developed. Most of the original topics were covered during the scheduled calls. Several collaborative proposals were developed and are ongoing to address technical issues/ needs which arose from the discussion.

2.6.3. Lessons Learned

The SAC learned that sea level rise science activities in the region are to a large extent done by either federal science agencies or academics, neither of which are strongly linked to the needs of the regional stakeholders. Strengthening that link so that the science can address stakeholders' needs is the challenge.

Sea level rise scenarios that cities will use in their planning will be determined by each city, which often will contract an engineering company. The projections they use will usually refer to authoritative federal government projects: for example, the National Climate Assessment or the USACE sea level rise calculator. It was not appropriate for this committee to develop projections –rather, to help stakeholders understand them.

Members of the SAC interacted with other committees in various ways. For example, some members interacted with the Citizen Engagement Working Group to discuss the timing of impacts to the school system with school superintendents. It became clear that there is a need for this type of very specific analyses and discussions of sea level rise impacts and that this should be a priority moving forward. Discussions of technical issues with local decision makers can lead to easily realized action which will improve resiliency.

2.6.4. Recommendations

The following recommendations were developed by the Science Advisory Committee:

1. We recommend that the function of the SAC continue regardless of the fate of the IPP.
2. We recommend that the newly funded Commonwealth Center for Recurrent Flooding Resiliency (CCRFR) function as the coordinating organization for the committee. The CCRFR will be responsible for forming the steering group for the Science Committee.
3. We recommend that the main goal of the SAC be to provide a mechanism to assure that the sea level rise science needs and requirements of regional stakeholders are addressed.
4. We recommend that the SAC include the following at a minimum: regional scientists and engineers familiar with RSLR, storm water managers and coastal engineers with the cities and HRPDC, engineers from the companies contracted by the cities and region, relevant Commonwealth agencies including water resources, federal agencies including NOAA/NOS, NOAA/NWS, Interior/USGS, NASA, DOD, Interior/FWS, Interior/NPS, local WFO Wakefield, etc.
5. We recommend that over the coming year the committee facilitate meetings with regional stakeholders to determine their specific requirements.
6. We recommend the following specific tasks -- subject, of course, to future revision. (Note – in many cases, the committee may facilitate an activity rather than provide that activity itself.)
   a. Monthly or bi-monthly conference calls. These will be initiated by the CCRFR.
   b. Topical conferences as appropriate. These may be done as part of the ongoing Hampton Roads Adaptation Forums hosted by HRPDC, ODU, Virginia Sea Grant and others.

c. Topical reports – possible annual or bi-annual "State of the Region – Sea level rise and recurrent flooding."

d. Consider expanding beyond sea level rise and flooding to include other climate change variables: air temperature, rainfall, humidity, etc.

e. Facilitate creation of a web services portal for all relevant sea level rise data in the region.

f. Facilitate a knowledge database for sea level rise science relevant to the region, possibly using the ODU Digital Commons system supported by the ODU Libraries.

g. Facilitate reports to federal agencies on needs/requirements. These would be developed by regional stakeholders.

h. Coordination with Hampton Roads Adaptation Forums and other relevant organizations in the region. For example – professional engineering societies.

i. Facilitate data telemetry and broad distribution of local real-time water level observations to all of Hampton Roads.

2.7. Private Infrastructure Advisory Committee

2.7.1. History, Objectives & Strategy

The PIC was chaired by Carol Considine, Associate Professor, Engineering Technology, Old Dominion University, and Pete Perritt, President, Building Constructive Solutions, was co-chair. Additional PIC members are listed in Appendix I in the independent PIC report.

The Private Infrastructure Advisory Committee (PIC) had an official public kickoff on December 10, 2014, at the Federal Emergency Management Agency National Exercise Division event, side by side with many other committees and working groups. This event was an opportunity to identify local businesses and citizens that were interested in advancing resiliency in the region. Participants at the event pertinent to the critical private infrastructure sectors, and firms that support this sector -- engineering, consulting, and construction -- were present and expressed support in moving forward as part of the PIC. While it is important to have a broad cross-section of participation and include critical infrastructure support companies, it was necessary to ensure that all private critical infrastructure sectors pertinent to the region were included in either the PIC or the Infrastructure Working Group (IWG) that included public infrastructure entities.

The Private Infrastructure Committee's membership was developed from the Department of Homeland Security Critical Infrastructure Sectors list (https://www.dhs.gov/critical-infrastructure-sectors) and that list and membership are found in the Private Infrastructure Committee Report in Appendix I. The following is a summary of critical infrastructure sectors and their members included on the PIC:

- Commercial Facilities: Hampton Roads Realtors Association and Hampton Roads Association for Commercial Real Estate (Phase 1)
- Communications and Information Technology: Verizon
- Energy: Dominion Virginia Power, Virginia Natural Gas

- Healthcare and Public Health: Sentara Norfolk General Hospital
- Transportation: Virginia Maritime Association

Developing contacts within pertinent organizations can be difficult. The key to success in contacting the correct individual can be a combination of networking and persistence. In many cases, the correct person is a risk manager, facilities manager, or engineer within the organization. These are the people that will be tasked with solving problems related to sea level rise (SLR) and they have a vested interest in participation.

Not every organization contacted was interested in participating in the Pilot Project, for example, those contacted within the banking industry declined to participate. However, the final outcome/deliverables were not impacted by the missing critical infrastructure sectors or companies, though this may not always be the case.

The PIC used the Charter to guide its work. A scope of work was developed from the Charter in the spring of 2015 and work was completed based on that scope. The only change to the scope of work was that adaptive planning was completed for one infrastructure project instead of two infrastructure projects. The original intent was to have one of the adaptive planning projects to come from private infrastructure, specifically, the electrical sector; however, we found that Dominion Virginia Power had already hardened their substation facilities for hurricane preparedness to a level beyond the SLR and storm surge scenarios adopted by the IWG.

2.7.2. Actions & Accomplishments

The PIC was responsible for providing support to the IWG regarding critical private infrastructure for the Pilot Project. Support included identification of: critical private infrastructure, dependencies and interdependencies between private and public infrastructure, best practices of SLR adaptation by industry sector, and identification of restrictions and limitations (administrative, managerial, jurisdictional, or legal) to private/public SLR preparedness infrastructure planning. In Phase II of the Pilot Project, the PIC supported IWG in the adaptation planning for one selected infrastructure project in the Hampton Roads region.

The PIC organized the work plan to meet the list of deliverables noted in the final PIC report and during the two-year project focused on identification and engagement of privately owned critical infrastructure, identification of current practices and barriers to implementation of SLR adaptation measures, sharing of best practices related to SLR adaptation, identification of resources available for companies to plan for SLR adaptation, and outlining recommendations related to privately owned infrastructure for SLR adaptation.

During Phase II of the Pilot Project the PIC decided that it would be helpful in developing recommendations (resiliency strategies) to review the resiliency planning documents that have been completed in other regions of the United States. The New Orleans region and Southeast Florida region have both made significant progress in developing resiliency plans that are being implemented in their regions. It is significant to note that while neither region has legislated action related to these resiliency plans, the strategies and visions laid out in their regional documents are being implemented voluntarily by local governments to strengthen their regions' resiliency. These documents are available, respectively, at http://resilientnola.org/wp-content/uploads/2015/08/

Resilient_New_Orleans_Strategy.pdf and http://www.southeastfloridaclimatecompact.org/compact-documents/. There are additional coastal resiliency strategies that could be reviewed for guidance such as San Francisco, Boston, New York, and New Jersey.

2.7.3. PIC Methodology

The PIC organized its work to meet the list of deliverables noted in the full PIC report. This was accomplished primarily during scheduled meetings, using presentations and discussions. The following summarizes the significant presentations, meeting discussions and work product of the PIC, with a more detailed accounting in the full PIC Report in Appendix I:

2.7.3.1. Identification and Engagement of Privately Owned Critical Infrastructure

Using the Department of Homeland Security Critical Infrastructure Sectors list, provided in Table 1 under the Membership Development section of this report, firms listed were contacted and asked to participate in the Pilot Project. The committee had representation from the commercial facilities/real estate, communications, energy, healthcare, information technology, and transportation sectors. There was no representation from the financial sector. The private transportation sector was represented by the maritime industry but there was no representation of air or rail transportation. While the energy sector was represented by the electrical and gas industries, there was not representation from the oil transportation, coal, alternative energy, or storage industries.

The Pilot Project was focused on process, not final solutions. The lack of participation from all critical infrastructure sectors did not detrimentally impact the project but the process may have been enhanced by their participation. In addition, not all committee members attended every meeting or were fully engaged in the work of the committee. Recommendations for inclusion of private critical infrastructure in future SLR adaption planning include:

- Quarterly meetings may be more appropriate. Monthly meetings may require too much time from private companies.
- Education on SLR and storm surge impacts and risks, as well as how adaptive actions can be incorporated in operations and maintenance and capital improvement cycles, may increase interest in adaptation.
- Case studies looking at specific watersheds within the Hampton Roads region may make the SLR adaptation planning more pertinent to firms. Case studies allow examination of actual infrastructure in the case study area and demonstrate SLR scenarios, future impacts, and related risks of SLR.
- Municipalities may want to reach out to private critical infrastructure firms in their jurisdiction, encourage their participation, and educate them on the importance of their participation in regional resiliency efforts.

2.7.3.2. Identification of Current Practices for the Electrical Substations, Healthcare and Maritime Industries

There were two strategies employed to identify current practices related to SLR adaptation/resiliency: private infrastructure companies participating in the Pilot Project were given the

opportunity to present their resiliency/emergency planning efforts, and resources related to resiliency/adaptation standards for specific industries were researched and compiled.

Sentara Norfolk General Hospital and Dominion Virginia Power both provided presentations on their current efforts in resiliency/emergency management planning. Sentara Norfolk General Hospital specifically and the entire Sentara healthcare system are proactive in severe weather and emergency preparedness. The hospital system must comply with the standards of the American Society for Health Engineering. Part of these standards include the development of Hazard Vulnerability Analysis, which includes a matrix to determine risk exposure. Sentara is including adaptation/hardening of facilities in all capital improvement projects.

Dominion Virginia Power has been proactive in hurricane preparedness planning per Federal Energy Regulatory Commission (FERC) requirements. They have already elevated and hardened some of their facilities. They are active in CIGRE, the Council on Large Electrical Systems, which is an international nonprofit association that promotes collaboration and knowledge sharing with experts around the world to improve electrical systems.

While neither Sentara nor Dominion Virginia Power are incorporating SLR into current resiliency/emergency management planning, both agreed that it could be incorporated in future planning. Other committee members noted that they also have emergency management planning in place, but they do not include SLR into this planning. Suggestions to help the infrastructure sector include SLR in long-range planning include:

- Provide regional SLR scenarios for private industry to incorporate in long-range planning. This standardization will eliminate confusion across the region and enable companies and industries with facilities throughout the region to proactively adapt to SLR.

Virginia Maritime Association provided background on Virginia's ports including their importance and status nationally, as the second largest on the East Coast in tonnage and third in containers, and their impact on the Hampton Roads region, with over $60 billion in annual spending and contributing 6.9% of the gross state product. They outlined the components of the marine transportation system and the varied and extensive manufacturing and distribution facilities in Virginia that are reliant on Virginia's port operations. They noted that the maritime industry appears to have a varied response to SLR based on size of company and resource availability. Larger companies recognize the risk and are starting to think in terms of capital reinvestment, but smaller firms do not have the capacity to move in this direction.

Williams Mullen staff provided background on the regional benefits of coastal/shoreline property, related industries, and the importance of the supporting infrastructure. They presented a summary of physical impacts and risk factors related to SLR, the need to consider the physical, operational, environmental, and legal ramifications of the impacts and risk. They discussed the financing needs to adapt to SLR risk and recognized the business opportunities that will be developed as companies implement resiliency/adaptive strategies.

Of importance to the Hampton Roads region as it moves forward in SLR planning, is the recognition that private and public infrastructure systems are coupled and cannot be separated, requiring collaborative problem solving across all infrastructure systems. An example of this related to the ports is that while the ports may be publicly owned and operated, they are served

by the private operations of the terminals for transportation of goods. Both are necessary for economic success.

Suggestions related to coastal/shoreline industries provided by Williams Mullen included:

- Education and vulnerability messaging for coastal businesses is necessary and should include the risk, assessment tools, planning strategies, resources, adaptation strategies, etc.
- Incentives for investment in capital improvements for resiliency/adaptive actions should be made available. (Resiliency enhancement = tax break)
- Industry associations are an excellent resource and should be leveraged for education on SLR and resiliency planning strategies.
- The maritime industry is lacking in resiliency planning resources when compared to other industry sectors and development of those resources would be beneficial.
- Federal, state, regional, and municipal governments should provide leadership to industry in terms of SLR planning scenarios.
- Environmental hazards and cleanup of environmental sites along the coastline need consideration in regional SLR planning.
- Develop strategies and opportunities for new business development in the area of SLR adaptation. Examples: green infrastructure business, flooding applications, etc.

The identification of current practices noted above is limited in scope to three infrastructure sectors from three specific perspectives. Additionally, the region should conduct further research on current industry practices related to SLR planning to include all industry sectors and all business sizes.

2.7.3.3. Identification of Business Risk Related to SLR and Coordination with Emergency Management Services

Williams Mullen also provided background on the operational, capital, financial, and legal risk factors associated with SLR. The presentation highlighted the importance of the shoreline and water as a key factor in the regional economy and the reliance of that economy driver on other infrastructure that is compromised during flooding events.

Physical impacts and economic impacts were discussed in terms of how they may create changes in land use planning, government and private funding available for investment, demographic shifts and lifestyle changes. These changes, if managed well, can create opportunities in the region. Local business enterprises need to evaluate business risk associated with SLR considering all risk factors and their impact to earnings, and liquidity property/assets market value. Evaluating risk is difficult when the risk, like SLR, is uncertain and the options to minimize or mitigate risk are complex, costly and evolving. Both public and private investment will be necessary for financing of infrastructure, resiliency costs, and for new business development in the areas of resiliency.

The City of Virginia Beach's Deputy Emergency Management Coordinator, Erin Sutton, joined the PIC to discuss critical infrastructure. She explained how critical infrastructure is prioritized in the Commonwealth and introduced the DHS-funded Port Security Risk Assessment that is underway to identify critical infrastructure, dependencies and interdependencies. She discussed

the local emergency planning committee strategies and actions taken to engage private facilities in emergency planning and highlighted the partnerships that have been created with federal, Commonwealth, and private industry in the region.

2.7.3.4. Identification of Resources

The PIC has identified resources for private industry use that include best practices for adaptation to climate change and SLR. It is limited in scope and the listing of a resource is not a recommendation for use. It is recommended that the additional resources be identified and that a resource library be made available to the region. The list of resources identified is located in the Key Resources/Literature section of the full PIC report in Appendix I.

During the process of resource identification, it was noted that individual industry sectors are developing their own best practices and updating industry regulations and requirements to incorporate resiliency/adaptation standards. Examples of this are the CIGRE publication, Air Insulated Substation Design for Severe Climate Conditions, B3.31, 2014, which Dominion Power has contributed to, and the standards for the American Society for Health Engineering. Additional resources by industry sector should be identified as needed.

The U.S. Climate Resiliency Toolkit is a useful starting point for all industries. (http://toolkit.climate.gov/get-started/overview). This resource includes a five-step process to build climate resilience: (1) Identify the Problem; (2) Determine Vulnerabilities; (3) Investigate Options; (4) Evaluate Risks & Costs; (5) Take Action. The toolkit provides a framework for individuals, businesses, and communities to respond to the challenges of climate change.

2.7.4. Case Studies

2.7.4.1. EIMA

The U.S. Department of Energy, Energy Infrastructure and Modeling and Analysis Division (EIMA) recently completed a study to assess the potential exposure of energy facilities in the Hampton Roads region to a general rise in sea level and from storm surge at these higher sea levels. The analysis focused on the risk in 2050 and 2100, and included electricity assets, natural gas assets, and petroleum assets. The results of the study indicate that these assets would not be inundated under the National Climate Assessment (NCA) Intermediate-High SLR Scenario in 2050. However, there is significant risk to these assets when a storm surge associated with a Category 4 storm is considered. In addition, the NCA Intermediate-High Scenario predicts 5 feet of SLR by 2100, which would inundate multiple energy assets in Hampton Roads. A Category 1 storm in addition to the 5 feet of SLR would cause extensive inundation of energy assets. The results of this report are being shared with respective energy providers for their consideration in SLR planning and adaptation efforts.

2.7.4.2. Little Creek/Pretty Lake Case Study

The IWG selected the Little Creek/Pretty Lake Case Study area and SLR and storm surge scenarios that were evaluated as part of the case study. Please refer to the IWG report and/or Case Study Technical Report summary in the appendix for this information.

Tom McNeilan of McNeilan and Associates was involved in preliminary design work for the City of Norfolk Pretty Lake storm surge barrier. He provided a context of the study, that it was

completed prior to Superstorm Sandy and also pre-dated the current thinking on incorporating blue and green infrastructure into solutions. He indicated that at the time of the study, the City of Virginia Beach was approached to see if they were interested in working together with the City of Norfolk on a solution to the Little Creek/Pretty Lake watershed and that they declined involvement at that time. He acknowledged that while a storm surge barrier at Shore Drive to protect Pretty Lake could increase flooding risk at Little Creek Amphibious Base and Little Creek watershed, the impact is not likely to be significant.

He outlined the geological and subsurface conditions of the area highlighting that the area is relatively flat with a median elevation of 9 feet and that 25% of the watershed is below 7 feet in elevation. It is not unusual for low ground in East Ocean View to be moderately inundated in severe storms and both storm surge and sea level rise are issues for the area. When considering protection of the Pretty Lake area, it is important to recognize that the watershed is relatively large in comparison to the outlet, and that flood protection is required at the outlet of Pretty Lake and also at the shore along the Chesapeake Bay.

The current Dutch water management perspective was discussed, which includes consideration of water as where the environment meets the economy. While barriers are needed in some cases, you cannot depend on them exclusively. Hybrid solutions of gray and green infrastructure are necessary and can be an avenue for providing multiple lines of defense. Water strategies that are implemented should include options that slow the water down, store and use the water, and then drain the water after an event is over.

2.7.4.3. Mapping Infrastructure Dependencies

In order to understand critical infrastructure internal and external dependencies, a spreadsheet was developed that enabled infrastructure systems to map internal dependencies, dependencies within their own systems, and external dependencies, dependencies upon other infrastructure systems. Two spreadsheets, Internal Factors and External Dependencies, were developed and infrastructure sectors were asked to complete an analysis of their systems. We limited the analysis to the Little Creek/Pretty Lake area based on the scope of the Pilot Project; however, this should be done for the entire Hampton Roads region.

The Internal Factors spreadsheet required each infrastructure system to develop a list of internal factors that they are dependent on for operations. For example, hospital systems' internal factors might be: water, power, communications, staff, sanitary, HVAC, security, computer systems, medical gas, and sustenance and supplies. Once a list of internal factors was established, that list was evaluated within the selected geographic area based on SLR and storm surge scenarios. The evaluation of internal factors was completed based on the questions of: Are these internal factors vulnerable under this scenario; and how vulnerable are they under this scenario? The evaluation of vulnerability was based on a scale of: not vulnerable (no impact); low vulnerability (less than 33% of impact); medium vulnerability (less than 66% of impact) and high vulnerability (system impact greater than 66%).

Each system was then evaluated based on the dependencies of the internal factors on external infrastructure systems. For example, a hospital's internal factors would be evaluated against the following external infrastructure systems: city water, electric, gas, communications (data/

internet), communications (voice), transportation (air), transportation (roads), transportation (rail), transportation (vessel), sanitary, sanitary treatment, medical facilities, federal facilities, emergency services, and vehicle fuel. The evaluation of internal factor dependency on external infrastructure was completed based on the question of: How dependent are your internal factor operations on the external infrastructure system? The evaluation of threat to internal operations was based on a scale of: no threat (no impact); low threat (less than 33% impact); medium threat (less than 66% impact) and high vulnerability threat (system impact greater than 66%). In evaluating threat to internal operations, the existence of emergency planning was taken into account. For example, hospital systems may have a 72-hour emergency electrical supply or sanitary pumping stations may have a 24-hour emergency power backup system. These worksheets can be found in Appendix X.

2.7.5. Lessons Learned

2.7.5.1. Lessons Learned from Little Creek/Pretty Lake Case Study

The Little Creek/Pretty Lake Case Study includes the example and results of the infrastructure internal and external dependencies evaluation that was completed as part of the Pilot Project. As noted earlier, the results of the evaluation of critical infrastructure will vary based on the location in which the analysis is done within the region and the vulnerability of the area to SLR and flooding. The following is a summary of the impacts to infrastructure systems evaluated in the case study area:

- The scenario of 1.5' of SLR will have no threat to critical infrastructure systems. Systems have already been hardened or are located at elevations at which there is not an impact.
- The scenario of 1.5' of SLR + 100-year storm surge will have some threat to all infrastructure systems evaluated. There is a low threat to the medical facility, and City of Norfolk water supply and water distribution systems. There is a medium threat to electrical infrastructure and City of Norfolk sanitary and a low threat to City of Virginia Beach sanitary and water distribution.
- The scenario of 3.0' of SLR will have relatively low threat to City of Norfolk water supply, water distribution and sanitary systems. The City of Virginia Beach has a low threat to the collection system of their sanitary but no threat to the other parts of the system.
- The scenario of 3.0' of SLR + 100-year storm surge will have a high level or threat to a portion of infrastructure systems evaluated in the case study area except Sentara Independence, which is located on relatively high ground just outside the case study area.

During the process of evaluating infrastructure systems in the case study area, the following insights were noted:

- In the case study area, SLR (limited to 3 feet) will not have a major impact on infrastructure systems analyzed but the addition of storm surge to SLR will create significant problems. However, low-lying roads will be inundated, which will impact residents significantly.
- Infrastructure evaluation results will vary based on the location within the region in which the analysis is completed and the vulnerability of the specific area to SLR and flooding related to storm surge.

- The City of Norfolk and the City of Virginia Beach use different power backup systems for pumping stations, with the City of Virginia Beach using natural gas for backup power and the City of Norfolk using petroleum-based backup generators. This information was previously not shared between jurisdictions.

2.7.5.2. Barriers to implementation of SLR Infrastructure Adaptation Measures

During Phase I of the Pilot Project, the PIC identified challenges and barriers to the regional infrastructure planning for SLR that included the following items:

- Identification of infrastructure, interdependencies between private and public infrastructure, and vulnerabilities;
- Private industry needs to know what SLR amount that they should be using for planning in short and long term;
- Uncertainty on how public and private organizations will work together;
- Proprietary information, how will it be shared and protected;
- Codes regarding construction standards related to SLR vary by city, therefore, a regional or Commonwealth code requirement should be implemented to eliminate confusion;
- Underwriter insurance requirements may differ from code requirements, causing confusion; and
- Financial/funding barriers.

During the process of working through the case study in the Little Creek/Pretty Lake area, the IWG and PIC experienced these examples of institutional governance barriers:

- Fragmentation, lack of formal interaction with government – not all critical infrastructure entities were invested in participating in the Pilot Project and not all that did participate were invested in evaluating infrastructure interdependencies in the case study area. This included both public and private infrastructure entities.
- Stove-piped functionality of agencies – that is the nature of our infrastructure systems and the exercise of mapping of interdependencies between critical infrastructure systems had not been done previously in Hampton Roads (exclusive of federal facilities).
- Government department and sector-based structures of agencies – prior to the IPP the municipalities had not received infrastructure information (example: storm water loading) from adjacent jurisdictions.
- Legal barriers – National security requirements prevent the sharing of information from federal facilities and Protection of Critical Infrastructure Information (PCII) also creates a legal barrier for sharing of critical infrastructure information.

While the region has exceptional scientific resources and support, including the strength of the Science Advisory Committee participation in the Pilot Project, science remains a barrier in the region. Specifically, the type of information that is needed in terms of more certainty are the rates of SLR or local data on storm intensity and frequency, flooding impacts and vulnerabilities.

The PIC also identifies resources and funding as barriers to infrastructure adaptation moving

forward. A regional approach to funding will provide more opportunities for success. Individually only one city, Virginia Beach, is ranked in the top 50 cities in the United States (www.census.gov). By comparison, the combination of the population in Virginia Beach, Norfolk, Newport News, Portsmouth, and Hampton puts the region in a comparable position with the top 10 cities in the United States.

2.7.5.3. Solutions to Barriers to Implementation of SLR Infrastructure Adaptation Measures

It is important to note that Hampton Roads has been building regional capacity for adaptation to SLR, which provides a pre-existing advantage, based on the work of municipalities, agencies, non-profits, and universities. Entities involved in this work include but are not limited to: Norfolk, Virginia Beach, Newport News, Hampton, Portsmouth, Hampton Roads Planning District Commission (HRPDC), Hampton Roads Transportation Planning Organization (HRTPO), Wetlands Watch, Urban Land Institute (ULI), Old Dominion University (ODU), Virginia Institute of Marine Science (VIMS), and William & Mary.

The IWG and PIC committees found success using the following strategies outlined by Ekstrom and Moser in their committee work:

- *Gathering data* – the committees gathered data from many existing studies, national and from the Hampton Roads region, which were reviewed and referenced in the committee work. These references are outlined in the reference sections of both the IWG and PIC reports. This strategy also led into self-education and learning and information sharing strategies.
- *Networking/formal partnerships* – the IWG and PIC were able to break down institutional stove piping barriers using department and sector-based structures of agencies to coordinate and share information (engineers/planner). This strategy was extremely successful and should be implemented in the future regional SLR organization. While formal partnerships were not developed, informal partnerships have been formed that will be beneficial for future infrastructure analysis and planning. In addition, the final recommendations from the Pilot Project will outline a governance structure for the region that can support continuing efforts of regional adaptation.
- *Leadership* – the IWG and PIC committees provided leadership in the Pilot Project by the selection of the case study area of Little Creek/Pretty Lake. This case study area was also adopted by the Citizen Engagement Working Group and the Public Health Working Group.
- *Funding and Policy & Management Changes* – Both the IWG and PIC final recommendations include recommendations that address funding and policy and management recommendations for the Hampton Roads region moving forward. It was beyond the scope of the Pilot Project to implement actions in either of these areas.

2.7.6. PIC Recommendations

1. Federal agencies are going to be instrumental partners in SLR planning and adaptation moving forward. The Department of Defense agencies and other federal agencies should be considered as partners with a formal role in decision making. This may require legislative changes at the federal and state level.

2. Funding for adaptation in Hampton Roads should be sought from public and private sources. Every year NOAA compiles a list of currently available, climate-related funding opportunities. The current list can be found in Appendix I-2 and was last updated on January 15, 2016.
3. Interdependencies between private infrastructure and public infrastructure systems will require collaborative problem solving across all infrastructure systems. Private critical infrastructure needs to be accounted for in these efforts for SLR adaptation planning.
4. Private infrastructure systems need reliable information and guidance in planning for SLR. Provide regionally recognized science-based SLR scenarios for private industry to incorporate in long-range planning. This standardization will eliminate confusion across the region and enable companies and industries with facilities throughout the region to proactively adapt to SLR.
5. The region should develop or adopt a tool for evaluation of SLR impacts on critical infrastructure, including internal and external dependencies. A regional assessment by watershed is necessary to understand infrastructure dependencies and to develop resiliency plans for implementation.
6. Develop building code strategies that can be implemented on a regional basis for construction and substantial improvements to existing structures to mitigate against flooding, severe wind and SLR. Some strategies for consideration include: freeboard regional standard, 500-year flood plain management, etc.
7. Ensure business and industry (and related trade groups) are active participants in shaping regional strategies and methods to address SLR and related risks and concerns and the development of any regional organization that may facilitate planning and/or implementation efforts.
8. Incent business and industry action and innovation to address SLR and related risk and concerns through financial and public recognition mechanisms.
9. The region should develop a business and industry outreach program that would:
    - Increase awareness among business and industry sectors, particularly small and mid-sized businesses, as to the concerns and risks associated with SLR, storm surge and coastal flooding trends
    - Develop toolkits or portals to toolkits that would serve the specific needs of business and industry in addressing such risks and concerns (i.e., data gathering/management, risk evaluation and operational, capital investment planning, economic opportunities arising from such risk and issues, and public policy notification and tracking). A resource that is useful is the U.S. Climate Resiliency Toolkit (http://toolkit.climate.gov/get-started/overview).

2.7.7. SLR Recommendations Drawn from New Orleans and Southeast Florida

The PIC and IWG understand the importance of looking to other cities and regions that are facing similar threats from SLR, and the committees specifically reviewed climate action/resiliency plans from New Orleans and Southeast Florida to understand their strategies as they may be

applicable to Hampton Roads. New Orleans and Southeast Florida have both developed climate action and resiliency plans with regional recommendations that are applicable to Hampton Roads. Many of these same recommendations were discussed during the course of the Pilot Project.

These recommendations should be viewed as a preliminary framework to help guide policies in the region. It is important to emphasize that these recommendations do not serve as a mandate for the region but rather options that a regional entity or municipality may adopt and utilize based on its interests and vision for the future. Over time, the region may enhance these recommendations as scientific data and projections are refined to develop best management practices for the region. Both committees voted unanimously to include the following recommendations for Hampton Roads.

2.7.7.1. SLR Recommendations from Southeast Florida

1. Develop regionally consistent sea level rise planning scenarios for the coming decades. Require update every four years, immediately after United States National Climate Assessment update, to include rapidly changing body of scientific literature.
2. Develop regionally consistent methodologies for mapping sea level rise impacts.
3. Develop regionally consistent criteria for risk assessment related to sea level rise using a jurisdiction's unique risk factors.
4. Develop land use strategies that may be implemented for sea level rise that consider adaptation, restoration and growth. These strategies support Virginia Code 15.2-2223.3 that require comprehensive plans to incorporate strategies to address projected sea level rise and recurrent flooding.
5. Develop regionally consistent flood maps reflective of risk assessment and mutually agreed-upon suite of storm events under future sea level rise scenarios to inform planning.
6. Identify regional infrastructure projects based on risk of flooding and tidal inundation to be used as a basis for identifying and prioritizing adaptation needs and strategies.
7. Evaluate existing water management (storm water and fresh water supply) systems and flood control/drainage structures under sea level rise and storm surge scenarios. Reflect the capacity and interconnectivity of the surface water control network and develop feasible regional adaptation strategies.
8. Identify regionally consistent analytical methods for application in analysis of infrastructure design, water resource management (storm water and fresh water supply) and hazard mitigation. Identify a common set of tools that consider both costs and consequences.

2.7.7.2. SLR Recommendations from New Orleans

1. Develop a regional urban water plan
2. Develop model watershed flood plain management plans for the Hampton Roads region
3. Design and implement a regional climate action plan
4. Develop a business resilience initiative

5. Implement balanced use of green infrastructure and blue infrastructure strategies regionally
6. Incentivize commercial and residential property owners to implement green and blue infrastructure on private property (storm water fee reductions)
7. Require new developments (>5000sf) and redevelopments to treat and or store first 1-1/4" of rainwater on site.
8. Provide incentives to commercial and residential property owners to adapt to SLR such as resources, capacity and expertise.
9. Develop a "water management" economy in Hampton Roads.

2.8. Economic Impacts Advisory Committee

2.8.1. History, Objectives & Strategy

The Economic Impacts Advisory Committee (EIAC) was formed at a much later stage than the other working groups and advisory committees. Dr. Larry Filer, Chair of the Department of Economics at Old Dominion University and Associate Director for the Center for Economic Analysis and Policy (CEAP), agreed to chair the group in the early fall of 2015. The first four months were dedicated to engaging committee members, contacting those individuals and securing commitments to serve. Tremendous efforts were made to include individuals from both academia and the private sector. There was a strong focus on commercial development, real estate and insurance with the private sector members. The academic members were chosen based on sea level rise work that was being done by faculty at the main flagship universities in the Commonwealth.

The choices from academia were influenced more by the organization than the individuals, though the representatives from William & Mary and UVA were known for their work on sea level rise/flooding issues. Some significant work was underway at The Virginia Coastal Policy Center at the College of William & Mary. Work on flooding resilience and sea level rise was also being conducted at the Cooper Center for Public Policy at the University of Virginia.

The private sector representatives were chosen based on the firm. Both Poseidon and Clark Nexsen are undertaking major commercial building projects in "at risk" coastal areas. This includes locations outside the Hampton Roads metro area and, in some cases, outside the state of Virginia.

The complete list of committee members is shown in the full committee report in Appendix J of this report.

2.8.2. Actions & Accomplishments

The advisory group served as a liaison to the working groups – providing guidance on related issues as they arose. The scope of work changed early in 2016 when the advisory group decided to establish a research agenda for the advisory group knowing that this research agenda would stretch beyond the length of the IPP. This work would be done in addition to the advisory work being done for the working groups, to take advantage of the human capital of the EIAC.

Early in the research process, it became apparent that a number of "impact" studies were being

conducted by various government agencies, consulting firms and regional organizations on behalf of localities in Hampton Roads. Therefore, the primary objective of the EIAC during Phase 2 was to convene a day-long conference where all of the agencies and consulting firms conducting impact studies could be brought together to present their scope of work, data limitations and initial or final findings. The goal of the event would be to provide an opportunity for collaboration and sharing among agencies that typically operate in isolation.

On May 18, 2016, the EIAC held The Economic Impacts of Sea level Rise in Hampton Roads: An Appraisal of the Projects Underway. The event was held in partnership with the Infrastructure Working Group from the Pilot Project. Presenters included:

- U.S. Department of Transportation
- U. S. Army Corps of Engineers
- Department of the Navy
- Hampton Roads Planning District Commission
- Department of the Interior
- Dewberry Consultants LLC
- City of Virginia Beach
- City of Norfolk
- RTI International

Figure 2-5. EIAC Appraisal of Projects

A number of common issues and themes emerged from the presentations. Recommendations for these issues have become part of the final recommendations from the EIAC.

The EIAC proposed three initial research focus areas for the group and presented this research plan to the Steering Committee for feedback. These areas would serve to guide the research agenda of the group beyond Phase 2. The three research areas are:

1. The impact of sea level rise on commercial development

   This is going to include an intensive look into the new zoning requirements that coastal cities are using in flood-prone areas and whether commercial developers will be able to satisfy these requirements. If these requirements are too onerous, the outcome will essentially be empty, non-revenue-generating land.

2. The impact of sea level rise on business attraction

   It is quite likely that coastal cities will face difficulty in attracting new business if it is not perceived that the city has its hands around the issue of recurrent flooding and inundation. There is some research out there that looks at residential migration from flood-prone areas, but little work has been done on firm relocation.

3. Regional cooperation and the HUD Community Rating System

   Only 5% of the eligible localities in the U.S. participate in the HUD Community Rating System despite very large reductions in premiums on flood insurance for the residents. In an area like Hampton Roads, cooperation by all the localities on the same level might be helpful to get the largest joint benefit. Aggressive participation by Norfolk (for example) alone, would not matter much if Virginia Beach does nothing, and vice versa. As it stands, only Norfolk and Gloucester appear to be participating at all.

2.8.3. Recommendations

The EIAC:

1. Recommends all localities within the Hampton Roads Planning District maintain a consistent, updated database on properties. The data will include information on first floor elevation of structures. At the very least, localities would maintain information on the foundation type of the structure;
2. Recommends a database be kept, tracking all economic impact studies being conducted within the Hampton Roads region. The database would include information on the projects' scope, initial findings and delivery date. The database would be housed on a public website and be updated in a timely manner (perhaps the website of the new Commonwealth Center for Flooding Resiliency);
3. Urges ODU to hold an annual event that brings together government agencies, local government officials and consulting firms conducting studies of the economic impact of sea level rise and recurrent flooding on Hampton Roads;
4. Recommends that localities within the Hampton Roads Planning District coordinate with other localities, whenever possible, to conduct economic impact studies. This ensures that the studies are broader in geographical scope and provide a more regional view of the impacts of sea level rise.

2.9. Collaborations for Coastal Resilience

The event "Collaborations for Community Resilience" took place on December 10, 2015, at ODU, and served as not only an internal check-in with stakeholders locally, but also as an opportunity to learn from those facing similar climate impacts in New Orleans, Southeastern Florida, and Michigan.

The event had over 200 registrants and approximately that many attendees. Most guests stayed for the duration of the program, and the event was covered by a local television station on the evening news, increasing awareness among citizens on both the risks of sea level rise and the idea that our region is working toward innovative solutions.

Figure 2-6. Panel Discussion of Thriving with Water

The highlights of the event included keynote presentations by Dr. Jennifer Jurado of Broward County, Florida and Robin Barnes of Greater New Orleans, Inc. entitled "Regional Collaborative in the Face of Coastal Change" and "Creating an Economy from Resiliency," respectively. Both of these topics are especially timely as our local leaders begin to work together more effectively and we look for ways to develop a regional industry cluster around the resilience concept. Other panels included information on alternative approaches to the DOD Pilot (Michigan Army National Guard), resilience in Virginia, a path forward for Hampton Roads, and federal perspectives from various agency representatives.

All events of this size encounter stumbling blocks in the planning phase. Here, a major challenge was recruiting guest speakers from the other pilots around the country, as initially planned. While representatives from the Chief Resilience Officer's department in Colorado expressed interest, they had a scheduling conflict. The Pilot Projects in Idaho and Houston were less interested in an information exchange. We are very grateful that our guests from Florida, New Orleans, Michigan, and Washington, D.C., attended.

When the IPP concludes, stakeholders must continue to gather on a regular basis to share information, lessons learned and strategies. Extra-regional guests are incredibly important as Hampton Roads hopes to both learn from other regions' successes and failures. Continued collaborations should be established, possibly through facilitation by ODU and other academic partners.

Figure 2-7. Robin Barnes of Greater New Orleans, Inc. Addressing the conference

3. IPP Recommendations

3.1. Summary of Recommendations and Selection Process

Recommendations of each working group and advisory committee are included in the respective section, and are also included in the summary chart below. These recommendations are the result of careful consideration over two years by invested stakeholders, but should not be construed as the recommendations of the Steering Committee or any participating organization.

While some recommendations chart specific paths forward or spell out specific tasks, there are many overall themes running through the recommendations. One of those themes include institutionalizing and formalizing relationships built during the course of the two-year pilot process. Many critical positions, especially those in our military partners, last only two to three years. While there are many benefits to this system, institutional knowledge of this unique subject and relationships are lost and must be rebuilt over time. In the natural course of career progression, others change positions too, whether within municipal governments, private infrastructure or other sectors. All committees felt that establishing more formalized relationships so that collaborative sea level rise and resilience planning was just a part of the defined scope of work was critical.

Furthermore, many committees recognized both research, data availability and data integration as priorities. Effective sharing of best available data enables decision makers at the local, state, and federal levels as well as within the private sector. Research across focus areas should remain a priority, however, equally important is the effective communication within the Hampton Roads community with regards to different studies, tools, and available data.

Also, both the Infrastructure Working Group and Private Infrastructure Advisory Committee carefully studied the history of collaborative planning for sea level rise and resilience in both New Orleans, Louisiana, and Southeast Florida, including Miami. Recognizing that each of these regions varies from Hampton Roads, successful initiatives and strategies from these regions were carefully adapted in the recommendations to fit the needs of Hampton Roads. Though the Pilot is intended to be a model for other regions, Hampton Roads is not the first region to address these issues and successful strategies employed in these regions could also be successful in Hampton Roads. Furthermore, many committees cited the importance of the Whole of Government and Whole of Community approach with regards to planning, implementing, and funding adaptation. As the region moves forward, collaboration and information and strategy sharing should remain a priority.

Working Group/Committee	Recommendations
Working Group Consensus Recommendations	1. In an effort to capture the valuable expertise, relationships, and partnerships developed throughout the course of the IPP, working group, advisory committee chairs and members should be formally invited to participate in and meaningfully included in ongoing activities. 2. In furtherance of the above, the follow-on entity should work to formalize and institutionalize the relationships described above.
Economic Impacts Advisory Committee	1. All localities within the Hampton Roads Planning District should maintain a consistent, updated database on properties. The data will include information on first floor elevation of structures. At the very least, localities would maintain information on the foundation type of the structure. 2. Create a database that keeps track of all economic impact studies being conducted within the Hampton Roads region. The database would include information on the projects' scope, initial findings and delivery date. The database would be housed on a public website and be updated in a timely manner (perhaps the website of the new Commonwealth Center for Recurrent Flooding Resiliency). 3. Urges ODU to hold an annual event that brings together government agencies, local government officials and consulting firms conducting studies of the economic impact of sea level rise and recurrent flooding on Hampton Roads. 4. Localities within the Hampton Roads Planning District should coordinate with other localities, whenever possible, to conduct economic impact studies. This ensures that the studies are broader in geographical scope and provide a more regional view of the impacts of sea level rise.
Science Committee	1. The function of the committee should continue regardless of the fate of the IPP. 2. The newly funded Commonwealth Center for Recurrent Flooding Resiliency (CCRFR) should function as the coordinating organization for the Committee. The CCRFR will be responsible for forming the steering group for the Science Committee.

3. The main goal of the Science Committee should be to provide a mechanism to assure that the sea level rise science needs and requirements of regional stakeholders are addressed.
4. The Science Committee should include the following at a minimum: regional scientists and engineers familiar with RSLR, storm water managers and coastal engineers with the cities and HRPDC, engineers from the companies contracted by the cities and region, relevant Commonwealth agencies including water resources, federal agencies including NOAA/NOS, NOAA/NWS, Interior/USGS, NASA, DOD, Interior/FWS, Interior/NPS, local WFO Wakefield, etc.
5. Over the coming year the committee will need to facilitate meetings with regional stakeholders to determine their specific requirements.
6. Implement the following specific tasks (subject, of course, to future revision). Note: In many cases the committee may facilitate an activity rather than provide that activity itself.
   - Monthly or bi-monthly conference calls – These will be initiated by the CCRFR.
   - Topical conferences as appropriate – These may be done as part of the Adaptation Forums.
   - Topical reports – possible annual or bi-annual "State of the Region – Sea level rise and recurrent flooding."
   - Consider expanding beyond sea level rise and flooding to include other climate change variables: air temperature, rainfall, humidity, etc.
   - Facilitate creation of a web services-based portal for all relevant sea level rise data in the region.
   - Facilitate a knowledge database for sea level rise science relevant to the region possibly using the ODU Digital Commons system supported by the ODU Library
   - Facilitate reports to federal agencies on needs/requirements – these would be developed by regional stakeholders.
   - Coordination with Hampton Roads Adaptation Forums and other relevant organizations in the region., e.g., professional engineering societies.
   - Facilitate data telemetry and broad distribution of local real-time water level observations to all of Hampton Roads.

Citizen Engagement Working Group	1. Recognize that sea level rise is a serious issue that touches the entire region and that engagement on a piecemeal basis or on the basis of governmental purview, municipal boundaries, local political will or current levels of stakeholder interest is not a viable long-term strategy for a challenge of this magnitude. 2. Identify a respected regional entity to "own" and be responsible for being the thought leader on sea level rise in Hampton Roads and for convening Whole of Community deliberations regarding sea level rise. 3. Use the best practices of civic science – including good facilitation process and good methods for information dissemination and feedback – to engage all stakeholders in sea level rise deliberation and decision making from the very start. 4. Create benchmark and ongoing internal and external tracking metrics for assessing the performance and effectiveness of the engagement program and its impact on the ability of the Hampton Roads region to rise to the challenge of sea level rise.
Public Health Working Group	1. Some of the most serious impacts of sea level rise are those affecting public health. Consequently, there will be a continuing need for public health issues to be an integral part of current and future sea level rise adaptive planning efforts. 2. In the Hampton Roads region, it will be essential to continue and further expand the activities and the membership of the Public Health Working Group. 3. One important area of focus needs to be on understanding potential public health impacts of sea level rise, and the implications of those impacts for planning, training, preparedness, practice, and decision making. 4. Another area of focus should deal with how public health expertise in such areas as health and environmental risk communication, health-related community outreach, working with vulnerable/special needs populations, epidemiology, industrial hygiene, and public health emergency preparedness can best contribute to broader sea level rise adaptation efforts.

	5. Research on the public health dimensions of sea level rise will be a continuing area of emphasis. In this regard, new tools such as EnviroAtlas have the potential to improve our understanding of environment-health relationships, and to enhance sea level rise adaptation planning efforts. 6. Preparing the next generation of public health professionals to grapple with sea level rise issues will also be vital. Curricular innovations, new practicum sites, new courses, and related initiatives such as those described above all have a role to play in contributing to this effort.
Legal Working Group	See Appendix C-1 Draft Resolution
Infrastructure Working Group	1. This region should undertake development and formation of a functional process and organization to facilitate regional collaboration, including the local governments, regional, state, tribal and federal agencies, and other entities, that have the most imminent impact from and interest in sea level rise. This organization might ultimately be evolved to be considered a "commission, board or council" under Virginia law. It should have authority to foster collaboration among federal, tribal, state and local agencies, with support from academia, and should serve as a collaborative agency to oversee regional matters of importance in facilitating regional sea level rise planning and actions. 2. Federal agencies in the Hampton Roads region must have a way to work directly with the local governments, including determination and processes for approval of authorities and appropriations for funding. This process should begin as an MOU or set of MOUs between federal agencies and local governments or a regional entity representing them. When authority for collaboration with local governments is unclear or too restrictive to support effective planning, federal agency headquarters should issue guidance providing their field activities with the authority they need to collaborate effectively with local governments. If a federal agency determines that its ability to collaborate is constrained by federal statute, legislation should be sought to provide that agency authority to collaborate with local governments. Certain existing intergovernmental programs, such as the National Ocean Council and collaboration in the areas of homeland security and emergency management, provide models for legislation authorizing intergovernmental collaboration.

	3. The region should establish a definitive set of regional sea level rise planning standards and scenarios to be adopted, along with a minimum base floor elevation, and a standard vertical datum. The affected local governments and regional, state, tribal, and federal agencies will then be able to work from the same set of scenarios in regional and local planning efforts to address sea level rise and recurrent flooding impacts, adaptation and mitigation. • The necessity for planning scenario development and use in decision making for planning is as stated in the April 2016 SERDP report : "Regional Sea Level Scenarios For Coastal Risk Management: Managing The Uncertainty Of Future Sea Level Change And Extreme Water Levels For Department Of Defense Coastal Sites Worldwide" (SERDP, April 2016). "This report and its accompanying scenario database provide regionalized sea level and EWL scenarios for three future time horizons (2035, 2065, and 2100) for 1,774 DoD sites worldwide. The decision-making paradigm must shift from a predict-then-act approach to a scenario-based approach. The primary purpose of this report and its associated scenario database is to enhance and increase the efficacy of screening-level vulnerability and impact assessment for DOD coastal sites worldwide containing permanent or enduring assets" (Page ES-1 and ES-2). With the significant federal presence locally in Hampton Roads, federal processes should be considered in determining standards for regional procedures so that there is not inadvertent conflict resulting in negative impacts on regional planning efforts over time. • Federal government leadership and input could make achieving federal standards clearer and simpler for regional efforts. • A definitive set of regional sea level rise scenarios is essential for addressing planning issues that overlap jurisdictional boundaries, particularly land use planning and critical infrastructure design, planning, project prioritization and, ultimately, construction. 4. Regional identification, evaluation, and prioritization of critical infrastructure vulnerability to sea level rise impact within the next 30, 50, and 75 years should be undertaken. This work should include development of models and methods to understand and incorporate economic impact of adaptation, replacement, or relocation of such infrastructure, along with other social and cultural factors that should be considered.

Private Infrastructure Committee	1. Federal agencies are going to be instrumental partners in SLR planning and adaptation moving forward. The Department of Defense agencies and other federal agencies should be considered as partners with a formal role in decision making. This may require legislative changes at the federal and state level. 2. Funding for adaptation in Hampton Roads should be sought from public and private sources. Every year NOAA compiles a list of currently available, climate-related funding opportunities. The current list can be found in Appendix I-2 and was last updated on January 15, 2016. 3. Interdependencies between private infrastructure and public infrastructure systems will require collaborative problem solving across all infrastructure systems. Private critical infrastructure needs to be accounted for in these efforts for SLR adaptation planning. 4. Private infrastructure systems need reliable information and guidance in planning for SLR. Provide regionally recognized science-based SLR scenarios for private industry to incorporate in long-range planning. This standardization will eliminate confusion across the region and enable companies and industries with facilities throughout the region to proactively adapt to SLR. 5. The region should develop or adopt a tool for evaluation of SLR impacts on critical infrastructure, including internal and external dependencies. A regional assessment by watershed is necessary to understand infrastructure dependencies and to develop resiliency plans for implementation. 6. Develop building code strategies that can be implemented on a regional basis for construction and substantial improvements to existing structures to mitigate against flooding, severe wind and SLR. Some strategies for consideration include: freeboard regional standard, 500- year flood plain management, etc. 7. Ensure business and industry (and related trade groups) are active participants in shaping regional strategies and methods to address SLR and related risks and concerns and the development of any regional organization that may facilitate planning and/or implementation efforts. 8. Incent business and industry action and innovation to address SLR and related risk and concerns through financial and public recognition mechanisms.

	9. The region should develop a business and industry outreach program that would: • Increase awareness among business and industry sectors, particularly small and mid-sized businesses, as to the concerns and risks associated with SLR, storm surge and coastal flooding trends; • Develop toolkits or portals to toolkits that would serve the specific needs of business and industry in addressing such risks and concerns (i.e., data gathering/management, risk evaluation, and operational, capital investment planning, economic opportunities arising from such risk and issues, and public policy notification and tracking). A resource that is useful is the U.S. Climate Resiliency Toolkit (http://toolkit.climate.gov/get-started/overview).
Private Infrastructure Committee/ Infrastructure Working Group Joint Recommendations	*The PIC and IWG understand the importance of looking to other cities and regions that are facing similar threats from SLR. New Orleans and Southeast Florida have both developed climate action plans with regional recommendations that are applicable to Hampton Roads. Many of these same recommendations were discussed during the course of the Pilot Project. Both committees voted unanimously to include the following recommendations for Hampton Roads. These recommendations should be viewed as a preliminary framework to help guide policies in the region. It is important to emphasize that these recommendations do not serve as a mandate for the region but rather options that a regional entity or municipality may adopt and utilize based on its interests and vision for the future. Over time, the region may enhance these recommendations as scientific data and projections are refined to develop best management practices for the region.* **From Southeast Florida:** • Develop regionally consistent sea level rise planning scenarios for the coming decades. Require update every four years, immediately after United States National Climate Assessment update, to include rapidly changing body of scientific literature. • Develop regionally consistent methodologies for mapping sea level rise impacts. • Develop regionally consistent criteria for risk assessment related to sea level rise using jurisdiction unique risk factors.

	• Develop land use strategies that may be implemented for sea level rise that consider adaptation, restoration and growth. These strategies support Virginia Code 15.2-2223.3 that requires comprehensive plans to incorporate strategies to address projected sea level rise and recurrent flooding. • Develop regionally consistent flood maps reflective of risk assessment and mutually agreed-upon suite of storm events under future sea level rise scenarios to inform planning. • Identify regional infrastructure projects based on risk of flooding and tidal inundation to be used as a basis for identifying and prioritizing adaptation needs and strategies. • Evaluate existing water management (storm water and fresh water supply) systems and flood control/drainage structures under sea level rise and storm surge scenarios. Reflect the capacity and interconnectivity of the surface water control network and develop feasible regional adaptation strategies. • Identify regionally consistent analytical methods for application in analysis of infrastructure design, water resource management (storm water and fresh water supply) and hazard mitigation. Identify a common set of tools that consider both costs and consequences. **From New Orleans:** • Develop a regional urban water plan. • Develop model watershed flood plain management plans for the Hampton Roads region. • Design and implement a regional climate action plan. • Develop a business resilience initiative. • Implement balanced use of green infrastructure and blue infrastructure strategies regionally • Incentivize commercial and residential property owners to implement green and blue infrastructure on private property (storm water fee reductions). • Require new developments (>5000sf) and redevelopments to treat and or store first 1-1/4" of rainwater on site. • Provide commercial and residential property owners incentives to adapt to SLR: resources, capacity and expertise. • Develop a "water management" economy in Hampton Roads.

3.2. Identified Barriers to Collaborative Whole of Government & Community Planning

At the outset of the IPP, the Charter, outwardly recognized a few initial barriers to collaborative planning. Local federal partners were delegated as federal liaisons instead of Steering Committee members. This designation was to prevent any appearance that federal partners were engaging in local governance, which they were not. Additionally, ODU agreed to convene the project out of a sense of duty to the community, and provided support over the course of the two-year project. Although this funding was limited, the success of the project was directly a result of the facilitation by a neutral and trusted academic partner. Not to be overlooked, VCPC and VIMS also provided countless hours of support and expertise over the course of the two-year project.

Throughout the course of the two-year IPP, the conveners, committee chairs, and Steering Committee members encountered several additional barriers to collaborative Whole of Government and Community. The IPP itself had multiple audiences: local and national. Local stakeholders were motivated by the opportunity to make progress locally and build new partnerships and strategies to combat flooding in Hampton Roads. Our federal stakeholders were interested not only in their own bases, but how these strategies could be employed elsewhere to combat a variety of challenges.

With regards to stakeholder engagement, many participants were recruited shortly following the execution of the Charter, by invitation to a FEMA National Exercise Program event at ODU on December 2, 2014. However, as referenced in committee reports, additional outreach was needed in order to recruit individuals who would commit to active participation. Even then, committee members were all volunteers, even those tasked by their organizations with participation. As such, their time and ability to complete work between meetings was often limited. Additionally, most military positions experience high rates of turnover in leadership and staffing, requiring constant updating of new officers and building new relationships. Nonetheless many volunteers committed many hours to the project, working with their own teams, and sharing information to move the project forward.

Another challenge, primarily involving the IWG and PIC, involved the challenge of choosing sea level rise and flooding scenarios by which to analyze infrastructure interdependencies. As noted by the PIC and IWG reports, there was concern that the timeframes that correlated with the selected scenarios portrayed conditions that exceed those under current use by those cities. The solution for this particular project was to remove specific timeframes from the scenarios selected. This solution does not solve the long-term challenge of rectifying the natural uncertainty of scientific research with engineers' and business owners' need for a specific number for which to plan. One frequent workaround is to plan for higher floodwaters for more critical infrastructure.

The Whole of Government nature of the project frequently highlighted the fragmentation between governments. There is no required interaction or planning for sea level rise and recurrent flooding impacts, and as such, not all critical infrastructure entities or governments were invested in participating in the Pilot Project. Additionally, this issue of fragmentation carries forward beyond the IPP. While municipalities now meet at HRPDC as a part of the

Coastal Resilience Committee, participation is not required and federal, state, academic, and community partners participate voluntarily as guests. Localities in Hampton Roads do not all face the same threat with regards to sea level rise and flooding, and as such have different levels of prioritization of the issue. One solution to this would be to create "coalitions of the willing" either outside of or inside of existing structures as has been done in Southeast Florida.

As noted by the PIC and IWG, our infrastructure and other systems are highly stove-piped, resulting in a variety of challenges. With regards to infrastructure, interdependencies had not been fully studied. Additionally, even within cities, different departments deal with different aspects of flooding and sea level rise and may not effectively communicate. Many cities are making great strides to overcome this by having sea level rise or flooding groups that meet across departments regularly, and the City of Norfolk, as a part of Rockefeller 100 Cities, has a Chief Resilience Officer to act in partnership with the various departments working on these issues.

Overall, there was a lack of communication about basic infrastructure and strategies between municipalities and neighboring bases prior to this project. Seemingly small victories occurred regularly throughout the work of the IPP when information was shared to more effectively enable planning in the neighboring municipality or base. However, this information was limited due to national security requirements and the inability of federal facilities to share certain infrastructure information.

IPP stakeholders worked diligently to overcome many of these barriers by building relationships and connecting and leveraging ongoing work in this area. The extensive list of proposed recommendations provides further steps to moving forward with collaborative planning for sea level rise resilience in Hampton Roads. Strong leadership from volunteers and support of ODU faculty was key to the success of the project and developing those essential relationships throughout the course of the IPP.

3.3. Other Considered Collaborative Strategies

Throughout the course of the IPP, the Steering Committee was tasked with determining what types of authorities and strategies would best allow for Whole of Government and Whole of Community preparedness and resilience. The LWG carefully analyzed 10 potential structure options, detailing various party's ability to engage with such a structure, authority, funding, and more. Additionally, the matrix clearly showed where authority to establish such a structure already existed, required locality action, General Assembly action, or Congressional action. The matrix is available in Appendix D-4.

3.4. Proposed Resolution

At the request of the Steering Committee, the LWG prepared a draft resolution designed to effectively close the IPP. HRPDC had expressed a desire to lead a continued collaborative process through its Coastal Resilience and other committees, and the Steering Committee agreed that this was a natural next step. The resolution detailed the consensus positions of the Steering Committee as made clear to the LWG during the course of multiple meetings, as well

as charged the HRPDC with leading continued efforts. Working group and committee chairs, federal liaisons, and members of the Steering Committee agreed to move forward with the resolution after providing feedback to the LWG.

Consensus conclusions detailed the capacity of a regional entity charged with collaborative planning for sea level rise resilience, whether a new entity was created or an existing one altered. Additionally, the resolution acknowledged that HRPDC was the lead agency for collaborative planning. One primary conclusion was that the federal government and its agencies, including the uniformed services and the Virginia state government, participate to the full extent of their authority.

However, after presenting the resolution to the Hampton Roads Chief Administrative Officer Committee, the HRPDC provided comments to the resolution and noted that they could not sign as currently drafted. While the CAO Committee expressed support for the HRPDC to act as a leader in coordination of regional sea level rise and coastal resiliency planning efforts, they could not support the resolution as it focused on implementation in addition to planning, and requested that the HRPDC consider such entities as special service district authorities or joint exercise of local government powers by agreement (similar to the Southeast Florida Climate Compact) over the long term.

The resolution and official comments from HRPDC are attached in Appendix C-1 and Appendix C-2, respectively.

4. Conclusions

The goal of the IPP was two-fold: First, to provide a template for Whole of Government resilience planning useful to our federal partners, and second, to provide stakeholder-generated recommendations for moving forward with a Whole of Government and community planning process in Hampton Roads, Virginia.

Though the IPP recommendations and resolution are non-binding on participants, there is great significance in that many stakeholders from across the region and across sectors came together to propose these next steps and solutions to build resilience in Hampton Roads. Furthermore, the IPP shows that localities and federal agencies stand ready and willing to find new ways to collaborate when both become more resilient as a result. An example of this is the kickoff of the Joint Land Use Study, which will be led by HRPDC, and in a "first of its kind" approach, consider sea level rise as an encroachment. The study partners will include Virginia Beach and Norfolk and look to Joint Expeditionary Base Little Creek-Fort Story, Naval Air Station Oceana, Naval Station Norfolk and Naval Support Activity Hampton Roads and include an implementation strategy to ensure recommendations are realized. Furthermore, the Science Advisory Committee's regular phone meetings have resulted in various collaborations including one between ODU researchers and NASA researchers looking to obtain accurate information with regards to localized subsidence data.

Though Hampton Roads is unique in that it is home to the largest Naval base in the world, a key port, and a unique history and geography, the lessons learned throughout the IPP can be utilized elsewhere. Following the Collaborations for Community Resilience event, guests from the Michigan Army National Guard considered moving forward with a Charter similar to the IPP for their resilience pilot project. While recommendations may be unique based on regional differences, many strategies will remain the same.

Furthermore, the IPP saw a successful new role for universities as noted by Secretary of State John Kerry when he visited ODU's campus in November 2015. As a neutral convener and non-partisan broker of expertise, ODU was proud to convene the IPP, but stands ready to change roles and lead other applied research efforts related to both local and global resilience whether through the Commonwealth Center for Recurrent Flooding Resilience, the ODU Resilience Collaborative, or other initiatives.

While the next steps for Hampton Roads remain with its localities and ultimately its citizens, the region has the tools and resources to move forward with a collaborative process for sea level rise planning and resilience.

Full Report & Appendices can be found on www.centerforsealevelrise.org

Hampton Roads Sea Level Rise Preparedness & Resilience Intergovernmental Pilot Project

Phase 2 Report: Appendices

Appendix Contents

APPENDIX A

Hampton Roads Sea Level Rise Preparedness and Resilience Intergovernmental Planning Pilot Project Charter

Hampton Roads Sea Level Rise Preparedness and Resilience
Intergovernmental Planning Pilot Project
Charter
October 10, 2014

Mission

The mission of the Pilot Project is to develop a regional "whole of government" and "whole of community" approach to sea level rise preparedness and resilience planning in Hampton Roads that also can be used as a template for other regions.

Vision

Upon completion of the Pilot Project, Hampton Roads will have in place intergovernmental planning organizational arrangements and procedures that can effectively coordinate the sea level rise preparedness and resilience planning of Federal, state and local government agencies and the private sector, taking into account the perspectives and concerns of the citizens of the region.

Statement of the Problem

The Hampton Roads region has an economy and culture tied largely to the strength of its ports and waters. Its geography has attracted large military installations, shipping ports, manufacturing facilities, commercial fishing, residential development, academia, outdoor recreation and tourism. The vitality of the region as a whole is dependent upon the continuing maritime and coastal activity. Additionally, the operational effectiveness of the military bases in the region are critical to US national security.

The Hampton Roads region is already being impacted by sea level rise and this is projected to continue over the next century. The impacts of sea level rise are broad and without effective preparedness and resilience measures in place will have potentially serious consequences for the region, threatening the regional economy, safety and quality of life, and the ability of the region's government and business sectors, such as military bases, transportation and public and private utilities, to carry out their missions. Effective regional preparedness and resilience planning for sea level rise requires coordination of the planning efforts of Federal, state and local government agencies and the private sector, with public participation in the planning process.

Timeline

The Pilot Project will be conducted in two phases, each tentatively lasting one year.

Phase I. June 2014 – June 2015.
The goal of the first phase is to develop organizational structure and operating procedures for intergovernmental coordination of sea level rise preparedness and resilience planning.
Phase I will include fact-finding to identify the relevant stakeholders in the regional sea level rise planning effort; review Federal, Commonwealth of Virginia, and regional reports and policy

documents that may provide guidance or recommendations applicable to this regional planning effort; review other regional sea level rise planning efforts in the United States and abroad to identify lessons learned and best practices; and assess the value of modeling and simulation tools for the initial planning efforts to be launched in Phase II. Utilizing the information gathered, the Project shall conclude Phase I with a report identifying the findings of the Steering Committee.

Phase II. June 2015 – June 2016.
The goal of the second phase is to use the findings of the Steering Committee to draft a Memorandum of Understanding among the members of the Pilot Project that establishes an intergovernmental planning coordination organization that will commence operations upon conclusion of the Pilot Project. The Phase I report will be used conduct initial coordination of sea level rise preparedness and resilience planning on a trial basis to test and refine organizational structure and operating procedures. The lessons learned from the initial planning coordination efforts in Phase II will be used to prepare the Memorandum of Understanding.

Initial Structure

Voluntary Participation
Participation in the IPP is voluntary. Steering Committee members, Liaisons, Working Group members and Advisory Committee members may withdraw at any time for any reason. Participation in the IPP does not bind any member, or the organization that he or she represents, to any action or expenditure. Participation in the IPP does not obligate any member, or the organization he or she represents, to enter into any agreement or Memorandum of Understanding.

Steering Committee
Voting Members:
- Commonwealth of Virginia
  - Office of the Secretary of Natural Resources
  - Virginia Port Authority
  - Virginia Department of Transportation, Hampton Roads District
  - Virginia Coastal Zone Management Program
  - Virginia Department of Conservation and Recreation
- Hampton Roads Regional Organizations and Local Authorities
  - Chair and Vice Chair, Hampton Roads Planning District Commission
  - Two Chief Administrative Officers selected by the HRPDC chair
  - City of Norfolk, Office of Emergency Preparedness and Response
- Private Sector
  - Huntington Ingalls Newport News Shipbuilding

Federal Government Liaisons

- US Navy
  - Commander Navy Region Mid-Atlantic
  - Commanding Officer, Naval Facilities Engineering Command Mid-Atlantic

Commander, Norfolk District, US Army Corps of Engineers
Commander Joint Base Langley-Eustis
US Coast Guard
Commanding Officer, US Coast Guard Shore Infrastructure Logistics Center
Commander Fifth Coast Guard District
National Security Council
Council on Environmental Quality

Responsibilities of Steering Committee Members and Federal Liaisons

- Actively contribute to the deliberations of the Steering Committee.
- Attend Steering Committee meetings and participate in other Steering Committee activities to the maximum extent possible.
- Principals may designate an alternate who has authority to speak and vote on behalf of the principal.
- Keep the Member's organization informed of Steering Committee deliberations and activities, and provide feedback to the Steering Committee as appropriate
- Provide "reach back," serving as a link to other offices in the Member's organization that may be able to provide information, analyses.

Chair and Vice Chair

The Steering Committee shall elect a Chair and Vice Chair from among its members to serve one year terms from the date they are elected.

Working Groups

The Steering Committee will establish Working Groups and Advisory Committees as required to accomplish the mission of the Pilot Project. Federal agencies will serve as liaisons to the Working Groups and Advisory Committees, as appropriate. The following list is provided as an initial structure and may be modified as necessary by the Steering Committee.

The Working Groups shall fulfill fact-finding, advisory, and/or planning functions. The Steering Committee shall task each Working Group with specific goals and functions. The Chairperson of the Working Group shall oversee the activity of the Working Group and report to the Steering Committee.

Legal Working Group. This Working Group will address legal issues that arise during the Pilot Project and draft a Memorandum of Understanding (MOU) for the follow-on project that emerges from the pilot project. The draft MOU will be submitted to the Steering Committee no later than April 2016. The Working Group will consult with contacts designated by other Steering Committee members.

Infrastructure Planning Working Group. This Working Group will recommend which infrastructures in Hampton Roads require adaptation planning and formulate recommendations for intergovernmental coordination of that planning, and in consultation

with the Private Infrastructure Advisory Committee, formulate recommendations for privately owned infrastructure planning.

Land Use Planning Working Group. This Working Group will recommend which land use related plans, programs and policies in Hampton Roads require adaptation planning and formulate recommendations for intergovernmental coordination. In consultation with the Municipal Planning Advisory Committee, the Working Group will address land use planning, floodplain management, local government comprehensive plans, zoning, building codes and other plans, programs and policies it identifies in the course of its work.

Citizen Engagement Working Group. This Working Group will prepare a communications and engagement plan for the Steering Committee that addresses informing the public on the Pilot Project on an on-going basis, and soliciting public comment on recommendations for intergovernmental coordination of planning. The Working Group also will coordinate messaging, oversee the ODU public-facing web site, and organize public events. The individuals listed below may designate Working Group members from their organizations, but are themselves responsible for approving the communications and engagement plan that will be submitted to the Steering Committee. The Working Group will consult with contacts designated by the other Steering Committee members and with the Citizen Engagement Advisory Committee.

Advisory Committees

The Steering Committee will establish Advisory Committees as required to accomplish the mission of the Pilot Project and designate Chairpersons for each. Advisory Committees will provide information and recommendations to the Working Groups and the Steering Committee. The following list is provided as an initial structure and may be modified as necessary by the Steering Committee.

Phase I

Science Advisory Committee
Economic Impacts Advisory Committee
Municipal Planning Advisory Committee
Private Infrastructure Advisory Committee
Citizen Engagement Advisory Committee
Senior Leadership Advisory Committee

Additional Advisory Committees for Phase II

Engineering, Planning and Design Solutions Advisory Committee
Industry Advisory Committee
Legal and Legislative Advisory Committee
Natural Environment Advisory Committee

Deliverables

Phase I

- October 2014. Elect a Chair of the Steering Committee, approve chairs for the advisory committees, and approve a work plan for Phase I
- October 2014. Initial report on the jurisdictional and legal issues that must be addressed in establishing an intergovernmental planning organization. (Legal Working Group)
- December 2014. Report on the initial organizational structure and operating procedures for coordinating intergovernmental planning in Phase II, including proposals for resolving management and administrative issues, and the jurisdictional and legal issues identified by the Legal Working Group.
- February 2015. Report on specific preparedness and resilience planning issues to be addressed in Phase II. This need not encompass the full range of issues that should be addressed; it should identify a set of issues that reasonably can be addressed within anticipated time and resource constraints. The Scope of Planning section below provides a starting point for identifying these preparedness and resilience planning issues.
- March 2015. Report on the administrative, management, jurisdictional and legal issues that must be addressed to commence coordinated intergovernmental planning in Phase II and to establish an intergovernmental planning organization upon completion of the Pilot Project.
- April 2015. Submit Plan of Action for Phase II.
- June 2015. Final report on Phase I, including all the deliverables listed above and a template for establishing an intergovernmental planning organization that can be adapted to the unique circumstances of other regions.

Phase II

- July 2015. Commence work on the Action for Phase II.
- December 2015. Report on recommended organizational structure and operating procedures for the intergovernmental planning organization that will be established upon completion of the Pilot Project.
- January 2016. Progress Report on coordination of planning on the specific planning issues addressed in Phase II, including lessons learned during the planning process.
- March 2016. Comprehensive, detailed list of the preparedness and resilience planning issues to be addressed by the intergovernmental planning organization, including a list of the critical infrastructures that need to be included.
- March 2016. Procedures for monitoring implementation of individual plans developed by government agencies and stakeholders to ensure consistency with the regional interagency planning coordination guidance developed by the intergovernmental planning coordination organization, and periodic review of regional plans to improve them based on experience with implementing them and to keep them current with changing circumstances.
- April 2016. Memorandum of Understanding among the members of the Pilot Project that establishes an intergovernmental planning coordination organization that will commence operations upon conclusion of the Pilot Project.
- May 2016. Submit Plan of Action for the intergovernmental planning organization for the first two years after the Pilot Project, June 2016 – June 2018.

- June 2016. Final report on Phase II, including all the deliverables listed above and an update to the template developed in Phase I based on the lessons learned in Phase II.

Key Issues

A number of issues must be addressed in establishing an intergovernmental planning organization for coordinating sea level rise preparedness and resilience planning:

- Authority: The degree to which the intergovernmental planning organization will be able to coordinate regional planning, which could range from making recommendations on coordination of specific plans and policies across multiple government agencies and jurisdictions, to producing integrated regional plans to be implemented by all the government agencies and jurisdictions in the region.
- Structure: Government agencies and key private sector stakeholders that need to be included in coordination of planning, and public engagement.
- Governance: Leadership of the intergovernmental planning organization and decision-making procedures.
- Scope of Planning: Plans and policies to be coordinated, which could cover land use plans, local government comprehensive plans, zoning and building codes, floodplain management, design and prioritization of transportation projects, construction projects to protect or accommodate, resiliency requirements for privately owned infrastructure such as electrical distribution, natural gas and telecommunications, and other planning issues.
- Resources: Staffing and sources of funding for the intergovernmental planning organization, including the cost of research, travel and events required during the planning process.
- Execution: Monitoring implementation of individual plans developed by government agencies and stakeholders to encourage and assess consistency with the regional planning recommendations developed by the intergovernmental planning organization, and periodic review of regional plans to improve them based on experience with implementing them and to keep them current with changing circumstances.

Scope of Planning

The Pilot Project will adopt the adaptive management approach to planning. Application of this approach will be developed in Phase I and included in the Phase I Final Report. Phase II will include an initial test of the adaptive management approach.

Initial planning will address the four major impacts of sea level rise:
- Permanent inundation
- Increased tidal flooding
- Increased storm-related flooding, both frequency and magnitude. This is referred to as recurrent flooding in Commonwealth of Virginia planning.
- Combined impact of sea level rise, precipitation and groundwater elevation on storm water drainage.

The Pilot Project will assess whether additional sea level rise impacts should be added in Phase II or at a later time, including shoreline erosion, saltwater contamination of aquifers, and loss of wetlands and other natural areas that provide buffers against storm surge.

Planning will encompass the three strategies for adaptation:

- Protect
- Accommodate
- Retreat

Planning will address intergovernmental and private stakeholder coordination of key plans and policies:

- Land use planning, to ensure that adjacent areas controlled by different government agencies or private stakeholders adopt mutually supportive measures for adapting to permanent inundation, tidal flooding and storm surge
- Engineering and construction solutions for protecting vulnerable areas, which may have to extend across jurisdictional boundaries and encompass areas owned by private stakeholders
- Ensuring the resilience of critical infrastructure, including transportation, electrical distribution, water supplies, sanitation systems, telecommunications and others on the Department of Homeland Security list of critical infrastructures.

The Steering Committee will keep abreast of parallel Federal, Commonwealth of Virginia and Hampton Roads regional efforts that may impact the Pilot Project, including:

- Council on Climate Preparedness and Resilience and the State, Local and Tribal Leaders Task Force established by Presidential Executive Order 13653, "Preparing the United States for the Impacts of Climate Change"
- US Army Corps of Engineers North Atlantic Coast Comprehensive Study
- Federal Emergency Management Agency Floodplain Management Program and Region III Coastal Analysis and Mapping Storm Surge Study
- Virginia General Assembly, Joint Subcommittee on Recurrent Flooding
- Governor's Climate Change and Resiliency Update Commission
- Hampton Roads Planning District Commission Special Committee on Recurrent Flooding and Sea Level Rise

Communications and Public Engagement

Federal statues and the Code of Virginia contain specific requirements for informing the public on the activities of public bodies and soliciting public input on proposed polices. The Steering Committee will ensure that the Pilot Project complies with applicable statutory requirements and coordinates its communications and outreach with those of participating government organizations.

Initial Management

Old Dominion University will serve as convener and facilitator until the Steering Committee takes action on permanent management.

Resources

- For Phase I Old Dominion University will serve as convener and facilitator, and provide a password-protected portal for Steering Committee members and an open web site for the public. ODU will identify staffing and resources required to carry out those functions. Individual government agencies and private stakeholders will fund their own expenses during Phase I.

- In Phase I the Pilot Project will identify staffing and sources of funding for the Phase II of the Pilot, in which initial coordination of planning efforts will commence. This should include the cost of staffing, research, travel and events required during the planning process.

This Charter is this ____ day of _____, 2014,
hereby signed by the following, consisting of the Steering Committee and Federal Liaisons to the Hampton Roads Sea Level Rise Preparedness and Resilience Planning Intergovernmental Pilot Project.

Steering Committee

_____
Commonwealth of Virginia, Office of the Secretary of Natural Resources

_____
Virginia Port Authority

_____
Virginia Department of Transportation, Hampton Roads District

_____
Virginia Coastal Zone Management Program

_____
Virginia Department of Conservation and Recreation

_____
Hampton Roads Planning District Commission

_____
City of Norfolk, Office of Emergency Preparedness and Response

_____
Huntington Ingalls Newport News Shipbuilding

Federal Liaisons

_____
Commander Navy Region Mid-Atlantic

_____
Commanding Officer, Naval Facilities Engineering Command Mid-Atlantic

_____
Commander, Norfolk District, US Army Corps of Engineers

_____
Commander Joint Base Langley-Eustis

_____
Commanding Officer, US Coast Guard Shore Infrastructure Logistics Center

_____
Commander Fifth Coast Guard District

This Charter is this 10th day of October, 2014, hereby signed by the following, consisting of the Steering Committee and Federal Liaisons to the Hampton Roads Sea Level Rise Preparedness and Resilience Planning Intergovernmental Pilot Project.

Steering Committee

Commonwealth of Virginia, Office of the Secretary of Natural Resources

Virginia Port Authority

Virginia Department of Transportation, Hampton Roads District

Virginia Coastal Zone Management Program

Virginia Department of Conservation and Recreation

Hampton Roads Planning District Commission

City of Norfolk, Office of Emergency Preparedness and Response

Huntington Ingalls Newport News Shipbuilding

Federal Liaisons

Commander Navy Region Mid-Atlantic

Commanding Officer, Naval Facilities Engineering Command Mid-Atlantic

Col, U.S. Army
Commander, Norfolk District, US Army Corps of Engineers

Col, USAF
Commander Joint Base Langley-Eustis

Commanding Officer, US Coast Guard Shore Infrastructure Logistics Center

Commander Fifth Coast Guard District

This Charter is this ____ day of _____, 2014, hereby signed by the following, consisting of the Steering Committee and Federal Liaisons to the Hampton Roads Sea Level Rise Preparedness and Resilience Planning Intergovernmental Pilot Project.

Steering Committee

Commonwealth of Virginia, Office of the Secretary of Natural Resources

Virginia Port Authority

Virginia Department of Transportation, Hampton Roads District

Virginia Coastal Zone Management Program

Virginia Department of Conservation and Recreation

Hampton Roads Planning District Commission

City of Norfolk, Office of Emergency Preparedness and Response

Huntington Ingalls Newport News Shipbuilding

Federal Liaisons

Commander Navy Region Mid-Atlantic

Commanding Officer, Naval Facilities Engineering Command Mid-Atlantic

Commander, Norfolk District, US Army Corps of Engineers

Commander Joint Base Langley-Eustis

Commanding Officer, US Coast Guard Shore Infrastructure Logistics Center

Commander Fifth Coast Guard District

This Charter is this 14 day of October, 2014, hereby signed by the following, consisting of the Steering Committee and Federal Liaisons to the Hampton Roads Sea Level Rise Preparedness and Resilience Planning Intergovernmental Pilot Project.

Steering Committee

Commonwealth of Virginia, Office of the Secretary of Natural Resources

Virginia Port Authority

Virginia Department of Transportation, Hampton Roads District

Virginia Coastal Zone Management Program

Virginia Department of Conservation and Recreation

Hampton Roads Planning District Commission

City of Norfolk, Office of Emergency Preparedness and Response

Huntington Ingalls Newport News Shipbuilding

Federal Liaisons

Commander Navy Region Mid-Atlantic

Commanding Officer, Naval Facilities Engineering Command Mid-Atlantic

Commander, Norfolk District, US Army Corps of Engineers

Commander Joint Base Langley-Eustis

Commanding Officer, US Coast Guard Shore Infrastructure Logistics Center

Commander Fifth Coast Guard District

This Charter is this 31ST day of OCTOBER, 2014, hereby signed by the following, consisting of the Steering Committee and Federal Liaisons to the Hampton Roads Sea Level Rise Preparedness and Resilience Planning Intergovernmental Pilot Project.

Steering Committee

Commonwealth of Virginia, Office of the Secretary of Natural Resources

CEO/EXECUTIVE DIRECTOR

Virginia Port Authority

Virginia Department of Transportation, Hampton Roads District

Virginia Coastal Zone Management Program

Virginia Department of Conservation and Recreation

Hampton Roads Planning District Commission

City of Norfolk, Office of Emergency Preparedness and Response

Huntington Ingalls Newport News Shipbuilding

Federal Liaisons

Commander Navy Region Mid-Atlantic

Commanding Officer, Naval Facilities Engineering Command Mid-Atlantic

Commander, Norfolk District, US Army Corps of Engineers

Commander Joint Base Langley-Eustis

Commanding Officer, US Coast Guard Shore Infrastructure Logistics Center

Commander Fifth Coast Guard District

This Charter is this ____ day of _____, 2014, hereby signed by the following, consisting of the Steering Committee and Federal Liaisons to the Hampton Roads Sea Level Rise Preparedness and Resilience Planning Intergovernmental Pilot Project.

Steering Committee

Commonwealth of Virginia, Office of the Secretary of Natural Resources

Virginia Port Authority

Virginia Department of Transportation, Hampton Roads District

Virginia Coastal Zone Management Program

Virginia Department of Conservation and Recreation

Hampton Roads Planning District Commission

City of Norfolk, Office of Emergency Preparedness and Response

Huntington Ingalls Newport News Shipbuilding

Federal Liaisons

Commander Navy Region Mid-Atlantic

Commanding Officer, Naval Facilities Engineering Command Mid-Atlantic

Commander, Norfolk District, US Army Corps of Engineers

Commander Joint Base Langley-Eustis

for C. Bonn, CAPT, USCG

Commanding Officer, US Coast Guard Shore Infrastructure Logistics Center

Commander Fifth Coast Guard District

APPENDIX B

Hampton Roads Sea Level Rise Preparedness and Resilience Intergovernmental Pilot Project

Hampton Roads Sea Level Rise Preparedness and Resilience Intergovernmental Pilot Project

Phase 1 Report:

Accomplishments and Lessons Learned

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November 2015

Acknowledgements:

The **Hampton Roads Sea Level Rise Preparedness and Resilience Intergovernmental Pilot Project Phase 1 Report: Accomplishments and Lessons Learned** was developed through a collaborative process that included the active participation of the Working Group and Advisory Committee Chairs, the Steering Committee, and other key stakeholders.

This report is presented with gratitude and appreciation to the community of stakeholders working collaboratively to prepare for sea level rise and recurrent flooding in Hampton Roads and build a more resilient Virginia. Thank you to all of our partners who not only assisted with the development of this report but more importantly have dedicated countless hours to the IPP project and other parallel initiatives whether as part of their professional duties or out of a sense of responsibility. Your hard work each day advances our shared mission of a resilient nation, Commonwealth, and Hampton Roads.

A very special thank you to the current and past members of the IPP Steering Committee, Federal Liaisons, Conveners, Working Group and Advisory Committee Chairs, and several key advisors:

John Allen, *former Commander Joint Base Langley Eustis, COL, US Air Force*
David Architzel *former Old Dominion University Director of Military Affairs, Senior Advisory Committee, Vice Admiral, US Navy, (Ret)*
Dr. Larry Atkinson, *Co-Chair Science Advisory Committee, Old Dominion University*
Sharon Baxter, *Director, Division of Environmental Enhancement Department of Environmental Quality*
Dr. Steven Becker, *Chair Public Health Working Group, Old Dominion University*
George Bonner, *Commander USCG Shore Infrastructure Logistic Center, CAPT, USCG*
Chris Bonney, *Co-Chair Citizen Engagement Working Group, Bonney Research, Hampton Roads Center for Civic Engagement*
Dr. Joseph Bouchard, *Blue Moon Foundation, CAPT, US Navy, (Ret)*
Kit Chope, *VP, Sustainability and Process Excellence, Virginia Port Authority*
Carol Considine, *Chair Private Infrastructure Advisory Committee, Old Dominion University*
Dr. Michelle Covi, *Co-Chair Citizen Engagement Working Group, Old Dominion University, Virginia Sea Grant*
Bob Fallon, *Director, Facilities and Waterfront Support, Newport News Shipyard, Huntington Ingalls*
Evan Feinman, *prior Deputy Secretary of Natural Resources, Commonwealth of Virginia*
Anthony Figiera, *Lt Colonel, US Air Force*
Dr. Larry "Chip" Filer, *Chair Economic Impacts Committee, Old Dominion University*
Mayor Joe Frank, *Chair Senior Advisory Committee, Former Mayor Newport News, Virginia*
Kevin Head, *Joint Base Langley-Eustis, COL, US Air Force*
Dr. Carl Hershner, *Co-Chair Science Advisory Committee, Center for Coastal Resources Management at Virginia Institute of Marine Science*
Roy Hoagland, *Chair Legal Working Group, Virginia Coastal Policy Clinic, William & Mary School of Law*
Randy Keaton, *Deputy Director, HRPDC*
Jason Kelly, *Commander Norfolk District, COL, USACE*

John Korka, *former Commanding Officer NAVFAC Norfolk, Rear Admiral, US Navy*
Dr. Mark Luckenbach*, Virginia Institute of Marine Science*
John Marburger*, CDR, US Navy*
Amy Matzke-Fawcett, *Communications Specialist, Old Dominion University*
Angela Navarro*, Deputy Secretary of Natural Resources, Commonwealth of Virginia*
Mark Nevitt*, Legal Working Group, CDR, US Navy JAG Corps,*
Jim Oliver*, Senior Advisory Committee*
Ann Phillips*, Chair Infrastructure Working Group, Rear Admiral, US Navy (Ret.)*
Craig Quigley, Senior Advisory Committee, Director, *Hampton Roads Military and Federal Facilities Alliance, Rear Admiral, US Navy (Ret)*
Jim Redick, Chair *Co-Chair Secure Commonwealth Panel Sub-Committee on SLR; Emergency Preparedness & Response, City of Norfolk*
Pat Rios, *Commanding Officer NAVFAC Norfolk, CAPT, US Navy*
Shawn Talmadge, Co-Chair *Homeland Security and Resilience Staff Director, Commonwealth of Virginia* **Teddie Thorogood,** *Chief of Resources and Planning, Coast Guard District 5*
Ray Toll, *Director for Coastal Resilience Research, Old Dominion University*
Burrell Saunders*, Chair Land Use Planning Working Group, Saunders + Crouse Architects, Urban Land Institute Hampton Roads*
Kevin Slates*, Director, Chief of Naval Operations, Energy and Environmental Readiness Division***,** *Rear Admiral, US Navy*
Dixon Smith, *former Commander Naval Region Mid-Atlantic, Vice Admiral, US Navy*
James Utterback, *Virginia Department of Transportation, Hampton Roads District*
Jon White, *Chair of Navy Task Force Climate Change, Rear Admiral, US Navy*
Ricky Williamson, *Commander Naval Region Mid-Atlantic, Rear Admiral, US Navy*
Heather Wood, *former Sustainability Director, Port of Virginia; Kennedy Jenks Consultants*
Mayor Kenneth Wright, *Chair, HRPDC; Mayor, City of Portsmouth*

Executive Summary

Initiated in June 2014, the Hampton Roads Sea Level Rise Preparedness and Resilience Intergovernmental Pilot Project (Intergovernmental Pilot Project or IPP) convened at Old Dominion University is an effort to use the knowledge skills and expertise of all regional stakeholders to create a framework or template for intergovernmental strategic planning that can be used outside the region; and, to implement that integrated strategy in Hampton Roads, Virginia creating an effective and efficient method for planning holistically for sea level rise and recurrent flooding.

With active stakeholders from the Department of Defense, federal agencies and the White House as well as the Commonwealth of Virginia and many localities across Hampton Roads, Virginia, the IPP is truly a "whole of government" effort. Knowing water knows no jurisdictional bounds, that level of intergovernmental collaboration is necessary to develop integrated regional solutions and implement effective sea level rise preparedness and resilience strategies. Additionally, the wider community in Hampton Roads recognizes that they too will be affected by not only sea level rise itself, but also the adaptation strategies implemented in preparation. Thus, IPP stakeholders include representatives from private industry, infrastructure, non-profits, the real estate community, and vulnerable communities. Furthermore, while the IPP was conceived in Hampton Roads, the IPP recognizes that sea level rise affects the entire Commonwealth, and a successful 'whole of government and community' approach must eventually include regions beyond Hampton Roads and reach across the Coastal Virginia and the Commonwealth as a whole.

Throughout the past year stakeholders have attended numerous IPP meetings and many supporting events, but they have also, through their own personal and professional lives driven the resilience conversation in Hampton Roads and beyond. The IPP is completely unfunded and exists not as an entity, but as an experiment, bringing together the community, and leveraging and building upon other initiatives from the Secure Commonwealth Panel's Subcommittee on Sea Level Rise to Urban Land Institute's Resilient Region Reality Checks to NOAA and NASA scientists.

The first Phase of this two-Phase, two-year project came to completion during the summer of 2015 with a daylong leadership retreat. This report summarizes the stakeholder engagement and due-diligence process stakeholders undertook during Phase 1, but does not detail each meeting or event that took place. Phase 2 will continue to build on other initiatives and count on stakeholders to use these networks and knowledge to create an enduring entity, organization, or strategy to continue using economies of scale and the "whole of government and community" model for sea level rise preparedness and resilience in Hampton Roads and elsewhere.

Phase 1 Report: Accomplishments and Lessons Learned

Overview of Intergovernmental Pilot Project

Background

The Hampton Roads Intergovernmental Pilot Project was initiated to promote collaboration in a diverse region vulnerable to sea level rise, recurrent flooding, and coastal storms. While many news reports and scientific studies quantifying the risk vary, there is no question of vulnerability. For example, NOAA has cited Hampton Roads as the U.S.'s second largest population center at risk from sea level rise.[1] More recently recently, in June 2015, CoreLogic estimated that nearly 400,000 properties are exposed to flood or surge inundation regionally.[2] In order to consider living with the water in Hampton Roads, the region must join together and act innovatively and proactively.

This elevated risk is a result of geophysical as well as socio-economic factors. The geophysical conditions include a primarily flat topography, mostly within a few meters of sea level, a high rate of land subsidence, and an extensive network of tidal waterways weaving throughout the region. The Virginia Institute of Marine Science (VIMS) *Recurrent Flooding Study for Tidewater Virginia* (2013) report commissioned by the Virginia General Assembly highlighted the cities of Virginia Beach, Portsmouth, Norfolk, Chesapeake, Hampton, and Poquoson as confronting significant challenges related to sea level rise, assuming a 1.5 foot rise in sea level and a 3 foot storm surge. The study found that in these localities the percentage of the total land area vulnerable to flooding ranged from 11% to 69%.[3]

The region has a population of over 1.7 million people, many of whom depend on the waterways indirectly for employment or for recreation, as well as a high concentration of valuable commercial, industrial, and military assets benefiting from their direct access to water-dependent assets. Along with other federal facilities, Naval Station Norfolk, the largest naval base in the world, and the Port of Virginia, which generates $60 billion in annual spending,[4] are key economic drivers in the region. Supporting industries including shipbuilding and repair, defense contracting, rail transport and truck transport play a key role economically. Commercial and recreational fishing, outdoor recreation, tourism and the associated real estate development, and many other industries take advantage of the shorelines, wetlands and beaches. Institutes of higher education in the area, also economic drivers, boast strengths in water related programs and research. These industrial, commercial, residential, and

[1] Climate Change and the Chesapeake Bay, FAQ: Frequently Asked Questions, NOAA, available http://collaborate.coast.noaa.gov/nroc/Shared%20Documents/Interagency%20Climate%20Change%20Meeting%20-%20June%202009/Background%20Materials/FAQClimateChangeinCB8.08.pdf .

[2] Howard Botts, et. al. *2015 CoreLogic Storm Surge Report*, CORELOGIC, (June 2015) http://www.corelogic.com/research/storm-surge/corelogic-2015-storm-surge-report.pdf.

[3] Virginia Institute for Marine Science (VIMS). (2013). *Recurrent Flooding Study for Tidewater Virginia*, available http://ccrm.vims.edu/recurrent_flooding/Recurrent_Flooding_Study_web.pdf.

[4] Roy L. Pearson, *The Fiscal Year 2013 Virginia Economic Impacts of the Port of Virginia,* WILLIAM AND MARY, RAYMOND A. MASON SCHOOL OF BUSINESS (Dec. 26, 2014) http://www.portofvirginia.com/pdfs/POV%20Econ%20Impact%20Study%202014.pdf.

environmental assets and pillars of the economy are key to the region's success, but are at risk from the rising level of the very waters that drew them to Hampton Roads.

Photo Courtesy of Old Dominion University

With a vast array of resources threatened by sea level rise, leaders across the region recognize that resources must be managed collectively and strategically for the region to continue thriving with the water as it has for hundreds of years. In order for the region to succeed moving forward, innovative adaptation strategies must be developed, evaluated and implemented. Adaptation strategies include changing land use patterns and regulations, building major storm protection infrastructure, implementing changes in local stormwater management approaches, and many more.

This wide range of both challenges and potential solutions crosses numerous governmental boundaries, both vertically and horizontally, as water knows no political borders. With 17 independent local jurisdictions in the region, and a prominent federal presence and investment, along with significant state resources, the need for effective and strategic regional planning and response across jurisdictional boundaries is essential but challenging. Regional collaboration could result in outcomes that:

- Avoid duplication and maintain consistent minimum design standards across the region.
- Allow for whole of system adaptation and reliability.
- Minimize disruption when multiple infrastructure agencies or companies must harden or otherwise alter their installations in the same area, through coordination of resources.
- Result in more effective regional solutions through utilizing economies of scale.

Government:

Depending on how the region is defined, Hampton Roads, Virginia includes approximately 17 municipal governments[5] and 16 federal agencies.[6] The region has several regional planning and service organizations as well, which facilitate various levels of inter-municipal cooperation. Across the 17 municipalities, the region varies greatly in land use patterns and socio-economic makeup, creating the illusion of competitive interests across the region, however the region is united in the effort to address recurrent flooding and sea level rise.

Regionally, the Hampton Roads Planning District Commission (HRPDC), for example, has taken great leadership in addressing sea level rise and recurrent flooding with its members and by providing a series of reports on local climate impacts.[7] Again, though the scope of the IPP was initially limited to the HRPDC geographic boundaries, stakeholders have recognized that this does not fully represent the affected region across Coastal Virginia.

Additionally, several important aspects of local operations and infrastructure are managed directly by the Commonwealth, and at the recommendation of the Secure Commonwealth Panel Recurrent Flooding Sub-Panel,[8] the Commonwealth has recently appointed a Chief Resilience Officer to lead incident command for coastal resilience issues. All of these governmental entities and political subdivisions are either currently impacted or will be impacted by coastal flooding. Moreover, the Commonwealth of Virginia is a Dillon Rule state, meaning that localities are limited in their authority to the powers granted them by the General Assembly. The Commonwealth has an inescapable role in ensuring localities have the tools necessary to adapt effectively.

[5] See generally, Hampton Roads Planning District Commission, Locality Profiles available http://hrpdcva.gov/page/locality-profiles/. While HRPDC reflects the geographical boundaries of Hampton Roads, it does not reflect the full region of the Commonwealth affected by sea level rise.

[6] See generally, Hampton Roads Military and Federal Facilities Alliance for overview information and resources regarding the various federal and defense installations and agencies located in Hampton Roads, available: http://hrpdcva.gov/page/locality-profiles/.

[7] See Hampton Roads Planning District Commission Planning Reports http://www.hrpdcva.gov/news/index/category/id/11/.

[8] Jim Redick and Senator John Watkins, Co-Chairs, *Recommendations to the Secure Commonwealth Panel on the Issue of Sea Level Rise and Recurrent Flooding in Coastal Virginia*, Secure Commonwealth Panel Recurrent Flooding Sub-Panel (Sept. 5, 2014) http://ccrm.vims.edu/SCPRecommendationsReport_Sept2014.pdf.

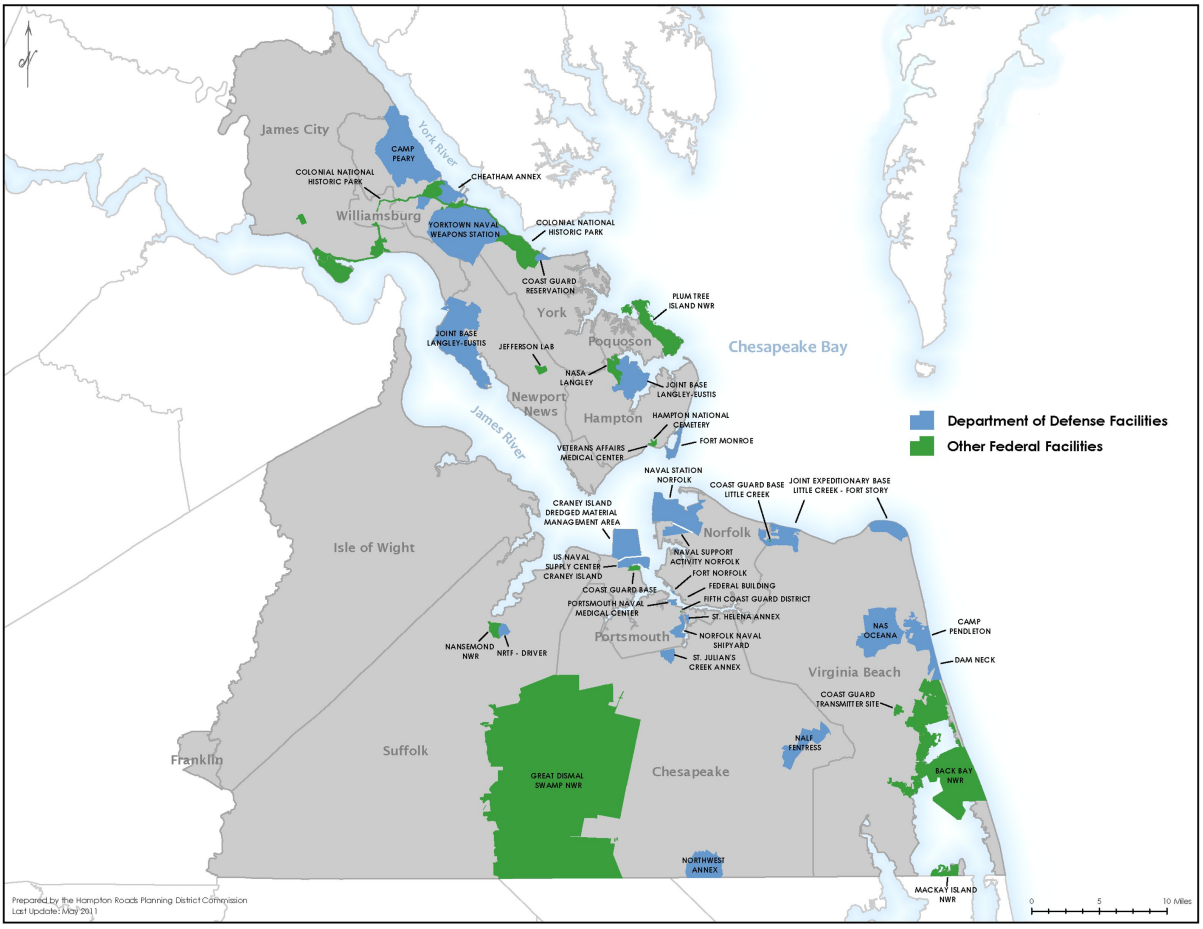


Figure 1. Hampton Roads Region Municipalities and Federal Facilities, *Image Courtesy of the Hampton Roads Military and Federal Facilities Alliance*

Private Infrastructure:

Several critical components of the infrastructure system in Hampton Roads (electricity, natural gas, telecommunications, freight rail, healthcare, etc.) are privately owned.[9] While many large private companies are investing heavily in resiliency planning of their assets and are able to dedicate resources to business continuity in the face of flooding, many smaller companies simply do not have the information and resources available. Additionally, many of these companies know that they are only as strong as their workforce; their employees need to be able to both access the workplace and ensure the safety of their loved ones and homes. In addition, strategies and industry standards developed by companies prioritizing resilience as a means of protecting their own assets can benefit other private companies both in the region and elsewhere. Thus these companies are beginning to understand the benefits of collaboration and are active participants in the IPP.

[9] National Infrastructure Protection Plan (2013), available http://www.dhs.gov/sites/default/files/publications/National-Infrastructure-Protection-Plan-2013-508.pdf.

Community:

Current and future residents, businesses, and non-profits of Hampton Roads are exposed to risks associated with flooding and those risks increase with sea level rise. Like pollution and other pervasive phenomena, sea level rise does not know jurisdictional boundaries and will impact citizens across the region, especially our low and moderate-income families and senior citizens.

Importantly, the community will also be greatly impacted by the region's approach and chosen adaptation strategies either temporarily (e.g. construction) or permanently (e.g. neighborhood buy-outs or storm surge barriers). As such, both community education and input are vital components of resiliency in Hampton Roads. Thus far the messaging surrounding both the risks of coastal flooding and sea level rise, as well as the potential adaptation methods for the region, has left substantial room for improvement through a collaborative approach.

Although many individuals, businesses, institutions, and government agencies are informed and developing plans to adapt and to protect assets, their work often occurs in or is based on inaccurate or unreliable data, putting this work at risk from decisions and actions made by key intersecting parties:

- If a state bridge connection is hardened with a raised deck and reinforced supports, but the local access is impassable due to high water, the state investment in the bridge becomes worthless.
- A hospital built to withstand Category 5 hurricane winds, storm surge, and sea level rise is of little use if roads flood, power is lost, drinking water is contaminated, sewer service fails, or fuel supplies are cut off.

In addition to the challenges noted above, the Hampton Roads region's geophysical, ecological, and engineered environments as well as its legal, economic, and social systems are technically complex. Integration of access to the best available technical, scientific, legal, economic, and planning information is an essential element of effective response.

The risks associated with sea level rise are great in Hampton Roads. The potential for opportunity within a proactive region are also great. As one of the first regions in the US proactively and collaboratively addressing a major threat from sea level rise, Hampton Roads is uniquely positioned to be a pioneer in the field of coordinated planning, adaptation, research, and response.

Intergovernmental Pilot Project

The IPP is a 2-year project officially launched in June 2014 with a goal of addressing these challenges through a collaborative process that seeks to engage all major stakeholders. Envisioned as an initial step towards the development of systematic, structured coordination of Hampton Roads' planning for and response to sea level rise risks in the region, the IPP aims to bring a Whole-of-Government and Whole-of-Community approach to addressing these issues.

The White House and Department of Defense each initiated three regional pilots following President Obama's Executive Order, "Preparing the United States for the Impacts of Climate Change." The Hampton Roads Intergovernmental Pilot Project is the only geographic location on both lists, and the

only pilot convened by a university across a region as varied as Hampton Roads. Furthermore, this initiative is the only one exploring the whole of government/community model and addressing coastal resiliency with a focus on regional resilience and local mitigation and adaptation to address national security concerns and economic impacts.

MISSION: *The mission of the IPP is to establish in Hampton Roads a regional Whole of Government & Whole of Community organizational framework and procedures that effectively coordinate SLR Preparedness & Resilience Planning.*

VISION: *A regional 'whole of government' and 'whole of community' approach to sea level rise preparedness and resilience planning in Hampton Roads that also can be used as a template for other regions.*

Recently highlighted by President Obama's 2010 National Security Strategy[10] the IPP utilizes the Whole of Government concept to improve integration and collaboration across federal, state, and local governmental agencies to more effectively leverage limited resources in order to plan for sea level rise and coastal flooding. Because this is a cross-jurisdictional issue, application of the Whole of Government approach to sea level rise preparedness and resilience planning will benefit the region greatly.

However, in a region of 17 localities, the whole of government process does not come easily, and the IPP aims to build bridges and increase understanding and collaborative processes during its two year experiment. Slowly moving towards a more formal planning arrangement ensures that due diligence is completed through the committee and working group structure, developing a more concrete vision of a final arrangement that can be recommended.

Though the Whole of Government concept was the initial goal of the White House and Department of Defense Pilots, the Whole of Community concept was added to bring regional ownership to the process. While the IPP will act as a model throughout the country for collaborative planning for climate impacts, in order to benefit as a region and to garner local buy-in, a true community effort is key. The IPP two-year process is designed to be an iterative one, with input gathered from all interested stakeholders in a manner that allows for adaptive management in response to changing information and conditions.

In the first year over 200 people have participated in Working Group or Committee meetings, and even more have attended community events designed to inform the process. A primary example of the iterative process included the Resilient Region Reality check jointly held by Urban Land Institute Hampton Roads and Old Dominion University, which was a region-wide multi-sector approach to communicating risks in the community and receiving feedback on community priorities. In addition to

[10] See *National Security Strategy, 2010*, available https://www.whitehouse.gov/sites/default/files/rss_viewer/national_security_strategy.pdf. See also, Presidential Policy Directive (PPD-8): National Preparedness, available http://www.dhs.gov/presidential-policy-directive-8-national-preparedness.

hosted events, staff and volunteers regularly give presentations or workshops to interested groups, from civic leagues to Lead Hampton Roads.

Photo Courtesy of Old Dominion University

Participation in the IPP remains completely voluntary, for both Steering Committee members, and working group and working committee members. While some organizations, agencies, and localities, have tasked staff members with participation, others have simply volunteered their time and expertise. In Phase 1, Eric Jabs, CAPT, USN Ret. and Old Dominion University PhD candidate conducted a survey of IPP participants as a part of his dissertation research. His preliminary findings reveal that 92% of IPP stakeholders and respondents think the activities of the IPP have already had or will have a positive impact on regional resilience. After one year, this is a resounding vote of confidence in the collaborative process modeled in the Charter moving forward.

Old Dominion University (ODU) acts as the convener of the IPP and supports it with expert faculty, research facilities, and access to partnerships within academia, which expand the resources available to the IPP (e.g., the Virginia Institute of Marine Science (VIMS) and William and Mary's Virginia Coastal Policy Center).

Despite herculean volunteer efforts, the IPP is limited by a lack of funding. Thus developing sustainable sources of funding for not only IPP Phase 2 efforts but the resulting entity or organization must be prioritized.

Funding

Importantly, the IPP is not independently funded. ODU and other partners have donated support by providing significant staff time, communications support, and the underwriting of various IPP events. Working groups of volunteers have contributed significant time. This time commitment of volunteer resources is not sustainable over a long period of time. As the convener, ODU has staffed the IPP, though at the end of Phase 2 when a new entity is created, independent staffing and funding will be necessary, though there will likely remain University research support from across the region.

The IPP is a two-phase project, each phase expected to last approximately one year. Objectives for each phase are attached in the Appendix.

Overall Goals and Expected Outcomes

The overall goal of the IPP is to create intergovernmental planning organizational arrangements and procedures to effectively coordinate sea level rise preparedness and resilience planning of Federal, State, and Local government as well as the private sector, in the context of the perspectives and concerns of the citizens of the region.

Participants

Participants in the IPP are drawn from multiple government organizations and agencies as well as private industry, academe, and non-profit sector. The organizations participating as of June 18, 2015 are listed on the attached Appendix and include at least 18 federal agencies or facilities, many Commonwealth partners, regional partners, municipalities, and the private sector. While the IPP has over 200 stakeholders, a goal for Phase 2 will be encouraging broad municipal support, which is essential to long-term success in regional planning. Although the HRPDC is an active partner and counts all 17 localities in Hampton Roads among its members, not all municipalities participate individually though all are invited.

Project Structure

The IPP structure consists of a Steering Committee, which directs the overall strategic direction for the Pilot and is informed and supported by a set of Working Groups and Advisory Committees. Steering Committee membership includes private industry, state and local representatives as well as non-voting federal liaisons. Because the results of the IPP will result in a proposal for effective local planning, Federal Liaisons are active participants but not voting members of the committee.

STEERING COMMITTEE	
Jim Redick, Chair	*Co-Chair Secure Commonwealth Panel Sub-Committee on SLR; Emergency Preparedness & Response, City of Norfolk*
Shawn Talmadge, Co-Chair	*Homeland Security and Resilience Staff Director, Commonwealth of Virginia*
Mayor Kenneth Wright	*Chair, HRPDC; Mayor, City of Portsmouth*
Randy Keaton	*Deputy Director, HRPDC*
Kit Chope	*VP, Sustainability and Process Excellence, Virginia Port Authority*
Angela Navarro	*Deputy Secretary of Natural Resources, Commonwealth of Virginia*
Bob Fallon	*Director, Facilities and Waterfront Support, Newport News Shipyard, Huntington Ingalls*
James Utterback	*Virginia Department of Transportation, Hampton Roads District*
Sharon Baxter	*Director, Division of Environmental Enhancement Department of Environmental Quality*
FEDERAL LIAISONS	
RDML Rick Williamson	*Commander Naval Regional Mid-Atlantic*
COL Jason Kelly	*USACE, Commander Norfolk District*
CAPT George Bonner	*Commander USCG Shore Infrastructure Logistic Center*
Teddie Thorogood	*CFD5*

CAPT Pat Rios	*Commanding Officer NAVFAC Norfolk*
COL Kevin Head	*Joint Base Langley-Eustis*
CONVENER	
Ray Toll	*Director for Coastal Resilience Research, Old Dominion University*

Figure 2. IPP Steering Committee as of October 1, 2015

The Legal, Infrastructure Planning, Land Use Planning, and Citizen Engagement Working Groups were formed by the Charter, while the Public Health Working Group was formed at a meeting of the Steering Committee in April 2015 after acknowledgement of a planning gap. Advisory Committees were convened as well, to provide key information to the Working Groups and Steering Committee. Figure 3 shows the basic organizational structure with primary communication relationships between Steering Committee, Working Groups, and Advisory Committees.

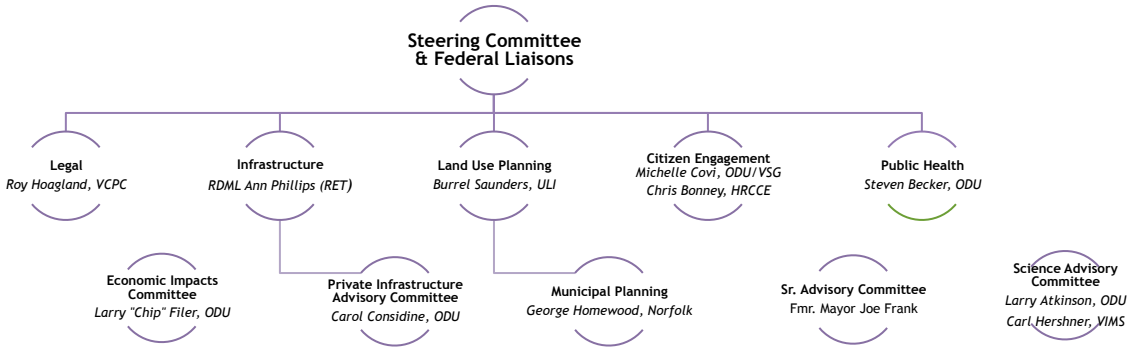


Figure 3. IPP Organizational Structure

Project Status as of July 2015

Deliverables

In October 2014, the Steering Committee signed the Charter and formation of the various Working Groups and Advisory Committees commenced. By July 2015, every Working Group and Committee but the Economic Impacts Advisory Committee had a chair and was operational.

During Phase 1, the Legal Working Group established several operating principles for consideration by the Steering Committee and worked to develop a "Legal Primer Version 1." The Primer details federal, state, and local laws and regulations related to planning for sea level rise, serving as a reference document for the Steering Committee and the other Working Groups (See Appendix).

All active Working Groups and Committees have set forth Action Plans and Scopes of Work during the course of Phase I, briefed the Steering Committee and Senior Advisory Committee on their efforts and requested feedback.

While some of the Phase I deliverables are on a longer timeline than originally anticipated, the IPP remains on track to propose an intergovernmental planning structure or structures by the end summer

of 2016. This proposal will be in coordination and support of other regional entities and organizations working towards a resilient future in Hampton Roads.

Though timelines will be altered from the original Charter schedule, the focus will remain on adapting to lessons learned in Phase 1 in the pursuit of establishing a regional entity focused on collaborative resilience planning, and many objectives remain the same. Based on research and lessons learned the Legal Working Group will report on potential structures for continued collaboration and operating procedures for the intergovernmental planning organization that will be established upon completion of the IPP, and the conveners will continue to provide updates to all stakeholders and the community. By the summer of 2016 the results will include a clear path forward for the region and the signing of a memorandum of understanding among partners to create a new entity in Hampton Roads if needed. A final report will be issued soon after the completion of Phase 2.

Project Milestones

As of July 2015, several major milestones have been achieved by the IPP:

Summer 2014

- ***White House announces pilots at the IPP Kickoff at TechSurge[11] on June 3, 2014:*** In front of over 250 government and private industry planners, engineers, scientists, and others, both the IPP and the creation of the Mitigation and Adaptation Research Institute at Old Dominion University were announced. The IPP announcement panel included many current Steering Committee members and set the stage for the initiative with support from the Pentagon, the White House, the State and the region. The event closed with a short speech by EPA Administrator Gina McCarthy. This event also marked the beginning of the White House list of 3 pilots, IPP being the first.

Photo Courtesy of Old Dominion University

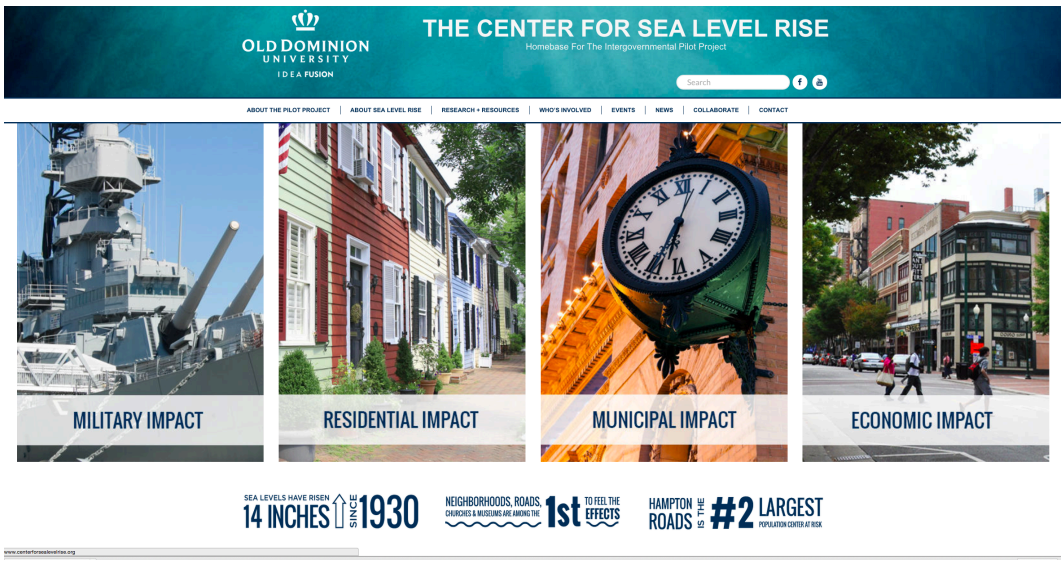
- ***Rising to the Challenge: Bipartisan Forum Organized by Sen. Kaine:*** Organized by Senator Kaine, Rising to the Challenge made national media take notice of the collaborative approach to sea level rise preparedness in Hampton Roads. In addition to Sen. Kaine, event panelists

[11] TechSurge is a program of the Marine Technology Society, information is available: https://www.mtsociety.org/conferences/techsurge/.

included both Republican and Democratic members of the Hampton Roads Congressional delegation, as well as the Mayors of Virginia Beach and Norfolk and focused on leveraging expertise to take action on sea level rise preparedness and resilience.

Photo Courtesy of Old Dominion University

- ***Website Launch:*** The website, www.centerforsealevelrise.org , is constantly being updated with relevant resources and news. In addition to the newsfeeds, resources, social media accounts, and newsletter sign-up, the website also hosts a calendar listing many local, regional, national, and virtual events as well as IPP meetings and activities. Since the website has launched the ODU team has also used the "Center for Sea Level Rise" Facebook account and @ODUsealevelrise Twitter accounts to promote awareness and IPP activities.



Fall 2014

- ***Charter Drafted and Signed:*** At a meeting of the Steering Committee on October 10th, 2014, many steering committee members signed on to the Charter (see Appendix).

- ***Sen. Kaine Letters:*** Sen. Kaine sends letters to federal agencies urging participation in IPP and agency responses sent to Sen. Kaine. The agencies replied throughout the winter with support, and designated points of contact for Hampton Roads. (See Appendix)

- ***Department of Defense (DoD) Orders:*** DoD officially acknowledged the Hampton Roads Intergovernmental Pilot as one of their three pilots throughout the country, and designated Navy as the lead service. (See Appendix)

Winter 2014-2015

- ***FEMA NEP Tabletop Exercise:*** FEMA National Exercise Program and the IPP participated in a day-long event serving as the first meeting of all Working Groups and Committees. In the afternoon, participants took a long-view of resilience planning and described how Hampton Roads would function in our children's and grandchildren's time. The report from this event is in the Appendix.

Photo Courtesy of Old Dominion University

- ***HRPDC Votes to Officially Participate in the IPP:*** The HRPDC Commission officially voted to participate in the IPP, assigning Chair, Mayor Wright of Portsmouth, and Acting Executive Director, Randy Keaton, to the Steering Committee.

- ***Committees Begin Work Engaging Stakeholders and Developing Work Plans:*** Following the work completed during the FEMA NEP Tabletop Exercise, Working Groups and Committees initiated meeting independently, engaging more volunteers and developing work plans.

Spring 2015

- ***Continued Committee Work:*** Committees continued to engage new members, and develop work plans. Work plan status reports and feedback opportunities were provided to the Steering Committee and the Senior Advisory Committee in March 2015 (initially scheduled for February and delayed due to winter weather).

- ***FEMA Federal Flood Risk Management Standard Public Listening Session:*** After the announcement of the new Flood Risk Management Standard to improve the nation's resilience to climate change, IPP stakeholders facilitated an official Listening Session for FEMA at ODU. Comments on the FFRMS closed in May 2015, and a revised Standard has not yet been issued.

- ***HUD NRDC Competition, Public Listening Session for the Commonwealth's Application:*** The IPP fully supports and leverages its stakeholder network to assist the Commonwealth in HUD's National Disaster Resilience Competition (NDRC). As Part of Phase 1 of the NDRC a public listening session was held regarding the Competition.

- ***Urban Land Institute Resilient Region Reality Check:*** As the first installment of an annual iterative process involving community feedback to prioritize resilience planning while educating the region, citizens from across ages, socio-economic backgrounds, and business sectors, came together for a day-long event as part of the Citizen Engagement Committee's work plan development and outreach.[12]

Photo courtesy of Rich-Joseph Facun

[12] Resilient Region Reality Checks are programs of the Urban Land Institute and Urban Land Institute Hampton Roads, Information is available: http://virginia.uli.org/uli-action/resilient-region/ .

Summer 2015

- ***Phase 1 Wrap-Up:*** Phase 1 of the IPP officially closed in Summer 2014, and the IPP has now moved on to accomplishing Phase 2 goals with a lens towards lessons learned during the first year.

- ***ULI Resilient Region Reality Report:*** At the Urban Land Institute Hampton Roads Resilient Region Reality Check-In, Michelle Covi, co-chair of the Citizen Engagement Committee presented the results of the Resilient Region Reality Check that took place in March 2015. The Report from the December 2014 Advisory Panel on Fort Norfolk was also presented.[13]

- ***Newsletter Initiated****:* As more volunteers sign on to participate, and regional and national interest has grown in the IPP, the conveners have initiated a regular newsletter to provide open lines of communication. The website, Facebook, and Twitter accounts also provide easy means of staying informed.

Other important steps with respect to SLR planning have been taken in Hampton Roads and the Commonwealth since June 2014. The IPP aims to collaborate with, leverage and build upon the work of other organizations promoting adaptation and resilience planning in the region as part of the Whole of Government and Whole of Community process. The items below represent a small sample of the many conferences, events, local, state and federal initiatives taking place to increase resilience in Hampton Roads.

Summer 2014:

- ***Governor's Climate Change and Resiliency Update Commission:*** The bi-partisan commission is comprised of leaders from around the state including Ray Toll, the convener of the IPP, Ben McFarlane, of HRPDC and IPP stakeholder, and many other partners. The Commission, tasked with developing a short list of priorities for the current Administration, will wrap up in late 2015.

- ***HRPDC Special Committee on Recurrent Flooding (Now Sea Level Rise Advisory Committee) established:*** At the request of local leadership, HRPDC established what is now the Sea Level Rise Advisory Committee to develop recommendations for local governments and advocate for federal and state support. All municipalities were invited to appoint staff to the committee, which meets regularly. Many IPP stakeholders are also the designated committee members, and IPP convener staff regularly attends to coordinate.

- ***Joint Subcommittee to Study Recurrent Flooding:*** Pursuant to HJ 16 (2014) and SJ 3 (2014) the committee is tasked with formulating recommendations for the development of a

[13] Ibid. Juita-Elena (Wie) Yusuf, Michelle Covi, and Burton St. John III, *Hampton Roads Resilient Region Reality Check Report* (2015), Presentation available http://virginia.uli.org/wp-content/uploads/sites/90/2015/07/Hampton-Roads-Resilient-Region-Reality-Check-2.pdf and Report available http://www.centerforsealevelrise.org/recent-news/resilient-region-reality-check-in-reports/ .

comprehensive and coordinated planning effort to address recurrent flooding. Final recommendations will be presented to the 2016 Session of the General Assembly. (See Appendix for Interim Report)

Fall 2014:

- ***Recommendations to the Secure Commonwealth Panel on the Issue of Sea Level Rise and Recurrent Flooding in Coastal Virginia:*** After a lengthy process involving many stakeholders throughout the state and approaching sea level rise from an incident command system perspective, the sub-panel submitted the report to the Secure Commonwealth Panel detailing clear recommendations. The comprehensive analysis by the Recurrent Flooding Sub-Panel put forward in this report inform the collaborative planning efforts of the IPP. In addition, the lead author and co-chair of the sub-panel sits on the IPP Steering Committee. The full report can be accessed at www.norfolk.gov/DocumentCenter/View/17786.

Winter 2014

- ***Chief Resilience Officer Appointed:*** Secretary of Public Safety and Homeland Security, Brian Moran was appointed by Governor McAuliffe as the Chief Resiliency Coordinator fulfilling a recommendation of the Secure Commonwealth Panels Subcommittee's Report.

- ***NIST Disaster Resilience Workshop in San Diego:*** As part of the National Institute of Standards and Technology's (NIST) development of an Initial Disaster Resilience Framework workshops were conducted around the country to provide opportunities for stakeholders to engage and provide feedback on resilience planning and implementation strategies. ODU Convener, Emily Steinhilber, presented the Pilot stakeholder engagement and 'whole of government and community' methods to NIST leadership and stakeholders.

Summer 2015

- ***United States Senate Democratic Steering and Outreach Committee:*** Ray Toll briefed many United States Senators from across the nation on the proactive activities taking place on the ground in Hampton Roads focusing on the IPP.

- ***Dutch Dialogues Hampton Roads, Life at Sea Level:*** After the success of the Dutch Dialogues in other regions through the country including New Orleans, a delegation of water management specialists from the Netherlands collaborated with local experts and stakeholders at Slover Library in Norfolk. The five-day charrette focused on two vulnerable areas – the Tidewater area in Norfolk, and the Newmarke Creek area in Hampton and Newport News. Many IPP stakeholders participated throughout the weekend as experts developed innovative water management solutions specifically for Hampton Roads.

- ***IPP Strategic Planning Session:*** At the close of Phase 1, the IPP Steering Committee, Working Group and Committee Chairs, and conveners participated in a day long retreat to look back on

the past year, and set a clear path forward for Phase 2. During this meeting, the Steering Committee elected Jim Redick of the City of Norfolk & Secure Commonwealth Panel as Chair and Shawn Talmudge, Homeland Security and Resilience Staff Director for the Commonwealth of Virginia as Vice-Chair.

Committee Reports

Steering Committee & Federal Liaisons

Chair: Jim Redick, *City of Norfolk, Emergency Manager & Co-Chair Secure Commonwealth Panel Sub-Panel on Recurrent Flooding (As of August 4, 2015)*

Vice Chair: Shawn Talmadge, *Homeland Security and Resilience Staff Director, Secretariat of Public Safety and Homeland Security (As of August 4, 2015)*

Convener: Ray Toll, *Director of Coastal Resilience Research, Old Dominion University*

The Steering Committee (see Appendix) and Federal Liaisons are all representatives of their organizations or sectors and participate voluntarily in the IPP. Understanding the risks faced by the region as well as the potential opportunities to a proactive region these leaders are committed to the collaborative process as established in the Charter (see Appendix). Many Steering Committee leaders came together at the IPP launch in June as well as at a bi-partisan event hosted by Senator Kaine later that month to discuss the IPP concept with a public audience. The Steering Committee and Federal Liaisons then met on October 10th, 2014 to discuss a path forward and sign the Charter.

On December 2nd, 2014, the Steering Committee & Federal Liaisons (IPP Leadership) came together at a large event in Norfolk, Virginia to launch the IPP Working Groups and Advisory Committees as part of a FEMA National Exercise Program event. From that point on the Working Groups and Advisory Committees continued to work on their own by following the direction given in the Charter under the leadership of the Convener, Ray Toll.

The IPP Leadership attended a joint meeting of the Senior Advisory Committee on March 18th, 2015, to provide feedback and discuss progress with all active Working Group and Advisory Committee Chairs. The next month on April 27th, IPP Leadership met jointly with the Legal Working group to discuss a logistical path forward for the "post-IPP" framework and entity in Hampton Roads. As a result of this productive meeting, the IPP Leadership, Working Group and Advisory Committee Chairs and selected Senior Advisors, participated in a facilitated strategic planning retreat to formalize the transition from Phase 1 to Phase 2 of the Pilot (see Minutes in Appendix).

Following the Retreat, the IPP Leadership emerged a stronger body capable of providing direction to Working Groups and Advisory Committees focused on creating both a nationally applicable framework as well as recommendations for a local entity charged with sea level rise preparedness and resilience. Among other decisions and strategies discussed, the Steering Committee appointed a Chair and Vice

Chair as seen above and determined that for simplification during the duration of the Pilot the boundaries would be reflective of the Hampton Roads Planning District Commission boundaries, but the group recognized the value of an inclusive approach that included all of those impacted by sea level rise and recurrent flooding within the Commonwealth.

Working Groups

Legal Working Group

Chair: Roy Hoagland, *Director, Virginia Coastal Policy Center, William & Mary Law School*

Date of Formation: September 2014

Scope of Work:

As defined by the Charter, the Legal Working Group (LWG) will address legal issues that arise during the IPP and draft a Memorandum of Understanding (MOU) for the follow-on project that emerges from the IPP. The draft MOU will be submitted to the Steering Committee no later than April 2016. The Working Group will consult with contacts designated by other Steering Committee members.

Key Findings and Actions:

- The LWG has sought an attorney from every Hampton Roads jurisdiction to participate in addition to private leadership groups, and has requested that the Steering Committee send a formal participation invitation letter to all Hampton Roads jurisdictions as follow up.
- The LWG has assigned liaisons to all Working Groups and Committees to communicate any legal questions that may arise to the LWG, but does not serve as counsel to the Working Groups or Committees.
- The LWG has developed the first version of a Legal Primer to serve as a legal reference document for the Steering Committee and other Working Groups and Advisory Committees. This living document will be supplemented as additional issues and questions arise, and the current version can be found in the Appendix.
- By the close of 2015, the LWG will have a set of permanent structure options available to share with the Steering Committee per the Steering Committee strategic planning meeting in August 2015.

Infrastructure Planning Working Group

Chair: Ann C. Phillips, *Rear Admiral, US Navy (Ret.)*

Formed: November 2014

Scope of Work:

As defined in the Charter, the Infrastructure Working Group (IWG), will review critical infrastructure in the Hampton Roads region, determine which are most suited to and will be most positively affected by

adaptation planning, and, make recommendations to the Steering Committee for intergovernmental coordination of that planning.

The IWG will further coordinate with the Private Infrastructure Advisory Committee, as well as other IPP working groups and committees where required due to impact on public infrastructure, to formulate recommendations to coordinate with privately owned infrastructure planning.

In its early meetings the IWG identified additional objectives in order to complete its work. The IWG aims to:

- Ensure appropriate agencies and organizations are represented in the IWG, with a focus on inclusion of municipalities, working through City Managers, to address representation as they designate.
- Address and identify representative studies that address SLR impact, adaptation planning, and critical infrastructure protection as applicable to the Hampton Roads region.
- Identify and obtain access to modeling and simulation efforts that may support, and or have already been developed in support of SLR impact, in particular as related to identification of and planning to protect, build resiliency, and where practical, quantify efforts to prioritize planning and protection of critical infrastructure across the HR region. Consider work done by Federal or State level agencies that may already be available and may facilitate working group's objectives.
- Working with the Private Infrastructure Advisory Committee, consider privately owned utilities in this prioritization effort where they impact resiliency of public infrastructure.

Key Findings:

- The IWG does not recommend or endorse recommendations of any particular scientific body or report. For the purposes of conducting a test planning scenario, the IWG with the recommendations of VIMS and support of the Science Advisory Committee have made the following selections. This is not a "prioritization" demonstration or an endorsement of particular sea level rise planning scenarios.

- There are a number of quality studies done in this region surrounding the impact of storm surge and sea level rise on transportation infrastructure with focus on military transportation and use. Likewise, several notable studies from either the larger regional area, or from other areas, (RRAP, Gulf Coast II and NACCS) provide considerable insight into processes used to review the impact of storm surge and SLR, not only in this region, but elsewhere similar impacts are occurring. Further, NASA, NOAA, National Climate Assessment, VIMS, USACE, all have or use models that provide ever more accurate understanding of past SLR activity, and future SLR and subsidence predictions regionally. However, there is not a single study that this team has reviewed to date that describes what to do about SLR impact, in this area or elsewhere, other than in very general terms. There is a great need for such a study in this region, and for detailed analysis of the options, the cost of those options, and the cost of not doing any of those options and simply dealing with the after effects of storm surge and SLR activity as they occur. Until

such a study is undertaken, it will be very difficult for this region to prioritize regionally, and determine which actions will be the most cost effective and impactful, regionally, over time.

- Policy documents or studies reviewed recommend a collaborative regional planning process, and recommend action be taken to this end sooner rather than later. Whether talking about this region or others, complacency towards planning for a slow but nevertheless impactful threat only ensures a more costly and more negative outcome the longer that action is delayed. This committee feels a regionally structured plan, with clear legal authority, funded, executed and monitored by whatever government processes are necessary can achieve long-term success.

- The success of this committee to date stems from the participation of Federal, State, and Local government participants, which, according to membership, is the first time they have participated locally on this topic in a group with this level of diversity.

- Collaboration between committees and working groups of the IPP effort, in particular at the leadership level, will be critical to the success of Phase II of this pilot. At present there is not a format or venue for this collaboration to take place in a structured way. It is not clear to the IWG that all committees and working groups have the same understanding of IPP objectives and outcomes for Phase II.

- The IWG appears to be one of the more active bodies in the IPP. While this may be appropriate up to this point, it is the opinion of the IWG that other committees and working groups need to engage more fully to ensure that any findings are supported by sound analysis and research, to the extent possible. Broader engagement of such committees and working groups is also vital to obtain a regional consensus regarding future planning activities.

- Steering Committee participation and activity is critical to IPP success. Late engagement of the Steering Committee will eventually hinder the overall outcome and success of the effort. Increased engagement of the Steering Committee will be critical to address decisions that need to be made by the committees and working groups, despite data gaps and potential conflicts that could arise between the varying representatives as the planning decisions become more definitive. The retreat taking place at the transition from Phase 1 to Phase 2 and naming of Steering Committee leadership should drive Steering Committee engagement.

- Committee members and chairpersons participate as volunteers. There are inherent limitations to using voluntary working groups without committed staff hours or funding to conduct work of this complexity. Specific funding opportunities should be investigated across federal, state, local and non-profit partners, to address staffing issues and to ensure staffing consistency. In addition, funding for working group leadership and documentary support, and other key positions should be prioritized. In order to adequately document this effort, in particular in Phase II, assistance in documenting meeting proceedings and specific committee activities will be critical to success, and that assistance should be supported by the convening leadership (ODU) to ensure the outcomes and IPP processes are documented appropriately and with consistency.

- While there is such a thing as too many committee members, it is critical to ensure adequate and diverse representation from across the region.

- Representative exchange across committees (as in the Legal WG assigning reps to the other WG's) has been very effective.

- A lot of work addressing SLR has previously been completed by several agencies. Bringing all of these disparate studies together has been a task unto itself but necessary in order to not duplicate work.

- There are significant data gaps that need to be addressed with respect to Economic Modeling in Phase II and beyond. For instance, the IWG has concluded that any planning activities taken to address infrastructure need to address the cost and benefits of proposed actions to aid in decision-making. Despite these identified needs, the Economic Impacts Advisory Committee created to study such issues has not had any meetings to date; therefore, their engagement must increase dramatically in Phase II.

Land Use Planning Working Group

Chair: Burrell Saunders, *Chairman, Urban Land Institute Hampton Roads & Saunders + Crouse Architects*

Formed: December 2014, Reinitiated in April 2015

Scope of Work:

In accordance with the Charter, the Land Use Planning Working Group (LUWG) will recommend which land use related plans, programs and policies in Hampton Roads require adaptation planning and formulate recommendations for intergovernmental coordination. In consultation with the Municipal Planning Advisory Committee, the Working Group will address land use planning, floodplain management, local government comprehensive plans, zoning, building codes and other plans, programs and policies it identifies in the course of its work.

Key Findings:

- Because the term "land use" encompasses so many elements of the ways in which we live, work, and do business in Hampton Roads, the Land Use group envisions its mission extending beyond the length of the IPP though continued collaborations of the Urban Land Institute Hampton Roads, Old Dominion University, and other partners.

- During Summer 2015 the LUWG engaged in extensive due diligence comparing current land use practices and recommendations for coastal resilience in Hampton Roads with practices and recommendations nationally. In addition, the LUWG has initiated the process of understanding both water-dependent and non-water-dependent land uses locally in an effort to develop short, mid, and long-term strategies for smart land use practices in the face of coastal change.

- Next, the LUWG envisions facilitating a regional mapping exercise or charrette to better understand our assets, liabilities, and opportunities as they pertain to our current water-dependent and non-water-dependent land use patterns.

- Moving into the exploration phase of land use planning, the group will address a number of specific study areas, modeled on similar work completed by ULI in Boston addressing high and low vulnerability areas locally and generating short reports on each site. The group will then initiate a series of workshops and continue to lead an iterative process coupling exploration and understanding with implementation recommendations.

Citizen Engagement Working Group

Chairs: Michelle Covi, *Climate Adaptation and Resilience, Assistant Professor of Practice, Old Dominion University, Virginia Sea Grant,*
Chris Bonney, *Chair, Hampton Roads Center for Civic Engagement & Bonney & Company*

Formed: December 2014. Re-structured April 2015.

Scope of Work: As defined by the Committee in support of the Charter, the Citizen Engagement Working Group (CEWG) shall identify optimum strategies for creating respectful engagement between "whole of community" and "whole of government." The CEWG shall also identify and segment key community segments, identify and tap into established community networks to assist in engagement and communications activities, identify and develop strategies for overcoming obstacles to engagement and communications. Identify community priorities for coordinating sea level rise preparedness and resilience activities. Create "base level" engagement and communications template suitable for all communities. Add customized elements for different communities.

Key Findings:

- Regional collaboration and public education and outreach are high priorities that apply directly to the CEWG.
- There are many established networks and ways of reaching people.
- There is a great deal of diversity in the networks and many ways to get word out from Girl Scouts to seniors.
- We are missing key groups in our engagement efforts.
- We need to find or develop strategies to have effective two-way engagement of citizens with resilience.

Public Health Working Group

Chair: Dr. Steven Becker, *Professor of Community and Environmental Health, Old Dominion University*

Date of Formation: April 2015

Scope of Work:

The aim of the newly-established Public Health Working Group is to make public health an integral part of the work of the pilot. Some of the most serious impacts of sea level rise are those affecting public health. At the most obvious level, bigger storm surges and increased flooding can result in deaths and injuries in affected communities. But there are also numerous, important indirect public health consequences of sea-level rise. For example, higher sea-water levels can encroach on essential public health facilities such as sewage treatment sites, water purification facilities, septic tanks, and even landfills, endangering water quality and spreading biological and chemical contamination. Rising sea-levels can also result in increased salinity of estuaries and aquifers, affecting critical drinking water supplies. Meanwhile, increased flooding can cause population displacement and dislocation, resulting in mental health effects and other health issues. And standing water left after floods can enable the rapid growth of mosquito populations, spreading infectious disease. These and many other effects make it clear that public health impacts and implications are central to the problem of sea-level rise.

The aim of the newly-established Public Health Working Group is to effectively incorporate public health issues, challenges, expertise and solutions into the work of the pilot. More specifically, the Public Health Working Group aims to:

- Analyze public health issues as they pertain to sea level rise in Hampton Roads.
- Identify ways to incorporate public health issues into the projects and activities of the IPP.
- Involve and engage the public health community in the work of the IPP.
- Identify special areas of expertise that public health can contribute to the IPP. These include public health emergency preparedness, health and environmental risk communication, health-related community outreach, epidemiology, industrial hygiene, and working with vulnerable/special needs populations.
- Develop new and innovative solution-oriented projects to address public health aspects of sea-level rise locally and in a way that may serve as a model for other communities around the nation.

Advisory Committees

Science Advisory Committee

Chairs: Larry Atkinson, *Professor of Oceanography, Old Dominion University*
Carlton Hershner, *Director, Center for Coastal Resources Management*, *Virginia Institute of Marine Science*

Formed: December 2014

Scope of Work:

The Science Advisory Committee is responsible for providing the Executive Steering Committee with critical information based on relevant scientific research of interest to the IPP. Topics will include information on global mean sea level rise, local relative sea level rise, vertical land motion, dynamical ocean change, ocean fingerprinting, extreme water levels, decision frameworks, risk management, and uncertainty management in addition to any other scientific inquiries made by the Executive Steering Committee.

Additional work includes providing updates on the activities of Federal agencies relevant to Hampton Roads to other stakeholders and developing a plan for and a mechanism to provide integrated information on science observations and information.

The Science Advisory Committee will also develop a 'roadmap' or 'framework' for summarizing sea level rise knowledge, integrating information, and identifying gaps in sea level rise observation.

Key Findings:

- The formation of the IPP and the Science Committee has significantly helped mobilize various state and federal science agencies to approach the needs of the region.

- It is important to keep critical lines of communication open between the many stakeholders and the science agencies.
    - Bi-weekly conference calls between the science agencies and local scientists are established and will continue for the purpose of facilitating the scientific needs of the Pilot and Hampton Roads Region. This call includes many scientists at NOAA headquarters and various USGS offices in Virginia and California.
    - A subsidence group has been coordinated by USGS that has met at HRPDC and will be developing a plan for subsidence measurements.
    - A Science Committee liaison to other Committees and Working Groups helps to communicate scientific information to other stakeholders and to learn what information needs exist in the other groups.
    - Specific findings of the Science Committee are collected in regular Newsletters published by the Committee and are included in this report as an Appendix.

- VIMS is in the process of completing it's tasking by the Governor's Climate Change and Resiliency Update Commission to update the sea level rise projections for coastal Virginia.

Economic Impacts Advisory Committee

Chair: Chip Filer, Associate Professor, Old Dominion University (as of September, 2015)

Formed:

While a group met during the December 2014 FEMA event, the group has not continued meeting, however, we expect this group to coalesce in the beginning of Phase 2, as many economists and private sector individuals are willing to collaborate as a member of this committee.

Scope of Work:

There is no scope of work clearly delineated in the Charter, and the group has not drafted a Scope of Work. We expect this Committee to work in a similar manner as that of the Science committee – experts from private, federal, state, local, and academic backgrounds coming together to address research gaps relevant to effective coastal resilience planning in Hampton Roads. Should the IPP become a separate funded entity, the scope of the Economic Impacts committee may change as funding becomes available to fund specific studies. Additionally, this or another committee should address, in detail potential funding mechanisms for adaptation to sea level rise regionally.

Key Findings:

While there are no significant key findings of the group, it is clear that in order to motivate a region to plan effectively for sea level rise and coastal change, significant information must be known with regards to the economic impacts of both doing nothing as well as implementing various methods of adaptation.

Municipal Planning Advisory Committee

Chair: NA

Formed: While a group met during the December 2014 FEMA event, the group has not continued meeting.

Scope of Work:

This group has not established an independent scope of work and instead the IPP closely monitors activity of the HRPDC Sea Level Rise Advisory Committee.

Key Findings:

This group has not been initiated in part due, to a Pilot effort not to duplicate existing committee work or processes within the region, but instead to collaborate with existing structures. In June 2014, HRPDC established the Special Committee on Recurrent Flooding and Sea Level Rise now called the Sea Level Rise Advisory Committee. Due to the Pilot's close relationship with the HRPDC, and the HRPDC's existing relationship with municipal staff across all 17 jurisdictions, the Pilot chose to instead request the HRPDC committee representative to participate in the LUWG and also attends meetings of the Sea Level Rise Advisory Committee. Despite the lack of independent Municipal Planning Advisory Committee, the Pilot maintains the importance of close relationships with municipal staff involved in sea level rise planning, and more municipal participation at all levels is welcomed and encouraged.

Private Infrastructure Advisory Committee

Chair: Carol Considine, *Associate Professor of Engineering Technology, Old Dominion University*

Formed: February, 2015

Scope of Work: The Private Infrastructure Committee (PIC) is responsible for providing support to the Infrastructure Planning Working Group (IWG) regarding critical private infrastructure for the IPP. Support will include identification of: critical private infrastructure, dependencies & interdependencies between private and public infrastructure, best practices of sea level rise (SLR) adaptation by industry sector and restrictions and limitations (administrative, managerial, jurisdictional or legal) to private/public SLR preparedness infrastructure planning. In Phase II of the IPP, the PIC will support IWG in the adaptation planning for two (2) selected infrastructures in the Hampton Roads region.

Key Findings:

- In order to minimize stakeholder engagement time, and begin work, the committee was composed of representative private infrastructure organizations. For example, while other hospitals operate in the area, only Sentara participated in the committee and the same was true for other sectors. In some cases, such as the electric industry this was not an issue as Dominion is the only provider regionally.
- The Private Infrastructure Committee has identified the following restrictions and limitations (administrative, managerial, jurisdictional or legal) to private/public SLR preparedness infrastructure planning:
    - The ability to identify interdependencies between private and public infrastructure and vulnerabilities when some information is proprietary.
    - Private industry, including infrastructure, needs to be informed as to what amount of sea level rise they should be using for planning in the short and long term or provided the necessary information to draw their own conclusions
    - Uncertainty on how public and private organizations will work together (public/private partnerships)
    - Methods of sharing and protecting proprietary information should be developed for the purposes of resiliency planning
    - Codes regarding construction standards related to SLR vary by city, a regional or Commonwealth code requirement should be implemented to eliminate confusion and could be included in DCR's Floodplain Management Plan for the Commonwealth or elsewhere as applicable.
    - Underwriter insurance requirements may differ from code requirements causing confusion. What are the underwriter requirements by industry sector for the region?
    - Financial/funding barriers

- The U.S. Department of Energy, Energy Infrastructure and Modeling and Analysis Division (EIMA) has recently completed a study to assess the potential exposure of energy facilities in the Hampton Roads region to a general rise in sea level and from storm surge at these higher sea levels. The analysis focused on the risk in 2050 and 2100, and included electricity assets, natural gas assets, and petroleum assets. The results of the study indicate that these assets would not be inundated under the National Climate Assessment (NCA) Intermediate-High SLR Scenario in 2050. However there is significant risk to these assets when a storm surge associated with a

Category 4 Storm is considered. In addition, the NCA Intermediate-High Scenario predicts 5 feet of SLR by 2100, which would inundate multiple energy assets in Hampton Roads. A Category 1 storm in addition to the 5 feet of SLR would cause extensive inundation of energy assets. The results of this report are being shared with respective energy providers for their consideration in SLR planning and adaptation efforts.

- Dominion Power has been proactive in hurricane preparedness planning per Federal Energy Regulatory Commission (FERC) requirements. They have already elevated and hardened some of their facilities. They are active in CIGRE, the Council on Large Electrical Systems, which is an international non-profit association that promotes collaboration and knowledge sharing with experts around the world to improve electrical systems. They have contributed to the development of and use the "Air Insulated Substation Design for Severe Climate Conditions, B3.31", 2014, CIGRE publication which provides best practices for design of electrical infrastructure. While they have not incorporated sea level rise (SLR) into their current hurricane preparedness planning, they indicate that incorporating it in future planning will not be difficult.

- Lessons learned from Hurricane Isabel in 2003, and Hurricane Katrina in 2005 should inform the pilot's planning process.

- Sentara Norfolk General Hospital, the only Level-1 Trauma Center in the region, specifically and the entire Sentara systems are proactive in severe weather and emergency preparedness. The hospital system must comply with the standards of the American Society for Health Engineering. Part of these standards includes the development of Hazard Vulnerability Analysis, which includes a matrix to determine risk exposure. Sentara is including adaptation/hardening of facilities in all capital improvement projects.

- Federal agencies are going to be instrumental partners as the pilot moves forward. Both the U.S. Department of Energy and the U.S. Environmental Protection Agency have provided or highlighted resources that they have to inform the pilot (data/reports) and contribute to best practices.

- The Private Infrastructure committee serves a support role to the Infrastructure Working Group. Having a liaison between these two committees has been critical in keeping the committee informed. It has also been informative and beneficial to have a liaison from the Legal Committee regularly attend and participate in the Private Infrastructure committee. As a support committee the work of the committee is heavily dependent on the decisions made within the Infrastructure Working Group.

- Private industry is becoming more aware of the impacts of SLR on the Hampton Roads region, however additional outreach is necessary. Some key industries are proactively identifying how SLR will impact their specific industry and are starting a process to incorporate SLR in their

planning process. There are many tools available to aid industry in the planning process, however additional research to identify these tools and make the available to industry in one location is necessary. In addition, research of best practices for public/private partnerships will be important as the IPP is formalized and continues to move forward.

Senior Leadership Advisory Committee

Chair: Joe Frank, *Former Mayor of Newport News & Partner, David, Kamp, & Frank LLC*

Formed: December 2014

Scope of Work:

The Senior Advisory Committee consists of community leaders, both retired and active, with extensive personal and professional networks as well as expertise in local, state, and national, policies and procedures. This group does not have formal tasking, but exists to provide support to the Convening staff as well as the Steering Committee when necessary.

Key Findings:

The Senior Advisory Committee first met during the December 2014 FEMA event and subsequently in March 2015 to be briefed by all active Working Groups & Committees. Since March 2015, the group has been called on as needed to provide advice to the conveners or members of the Steering Committee, and has participated in Steering Committee meetings in an advisory capacity. IPP participants believe, that while many of these committee members do not fit formally into focus areas of the IPP, the experiment would not be complete without certain members' guidance and support.

Conclusion

After one year of IPP activity, the region is well on its way to establishing not only an entity to initiate regional sea level rise collaboration after the completion of Phase 2, but also an ongoing process for community engagement, research collaboration, and a Hampton Roads equipped to thrive with the water as it has done for hundreds of years.

While the organizational and stakeholder engagement process is time consuming, the process has been rewarding not only for the IPP leaders and conveners, but for many participants. Many goals initially set forth in the Charter have been accomplished and the process will move forward in Phase 2 with a greater eye towards establishing a long-term arrangement for collaboration with federal, state, local, and private parties.

Photo Courtesy of Amy Matzke-Fawcett

APPENDIX C-1

THE STEERING COMMITTEE OF THE HAMPTON ROADS SEA LEVEL RISE PREPAREDNESS AND RESILIENCE INTERGOVERNMENTAL PLANNING PILOT PROJECT RESOLUTION

RESOLUTION

THE STEERING COMMITTEE OF THE HAMPTON ROADS SEA LEVEL RISE PREPAREDNESS AND RESILIENCE INTERGOVERNMENTAL PLANNING PILOT PROJECT

WHEREAS, the undersigned constitute the Steering Committee of the Hampton Roads Sea Level Rise Preparedness and Resilience Intergovernmental Planning Pilot Project (the IPP);

WHEREAS, the IPP has for the past two years engaged in a study of the challenges and opportunities that sea level rise and resilience planning present to the Hampton Roads region of coastal Virginia;

WHEREAS, the Vision of the IPP is "a regional 'whole of government' and 'whole of community' approach to sea level rise preparedness and resilience planning in Hampton Roads that also can be used as a template for other regions;"

WHEREAS, the Mission of the IPP is to establish, at the close of the IPP, a 'whole of government' and 'whole of community' "organizational framework and procedures that effectively coordinate sea level rise preparedness and resilience planning;"

WHEREAS, the Steering Committee created a number of Working Groups and Advisory Committees, each group and committee charged with assessing targeted sea level rise and resilience planning issues and challenges;

WHEREAS, representatives of various localities and political subdivisions, the Hampton Roads Planning District Commission, the Office of the Governor, Virginia state agencies and programs, key branches of the United States Departments of Defense and Homeland Security, other federal civilian agencies and programs, academia, non-governmental organizations, and private sector and industry stakeholders have participated in the work of the IPP, serving on IPP Working Groups and Advisory Committees, all providing valuable information, advice, and recommendations to the Steering Committee;

WHEREAS, the Federal Government Liaisons as defined in the IPP Charter participated as prominent and key advisors and collaborators to the extent permitted by federal law;

WHEREAS, the formal two-year period and work of the IPP is to end as of June 30, 2016;

WHEREAS, the IPP's work has culminated in a series of reports and findings by the IPP Working Groups and Advisory Committees, as reflected in the final report of the IPP, a copy of which is attached hereto;

WHEREAS, the Steering Committee has reviewed and considered various structural options for the entity envisioned in the Mission to continue the ongoing work of accomplishing 'whole of government' and 'whole of community' collaboration; and

WHEREAS, the Hampton Roads Planning District Commission (HRPDC) has formally expressed its interest and willingness to fulfill this collaborative role in furtherance of the Vision and Mission of the IPP.

NOW, THEREFORE, BE IT RESOLVED:

I. That the Steering Committee endorses the following Conclusions regarding the structure of an entity for accomplishing the aforementioned ongoing collaborative work:

> Conclusion 1: That the entity have the capability to facilitate, plan, and implement action.
>
> Conclusion 2: That the entity incorporate in its deliberations and operations the Federal government and its agencies, including the uniformed services, as well as the Virginia state government and its agencies, local governments, and other existing political subdivisions, to the full extent of each of their respective lawful authorities and abilities.
>
> Conclusion 3: That the geographical boundaries for the work of the entity be the same as those of the Hampton Roads Planning District, consisting of 17 jurisdictions (http://www.hrpdcva.gov/page/officers-and-members/), excepting therefrom any particularized partnerships or collaborations that may of necessity or by choice arise within or beyond those boundaries.
>
> Conclusion 4: That the entity initially facilitate and plan actions which are then carried out through coordinated, designated implementers, such as existing local governments, political subdivisions, or coalitions of these groups, and that the entity consider the option of implementing actions on its own in the long term.
>
> Conclusion 5: That the entity have dedicated professional staffing.
>
> Conclusion 6: That the entity have a sustainable source of revenue, initially for its administration and operation, and in the longer term for implementing action.
>
> Conclusion 7: That the entity incorporate participation and advice from sectors throughout the region, including private business and industry, academia, non-governmental organizations, community organizations, and residents in its ongoing work.
>
> Conclusion 8: That the entity lead efforts to establish regional infrastructure development standards for resiliency to the impacts of sea level rise.
>
> Conclusion 9: That the entity examine and consider over the next eighteen (18) months the need for the creation of a special service district authority or the joint exercise of local government powers by agreement in order to successfully implement action over the long term.

II. That the HRPDC shall initially serve as the lead for the ongoing collaborative work of the 'whole of government' and 'whole of community' efforts among the Steering Committee

and the other participants in the IPP to date, providing leadership consistent with the Conclusions contained herein; and

III. That the HRPDC, with the continued work and participation of the Steering Committee and the other participants in the IPP to date, and others as the collaborative participants deem necessary and appropriate, shall by January 1, 2018, provide a publicly available report on progress made towards the accomplishment of the Conclusions described herein.

RESOLVED this _____ day of _____, 2016, by and among:

Steering Committee

_____
Commonwealth of Virginia, Office of the Secretary of Natural Resources
Name:
Title:

_____
Commonwealth of Virginia, Office of the Secretary of Public Safety and Homeland Security
Name:
Title:

_____
Virginia Port Authority, CEO and Executive Director
Name:
Title:

_____
Virginia Department of Transportation, Hampton Roads District
Name:
Title:

_____
Virginia Coastal Zone Management Program
Name:
Title:

_____
Hampton Roads Planning District Commission
Name:
Title:

_____
City of Norfolk, Chief Resiliency Officer
Name:
Title:

_____
City of Virginia Beach
Name:
Title:

_____
Huntington Ingalls Newport News Shipbuilding
Name:
Title:

KEY PARTICIPANTS
IN THE INTERGOVERNMENTAL PLANNING PILOT PROJECT

The following Federal Government Liaisons, Working Groups, and Advisory Committees have participated in the work of the IPP and provided it with information, advice, and recommendations.

Federal Government Liaisons

_____
Commander Navy Region Mid-Atlantic
Name:
Title:

_____
Commanding Officer, Naval Facilities Engineering Command Mid-Atlantic
Name:
Title:

_____
Commander, Norfolk District, US Army Corps of Engineers
Name:
Title:

_____
Commander Joint Base Langley-Eustis
Name:
Title:

_____
Commanding Officer, US Coast Guard Shore Infrastructure Logistics Center
Name:
Title:

_____
Commander Fifth Coast Guard District
Name:
Title:

Working Groups and Advisory Committees

_____

Legal Working Group
Name:
Title:

_____

Infrastructure Planning Working Group
Name:
Title:

_____

Citizen Engagement Working Group
Name:
Title (co-chairs):

_____

Citizen Engagement Working Group
Name:
Title (co-chairs):

_____

Public Health Working Group
Name:
Title:

_____

Private Infrastructure Advisory Committee
Name:
Title:

_____

Science Advisory Committee
Name:
Title:

_____

Economic Impacts Advisory Committee
Name:
Title:

APPENDIX C-2

HRPDC Comments to the Consensus Resolution

August 18, 2016

Memorandum #2016-104

TO: Intergovernmental Pilot Project Steering Committee

BY: James M. Bourey, Chair, Hampton Roads Chief Administrative Officers Committee

RE: Comments on Proposed Resolution by the Steering Committee of the Sea Level Rise Preparedness and Resilience Intergovernmental Pilot Project

The Hampton Roads Chief Administrative Officer (CAO) Committee consists of the 17 administrators and managers of the jurisdictions that comprise the Hampton Roads Planning District Commission (HRPDC). The CAO Committee has reviewed the resolution prepared by the Steering Committee of the Sea Level Rise Preparedness and Resilience Intergovernmental Pilot Project and offers the following comments:

1. The Regional CAO Committee supports efforts by the HRPDC to play a lead role in the coordination of regional sea level rise/coastal resiliency planning efforts. The Committee believes that the HRPDC, as an existing organization formed by the Code of Virginia, is well positioned to serve in this coordination role. The Regional CAO Committee has supported several HRPDC initiatives over the past few months to advance regional sea level rise planning efforts, including the following:

   - Appointment of Deputy Administrators to serve on the HRPDC Coastal Resiliency Committee
   - Allocation of funds to the HRPDC to create a new Coastal Resiliency Planner Position
   - Supporting the HRPDC's role to serve as project manager for two Joint Land Use Studies (JLUS) that will focus on sea level rise in the cities of Virginia Beach/Norfolk and the cities of Portsmouth/Chesapeake, in cooperation with the military installations located in these jurisdictions.
   - Supporting the preparation of the Hampton Roads Hazard Mitigation Plan through the HRPDC.

   In addition, over the past several months the CAO Committee has dedicated meeting time to discuss land subsidence monitoring approaches as well as the water injection project proposed by the Hampton Roads Sanitation District which could have a positive role in reversing land subsidence trends in the region.

2. The CAO Committee believes that the Hampton Roads Region can collaborate on sea level rise without the formation of a new regional organization. In addition, the CAO Committee noted that while planning and consensus building can occur at the

regional level, the responsibility and authority for implementation will rest with each of the individual local governments.

The CAO Committee is concerned about several sections of the resolution that run counter to this philosophy, including the following sections listed under the Be It Resolved section:

Conclusion 1: "That the entity have the capability to facilitate, plan **and implement action"**

Conclusion 4: "…that the entity **consider the option of implementing actions on its own in the long term."**

Conclusion 6: "That the entity have a sustainable source of revenue, **initially for its administration and operation, and in the longer term for implementing action.**

Conclusion 9: That the entity examine and consider over the next 18 months **the need for the creation of a special service district authority or the joint exercise of local government powers by agreement in order to successfully implement action over the long term.**

The Regional CAO Committee is concerned about the references noted above. We support an approach where planning and consensus building will occur at the regional level under the existing authority of the HRPDC, with implementation remaining the role of local jurisdictions. Rather than investing time and resources in the creation of a new entity, the CAO Committee believes the region would be better served by moving forward with a regional and collaborative planning effort through the HRPDC which can develop effective strategies for addressing sea level rise and coastal resiliency issues.

APPENDIX D-1

Legal Working Group Membership

Legal Working Group Membership

COMMITTEE CHAIR(S) & AFFILIATION(S):

Roy A. Hoagland
Chair, IPP Legal Working Group
Director, Virginia Coastal Policy Clinic, William & Mary Law School

CURRENT COMMITTEE MEMBERSHIP:

Name	*Organization*	*Position*	*Email*
Adam Olson	US Coast Guard	Member	Adam.B.Olson2@uscg.mil
Andrew Larkin	NOAA	Member	andrew.w.larkin@noaa.gov
Ben McFarlane*	Hampton Roads Planning District Commission	Member	bmcfarlane@hrpdcva.gov
Cynthia Hall	City of Norfolk	Member	cynthia.hall@norfolk.gov
Deborah Loomis*	US Navy	Member	deborah.loomis@navy.mil
Dominick Yacono	US Navy	Member	dominick.yacono@navy.mil
Duncan Pitchford*	Office of the Attorney General	Member	JPitchford@oag.state.va.us
Elizabeth Dietzman	Harbor Group Int'l LLC.	Member	elizdietzmann@gmail.com
Ellen Porter	Office of the Attorney General	Member	eporter@oag.state.va.us
Jeremy Forrest	Kristina Beavers, Attorney at Law	Member	jdforrest@email.wm.edu
Joseph M Durant	City of Newport News	Member	jdurant@nnva.gov
Kelly Lackey	City of Chesapeake	Member	klackey@CityOfChesapeake.Net
Lynne Rhode*	Office of the Attorney General	Member	LRhode@oag.state.va.us
Mary Pohanka*	US Navy	Member	mary.pohanka@navy.mil
Mark Nevitt*	US Navy	Member	mark.nevitt@navy.mil

Mark Popovich	Isle of Wight	Member	mpopovich@isleofwightus.net
Miguel Padilla	US Coast Guard	Member	Miguel.n.Padilla@uscg.mil
Roy A. Hoagland*	William & Mary Virginia Coastal Policy Center	Chair	rahoagland@wm.edu
Ryan M Anderson	US Navy	Member	ryan.m.anderson1@navy.mil
Speaker Henry R Pollard*	Williams Mullen	Member	hpollard@williamsmullen.com
Veronica Meade	City of Hampton	Member	vmeade@hampton.gov

*Executive Committee Member

APPENDIX D-2

Legal Primer Memo

WILLIAM & MARY
LAW SCHOOL
VIRGINIA COASTAL POLICY CENTER

To: Jim Redick, Chair, IPP Steering Committee

Fr: Roy Hoagland, Chair, IPP Legal Working Group

Da: August 13, 2015

Copy: Ray Toll, Director of Coastal Resilience Research, ODU
Emily Steinhilber, Assistant Director of Coastal Resilience Research, ODU
IPP Legal Working Group Members

RE: IPP LEGAL PRIMER

Jim:

Please note the attached Legal Primer for the IPP. The generation of this product is the result of discussions at the IPP FEMA workshop last year and subsequent dialogue among the Legal Working Group members along with conversations of those members with other Working Group representatives.

As noted in the Executive Summary of the Legal Primer, the Primer is intended to complement the efforts of both the Steering Committee and the various Working Groups. The goal of the Primer "is to serve as a reference guide to assist members of the Working Groups in addressing the myriad legal issues that have been identified as particularly pertinent to the coordination of sea level rise preparedness and resilience planning across governmental and community lines." In creating this document, the Legal Working Group envisioned updating the Primer as appropriate when necessary to "reflect changes in policy and law." To do so effectively, we seek feedback on the Primer on an ongoing basis from all members of the Steering Committee and Working Groups.

The Primer contains not only a wealth of substantive law, but also an important disclaimer:

> *This Legal Primer is not intended to serve as and should not be taken as legal advice or other communication to a client, or as attorney work product. Accordingly, this Legal Primer is not subject to either the Attorney-Client Communication Privilege or the Attorney Work Product Privilege. Nothing contained in this Legal Primer constitutes any type of official opinion from any of the governmental attorneys, or their offices, who participated in its drafting. It is designed as a baseline document that can assist participants outside the Legal Working Group. For further consultation by the Pilot Project working groups and the Steering Committee generally, please contact your Legal Working Group liaison. For agency specific questions, please consult your respective legal counsel within your organization.*

I am requesting that you please ensure the distribution of the Primer to the Steering Committee and Working Groups with this memo accompanying the document. Should anyone working within the IPP collaborative have any questions, they should feel free to direct them to either their Legal Working Group liaison or me. My contact information is: rahoagland@wm.edu; 804.221.0404 (c); 757.221.7404 (o). I am also asking that you have the Primer posted on the IPP webpage; we will also host it on the Virginia Coastal Policy Center website.

Finally, please note that the production of this Primer, while reflecting the collective effort of the members of the Legal Working Group, would not have been possible without the assistance of Commander Mark Nevitt of the US Navy. We thank him and the Navy for their willingness to contribute in such a substantial manner.

Roy A. Hoagland
Chair, IPP Legal Working Group
Director, Virginia Coastal Policy Clinic, William & Mary Law School

APPENDIX D-3

Legal Working Group Legal Primer

Hampton Roads Sea Level Rise Preparedness and Resilience Intergovernmental Pilot Project

Legal Working Group

Legal Primer[1]

Executive Summary

The Hampton Roads area is experiencing the highest rates of sea-level rise along the U.S. East Coast. It is second only to New Orleans, Louisiana as the largest population center at risk from sea level rise in the country.[2] And it is anticipated that Virginia will experience between 2.3 to 5.2 feet of sea level rise by the end of the century.[3] This unprecedented challenge requires a comprehensive and effective planning response.

The mission of the Hampton Roads Sea Level Rise Pilot Project ("Pilot Project") is to develop a regional whole of government and whole of community approach to sea level rise preparedness and resilience planning for the Hampton Roads community. This is a two-year project with the goal of establishing arrangements and procedures that can effectively coordinate the sea level rise preparedness and resilience planning of federal, state, and local government agencies, citizens groups, and the private sector. Ideally, this Pilot Project will generate a template for use by other regions of the United States also working with similar issues of sea level rise preparedness and this Legal Primer is an important part of this effort. It provides an overview of the myriad legal and policy concerns that the Pilot Project will face in developing practical and whole of government solutions.

[1] Several members of the Legal Working Group assisted with the creation of this document. They include: Professor Roy Hoagland (Director: Virginia Coastal Policy Center); Mr. Joe Durant (Newport News City Attorney Office); Mr. Jeremy Forrest (Virginia Coastal Policy Center Student); Ms. Kelly Lackey (City of Chesapeake); Lieutenant Commander Deborah Loomis, JAGC, USN (Fleet Forces Command Legal); Mr. Benjamin McFarlane (Hampton Roads Planning District Commission); Commander Mark Nevitt, JAGC, USN (Region Environmental Counsel, Mid-Atlantic); Mr. Adam Olson (USCG Legal); Mr. Miguel Padilla (USCG Legal); Mr. J. Duncan Pitchford (Commonwealth of Virginia Attorney General's Office); Mr. Henry "Speaker" Pollard (Law Firm of Williams Mullin); Mr. Mark Popovich (Isle of Wight County Attorney); Ms. Lynne Rhode (Commonwealth of Virginia Attorney General's Office).

[2] WORLD RESOURCES INSTITUTE, *Sea Level Rise and Its Impact on Virginia,* (Jun. 2014) http://www.wri.org/publication/sea-level-rise-virginia

[3] *See, e.g.,* Andrew C. Stilton & Jessica Grannis, *Virginia Case Study: Stemming the Tide How Local Governments can Manage Local Flood Risks,* GEORGETOWN CLIMATE CENTER (May 2012); VIRGINIA INSTITUTE OF MARINE SCIENCE (VIMS), RECURRENT FLOODING STUDY FOR TIDEWATER VIRGINIA

As presently organized, the Pilot Project has a Steering Committee, a Legal Working Group, and five subject matter working groups addressing specific areas of concern. The Steering Committee consists of members from state and local government, non-voting liaison members from the federal government (Navy, Coast Guard, Army Corps of Engineers, Air Force), and private industry. The Legal Working Group is chaired by Professor Roy Hoagland (Clinical Professor, William & Mary School of Law) and consists primarily of attorneys from public (federal, state, and local) and private law practices.

Five subject matter working groups receive support from the Legal Working Group in some capacity:

(1) Private Infrastructure;
(2) Public Infrastructure;
(3) Citizen's Engagement;
(4) Land Use; and
(5) Public Health.

This Legal Primer complements the efforts of both the Steering Committee and these Working Groups. Its goal is to serve as a reference guide to assist members of the Working Groups in addressing the myriad legal issues that have been identified as particularly pertinent to the coordination of sea level rise preparedness and resilience planning across governmental and community lines. This Primer contains inserted hyperlinks to source documents throughout the document as well as footnotes and applicable reference material to assist the reader.

As sea level rise and resiliency planning is a fast-moving and ever-changing area of policy and law, it is envisioned that this Legal Primer may be updated to reflect changes in policy and law. Feedback on this product is sought from all members of the Pilot Project Working Groups. This Primer necessarily focuses on planning for sea level rise adaptation at the state, local, and federal levels to address foreseeable effects of sea level rise, recurrent flooding, and other related risks. It does not specifically focus on climate mitigation measures (such as the reduction of Greenhouse Gas (GHG) emissions), as this is not the central purpose of the Pilot Project.

Adaptation is defined by the U.S. Environmental Protection Agency (EPA) as the "adjustment or preparation of natural or human systems to a new or changing environment which moderates harm or exploits beneficial opportunities." [4] Adaptation measures can either be structural or non-structural. Traditionally, flood and erosion risks have been managed using structural techniques such as sea walls and levees. [5] Non-structural adaptation measures include changes to land use practices that can be done via a change in zoning regulation. Legal authorities and

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[4] *Adaptation Overview,* U.S. ENVTL. PROTECTION AGENCY, *http*://www.epa.gov/climatechange/impacts-adaptation/adapt-overview.html (last visited Jul. 28, 2015).

[5] This is often referred to as "armoring" infrastructure. *See, e.g.,* Stilton & Grannis, *supra* note 3, at 1.

issues relevant to both structural and non-structural adaptation measures are addressed in this Primer.

This Legal Primer is not intended to serve as and should not be taken as legal advice or other communication to a client, or as attorney work product. Accordingly, this Legal Primer is not subject to either the Attorney-Client Communication Privilege or the Attorney Work Product Privilege. Nothing contained in this Legal Primer constitutes any type of official opinion from any of the governmental attorneys, or their offices, who participated in its drafting. It is designed as a baseline document that can assist participants outside the Legal Working Group. For further consultation by the Pilot Project working groups and the Steering Committee generally, please contact your Legal Working Group liaison. For agency specific questions, please consult your respective legal counsel within your organization.

I. Jurisdictional Issues: Federal, State, & Local Law

As a general matter, zoning, flood management and building codes are a matter of state and local government law. Each working group should be cognizant of the various jurisdictions' comprehensive plans, zoning ordinances, and building codes for the jurisdictions in which they are working and consult these various source documents to guide their work. A table of applicable local law is found in section I.C.

A. Federal and Constitutional Law

The federal government, to include the Department of Defense (DoD) and all federal agencies, is a large property owner within the Hampton Roads region. Adaptation measures at federal agencies and on federal property effectively fall outside the state and respective locality's zoning and building guidance.

1. Doctrine of Sovereign Immunity and Federal Supremacy: Under the legal doctrine of sovereign immunity, the U.S. government (and its agencies) may not be sued without its express consent through an explicit congressional waiver.

    a. Federal supremacy ensures that state and local governments cannot hinder essential government functions. Hence, as a general matter, the activities of the federal government are often free from state and local government regulation.[6]

    b. In the land use and building code context, a congressional waiver of sovereign immunity *does not* exist. Thus, state and local building and property codes cannot generally be enforced against federal facilities. Federal law requires that each building constructed or altered by a federal agency must consider the laws of a state or political subdivision of a state which would apply if it were not a building constructed or altered by a federal agency. These include

[6] McCullough v. Maryland, 17 U.S. 316 (1819).

consideration of state and local zoning laws and laws relating to landscaping, open space, historic preservation, and similar laws.[7] Nevertheless, this does not constitute a sovereign immunity waiver and does not authorize a fine, penalty, or cause of action against a federal agency for failure to comply.[8] In sum, it does not mandate compliance – only that consideration is given.

c. However, there are numerous federal environmental laws where Congress has waived sovereign immunity (such as the Clean Water Act), which requires federal agencies and their facilities to comply with environmental laws and requirements in the same manner and to the same extent as a non-governmental entity. Key federal laws are discussed in greater detail below.

2. Other Constitutional Law Principles and Textual Provisions

a. Property Clause: Article IV of the Constitution states that "Congress shall have power to dispose of and make all needful Rules and Regulations respecting . . . the Property belonging to the United States; and nothing in this Constitution shall be so construed as to prejudice any Claims of the United States, or of any particular State."[9] The Property Clause provides constitutional authority for the management and control of federal lands by Congress.

b. Takings Clause: Under Article V, "private property shall [not] be taken for public use, without just compensation."[10] The Takings Clause effectively limits the power of eminent domain by requiring compensation of the landowner.[11]

c. The Supremacy Clause: This provision states that the Constitution, federal laws, and treaties "are the Supreme Law of the Land."[12] The Supremacy Clause ensures the supremacy of federal law over state law in the event of a conflict, provided that Congress is acting pursuant to its constitutionally authorized powers.

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[7] 40 U.S.C. § 3312 (c)(1)-(2).
[8] 40 U.S.C. § 3312 (f).
[9] U.S. CONST. art. IV. § 3 cl. 2.
[10] U.S. CONST. amend. V. State and Federal jurisdiction may be considered exclusive, partial, concurrent, or proprietorial. This is a complex area of law and questions should be directed to the appropriate member of the Legal Working Group as they arise.
[11] In certain circumstances, federal courts have applied a broad view of "public use" and have not restrained state and local governments from seizing privately owned land for private commercial development on behalf of private developers. *See* Kelo v. City of New London, 545 U.S. 469 (2005). However, pursuant to a recent amendment to the Virginia Constitution, state and local governments are severely constrained, if not altogether prohibited, in taking such action. *See* Va. Const., art. I, § 11.
[12] U.S. CONST. art. VI. cl. 2.

d. Underlying Federalism Principles:[13] It is beyond the scope of this Primer to address all the federalism issues associated with sea level rise in Hampton Roads, but the Tenth Amendment states that all powers not delegated to the United States by the Constitution remain at the state level.[14]

3. U.S. Law: Zoning Requirements and Building Codes

a. As discussed above, state and local building codes must be considered by federal agencies when constructing, but they are not binding regulatory requirements.

b. 40 U.S.C. § 3312: "Compliance with Nationally Recognized Codes"

i. A building constructed by a Federal Agency "shall be constructed or altered . . . in compliance with one of the nationally recognized model building codes and with other nationally recognized codes. . . "[15] Projects for construction shall be constructed to the maximum extent feasible with one of the nationally recognized model building codes.

ii. Each building constructed or altered by the Administrator of the General Services shall be done only after consideration of all requirements – to include state or local zoning laws – which would apply to the building if it were not a building constructed or altered by a federal agency.[16]

iii. Neither of these obligations amount to a federal sovereign immunity waiver, however. Hence, they do not create a cause of action for non-compliance.

c. The General Services Agency (GSA) has the authority to with promulgate regulations governing the acquisition, use, and disposal of real property. It applies the technical requirements issued by the International Code Council (ICC). The ICC family of codes is available at www.iccsafe.org.[17]

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[13] Federalism is defined as "The relationship and distribution of power between the individual states and the national government." BLACK'S LAW DICT. 253 (POCKET ED. 1996).
[14] U.S. CONST. amend X. "The powers not delegated to the United States by the Constitution, nor prohibited by it to the States, are reserved to the States respectively, or to the people." Real property owned by a sovereign (The United States) within the geographic boundaries of another sovereign (an individual state) creates a question of which sovereign's law will apply to that property.
[15] 40 U.S.C. § 3312 (b).
[16] 40 U.S.C. § 3312 (c).
[17] Inasmuch as Virginia models its statewide building code on such standards and other national standards, the risk of conflict between federal building standards and what would normally be required at the state or local levels in Virginia appears to be reduced in this respect. *See* Va. Code Ann. §§ 36-98 & 36-39.

4. Applicable Federal Statutes Impacting Sea Level Rise Preparedness and Governance

   a. Coastal Zone Management Act (CZMA)[18]

      i. Purpose. To encourage and assist states to develop and implement management programs over the use of the land and water resources of the Coastal Zone. The CZMA minimizes loss of life and property caused by improper development in flood-prone, storm-surge, and erosion-prone areas.

      ii. Applicability. Each federal agency must ensure consistency with approved state coastal zone management programs, "to the maximum extent practicable," when 1) conducting or supporting activities directly affecting the coastal zone or 2) undertaking any development project in the coastal zone.[19]

   b. Clean Water Act (CWA)[20]

      i. Purpose. To restore and maintain the chemical, physical, and biological integrity of the Nation's waters. It requires the establishment of water quality standards and sets permit requirements for point source pollutant discharges into "waters of the United States" of dredge and fill material and of pollutants contained in industrial and municipal wastewater and industrial, municipal and construction stormwater discharges. "Waters of the United States" was recently clarified by EPA and U.S. Army Corps of Engineers regulations following a string of Supreme Court cases.[21]

      ii. Virginia has a fully authorized National Pollutant Discharge Elimination System (NPDES) permitting authority under the Clean Water Act. Virginia Authorization to Implement. Pursuant to EPA-granted authorization, most of day-to-day administration and implementation of the Clean Water Act's permit programs for wastewater and stormwater discharges occurs at the state level in Virginia.[22]

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[18] 16 U.S.C. §§ 1451-66.
[19] 16 U.S.C. § 1456.
[20] 33 U.S.C. §§ 1251-1387, *See* §1344, entitled "Permits for Dredged or Fill Material."
[21] EPA and the Corps of Engineers have just revised the definition of "waters of the United States." *See* 80 Fed. Reg. 37054 (June 29, 2015), *to be codified at* 40 CFR 230.3 and 33 CFR 328.3.
[22] *State Program Status,* U.S. ENVTL. PROTECTION AGENCY, http://water.epa.gov/polwaste/npdes/basics/NPDES-State-Program-Status.cfm (last visited Jul 28, 2015).

iii. Sovereign Immunity Waiver.[23] Each federal agency "shall be subject to, and comply with, all Federal, State, interstate, and local requirements, administrative authority, and process and sanctions respecting the control and abatement of water pollution . . ."

c. Clean Air Act (CAA)[24]

i. Purpose. To protect and enhance the quality of the Nation's air resources so as to promote the public health and welfare. The CAA establishes a complex permitting program for the control of emissions of certain pollutants into the lower and upper atmosphere.

ii. Sovereign Immunity Waiver.[25] A federal agency having jurisdiction over any property or facility or engaged in activity resulting or which may result in the discharge of air pollutants "shall be subject to, and comply with, all Federal, State, interstate, and local requirements, administrative authority, and process and sanctions respecting the control and abatement of air pollution in the same manner, and to the same extent as any nongovernmental entity."

iii. The Clean Air Act addresses climate mitigation efforts through the regulation of Greenhouse Gas (GHG) emissions.

iv. A recent Supreme Court case, *Massachusetts v. EPA*, serves as an important precedent in describing the scope of the Clean Air Act's ability to address rising sea levels. Under *Massachusetts v. EPA,* the state of MA brought suit against EPA for failure to regulate GHG emissions, and was found to have judicial standing.[26]

v. Virginia Authorization to Implement. Pursuant to EPA-granted authorization and approval of Virginia's State Implementation Plan, most of the day-to-day administration and implementation of the Clean Air Act's permit programs occur at the state level in Virginia.[27]

d. Resources Conservation and Recovery Act (RCRA)[28]

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[23] 33 U.S.C. § 1323.
[24] 42 U.S.C. § 7401 *et seq*.
[25] 42 U.S.C. § 7418.
[26] The standing requirements are easier for the state (vice an individual) to meet. *See* Massachusetts v. EPA, 549 U.S. 497 (2007).
[27] *See* 40. C.F.R. §§ 52.5420 *et seq*.
[28] 42 U.S.C. § 6901 *et seq*.

i. Purpose. To reduce or eliminate the generation of hazardous waste. To treat, store, or dispose of hazardous waste so as to minimize threat to human health and the environment. Also controls the management of non-hazardous solid waste at landfills.

ii. Sovereign Immunity Waiver. [29] A federal agency or department having jurisdiction over any solid waste management site or engaged in any activity resulting, or which may result, in the disposal or management of solid or hazardous waste shall be subject to, and comply with, all Federal, State, interstate, and local requirements respecting control and abatement of solid waste or hazardous waste disposal and management.

iii. Virginia Authorization to Implement. Pursuant to EPA-granted authorization, day-to-day administration and implementation of RCRA programs occurs at the state level in Virginia.[30]

e. National Environmental Policy Act (NEPA)

i. Purpose. NEPA requires federal government and all agencies to "use all practicable means to create and maintain conditions under which man and nature can exist in productive harmony. . ."[31]

ii. Council on Environmental Quality (CEQ) Draft Guidance on Climate Change and Greenhouse Gas Emissions. Provides *draft* guidance to Federal agencies on how to consider greenhouse gas emissions and the impacts of climate change in their NEPA analysis.

f. Coastal Barriers Resources Act (CBRA)

i. Purpose. To minimize loss of human life, wasteful expenditure of Federal revenues, and damage to fish, wildlife, and other natural resources associated with the coastal barriers along the Atlantic and Gulf Coasts. Regulates the issuance of flood insurance under the National Flood Insurance Program within coastal areas designated as Coastal Barrier Resources System (CBRS) units, as well as

[29] 42 U.S.C. § 6961.
[30] *Virginia RCRA Authorization Records,* U.S. ENVTL. PROTECTION AGENCY, http://www.epa.gov/reg3wcmd/RCRA_State_Star/rcra_star_va_index.html (last visited Jul. 28, 2015).
[31] 42 U.S.C. § 4331 (b).

financial assistance provided by FEMA to applicants in CBRS units.

ii. Sovereign Immunity Waiver.[32] CBRA does not provide for a waiver of federal sovereign immunity. Instead, it has a provision that outlines of "priority of laws" between federal and state regulation of CBRS land that also strives to protect state regulation of land within its boundaries.

g. Endangered Species Act (ESA)[33]

i. Purpose. To conserve endangered and threatened species and resolve water resource issues in concert with endangered species conservation.

ii. Sovereign Immunity Waiver.[34] Each federal agency must ensure that any action authorized, funded or carried out by that agency is not likely to jeopardize the continued existence of any endangered/threatened species or result in destruction or adverse modification of critical habitat for such species.

h. Fish and Wildlife Coordination Act:[35]

i. Purpose. The Fish and Wildlife Coordination Act of 1934, as amended, requires that wildlife, including fish, receive equal consideration and be coordinated with other aspects of water resource development. This is accomplished by requiring consultation with U.S. Fish and Wildlife Service (USFWS), National Oceanic and Atmospheric Administration (NOAA) Fisheries, and appropriate state agencies whenever any body of water is proposed to be modified in any way and a federal permit or license is required.

i. Marine Mammal Protection Act (MMPA)[36]

i. Purpose. The MMPA's purpose is to protect essential marine mammal habitats, including the rookeries, mating grounds, and areas of similar significance from the adverse effect of man's actions.

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[32] 16 U.S.C. § 3507.
[33] 16 U.S.C. § 1531 *et seq*.
[34] 16 U.S.C. § 1536.
[35] 16 U.S.C. §§ 661 – 667e.
[36] 16 U.S.C. § 1361 *et seq*.

j. Migratory Bird Treaty Act (MBTA)[37]

i. Purpose. The MBTA's purpose is to protect migratory birds native to the United States and in danger of extinction from being killed, captured, taken, or exported.

k. Magnuson-Stevens Fishery Conservation and Management Act[38]

i. Purpose. The Magnuson-Stevens purpose is to conserve and manage the fishery resources found off the coasts of the United States, and promote the protection of essential fish habitat (EFH) in the review of projects conducted under Federal permits, licenses, or other authorities that affect or have the potential to affect such habitat. It requires federal agencies to consult with NOAA Fisheries when any activity proposed to be permitted, funded, or undertaken by a federal agency may have adverse effects on designated EFH.

l. National Historic Preservation Act (NHPA)[39]

i. Purpose. The NHPA's purpose is to protect the nation's historical and cultural foundations against inadvertent loss or alteration, and to improve the planning and execution of Federal and federally assisted projects to encourage their preservation.

m. National Historic Lighthouse Preservation Act (NHLPA)[40]

i. Purpose. The NHLPA's purpose is to create a process and policies for the conveyance of historic light stations, and to monitor their use.

5. Federal Executive Orders & Executive Guidance: There have been numerous executive orders addressing *federal agency* efforts relating to sea level rise.

a. Executive Order 13693: "Planning for Federal Sustainability in the Next Decade." Primarily related to climate mitigation measures, it orders the reduction of Greenhouse Gas emissions and sets sustainability goals for federal agencies.

b. Executive Order 13690: "Establishing a Federal Flood Risk Management Standard and a Process for Further Soliciting and Considering Stakeholder Input." This executive order updates an

[37] 7 U.S.C. § 703 *et seq*.
[38] 16 U.S.C. § 1801 *et seq*.
[39] 16 U.S.C. § 470.
[40] 16 U.S.C. § 470w-7.

earlier E.O. addressing federal action in floodplains and establishes new flood plain standards for federal actions.

c. Executive Order 13677: "Climate Resilient International Development." Establishes a working group on Climate-Resilient International Development which will identify, develop, and assess federal agency strategies, programs and investments towards climate-resilience.

d. Executive Order 13653: "Preparing the United States for the Impacts of Climate Change." Encourages, through agency guidance, grants, and technical assistance, climate-resilient investments by states, local communities, and tribes.

e. Executive Order 13547: "Stewardship of the Ocean, Our Coasts, and the Great Lakes." Establishes a national policy to ensure protection and restoration of ocean, coastal, and Great lakes ecosystems, enhance sustainability of ocean and coastal economies, respond to climate change, and coordinate with national security and foreign policy interests.

f. Federal Climate Action Plan (June 2013): directs federal agencies to take the appropriate actions to reduce risk to federal investments, specifically to "update their flood-risk reduction standards."

6. Applicable Federal Agencies & Programs

a. Environmental Protection Agency (EPA)[41]

i. Provides information regarding the effects of climate change on coastal areas, including sea level rising and flooding. EPA also provides a Sea Level Rise and Coastal Flooding Impacts Viewer to "visualize the potential impacts of sea level rise on coastal communities," including Mississippi, Alabama, Texas, and Florida. Additional coastal counties are anticipated to be added over time.

b. Federal Emergency Management Agency (FEMA)

i. Created by the Disaster Relief Act of 1974[42] to provide federal natural disaster assistance to state and local governments.

ii. Encourages the development of disaster preparedness plans by state and local government.

[41] 40 C.F R. § 1.
[42] 42 U.S.C. § 5131, *et seq*.

c. National Oceanographic and Atmospheric Association (NOAA)[43]
NOAA provides a Sea Level Trends map that illustrates regional trends in sea level, with arrows representing the direction and magnitude of change. It also provides detailed information for each area identified on the map.

d. U.S. Geological Survey (USGS)[44]
The USGS partners with NOAA to release a report that "examines and describes climate change impacts on coastal ecosystems and human economies and communities, as well as the kinds of scientific data, planning tools and resources that coastal communities and resource managers need to help them adapt to these changes."[45]

e. National Aeronautics and Space Administration (NASA)
NASA provides information regarding climate change and vital signs of the planet including sea level and sea level rise data, indicating that the rise is due to two primary causes: "added water from melting land ice and the expansion of sea water as it warms." NASA also provides charts showing the change in sea level.

f. National Flood Insurance Program[46]

i. Provides affordable insurance to property owners to help reduce the impact of flooding on private and public property. NFIP also "encourages communities to adopt and enforce floodplain management regulations."

ii. The NFIP program "reduces the socio-economic impact of disasters by promoting the purchase and retention of Risk Insurance in general, and National Flood Insurance in particular."

iii. FEMA provides a Flood Insurance Rate Map (FIRM). This is "the official map of a community on which FEMA has

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[43] 15 C.F.R.§ 9.
[44] 30 C.F.R. § 2 (A) (4).
[45] Louis Cafiero and Catherine Puckett, *USGS-NOAA: Climate Change Impacts to U.S. Coasts Threaten Pub. Health, Safety and Econ.*, U.S. GEOLOGICAL SURVEY (Jan. 28, 2013, 1:00 PM); *see also* Adele Young & Kristen Clark, *Go Green, Save Money: Lowering Flood Insurance Rates in Virginia with Stormwater Management and Open Space*, VIRGINIA COASTAL POLICY CLINIC WHITE PAPER (2015) (showing how "local governments can save constituents money and build support for stronger environmental protection is to participate in the Federal Emergency Management Agency's (FEMA) "Community Rating System" (CRS) program –a voluntary incentive program that awards credits to communities that implement proactive measures to reduce flood risk").
[46] 42 U.S.C. § 4001, *et seq*.

delineated both the special hazard areas and the risk premium zones applicable to the community."[47]

g. Readiness and Environmental Protection Integration (REPI)[48]

i. Provides a current statutory basis to allow DoD to enter into cost-sharing partnerships with outside groups (e.g., The Nature Conservancy) to protect land areas *outside* the military installation and to ensure that development around the installation is conducive to mission readiness and operations. REPI allows the military to enter into agreements with eligible entities (e.g., states, political subdivision of a state, or a private entity with a conservation or preservation goal) to address the use or development of real property "in the vicinity of or ecologically related to" military installations for purposes of:

1. Limiting any development or use of the property that would be incompatible with the mission of the installation;

2. Preserving habitat on the property that is compatible with environmental requirements and relieve environmental restrictions that interfere (directly or indirectly) with military testing or operations on the installations.

h. National Levee Safety Program[49]: establishes a "Committee on Levee Safety" to inspect levees – defined as "embankment[s], including floodwalls, the primary purpose of which is to provide hurricane, storm, and flood protection" – and issue recommendations for a national levee safety program.

7. Agency Specific Policy Guidance

a. Department of Defense (DoD) and Military Departments. Within DoD, the current Unified Facilities Code states that DoD planners should *consider* climactic conditions during construction, but it does not formally mandate specific sea level rise or climate resilient investment in any one project. In addition, there is not an easily identified "climate change" or "climate adaptation" fund that is appropriated by Congress and specifically designated for future climate resilient investment.

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[47] *Flood Insurance Rate Map,* FEMA, http://www.fema.gov/flood-insurance-rate-map-firm (last visited Jul. 28, 2015).
[48] 10 U.S.C. § 2684a, entitled, "Agreements to limit encroachments and other constraints on military training, testing and operations."
[49] 33 U.S.C. §§3301 *et seq*.

i. DoD projects on federal installations must take into account two important components: (1) the Unified Facilities Criteria; and (2) the DoD funding process. The Unified Facilities Criteria applies to the Military Departments, the Defense Agencies, and DoD Field Activities for planning, design, construction, sustainment, restoration, and modernization of facilities, regardless of funding source. Not all documents apply to all services; an alpha-designator following the document number indicates a document applying to a particular service (e.g., A for USACE, F for Air Force, N for Navy).

ii. DoD Climate Adaptation Roadmap

iii. Center for Naval Analyses Studies[50]

iv. 2014 Quadrennial Defense Review

v. Navy Task Force Climate Change

vi. Center for Climate and Security Resource Hub

b. Department of Homeland Security (DHS) Policy. DHS applies DHS-specific Environmental Management directives 025-21, 023-02, and 023-01, and "where practicable," tries to meet or exceed sustainable practice goals of other federal agencies.

i. DHS Directive 007-03: *Integrated Risk Management* - Establishes responsibilities for implementing DHS policy for risk management, including mitigating risks from natural disasters.

ii. U.S. Coast Guard (USCG) - Agency Specific Policy Guidance [51]

1. COMDTINST 16478.5- *Environmental Compliance Evaluation*: Establishes policies, procedures, and responsibilities for the Coast Guard Environmental Compliance Evaluation (ECE) Program.

2. COMDTINST 16475.1D- *National Environmental Policy Act Implementing Procedures and Policy for*

[50] *See* CTR. FOR NAVAL ANALYSIS (CNA): NATIONAL SECURITY AND THE THREAT OF CLIMATE CHANGE (2014).
[51] The U.S. Coast Guard is organizationally part of the Department of Homeland Security (DHS).

Considering Environmental Impacts: Establishes policies and responsibilities for Coast Guard implementation of the NEPA, *supra* at I (A) (3) (c), including provisions for USCG planning, environmental documentation, and preparation of Environmental Impact Statements.

3. COMDINST 16004.2A- *Coastal Zone Management, Federal Consistency Procedures*: Establishes policies and procedures for USCG implementation of Coastal Zone Management Act (CZMA), including USCG procedures, exemptions, and State Agency objections to USCG determinations.

4. USCG Western Hemisphere Strategy (2014), at 16-23: noting that climate change will exacerbate transnational risks and threats. Rising sea levels could lead to coastal erosion, property destruction, and an increase in displaced refugees who become even more vulnerable to extreme weather events. Changing precipitation patterns can reallocate flood and draught, disrupting access to food and water in vulnerable areas. Extreme weather events produce dangerous storm surges, disrupt trade routes, and consume resources of responding agencies.

B. State Law: Commonwealth of Virginia

The Commonwealth of Virginia is a Dillon Rule state.[52] Under the Dillon Rule, localities have the authority to act only in instances where they have been expressly granted such authority from the Commonwealth of Virginia or as may reasonably be inferred therefrom. The Dillon Rule requires Virginia courts to narrowly interpret delegations of power to local governments. However, the exercise of police powers is given greater leeway routinely, and this is particularly true for issues of safety and welfare which would reasonably include adaptation measures for sea level rise.[53] Indeed, prior legal analysis indicates that the Dillon Rule should only have a limited

[52] "Dillon's Rule" is named after John Dillon, a Chief Justice Iowa Supreme Court Justice who crafted the rule in the 19th century. It was quickly adopted by Virginia and several other states. In contrast to the Dillon Rule, in "Home Rule" allows local governments to make public policy decisions, such as creating special zoning and tax districts to finance a specific infrastructure project (arena, road, etc.), unless the state has specifically limited local authority.

[53] Res. Conservation Mgmt., Inc. v. Bd. of Supervisors of Prince William County, 238 Va. 15, 22, 380 S.E.2d 879, 883 (1989) (stating that when a locality regulates local physical hazards, "specificity is not necessary even under the Dillon Rule"); *see also* Stilton & Grannis, *supra* note 3, at 6 (asserting that "accounting for sea-level rise would not require local governments to imply new powers or impose new criteria").

impact on planning for sea level rise at the local level due to broad delegations that are in place.

The Virginia Supreme Court has stated that localities cannot generally be hamstrung when regulating land use.[54] As discussed in greater detail below, the Virginia legislature has already delegated a myriad of flood control, zoning, and similar authorities to local governments – all areas of importance when determining local authority to address sea level rise and recurrent flooding. And the legislature continues to act on such measures.

Furthermore, multiple state programs, laws, regulations, executive initiatives and policies both directly and indirectly address concerns associated with sea level rise and resiliency planning.

1. Dillon Rule Overview: Municipalities exercise only the powers specifically granted by the state, the powers necessary to carry out the specifically granted powers, and the powers indispensable to the declared purposes of the municipality. Accordingly, while there have been broad delegations to localities in Virginia in flood control and zoning, it still remains important to have a legal basis within local law that is derived from a Virginia statute delegating such authority as applied to local zoning, water quality, and sea level rise issues.

2. Virginia State Constitution

   a. Places a prohibition against damaging or taking of private property except and only to the degree necessary for public use, and then only with just compensation (Art 1, Sec. 11). This allows for compensation for damages, not only the taking of private property.

   b. Authority for and limitations on local government debt: (Article VII, Sec. 10).

3. Key Judicial Rulings Applying Virginia Constitutional Law

   a. *Livingston v. VDOT*: May place localities at increased risk for takings liability when private property is damaged due to the locality's failure to maintain a public improvement.[55]

   b. *Byler v. Va. Elec. & Power Co.*: Va. Const. Art. 1, § 11 of the Virginia Constitution does not authorize a remedy for diminution in property value caused by public improvement, such as power lines.[56]

   c. *Kitchen v. City of Newport News*: Landowner's inverse condemnation claim alleged sufficient facts, and survived demurrer

[54] Chesapeake v. Garden Enter., 253 Va. 243, 246, 482 S.E.2d 812, 814 (1997).
[55] 284 Va. 140, 726 S.E.2d 264 (2012).
[56] 284 Va. 501, 731 S.E.2d 916 (2012).

filed by City of Newport News, when City's infrastructure led to a series of floods on landowner's property.[57]

4. Virginia State Law: Flood Control

   a. State interest in flood control: Virginia law authorizes the implementation of measures to mitigate and alleviate the effects of stormwater surges and flooding.[58]

   b. Flood protection programs and coordination: Authorizes the implementation of flood prevention programs to minimize loss of life, property damage, and negative impacts on the environment.[59]

   c. Construction of dams, levees, seawalls, etc: Authorizes localities to construct such items to prevent tidal erosion, flooding or inundation of such locality.[60]

   d. Condemnation by localities authorized: Authorizes localities to acquire by condemnation title to land, buildings, easements, earth, and water.[61]

5. Virginia State Law: Zoning

   a. Building of houses and establishing setback lines: Authorizes localities to adopt mandatory setbacks. Setbacks are building restrictions that establish a distance from a boundary line where owners are prohibited from building structures.[62]

   b. Zoning ordinances generally: Authorizes localities to classify the use of land, flood plains, etc.[63]

   c. Purpose of zoning ordinances: Authorizes localities to create zoning ordinances to protect surface water and ground water, from loss caused by flood, and to preserve historic areas.[64]

   d. Matters to be considered in drawing and applying zoning ordinances and districts: Authorizes localities to draw zoning ordinances and districts considering future requirements of community as to the

[57] 275 Va. 378, 657 S.E.2d 132 (2008).
[58] Va. Code Ann. § 10.1-658.
[59] Va. Code Ann. § 10.1-659.
[60] Va. Code Ann. § 15.2-970.
[61] Va. Code Ann. § 15.2-1901.1.
[62] Va. Code Ann. § 15.2-2279.
[63] Va. Code Ann. § 15.2-2280.
[64] Va. Code Ann. § 15.2-2283.

land, preservation of flood plains, the preservation of life and property, etc. [65]

6. Virginia State Law - Coastal Zone Management State Program Consistency Review. Under the federal Coastal Zone Management Act (CZMA), certain actions and projects occurring in the designated coastal zone of Virginia must under consistency review to ensure compliance with state coastal zone programs. This review process is administered by the Virginia Department of Environmental Quality.[66]

7. Virginia State Law: Water Quality, Water Use and Related Resources Protection

   a. Virginia water resources policy – generally.[67]

   b. State ownership and control of tidal and non-tidal submerged lands.[68]

      i. Improvement of navigability.[69]

      ii. Piers, docks and landings.[70]

   c. Submerged bottomlands belonging to state should be maintained for public use.[71]

   d. State Water Control Law: Provides overarching foundation for most of Virginia's major water quality and water resources management programs.[72]

   e. Wetlands protection:

      i. Virginia Water Protection Permit Program.[73]

      ii. Wetlands impact permits and local wetland boards.[74]

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[65] Va. Code Ann. § 15.2-2284.
[66] *See* Exec. Order No. 35 (Va. 2014), *available at* https://governor.virginia.gov/media/3490/eo-35-continuation-of-the-virginia-coastal-zone-management-program.pdf. For program information *see generally* http://www.deq.virginia.gov/Programs/CoastalZoneManagement/DescriptionBoundary.aspx.
[67] Va. Code Ann. §§ 62.1-10 *et seq;* 9 VAC 25-390-10 *et seq*.
[68] Va. Code Ann. §§ 28.2-1200 *et seq*.
[69] Va. Code Ann. §§ 62.1-155 *et seq*.
[70] Va. Code Ann. § 62.1-164 *et seq*.
[71] *See* Va. Code Ann. §§ 28.2-1200 and 28.2-1205 (applies to state-owned bottomlands).
[72] Va. Code Ann. §§ 62.1-44.2 *et seq*.
[73] Va. Code Ann. §§ 62.1-44.15:20 *et seq*.; 9 VAC 25-210-10 *et seq*.
[74] Va. Code Ann. §§ 28.2-1300 *et seq*.

iii. Wetlands policy.[75]

f. Surface water withdrawals, preservation of instream flow, interbasin transfers of water: Virginia Water Protection Permit Program.[76]

g. Stormwater management and erosion control

i. Stormwater discharges by localities, certain government facilities and higher education institutions: Virginia Stormwater Management Act.[77]

ii. Stormwater discharges and erosion management for land-disturbing and other construction activities and post-development stormwater control (private and public property).

h. Stormwater discharges and post-development controls: Virginia Stormwater Management Act[78]; Virginia Stormwater Management Program Regulations[79]. Erosion and sediment control: Erosion and Sediment Control Law [80] ; Erosion and Sediment Control Regulations.[81]

i. Chesapeake Bay and tributary protections (buffers, set-backs and other land use restrictions): Chesapeake Bay Preservation Act;[82] Chesapeake Bay Preservation Regulations.[83] The CBPA could be utilized by localities to prohibit construction 100 feet from the edge of the wetland or shore. CBPA buffers do not apply to federal lands.

j. Coastal sand dune and beach protection.[84]

k. Wastewater and sewer control:

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[75] 9 VAC 25-380-10 *et seq*.
[76] Va. Code Ann. §§ 62.1-44.15:20 *et seq*.; Va. Code Ann. § 62.1-44.15(17); 9 VAC 25-210-10 *et seq*.
[77] Va. Code Ann. §§ 62.1-44.15:24 *et seq*.); Virginia Stormwater Management Program Regulations (9 VAC 25-870-10 *et seq*.
[78] §§ 62.1-44.15:24 *et seq*.
[79] 9 VAC25-870-10 *et seq*.; (control of stormwater from non-construction industrial activities (Va. Code Ann. § 62.1-44.15(5); 9 VAC 25-31-120; myriad general permit regulations)
[80] Va. Code Ann. §§ 62.1-44.15:51 *et seq*.
[81] 9 VAC 25-840-10 *et seq*.
[82] Va. Code Ann. §§ 62.1-44.15:67 *et seq*.
[83] 9 VAC 25-830-10 *et seq*.
[84] Va. Code §§ 28.2-1400 *et seq*.

i. Industrial wastewater: Wastewater discharges; [85] no-discharge treatment systems.[86]

ii. Municipal wastewater (domestic and industrial sewage) treatment and discharges.[87]

iii. Septic systems and other sewage handling.[88]

l. Animal feeding operations ("AFOs"):

i. No discharge;[89]

ii. With discharge.[90]

m. Waterworks and Water Supply:

i. Waterworks and public water supply treatment.[91]

ii. Virginia water supply and resources planning.[92]

iii. Impoundment of surface waters.[93]

8. Solid waste collection, recycling and disposal (e.g., landfill siting, design construction, and contamination): Virginia Waste Management Act;[94] Virginia Solid Waste Management Regulations.[95]

9. Hazardous waste generation, storage, treatment, transportation and disposal: Virginia Waste Management Act;[96] Virginia Hazardous Waste Management Regulations.[97]

10. Voluntary Remediation Program: Addresses voluntary cleanup of properties with contamination or potential contamination where remediation is not clearly mandated by law.[98]

11. Storage tanks and petroleum releases, generally

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[85] Va. Code Ann. § 62.1-44.15(5); 9 VAC 25-31-10 *et seq.*
[86] 9 VAC 25-32-10 *et seq.*
[87] Va. Code Ann. § 62.1-44.15(5); 9 VAC 25-31-10 *et seq.*; 9 VAC 25-790-10 *et seq.*
[88] Va. Code Ann. § 32.1-163 *et seq.*; 12 VAC 5-610-10 *et seq.*
[89] Va. Code Ann. § 62.1-44.15(5); 9 VAC25-32-10 *et seq.*; 9 VAC 25-192-10 *et seq.*
[90] Va. Code Ann. § 62.1-44.15(5); 9 VAC 25-31-10 *et seq.*
[91] Va. Code Ann. §§ 32.1-167 et seq.; 12 VAC 5-590-10 *et seq.*
[92] Va. Code Ann. §§ 62.1-44.35 *et seq.*; 9 VAC 25-780-10 *et seq.*
[93] Va. Code Ann. §§ 62.1-104 *et seq.*
[94] Va. Code Ann. §§10.1-1400 *et seq.*
[95] Va. Code Ann. §§10.1-1400 *et seq.*
[96] Va. Code Ann. §§10.1-1400 *et seq.*
[97] 9 VAC 20-60-12 *et seq.*
[98] Va. Code Ann. § 10.1-1232; 9 VAC 20-160-10 *et seq.*

a. Underground storage tanks ("UST's): Regulation of use of UST's and associated releases and spills.[99]

b. Aboveground storage tanks ("AST's") and petroleum releases generally: Regulation of AST's, contingency planning for AST storage and releases, and remediation and liability for releases from AST's and non-tank releases.[100]

12. Open space preservation and conservation

a. Open Space Land Act: authorized localities to acquire lands to provide for open, undeveloped space.[101]

b. Virginia Conservation Easement Act: Creates state tax incentives for the preservation of undeveloped land through conservation easements.[102]

13. Virginia Administrative Process Act (VAPA): General standards for making case decisions and developing and issuing regulations by state and local agencies and bodies (similar to federal Administrative Procedure Act).[103]

14. Key Virginia Common Law[104] Concepts

a. State Riparian Water Rights:

i. Each property owner is entitled to the natural flow of water in a natural watercourse adjoining real property subject to "reasonable use" of water of upstream riparian[105] owner.

ii. There is a riparian right to flow and reasonable use tied to ownership of land adjacent to a stream; the right lies not in the water itself, but in reasonable use thereof so as not to injure downstream riparian owner.[106]

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[99] Va. Code Ann. §§ 62.1-44.34:8 *et seq.*; 9 VAC 25-580-10 *et seq.*
[100] Va. Code Ann. §§ 62.1-44.34:14 *et seq.*; 9VAC25-91-10 *et seq.*
[101] Va. Code Ann. §§10.1-1700 *et seq.*
[102] Va. Code Ann. §§ 10.1-1009 *et seq.*
[103] Va. Code Ann. §2.2- 4000 *et seq.*
[104] "Common Law" is defined as "the body of law derived from judicial decisions and opinions, rather than from statutes and constitutions." BLACK'S LAW DICTIONARY 113 (POCKET ED. 1996).
[105] Riparian rights is the rule that owners of land bordering on a waterway have equal rights to use the water passing by their property. BLACK'S LAW DICTIONARY 554 (POCKET ED. 1996).
[106] *See* Mumpower v. Bristol, 90 Va. 151, 17 S.E. 853 (1893); Hite v. Luray, 175 Va. 218, 8 S.E.2d 369 (1940); Purcellville v. Potts, 179 Va. 514, 19 S.E.2d 700 (1942*). But see* Va. Code §§ 62.1-10 *et seq.*

iii. Riparian ownership also entitled to use of shoreline for access to property and to water, including right to install piers in a manner not interfering with navigation of the watercourse, but this has been modified by statute.[107]

b. Real and Personal Property-Related Causes of Action

i. Trespass: Claim by property owner resulting from damage (including loss of use and enjoyment) caused by other party's unauthorized entry (or other party causing something to enter upon the property; requires actual physical entry.[108]

ii. Nuisance Law

1. Private nuisance: Claim by property owner for damage (including loss of use and enjoyment) caused by another party's use of his own property (noise, light, noxious odors); does not necessarily involve physical entry onto injured party's property.[109]

2. Public nuisance: An activity or condition that of itself poses a danger to the public at large; it may be remedied by governmental authorities.[110]

iii. Negligence: Failure to exercise the level of care a reasonably prudent person would perform under like circumstances to avoid harm to another; the law attributes a duty of care owed to another.[111]

iv. Strict liability: Liability arising through inherently and ultra-hazardous dangerous actions of a party (e.g., blasting); liability arises regardless of fault or negligence; duty imposed by law given nature of circumstance.[112]

15. Key Virginia Executive Orders

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[107] Langley v. Meredith, 237 Va. 55, 376 S.E.2d 519 (1989); Evlyn v. Commonwealth, 46 Va.App. 618, 621 S.E.2d 130 (2005). *See also* Va. Code Ann. §§ 62.1-164, 28.2-1205 and 28.2-1209.

[108] *See, e.g.,* Tate v. Ogg, 170 Va. 95, 195 S.E. 496 (1938); Nature Conservancy v. Machipongo Club, *Inc.*, 419 F. Supp. 390 (E.D. Va. 1976).

[109] Barnes v. Graham Virginia Quarries, Inc., 204 Va. 414, 132 S.E.2d 395 (1963); Bowers v. Westvaco Corp., 244 Va. 139, 419 S.E.2d 661 (1992).

[110] Breeding v. Hensley, 258 Va. 207, 519 S.E.2d 369 (1999); Taylor v. City of Charlottesville, 240 Va. 367, 397 S.E.2d 832 (1990).

[111] Gossett v. Jackson, 249 Va. 549, 457 S.E.2d 97 (1995); Griffin v. Shively, 227 Va. 317, 315 S.E.2d 210 (1984).

[112] M.W. Worley Const. Co., Inc. v. Hungerford, Inc., 215 Va. 377, 210 S.E.2d 161 (1974). *See also* Arlington Forest Associates v. Exxon Corp., 774 F. Supp. 387 (E.D. Va. 1991).

i. EO-35 (Dec. 2, 2014): Continuation of the Virginia Coastal Zone Management Program

ii. EO-19 (July 1, 2014): Convening the Governor's Climate and Resiliency Update Commission

iii. EO-4 (Jan. 11, 2014): Delegation of the Governor's Authority to Declare a State of Emergency

16. Recent Relevant Virginia State Legislation

i. House Bill 1812 (2015): Chesapeake Bay Watershed Agreement; requirements of annual report that addresses 2014 Chesapeake Bay Agreement.

ii. House Bill 1817 / Senate Bill 1079 (2015): Directs the Department of Conservation and Recreation to regularly update the flood protection plan for the Commonwealth and to make the plan accessible online. Passed March 2015.

iii. Senate Bill 1443 (2015): Titled "Comprehensive plan shall incorporate strategies to combat projected sea-level rise and recurrent flooding." Provides that any locality included in the Hampton Roads Planning District Commission *shall* incorporate into the next scheduled and all subsequent reviews of its comprehensive plan strategies to combat projected relative sea-level rise and recurrent flooding.[113] This requires such review to be coordinated with the other localities in the Hampton Roads Planning District Commission and requires that the Department of Conservation and Recreation, the Department of Emergency Management, the Marine Resources Commission, Old Dominion University, and the Virginia Institute of Marine Science provide assistance upon request from one of these local jurisdictions.[114]

17. State-level Climate Resiliency and Preparedness Efforts

i. Governor's Chief Resiliency Officer

ii. Governor's Climate Change and Resiliency Update Commission

iii. General Assembly Joint Subcommittee on Recurrent Flooding

iv. Secure Commonwealth Panel, Flooding Subpanel Report

[113] Comprehensive plans establish the general blueprint for future community development. Va. Code Ann. §§ 15.2-2223 to 15.2-2232.
[114] Added at Va. Code Ann. § 15.2 – 2223.3.

C. Municipal and Locality Law

"Hampton Roads" is not specifically defined in the Pilot Charter. And different definitions are used by the Hampton Roads Planning District Commission,[115] the Hampton Roads Transportation Planning Organization,[116] and the U.S. Office of Management and Budget.[117] The definition of Hampton Roads used by the Hampton Roads Planning District Commission will be used as the starting point for the purposes of the Legal Primer and will be adjusted when we receive further clarification from the Steering Committee.

1. Property and Infrastructure

Many relevant powers have already been granted by the state to local governments, which serves to minimize Dillon Rule concerns in some cases. Among these are the powers to obtain and utilize real property, to undertake infrastructure projects, to regulate the use of land, and to regulate construction. Many of these powers are implemented through state-local cooperative programs, where state law mandates the creation of regulations which are then implemented through local programs.

Localities in Virginia have broad authority to undertake infrastructure projects to combat flooding and coastal erosion.[118] For example, Virginia Code Ann. § 15.2-970(A)-(B), entitled "Construction of dams, levees, seawalls, etc." is particularly relevant for looking to the authority for localities to take adaptation measures and is an example of a structural adaptation measure that has been granted to localities. Virginia state law broadly allows localities to construct dams, levees, seawalls to prevent flooding. It states:

> Any locality may construct a dam, levee, seawall or other structure or device, or perform dredging operations hereinafter referred to as "works," the purpose of which is to prevent the tidal erosion, flooding or inundation of such locality, or part thereof. The design, construction,

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[115] The Hampton Roads PDC includes the Cities of Chesapeake, Franklin, Hampton, Newport News, Norfolk, Poquoson, Portsmouth, Suffolk, Virginia Beach, and Williamsburg, the Counties of Gloucester, Isle of Wight, James City, Southampton, Surry, and York, and the Town of Smithfield.

[116] The Hampton Roads TPO includes the Cities of Chesapeake, Hampton, Newport News, Norfolk, Poquoson, Portsmouth, Suffolk, Virginia Beach, and Williamsburg, and the Counties of Gloucester, Isle of Wight, James City, and York.

[117] The Virginia Beach-Norfolk-Newport News Metropolitan Statistical Area includes the Cities of Chesapeake, Hampton, Newport News, Norfolk, Poquoson, Portsmouth, Suffolk, Virginia Beach, and Williamsburg, and the Counties of Gloucester, Isle of Wight, James City, Mathews, and York. It also includes Gates County and Currituck County, North Carolina.

[118] *See generally* Va. Code Ann. §§ 15.2-900 *et seq*.

performance, maintenance and operation of any of such works is hereby declared to be a proper governmental function for a public purpose.[119]

Localities, including cities, counties, and towns, in Virginia have the explicit authority to purchase, sell, and use real property for public uses,[120] as well as the power of eminent domain or condemnation to acquire real or personal property for public uses.[121]

Localities are also granted broad sovereign immunity (i.e. freedom from lawsuit) when undertaking these projects. The exception to this rule occurs in the case of eminent domain if the infrastructure results in a taking of property without just compensation.[122]

In addition, the Virginia Supreme Court has determined that localities are responsible for damages to property resulting from any infrastructure which causes flooding to property.[123]

2. Land Use and Planning

Title 15, Chapter 22 of the Code of Virginia governs local powers related to land use and planning. Section15.2-2223 directs local planning commissions to prepare and recommend comprehensive plans for their jurisdictions and governing bodies to adopt such plans. All seventeen localities in the Hampton Roads Planning District have adopted comprehensive plans. Several additional laws require comprehensive plans to address issues relevant to this project.

Section 15.2-2223.2 requires localities in Tidewater Virginia[124] to incorporate coastal resource management guidance into their comprehensive plans.

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[119] Va. Code Ann. § 15.2-970(A). It further states, "No person, association or political subdivision shall bring any action at law or suit in equity against any locality because of, or arising out of, the design, maintenance, performance, operation or existence of such works but nothing herein shall prevent any such action or suit based upon a written contract. This provision shall not be construed to authorize the taking of private property without just compensation therefor and provided further that the tidal erosion, flooding or inundation of any lands of any other person by the construction of a dam or levee to impound or control fresh water shall be a taking of such land within the meaning of the foregoing provision." Va. Code Ann. § 15.2-970(B).

[120] Va. Code Ann. § 15.2-1800.

[121] Va. Code Ann. § 15.2-1901. But see Va. Const. art. I, § 11 and Va. Code Ann. § 1-219.1 as to severe limits on such authority in connection with economic development activities.

[122] Va. Code Ann. § 15.2-970(B).

[123] *See* Jenkins v. Shenandoah County, 246 Va. 467, 436 S.E.2d. 607 (1993); Livingston v. Virginia Department of Transportation, 284 Ba. 140, 726 S.E.2d 264 (2012); *see also* James Andris, *State and Local Liability for Failure to Adapt and Protect Against Recurrent Flooding: Applying Farmers Insurance Legal Framework to Virginia Circumstances*, VCPC WHITE PAPER (Spring 2015).

[124] Tidewater Virginia is defined in §62.1-44.15:68 to include the Counties of Accomack, Arlington, Caroline, Charles City, Chesterfield, Essex, Fairfax, Gloucester, Hanover, Henrico, Isle of Wight, James City, King and Queen, King George, King William, Lancaster,

Comprehensive plans establish the blueprint for future community development that is legally implemented via local zoning ordinances.[125] Beginning July 1, 2015, this will require that localities in the Hampton Roads Planning District Commission incorporate strategies to address sea level rise and recurrent flooding into their comprehensive plans. Section 62.1-44.15:74 directs local governments in Tidewater Virginia to incorporate the protection of the quality of state waters into their comprehensive plans.

In addition to these specific requirements, localities are also required or authorized to adopt policies and ordinances to regulate the general use of land. Section 15.2-2240 requires localities to adopt subdivision ordinances. Section 15.2-2280 allows localities to adopt zoning ordinances to regulate the use of land and the dimensions and the construction of structures.[126]

3. Regulation of Construction

Several state laws establish programs that are developed by state agencies and implemented by local governments through local ordinances. For example, the Virginia Board of Housing and Community Development adopts and amends the Virginia Uniform Statewide Building Code (USBC). The USBC is then adopted by reference by localities and amended as allowed and appropriate. Similar state-local programs cover stormwater management, erosion and sediment control, Chesapeake Bay preservation, and floodplain management.

As noted above, the State Water Control Board permits, regulates, and controls urban and suburban stormwater runoff in connection with its authority to administer the Clean Water Act in Virginia. Part of this program involves the regulation of municipal storm water discharges and permitting of municipal separate storm sewer systems ("MS4s").[127] MS4's are required to obtain permits for their municipal stormwater discharges, and they are required (and localities not required to have permits are authorized) to adopt local Virginia Stormwater Management Programs (VSMPs) to regulate land-disturbing activities.

Similarly, the State Water Control Board has developed and adopted regulations to control soil erosion, sediment deposition, and nonagricultural runoff.[128] Counties and cities must adopt and administer local Virginia Erosion and Sediment

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Mathews, Middlesex, New Kent, Northampton, Northumberland, Prince George, Prince William, Richmond, Spotsylvania, Stafford, Surry, Westmoreland, and York, and the Cities of Alexandria, Chesapeake, Colonial Heights, Fairfax, Falls Church, Fredericksburg, Hampton, Hopewell, Newport News, Norfolk, Petersburg, Poquoson, Portsmouth, Richmond, Suffolk, Virginia Beach, and Williamsburg.

[125] *See* Stilton & Grannis, *supra* note 3.

[126] This includes the use of land, buildings, structures, and other premises for . . . flood plain and other specific uses.

[127] *See* Va. Code Ann. § 62.1-44.15:27; 9 VAC 25-870-10 *et seq*.

[128] Va. Code § 62.1-44.15:52; 9 VAC 25-840-10 *et seq*.

Control Programs (VESCPs); towns may adopt their own or remain subject to the appropriate county's program.[129]

Further, pursuant to the Chesapeake Bay Preservation Act (CBPA), the State Water Control Board has developed regulations, performance standards, and policies to promote the quality of state waters in Tidewater Virginia, particularly as to the control of sedimentation and other effects of development activities.[130] The regulations call for protective measures to be incorporated into local land use planning ordinances.[131]

Both the state government and local governments have a role in floodplain management. However, the regulations governing local floodplain management programs are more directly influenced by the National Flood Insurance Program and not state regulations per se. As noted above, the VA Department of Conservation and Recreation is required (among other tasks) to develop a flood protection plan for the Commonwealth and to assist localities in managing activities within floodplains.[132] This is achieved through the provision of technical assistance and the development of guidance and model ordinances for local consideration and adoption. One feature of local floodplain management programs is the degree to which they can go beyond state recommendations. Specifically, localities are allowed to implement a freeboard requirement that applies to new construction in designated floodplains and in some cases substantial additions or modifications. It is beyond the scope of this primer to provide an in-depth discussion of each locality's laws, but a representative discussion is provided below for Norfolk, Newport News, and Poquoson.

a. Norfolk

The City of Norfolk's zoning ordinance is found in Chapter 11 of Norfolk's municipal code. Norfolk has adopted Virginia's Uniform Statewide Building Code (USBC) as a comprehensive body of law. Under Section 11.1-4 of the Building Code, the City of Norfolk also establishes "climactic and geographic design criteria" that is unique to Norfolk, VA. The minimum standards for the control of erosion and sediment in the city shall be those standards in the regulations adopted in the State Erosion and Sediment Control Program and in the Virginia Erosion and Sediment Control Handbook. (Section 15-3, Norfolk Code) Lastly, Norfolk recently updated its floodplains ordinance.

b. Newport News

The Zoning Ordinance of the City of Newport News is found under Chapter 45 of the City Code. This includes the City's Floodplain Development Regulations in Article XXXI, Division 2 of that Chapter (§ 45-3110 through § 45-3125.5). This division creates an overlay district for the City detailing the Flood Plains as required by FEMA. The current regulations require that the level of the lowest floor in any

[129] Va. Code § 62.1-44.15:54.
[130] Va. Code Ann. §§ 62.1-44.15:67 *et seq*.; 9 VAC 25-830-10 *et seq*.
[131] *See* 9 VAC 25-830-60.
[132] Va. Code Ann. § 10.1-602.

building must be at an elevation of two feet above the base flood level, which is defined as the 100 year storm (or a storm with a 1% likelihood of occurring in any given year) The City does not as yet have any ordinances that directly address sea level rise. Because Virginia Code Section 15.2-2223.3 went into effect on July 1, 2015, the City will need to address sea-level rise and recurrent flooding as part of its Comprehensive Plan.

c. Poquoson

Poquoson's Flood Plain ordinances appear in Chapter 42 of its City Code. Poquoson Code § 42-71(c) requires that the lowest floor of any new construction be three feet above the base flood level. As to manufactured or modular buildings, the lowest floor must be one foot above base flood level. Poquoson Code § 42-74(a)(1). And Poquoson has recently adopted a comprehensive plan that takes into account sea level rise.

d. Hampton Roads Locality Table

The following table includes references to primary local ordinances in Hampton Roads covering zoning, Chesapeake Bay Preservation, subdivision of lands, stormwater management, erosion and sediment control, and floodplain management. The locally established freeboard requirement is also included. Except where noted, all references refer to the respective localities' Code of Ordinances.

Locality	Zoning	Chesapeake Bay Preservation	Subdivision	Stormwater Management[133]	Erosion and Sediment Control	Floodplain Mgmt[134]	Freeboard Requirement [135]
Chesapeake	Separate Ordinance	Chapter 26 Article IX	Chapter 70	Chapter 26 Article VII	Chapter 26 Article III	Chapter 26 Article IV	1.5'
Franklin	Appendix D	N/A	Appendix C	Chapter 25.7	Chapter 9	Zoning Ordinance Article XXI	0'
Gloucester	Appendix B	Chapter 5.5	Chapter 15	Chapter 6	Chapter 7.5	Chapter 8.5	2'
Hampton	Separate Ordinance	Zoning Ordinance Chapter 17.3 Article X	Chapter 35	Chapter 33.2	Chapter 13.1	Zoning Ordinance Chapter 17.3 Article V	3'
Isle of Wight	Appendix B	Appendix B-1	Appendix A	Chapter 14A	Chapter 6	Zoning Ordinance Article XI Sec. 6-4000	1.5'
James City	Chapter 24	Chapter 23	Chapter 19	Chapter 18A	Chapter 8	Zoning Ordinance Article VI Division 3	2'
Newport News	Chapter 45	Chapter 37.1 Article V	Appendix B	Chapter 37.1	Chapter 37.1 Article VII	Zoning Ordinance Article XXXI Division 2	2'
Norfolk	Appendix A	Zoning Ordinance	Chapter 42.5	Chapter 41. and Chapter 41.2	Chapter 15	Zoning Ordinance	3'

[133] EPA has developed a model ordinance for erosion and sediment control at http://water.epa.gov/polwaste/nps/mol2.cfm

[134] "Floodplain management" is defined as the operation of a community program of preventive and corrective measures to reduce the risk of current and future flooding, resulting in a more resilient community. http://www.fema.gov/floodplain-management

[135] Freeboard is a factor of safety usually expressed in feet above a flood level for purposes of floodplain management. "Freeboard" tends to compensate for the many unknown factors that could contribute to flood heights greater than the height calculated for a selected size flood and floodway conditions, such as wave action, bridge openings, and the hydrological effect of urbanization of the watershed. Freeboard is not required by NFIP standards, but communities are encouraged to adopt at least a one-foot freeboard to account for the one-foot rise built into the concept of designating a floodway and the encroachment requirements where floodways have not been designated. Freeboard results in significantly lower flood insurance rates due to lower flood risk. *See* https://www.fema.gov/freeboard

		Chapter 11 Section 11-2				Chapter 11 Section 11-3	
Poquoson	Appendix A	Chapter 9.1	Chapter 33.1	Chapter 31.2	Chapter 11	Chapter 14	1.5’
Portsmouth	Chapter 40.1	Chapter 9.1	Chapter 33.1	Chapter 31.2	Chapter 11	Chapter 14	1.5’
Smithfield	Separate Ordinance	Zoning Ordinance Article 3.P	Separate Ordinance	N/A	Zoning Ordinance Article 11.A	Zoning Ordinance Article 3.O	0’
Southampton	Chapter 18	N/A	Chapter 14	Chapter 13.5	Chapter 6	Zoning Ordinance Article XIV	1’
Suffolk	Unified Dev. Ordinance	UDO Article 4 Section 31-415	UDO Article 5	Chapter 35	Chapter 34 Article III	UDO Article 4 Section 31-416.1	0’
Surry	Appendix A	Zoning Ordinance Article III Sec. 3-1400	Separate Ordinance	N/A	Chapter 102 Article III	Zoning Ordinance Article III Sec. 3-1500	0’
Virginia Beach	Appendix A	Appendix F	Appendix B	Appendix D	Chapter 30 Article III	Appendix K	2’
Williamsburg	Chapter 21	Zoning Ordinance Article VIII	Chapter 16	Chapter 7 Article I	Chapter 7 Article II	Zoning Ordinance Article XII	0’
York	Chapter 24.1	Chapter 23.2	Chapter 20.5	Chapter 23.3	Chapter 10	Zoning Ordinance Division 7 Sec. 24.1-373	3’

II. Additional Considerations – Planning and Coordination

A. Federal Agency Coordination Issues: As a general matter, this effort is aligned with existing executive order guidance on federal support for planning for the impacts of climate change.

i. Stafford Act, Amended by the Disaster Mitigation Act of 2000[136]. Authorizes the President to establish disaster preparedness program that utilizes all appropriate agencies and includes coordination of Federal, State, and local preparedness programs. The President will provide technical assistance to States in developing preparedness programs, assist State and local governments following disasters, and for recovery of damaged public and private facilities.

ii. Posse Comitatus Act:[137] Prohibits direct military assistance for law enforcement purposes.

1. DoD: Statutorily applies to Army and Air Force. By DoD and Department of the Navy policy, this restriction also applies to the Navy and Marine Corps.[138]

2. DHS/USCG: USCG is not subject to or restricted by 18 U.S.C. § 1385.

3. National Guard: Restrictions apply when in federal service. Restrictions do not apply when in state service.

iii. Authorities Allowing Mutual Support Agreements Between Federal Agencies and Local Governments

1. Defense Support of Civil Authorities: DoD Directive 3025.18

2. USCG: 14 U.S.C. § 93[139]

a. Investigate plans and devices relating to performance of any Coast Guard Function, and cooperate and coordinate such activities with other Government and private agencies

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[136] 42 U.S.C. § 5131, *et seq*.
[137] 18 U.S.C. § 1385. ("Whoever, except in cases and under circumstances expressly authorized by the Constitution or Act of Congress, willfully uses any part of the Army or the Air Force as a posse comitatus or otherwise to execute the laws shall be fined under this title or imprisoned not more than two years, or both.")
[138] 10 U.S.C. § 375.
[139] 14 U.S.C. § 93.

b. Accept and utilize, in times of emergency in order to save life or protect property, such voluntary services as may be offered to the USCG.

c. Enter into cooperative agreements with states, local governments to accept and utilize voluntary services for the maintenance and improvement of natural and historic resources.

3. Fiscal Law Concerns: It is beyond the scope of this Primer to provide an in-depth analysis of all the fiscal law limitations associated with the expenditure of federal money, but money appropriated by Congress must be spent consistent with fiscal law principles governing purpose, time, and amount.[140]

B. Environmental Justice

i. Definition: "Fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations and policies."[141]

ii. As always, planners and policymakers will have to be mindful of issues of environmental justice, particularly as they weigh the various options of which areas to defend, where to adapt, and where to retreat.

iii. Executive Order 13,166: Requires federal agencies to examine the services they provide, identify any need for services to limited English proficient persons (LEP), and develop a plan and implement a plan to provide services so that LEP persons can have meaningful access to them.

C. Outside Requests for Information

i. Federal: Freedom of Information Act (FOIA)[142]

1. FOIA provides the public the right to access records from any federal agency.

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[140] For example, the Purpose Statute states, "Appropriations shall be applied only to the objects for which the appropriations were made except as otherwise provided by law." 31 U.S.C. § 3101 (a) (2014).
[141] *Environmental Justice,* U.S. ENVTL. PROTECTION AGENCY, http://www.epa.gov/environmentaljustice/ (last visited Aug. 12, 2015).
[142] 5 U.S.C. § 552, *et seq*.

a. Generally any person, regardless of citizenship, can make a FOIA request.

b. Each federal agency individually processes its own FOIA requests. The federal agency will respond to requests with a letter, search for the requested information, and determine which parts and records can be disbursed.

c. FOIA does provide for the charging of certain types of fees in some situations, however, a fee waiver may be granted in situations in which the disclosure of the information is in the public interest.[143]

2. Federal agencies are required to disclose information unless it falls in one of nine exemptions. For example:

a. Information that is prohibited from disclosure by another federal law.

b. Trade secrets or commercial or financial information that is confidential or privileged.

c. Information that, if disclosed, would invade another individual's personal privacy.

d. Geological information on wells.

ii. Virginia Freedom of Information Act[144]

1. Public Records to be open to inspection; procedure for requesting records and responding to request; charges; transfer of records for storage, etc."[145]

2. Exclusions: Records relating to public safety, administrative investigations, records of specific public bodies, proprietary records and trade secrets, etc. [146]

[143] *Frequently Asked Questions*, FOIA.GOV, http://www.foia.gov/faq.html (last visited May 27, 2015).
[144] Code of Virginia § 2.2-3700, *et seq*., http://law.lis.virginia.gov/vacode/title2.2/chapter37/
[145] Va. Code § 2.2-3704.
[146] Va. Code § 2.2-3705. Please see specifics as contained in the statute.

Appendix I

I. Legal Issues: Public Infrastructure Working Group

A. Chair: RDML (ret.) Ann Philips

B. Legal Working Group Liaison: Mr. Joe Durant

II. Legal Issues: Private Infrastructure Working Group

A. Chair: Prof. Carol Considine

B. Legal Working Group Liaison: Speaker Pollard

III. Legal Issues: Land Use Working Group

A. Chair: Burrell Saunders

B. Legal Working Group Liaison: Speaker Pollard

IV. Legal Issues: Public Health Working Group

V. Legal Issues: Citizen Engagement Working Group

A. Chair: Chris Bonney

B. Legal Working Group Liaison: Lesa Yeatts, J. Duncan Pitchford

C. The White House has provided guidance on citizen engagement and key considerations that should be made in a document entitled, "Public Deliberation: A Manager's Guide to Civic Engagement."

Appendix II: Existing Studies and Bibliography

I. Existing Studies / Bibliography[147]

A. Federal Studies

i. U.S. Army Corps North Atlantic Comprehensive Study Report

ii. Future Federal Adaptation Efforts Could Better Support Local Infrastructure Decision Makers (Government Accountability Office (GAO)

iii. DoD Can Improve Infrastructure Planning and Processes to Better Account for Potential Impacts (Government Accountability Office (GAO).

iv. Congressional Research Service (CRS): Climate Change and Existing Law: A Survey of Legal Issues Past, Present, and Future

v. U.S. Army Corps Strategic Environmental Research and Development Plan (SERDP) Studies

B. State Studies

i. Recommendations of the Secure Commonwealth Panel

ii. General Assembly Commission on Recurrent Flooding

iii. VIMS 2013 Recurrent Flooding Report

iv. 2008 Governor's Commission on Climate Change Findings and Recommendations

v. Who is Doing What in Virginia? A Guide to Current Adaptation Efforts to Sea Level Rise and Flooding

C. Academic Studies and Reports: Georgetown Climate Center

i. Adaptation Tool Kit for Sea Level Rise

ii. Virginia Case Study: *Stemming the Tide How Local Governments can Manage Local Flood Risks*

[147] This is not an all-inclusive list, but serves as a representative sample of some of the studies that the Steering Committee and Working Groups may encounter.

APPENDIX D-4

Chart of Potential IPP Steering Committee Successor Entity Structure Options and Features

Chart of Potential IPP Steering Committee Successor Entity Structure Options and Features

Draft 5/23/16

Best viewed in hard copy when printed on 11x17 inch paper.

Potential Structure Options	Existing Legal Authority Sufficient to Organize	Use of MOU Sufficent to Organize	Would Result in Binding/Contractual Commitments/Obligations by/on Members	Localities in Advisory Role	Localities as Voting Members	State Government in Advisory Role	State Government as Voting Member	Federal Agency Stakeholders in Advisory Role	Federal Agency Stakeholders as Voting Members	Military Branch Stakeholders in Advisory Role	Military Branch Stakeholders as Voting Members	Private Sector in Advisory Role	Private Sector as Voting Members	NGO's in Advisory Role	NGO's as Voting Members	Able to Receive Federal Funding (Subject to Fed. Budget)	Able to Receive State Funding (Subject to State Budget)	Able to Seek and Accept Private Sector/Nonprofit Funding/Financing	Admin. Costs Funded by Member Voluntary Contributions	Admin. Costs Funded by Member Mandatory Contributions	Authority to Impose Service Fees on Public To Cover Admin. Costs	Authority to Impose Service Fees on Public To Fund Project Implementation Costs	Authority to Impose Special Assessments on Public to Fund Implementation Costs	Authority to Tax To Fund Project Implementation	Authority to Zone Land Use	Authority to Set Building Codes	Authority to Establish/Enforce Overlay Districts	Powers of Eminent Domain	Public Notice/Hearing Required for Certain Actions	**NOTES:** Items marked in orange require new (underlined) or supplemental/specific legislation (not underlined) by the General Assembly and/or Congress. Items marked in yellow require local action to create, approve or implement. **N/A = Not Applicable Y = Yes N = No O = Optional**
HRPDC with No Coordinated Locality Implementation	Y	N/A	N	N	Y	O	N	O	N	O	N	Y	N	Y	N	Y	Y	Y	Y	N	N	N	N	N	N	N	N	N	N	O	**Notes:** HRPDC leads planning and facilitates collaboration, and localities implement actions, but no agreed upon framework beyond current HRPDC authority. Some aspects could occur by formation of related nonprofit.
HRPDC with Localities As Coordinated, Designated Implementers	Y	Y	O	N	Y	O	N	O	N	O	N	Y	N	Y	N	Y	Y	Y	Y	N	N	N	N	N	N	N	N	N	N	O	**Notes:** HRPDC leads planning and facilitates collaboration and localities implement actions under voluntary, written framework that provides basic guidance and parameters. Some aspects could occur by formation of related nonprofit.
HRPDC - Planning, Facilitating, Funding and Implementing	N	N	N	N	Y	O	N	O	N	O	N	Y	N	Y	N	Y	Y	Y	O	O	O	O	O	O	N	N	N	O	O		**Notes:** HRPDC plans, facilitates ***and*** implements actions under expanded authority or by formation of related entity. Some aspects could occur by formation of related nonprofit.
Joint Exercise of Powers by Political Subdivisions, per Agreement (similar to Southeast Florida Compact)	Y	Y	O	N	Y	O	O	O	N	O	N	O	N	O	N	Y	Y	Y	O	O	O	O	O	N	N	N	O	N	Y		**Notes:** Per Va. Code section 15.2-1300, two or more political subdivisions may, by agreement, join together to carry out the powers and/or duties they are authorized and/or required to perform, subject to other statutory limitations.
Public-Private Partnership - General	Y	Y	Y	Y	Y	Y	O	O	N	O	N	Y	Y	Y	O	Y	Y	Y	Y	O	O	O	O	N	N	N	N	N	N		**Notes:** Could promote private sector management and financing.
Greater New Orleans, Inc. Urban Water Plan Model	Y	N	N	Y	Y	O	N	O	N	O	N	Y	Y	Y	Y	Y	Y	Y	O	O	N	N	N	N	N	N	N	N	N		**Notes:** A public-private approach with private sector led nonprofit recommending plans and standards for managing flooding issues. Local and regional governmental bodies can choose to adopt and implement recommendations.
Chesapeake Bay Watershed Agreement (2014) Model	Y	Y	N	O	N	N	Y	N	Y	O	O	O	N	O	N	Y	Y	Y	Y	N	N	N	N	N	N	N	N	N	N		**Notes:** Federal/State collaborative approach to research, policy, and best management practices pursuant to written, voluntary framework agreement. Decisions of body give technical credibility to and serve as guidance for federal, state, local and private sector actions.
Special Service District/Authority Created by General Assembly	Y	N	O	O	O	O	N	O	N	O	N	O	N	O	N	O	O	O	O	O	O	O	O	O	N	N	O	O	O		**Notes:** A separate political subdivision created by General Assembly to oversee and manage planning, financing and implementation.
Special Service District/Authority Created by One or More Localities	Y	Y	Y	N	Y	Y	N	O	N	O	N	O	N	O	N	Y	Y	Y	O	O	O	O	O	Y	N	N	Y	N	Y		**Notes:** A separate political subdivision created by participating localities to oversee and manage planning, financing and implementation.
State Agency With Regulatory Authority	N	N/A	N	N/A	N	N	Y	O	N	O	N	Y	N	Y	N	Y	Y	Y	N/A	N/A	O	O	N	N	N	O	O	O	N		**Notes:** Current or new agency granted authority by General Assembly to plan, facilitate, fund (or arrange for funds), and implement actions through regulation applicable to state agencies, localties and political subdivisions, and private sector parties.

APPENDIX E-1

Infrastructure Working Group Final Report

Infrastructure Working Group Final Report

COMMITTEE CHAIR(S) & AFFILIATION(S): **Ann C. Phillips, Rear Admiral, USN (Retired)**
CURRENT COMMITTEE MEMBERSHIP:

Name	Organization	*Position*	Email
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Guest Participants/Advisors:			
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Joe Bouchard, CAPT USN (Ret.) PhD.	12/2015 – 03/ 2016 BlueMoonFund 04-2016 – Present/Advisor	Fellow Private Citizen	*josephbouchard76@gmail.com*
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Ray Toll, CAPT USN (Ret.)	Old Dominion University	Convener	*rtoll@odu.edu*

MEMBERSHIP DEVELOPMENT/STAKEHOLDER ENGAGEMENT:

As a part of the formation of the Charter, a preliminary list of potential committee and working group members was developed and as working group and committee chairs came onboard, they were provided the tentative list of membership and contact information. The IWG Chair had some exposure to several of the names on the IWG list through previous and recent military service, and connections through other aspects of the community through recent community board membership. Other proposed members were contacted referencing the pilot effort by email or phone. No organization on the initial list declined to participate, but often there were several different participants or names offered until the final representative sorted itself out with time, or the appropriate job title or focus could be identified. Some organizations swapped out participants as time went on during the pilot project due to other work obligations.

The initial participation list for the IWG did not include any representatives from cities or municipalities (evaluated as a clear shortfall by the group) and these were sought during the 10 December, 2014 FEMA event, or through other group members. Initially the objective was that every city with near term sea level rise impact would have representation, but this was not feasible due to numbers and availability, so an effort was made to ensure representation from the cities with the most impact, and also that diversity of locale was represented within the IWG in that cities from both the "Peninsula" and from the "Southside" of Hampton Roads were included. Regional and Commonwealth public organizations with responsibility for infrastructure included Hampton Roads Planning District Commission (HRPDC), Hampton Roads Transportation Planning Organization (HRTPO), Virginia Department of Transportation (VDOT), and Hampton Roads Sanitation District (HRSD). Both Navy and Air Force included representation from their respective regional Engineering Commands. Naval Facilities and Engineering Command Liaison officers joined later in the process. The IWG was fortunate to be able to include representation from DOT, DOE and DHS and to continue with that representation throughout the project. Virginia Port Authority/Port of Virginia supported the IWG for Phase I of the Pilot, but due to personnel changes, only supported the Steering Committee for Phase II of the project, which was sufficient participation.

Norfolk International Airport declined to participate throughout the project. They were initially contacted by the PIC Chair during Phase I, and then contacted again, by the PIC, IWG and Legal Working Group during Phase II once the study area had been defined, which included their property,

and they again declined participation or even to accept a brief on the project. While this did not unduly impact the Pilot outcome it did present the unique circumstance of a quasi-public entity, publicly regulated and funded and under supervision of several federal, state and local agencies, most of whom were study participants (DOT, DHS, VDOT, City of Norfolk) vulnerable to sea level rise and storm surge impact over time, declining to participate in a regionally - sponsored project.

For perspective, the Private Infrastructure Advisory Committees' membership was developed from the Department of Homeland Security Critical Infrastructure Sectors list and that list and membership is found in the Private Infrastructure Committee Report Section. Some critical infrastructure sectors overlapped in committee membership and they are noted below:

- Defense Industrial Base: VA Maritime Association was on the PIC. Huntington Ingalls Industries was on Steering Committee
- Transportation Systems: Virginia Maritime Association was on the PIC, Port of Virginia was on the Steering Committee, Virginia Department of Transportation, Hampton Roads Transportation Planning Organization were on the IWG

In addition the following is a summary of critical infrastructure sectors and their members included on the IWG:

- Government Facilities: Naval Facilities Engineering Command, Joint Base Langley-Eustis, Navy Region Mid-Atlantic, Joint Expeditionary Base Little Creek/Fort Story, US Army Corps of Engineers City of Norfolk, City of Virginia Beach, City of Hampton, and City of Newport News
- Sector Specific Agencies: DHS, DOT, DOE, HRPDC, HRTPO, HRSD, VDOT
- Transportation Systems: Port of Virginia on Steering Committee, VDOT, HRTPO on IWG
- Water and Wastewater Systems: HRSD, Cities of Norfolk, Virginia Beach, Hampton, Newport News

SUMMARY/SCOPE OF WORK:

The Infrastructure Working Group derived its initial task list from the Charter and modified it over time to meet practicable goals and objectives, as well as to add additional requirements where they became apparent. Once the PIC stood up, the IWG coordinated goals, objectives, scope of work and tasks with the Private Infrastructure Advisory Committee as envisioned in the Charter.

IWG tasks and objectives in Phase II were modified to include those tasks still outstanding after Phase I, plus include additional tasking necessary to continue to meet the Charter's Goals and Objectives for the Pilot Project.

IWG Objectives Phase 1

1. Ensure appropriate agencies and organizations are represented in the IWG. *This effort was ongoing throughout the Pilot, to ensure membership supported expertise and areas included in the IWG's work.*
2. Address and identify representative studies that address SLR critical infrastructure protection as applicable to the Hampton Roads region. Further expand this effort to include studies done in

support of other regional efforts, nationwide, and internationally if appropriate, to glean any supporting information that pertains to this effort.

3. Identify and obtain access to modeling and simulation efforts that may support, and or have already been developed in support of SLR impact, in particular as related to identification of and planning to protect, build resiliency, and where practical, quantify efforts to prioritize planning and protection of critical infrastructure across the HR region.
4. Identify and prioritize Sea Level Rise-vulnerable critical infrastructures in the Hampton Roads region. (*Not possible in the scope and timeline of the pilot effort; descoped to selection of a specific study area, and understanding of critical infrastructure within that study area.)*
5. Understand critical dependencies and interdependencies impacting these infrastructures. *(Shifted to Phase II of the Pilot.)*
6. Determine those with the greatest impact to the most municipalities, and federal, state, and local agencies, and make recommendations to the Steering Committee as to which of those infrastructures might be best suited to adaptation planning (for Phase II) at a regional level to ensure future resiliency. *(Restructured to selection of a study area that would drive a set of key criteria selected by the IWG that would best represent the challenges of adaptation and resiliency planning between cities, municipalities and federal or state entities.)*
   6.1. Working with the Private Infrastructure Advisory Committee, consider privately owned utilities in this prioritization effort where they impact resiliency of public infrastructure.
   6.2. Working with the Private Infrastructure Advisory Committee, consider other private infrastructure, vulnerable to Sea Level Rise, that should be considered as critical to the HR Regions, and thus be suitable for private adaptation planning.
7. Determine restrictions and limitations, be they administrative, managerial, jurisdictional or legal, to regional adaptation planning, and, formulate recommendations, in coordination with the Legal Working Group and other working groups and committees to address /resolve/modify those restrictions.
8. Develop POAM for Phase II of the Pilot Project to affect adaptation planning to address SLR impact on selected infrastructure/s/.
9. Finally, it was understood that the time and fiscal restrictions of this pilot project may limit some of what was planned to accomplish. The IWG's goal was to make proposals that could most reasonably be addressed within the time and resource constraints and restraints in place, as thoroughly as possible, while meeting the spirit and intent of the project.

<u>IWG Objectives Phase II</u>

1. In lieu of identifying and prioritizing critical infrastructures within the Hampton Roads Region considered vulnerable to Sea Level rise in total, (from Phase I Objectives) the IWG determined to select vulnerable critical infrastructure or critical infrastructure as suitable for adaptation planning and that would meet the largest number of pre-determined criteria, as determined by the IWG, to support the goals and objectives of the Pilot Project. *Identification and prioritization of regional infrastructure, deemed critical or vulnerable, and impacted by sea level rise, should be done at a region -wide level, but it was beyond the abilities of this working group to accomplish this significant and time-consuming task.*

2. Identify by latitude/longitude, and appropriate grid maps of watershed, or other appropriate identification methods, the exact geographical area included in the study area selected.
3. Once identified, complete GIS mapping of all selected SLR planning scenarios. While all may not be used in the final planning process, all should be completed to a reasonable degree of fidelity so that those scenarios that are used can be chosen and described appropriately.
4. Identify critical infrastructure impacted in the region selected, by city, or region. This task was later modified to focus on the DHS determined critical infrastructure within the Study Area selected. Critical determination was done using DHS criteria and data (Department of Homeland Security Critical Infrastructure Sectors (https://www.dhs.gov/critical-infrastructure-sectors), as well as by soliciting input from the cities, municipalities and federal agencies with infrastructure within the study area. Of note, one Federal/State/Local agency within the study area, Norfolk International Airport, declined to participate in the study.
5. Identify critical dependencies/interdependencies between critical infrastructures, utilities, public and private, within the study area.
6. Identify data and knowledge gaps in regard to dependencies and interdependencies that might impact the decision making process in regard to resiliency, adaptation, or other planning decisions. (Example: finished floor elevations of building infrastructure).
7. Identify legal and policy gaps or impediments to planning and future execution. Focus on areas in particular between public and private planning entities, and between federal, state and local planning entities.
8. Develop a methodology and recommended template for planning such activities, including a checklist of recommendations and lessons learned, that can be implemented by other communities working with similar challenges.

MEETING SCHEDULE/INTERACTION OF THE WORKING GROUP/COMMITTEE:

The first meetings of the IWG were via phone conference 14 and 19 November 2014 in preparation for the 2 December 2014 FEMA Table Top event held at ODU. The first in-person meeting of the group was at the FEMA Table Top event, and the group met monthly starting in January of 2015. Meetings typically lasted for 2 hours. While this may seem long, as the IWG grew and participants gained an interest in the outcome of the Pilot Project, it was essential that everyone had time to speak or offer an opinion and to do this required a two hour meeting. As the group worked through objectives, tasks and other requirements for the Pilot Project, there were often phone calls or email exchanges between members of the group and the Chairman. Further, as some of the initial tasks were to seek out and review any existing studies in regards to sea level rise impact on the Hampton Roads region or elsewhere that may be pertinent due to methodology or for other reasons, various group members would find studies of interest to the others, and forward them, or articles or other publications pertaining to sea level rise to the rest of the group. The IWG was fortunate that the Center for Sea Level Rise was able to assist with securing conference room meeting space in their building at 4111 Monarch Way, which greatly facilitated regular meeting opportunities.

Presentations made to the Infrastructure Working Group:

Title: Gulf Coast II Study, Phase 2 – Engineering Analysis and Assessment–

Presenter: Jake A. Keller, LS, PPM, PPA (Principal PM, Principal Professional Associate)
Vice President
National Technical Director of Civil Engineering
Parsons Brinkerhoff
277 Bendix Road, Suite 300
Virginia Beach, Virginia 23452

Date: May 11, 2015 IWG Meeting
File Name: FHWA-HEP-15-04.pdf

Summary: Impacts of Climate Change and Variability on Transportation Systems and Infrastructure: The Gulf Coast Study, Phase 2, Assessing Infrastructure for Criticality in Mobile, AL, Task 3.2: Engineering Assessments of Climate Change Impacts and Adaption Measures, Prepared for The U. S. DOT Center for Climate Change and Environmental Forecasting, Prepared by Parsons Brinckerhoff and IC International, FHWA-HEP-15-04, August 2014. Outlined the eleven step adaptation approach or engineering assessment process used by Parsons Brinckerhoff to conduct the analyses, in particular to approach outcomes for specific critical infrastructure sites. The assessment included specific case studies for selected critical infrastructures that can serve as examples of not only how to conduct the eleven step process, but include descriptions of the methodologies used to conduct the assessment, an understanding of the assets' vulnerability, and lessons learned from the effort. Of note, the analyses also included climate impact and planning (conducted by ICF International)

Title: Hampton Roads RRAP

Presenter – Rob Mooney, DHS Southeast Virginia Regional Representative
Date – 21 January, 2015
File name – N/A Not authorized for open source media release.

Summary: Agent Mooney reviewed the objectives of the RRAP program overall, and the specific items addressed in the Hampton roads, RRAP. He emphasized the interest in critical infrastructure, much of which is Protected Critical Infrastructure Information and as such cannot be presented in an open source environment. The Hampton Roads RRAP looked at critical infrastructure from the perspective of any threat to that infrastructure, and while sea level rise is included in that review, it is not necessarily the most critical threat in every case. For additional details on the specific threats presented in the overall analysis of this particular study IWG members had to qualify for and then complete the requirements to be granted PCII access. While the State of Virginia was very helpful in working through this process, by the time the process was finished for those group members who could qualify for it, the need had diminished, and the group determined that as PCII information could not be included in any final report, the specific access was not required, in lieu of an understanding of how the data was collected and analyzed by Argonne Labs for DHS, and the types of data included, rather than the specifics of data as analyzed for this particular RRAP study, which could not be included in any final report. IN addition, The DHS Office of Cybersecurity and Infrastructure Analysis (aka "OCIA") and Pacific National Laboratory (PNL) collaborated on the *Norfolk, Virginia Sea Level Rise Analysis Report,* completed in July 2016, and this year, OCIA and PNL have been conducting a follow-on study, an analytic and modeling effort to examine the potential impact to Naval Station Norfolk resulting from a Category 3 hurricane and a significant storm surge to include potential impacts

resulting from projected sea level rise conditions over a 20 and 50 year timeframe. The study will examine multiple critical infrastructure sectors, but several DHS partners, to include the U.S. Navy, have requested that they closely examine the potential impact of the hypothetical scenario within the Transportation Sector. DHS expects this follow-on study to be published by the end of 2016.

Title: Gulf Coast Study Phase 2. Identifying Critical Transportation Assets in Mobile, Alabama.

Presenter: Ms. Cassie Baht -Snow, ICF International
Date: 15 June 2015
File name: 2014-06 Gulf Coast 2-TASK 1- Identifying Critical Transportation Assets 15 Aug 2016

Summary: Ms. Baht discussed the specific methodology development for the GC II Study, Phase 2 Criticality Assessment, and how that methodology was implemented during the course of the GC II work, specifically, how the ability to prioritize critical transportation infrastructure was determined and executed. Each transportation mode (there were 6: air, transit road, highway, rail, pipeline, ports) was evaluated based on criticality categories, (Connections, Purpose, Function) and then further evaluated based on 3 key considerations, (Operational, Health and Safety, and Socio-economic). Each Key Consideration was then broken down into additional related sub considerations - which were then placed into a table with the considerations and sub considerations across the top and the specific facilities (provided by the City of Mobile) down the side. This allowed the ability to delineate important assets, develop a scoring summary to help prioritize those assets based on known data (with "good engineering judgment" applied to fill in data gaps) and come up with an organized quantitative criticality assessment comparison across each transportation mode. *This level of detailed analysis would be essential to the Hampton Roads Region developing its own critical infrastructure prioritization across the region, but that task was beyond the scope and abilities of the Infrastructure Working group and in fact the IPP*.

Title: Climate Change Adaptation Capabilities

Presenter Alan Strasser, DOT representative to the IWG
Date: March 13, 2015
File name: N/A

Summary: Argonne National Laboratory supports Department of Homeland Security and Department of Energy with scientific data and analysis capabilities. In particular, they did the data analysis for the Hampton Roads RRAP and other significant studies. This presentation discussed their processes and methodologies for conducting the analysis related to the RRAP study, without disclosing specific PCII details of that study. The intent was to give the IWG a better understanding of the analysis capabilities resident in the Argonne laboratory and also to understand how those analytic capabilities could be brought to bear in support of analysis to better understand the impact of sea level rise on critical regional infrastructure. The brief particularly called out the need for high resolution scenario data to justify starting adaptation projects, and further called out the knowledge that critical infrastructure impacted by sea level rise existed in most sectors, and the barriers to adaptation to prepare that critical infrastructure for the future exist at the federal, state and local levels of government.

Title: North Atlantic Coast Comprehensive Study Overview

Presenter – Michelle L. Hamor, US ARMY CORPS of Engineers, Norfolk District, Chief, Flood Plain Management Services
Date: 13 February 2015
File name:
<http://www.nad.usace.army.mil/Portals/40/docs/NACCS/NACCS_main_report.pdf>

Summary: Ms. Hamor briefed the group using the initial summary overview provided with the USACE release of the NACCS study. This high-level overview discussed the findings of the study, and in particular the attention paid to outlining mitigation strategies for coastal regions to better prepare them to sustain a significant storm. Adaptation and resiliency measures considered included a variety of strategies and structures from hardened engineering resources, to natural shoreline enhancement and development. Each region of the Hurricane Sandy impacted area coastline was evaluated and additional adaptation opportunities to further improve existing shoreline structures proposed. In addition, several areas were selected for additional detailed engineering study, largely based on work already in progress. Norfolk, Virginia was one of the areas selected, and the work done by engineering firms at the request of the City of Norfolk was evaluated by USACE and included in the study as adaptation measures suitable for consideration.

Title: Sea Level Rise and Recurrent Flooding Response Plan, Analytic Framework, Federal Highway Administration

Presenter: Alan Strasser
Date: 8 November, 2015
File name: Not Applicable

Summary: This brief discussed the process FHWA uses to assess sea level rise and storm surge impacts to its critical infrastructure and determine methodologies for adaptation planning for that infrastructure. The process includes Scenario development, Hazard and Data Mapping, Vulnerability and Risk Assessment, and the development of a Risk Portfolio, which is then weighted, prioritized, and planned towards. The brief also included the FHWA process for impact/criticality assessment, and a discussion of the weighting scale used to demonstrate relative impact of assets against one another. This process could also be used in future studies to identify, determine, define, assess, and prioritize overall infrastructure criticality for the Hampton Roads Region.

Title: **Potential Exposure of Energy Assets in the Norfolk Metropolitan Statistical Area to Sea Level Rise and Storm Surge**

Presenter: Alice Lippert. Senior Technical Advisor, Sustainable Energy, Department Of Energy
Date: 05 June 2015
File name: <http://www.energy.gov/sites/prod/files/2014/10/f18/DOE-OE_SLR%20Public%20Report_Final%20_2014-10-10.pdf>

Summary: This memorandum summarized the work of the Energy Infrastructure Modeling and Analysis Division (EIMA) of the US Department of Energy's Office of Electricity Delivery and Energy Reliability, and assessed the potential exposure of energy facilities in the Norfolk Metropolitan Statistical Area to both sea level rise and storm surge at higher sea levels. The analyses focused on risk levels at 2050 and 2100, and included over 160 energy assets in the area studied - including electricity assets (power plants and substations) , natural gas (storage and pipelines) , and petroleum assets (terminals, refinery and pipelines.)

The analysis indicated that under the National Climate Assessment Intermediate -High scenario (1 foot of inundation by 2050) , none of these assets would be significantly impacted, but that 1 foot of SLR plus a Category 4 Storm Surge would inundate large and critical electricity, petroleum and natural gas assets. By 2100 under the NCA Intermediate- High scenario, with 5 feet of SLR, the SLR alone would inundate significant assets, and a Category 1 storm on top of the SLR inundation would create even more extensive inundation of these critical assets.

Title: National Institute of Standards, Community Resilience Planning Guide for Buildings and Infrastructure Systems.

Presenter**: Carol Considine, Associate Professor, Old Dominion University**

Date: 07 December 2015

File name: <http://www.nist.gov/el/resilience/draft-community-resilience-guide.cfm>

Summary: The NIST Community Resilience Planning Guide is designed to assist communities in their whole community preparedness preparations, in prevention, protection, mitigation, response and recovery from those threats and hazards that pose the greatest risk to the individual communities. A part of the preparation process includes identifying and understanding dependencies and interdependencies of systems, across the full spectrum of community wholeness. This brief, using the NIST Guide as its template, described a potential process to use for the purposes of the IPP to accomplish the IWG and PIC tasking of understanding dependencies and interdependencies of critical infrastructures and systems within the Pretty Lake Study area. The NIST Vol II, Chapter 10, Dependencies and Cascading Effects, shows and describes one methodology for tracking and understanding how infrastructure internal and external dependencies for a specific segment of critical infrastructure could be shown and understood. *While an effective method for mapping these dependencies, ultimately, the PIC and IWG determined this method to be too complex for the need and time available to both working groups, and so used a version of this template matrix, combined with the Gulf Coast II study matrix process to create its own matrix that could be evaluated within the context of the working group efforts. This matrix is referenced in the PIC report and the Pretty Lake Case Study sections of the IPP report.*

Title: RC 1701 , Risk Quantification for Sustaining Coastal Military Installation Asset and Mission Capabilities (RC-1701), Final Report, Submitted to The Strategic Environmental Research and Development Program (SERDP), Submitted by U. S. Army Engineer Research and Development Center, 6 June 2014

Presenter: (Author) Kelly A. Burks-Copes, Ph.D.
U. S. Army Engineer Research and Development Center
Vicksburg, MS 39180

Date of Discussion: This study was not formally presented to the group but was often referenced in ongoing efforts to better understand the impact of sea level rise on federal, and in particular, military installations within the Hampton Roads Region supporting both Phases of the IPP and the Little Creek / Pretty Lake Case Study.

File name: RC_1701_Final_Report.pdf <https://www.serdp-estcp.org/Program-Areas/Resource-Conservation-and-Climate-Change/Climate-Change/Vulnerability-and-Impact-Assessment/RC-1701>

Title: Multiple: Preliminary Engineering Feasibility Report Pretty Lake Watershed, City of Norfolk City-Wide Flooding Contract, Work Order No. 2

Presenter: John White, Senior Storm Water Engineer, City of Norfolk

Date: 10 August 2015

File name: <http://www.norfolk.gov/documentcenter/view/1776>

Summary: This work was done by engineering firms in support of the City of Norfolk to achieve a 10% level of effort and engineering design on a potential gate structure (and alternatives) to reduce flooding of the Pretty Lake area from storm surge and high tides upstream of the Shore Drive Bridge.

Mr. White spoke to the IWG about the challenges of flooding in the Pretty Lake area, and how that flooding had continued to worsen over the years to the point that the City included this area on its list of priorities for recurrent flooding and storm surge adaptation and reduction. The 10 % level of effort work was done to consider the adaptation measures most suitable for preventing back flooding and storm surge into the largely residential area. It included cost estimates and feasibility studies for the types of structures most suitable for closing the inlet to Pretty Lake, as well as raising additional road bed structures in the area to prevent flooding access via those low lying areas. Because of its proximity to JEBLCRK and the City of Virginia Beach which each share watersheds that drain into Little Creek from other sources, this area was chosen by the IWG as its study area for the purposes of understanding the nature and challenges of regional coordination required to solve this problem with the goal of determining the best possible outcome for both of the cities and the Federal facility.

STRATEGY:

The IWG worked to follow direction in the Charter to determine its initial goals and objectives. The IWG first developed a Mission Statement, shown below, and then as derived from the Charter and also took from specifically delineated Infrastructure Working Group depiction in the Charter page 3, developed the first of the Objectives/Deliverables for Phase I and II of the Pilot project. (Shown in Summary/Scope of work).

Infrastructure Working Group MISSION STATEMENT
" The Infrastructure Working Group, in supporting the Hampton Roads Sea Level Rise Preparedness and Resilience Intergovernmental Planning Pilot Project Steering Committee, will review critical infrastructures in the Hampton Roads region, determine which are most suited to and will be most positively affected by adaptation planning, and make recommendations to the Steering Committee for intergovernmental coordination of that planning. The IWG will further coordinate with the Private Infrastructure Advisory Committee, to formulate recommendations to coordinate with privately owned infrastructure planning."

The first Phase of the Pilot project for the IWG focused on gathering and understanding the body of work in the form of studies and other documentation that addressed sea level rise in the Hampton Roads region, or was related to sea level rise in the region, or was related to sea level rise in other regions in a manner that may be useful to the IWG in determining and discovering deliverables as aligned with the goals and objectives of the pilot project. As studies were determined to be of particular interest, the IWG arranged opportunities to learn more about their specific objectives through on site briefs, or through phone briefs or other contact with the authors of the work in question. The IWG was also looking for methodologies used in other projects that might be of use in making decisions for this project, and so also investigated areas of interest in that regard as such opportunities presented themselves. Once study and methodology review was completed (with due consideration for other studies that completed during the two years of the IPP) , the IWG turned its attention to understanding how to best select critical infrastructure, or critical infrastructures that would be suitable for Phase II study.

During Phase II of the Pilot the IWG selected sea level rise scenarios for study that were suitable for consideration for the potential study areas once selected, and that represented feasible challenges to sea level rise, and resiliency and adaptation planning for the Hampton Roads Region. Using methodology from the DOT sponsored Gulf Coast II study, the IWG created its own matrix of selection criteria to select an appropriate study area and solicited input from within the Working Group for

areas that might be suitable and that were vulnerable to sea level rise impact under the scenarios chosen. The IWG then weighted those scenarios and vote on a selection that received the highest overall grade. The area chosen was the Pretty Lake/ Little Creek region, which included territory from the Cities of Norfolk, Virginia Beach and the Department of Defense Joint Expeditionary Base Little Creek/Fort Story. In coordination with the PIC, the IWG then worked to identify critical infrastructure within the study are selected (using DHS Critical Infrastructure Taxonomy Criteria) and evaluated dependencies and interdependencies of this infrastructure using a matrix development process in coordination with the PIC. Once dependencies and interdependencies were evaluated, the IWG considered challenges and impediments to adaptation planning and made recommendations to facilitate intergovernmental coordination of that planning.

DELIVERABLES PLANNED (Phase 1 & 2): (See Summary/ Scope of Work)

DELIVERABLES ACCOMPLISHED/NOT ACCOMPLISHED:

The most significant change to deliverables for both Phase I and Phase II was the decision not to attempt to identify and prioritize all critical infrastructure within the Hampton Roads Region that was vulnerable to sea level rise. While such a detailed criticality analysis is absolutely essential to help the region understand and prioritize regional resiliency, adaptation and planning strategies, it was beyond the scope and abilities of the IWG in the time allotted to execute such a task. Instead, the IWG selected, from a pool of potential vulnerable areas within the region as brought forward by the IWG membership, an area of critical vulnerability that best exemplified the critical impediments and challenges to regional whole of government adaptation planning, and tailored deliverables to be specific to that case study area.

Other minor edits and modifications to deliverables were made during the course of the Pilot to allow the IWG to move forward or to scope a task appropriately. A specific Plan of Action and Milestones (POAM) for Phase II was not created (a deliverable from Phase I), in lieu of a running list of tasks promulgated and updated with each set of meeting minutes. The IWG also considered the review of resiliency planning documents completed by other regions in the Unites States that was initiated by the PIC, most specifically of South Florida and New Orleans regions, and with the PIC, unanimously approved a list of recommended actions and processes adaptable to and suitable for near term implementation the Hampton Roads Region, and further made mention of many of the adaptation strategies therein in its list of final recommendations from the Pilot. The list of recommended actions can be found in the PIC section of the IPP report, in the IWG list of references, and the Little Creek / Pretty Lake Case Study , Appendix {XX} of this report.

DELIVERABLES:

As discussed in the Summary and Scope of Work, Deliverables from the IWG were drawn from the Charter, and in some cases interpreted from larger overall goals and objectives for the Pilot Project. Phase 1 focused on discovering, collating and reviewing studies related to the impact of sea level rise on the Hampton Roads region in any area of focus (transportation, military use, as examples) and base-lining the body of knowledge of the working group on those studies and the topic. The group then considered methodologies, models, matrices used in the studies in question, or in other reference documents, to understand which of them might be useful in assisting in prioritizing regional critical infrastructure impacted by sea level rise.

In Phase II the IWG finalized the selected area of the region that best exemplified the challenges of whole of government planning on a scale suitable for accomplishing IPP objectives. It then used DHS Critical Infrastructure definitions (Homeland Security.gov, *Infrastructure Data Taxonomy-Version 4*, February, 2011), with the help of the IWG DHS Representative to gain access to what was considered critical infrastructure within the selected Little Creek / Pretty Lake area. The IWG further identified specific sea level rise scenarios, using NOAA/National Climate Assessment scenario curves as modified by VIMS, (See Page 27 of this report), and with assistance from HRPDC developed GIS mapping representations of the impact of the selected curves on the Pretty Lake /Little Creek area. They then, in coordination with the PIC, developed and completed infrastructure dependency/interdependency matrices to gain insight into critical aspects of regional infrastructure and the interconnected requirements for functionality. Once this was complete, the IWG selected which areas within the study region were considered most critical by the cities and federal agencies, and considered planning process actions and limitations to those actions that might require modification to facilitate achieving a whole of government planning process for regional sea level rise adaptation.

IWG Deliverables by Task for Phases I and II

- Identify representative studies that address SLR critical infrastructure protection as applicable to the Hampton Roads region. Further expand this effort to include studies done in support of other regional efforts, nationwide, and internationally if appropriate, to glean any supporting information that pertains to this effort.
    - The IWG reviewed studies as listed in the Key Resources and Literature section of this report.
    - A number of excellent studies have been completed by HRPDC and HRTPO and the Army Corps of Engineers in reference to regional sea level rise impact, impact on transportation, and impact on military transportation. Further, the Department of Transportation, Sandia National laboratory, Argonne National Laboratory, The Volpe Center, Oak Ridge National Laboratory, and the Army Engineer Research and Development Center have also completed noteworthy studies on specific aspects or area of the region, and several cities and municipalities have done or are in the process of executing their own analysis with the assistance of engineering firms.
    - Specific studies of particular interest were briefed to or discussed by the IWG as a part of its meeting process, and are identified in the Presentations Made to the IWG section of this report.
    - While the majority of these studies document very clearly the impacts of the pending inundation effects of sea level rise, recurrent flooding and storm surge on the Hampton Roads or other regions, very few of them (other than the DOT Gulf Coast I and II work focused specifically on transportation prioritization in the Mobile, AL, area) attempt to categorize infrastructure or project priorities, or identify regional adaptation and resilience solutions and opportunities on any other than a very high level and generic basis.

- Identify and obtain access to modeling and simulation efforts that may support, and or have already been developed in support of SLR impact, in particular as related to identification of and planning to protect, build resiliency, and where practical, quantify efforts to prioritize planning and protection of critical infrastructure across the HR region.
    - DOE has done modeling work for the City of Norfolk, and has also worked with the City of Virginia Beach in planning and modeling power resiliency. They shared this work with the Pilot project, updated with the best available information in a releasable form. This work was briefed to the IWG and PIC chairs, along with the DOE reps by Dominion power. (Lippert, A., U.S. Department of Energy, *Potential Exposure of Energy Assets in the Norfolk Metropolitan Statistical Area to Sea Level Rise and Storm Surge*. September, 2014)
    - DOT Gulf Coast II study contained a number of methodologies that could be of use in determining an infrastructure prioritization processes. The IWG reviewed and learned more about this work through two separate briefs given to the committee by representatives from Parsons Brinckerhoff and ICF International Most of the templates are available on line for use (**http://www.fhwa.dot.gov/environment/climate_change/adaptation/ongoing_and_current_research/gulf_coast_study/phase2_task3/task_3.2/index.cfm** , but the decision matrix used to select the most critical and vulnerable infrastructures for the GC II study work is not available publicly in an interactive version. The IWG reproduced that matrix in its entirety with the intent to of modifying it for IWG use in selecting an appropriate study area, but determined that the use of the entire matrix was too complicated to be completed in the time and with the available resources and so was descoped for use in selecting the pilot's study area for the IWG.
    - Many other modeling efforts were discussed in the course of gaining insight into the studies in question - none were suitable for use by the Pilot project in the time allotted and with the resources available but could be of use in more detailed future study efforts**. Specific modeling templates that were of particular interest and applicability included:**
        - **National Institute of Standards Resiliency Planning Guide Dependency/ Interdependency matrices**
        - **Gulf Coast I and II Study decision matrices**
        - **Hampton Roads Transportation Planning Organization Decision Planning Tool**
        - **Federal Highway Administration Analytic Framework.**

- Identify and prioritize Sea Level Rise-vulnerable critical infrastructures in the Hampton Roads region. (*Not possible in the scope and timeline of the pilot effort: descoped to selection of a specific study area, and understanding of critical infrastructure within that study area.)* Determine those critical infrastructures with the greatest impact to the most municipalities, and federal, state, and local agencies, and make recommendations to the Steering Committee as to which of those infrastructures might be best suited to adaptation planning (for Phase II) at a regional level to ensure future resiliency . *(Restructured to selection of a study area that would*

drive a set of key criteria selected by the IWG that would best represent the challenges of adaptation and resiliency planning between cities, municipalities and federal or state entities.)

- The IWG worked to gain insight into what DHS and the Commonwealth of Virginia considered as critical infrastructure within the region, both of which presented challenges for different reasons; the State of Virginia information was out of date, and the initial request for DHS information required access to protected critical infrastructure information, (PCII) which required vetting of committee personnel for access. Further, access to PCII required personnel being a non-private-infrastructure employee, (federal, state, local, and academia could be considered for access – but academia had to be directly related to the Pilot effort), and then required completion of a series of courses to ensure proper handling of material. Several of the committee members were able to complete the course work and gain access, but by the time the process was completed the need was no longer critical as the information required had been acquired by other means, and the IWG had determined that a full analysis and prioritization of regional critical infrastructure was not feasible within the confines of the pilot project.
- As stated above, this task was re-scoped to support prioritization of areas within the region that contained critical infrastructure, that were susceptible to recurrent flooding, sea level rise and storm surge, and that would include more than on city or municipality and some level of federal infrastructure, which would make them good candidates for understanding the challenges, impediments, and needs to facilitate whole of government and community resiliency and adaptation planning.
- After reviewing potential candidate area submitted by the IWG, and developing prioritized matrix criteria, the IWG weighed each area against the criteria selected and chose the best option as the area meeting the most criteria, in support of the Pilot Project's objectives.
- The area selected was not the most critical infrastructure in Hampton Roads, nor was it the most vulnerable, but, it included:
    - More than one city or municipality, and a federal agency, (actually more than one Joint Expeditionary Base Little Creek / Fort Story (JEBLCRK) and the Norfolk International Airport)
    - While not a defining characteristic, also Included a , a natural historic area (the Norfolk Botanical Gardens)
    - Contained a wide variance in economic, racial, social and private infrastructure demographic characteristics
    - Was similar in size, scope and challenge to other efforts underway within regional cities and municipalities
    - Had a 10% level of engineering effort study already completed and verified by one of the cities involved, and the US Army Corps of Engineers
    - Had the added challenge of being an area where the solution for an individual city or federal agency, if acted upon alone, would negatively impact the other two entities.
    - (Note: In the original intent for this identification of a study area for Phase II of the Pilot, the selection was to be determined by the Steering Committee. As the

steering committee was not actively engaged in the pilot project when the timeline was reached, the IWG and PIC chose to proceed with the areas chosen in the interest of moving forward with the Pilot process. They were later joined by and worked with other working groups and committees on the selected study area to complete the IPP objectives.)

  - During Phase II of the IPP, once the study area was selected, the DHS Rep to the IWG was very helpful in supporting access to critical infrastructure information for the study area, using DHS taxonomy, that was accessible and at a suitable level access to be of use in identifying adaptation processes and conducting dependency/interdependency analysis.

- Identify critical infrastructure impacted in the region selected, by city, or region. This task was later modified to focus on the DHS determined critical infrastructure within the Study Area selected.
  - Critical determination was done using DHS criteria and data (Department of Homeland Security Critical Infrastructure Sectors (https://www.dhs.gov/critical-infrastructure-sectors), as well as by soliciting input from the cities, and federal agencies with infrastructure within the study area.
  - Again, one Federal/State/Local agency within the study area, Norfolk International Airport, declined to participate in the study.
  - The Cities of Norfolk, Virginia Beach, and the Navy, (Naval Facilities Engineering Command) further identified areas of infrastructure (at an unclassified level) within the study area that they felt were critical and vulnerable. They were:
    - Little Creek Channel
    - Shore Drive Bridge
    - Weir to Lake Whitehurst
    - Weir to Little Creek Reservoir
    - Weir to Lake Bradford/Chubb Lake
  - In addition, once the initial dependency and interdependency matrices were completed, the Virginia Department of Transportation, Hampton Roads Transportation Planning section provided road inundation vulnerability maps for each watershed, showing the impact of from 1 to 6 feet of inundation. (VDOT, 2016, as found in the Little Creek / Pretty Lake Case Study Appendix E-4) This inundation was not specific to sea level rise or storm surge impact, but could be caused by recurrent storm water flooding, tidal flooding, or major weather event inundation. These inundation vulnerability maps are consistent with recent Hampton Roads Transportation Planning Organization studies (Belfield, HRTPO 2016) and with the IWG and PIC participants' best estimates of transportation impact as a dependency or interdependency under the scenario conditions outlined above and shown in the PIC and IWG dependency/Interdependency matrices referenced in the Little Creek / Pretty Lake Case Study (Appendix E-4) and in the Private Infrastructure Advisory Committee section of the final report.

- Identify by latitude/longitude, and appropriate grid maps of watershed, or other appropriate identification methods, the specific sea level rise scenarios to be used for adaptation planning for the study area chosen by the IWG.

- Identify the exact geographical area included in the study area selected (Shown in detail in the Little Creek / Pretty Lake Case Study Technical Report, Appendix E-4 and E-5).
- Once identified, complete GIS mapping of all selected SLR planning scenarios. While all may not be used in the final planning process, all should be completed to a reasonable degree of fidelity so that those scenarios that are used can be chosen.
- The following language was selected and approved by the IWG in support of the Sea Level Rise planning scenarios chosen:
    - ***"The infrastructure Working Group and Private Infrastructure Advisory Committee will evaluate the impacts of relative sea level rise scenarios of 1.5 feet and 3 feet on selected infrastructure in Phase II of the pilot. In addition, they will consider the impact of a "100 year flood" or the flood having a 1% chance of being equaled or exceeded in any given year on these two scenarios."***
    - Details on the scenario determination process can be found in the Case Study Selection section of this report (Pg. 21) .

- Identify critical dependencies/Interdependencies between critical infrastructures, utilities, public and private, within the study area, including critical dependencies and interdependencies impacting these infrastructures.
    - The PIC developed a matrix process, derived from the IWG review of the Gulf Coast II study and the PIC review of the NIST Resiliency Guide to map internal and external dependencies for critical infrastructure in the case study area. Both the PIC and IWG worked through these matrices for both public and private infrastructure included in the study area, with the Cities of Norfolk and Virginia Beach and the Navy (NAVFAC) supporting matrix completion for the study area from the IWG. The results of this work, and the matrices produced are detailed in the PIC section of the IPP Phase II report and in the Little Creek / Pretty Lake Case study found in Appendix E-4
- Identify data and knowledge gaps in regard to dependencies and interdependencies that might impact the decision making process in regard to resiliency, adaptation, or other planning decisions. (For example; understanding and documenting finished floor elevations of building infrastructure.)
    - While all cities and municipalities in the Hampton Roads region must meet at a minimum, the standards of the current Flood Risk Management Standard (FFRMS) Program for projects that include federal funding for future building in and affecting floodplains, they are able to and do make modifications of their own to local building codes and other standards, such that a common standard does not exist across the region.
    - In working through the Case Study area, it further became known that not all federal agencies have finished floor elevations of their buildings recorded and documented.
    - Further, "in implementing the standard," the FFRMS allows federal agencies to "select one of three approaches for establishing the flood elevation and hazard area they use in siting, design and construction" – shown below. This could also lead to differing adaptation strategies among the multiple federal entities in the region.
        - Utilizing best-available, actionable data and methods that integrate current and future changes in flooding based on science,

        - Two or three feet of elevation, depending on the criticality of the building, above the 100-year, or 1%-annual-chance, flood elevation, or
        - 500-year, or 0.2%-annual-chance, flood elevation.
    - Regional definitions of criticality and vulnerability of buildings and infrastructure appear to differ at the State and Local levels.
    - For this region to facilitate a coordinated regional approach to adaptation planning, the IWG recommends that federal, state and local agencies and authorities should select a common standard methodology from among those listed in the FFRMS to ensure consistent standards across the region.
    - Further, the IWG recommends that the region determine and accept a regional building standard and determine and develop other such standards and adaptation and planning criteria as a common baseline such that regionally - planning, adaptation, and resiliency measures are evaluated and future planning and execution decisions made against a common set of agreed upon standards.
    - The IWG strongly recommends that this be done on a regional level, such that the full scale and scope of the dependencies and interdependencies, as based upon a set of known and agreed upon standards will be known and understood.

- Determine restrictions and limitations, be they administrative, managerial, jurisdictional or legal, to regional adaptation planning, and, formulate recommendations, in coordination with the Legal Working Group and other working groups and committees to address /resolve/modify those restrictions, and Identify legal and policy gaps or impediments to planning and decision making about planning and future execution. Focus on areas in particular between public and private planning entities, and between Federal, State and Local planning entities.
    - The IWG observed there is no regional body to review, de-conflict, or prioritize SLR mitigation efforts. This places the responsibility on localities to develop individual partnerships and funding sources. The Pretty Lake Study highlighted how a single locality solution may be sub-optimal or even detrimental to other jurisdictions.
    - There is no specific bond issuing authority for SLR mitigation projects; without such authority, larger scale projects may be impractical.
    - Local, State and federal fiscal year planning horizons and implementation cycles differ, this makes alignment between near term implementation at the local level and collaboration at the federal level with differing federal entities extremely difficult.
    - Alignment within the regional federal agencies is critical to aligning future regional sea level rise and recurrent flooding adaptation planning and implementation of mitigation strategies at every level (federal, state, local.)
    - The USACE employs a three year planning cycle; however, local USACE leaders briefed that approximately half that time is required for higher headquarters review and approval. This limits the time available for coordination among localities to ensure that the proposed engineering solutions will not have an unintended detrimental effect on neighboring locales.
    - DoD facilities are managed by the Military Services and Defense Agencies with differing policies and priorities. Even within individual facilities, there are often distinct chains of command for resident operating forces and the installation. These factors combined

with the frequent rotation of local military leaders complicate the development of successful partnerships to address long term problems.
    - Access to technical data on DoD/DHS infrastructure is often necessarily restricted which can further complicate efforts to plan collaboratively.
- Develop a methodology and recommended template for planning such activities, including a checklist of recommendations and lessons learned, that can be implemented by other communities working with similar challenges.
    - The IWG's understanding of the task is that the full IPP Phase 2 report responds to this requirement.

EXAMPLES/MINI-CASE STUDIES:

The IWG focused in particular on understanding in detail the DOT Gulf Coast series of studies, and on the USACE NACCS study, in addition to the Pretty Lake Little Creek Case Study. Additional detail on that work is below.

Gulf Coast II – The IWG spent two meeting sessions reviewing and taking briefs about the Gulf Coast II study completed by DOT in 2011 (ref GC 2 Study, Task 1), and Gulf Coast Study, Phase 2 Of particular interest was the methodology used by U.S Department of Transportation, Mobile Metropolitan Planning Organization and the South Alabama Regional Planning Commission (SARPC) and supporting engineering firms to determine which transportation infrastructures were most critical and most vulnerable to, in this case, storm surge along the Mobile Alabama Gulf Coast. The specific charter of the GC II study was to consider and understand the impact of sea level rise and repetitive storm surge on the transportation networks and supporting infrastructure of the Mobile, Alabama region, and what would constitute an effective transportation system adaptation planning effort (GC 2 Pg.5).
DOT and study engineering firms were given a list by the Mobile Metropolitan Planning Organization, planning district of over 2000 transportation infrastructures deemed critical, as developed by local, regional, state and federal inputs evaluating against socioeconomic, operational and health and safety criteria. (GC 2 P 20, 21) They then worked through a detailed process of determining specific categorization criteria by which they developed a Criticality Assessment tool - a matrix and methodology to prioritize which were the most vulnerable critical transportation infrastructures, and then, using DOT's eleven step Engineering Assessment Process, (See CG 2 Study Slide deck, slide 66) recommend adaptation modifications for those infrastructures.
The IWG initially planned to use the GCII matrices exactly as designed but modified for the Hampton Roads region in the selection of the study area for Phase II of the Pilot project, but, decided that a full modification of the matrices was too complex for the scope of the pilot project. Instead the IWG designed a similar, but much simplified version of the GC II matrix for use in determining selection of an appropriate critical infrastructure study area, using some of the criteria selected by the GC II study, and then adding in its own recommendations, most specifically to include an area that stressed the whole of government planning challenges by including more than one city or municipality and at least one federal or state agency in the study area.

NACCS – The USACE North Atlantic Coast Comprehensive Study, a post Hurricane Sandy study, provided a comprehensive review of the vulnerability of coastline along the Atlantic Coast to storm surge, and impending sea level rise. This study not only reviewed vulnerabilities, but also made suggestions for adaptation strategies in a broad sense for the full scope of coastline considered within

the study confines. In addition, it selected several areas for specific review, one of which was Norfolk, Virginia, and in Appendix D, Attachment A, validated work done by the City of Norfolk for a number of critical infrastructure areas within the City, including the Pretty Lake area selected by the IWG for Phase II of the Pilot Project.

North Atlantic Coast Comprehensive Study: Resilient Adaptation to Increasing Risk (NACCS)
Final Report January 2014
US Army Corps of Engineers

Pretty Lake - City of Norfolk Engineering Work

The Pretty Lake Study was completed by the City of Norfolk with the assistance of local engineering firms in 2012, and identified adaptation and engineering solution strategies to a 10% level of engineering effort for adapting the Pretty Lake area to reduce storm surge and flooding impact. The work was validated through US Army Corps of Engineers Feasibility Phase Decision Document Review Planning process, initiated in October 2012, and was further reviewed, in detail, as a part of the USACE North Atlantic Coast Comprehensive Study, Appendix D, Attachment A, completed in January, 2014. Use of this region and study was suggested by a City of Norfolk Senior Storm Water Engineer, who was not a part of the IWG at the time, but was later asked to and did join the working group.
As the IWG evaluated the study area, it decided to expand it to include the Joint Expeditionary Base at Little Creek and the surrounding watersheds, including VA Beach watersheds 1 and 31 and Norfolk watersheds of Pretty Lake and Lake Whitehurst. Ultimately, this became the most practical of the potential study area chosen for the purposes of highlighting the challenges of whole of government and community adaptation planning**.** The IWG completed a separate Little Creek / Pretty Lake Case Study specific to its work during the Pilot Project, and a detailed overview of the Little Creek / Pretty Lake Case Study selection process and scenario selection process is included in that Case Study Along with the Full Case Study report, included as Appendix E-4 to the IPP Phase II Final report. .

See: http://www.norfolk.gov/index.aspx?nid=1059 for report documentation on the Pretty Lake effort.

Key Resources/ references / Literature for the Infrastructure Working Group may be found in Appendix (E-6)

CASE STUDIES/MAJOR WORK PRODUCTS:

A Little Creek/Pretty Lake Case Study Technical Report is included in Appendix E-4 & E-5, in addition to the detailed overview of the Little Creek/Pretty Lake Case Study selection process and scenario selection process shown below, it also contains a detailed description of the dependency/interdependency methodology and matrices used, as well as the outcomes and impacts to the study area.

Other Major IWG Work Products including the Case Study Selection process and the Scenario Curve Selection Process are discussed below:

IWG Case Study Selection Process:

Background: The IWG was tasked to conduct a thorough review of exiting studies related to sea level rise impact in the Hampton Roads Region, and to consider other relevant studies that while not specific to Hampton Roads, might contribute to gaining better insight and understanding of the challenges related to whole of government and community sea level rise adaptation planning. They were further tasked, initially, to identify and prioritize Sea Level Rise-vulnerable critical infrastructures in the Hampton Roads region. Determine those critical infrastructures with the greatest impact to the most municipalities, and federal, state, and local agencies, and to then make recommendations to the Steering Committee as to which of those infrastructures might be best suited to adaptation planning (for Phase II) at a regional level to ensure future resiliency.

Process: Early in the study review process, the IWG, with the help of IWG representatives from the Department of Transportation, identified the "Impacts of Climate Change and Variability on Transportation Systems and Infrastructure: The Gulf Coast Study, Phase 2" (referred to as the Gulf Coast II Study) as relevant to both of these tasks, and requested additional information about the work done in this effort through DOT and engineering firms who contributed to the effort. By chance, several of those firms were local to Hampton Roads or the Washington, DC area, and were able to provide on- site briefing and discussion of methodologies used for the Gulf Coast II Study infrastructure prioritization process to the IWG. The IWG spent two meeting sessions reviewing and taking briefs about this work.

Matrix Adaptation: Of particular interest was the methodology matrix, referred to as a Criticality Assessment tool used by U.S Department of Transportation, Mobile Metropolitan Planning Organization and the South Alabama Regional Planning Commission (SARPC) and supporting engineering firms to determine which transportation infrastructures were most critical and most vulnerable to, in this case, storm surge along the Mobile Alabama Gulf Coast. DOT and study engineering firms were given a list by the Mobile Metropolitan Planning Organization, planning district of over 2000 transportation infrastructures deemed critical, as developed by local, regional, state and federal inputs evaluating against socioeconomic, operational and health and safety

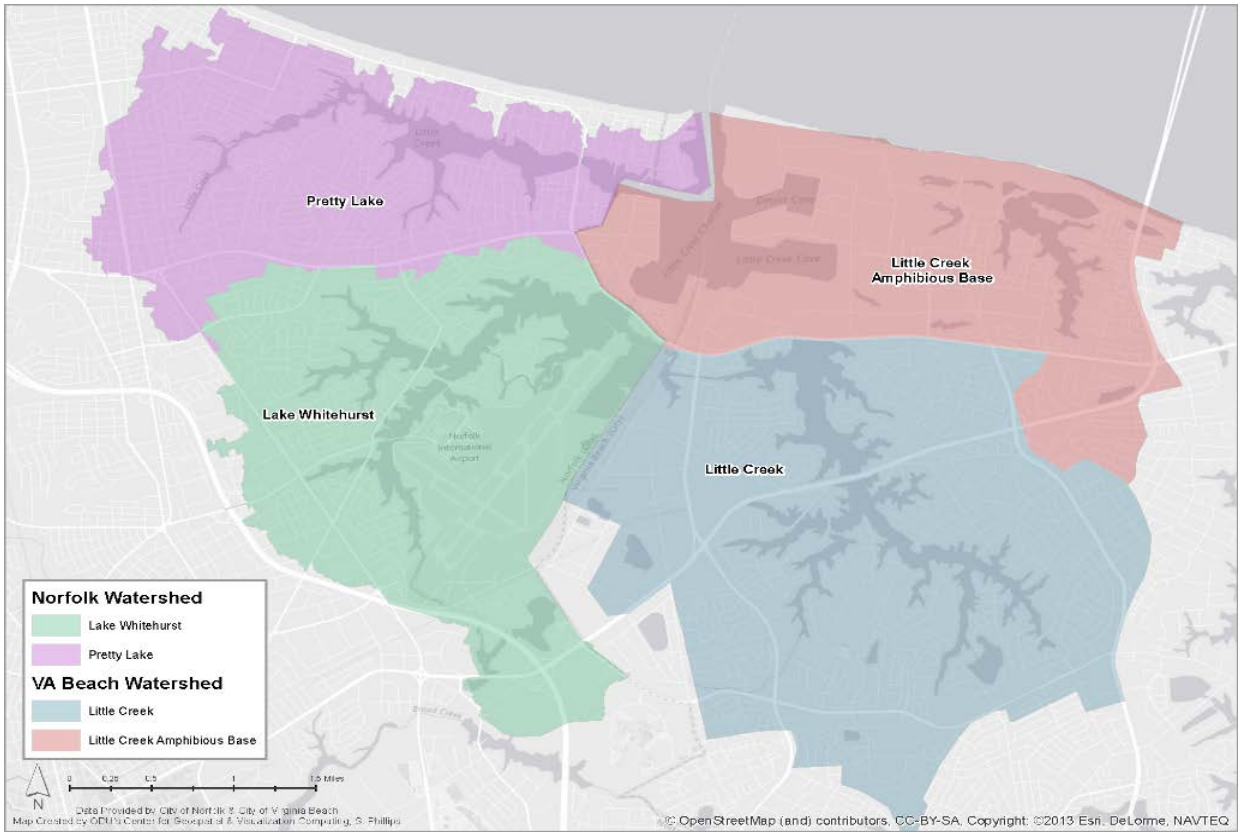
criteria. (Reference Gulf Coast II, P 20, 21) They then worked through a detailed process of determining specific categorization criteria by which they developed this Criticality Assessment tool - a matrix and methodology to prioritize which were the most vulnerable critical transportation infrastructures, and then, using DOT's eleven step Engineering Assessment Process, (as discussed in Gulf Coast II Study Slide deck, slide 66) recommend adaptation modifications for those infrastructures.

The IWG initially attempted to use the GCII matrices exactly as designed but modified for the Hampton Roads region in the selection of the study area for Phase II of the Pilot project, but, decided that a full modification of the matrices, while essential for future regional planning and infrastructure criticality prioritization, was far too complex for the scope of the pilot project. Instead the IWG designed a similar, but much simplified version of the GC II matrix for use in determining selection of an appropriate critical infrastructure study area. This matrix used some of the criteria selected by the GC II study, and then added in its own recommendations, most specifically to include an area that stressed the whole of government planning challenges by including more than one city or municipality and at least one federal or state agency in the study area. As previously stated, as the IWG's work evolved, it became apparent that a full identification and prioritization of critical and vulnerable infrastructure as related to sea level rise within the entire Hampton Roads Region was also not possible within the scope of the study effort. The group revised its tasking to focus on selection of critical infrastructure, suitable for adaptation planning, meeting a series of criteria developed by the IWG, and within the Hampton Roads Region, that would illuminate those challenges of whole of government and community planning. IN particular, they determined that the selected area should include as many agencies at the federal, state and local level as possible, in order to stress the overlapping nature of such an effort, or the absence of such coordination criteria, for the purposes of coordinated adaptation planning.

Selection: Members of the IWG suggested particular infrastructure that might be considered, in some cases soliciting their professional peers outside the IWG for their suggestions. This led to the group creating a list of potential critical infrastructure to be considered, which were then evaluated and scored against the criteria the IWG developed including weighting criteria also developed by the IWG to highlight specific aspects of the selected infrastructures. After the initial voting, the IWG added additional criteria including **consideration of regional economic impact** as a voting factor and **availability of existing data** on the infrastructure and infrastructure system in question as a screening factor. The final three infrastructure systems receiving the most votes were: Little Creek / Pretty Lake, Hampton Blvd., including NIT, NOB, and ODU each with 12 votes and Sentara/Fort Norfolk, Brambleton region with 8 votes. The IWG then voted as to which of those 3 critical regions should be selected for the Pilot work and selected the Little Creek / Pretty Lake area as most suitable for the pilot's objectives.

Assessing Criticality and Vulnerability - Hampton Roads, Virginia													
Infrastructure Planning Working Group, Hampton Roads Intergovernmental Planning Pilot Project													
Final Version 13 July 2015													
Factor Weights	**Screen**	**Screen**	**Screen**	**2**	**1**	**1**	**2**	**2**	**3**	**1**	**2**		
	Feasibility	Data Availability	More than 1 Agency (Ownership &/or Regulation)	More than 1 Municipality (Location)	At least 1 Private Utility	Lack of Redundancy	Known Problem Area	Evacuation Route	National Security Impact	Votes (7/13/15 End of Meeting)	Regional Economic Impact	Score	
Little Creek and upstream lakes	1	1	1	1	1	0	1	0	0	7	0	12	
HRBT & Approaches	0	1	1	1	1	0	0	1	1		1	0	
Hampton Blvd. (NIT, NOB, ODU; Lafayette River Br approaches)	1	1	1	0	1	0	1	0	1	4	1	12	
Sentara/Fort Norfolk/Brambleton/Mid-Town Tunnel Area	1	1	1	0	1	0	1	1	0	1	1	8	
Atlantic Ave and/or Laskin in VB	1	1	0	0	1	1	1	0	0		1	0	
Port Access to NIT (& VIG & PIT off of Hampton)	1	1	0	0	1	0	1	0	1		1	0	
Elizabeth River Shipyards (incl'g PNSY)	1	0	1	1	1	0	1	0	1		1	0	
Wetlands as it relates to fishing industry	0	1	1	1	1	1	1	0	0		1	0	
Surry Nuclear Power Plant	0	0	1	0	1	1	0	0	1		1	0	
Newport News Reservoir	1	1	0	1	1	1	1	0	0		1	0	
Newport News Shipbuilding (HII)	1	0	1	0	1	1	1	0	1		1	0	
Langley	1	0	1	0	1	1	1	0	1		1	0	
NOB	1	0	1	0	1	1	1	0	1		1	0	
Airport (ORF)	1	0	1	0	1	0	1	0	0		1	0	
Norfolk & Portsmouth Beltline	1	0	1	1	1	0	0	0	0		1	0	
										12			

Infrastructure Working Group Case Study Decision Matrix



Little Creek / Pretty Lake Case Study Watersheds

IWG Scenario Curve Selection Process:

Background: Once the IWG selected the critical infrastructure area of Little Creek / Pretty Lake, it next turned to the selection of sea level rise scenario curves to consider impact of sea level rise and storm surge under varying conditions on the study area. One of the challenges to making such a determination is which curves to use, as NOAA and US Army Corps of Engineers, both using National Climate Assessment (NCA) Data (from 2014) have generated scenario curves with very different projected sea level change predictions... Further, the Virginia Institute of Marine Science (VIMS) also using the latest NCA data, but modifying it for Hampton Roads' specific sea level rise and subsidence measurements, has also developed its own set of scenario curves - specific to this region, which closely trend with the NOAA curves. (See Federal curves 2014 and VIMS 2015 curves below.) In addition, cities and municipalities within the Hampton Roads region have worked with Engineering firms doing work specifically for their city, and developed scenario curve interpretations that, while using the same data as the Federal and VIMS curves, interpret the potential timelines to achieve the projected scenario elevations in different ways, in large part due to planning considerations for their individual cities.

Process: While aware of these different interpretations by cities and municipalities, the IWG chose to use VIMS NCA-based projections, modified for the Hampton Roads Region, and in keeping with the best available science, and initially selected a series of three specific timeframes (near, medium, far) and then selected sea level rise scenario curves within those timeframes to use to evaluate the impact on critical infrastructure within the Little Creek / Pretty Lake study area. In addition to the scenario projections for sea level rise, the IWG also added the consideration of the further impact of the additional depth of water projected by a "100-year flood" or the flood having a 1% chance of being equaled or exceeded in any given year for these scenarios.

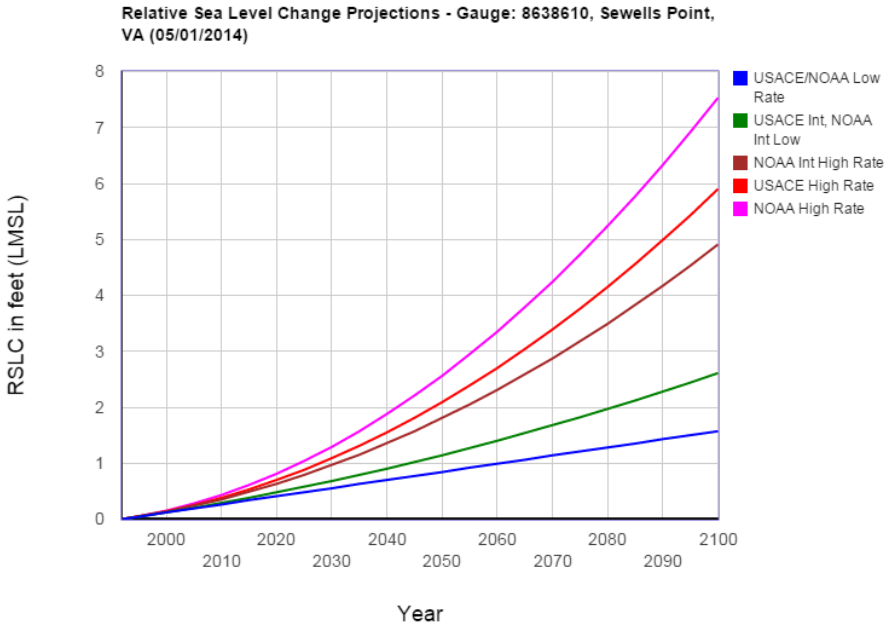
Final Curve Determination: After evaluation by planning departments in several of the cities participating in the Pilot project, there was concern that the scenarios selected, and the timeframes chosen, portrayed sea level rise elevations that exceeded those under current use by those cities, and in particular exceeded levels they used to address sea level rise planning with their constituents. The cities requested that the IWG consider modification of the scenario curves selected to more closely align with those in current use by the cities, and specifically requested any timeframes related to those scenarios be removed. Given the wide diversity and inherent uncertainty among the various temporal projections, it was agreed that for the purposes of the Pilot, it would be more straightforward to simply examine two specific scenario levels to evaluate the Little Creek / Pretty Lake study area to include ranges acceptable to all participating cities, and to remove discussion of timeframes for specific scenario events. The final language chosen and scenario curves used are shown below:

"The infrastructure Working Group and Private Infrastructure Advisory Committee will evaluate the impacts of relative sea level rise scenarios of 1.5 feet and 3 feet on selected infrastructure in Phase II of the pilot. In addition, they will consider the impact of a "100 year flood" or the flood having a 1% chance of being equaled or exceeded in any given year on these two scenarios."

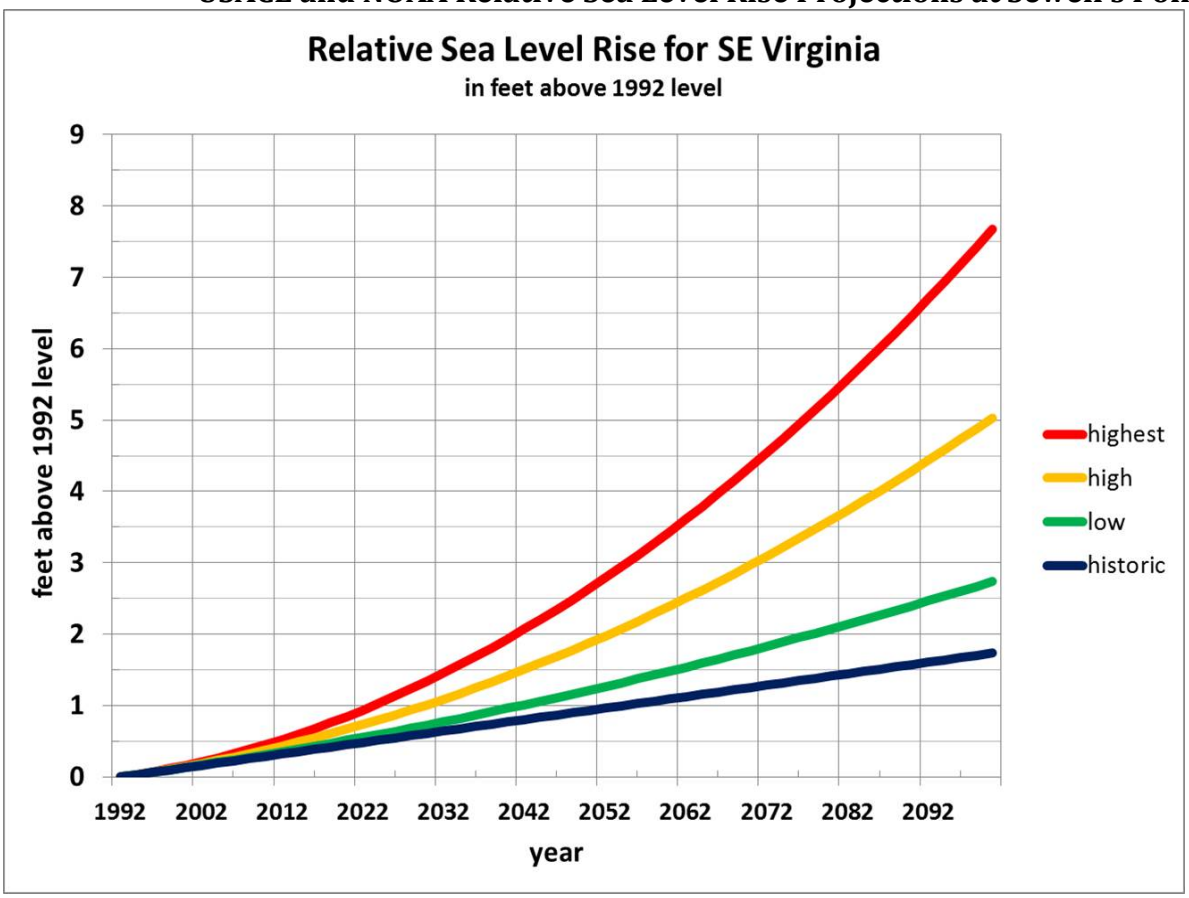
Virginia Beach SLR/RF Analysis
8638610, Sewells Point, VA
NOAA's Published Rate: 0.01457 feet/yr
All values are expressed in feet relative to LMSL

Year	USACE Low NOAA Low	USACE Int NOAA Int Low	NOAA Int High	USACE High	NOAA High
1992	0.00	0.00	0.00	0.00	0.00
1995	0.04	0.04	0.05	0.05	0.05
2000	0.12	0.12	0.13	0.14	0.15
2005	0.19	0.20	0.24	0.25	0.28
2010	0.26	0.29	0.35	0.38	0.43
2015	0.34	0.38	0.49	0.53	0.61
2020	0.41	0.48	0.63	0.70	0.81
2025	0.48	0.58	0.79	0.88	1.04
2030	0.55	0.68	0.97	1.09	1.29
2035	0.63	0.79	1.15	1.31	1.57
2040	0.70	0.90	1.36	1.55	1.88
2045	0.77	1.02	1.57	1.81	2.21
2050	0.84	1.14	1.81	2.09	2.56
2055	0.92	1.27	2.05	2.39	2.95
2060	0.99	1.40	2.31	2.70	3.35
2065	1.06	1.54	2.59	3.04	3.79
2070	1.14	1.68	2.87	3.39	4.24
2075	1.21	1.82	3.18	3.76	4.73
2080	1.28	1.97	3.49	4.15	5.24
2085	1.35	2.12	3.83	4.56	5.77
2090	1.43	2.28	4.17	4.99	6.33
2095	1.50	2.44	4.53	5.43	6.92
2100	1.57	2.61	4.91	5.90	7.53

Virginia Beach SLR/RF Analysis
8638610, Sewells Point, VA
NOAA's Published Rate: 0.01457 feet/yr



USACE and NOAA Relative Sea Level Rise Projections at Sewell's Point



Virginia Institute of Marine Science Relative Sea Level Rise Projections for Southeast Virginia, 2015.

LESSONS LEARNED (Phase 1 & 2), INCLUDING "SMALL VICTORIES", AND OTHER NOTES:

***Best Practices**:* Through the course if its work over duration of the Pilot Project, the Infrastructure Working Group came across a number of Lessons Learned, Best Practices, or points of interest across a range of specific topic areas that might be of use to collaborative planning and adaptation efforts in the Hampton Roads region, but also applicable as points of interest and consideration for other regions of the country working to adapt to sea level rise and recurrent flooding challenges. Topic areas below include Standards, Public Safety, Vulnerability and Criticality, Planning, Overall Planning Process Lessons Learned, Collaboration, Scenario Selection Process notes, Small Victories, Future Projects underway, and Questions for consideration in future studies.

Standards: The IWG found the need for regional standardization to be key to long term future planning success on a regional level. This is addressed throughout this report and in the final recommendations from this working group.

- Communities and regions should select as standard set of sea level rise scenarios specific to the nuances of geography and geology of the region, and use them as a common planning template. Intention is not to restrict to a single scenario, but to find a known and accepted compilation of SLR data that has been vetted by the scientific community and considered to be accurate and applicable for the Region. As discussed in the Deliverables Section of this report, Federal Flood Risk Management Standard (FFRMS) elevations, should be included as a standardized factor in detailed planning for specific projects in any regional planning towards sea level rise scenarios. The three options highlighted under the Federal Flood Risk Management Standard are;
    1. A two-foot elevation requirement for non-critical" infrastructure and a three-foot elevation requirement for critical infrastructure, to ensure placement above the 100 -year (1% annual chance) flood elevation;
    2. Elevate to a 500 year storm level, to ensure a flooding recurrence rate of less than 0.2%; or
    3. Use data and methods informed by best-available actionable climate science to establish elevation level to ensure locale-specific protection from flooding risk - implying that the most suitable should be determined regionally based on specific science applied to that region.
- Federal Flood Risk Management Standard compliance will be a criteria for Federal funding support for projects undertaken in impacted areas. The broad range of applicable standards is confusing and leads to diverse standards of adoption and compliance by cities and municipalities. Cities and Municipalities, as well as State and Federal agencies working to address sea level rise within a common region must select a common methodology from FFRMS and plan collaboratively to the same standard.
- Federal Government standardization of curves used for planning on federal facilities at locations impacted, now or in the future, by sea level rise and recurrent flooding, and promulgation of such standardization decisions, updated at appropriate timeframes, could make achieving an agreed upon standard clearer and simpler for regional efforts.
- Regional planning should include a standardized series of scenario curves, referenced to Federal curves, once determined, and include regional adaptation based on National Climate Assessment (NCA) Curves related back to potential timeframes based on scenario curve projections.

- Collaboration across jurisdictional boundaries could be more easily addressed on a regional basis with regionally common sea level rise scenarios.
- Failure to collaborate and plan regionally for sea level rise and recurrent flooding adaptation and mitigation risks loss of opportunity for federal funding support for larger regional projects, wasting of valuable taxpayer dollars on projects that are not suitable for regional solutions due to lack of funding support and collaboration , and the disenfranchising of smaller regional cities and municipalities that cannot afford to complete the scale or scope of required adaptation using their own available funds, or to qualify for larger federal or state funding endeavors on their own.
- Larger collaborative projects are more likely to be effective on a regional scale, and to receive federal support and attention than smaller independent individual city/municipality derived projects.
- Regional collaboration does not in any way preclude or impede cities and municipalities from adaptation planning for requirements unique to their defined property.

Public Safety: Consideration of public safety is an essential element of any sea level rise or recurrent flooding planning effort. While the scope of the IPP did not allow detailed review and incorporation of public safety measures in the project, the IWG felt that specific mention of this topic was important as a part of any template for future planning.

- The assessment prepared for the Pretty Lake Watershed is a baseline identifying impacts to existing public infrastructure, but it does not include public safety. Any future project, program or plan that includes Federal investments will require risk informed decisions in accordance with the Principles, Requirements and Guidelines for Water and Land Related Resources (CEQ, 2014).

    - A risk informed decision is one that reflects an understanding of potential events, their impacts to systems in place, and any potential consequences. Such decision methods will need to include assessing the potential for loss of life and injury from natural events in determining existing and future conditions in the decision making process. This approach has already emerged within Federal dam and levee safety programs in the U. S.
    - At present, evaluating the impacts of storms on public safety in a coastal environment remains difficult to quantify. Given this uncertainty, future studies need to support efforts to develop guidance for assessing impacts to human life. Areas that are worthy of research are (1) identifying what portions of the population are at risk, (2) the effectiveness of evacuation plans, and (3) the potential for loss of life and injury given these conditions.

- Include placement of HAZMAT, fuel storage and landfills, with accompanying potential for surface water, groundwater, land/facility and public water supply source contamination, as a part of any vulnerability work done under similar circumstances either in a more detailed planning phase or as part of any template used by regions nationally.

- Additional details on the impact of sea level rise and the possibility of environmental contamination resulting from either Sea Level rise or nuisance flooding of commercial or

industrial sites can be found in a white paper developed by Ms. Sarah Kinna, then of Tetratech, now of CB&I Federal Services which may be found in Appendix (E-2) to this report.

Vulnerability and Criticality: The essential nature of the determination of vulnerability and criticality appears across this report, and appears in the final recommendations as key to the region moving forward.

- As noted in the Gulf Coast 2 study, there is a difference between *vulnerability* and *criticality,* and Key leaders and planners should be thinking about both aspects. (How is the infrastructure vulnerable and is it critical?)
    - Some things that are vulnerable and important are not critical.
    - It may be easier to measure or quantify vulnerability through a scientific or engineering assessment; criticality, on the other hand, can be more subject to individual perceptions and values, and involves some subjective judgments.
    - Such values, whether they are on behalf of a government, community group or individual, are difficult to quantify, but may be nonetheless essential.
    - These include military preparedness and emergency response capabilities.

- The IWG suggests the City of Norfolk Pretty Lake Study engineering work and the matrix process as modified by the working group as a template for a Vulnerability selection process that can be applied to other regions.
- Any assessment of vulnerability of critical infrastructure must include vulnerability of emergency shelters that may serve other needs during routine operations, for example: schools and houses of worship.
- Cities and municipalities must first define how they view and plan to prioritize both vulnerability, and criticality before making determinations of what is vulnerable and what is critical. This particular topic came up again and again over the course of the IWG's work and will be essential to future adaptation and planning in the Hampton Roads region.

Planning: Throughout the Pilot process, cities discussed the importance of community planning and managing the perception of the community. Planning should include high- level perspective, and be reasonable, manageable and executable. Perception of planning in logical steps does matter to get long range planning started and accepted by an informed community. It is important to recognize that there are many solutions whether engineering - based or science - based. Engineering Based solutions are not the answer to every SLR problem therefore they should not be the only type of solution considered.

In identifying planning processes and lessons learned, the IWG understands that the planning level of effort for a pilot of this scope is not to the scale of specific project planning, by design. Specific project planning is to a much higher level of rigor and specified level of planned sea level rise preparedness. However, the group derived key points and lessons learned during the Pilot Project, listed below.

Adaptive redevelopment is key!

- Adaptive redevelopment is essential to any infrastructure engineering and construction planning and execution. Portions of the public infrastructure will undergo renewal as it ages. It is very important that policies and standards are implemented so that during reconstruction and renewal, the new infrastructure is resilient into the future. This may mean that some infrastructure is reinforced, constructed at higher elevation, or relocated or reconfigured.
- A suggested basic planning template could be: 1) Recognize problem, 2) Determine achievable steps, 3) Review and compare with best available science, 4) Inform citizens
- As taken from the Dutch Dialogue sponsored by HRPDC in June of 2015, held at the Slover Library in Norfolk, Virginia - and considering projects in the City of Hampton and the City of Norfolk - the most effective options available are: Berm, pond, and pump. Alternatives to consider include elevation, dune construction, and additional natural barrier construction. Additional alternatives can be found in the NACCS, as discussed, in the Presentations to the IWG portion of this report and in the References Section of this report.
- Understanding of (i) the nature of living shoreline development with regard to wetlands and (ii) likelihood of and anticipated locations of permanent net loss of wetland area and functionality at a local and regional scale. What will happen as those wetlands become inundated? How do we incentivize redevelopment or new development to incorporate appropriate shoreline design to account for need for wetlands to migrate uphill (e.g., a slope of 1:6, or 1:7 to drive gradual adjustment to rising waters)? How do we offset anticipated loss of wetland area/functionality over time and plan for feasible mitigation and/or replacement? To be able to do this we must think about how we do and build, to develop integrated designs, preserving potential replacement wetland locations and developing public funding/financing mechanisms and incentivizing private party investment/conservation.
- Consider the importance of community planning and managing the perception of the community and the interrelationships and dependencies between land use planning, infrastructure planning and financing, and economic development. Planning should include high level perspective, and be reasonable, manageable and executable. Perception with logic does matter to get long range planning started and accepted by an informed community. It is important to recognize that there are many solutions whether engineering -based, science-based or policy-based. Engineered solutions are not the answer to every SLR problem therefore they should not be the only type of solutions that are considered.
- Collaborative planning between federal government and local planning departments can ~~be~~ succeed, starting at the staff working level~~,~~ and with the exchange of information.
    - Federal considerations include long-term viability of federal facilities and infrastructure service provided by local/regional entities
    - Determining a permanent response process
    - Considering what kinds of “barriers” or flood management structures would be acceptable or possible
    - What is in the best interest of all parties impacted by this effort and challenge?

        - Negotiations with the federal agencies should begin with the benefits to these agencies identifying the existing methods to approach shared issues.
    - Local sponsorship has legal impact on funding authorizations for USACE and military base joint land use studies. Depending on federal authorization and programming, consider more than one local sponsor where feasible and appropriate to enhance regional perspective for such studies.
    - BRAC process and component must be considered.
    - Ongoing DoD Assessment of base vulnerability may impact criteria used.
    - Federal State and Local funding authorities already exist. The challenges are in the details and ability to collaborate across federal, state and local funding timelines and budget processes which often do not align.

<u>Planning Process Lessons Learned</u>:

Coordination with State, Local, and Federal Agencies will always be extremely challenging. Recommendations as a part of the process include but are not limited to:

- Determine existing conditions, as a yardstick to current conditions and circumstances and challenges with reference to recurring and persistent flooding, storm surge, and sea level rise. Which areas and dependencies/interdependencies are currently most vulnerable?
- Define today's issues, then look at how to plan to address them with regard to how they will be impacted and be expected to evolve in the future.
- Define the risk now, then consider prioritization with reference to potential solutions, and various costs and trade-offs.
- Determine where *common* risks exist now, and where they are likely to arise over time.
- Which risks are most shared should be balanced against feasibility and understanding of appropriate solutions for shared and non-shared risk. Individual efforts may be easier to accomplish if simpler, and should be executed where possible to establish record of success.
- Once the shared and non-shared risks are determined it is important to understand how will they evolve over time, and which stakeholders are affected, be they residents, business/industry, and government. Key to success: Do they relate to each other or not?
- Once risks are defined and understood: prioritize what needs to be "attacked", who needs to be involved, what kinds of solutions by category could be addressed (retreat, adapt, defend)
- Include existing programs and how to align them regarding the effort's key focus**.**
- Norfolk's downtown flood wall is an example of infrastructure that was intended to protect against storm surge, but that was nearing the end of its useful and effective life, and where adaptive resiliency will be critical in the future. Norfolk is addressing SLR adaptation on a project by project basis, assessing the necessary degree of resiliency based on the nature of the project.
- For short term planning, (< 30 years) localities should consider a higher curve (to show more potential for future sea level rise challenges which will drive more prudent planning and preparation)) and for long term planning (> 30 years) , pick a moderate (but not the lowest) curve to give additional flexibility to develop solutions over time.

- SLR impacts will vary greatly over the Hampton Roads region. For example, two feet of SLR has a much greater impact on downtown Norfolk, Poquoson, or Hampton than for other-regional localities, depending on topography.
- Even with no SLR conditions imposed, the IWG learned that many of the infrastructure dependencies and interdependencies were not widely known or understood.
- SLR and storm surge are separate factors affect where and how cities and municipalities should build. Sea Level Rise impacts where to build, Storm Surge impacts how to build.
- In planning, localities should assess the impacts of tidal action, rainfall levels, storm damage, and SLR.
- Beyond a certain point, the volume of storm water makes no difference: SLR means that the water stays around longer. The Gulf Coast II study developed a methodology to address impacts of and damages caused by moving water, wave and wind driven water-over time. This could be adapted to other regions in developing their planning process.
- Cities will need to develop the expertise to be able to project how scarce finances should be spent and how public credit should be leveraged.
- Cities need a regional understanding of vulnerable critical infrastructure impacted by sea level rise to help them determine their long term planning strategy and determine regionally cost effective solutions.
- Obtaining MS4 permits that allow localities to manage storm water the right way is essential to planning. MS4 permits (Municipal Separate Storm Sewer System permit) should be included in the planning design, if not, a legal risk could be associated with that – one possibility is perhaps incentivizing MS4 permitting and operation to account for SLR and flooding.
- U.S. DOT shared a draft of its Quantification Initiative, supported by U.S. DOT's Climate Change Center and Volpe Center. The report helped support a need identified by the Hampton Roads Pilot Phase I Report (2015) which states that the "IWG has concluded that any planning activities taken to address infrastructure need to address the cost and benefits of proposed actions to aid in decision-making" (p. 24). In collaboration with Hampton Roads Pilot, DOT is developing cost tool that provides methods for:
    - (1) Voluntary grantee consideration of financial impacts in infrastructure planning due to climate change and severe weather;
    - (2) Augmenting science-based implementation of the Federal Flood Risk Management Standard (EO 13690); and
    - (3) Prioritizing and managing U.S. DOT facilities to address EO 13653.
- On May 18, DOT took public comment on their report and presented its key findings at a forum called The Economic Impacts of Sea Level Rise in Hampton Roads: An Appraisal of Projects Underway. This forum, hosted at the Virginia Modeling and Simulation Center in Suffolk, was supported by Old Dominion University and was attended by over 50 parties from government, academia and the private sector. To date, U.S. DOT has received over 250 comments from over a dozen entities, included numerous parties that participated in the pilot. U.S. DOT continues to explore collaborations based on the report. The analysis also builds on input from the insurance industry regarding quantification methodologies. The report is funded through August 2017. For more information contact Alan Strasser at alan.strasser@dot.gov.
    - Further information about the 18 May 2016 Economic Impacts Forum, including topics presented and a summary of the day's events can be found in Appendix E-3.

- Planning impacts lessons learned, suggestions for consideration and challenges from Dependency/Interdependency matrix development:
    - Entire systems must be understood to be able to understand how specific segments are impacted (more than just the sewer system alone) including a discussion of MS 4 permit compliance, and what the impacts could be if the point of discharge and stormwater management practices and functionality (e.g., detention/retention ponds, underground storage, permeable pavement, etc.) were to change or degrade. It is difficult for every city representative to have that level of knowledge in a large city.
    - Focusing and understanding the impact of dependencies on one another in a qualitative sense when completing the matrix.
    - The challenges of maintaining consistency and being able to describe how dependencies were rated against one another.
    - The resiliency of the domestic fresh water supply regionally, including a discussion of Lake Gaston, but, within the City of Norfolk (who also supplies drinking water to Virginia Beach) understanding what vulnerabilities could exist.
    - Sewer treatment was likely more impacted by sea level rise than fresh water supply. Some impact to pump stations from backfill, from loss of SCADA controls, from prolonged submergence of the entire system.
    - Finished floor level of generators powering the stations, being raised, or not, to take into account SLR impact as they are upgraded.
    - Valuable insight that SLR will be considered as further future designs are considered and developed.
    - Understanding the contents of the matrix is essential to this process being of any use to another committee or group working this issue in another region.
    - Cities must determine methods to discuss potential for higher levels of sea level rise with their constituents. There is still a belief that the general public is not yet ready to believe higher numbers, even if they do believe there is an issue with sea level rise.
    - In the course of planning efforts, careful and continued determination of how to do public outreach, what methods work regionally (or elsewhere) and the degree and circumstances under which they have been successful? Buyouts are an option for FEMA Flood challenged areas. Action by a locality in this regard is an essential element and option, but is a highly charged and sensitive issue. Where practicable, localities will want to be able to move forward with the flexibility to take action without state or federal authorities imposing additional duties and greater unsupported costs upon them.
    - Sanitary sewer will be affected by flooding as sea water flooding will overwhelm the sewers as well as the pump station serving the collection system
    - Utilities should take into account flooding over manholes and take measures to avoid the inflows caused by standing waters
    - Need to protect the pump stations from high waters shorting out the electrical systems and preventing access by utility personnel
    - Need to reduce the amount of inflows from SLR from reaching the treatment plant as water with a high salt content harm the treatment process

- Storm water infrastructure and stormwater management and discharge compliance were not included in the dependency /interdependency matrix. While storm water was not evaluated, it is understood that it needs to be evaluated for future sea level rise studies "Storm water is the witching effect of flooding, tidal and SLR impact" – (Citation:) City Employee Hampton Roads Region

- **Knowledge gaps:**
  - **Environmental Expertise:** There is a need for expertise in environmental engineering and environmental regulatory and permitting.
  - Other knowledge gaps included: FEMA guidelines for storm damage resistance~~,~~ and HAZUS analysis capability.

Collaboration: The IWG believed that collaboration between regional entities at the federal, state, and local level is of the utmost importance in future sea level rise and recurrent flooding adaptation planning and solution implementation. This is one of the final recommendations from the Working Group.

- **There must be collaboration between all of the Hampton Roads localities as SLR does not recognize government boundaries.**
- **For the process to work, representatives from each affected government entity with actionable authority must be at the table.**
- Watershed management is a key issue for collaboration between cities and municipalities. Virginia Beach has 31 watersheds, 5 shared with Chesapeake, 6 with Norfolk, and 3 with North Carolina. The co-benefit here for the localities is in flood control and TMDL compliance cooperation.
- Navy has an Infrastructure database to manage not only construction status, but building age, upgrade, and storm resiliency. Recommend understanding of currency and effectiveness of this database, and that that knowledge be incorporated into any discussion between federal entities and local cities and municipalities. Further, consider whether any aspect of this model could be transferred or useable by localities, and or other facility owners.
- USACE has programs underway to assist in planning and cost share/CRS credits for cities civil works projects requiring a flood plain management plan. (*See Flood Plain Management Services and Planning Assistance to States (Virginia) – both USACE publications included as references in Appendix E-6)*

Scenario Selection Process Notes:

- After creating the Scenario maps for the Little Creek / Pretty Lake Case Study, HRTPO advised that when overlaid on basic Google map backdrops, flooding projections show the area of impact but do not clearly delineate the depth in relation to the surrounding elevations. This known inconsistency is easily managed with careful review of specific critical infrastructures considered.
- Acceptable limitations, provided they are documented as such, include the absence of wave mapping and wind surge impacts for the storm scenarios.

- Future such studies should consider the identification of the current impacts on study area infrastructure by recurrent flooding. Lake Bradford, low lying areas of Norfolk, and roadways through Shore Drive were listed as areas that are at risk today.

SMALL VICTORIES:

- **This Pilot Project is the first time Federal, State and Local agencies and authorities have extensively collaborated on the issue of sea level rise in the Hampton Roads region.**
- The willingness of the Cities of Norfolk and Virginia Beach, along with the U.S. Navy, to share their perspective on dependencies and interdependencies made the understanding of those areas in this report much more valuable.
- The perspective on filling out Dependency/Interdependency data would be different if, in addition to the Pretty Lake Study area, downtown Norfolk or other regions were taken into consideration (due to the low elevation and greater impact of flooding levels).
- The U.S. Navy has shared specific topography maps with City of Virginia Beach for Little Creek (on a restricted basis, and not publically releasable) as a result of meeting engineer to engineer and sharing future planning concerns during the course of the Pilot Project. This had not happened previously.
- The opportunity exists for Hampton Roads to take the lead across the nation in building regional resiliency in improving work and employment opportunities across and between cities and municipalities as SLR challenges and planning and execution evolve. While every region's solutions will be driven by its unique topography and geology, conditions existing in the region closely match those found in many other areas in the United States and across the globe.

Ongoing Projects of Interest, Future Studies Recommendations:

- Virginia Department of Transportation is developing an application (APP) to better alert commuters of high tides and potential flood locations. The work consists of 2 phases that include using flood sensors to gain real time information and sending commuters customized warnings/alerts ahead of time. This information is a critical need for citizens. It is insufficient to reply on local knowledge for awareness of where flooding occurs; community safety and awareness make knowledge of the predicted scope (depth) and duration of flooding, as well as detours and potential alternatives an imperative for the Hampton Roads region.
- VA South/Central Region DHS suggests that cities need to have a better understanding of what their critical infrastructures are. Cities should be able to identify them and prioritize by risk. Additional ongoing regional DHS work includes the DHS Office of Cybersecurity and Infrastructure Analysis (aka "OCIA") and Pacific National Laboratory (PNL) collaborated on the Norfolk, Virginia Sea Level Rise Analysis Report, completed in July 2016, a follow-on study, ongoing focused on an analytic and modeling effort to examine the potential impact to Naval Station Norfolk resulting from a Category 3 hurricane and a significant storm surge to include potential impacts resulting from projected sea level rise conditions over a 20 and 50 year timeframe. The study will examine multiple critical infrastructure sectors, but several DHS partners, to include the U.S. Navy, have requested that they closely examine the potential impact of the hypothetical scenario within the Transportation Sector. DHS expects this follow-on study to be published by the end of 2016.

- The Department of Defense is completing a global assessment on vulnerabilities, which includes flooding issues. DoD has also agreed to do a series of Joint Land Use Studies (JLUS), including the three currently underway or planned: Norfolk/Virginia Beach, Portsmouth Naval Shipyard/Chesapeake, and City of Hampton/Langley. The first of these, Norfolk/Virginia Beach still has full scope determination in progress. The issue of storm drains and water quality will be a part of this work, and in addition, critical infrastructures and climate adaptation with regard to where people that work for DoD live and how they use transportation that will be affected is also expected to be included.
- The Union of Concerned Scientists has just completed (July 2016 release date) a significant study *The U.S. Military on the Front Lines of Rising Seas,* that includes a detailed look at the impact of climate change, and the resulting rising seas and recurrent flooding on US Military Facilities within the continental United States. The impacts as described could be substantial, and will require dedicated and collaborative near and long term planning efforts not only across services, but across the communities where service members live and work.

Questions for future study:

1. How to define the impacts of SLR and risk management on regional military bases and infrastructure and how military operations and SLR risk management affect infrastructure "outside of the fence line" in the local communities;
2. How best to understand and manage the complexity of decision-–making for SLR risk management and resiliency and its regional impact on employees, services, transportation-and level of impact on or loss of capacity of national assets; and
3. How will SLR impacts to businesses and other commercial activity and related logistics be measured, documented and considered in the study effort (e.g., FEDEX/UPS-food distribution, etc.?)
4. How will the Defense Industrial Base, including the only shipyard with the capacity to build nuclear powered aircraft carriers be impacted?

Process Implementation

This process could be implemented in any location with an interest and critical mass of support to move forward. Development of a Charter to guide the process is critical, as is flexibility in determining the appropriate measures and tasks that can be completed or not in the time allotted, and by the nature of the organization formed.

In any such effort, an engaged and functioning steering committee is critical to the outcome of the overall process. Lack of engagement by and validation of membership in the IPP Steering Committee became a hindrance near the end of the first year of the pilot, as did several membership changes during the second year of the process. While some of this is inevitable, any steering committee must have an established means of support infrastructure to assist it in its work from the very beginning of the effort. That was absent in this project as there was no significant administrative support until the second year of the Pilot, and it was a detriment to the overall efforts of the project. Further, steering committee members and working group and committee chairs should be identified as early as possible in the process to ensure continuity of effort throughout.

In this instance, the IPP Charter recommended the formation of an initial set of committees and working groups in Phase I to start information gathering and knowledge baseline process, with the intent that additional committees and working groups might join the effort in the second phase of the pilot as more details on the process arose. A good example of this is the Legal Working Group standing up earlier than the other groups, which facilitated preparation of groundwork in the form of a Legal Primer that was very useful to the other committees and working groups as they started their own work. Further, the Infrastructure Working Group stood up before the Private Infrastructure Committee and began gathering foundational information with a review of studies and other work related to regional sea level rise impacts in Hampton Roads, such that when the PIC formed, it was ready to begin collaborating right away with questions about the impact and actions of private infrastructure regarding sea level rise adaptation measures. These two groups worked closely together for the remainder of the Pilot.

Not all the committees envisioned for Phase II actually came to fruition or were active, but the concept of building on key knowledge areas as the need becomes apparent is valid.

A neutral convener was essential to the effectiveness of the Pilot effort~~,~~ and, in many cases, ensured the participation of organizations that might otherwise have chosen not to be a part of the effort even though they are stakeholders in the issues. Having an institution of higher learning as the neutral convener also allowed science and engineering expertise to be brought to bear on the Pilot's efforts and added to the overall credibility of the project.

IWG FINAL RECOMMENDATIONS:

1) This region should undertake development and formation of a functional process and organization to facilitate regional collaboration, including the local governments, regional, state, tribal and federal agencies, and other entities, that face the most imminent impact from and have the greatest interest in sea level rise. This organization might ultimately be evolved to be considered a "commission, board or council" under Virginia law. It should have authority to foster collaboration among federal, tribal, state and local agencies, with support from academia, and should serve as a collaborative agency to oversee regional matters of importance in facilitating regional sea level rise planning and actions.

2) Federal civil agencies and military branches and localities in the Hampton Roads region must have a way to work together directly, particularly as to determination and processes for approval of authorities and appropriations for funding. This process should begin as an MOU or set of MOUs between federal agencies and local governments or a regional entity representing them. When authority for federal collaboration with local governments is unclear or too restrictive to support effective planning, federal agency or branch headquarters should issue guidance providing their respective field offices and personnel with the authority needed to collaborate effectively with local governments. If a federal agency or branch determines that its ability to collaborate is constrained by federal statute, legislation should be sought to provide that agency authority to collaborate with local governments. Certain existing intergovernmental programs, such as the National Ocean Council and collaboration in the areas of homeland security and emergency management, provide models for legislation authorizing intergovernmental collaboration.

3) The region should establish and adopt a definitive set of regional sea level rise planning scenarios and standards, including a minimum base floor elevation and a standard vertical datum set. The affected local governments and regional, state, tribal, and federal agencies will then be able to work from the same set of scenarios in regional and local planning efforts to address sea level rise and recurrent flooding impacts, adaptation and mitigation.

- **The necessity for planning scenario development and use in decision making for planning is as stated in the April 2016 SERDP report**: "Regional *Sea Level Scenarios For Coastal Risk Management: Managing The Uncertainty Of Future Sea Level Change And Extreme Water Levels For Department Of Defense Coastal Sites Worldwide."* SERDP, April 2016. "This report and its accompanying scenario database provide regionalized sea level and EWL scenarios for three future time horizons (2035, 2065, and 2100) for 1,774 DoD sites worldwide. The decision-making paradigm must shift from a predict-then-act approach to a scenario based approach. The primary purpose of this report and its associated scenario database is to enhance and increase the efficacy of screening-level vulnerability and impact assessment for DoD coastal sites worldwide containing permanent or enduring assets". (Page ES-1 and ES-2.) With the significant Federal presence in Hampton Roads, federal processes and standards should be accounted for and considered when developing regional procedures and standards so that there is not inadvertent conflict resulting in negative impacts on regional planning efforts over time.
- **Federal government leadership and input could make achieving federal standards clearer and simpler for regional efforts**.
- **A definitive set of regional sea level rise scenarios is essential for addressing planning issues that overlap jurisdictional boundaries, particularly as to land use planning and critical infrastructure design, planning, project prioritization and, construction.**

4) **Regional identification, evaluation, and prioritization of critical infrastructure vulnerability to sea level rise impact within the next 30, 50, and 75 years should be undertaken.** This work should include development of models and methods to understand and incorporate economic impact of adaptation, replacement, or relocation of such infrastructure, along with other relevant social and cultural factors.

5) The IWG noted that the National Climate Assessment (NCA) was updated in 2014 and that it is updated every 4 years, with updates potentially forthcoming every two years. The IWG recommends that VIMS should update its SLR assessment every four years, after each NCA, and more often if the U.S. Climate Science Program issues updated SLR projections in between the NCSs. VIMS should ensure that the NCASLR projections adequately account for the unique conditions in Hampton Roads, providing adjusted SLR projections as necessary. Another perspective is that relying on USACE curves would be better because they are updated sooner than those issued by VIMS. However, USACE and NOAA curves are not the same because they use different forecasting methodologies, making the NCA sea level scenarios the most authoritative source for planning. The IWG recommends that a regional Science Advisory Committee be established with responsibility for (i) reviewing the NCA and VIMS projections, and the projections used by federal agencies for their own planning, (in particular those of DoD and DOT as they have a considerable stake in the regions sea level rise challenges,) and (ii) recommending to the regional planning organization what SLR curves should be used for regional

planning. This IPP final report should acknowledge that there will be SLR scenario updates and that these updates should be incorporated into regional planning efforts – in addition to a collaborative decision as to which curves will be used regionally for planning purposes, and that planning scenarios will be updated on a timeline sufficient to address changes to these curves based upon best available science.

6) The PIC reviewed climate action/resiliency plans from New Orleans and Southeast Florida to understand their strategies and to include action/vision statements from their plans that are applicable to Hampton Roads. The IWG reviewed and also *unanimously agreed* to these recommendations, which can be found in the PIC section of the Phase II report.

APPENDIX E-2

Sea Level Rise Impact on Environmental Contamination

Sea Level Rise Impact on Environmental Contamination – February 2016. Ms. Sarah Kinna

Concerns with Sea Level Rise (SLR) relate to contamination in that flooding, both due to SLR or recurrent tidal or "nuisance flooding," could impact commercial or industrial sites at coastal locations by releasing pollutants (e.g. chemicals or fuels) or debris to surrounding areas.

Impacts of SLR occur due to increased storm damage, shoreline retreat, and changes in water tables. Changing water tables threaten wastes stored in surface impoundments and landfills by exerting additional hydrostatic pressure, or saltwater may permeate clay liners (Barth, et al., 1984).

Areas of concern include:

- Surface impoundments
- 55-gallon drums
- Above-ground storage tanks
- Large fuel storage
- Landfills
- Incinerators
- System structures associated with thermal, chemical, physical or biological treatment systems
- Land treatment systems
- Waste piles

Wastes of concern include, but are not limited to:

- Acids
- Alkalis
- Solvents
- Heavy metals
- Grease and oils
- Paint waste
- Polychlorinated biphenyls (PCBs)

For local facilities, hazardous chemicals in the workplace are regulated under the Emergency Planning and Community Right-to Know Act (EPCRA) hazardous chemical storage reporting requirements. A hazardous chemical is defined as "any substances for which a facility must maintain a MSDS under the OSHA Hazard Communication Standard, which lists the criteria used to identify a hazardous chemical." Additional reporting requirements apply to facilities which exceed threshold values for Extremely Hazardous Substances [40 Code of Federal Regulations (CFR) Part 355, Appendices A and B], retail gas stations exceeding a capacity of 75,000 gallons (which may also be compliant with Underground Storage Tank Regulations, 40 CFR part 281), diesel fuel stations exceeding 100,000 gallons (also may be compliant with 40 CFR 281), or any other hazardous chemical storage exceeding 10,000 pounds. A listing of chemicals must be sent to the State Emergency Response Commission (SERC), Local Emergency Planning Committee and local fire department. An inventory is required on a yearly basis. These reports include Tier I or Tier II Inventory Reports. Copies of Tier II reports are maintained by the Virginia Department of

Environmental Quality (VDEQ) and by local emergency departments. Tier II forms require basic facility identification information, employee contact information for both emergencies and non-emergencies, and information about chemicals stored or used at the facility. These reports are located at the Fire Marshall's Office in Norfolk, and the Office of Emergency Management in Virginia Beach. Current contacts for these officials are located on the city webpages, under those offices.

On the state and federal side, VDEQ and the Environmental Protection Agency (EPA), manage waste sites and permitting under Resource Conservation and Recovery Act (RCRA), as amended by Superfund Amendments and Reauthorization Act (SARA), and Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA).

RCRA prevents the building of hazardous waste surface impoundments, waste piles, land treatment units, and landfills from being located in a 100-year floodplain, or otherwise must be protected from washout (Barth, et al., 1984). Facilities must not cause environmental impacts if washout occurs. Impacts can be prevented through flood protection (e.g. not allowing floodwaters to reach the facility) or flood proofing (allowing flood waters to come in contact with, but not cause damage to).

EPA Region III manages Virginia sites, and a listing of all 121 RCRA Corrective Action sites can be found on EPA Region III's website.

Federal sites located in the vicinity of, but not in the study area, include:

Site / Location	Category / Current Action Level at Site	Notes
BAE Systems Repair, Norfolk	Restricted Land Use	Land use is restricted to industrial operations.
BASF Corp, Williamsburg	Corrective Action Selected	No hazardous materials are currently stored on site.
City of Chesapeake, Public Works	Correction Action Complete with Controls	No hazardous wastes are currently stored on site.
Controls Corporation of America (CONCOA), Virginia Beach	Corrective Action Complete without Controls	Site maintains a current air permit for welding and laser cutting operations.
Royster, Co., Chesapeake	Corrective Action Complete with Controls	Site manufactured fertilizer. Restrictions remain on emissions controls. No hazardous wastes remain on site.
Safety-Kleen Systems, Inc., Chesapeake	Corrective Action Complete without Controls	Site has a Class 2 permit modification to the facility's Hazardous Waste Management Permit. Storage of on-site solvents, paint wastes, and miscellaneous industrial wastes.
Sims Metal Management (Formerly Sierra Recycling Inc.), Suffolk	Corrective Action Complete without Controls	Corrective action chosen includes natural attenuation for soil and groundwater contamination, with land and groundwater use restrictions in place.

Virginia Emergency Fuel Storage, Yorktown	Construction of Corrective Action Complete	Remediation of fuels-contaminated groundwater is ongoing.
Western Refining, Yorktown	Corrective Action is Chosen.	Remediation of oil-contaminated groundwater is ongoing.

Sources Cited:

Barth, Michael C. et al. *Implications of Sea Level Rise for Hazardous Waste Sites in Coastal Floodplains.* Van Nostrand Reinhold Company, Inc. 1984. PDF.

APPENDIX E-3

The Economic Impacts of Sea-Level Rise in Hampton Roads: An Appraisal of the Projects Underway

The Economic Impacts of Sea-Level Rise in Hampton Roads: An Appraisal of the Projects Underway

May 18th, 2016

Virginia Modeling and Simulation Center
1030 University Blvd
Suffolk, VA 23435

Slides to each presentation are uploaded to ODU Digital Commons
http://digitalcommons.odu.edu/pilotproject_meetings_may2016/

In support of the Intergovernmental Pilot Planning Project (IPP) understanding of Economic Impact on the Hampton Roads Region related to Sea Level Rise and Recurrent Flooding, collaboratively developed by:

- ***IPP Infrastructure Working Group***
- ***IPP Economic Impacts Advisory Committee***
- ***U.S. Department of Transportation / Volpe Center***
- ***Old Dominion University***

Forum Synopsis: This forum was created through the combined efforts of U.S. DOT, the IPP Infrastructure Working Group and the IPP Economic Impacts Advisory Committee, supported by Old Dominion University. The concept and idea to hold such an event was initiated after conducting an initial review of U.S. DOT Quantification Initiative objectives and draft report responding to the Infrastructure Working Group's recommendation from Phase 1 of the IPP "that planning activities taken to address the impact of sea level rise on regional infrastructure should address costs and benefits of any proposed actions to aid in decision making." The Quantification Initiative, funded through August of 2017, and supported by U.S. DOT's Climate Change Center and Volpe Center, was and is working to specifically focus on economic impact in response to that recommendation. During the review process, additional opportunities for collaborative research became known, in that a number of other ongoing regional research projects existed in addition to those included in this initiative. As the DOT initiative took shape, the Infrastructure Working Group, Economic Impact Advisory Committee, and DOT participants felt that learning more about these ongoing initiatives focused on evaluating sea level rise and recurrent flooding impact and including economic impact, by organizations throughout the Hampton Roads Region and beyond, was of critical importance to the outcome of the DOT Initiative analysis. In an effort to gain insight from these studies, and to ensure both the opportunity to collaborate among the various sponsoring entities and to baseline and share economic data where known and feasible, this forum was convened to bring these various efforts and other interested parties together in one location in order to learn and understand each study effort's objectives, timeline, scope, and findings to date. Further, the forum included the opportunity to gain an understanding of current and future data needs; an opportunity to gather, share, and de-conflict information across and between these ongoing efforts; and establish opportunities for collaboration for current and future work in understanding and analyzing the economic impacts of sea level rise and recurrent flooding.

The agenda (Shown below - page 14) featured presentations from Department of Transportation, Department of the Interior, Department of the Navy, City of Virginia Beach, City of Norfolk, U.S. Army Corps of Engineers, Volpe Center, Dewberry, LLC, and RTI International. The audience included more than 50 participants from Federal, State and Local agencies, cities; municipalities and universities; regional non-profit organizations, and other interested parties.

After each project was presented, and questions fielded, the forum engaged in an open discussion with workshop participants on how to best move forward in a coordinated fashion, and considered potential collaborative research opportunities going forward in the region, many of which are still being explored.

Of particular note, studies with a focus on including more than one city or municipality were of interest to the group. Those are: The US DOT Quantification Initiative, the Department of Defense / US Navy Joint Land Use Study, the William and Mary Center for Coastal Policy Studies/RTI Institute *Economic Consequences of Failing to Adapt to Sea Level Rise Impact in Hampton Roads Study*, and the Department of Interior work to *Quantify the Effects of Climate Change.*

The Forum sponsors are also very grateful to Mr. Steve Kolk for his presentation on the *Appraisal of Actuarial Climate Risk Index* development and processes, and to the City of Norfolk/US Army Corps of Engineers and the City of Virginia Beach/Dewberry Consultants, LLC for their willingness to participate and share the work they are doing for their specific cities.

It is the objective of the sponsors that a similar economic forum, with an emphasis on the economic impacts of sea level rise and recurrent flooding within the Hampton Roads Region, might be conducted on an annual basis within the region to continue to expand the level of analysis and collaborative understanding and action.

Overview of Presentations:

1. U.S. DOT Quantification Initiative: DOT's Collaboration with the Hampton Roads Sea Level Rise Pilot - (*Alan Strasser, Department of Transportation*)

(*Please refer to the slides uploaded to Digital Commons)

- DOT's role in Hampton Roads IPP
    - Participant in the Hampton Roads Intergovernmental Pilot Project (IPP) with the Infrastructure Working Group (IWG) and the Economic Impacts Working Group.
    - Some of the same methodology used in the Gulf Coast study (sponsored by DOT, 2012-2014) has been used by the IWG
- Objectives of DOT's Quantification Initiative
    - Supports Hampton Roads Pilot Phase I Report (2015)
    - In collaboration with Hampton Roads Pilot, DOT is developing a cost tool that provides methods for:
        - Voluntary grantee consideration of financial impacts in infrastructure planning due to climate change and severe weather.
        - Augmenting science-based implementation of the Federal Flood Risk Management Std. (EO 13690)
        - Prioritizing and managing U.S. DOT facilities to address EO 13653
    - This report will not present binding regulations. Input is needed so that it can become useful to specific areas.
- Why Quantification is Important?

    - Must have understanding of what the cost will be to prepare the national transportation network for climate change
    - Addresses what communities are most vulnerable based on private and public assets
    - Defines cost and vulnerability
    - Addresses what tools can assist in project-specific justification and prioritizing future investments
- Next Steps
    - Continue coordination with Hampton Roads Pilot and Hampton Roads stakeholders on asset RM and disruption analysis
    - Continue coordination with TRB/NCHRP and FHWA on cost-benefit studies
    - Seeking partnership opportunities

2. Transportation Asset Exposure, Adaptation Alternatives, and Infrastructure Resilience [Steering Committee Project Appraisal] - (*Bahar Barami / Volpe Center)*

(*Please refer to the slides uploaded to Digital Commons)

- USDOT/Volpe Overall Scope and Timeline
    - Quantifying scale/scope of climate change risks
    - Inventory data sources and baseline conditions
    - Evaluating conventional models and tools
    - Identifying infrastructure adaptation measures
- Approach

Analyzes Infrastructure Resilience as a function of a region's ability to:

    - Identify vulnerabilities to climate risks and prepare to mitigate them
    - Quantify the economic impacts of SLR and flooding
    - Chart alternative pathways for adapting to the risks
    - Implement effective and cost-beneficial adaptation actions
- Climate Risk Components
    - Measured as a function of 3 key metrics
        1. Sea Level Rise
        2. Storm Surge
        3. Land Subsidence
    - Proximity to the sea, high density urban development, and lack of protective structures increase exposure to hazard; Norfolk's exposure is among highest in HR, with over 10% of its infrastructure assets (valued $1.3B-$2.2B) at risk of damage from SLR and flooding
    - Region-wide vulnerabilities, measured as a function of asset concentration; sensitivity to damage; the number of tunnels and bridges; and reliance on port commerce
    - Magnitude of damage as a function of the scale and costs of physical infrastructure destruction, business interruption costs, and loss of access to jobs and transport
- Key Features of Norfolk's Network
    - Bridges, tunnels, and major highways dominate the Norfolk Transportation Network
    - Norfolk's I-64 intersections, tunnels, and bridges are major chokepoints in the region
- Actual and Potential Weather Damage Estimates in Norfolk
    - SHELDUS: $117M, or $2.2M per year
    - HAZUS-MH: $1.4B
- Dominant Sectors in Norfolk Economy: Potential Sources of Instability

    - Norfolk's high concentration of military- and port- infrastructure assets represents potential vulnerabilities to cascading economic downturns:
        - Military accounts for over 32% of civilian jobs in Norfolk
        - Ports/Transportation- with POV's total economic impact of $10B—and Public Administration jobs together account for another 30% of Norfolk's employment
        - With two thirds of its jobs in three climate sensitive sectors, Norfolk is vulnerable to severe downturns in its regional GDP
- I-O Model Estimates of the Direct and Indirect Impacts of Climate-Related Disruption
    - Norfolk's losses ranged between $26M and $56M. These direct costs accounted for only 38% of the total losses
    - Adding the indirect costs of losses from business interruption and loss of the means of livelihood/access to jobs would raise the total losses from direct and indirect damages by a factor of 2.6, to a range of $70M to $144.6M
- Adaptation Planning Tools: Multi-Criteria Decision Making (MCDA) Process for Priority Setting (Good example of the tools which have been used)
    - Multi-Criteria Decision Making (MCDA) planning tool & IIA I-O Risk Filtering model:
        - Focuses on the long term impacts
        - Assists regional planners to conduct vulnerability assessments
        - Calculates scores for each candidate improvement project across several scenarios
        - Helps planners to develop a priority ranking of the LRTP projects
        - Four Criteria for Prioritization
            1. existing facility plans;
            2. proposed LRTP and Capital Investment Plan (CIP) projects;
            3. TAZ location of significant segments of the region; and
            4. funding-agency multimodal policies
- Adaptation Planning Tools: CAPTool
    - Asset management system for identifying critical or high-cost assets, appropriate countermeasures for their protection
        - 6-Step adaptation planning process
        - Consequence Threshold→Countermeasure Opportunities
- Next Steps: Resilience Analysis
    - Volpe Resilience Framework (Future Tasks)
        - Expand the analysis beyond the baseline condition inventory to include a broader infrastructure resilience approach
        - Conduct a full scale analysis of the Pilot region's transportation risks
        - Develop proposal for cost-effective mitigation/adaptation measures
        - Incorporating RM goals from NASA, DOD. DHS, USACE, EPA, Regional Planning Agencies is likely to generate significant regional benefit multiplier effects
- Next Steps: Close Data Gaps
    - Reducing the Siloes of Databases and Estimating Models
    - Integrating SLR Adaptation Approaches with Longer-Term Mitigation Solutions
    - Removing the Siloes of Transport Modes and Economic Security Strategies
- Next Steps: Collaboration with USDOT/Volpe Center
    - Interagency Integration of Analytical and Estimating Tools and Models
    - Promoting OST's Twinning Strategic Approach to Climate Resilience
    - Collaboration with ODU and EIAC members on Economic Impact Assessment

- Final report will be available by the end of August
    - Plan on using the models to do a full adaptation resilience analysis
    - Open to collaborating and expanding to other jurisdictions. Want to be responsive to what stakeholders want.

QUESTIONS:

1. As more federal interests come to SLR Impacted area nationwide, does DOT envision a continued framework evolving?
    - *Will be meeting with NASA in the coming weeks. One of the issues that will arise in the meeting is the fact there is no lead federal agency*
2. Based on VIMS suggestion of 1.5 ft. is that what you used in the analysis?
    - *That's what was accepted for most scenarios. We defer to regional experts.*
3. How far did the period of analysis go out to?
    - *As far as 2100. Some of them go through 2065.*
4. As far as the source of alternatives that were listed, were those taken from literature or did the DOT develop their own?
    - *Did not go in too deeply into this. Did not do adaptation cost planning because they did not have the data.*

3. Joint Land Use Study (JLUS) Project and Scope (*Brian Ballard, Naval Facilities and Engineering Command, Senior Community Planning and Liaison Officer and Ben McFarland, Hampton Roads Planning District Commission, Planning Director)*

(*Please refer to slides uploaded to Digital Commons)

- Point of study:
    - Compatibility between US Navy facilities and local assets outside the Navy facilities' fence line on how to adapt to flooding and SLR
    - Protect the mission of the military
- Covers military facilities
    - Naval Station Norfolk, NSA Hampton Roads, Joint Expeditionary Base Little Creek-Fort Story, Oceana, Dam Neck
    - Key Areas of interest: Norfolk/VA Beach and Portsmouth/Chesapeake
- Joint Base Langley-Eustis Study
    - Looking at climate adaptation and coordination
    - Sharing information across the waters
- Currently in the first phase
    - Organizing with the help of HRPDC
        - Developing/defining the scope
        - Establishing the coordination bodies (technical, and policy body)
        - 24 month process
- Overview on interest of working on these projects
    - By helping the military installations we are helping our communities (win-win)
    - Studies will offer a lot moving forward for Department of Defense Office of Economic Analysis (DOD OEA)
        - Planning coordination, compatibility factors, climate adaptation, communication, infrastructure, land use initiatives (local and state), roadway capacity, water quality. Developing an implementation plan and identify who's responsible for implementing.

- This study is the first of its kind and the OEA is taking it very seriously.
- Still in the process of developing the scope phase. –Will be hiring a consultant for both projects.

QUESTIONS:

1. Can you elaborate more on the transportation piece?
   - *As far as Norfolk and Virginia Beach they have an issue of roadways that are critical for people to use to get to military bases. Many people work in one community and live in another. We try to follow the impacts wherever the analysis takes us. Portsmouth has congestion and traffic issues along the Naval Medical Center. Hampton Roads Transportation Planning Organization (HRTPO) will be participating and Virginia Department of Transportation (VDOT) as well. There will be more to come.*
2. Will you be refining the economic analysis models? Will it be on a regional level or facility level?
   - *We haven't finalized the scope yet so we're not sure.*
3. Will the recommendations be physical or process oriented?
   - *Both process and physical (tangible efforts)*
4. Is there any consideration of public/private funding?
   - *High level political senior staff have the power/responsibility to decide. Important to note that just because you start a study it doesn't mean you will get that funding (we are competing with other studies).*
5. The JLUS effort will be able to obtain lessons learned. How will you ensure that there is a handoff?
   - *We will have some of the expertise from the pilot participate. Our consultant will look at this as well as VDOT.*
   - *Public engagements- all 4 federal localities will incorporate some sort of public engagement. From there they will handle their own local communities separately.*

4. *Economic Impact and Sea Level Rise: Economic Consequences of Failing to Adapt to Sea Level Rise in the Hampton Roads Region- (George Van Houtven and Brooks Depro, RTI International, supporting Center for Coastal Policy Studies, College of William and Mary – briefed by virtual connection)*

(*Please refer to the slides uploaded to Digital Commons)

- Main objective of the study
  - Assess the potential costs and economic impacts of not adapting to sea level rise in the Hampton Roads region.
- Two main components of Analysis
  - TASK 1: Analysis of damage costs due to sea level rise
    - Collecting parcel level data from HR area and using a risk based approach
  - TASK 2: Analysis of the regional economy-wide impacts of sea level rise
- Key questions for Task 2
  - What types of questions can be answered through economy-wide modeling?

    - Sea level rise brings about local damages.
        - Do damages spread or ripple through the broader economy?
        - Do ripples move in unexpected ways?
        - How significant are these secondary effects? Are we talking about ripples or waves?
        - Are there some sectors and income classes overly harmed (or helped)?
- Example Model Run: 100-Year Flood
    - Based on HAZUS-MH model runs for coastal flooding in 12 counties, estimated building value loss of about 3%.
    - Modeled these impacts as a 3% reduction in capital available to Hampton Roads Economy
- Economic Impact Indicators: Real GDP
    - Virginia economy shrinks
        - State of Virginia: $4.0 billion loss
            - Hampton Roads: $0.8 billion loss
            - Rest of Virginia: $3.2 billion loss
- Average consumer prices rise: Consumer Prices
        - Hampton Roads: increase by 3.4%
        - Rest of Virginia: 1.4%
- Economic Impact Indicators: Equivalent Income Change
    - State Income levels divided into 9 income classes
        - VA Equivalent Household Income Loss: $940 million
        - Range: -4.6 billion to +$15 billion

QUESTIONS:

1. Will you be able to evaluate some sort of transition matrix? (A matrix that shows transition from no loss→ to 75% loss→ to full loss)
    - *Only to the extent that we'll look at all parcels. We can show what kind of damage we would expect from each level. We can try to highlight that towards the end.*
2. What was the vertical data for those elevations? (referring to slide 13)
    - *It was in reference to the tide gauge where the 100 year flood is 2 meters above high tide.*
3. Data is different based on different localities. You're not looking at the structure itself if you're just looking at the parcel. Have you considered using the maximum elevation?
    - *Since we don't have the elevation of structures, maybe a better way to go would be to use the max elevation. This method would possibly be overestimating damages but would still be accounting for it.*

5. Quantifying the Impacts of Climate Change to the Department of the Interior- (*Johnathan Steele Climate Change Coordination, Office of Policy Analysis, & Christian Crowley, Economist, Office of Policy Analysis, U.S. Department of the Interior (DOI))*

(*Please refer to the slides uploaded to Digital Commons)

- DOI Climate Change Climate Preparedness Overview
    - Overview of DOI Mission

        - The goal is to work with partners and stakeholders and come together to develop a landscape conservation plan. Develop a strategy and implement that plan.
    - Initial Bureau Activities
        - National Park Service (NPS)
        - U.S. Fish and Wildlife Service (FWS)
        - U.S. Geological Survey
    - Secretary Order 3289
        - Landscape Conservation Cooperatives
        - Climate Science Centers
    - DOI Climate Change Adaptation Policies and Guidance
        - Departmental Manual Chapter (2012)
        - Guidance Documents (Health and Safety, Training, Facilities)
- Purpose and Goals of DOI's Work to Quantify Impacts of Climate Change
    - DOI's work is primarily in response to Executive Orders 13653 (Section 5) and 13693 (Section 13)
    - DOI Leadership interest in quantifying climate change impacts on DOI's water management responsibilities
    - Goals include:
        - Develop a framework that could be adapted and applied to other DOI regions and mission areas
        - Develop a better understanding of DOI's financial exposure to climate change
        - Develop a better understanding of costs for management options to manage climate change
    - Focused on 54 DOI sites in VA, NC, SC, and GA
- Estimating DOI's Financial Exposure to Climate Change in the Southeast U.S.
    - Looking at a cost and action approach
        - What impacts could we expect if the government took no sort of climate impact policy
    - Cumulative costs for 2015-2100 are $9-$10 million (2015-$)
- Basin Studies out West
    - Trying to forecast what water demand will be in the next half century
- SLAMM: Sea Level Affecting Marshes Model
    - Accounts for the dominant processes in wetland conversion and shoreline modifications during long-term sea level rise
    - Integrates SLR with infrastructure information

QUESTIONS:

1. Are you interested in the indirect impact issue?
    - *Currently not doing a study on that; we're more interested in looking at value at risk.*

6. AN APPRAISAL OF THE ACTUARIES' CLIMATE RISK INDEX (ACI): to Address Sea Level Rise Issues at Hampton Roads and Beyond- ***(Steve Kolk, Assistant Vice President of Pricing, American Integrity Insurance Company of Florida)*** (*Please refer to slides uploaded to Digital Commons)

Mr. Kolk was the lunch speaker and made remarks about the history of the ACI and the potential of the Actuarial Climate Risk Index (ACRI). He also addressed benefits of collaboration with the Volpe Center / DOT Study showing how the DOT pilot study could help actuarial work. He further outlined the benefits to actuaries of further study of SLR in Hampton Roads, which includes the following three items:

1. BETTER GRANULARITY: Refined data could improve the ACI giving Property Casualty with work by State. Further, the county detail would give necessary coastal reference points for measuring climate extreme impacts of Seal Level Rise (SLR).

2. BETTER USE OF DATA: Actuaries could help the Hampton Roads Pilot teams make best use of the wealth of data gathered to solve SLR problems

3. BETTER SCIENCE The analysis could be enhanced with expert modeling and forecasting skills of NOAA scientists and others.

In addition, he shared some glimpses into future actuarial work incorporating new and expanded modeling of the impacts of Climate change in future actuarial decision making.

7. Planning for SLR Resiliency in Virginia Beach- *(Dr. Brian Batten, Senior Scientist, Dewberry Consultants, LLC, supporting City of Virginia Beach)*

- Resiliency Viewpoint
    - Ensure the vibrant future of Virginia Beach
    - Core Strategies:
        - Engage in Systems thinking
        - Achieve Multiple Positive Outcomes
        - Maintain a Long-term View
        - Be Proactive and Prevent Problems
        - Create an Accurate Positive Community Image
        - Create Relationships and Partnerships
        - Value and Promote Diversity
        - Ensure Sustainability
- Moody's (Bond rating company) Questionnaire to Virginia Beach
    - How coastal Virginia cities are addressing SLR/Recurrent flooding
    - Can be found on www.wetlandswatch.org
    - Responses show that the city is being proactive in addressing SLR/recurrent flooding.
- Proactive Project Design
    - Adopted recommendations
        - Explore additional 1.5 ft. of SLR in the design and documentation of infrastructure projects
        - 3 ft. for major projects
        - Can accommodation be meaningfully achieved?
        - How is design informed by these scenarios?
- Comprehensive SLR Study Approach
    - 3 building blocks with the foundation being what the impacts actually are
        i. Implementation

ii. Adaptation Strategies
iii. SLR/Recurrent flooding Impacts

- Phase 1: Impact Assessment
  - How will vulnerability change with increasing flood levels due to SLR?
  - Use SLAMM model
  - Know from past FEMA work the changes in surge propagation.
  - Loss model used: HAZUS
- Risk Assessment Focus Areas
  - Shoreline/Land Vulnerability
  - Building Exposure
  - Future Development
  - Stormwater
  - Groundwater
  - Roads
  - Public Utilities
  - Agricultural
  - Societal
- Building Loss Model
  - HAZUS
  - HAZUS Flood Module
- Phase 2: Adaptation Strategies
  - **Objective**: Develop, assess and prioritize a range of adaptation strategies through feasibility and performance metrics that incorporate stakeholder input to inform climate adaptation and resilience plans across the City's diverse geography.
- Phase 3: Implementation
  - **Objective**: Integrate the best-performing adaptation strategies in actionable watershed-based climate adaptation and resilience plans that include funding and monitoring mechanisms to stimulate follow-on implementation.

QUESTIONS:

1. Has the city done a value of information analysis? What is the cost benefit?
   - *Don't have the best answer for this at the moment.*
2. To what extent is anyone tracking losses?
   - *Currently looking at gauges that can be used to warn the community that there is danger ahead.*
   - *Right now we do a poor job of capturing and storing/managing damages. Looking forward, we want to continue the conversation of damage management.*

8. Norfolk Flood Risk Management Study- ***(Colonel Jason Kelly, U.S. Army, Commander, US Army Corps of Engineers Hampton Roads District, Susan Conner, USACE, Michelle Hamor, Flood Plain Manager, USACE, Christine Morris, City of Norfolk Resilience Director, Sherida Bonton, USACE Financial Manager)***

(*Please refer to the slide uploaded to Digital Commons)

- City of Norfolk is funding 50% of this study
    - Expected to follow the 3x3x3 rule
    - Making risk informed decisions as we move forward
- 6 Step Planning Process ("The Beehive")
    1) Identify problems and opportunities
    2) Inventory and forecast conditions
    3) Formulate alternatives- [Where we are right now]
    4) Evaluate alternatives
    5) Compare alternatives
    6) Select recommended plan
- SMART Feasibility Study Process
    1) Scoping 3-6 months
    2) Alternative formulation & analysis
    3) Feasibility Level & analysis
    4) Chief's report
- Federal Objective
    - The Federal objective of water and related land resources planning is to contribute to national economic development (NED) consistent with protecting the Nation's environment, pursuant to national environmental statutes, applicable executive orders, and other Federal planning requirements
- National Economic Development (NED)
    - Change in value of national outputs of goods and services
    - NED Cost = all costs required to produce the benefits
    - NED Benefit = positive cha
    - NED Benefit less NED cost= NED Plan
- Analytical Requirements
    - Take a systems approach so that it does not just pinpoint to one area
    - Incremental Analysis- Incrementally justify each
    - Life cycle analysis-
        - Moving towards an event based analysis
- Data
    - North Atlantic Coast Comprehensive Study (USACE, 2015)

    - Data set is different depending on which locality you're looking at
    - Models used in studies are located here: http://planning.usace.army.mil/toolbox/current.cfm?Title=Model%20Certification&ThisPage=ModelCert&Side=No1717
- Identifying the NED Plan
    - Net benefits are benefits less project costs (total life cycle costs, including environmental mitigation)
    - Compare across project scales and between alternatives to determine plan that yields greatest NED benefits
    - Defines how we will move forward
    - Decision-makers always have the final say
- Alternatives Milestone
    - Must have defined:
        - Existing Conditions
        - Future Without-Project Conditions
        - Array of Alternatives
        - Methods for Comparison
- Next Steps
    - Gap Analysis of available data
    - Come to a strong understanding and continue to develop management measures
    - Use Formulation Strategies to Develop Alternatives (still in the process of figuring this out)
    - Develop Screening Criteria and Modeling Strategy (still in the process of figuring this out)
- Post Study
    - Chief's (of USACE) Report to Congress (takes at least 3 years)
    - Congress authorizes the project for construction
    - Preconstruction, Engineering and Design (PED) phase begins
    - Project must be budgeted ("new start" construction currently very competitive)
    - Once federal and non-federal funds are both available, construction can begin

QUESTIONS:

1. What exactly are you doing for the city of Norfolk?
    - *Norfolk city wide flood risk management study. Looking at it as an entire city system.*
    - *Will provide alternatives for how we should address our flooding.*
2. How does this study work with JLUS and other studies?
    - *We will work/coordinate with representatives from each study panel*

- *Trying to align the work that we're doing to get teams and the same organizations involved in it. We want to be looking at the same stuff the same way. We want to create an open line of communication*.

3. Does the Corps (USACE) or district have preferred models? How many models and how do we choose?
    - *We are now in review of what models will be appropriate. It all comes down to what is appropriate to certify. We only have about 3 that we've considered for this study.*
    - *Looking to work with more event based models*
4. Is your lack of ability to certify models based off of statutory restraint?
    - *No statutory restraints- it is however an in depth process.*
    - *More of a resource review time and money issue*
5. Can someone petition to get models certified?
    - *It is a process that is dealt with internally. (It is the Physical science realm working on it and they don't generally let anyone else in)*

Invitation Letter:

Old Dominion University

The Economic Impacts of Sea-Level Rise in Hampton Roads: An Appraisal of the Projects Underway

May 18th, 2016
8:30-5:00
Virginia Modeling and Simulation Center
1030 University Blvd
Suffolk, VA 23435
Please save the day on May 18th to attend this important event.

There is a great deal of work being done on the economic impacts of sea level rise and recurrent flooding in Hampton Roads by a number of federal agencies, localities, university centers, and research institutes. This event is an attempt to get a sense of what projects are ongoing, the scope of those projects, and what current and future data needs exist, as well as to establish opportunities for collaboration for current and future work in this area.

The agenda features presentations from Department of Transportation, Department of the Interior, Department of the Navy, City of Virginia Beach, City of Norfolk, Army Corps of Engineers, Volpe Center, Dewberry, LLC, and RTI International.

After each project has been presented we plan to have an open discussion with all workshop participants on how to best move forward in a coordinated fashion, and to surface any potential collaborative research opportunities going forward in the region.

If you have any questions, please contact lfiler@odu.edu or annclairephillips@gmail.com.

Please RSVP by May 16th to Sagan Jackson, Center for Sea Level Rise, at sjack041@odu.edu.

We hope you can attend.

Sincerely,

Chip Filer
Associate Professor of Economics
Old Dominion University

Ann Phillips
Chair, Infrastructure Working Group
Old Dominion University Intergovernmental Pilot Project

The Economic Impacts of Sea-Level Rise in Hampton Roads: An Appraisal of the Projects Underway
Agenda

May 18th, 2016

Virginia Modeling and Simulation Center
1030 University Blvd
Suffolk, VA 23435

8:00 AM – 8:30 AM	*Continental Breakfast*
8:30 AM – 9:00 AM	*Opening and Introductions: The Economic Blue Print to prepare for climate change impact* Dr. Larry "Chip" Filer, Associate Professor, Old Dominion University Rear Admiral Ann Phillips, USN (Ret.) Chair - Infrastructure Working Group
9:00 AM – 9:30 AM	*Transportation Assets in Hampton Roads* Bahar Barami, Economist, U.S. Department of Transportation, Volpe Center Alan Strasser, Moderator - Steering Committee, Center for Climate Change and Environmental Forecasting, U.S. Department of Transportation
9:30 AM – 9:45AM	Q& A
9:45 AM – 10:15 AM	Joint Land Use Study / Naval Station Norfolk, Joint Expeditionary Base Little Creek / Fort Story, Dam Neck, Naval Air Station Oceana Department of the Navy/ Naval Facilities Engineering Command
10:15 AM – 10:30 AM	Q&A
10:30 AM – 10:45 AM	Break
10:45 AM – 11:15 AM	Economic Impact/ Sea Level Rise, The Cost of Doing Nothing Center for Coastal Policy, College of William and Mary / RTI
11:15 AM - 11:30 AM	Q & A
11:30 AM – 12:00 PM	Jonathan Steel, Climate Change Coordination Office of Policy Analysis; Christian Crowley, Economist, Office of Policy Analysis, Department of Interior
12:00 PM - 12:15 PM	Q &A
12:00 PM – 12:50 PM	Lunch

	Steve Kolk, Assistant Vice President of Pricing American Integrity Insurance Company
12:50 PM – 1 PM	Break
1:00 PM – 2:00 PM	Virginia Beach Comprehensive Sea Level Rise/Recurrent Flooding Study City of Virginia Beach /Dr. Brian Batten, Senior Scientist, Dewberry Consultants, LLC
2:00 PM – 2:15 PM	Q&A
2:15 PM – 2:45 PM	Norfolk Flood Risk Management Study U.S. Army Corps of Engineers / City of Norfolk
2:45 PM – 3:00 PM	Q&A
3:00 PM – 3:15 PM	Break
3:15 PM – 4:30 PM	Future Collaboration and Call to Action – Dr. Larry “Chip” Filer
4:30 PM	Adjourn

APPENDIX E-4

Pretty Lake Study

Hampton Roads Sea Level Rise Preparedness & Resilience Intergovernmental Pilot Project

The Little Creek/Pretty Lake Infrastructure Case Study Technical Report

Carol Considine[1], Ann Claire Phillips[2], and Maura K. Boswell[3]

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Abstract

Climate change is creating coastal risk for communities throughout the United States. Communities located along the coast are particularly susceptible to the risk of sea level rise. Sea level rise analysis and adaptation responses in coastal communities require consideration of the watershed boundaries, specifically horizontal boundaries of watersheds that cross multiple municipal boundaries. The Hampton Roads Intergovernmental Pilot Project, a whole-of-government and whole-of-community approach to planning for and adapting to sea level rise, focused on the Little Creek/Pretty Lake communities of Hampton Roads and their surrounding watersheds in southeastern Virginia as a case study for coastal resiliency. Meeting the challenge of sea level rise will require a multi-sectorial response that includes citizens, community organizations, industry, and government. Understanding the risks that lie ahead and working together to make critical decisions regarding adaptation strategies and actions will be necessary for success.

Additional Key Words: sea level rise, storm surge, pilot project, infrastructure

Introduction

Cities, towns, and localities around the world will be impacted by the effects of climate change. Installations located along coastlines are already being impacted by sea level rise and face an increasing threat of flooding in the future. The impacts of sea level rise include risk to both structural components and operational components which can hurt regional and local economies (HRTPO 2016). This case study focuses on one cross-border region - the Little Creek/Pretty Lake communities - located in the Hampton Roads region of southeastern Virginia.

The Hampton Roads region is located in southeastern Virginia at the confluence of the Chesapeake Bay and Atlantic Ocean. As shown in Figure 1, it is home to 26 federal installations (DoD and non-DoD) and 17 municipal governments. It is recognized as being second only to New Orleans as the largest population center at greatest risk to sea level rise (IEN 2011). Municipalities located adjacent to the Atlantic Ocean and Chesapeake Bay are already experiencing the impacts of sea level rise and many are proactively planning to mitigate sea level rise impacts. The Hampton Roads region is experiencing sea level rise at approximately twice the global rate (Boon 2012; Ezer and Corlett 2012a, 2012b; Sallenger et al. 2012). This increased rate of sea level rise regionally is due to land subsidence and the slowing of the Gulf Stream (Boon et al. 2010; Ezer et al. 2013).

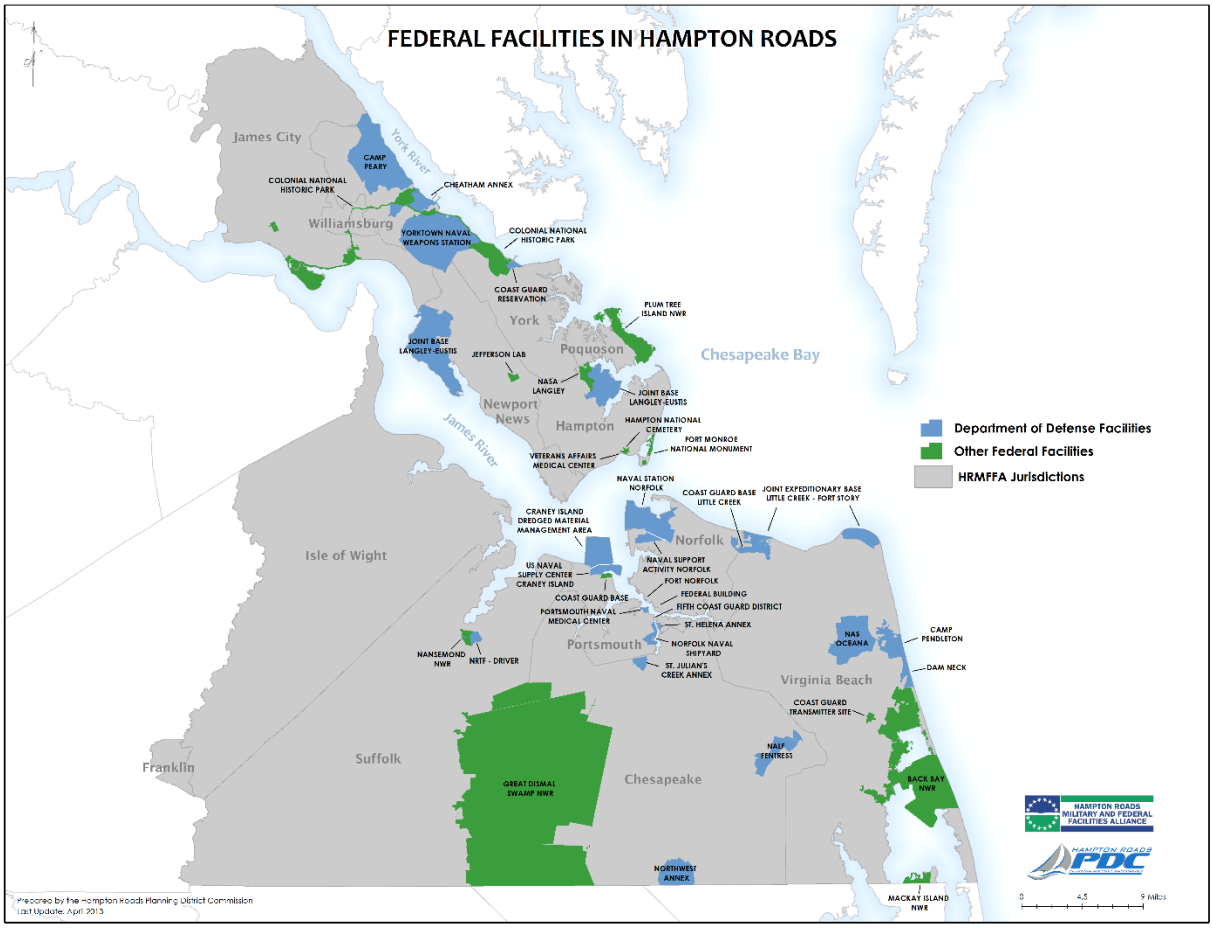

Figure 1 Hampton Roads Municipalities and Federal Installations.
Map produced by the staff of the Hampton Roads Planning District Commission, 2016

The 17 jurisdictions in the Hampton Roads region have historically planned and governed independently of one another. Adaptation planning for sea level rise is no exception. Currently there is no entity coordinating sea level rise planning for the region. Instead, each municipality is determining their own sea level rise planning scenarios and evaluating adaptation strategies independently of one another. In addition, the Department of Defense has evaluated sea level rise impacts to Naval Station Norfolk, but the analysis does not include impacts to local adjacent municipalities (SERDP 2013).

While it is not unusual for local, state, and federal entities to limit their planning to jurisdictional boundaries, water is not bound by those same geographic constraints. Planning for sea level rise will require that local, state, and federal entities consider functional boundaries of ecosystems or watersheds, rather than political boundaries. This will require coordination between local, state, and federal entities so that actions of local municipalities do not interfere with one another or the mission readiness of federal entities in the local area. Sea level rise preparedness actions led by local municipalities, if coordinated with each other and the federal installations, can increase resiliency for the entire region. Coordination and collaboration between entities can help achieve optimal outcomes.

The Hampton Roads Intergovernmental Pilot Project

The Hampton Roads Intergovernmental Pilot Project (Pilot Project) is a two year "whole-of-government", "whole-of-community" effort to recommend a governance structure for sea level rise planning in the Hampton Roads region. The Pilot Project was structured to be led by a Steering Committee and included five working groups (Legal, Infrastructure, Land Use Planning, Citizen Engagement, and Public Health) and five supporting committees (Economic Impacts, Private Infrastructure, Municipal Planning, Senior Advisory, and Science). The Steering Committee included high-level leaders at multiple levels of government (local, state, and federal) and from multiple sectors, including business, non-governmental, and civil society. Each of the working groups and committees were staffed by volunteers, with the majority of the chairs and co-chairs of the committees lead by faculty and staff affiliated with Old Dominion University, and the College of William and Mary. The Pilot Project was convened at Old Dominion University in the Center for Sea Level Rise.

While the intent was for the Steering Committee to lead the Pilot Project effort, it was the collaboration between working groups and committees that spearheaded the work. The Infrastructure Working Group (IWG) and Private Infrastructure Committee (PIC) focused on critical infrastructure through the selection of a case study area and scenarios of sea level rise and storm surge for analysis of risk and development of a process for collaboration across multi-sectorial organizations. The case study area was also adopted by the Citizen Engagement and Public Health working groups. The case study approach provided a context for local, state, and federal governments, and private industry to work together to evaluate the impacts of sea level rise on critical infrastructure and understand what mechanism could be employed or developed to provide collaborative solutions.

Process of Selection of the Case Study Location

The IWG conducted a thorough review of existing studies related to sea level rise impacts in the Hampton Roads Region, and considered other relevant studies that, while not specific to Hampton Roads, might contribute to gaining better insight and understanding of the challenges related to whole of government and community sea level rise adaptation planning. These efforts were undertaken to identify critical infrastructure suitable for a case study for the Pilot Project.

Early in the study review process, the Department of Transportation (DOT) identified the "Impacts of Climate Change and Variability on Transportation Systems and Infrastructure: The Gulf Coast Study, Phase 2" (GC II) as an example of identification and prioritization of infrastructure projects impacted by climate change. Of particular interest was the methodology matrix, referred to as a Criticality Assessment tool, used by U.S. Department of Transportation, Mobile Metropolitan Planning Organization and the South Alabama Regional Planning Commission (SARPC) and supporting engineering firms to determine which transportation

infrastructures were most critical and most vulnerable to, in this case, storm surge along the Mobile Alabama Gulf Coast as evaluated against socioeconomic, operational, and health and safety criteria (Gulf Coast Study 2016).

The IWG initially attempted to use the GC II Criticality Assessment Tool matrices exactly as depicted in the GC II work, with evaluation criteria modified for the Hampton Roads region in the selection of the study area for Phase II of the Pilot Project, and reproduced the GC II matrix in its entirety for this purpose. Eventually, the IWG realized that a full re-development of evaluation criteria for the matrices was too complex for the scope of the Pilot Project, and instead designed a similar, simplified version of the GC II matrix, (Evaluation factors shown in Table 1, Case Study Decision Matrix shown in Table 2) for use in determining selection of an appropriate critical infrastructure study area.

The IWG used some of the criteria selected by the GC II, and then added in its own criteria, most specifically to ensure the infrastructure selected for study stressed the whole of government planning challenges by including more than one city or municipality and at least one federal or state agency in the study area. Selection of critical infrastructure that would illuminate the challenges of multiple agencies and stress the overlapping nature of such an effort, or the absence of such coordination criteria, for the purposes of coordinated adaptation planning seemed appropriate.

Additional criteria included consideration of the regional economic impact and availability of existing data on the infrastructure and infrastructure system in question. Members of the IWG brought forward particular infrastructure projects for consideration, in some cases soliciting their professional peers outside the IWG for their suggestions. This led to the group creating a list of potential critical infrastructure options which were then evaluated and scored

against the evaluation and weighting criteria developed for the Pilot Project. The final three infrastructure systems considered were:

- Little Creek/Pretty Lake Communities
- Hampton Blvd. - including Norfolk International Terminal, Naval Station Norfolk, and Old Dominion University
- Sentara Hospital/Fort Norfolk, Brambleton Avenue

From these three infrastructure systems, the IWG selected the Little Creek/Pretty Lake communities as best meeting Pilot Project objectives.

Table 1 Evaluation Matrix Factors

Factor	Factor Weight*
Feasibility	Screen
Data Availability	Screen
More than 1 Agency (Ownership &/or Regulation)	Screen
More than 1 Municipality (Location)	2
At least 1 Private Utility	1
Lack of Redundancy	1
Known Problem Area	2
Evacuation Route	2
National Security Impact	3
Votes (7/13/15 End of Meeting)	1
Regional Economic Impact	2

*Screen is “1” for yes or “0” for no

Assessing Criticality and Vulnerability - Hampton Roads, Virginia													
Infrastructure Planning Working Group, Hampton Roads Intergovernmental Planning Pilot Project													
Final Version 13 July 2015													
Factor Weights	**Screen**	**Screen**	**Screen**	**2**	**1**	**1**	**2**	**2**	**3**	**1**	**2**		
	Feasibility	Data Availability	More than 1 Agency (Ownership &/or Regulation)	More than 1 Municipality (Location)	At least 1 Private Utility	Lack of Redundancy	Known Problem Area	Evacuation Route	National Security Impact	Votes (7/13/15 End of Meeting)	Regional Economic Impact	Score	
Little Creek and upstream lakes	1	1	1	1	1	0	1	0	0	7	0	12	
HRBT & Approaches	0	1	1	1	1	0	0	1	1		1	0	
Hampton Blvd. (NIT, NOB, ODU; Lafayette River Br approaches)	1	1	1	0	1	0	1	0	1	4	1	12	
Sentara/Fort Norfolk/Brambleton/Mid-Town Tunnel Area	1	1	1	0	1	0	1	1	0	1	1	8	
Atlantic Ave and/or Laskin in VB	1	1	0	0	1	1	1	0	0		1	0	
Port Access to NIT (& VIG & PIT off of Hampton)	1	1	0	0	1	0	1	0	1		1	0	
Elizabeth River Shipyards (incl'g PNSY)	1	0	1	1	1	0	1	0	1		1	0	
Wetlands as it relates to fishing industry	0	1	1	1	1	1	1	0	0		1	0	
Surry Nuclear Power Plant	0	0	1	0	1	1	0	0	1		1	0	
Newport News Reservoir	1	1	0	1	1	1	1	0	0		1	0	
Newport News Shipbuilding (HII)	1	0	1	0	1	1	1	0	1		1	0	
Langley	1	0	1	0	1	1	1	0	1		1	0	
NOB	1	0	1	0	1	1	1	0	1		1	0	
Airport (ORF)	1	0	1	0	1	0	1	0	0		1	0	
Norfolk & Portsmouth Beltline	1	0	1	1	1	0	0	0	0		1	0	
										12			

Table 2 Case Study Decision Matrix

Process of Selection of Scenarios

Once the IWG selected the critical infrastructure area of Little Creek/Pretty Lake communities, it next turned to the selection of scenarios for evaluation of sea level rise and storm surge. One of the challenges to making such a determination was deciding which sea level rise curves to use. NOAA, the US Army Corps of Engineers, and Virginia Institute of Marine Science (VIMS) all have created sea level rise curves specific to the Hampton Roads Region. All three curves vary in future sea level rise estimates; however, the NOAA and VIMS curves are closely aligned as shown in Figure 2 and Figure 3. To complicate matters, cities and municipalities within the Hampton Roads region have worked with engineering firms to develop scenario curve interpretations that, while using the same data as the Federal and VIMS curves, interpret the potential sea level rise timelines in different ways, in large part due to planning considerations for the individual cities. The IWG initially selected a series of three specific timeframes (near, medium, far) and then selected sea level rise elevations from the curves within those timeframes to evaluate the impact on critical infrastructure within the Little Creek/Pretty

Lake communities study area. In addition to the scenario projections for sea level rise, the IWG also added the consideration of the storm surge associated with a 100-year storm.

After evaluation by planning departments in several of the cities participating in the Pilot Project, there was concern that the scenarios selected, and the timeframes chosen, portrayed sea level rise elevations that exceed those under current use by those cities, and in particular exceeded levels they used to address sea level rise planning with their constituents. The cities requested that the IWG consider modification of the sea level rise scenarios selected to more closely align with those in current use by the cities, and specifically requested any timeframes related to those scenarios be removed. Given the wide diversity and inherent uncertainty among the various temporal projections, it was agreed that for the purposes of all parties continuing with the Pilot Project, it would be more straightforward to simply examine two specific sea level rise scenarios with the addition of storm surge associated with a 100-year storm. The language chosen and scenarios used are as follows:

"The Infrastructure Working Group and Private Infrastructure Advisory Committee will evaluate the impacts of relative sea level rise scenarios of 1.5 feet and 3 feet on selected infrastructure in Phase II of the Pilot Project. In addition, they will consider the impact of a "100-year flood" or the flood having a 1% chance of being equaled or exceeded in any given year on these two scenarios."

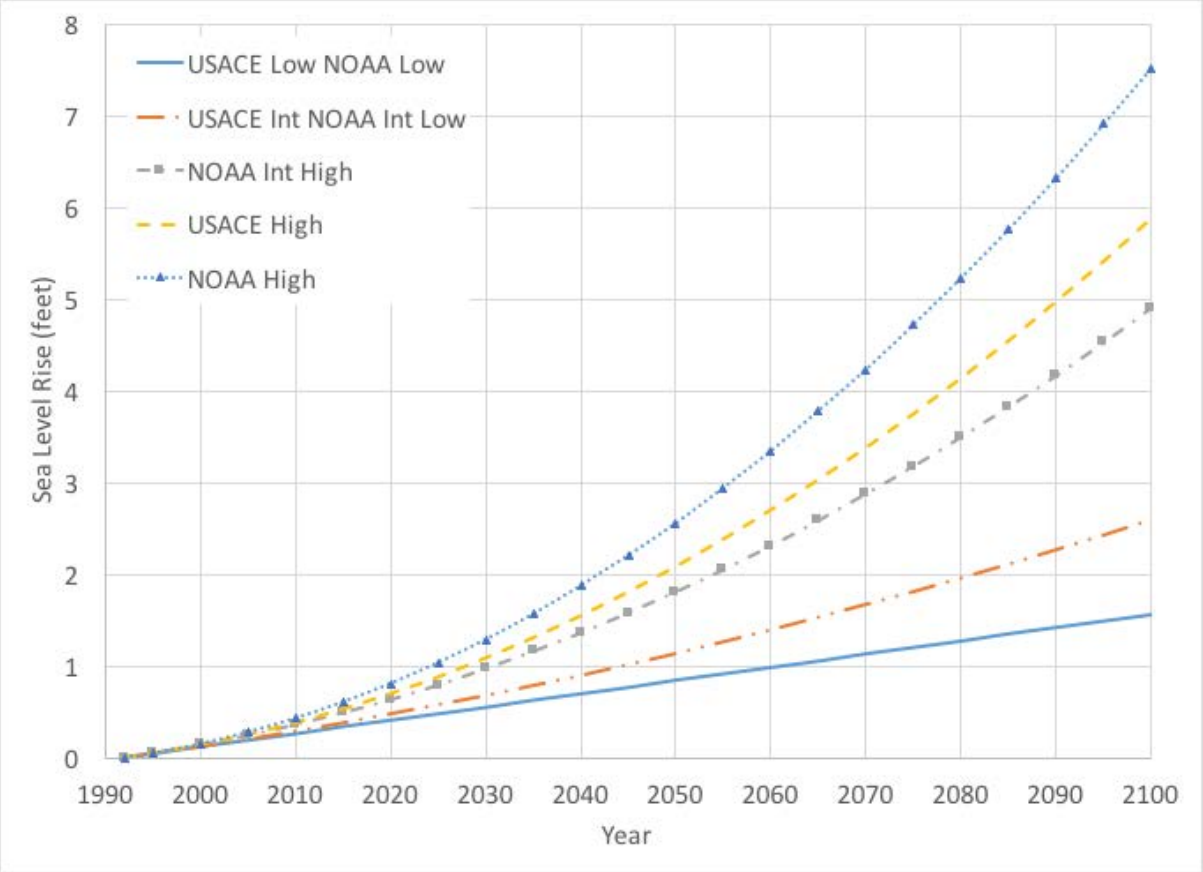

Figure 2 USACE and NOAA Relative Sea Level Rise Projections at Sewells Point

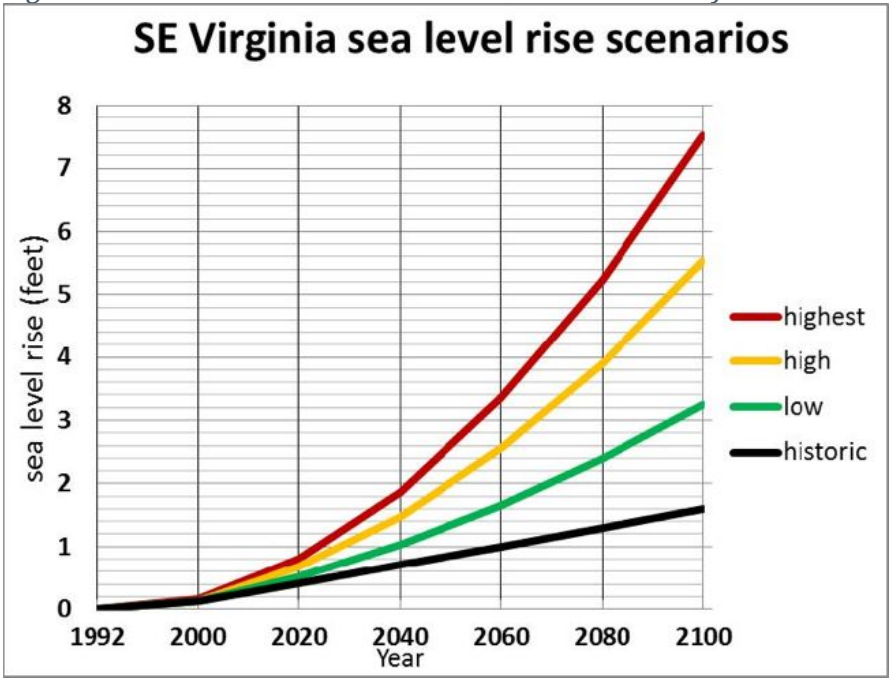

Figure 3 VIMS Relative Sea Level Rise Projections for Southeast Virginia

Case Study Overview

The Little Creek/Pretty Lake communities of Hampton Roads are located within the cities of Norfolk and Virginia Beach, and share watersheds with both cities and the Little Creek Amphibious Base. This is a relatively large watershed area with a narrow outlet to the Chesapeake Bay. The Little Creek Amphibious Base, shown in Figure 4, is located at the center of the watershed adjacent to the outlet to the Chesapeake Bay. The area is relatively low lying, with approximately 70% of the Pretty Lake area below 12 feet in elevation. The entire area is susceptible to flooding in major storm events.

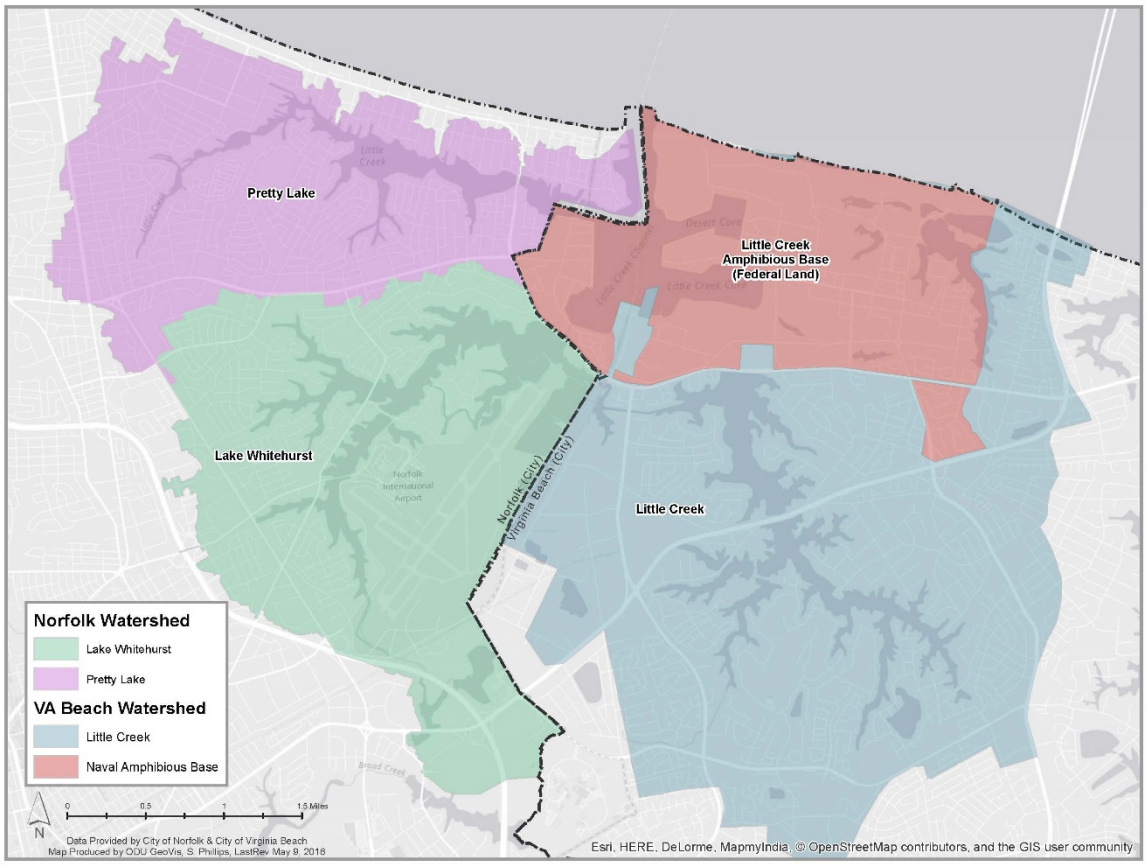

Figure 4 Little Creek/Pretty Lake Communities Case Study Area.

The City of Norfolk has included the Pretty Lake area in their Flood Protection Plan and in 2012 the City completed a 10% design development effort for a storm surge barrier to be located along the Shore Drive Bridge (Fugro 2012). The estimated cost of a storm surge barrier to protect Pretty Lake is $46.4 million (Fugro 2012) and would not protect the adjacent Little Creek Amphibious Base or neighborhoods in the City of Virginia Beach, both of which are susceptible to flooding. While the installation of the storm surge barrier at Pretty Lake may not increase flooding at Little Creek Amphibious Base or the Virginia Beach neighborhoods, a storm surge barrier located at the inlet to the watershed could provide storm surge and flooding protection for the entire watershed system.

Adaptation responses to sea level rise by any of these actors will impact each other, but no cooperative agreements are in place for a joint or collaborative response. This case study examines infrastructure at risk in the watershed, infrastructure interdependencies, and outlines mechanisms used for collaborative problem solving. The case study will demonstrate a path to collaboration that can inform communities and enable regional, multi-sectoral responses to sea level rise adaptation.

Watershed Context and Scenarios

Two of the City of Norfolk eight watersheds drain into the Little Creek/Pretty Lake communities' watershed system (City of Norfolk a 2016). Lake Whitehurst watershed contains Lake Whitehurst, a drinking water reservoir for the City of Norfolk and adjacent communities, and drains approximately 4.5 square miles of area. (City of Norfolk b 2016). Pretty Lake watershed contains Pretty Lake, a tidally influenced brackish water lake, and drains approximately four square miles of area. (Fugro 2012). The City of Virginia Beach Little Creek watershed drains approximately 12.8 square miles of area into the Little Creek/Pretty Lake

communities' watershed system and contains Lake Lawson and Lake Smith Recreational areas (Bernick 2009; City of Virginia Beach a 2016; City of Virginia Beach b 2016). The Little Creek Amphibious Base, located at the center of the Little Creek/Pretty Lake communities' watershed system, is approximately 3.3 square miles. (Little Creek Amphibious Base 2016)

The four sea level rise and flooding scenarios that were included in the case study are: (1) sea level rise of 1.5 feet, (2) sea level rise of 1.5 feet with 100-year storm surge, (3) sea level rise of 3.0 feet, and (4) sea level rise of 3.0 feet with 100-year storm surge (see Figures 5 through 8). These scenarios allow for the evaluation of sea level rise and the impact of low probability or infrequent, but high impact, flooding events.

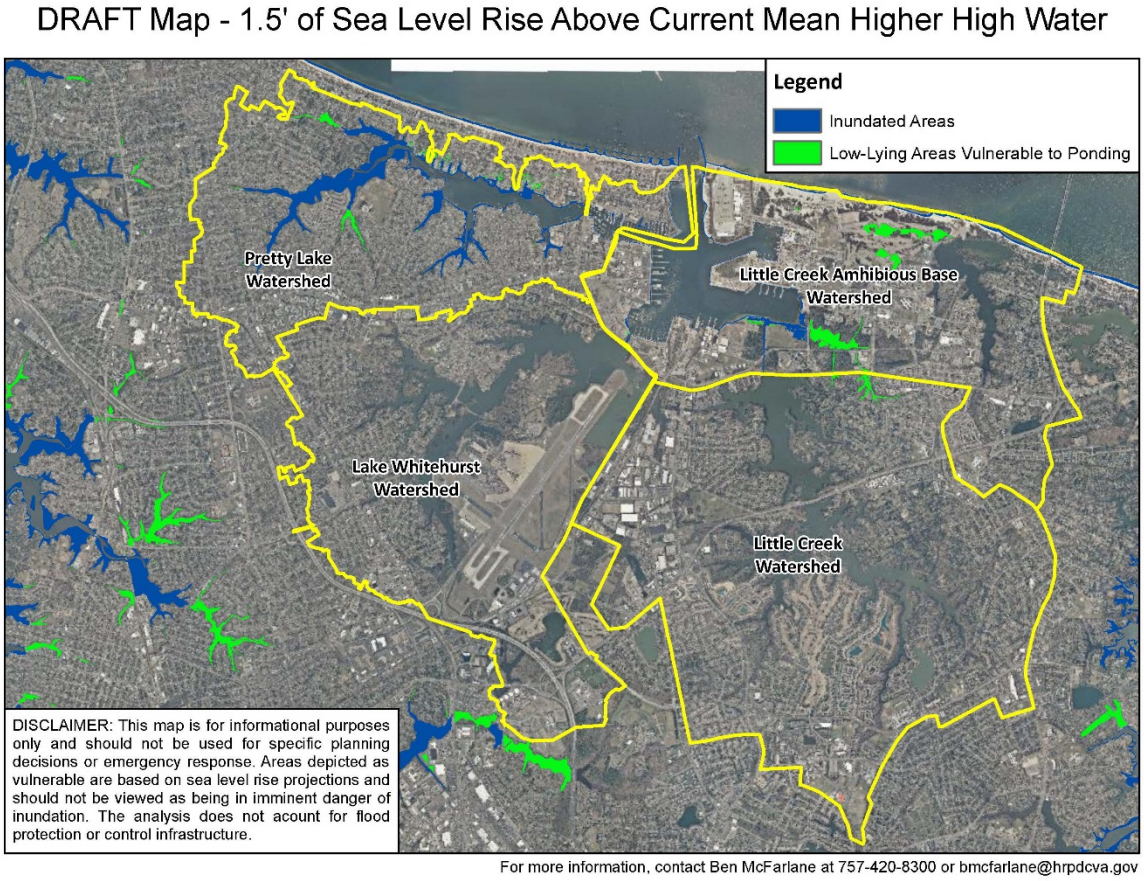

Figure 5 Case study area map, 1.5'of Sea Level Rise.
Map produced by the staff of the Hampton Roads Planning District Commission, 2016.

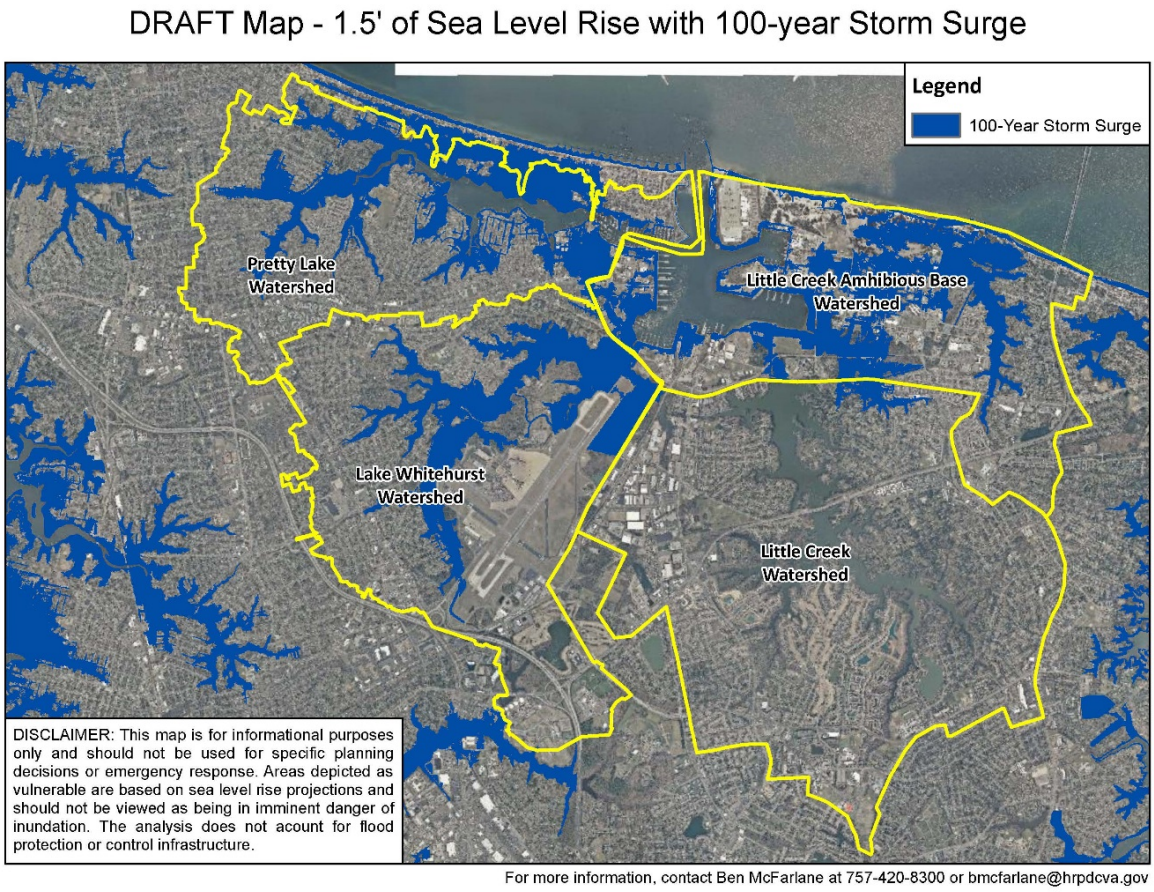

Figure 6 Case study area map, 1.5'of Sea Level Rise with 100-year Storm Surge
Map produced by the staff of the Hampton Roads Planning District Commission, 2016.

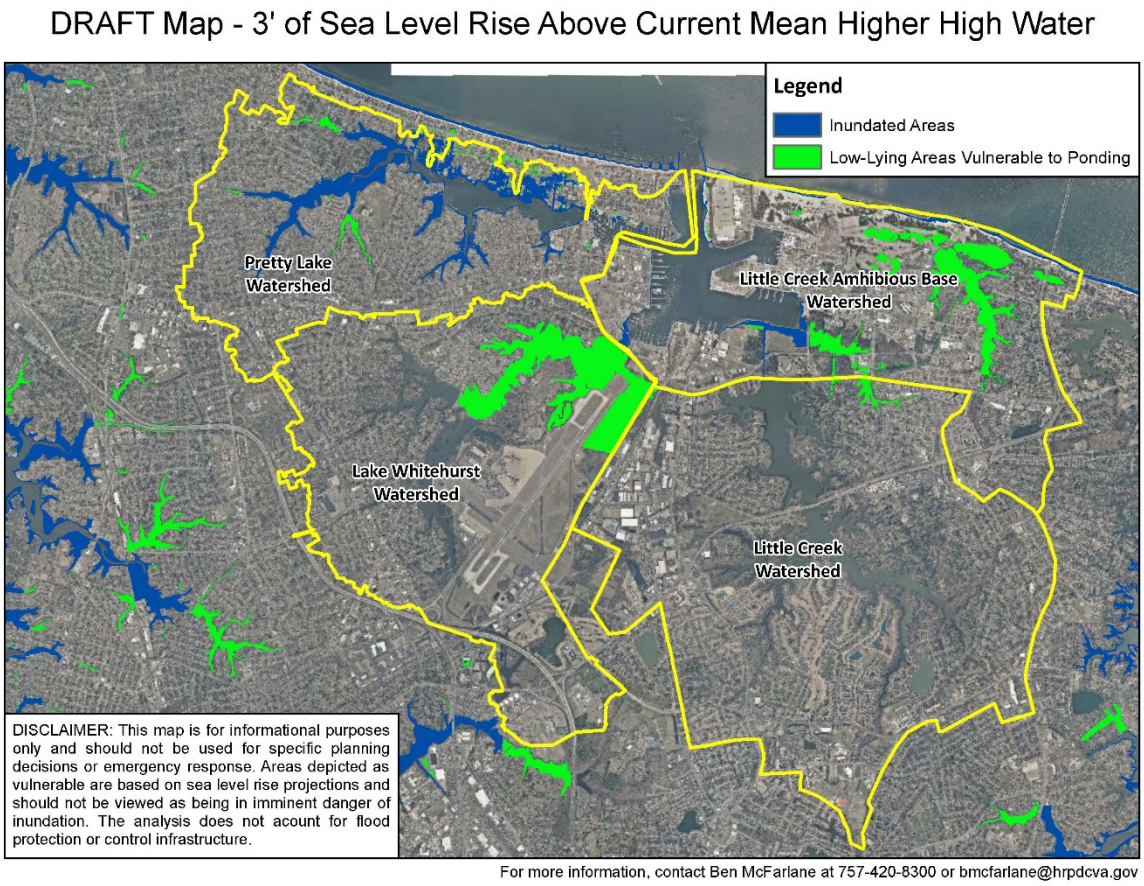

Figure 7 Case study area map, 3'of Sea Level Rise
Map produced by the staff of the Hampton Roads Planning District Commission, 2016.

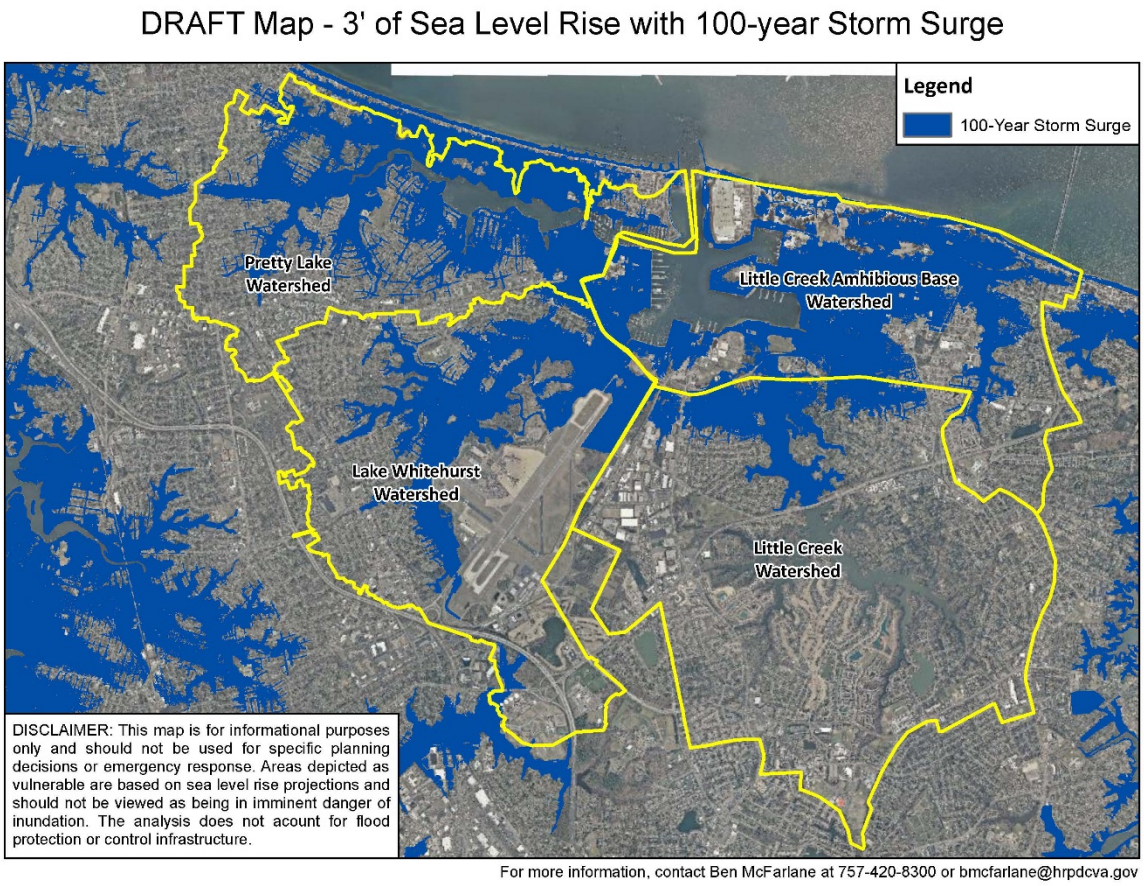

Figure 8 Case study area map, 3'of Sea Level Rise with 100-year Storm Surge. Map produced by the staff of the Hampton Roads Planning District Commission, 2016.

Infrastructure at Risk, Dependencies, and Interdependency Evaluation

The IWG, in conjunction with the PIC, focused on identifying critical infrastructure in the case study area that are at risk of sea level rise and flooding. With the assistance of the Department of Homeland Security representative to the IWG, and using DHS Infrastructure Taxonomy – Version 4 (February 2011), the IWG identified critical infrastructure within the scenario watersheds. The IWG then asked representatives from the Cities of Virginia Beach and Norfolk, and the Navy to validate the DHS information with their own knowledge of

infrastructure within the study area, and updated the DHS information accordingly. Figure (9) shown below, includes both the DHS critical infrastructure, and the releasable additions and revisions provided by both cities and the Navy (Naval Facilities Engineering Command).

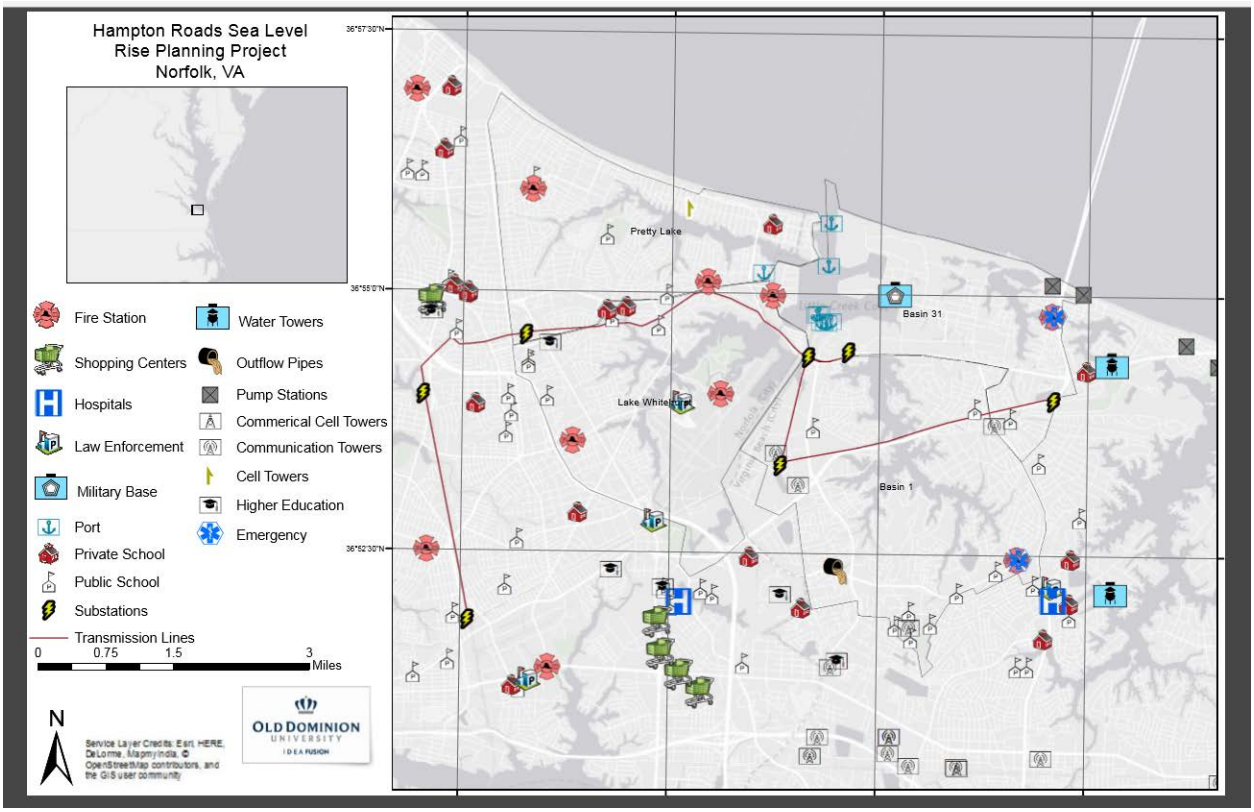

Figure 9 Little Creek/Pretty Lake Critical Infrastructure (Draft map 16 Sept)

The Cities of Norfolk, Virginia Beach, and the Navy, (Naval Facilities Engineering Command) further identified areas of infrastructure (at an unclassified level) within the study area that they felt were most critical and vulnerable to sea level rise across a range of dependencies and interdependencies. They were:

- Little Creek Channel
- Shore Drive Bridge (Includes Shore Drive vulnerability)

- Weir to Lake Whitehurst (Includes Shore Drive vulnerability)
- Weir to Little Creek Reservoir (Includes Shore Drive and Northampton Blvd (US Route 13) vulnerability)
- Weir to Lake Bradford/Chubb Lake

These vulnerabilities are also shown in Figures 10-13, VDOT Inundation maps..

The IWG and PIC then turned their attention to determining those elements of critical infrastructure most suitable for evaluation and deeper understanding of both internal and external dependencies and interdependencies. Not all critical infrastructure was evaluated for internal and external dependencies. The critical infrastructure evaluated for internal and external dependencies included: electrical, drinking water treatment and distribution, water supply, wastewater collection and treatment, and health/hospitals. In addition, the transportation system was evaluated based on inundation risk.

In order to understand dependencies (internal and external) of the critical infrastructure, members of the IWG and PIC mapped internal dependencies (i.e., dependencies within their own system), and external dependencies (i.e., dependencies on other infrastructure systems). The group's assessment of internal dependencies required the development of a list of internal factors that affect operations for each infrastructure system. For example, internal factors for a city sanitation system might include: collection system, power, pumping stations, force main, staff, communications, computer systems, vehicles and sustenance and supplies. Once a list of internal factors was established, that list was evaluated to determine vulnerability under the different sea level rise and storm surge scenarios. The evaluation of vulnerability was based on a scale of - not vulnerable (no impact), low vulnerability (less than 33% of impact), medium vulnerability (less

than 66% of impact), and high vulnerability (system impact greater than 66%). Table 3 provides a summary of infrastructure systems evaluated, their internal factors and their assessed vulnerability.

Table 3 Summary of Infrastructure Internal Factors and Assessed Vulnerability

Each system was also evaluated based on the dependencies of the internal factors on external infrastructure systems. For example, a city's sanitation system internal factors would be evaluated against the following external infrastructure systems: drinking water supply, electric, gas, communications (data/internet), communications (voice), air transportation, roads, rail, shipping, wastewater collection treatment, medical facilities, federal facilities, emergency services, and vehicle fuel. The infrastructure was then assessed according to the extent to which its internal operations depend upon the respective external infrastructure systems. The evaluation of threat to internal operations was based on a scale of: no threat (no impact); low threat (less than 33% impact); medium threat (less than 66% impact) and high vulnerability threat (system impact greater than 66%). In evaluating threat to internal operations, the existence of emergency planning was taken into account. For example, hospital systems may have a 72-hour emergency electrical supply or wastewater pumping stations may have a 24-hour emergency power back-up system. Table 4 summarizes the infrastructure system internal factors dependencies on external infrastructure systems.

Table 4 Summary of Infrastructure Internal Factors Dependencies on External Infrastructure Systems

Evaluation of infrastructure internal and external dependencies were combined into an overall assessment of risk and threat that spanned the entire case study area, irrespective of jurisdictional boundaries. Key findings include:

- The scenario of 1.5' of sea level rise will have no threat to critical infrastructure systems evaluated. Systems have already been hardened or are located at elevations where there is not an impact and no critical areas are inundated.
- The scenario of 1.5' of sea level rise with 100-year storm surge will have some threat to all infrastructure systems evaluated. There is a low threat to the medical facility, and City of Norfolk water supply and water distribution systems. There is a medium threat to electrical infrastructure and City of Norfolk wastewater and a medium threat to City of Virginia Beach wastewater and drinking water distribution.
- The scenario of 3.0' of sea level rise will have relatively low threat to City of Norfolk water supply, water distribution and wastewater systems. The City of Virginia Beach has a low threat to the collection system of their wastewater but no threat to the other parts of the system.
- The scenario of 3.0' of sea level rise with 100-year storm surge will have a high level or threat to infrastructure systems evaluated in the case study area except for one hospital which is located on relatively high ground just outside of the case study area.

In addition, once the initial dependency and interdependency matrices were completed, the Virginia Department of Transportation, Hampton Roads Transportation Planning section provided road inundation vulnerability maps for each watershed, showing the impact of from 1 to 6 feet of inundation. (VDOT, 2016, Figures 10 through 13) This inundation was not specific to sea level rise or storm surge impact, but could be caused by recurrent storm water flooding,

tidal flooding, or major weather event inundation. These inundation vulnerability maps are consistent with recent Hampton Roads Transportation Planning Organization studies (Belfield, HRTPO 2016) and with the IWG and PIC participants' best estimates of transportation impact as a dependency or interdependency under the scenario conditions outlined above and shown in the PIC and IWG dependency/Interdependency matrices.

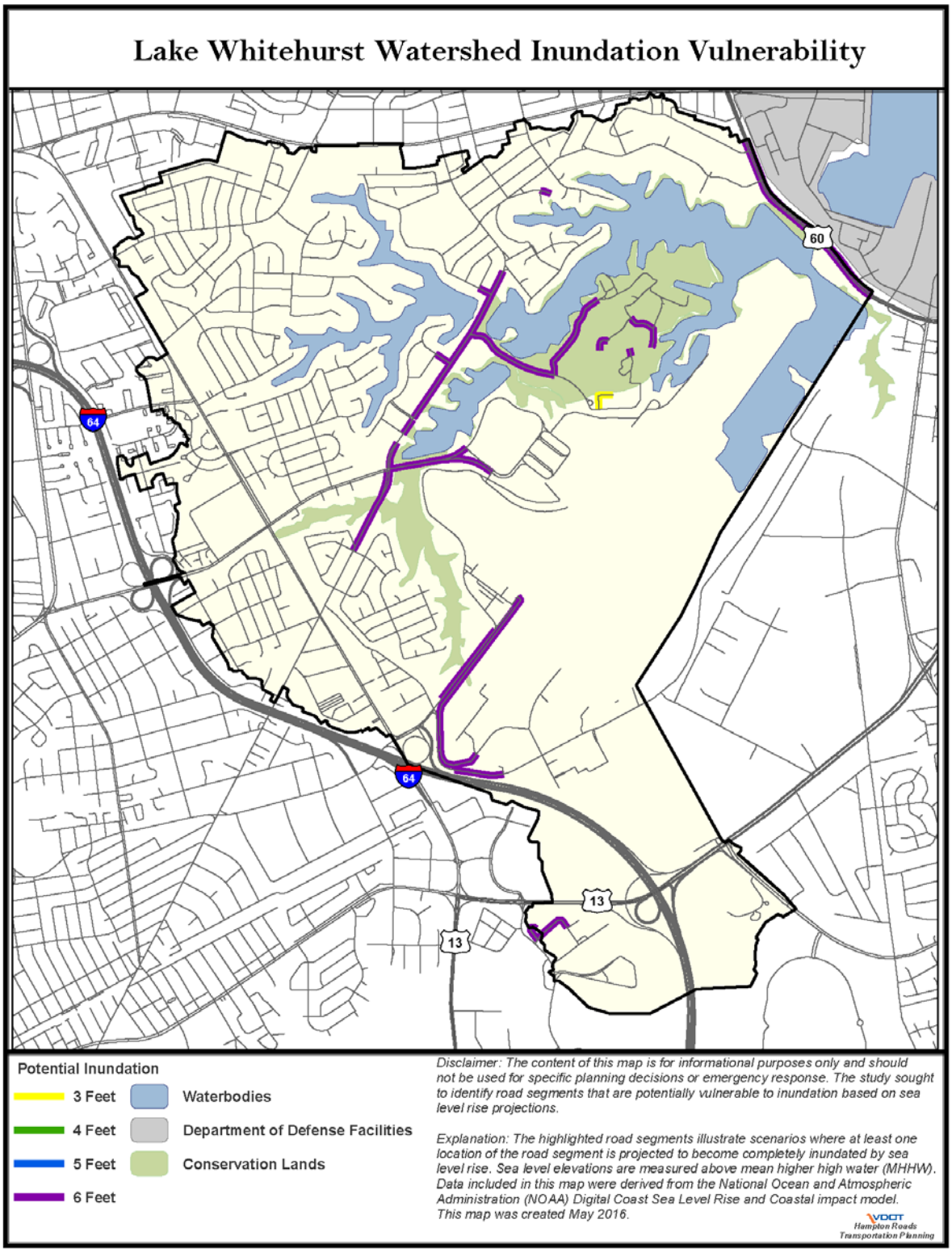

Figure 10 Lake Whitehurst Watershed Inundation Vulnerability

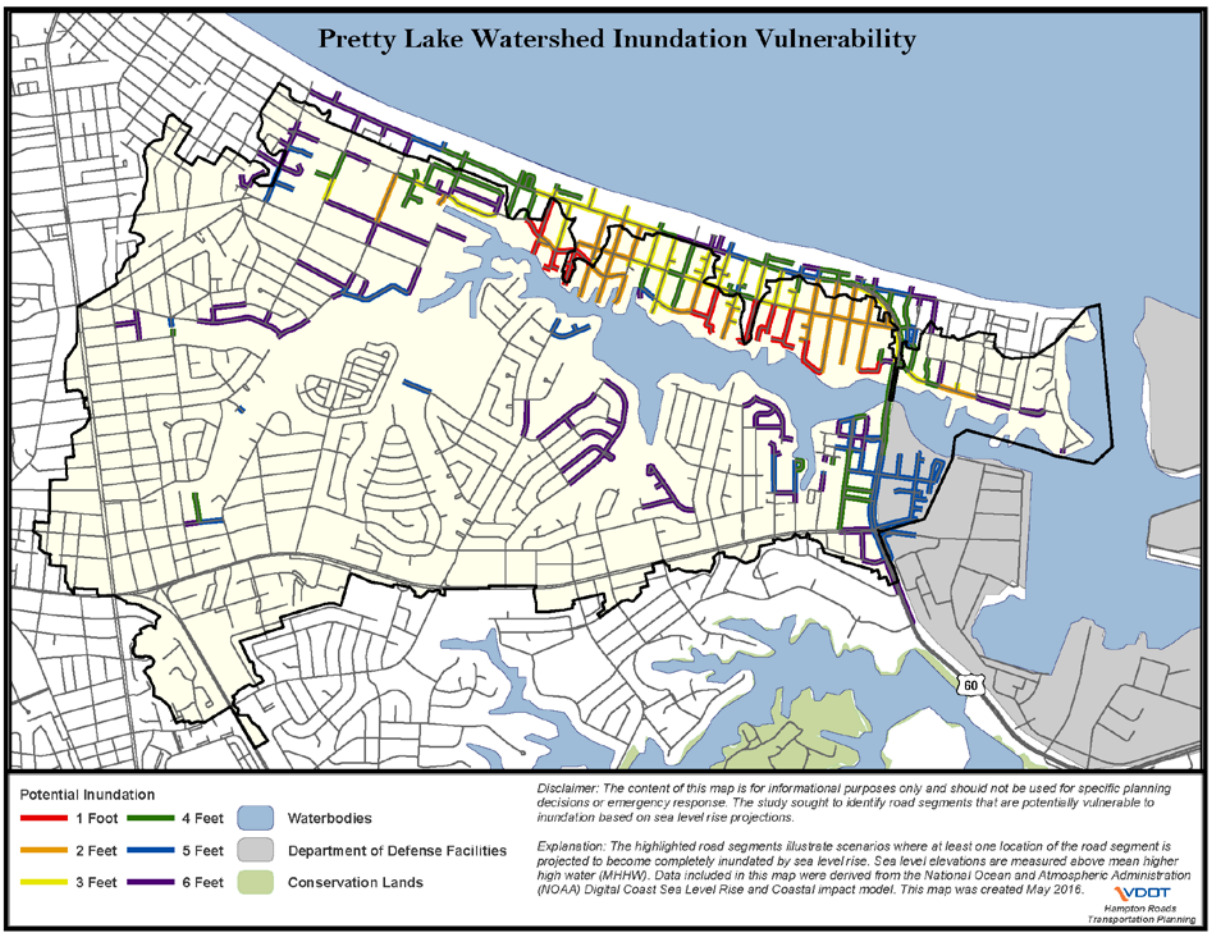

Figure 11 Pretty Lake Watershed Inundation Vulnerability

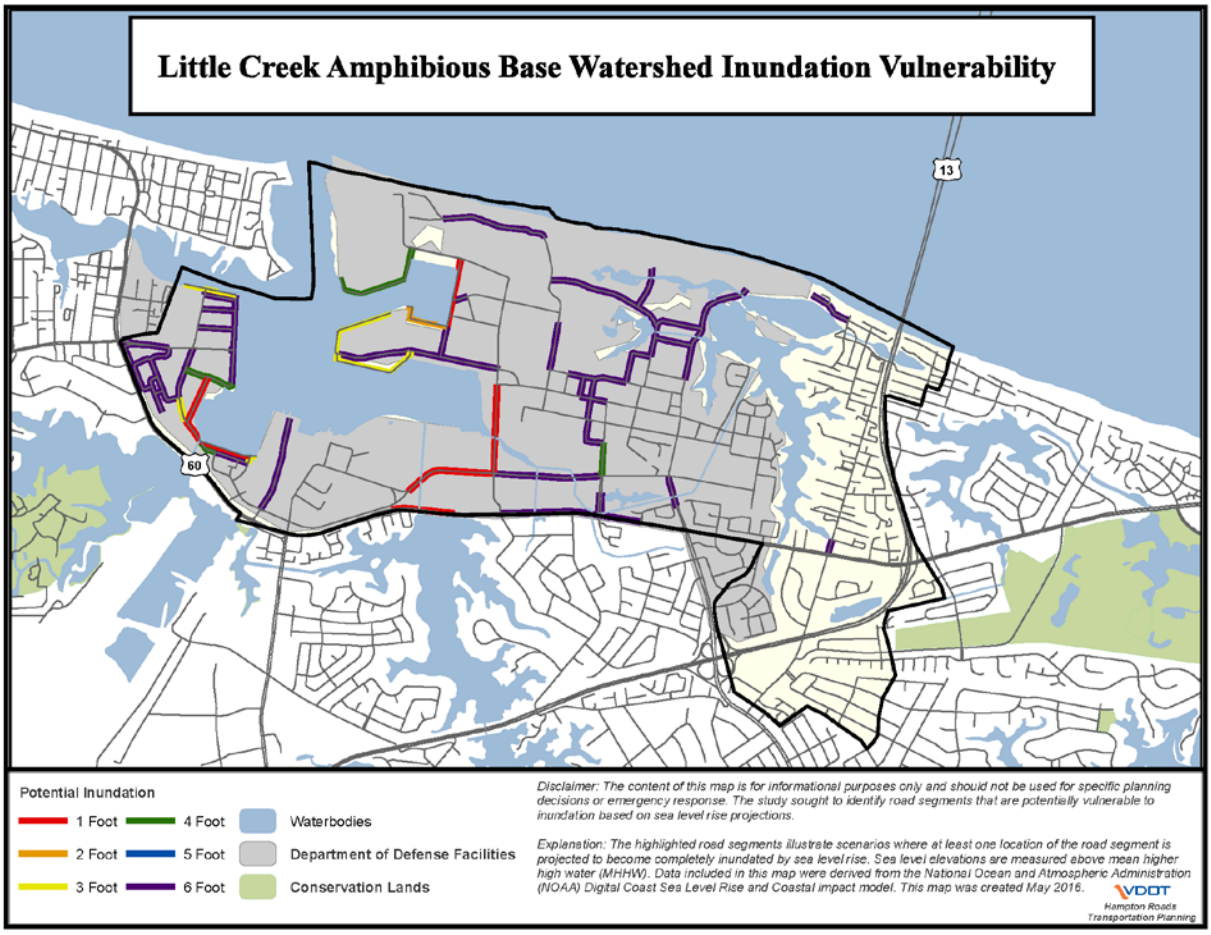

Figure 12 Little Creek Amphibious Base Watershed Inundation Vulnerability

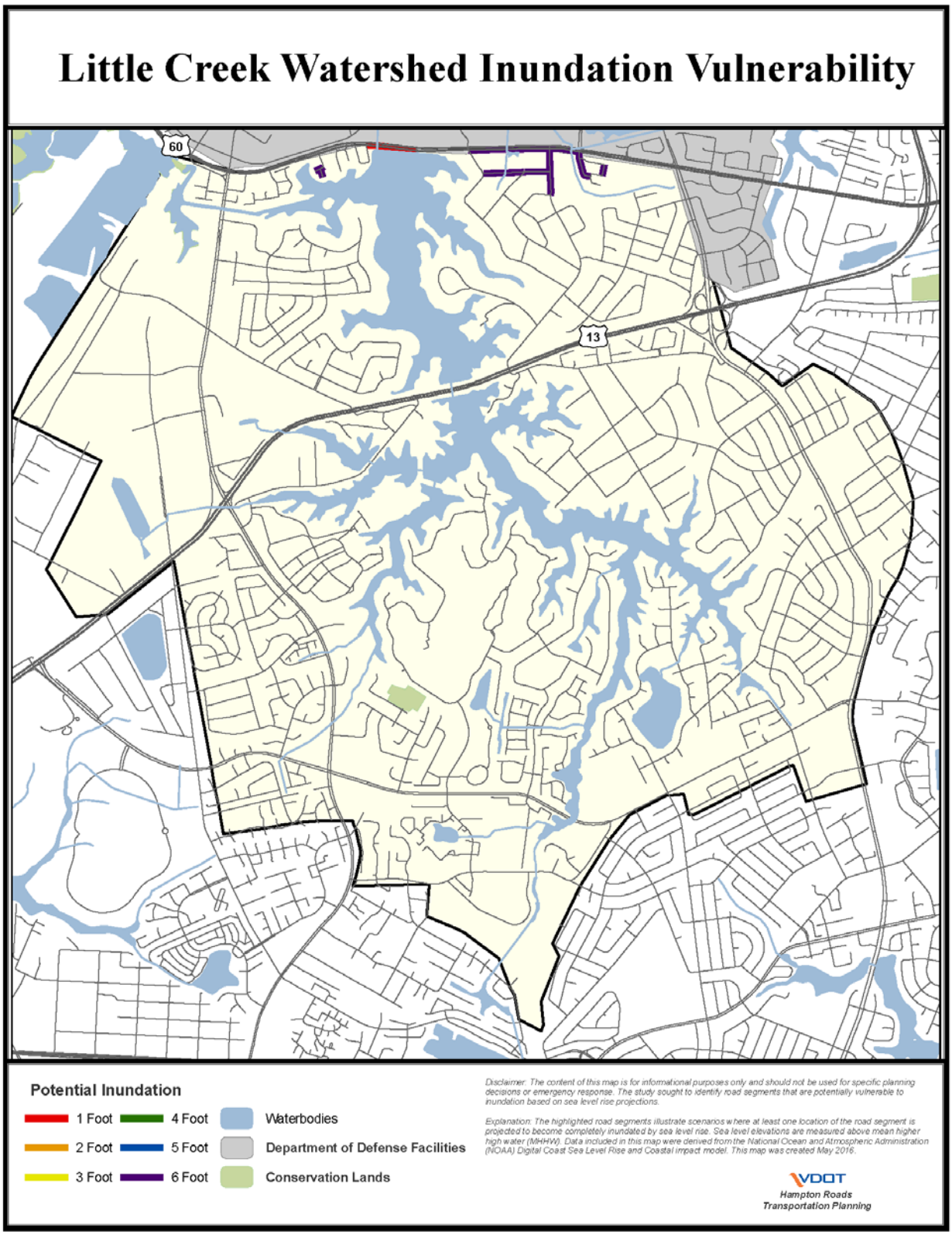

Figure 13 Little Creek Inundation Vulnerability

During the process of evaluating critical infrastructure systems in the case study area, several key insights were noted. First, in the case study area, sea level rise will not have a major impact on infrastructure systems evaluated, but the addition of storm surge with sea level rise will create significant problems. Second, local cities use different sources of power for back-up systems, one using liquid fuel generators and one using natural gas generators. This information was previously not shared between jurisdictions. Finally, the assessment process underscored that infrastructure evaluation results will vary based on the location within the region in which the analysis is completed and the vulnerability of the specific area to sea level rise and flooding related to storm surge.

Mechanisms to Collaborative Problem Solving

Ekstrom and Moser outline the most common strategies to overcome adaptation barriers: (1) data gathering and monitoring; (2) research; (3) self-education and learning; (4) information sharing; (5) creating awareness among staff, public, stakeholders; (6) communication, networking/formalized partnerships; (7) political maneuvering; lobbying; (8) taking lead, assuming leadership; (9) waiting for leadership; (10) prioritization; (11) staffing changes; (12) funding, fundraising, financing; (13) policy and management changes (Moser and Boykoff 2013). For the Pilot Project, the IWG and PIC committees found success using many of these strategies as outlined below:

- Gathering data – the committees gathered data from many existing studies, national and from the Hampton Roads region, which were reviewed and referenced in the committee work. This strategy also led into self-education and learning and information sharing strategies.
- Networking/formal partnerships – the IWG and PIC were able to break down institutional stove piping barriers using department and sector based structures of agencies to coordinate

and share information (engineers/planner). This strategy was extremely successful and should be implemented in the future regional SLR organization. While formal partnerships were not developed, informal partnerships have been formed that will be beneficial for future infrastructure analysis and planning. In addition, the final recommendations from the Pilot Project will outline a governance structure for the region that can support continuing efforts of regional adaptation.

- Leadership – the IWG and PIC committees provided leadership in the Pilot Project by the selection of the case study area of Little Creek/Pretty Lake communities. This case study area was also adopted by the Community Engagement Working Group and the Public Health Committee.
- Funding and Policy and Management Changes – Both the IWG and PIC final recommendations include recommendations that address funding and policy and management recommendations for the Hampton Roads region moving forward. It was beyond the scope of the Pilot Project to implement actions in either of these areas.

It is important to note that Hampton Roads has been building regional capacity for adaptation to sea level rise, which provides a pre-existing advantage, based on the work of municipalities, agencies, non-profits, and universities. Entities involved in this work include but are not limited to: City of Norfolk, City of Virginia Beach, City of Newport News, City of Hampton, City of Portsmouth, Hampton Roads Planning District Commission (HPPDC), Hampton Roads Transportation Planning Organization (HRTPO), Wetlands Watch, Urban Land Institute (ULI), Old Dominion University (ODU), Virginia Institute of Marine Science (VIMS), and College of William and Mary.

Conclusion

The Hampton Roads Intergovernmental Pilot Project provided an institutional arrangement that enabled a whole-of-government and whole-of-community approach to building regional resilience. This type of arrangement should be institutionalized in the region so that collaboration and cooperation among federal, state, and local governments, as well as private infrastructure systems, continues. As highlighted in the Little Creek/Pretty Lake communities case study, the Pilot Project facilitated networking and informal relationship building that broke down institutional stove piping barriers providing opportunities to coordinate and share information critical to regional adaptation across political, geographic, and watershed boundaries.

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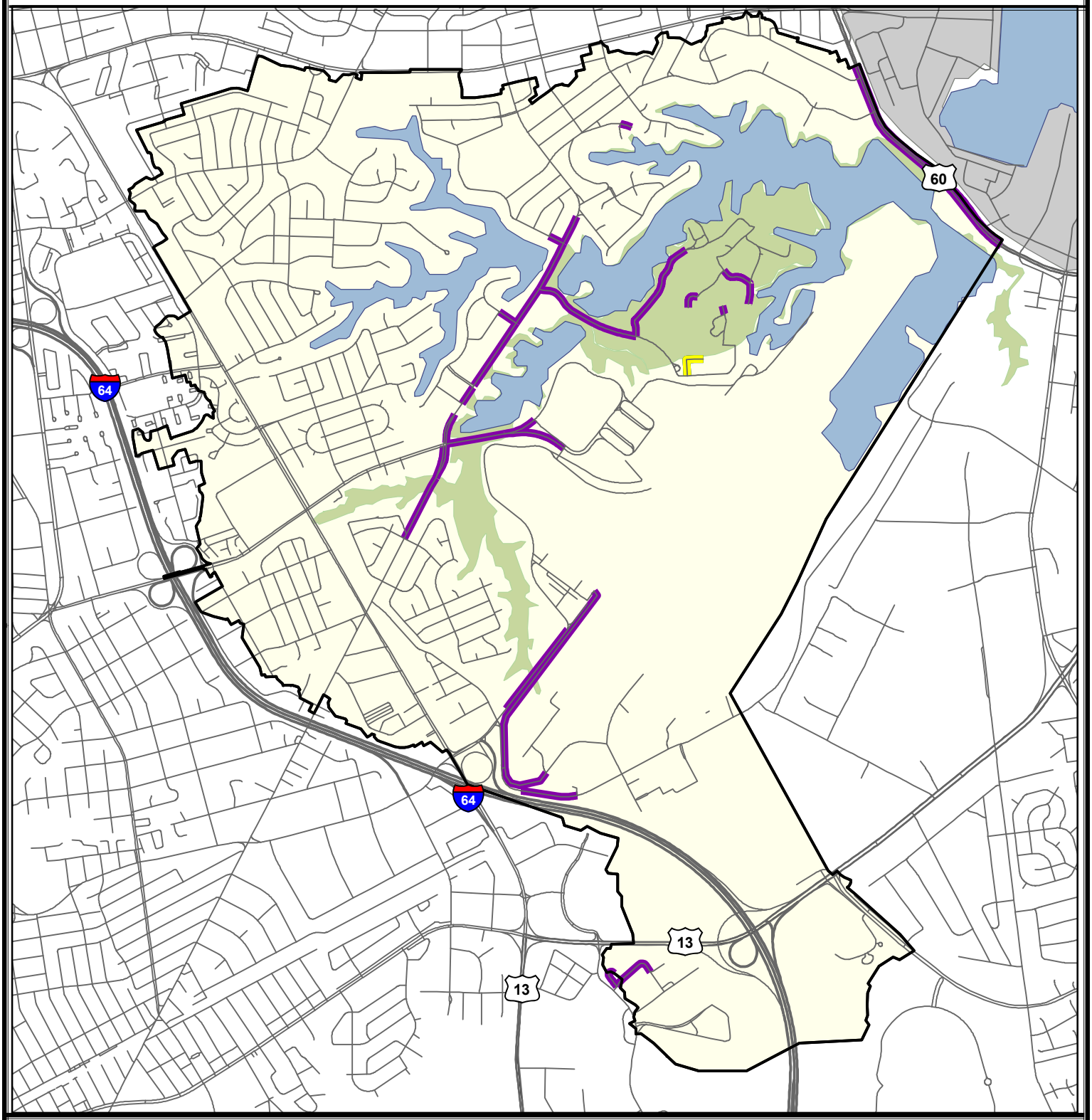
APPENDIX E-5

Pretty Lake Area Watershed Inundation Vulnerability Maps

Lake Whitehurst Watershed Inundation Vulnerability



Potential Inundation

- 3 Feet
- 4 Feet
- 5 Feet
- 6 Feet

- Waterbodies
- Department of Defense Facilities
- Conservation Lands

Disclaimer: The content of this map is for informational purposes only and should not be used for specific planning decisions or emergency response. The study sought to identify road segments that are potentially vulnerable to inundation based on sea level rise projections.

Explanation: The highlighted road segments illustrate scenarios where at least one location of the road segment is projected to become completely inundated by sea level rise. Sea level elevations are measured above mean higher high water (MHHW). Data included in this map were derived from the National Ocean and Atmospheric Administration (NOAA) Digital Coast Sea Level Rise and Coastal impact model. This map was created May 2016.

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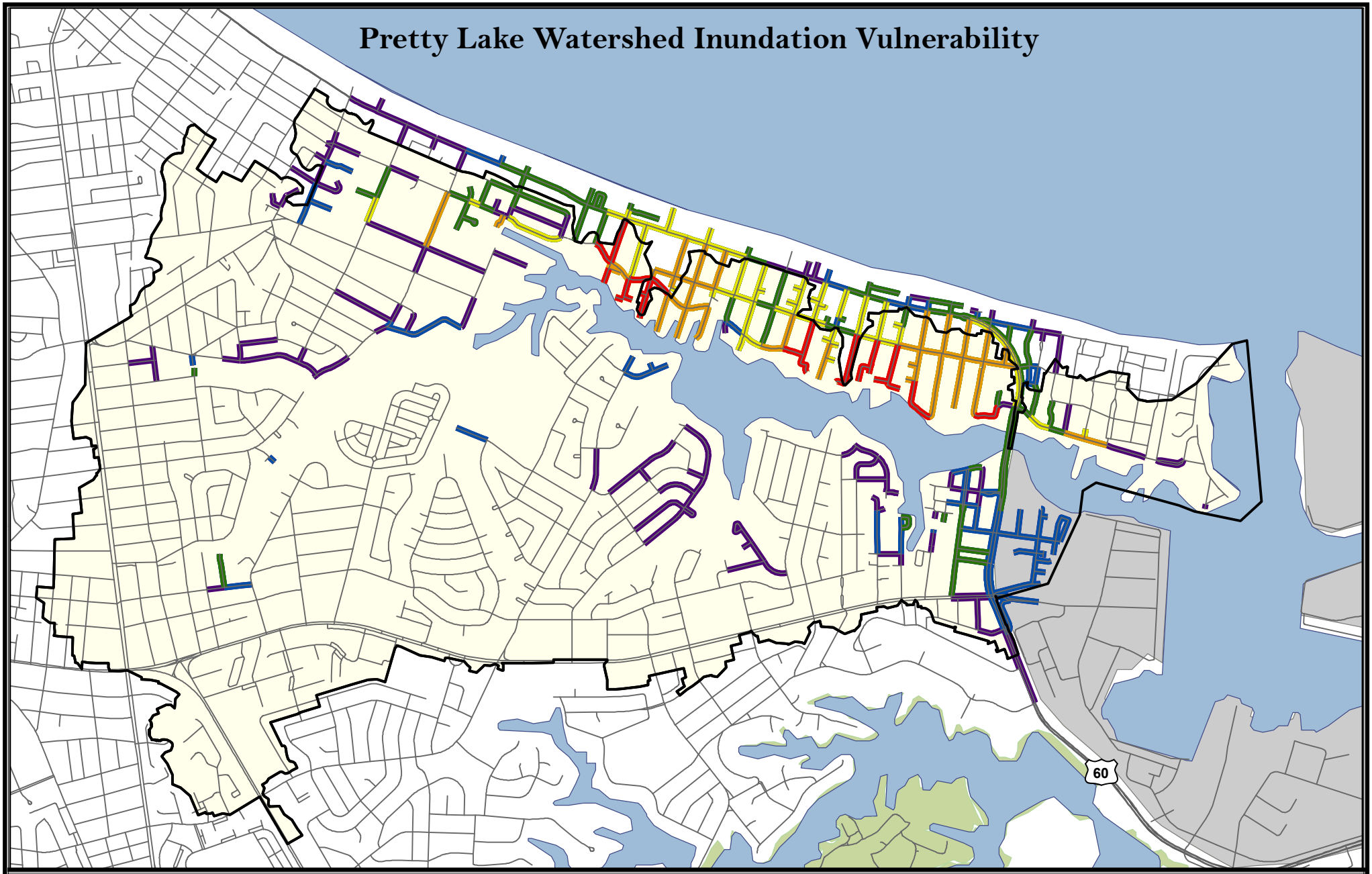
Hampton Roads
Transportation Planning

Pretty Lake Watershed Inundation Vulnerability



Potential Inundation

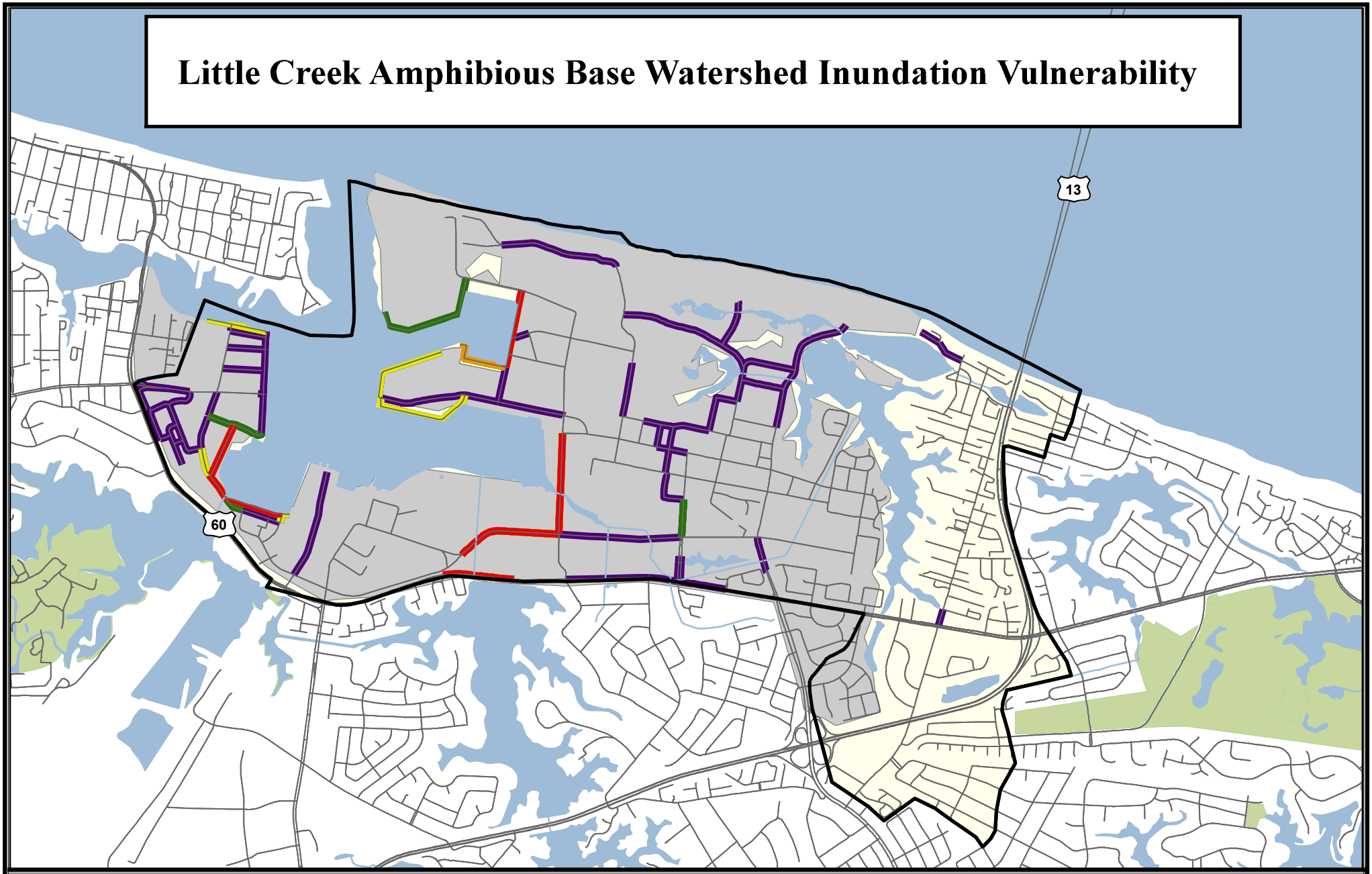
- 1 Foot
- 2 Feet
- 3 Feet
- 4 Feet
- 5 Feet
- 6 Feet
- Waterbodies
- Department of Defense Facilities
- Conservation Lands

Disclaimer: The content of this map is for informational purposes only and should not be used for specific planning decisions or emergency response. The study sought to identify road segments that are potentially vulnerable to inundation based on sea level rise projections.

Explanation: The highlighted road segments illustrate scenarios where at least one location of the road segment is projected to become completely inundated by sea level rise. Sea level elevations are measured above mean higher high water (MHHW). Data included in this map were derived from the National Ocean and Atmospheric Administration (NOAA) Digital Coast Sea Level Rise and Coastal impact model. This map was created May 2016.

[redacted]
Hampton Roads Transportation Planning

Little Creek Amphibious Base Watershed Inundation Vulnerability



Potential Inundation

- 1 Foot
- 2 Foot
- 3 Foot
- 4 Foot
- 5 Foot
- 6 Foot
- Waterbodies
- Department of Defense Facilities
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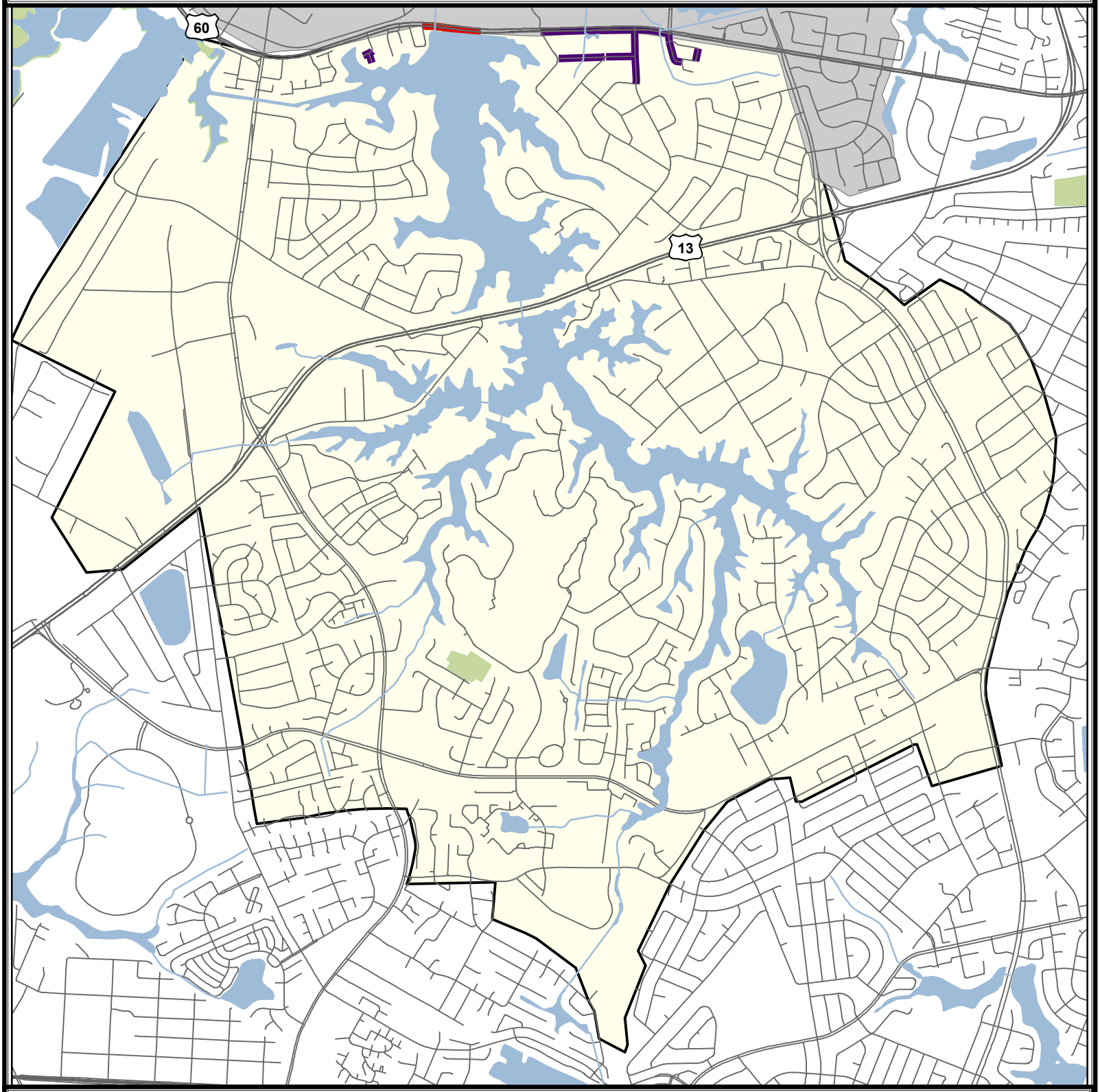
[redacted]

Hampton Roads Transportation Planning

Little Creek Watershed Inundation Vulnerability



Potential Inundation

- 1 Foot
- 2 Foot
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- Waterbodies
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Hampton Roads Transportation Planning

APPENDIX E-6

Infrastructure Working Group – Referenced Studies

Infrastructure Working Group – Referenced Studies

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APPENDIX F

Citizen Engagement Working Group Report and Recommendations

Hampton Roads Sea Level Rise Preparedness and Resilience Intergovernmental Planning Pilot Project:

Citizen Engagement Working Group Report and Recommendations

June 30, 2016

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Glossary

The meanings of some of the terms used in this report have either evolved over the course of the project, changes that are important to the reader's understanding of the conclusions and recommendations presented in this report. The following definitions apply to the terms identified below:

Whole of Government:	This term includes all governmental entities engaged in the project, whether they be at the federal, state or local level.
Whole of Community:	This term refers to all parties, governmental and otherwise, who are affected in any way by the challenge of sea level rise and its related issues in the Hampton Roads region of Southeastern Virginia.
Stakeholders:	This term describes any individual, organization or institution having either direct or indirect exposure to sea level rise and the issues it creates. Stakeholders may include, in addition to governmental entities, individual citizens, transient residents, civic, social, commercial and institutional entities.

Executive Summary:

Recommendations

The Civic Engagement Working Group's deliberations reflect considerable exploration, but can be reduced to just four key recommendations.

1. Recognize that sea level rise is a serious issue that touches the entire region and that engagement on a piecemeal basis or on the basis of governmental purview, municipal boundaries, local political will or current levels of stakeholder interest is not a viable long-term strategy for a challenge of this magnitude.
2. Identify a respected regional entity to "own" and be responsible for being the thought leader on sea level rise in Hampton Roads and for convening "whole of community" deliberations regarding sea level rise.
3. Use the best practices of civic science—including good facilitation process and good methods for information dissemination and feedback—to engage *all* stakeholders in sea level rise deliberation and decision making from the very start.
4. Create benchmark and ongoing internal and external tracking metrics for assessing the performance and effectiveness of the engagement program and its impact on the ability of the Hampton Roads region to rise to the challenge of sea level rise.

Introduction

In just a few years sea level rise has evolved from being a topic that just a few people in Hampton Roads—mostly those in the municipal and scientific circles—were thinking about to one that many across the region now recognize as one of, if not *the* defining long-term issues facing our region.

The Hampton Roads Sea Level Rise Preparedness and Resilience Intergovernmental Planning Pilot Project (IPP) provided a solid starting point for collaboration among governmental agencies. The addition of the Citizen Engagement Working Group (CEWG) to this project sought to explore how to bring rest of the region's stakeholders into deliberations about how the region addresses sea level rise.

Going into its work, the CEWG recognized the following:

- Healthy regions are defined by conditions that make it possible for *all* stakeholders to be involved from the start in shaping how important opportunities, problems and challenges that affect them are addressed.
- Regional deliberations, whether between or among governmental and nongovernmental entities, require assistance and guidance in facilitating authentic and collaborative engagement.
- Successful public policy deliberation requires willing participants, mutual respect, access to accurate and timely information, good process for identifying solutions and reconciling competing interests and expectations and, most importantly where governmental participation is required, a sincere predisposition on the part of governmental leadership to listen to and respect the outcome of the process.
- Different geographic and socioeconomic communities bring to the issue of rising waters different experiences, perspectives and expectations. Different communities may require different engagement strategies, communication channels and messages.

Discussion of Recommendations

Our study leads us to believe that the optimum strategy for addressing sea level rise and identifying and implementing adaptation solutions does not lie in identifying separate "whole of government" and "whole of community" strategies, but rather in developing a single "whole of region" strategy that unites science, academia, engineering, planning, governance and citizen/stakeholder participation in a collaborative environment.

The following steps are recommended:

1. **Recognize that sea level rise is a serious issue that touches the entire region and that engagement on a piecemeal basis or on the basis of governmental purview, municipal boundaries, local political will or current levels of stakeholder interest is not a viable long-term strategy.**

   Rising waters do not observe municipal boundaries. Even those living in Hampton Roads municipalities not impacted directly by rising waters may be impacted by the economic ripple effect of rising waters. Therefore, addressing sea level rise and recurrent flooding on the basis of political boundaries or current perceived vulnerability is not an efficient or effective way to address this regional environmental challenge.

2. **Identify a respected regional entity to "own" and be responsible for being the thought leader on sea level rise in Hampton Roads and for convening "whole of community" deliberations regarding sea level rise.**

   At the conclusion of the IPP no single entity will "own" thought leadership or responsibility for convening the region on issues related to sea level rise. Therefore, an entity having these characteristics must be identified:

   - Geographic scope as large as the issue and not bounded by municipal or other political boundaries within the region.
   - A record of dealing effectively with issues of a regional nature.
   - Welcoming to both "grassroots" and "grasstops."
   - Credible organizer and convener of science, government, academia and citizen and other stakeholders.
   - Trustworthiness.
   - Perceived impartiality.
   - Knowledge of the best practices of civic engagement.
   - Access to experienced civic engagement facilitators.
   - Experience communicating to the entire region.

3. **Use the best practices of civic science—including good facilitation process and good methods for information dissemination and feedback—to engage *all* stakeholders in sea level rise deliberation and decision making from the very start.**

   Creating successful civic engagement partnerships depends on the presence of conditions that must be specifically developed rather than left to chance:

   - There must be clearly defined goals and expectations.
   - Goals must reflect not only the needs of the governmental actors, but also the priorities of citizens.
   - The process must be open to all who have exposure to the impacts of sea level rise.
   - Participants in the process must have respect for and trust in each other
   - Collaborations between citizens and government require respect for all parties involved.
   - There must be confidence in the collaborative process and that its outcome will be given respect.

4. **Create benchmark and ongoing internal and external tracking metrics for assessing the performance and effectiveness of the engagement program and its impact on the ability of the Hampton Roads region to rise to the challenge of sea level rise.**

   To assure stakeholders, funders and other participants that the engagement of the entire region in addressing the challenge of rising waters is proceeding in an efficient and responsible manner, it will be necessary to establish internal and external benchmark and tracking metrics that monitor factors such as:

   - Levels of participation and inclusiveness.
   - Perceived levels of respect and trustworthiness in the process.
   - Perceived levels of success in meeting the challenge of sea level rise.
   - Awareness and understanding of the issues and implications of sea level rise among the general population.
   - Awareness and knowledge of information and resources available for mitigating and adapting as waters rise.

The Citizen Engagement Working Group

Members of the group included faculty from Old Dominion University with a research focus in communication and civic engagement as well as government staff, NGO staff and citizen volunteers, including:

Michelle Covi, Old Dominion University, Virginia Sea Grant, Co-chair

Chris Bonney, Hampton Roads Center for Engagement, Co-chair

Carolyn Caywood, League of Women Voters

Tim Cole, Virginia Beach School System

Joe Cook, The Sierra Club

Christina Deconcini, World Resources Institute

Angela Harris, Southeast Care Coalition

Julia Hillegas, Hampton Roads Planning District Commission

Erica Holloman, Southeast Care Coalition

Mike Kuhns, Peninsula Chamber of Commerce

Cathy Lewis, CIVIC Leadership

Barbara Mann, Tidewater Community College

Susan Maples, Virginia Institute of Marine Science, College of William and Mary

Dawud Muhammad, Southeast Care Coalition

Gail Nicula, Old Dominion University

Pam Northam, Lynnhaven River Now

Suzanne Puryear, The Planning Council

Duncan Pitchford, Office of the Attorney General

Lynn Rhode, Office of the Attorney General

Burton Saint John, Old Dominion University

Bert Schmidt, WHRO

Skip Stiles, Wetlands Watch

Todd Solomon, Hampton Roads Center for Civic Engagement

Jack Tynch – consultant

Denise Thompson, City of Norfolk

Raymond Wazeerud Din. Southeast Care Coalition

Lesa Yeatts, City of Hampton

Wie Yusef, Old Dominion University

Individuals and representatives of other groups and organizations, including civic, social, social justice and faith groups, were invited to provide input and participate in CEWG meetings and in events in which Old Dominion University, the IPP, Virginia Sea Grant, the Urban Land Institute, the Chrysler Museum, Dr. Covi and others were involved. In all, these events and groups brought into the working group's awareness the experiences and perspectives of dozens of other academic, commercial, governmental, design and engineering professionals and hundreds of at-large individuals from across the region.

History

The Citizen Engagement Working Group (CEWG) was formed in late 2014 to complement the Hampton Roads Sea Level Rise Preparedness and Resilience Intergovernmental Planning Pilot Project's *Whole of Government* approach with the perspective of the *Whole of Community*; that is, anyone in the Hampton Roads region who was not, or did not represent a municipal, state, regional or federal agency or branch of the Department of Defense. Over the course of the project the definition of "community" evolved to include *all* stakeholders, governmental and otherwise.

The working group chairs sought to complement the IPP by including in the working group a wide variety of non-governmental stakeholders from throughout the Hampton Roads region, including individuals and representatives of community, business, civic and social organizations and non-governmental institutional stakeholders. Almost all participants were volunteers.

The CEWG met on its own and in conjunction with other groups and events between December 2014 and June 2016. The group was co-chaired by Chris Bonney, a marketing researcher and former chair of the Hampton Roads Center for Civic Engagement, and Michelle Covi, PhD, Assistant Professor of Practice with Old Dominion University and part of the Virginia Sea Grant extension program.

Early meetings focused on the establishment of these goals:

- Create a partnership between the "whole of community" and the "whole of government."

- Develop engagement and communications strategies that enhance the capacity of Hampton Roads communities to:
    - Plan for flooding emergencies.
    - Prepare for sea level rise contingencies.
    - Strengthen social capital and resilience.
- Create a flexible and scalable template that can be customized for different communities.

Because the working group lacked both the manpower and funding resources necessary to commission its own original research, the CEWG adopted an expert opinion approach that sought initially to focus on 1) integration of the perspective of the non-governmental community into the IPP, 2) providing opportunities for the non-governmental community to contribute to the IPP and 3) development of recommendations for future citizen engagement working groups.

Early meetings identified the following issues:

- The *Whole of Community* includes many kinds of "communities."

  Communities are not defined solely by geographic or municipal boundaries. Nor do they all have recognizable "borders." Rather, they are defined by both strong and loose geographic, topographic, social, racial, economic and institutional connections and shared interests. Additionally, some are defined by their level of acceptance or denial of the existence of climate change and sea level rise, or by their level of trust in government and institutions. Attitudes towards the latter two bodies are more likely to be defined by socio-political perspectives than by any visible or tangible boundary.

- Strategies and Solutions Vary by Community.

  While the scientific issues may be similar, engagement, outreach and education that works in one community may not work in another. Therefore, ways of engaging and communicating and creating more adaptive and resilient neighborhoods may vary widely.

- The Best Practices of Civic Science:

  Creating an effective regional approach to rising waters, and particularly creating an effective and efficient partnership between the "whole of government" and the "whole of community" requires that both parties respect that:

  – Citizens and other stakeholders have an equal role and responsibility in the success of the region.

  – The greater the diversity, the greater the potential for innovative solutions.

  – There must be partnership, not prescription.

- Well-informed citizens supported by good process working in an environmental where their deliberation is respected will reach wise conclusions.
- Engaged citizens increase the likelihood of conditions for success.

The CEWG engaged in a number of investigations through briefings from invited experts in community, governmental and environment engagement.

In addition, group members conducted several case studies through partnerships with outside groups, including participation in the Hampton Roads Chapter of the Urban Land Institute's March 2015 Sea Level Rise conference and a foundation-funded research study conducted by several academic members of the CEWG in the neighborhoods adjacent to the Little Creek Naval Amphibious Base.

Opportunities and Challenges

The Citizen Engagement Working Group had both opportunities and challenges. Opportunities included:

- The opportunity to be of service to the region as it approaches one of its most defining issues of this century and beyond.
- The opportunity to bring Hampton Roads citizens and other non-governmental stakeholders into the discussion of sea level rise and shape how their peers in other regions can be brought into their respective climate change deliberations.
- The opportunity to define the scope of the Working Group's activity.

Challenges included:

- Limited direction and interaction with the IPP Steering Committee
- An almost entirely volunteer-driven membership structure.
- No budget for investigation, original research or pilot testing.
- Dependence on the work of organizations outside of the IPP
- Little interaction with other IPP working groups or structure for doing so.
- Resistance from other IPP working groups
- Varying levels of interest in sea level rise impact in the community.

Recommendations for Future Citizen Engagement Working Groups

We recommend that citizen engagement and non-governmental participants play a larger role in the region's discussion of sea level rise:

1. A healthy region requires engagement on the part of all of its members.
2. As the challenges of sea level rise become more acute over time and the costs and implications of dealing with rising waters increase, it is critical that non-governmental stakeholders remain included and involved in discussion and deliberation over mitigation strategies and tactics.
3. The engagement of the non-governmental citizenry must be given an equal place at the table and adequate funding and staff for necessary civic engagement initiatives.
4. The day-to-day civic engagement process management should be housed in a regional agency, where a knowledgeable and adequately funded staff can maintain an ongoing civic engagement initiative as the region's exploration of sea level rise adaptation and mitigation strategies continues over time.
5. Both overall and focused civic engagement initiatives must begin with clear goals and expectations.
6. Citizen engagement committees and other oversight group members must come into the process understanding that their role is to contribute to the process, not benefit personally from it.

Investigation

Briefings:

Best Practices of Contemporary Civic Engagement

The terms “civic engagement” and “public participation” are commonly used to describe processes that create and enable constructive interaction and collaboration between citizens and government that lead to better decision-making.

Civic engagement is important because a healthy democracy requires the participation of all of its members. Bringing more minds to complex tasks increases the likelihood of innovative results. There is also a strong correlation between the level and quality of citizen participation in the processes of governance and citizens’ perceptions of the effectiveness, accountability and efficiency of government.

Successful civic engagement creates an environment of trust. While it may be initially disruptive to traditional governmental decision-making processes, in the long run increased transparency makes getting things done easier, faster and less costly.

It is important to distinguish between what civic engagement is and isn’t. Critical elements of good civic engagement are:

- Two-way communication.
- An open and transparent process that gives all stakeholders an opportunity to participate in the process.
- Tools that show citizens and government how to work better together.
- Facilitation processes that ensure “safe spaces” and a forum where constructive and civil dialog prevail and all perspectives can be welcomed and respected.
- Openness to all issue stakeholders, not just the powerful and not just traditionally underserved populations (e.g. low-income, disabled, minorities, etc.).

Civic engagement is *not* a replacement for good day-to-day communications between governments and citizens, nor does it intend to slow down government decision-making (although there are circumstances in which citizens may prefer that decision-making be done at a more considered pace.)

The most important conditions for successful civic engagement are:

1. Citizens willing to take part in the process.
2. An engagement sponsor that respects citizen input.
3. Timely and accurate information about the issue being discussed.
4. Process that leads from confusion to conclusions and, where possible, consensus.
5. A sign from the engagement sponsors that the citizen participation was heard and respected.

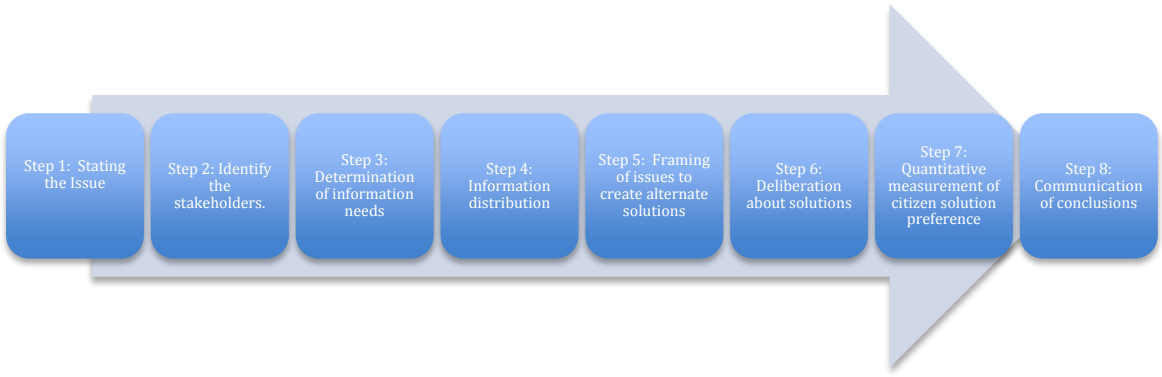
Successful civic engagement is additionally characterized by:

- Purposeful outreach
- Openness to all
- Geographic, physical and virtual accessibility
- Multiple points of contact
- Reliable information
- Timeliness
- Honesty and transparency

The goal of civic engagement is for citizens and government to reach decisions in a way that is efficient, that instills trust and that makes it possible for citizens to bring their best and most constructive thinking to the process of public decision making.

Typical Civic Engagement Process

The best practices of civic engagement adhere to this basic structure:



Step 1: *Stating the Issue:*

We start by describing the situation and the goal. What is the purpose for this civic engagement initiative? What decision(s) need to be made?

Step 2: *Identify the Stakeholders:*

Not every issue involves everyone in a city, county or region. The most important part of this stage is answering the question, "Who are the stakeholders for this issue?" The answer to this question identifies the people or perspectives who need to be represented in the project.

Step 3: *Determination of Information Needs:*

The next step is to determine what information will be needed for participants in the process to be able to make informed decisions.

Information falls into three broad categories and should be grouped accordingly:

- Undisputable facts.
- Generally accepted opinions
- Opinions that are not generally accepted

Step 4: *Information Distribution:*

Information can be distributed in any number of ways, including paper handouts, brochures, booklets, videos, subject expert presentations, paid

advertising, websites and webinars. Successful citizen engagement projects typical involve the use of multiple information distribution channels.

Step 5: *Issue Framing to Create Alternate Solutions:*

Making smart decisions requires the consideration of many possible outcomes. This step is sometimes referred to as "issue framing" because it involves the identification and exploration of different decision choices. No ideas should be dismissed at this stage. The concept is to get as many ideas out on the table as possible.

Step 6: *Deliberation about Solutions:*

Research shows that the optimum number of choices for citizens to ultimately consider is no more than three or four. Since a larger number of decision choices may have been created in the previous stage of the process, this step is about sorting through all of the options and, whether though the consolidation of ideas or simply dismissing some of the alternatives, getting down to that manageable number of choices.

Step 7: *Quantitative Measurement of Citizen Solution Preference:*

The kinds of discussions that have taken place up to this point typically involve small groups of people working together. Unfortunately, their findings are not statistically valid so far as being able to project their conclusions to the larger population is concerned. Therefore it is necessary to conduct properly done quantitative survey research to test the ideas produced in the earlier stages and let a larger sample of citizens or stakeholders weigh in on the choices.

The outcome of this step is typically a report that summarizes the survey and outlines citizens' overall preferences.

Step 8: *Communication of Conclusions:*

This final step involves not only the practical matter of getting on with the work that the work set into action, but also building trust by reporting back to citizens the results of the entire process and how citizen participation resulted in a solution or decision that both met the needs of the government and was made smarter and better because of the participation of the citizens in the process.

The goal of civic engagement is for citizens and government to reach decisions in a way that is efficient, that instills trust and that makes it possible for citizens to bring their best and most constructive thinking to the process of public decision making.

Citizen Engagement and Sea Level Rise in Hampton Roads

The foregoing discussion is important because of the distinction between the best practices of good citizen engagement process and the way that the sea level rise issue has been addressed in Hampton Roads, particularly in the way that discussion of the implications, challenges and solutions to sea level rise in Hampton Roads prior to the formation of the CEWG did *not* include serious or sincere citizen engagement.

As is often the case in such complex situations, the sea level rise discussion came about largely in three areas where there was not previously a record of public collaboration and authentic citizen engagement: municipal governance, regional planning and academia.

- Local governments, particularly the City of Norfolk, were unavoidably confronted with the challenge of rising waters as a result of increasingly uncharacteristic recurrent storm flooding.
- Frequent flooding and the need to accommodate rising waters in regional planning outlooks brought sea level rise to the attention of the Hampton Roads Planning District Commission.
- Concurrently, climate scientists, ocean scientists and others were detecting and conducting research to better understand more rapidly changing ocean conditions.

Meanwhile, citizen, commercial and institutional stakeholders in the region were not engaged in this discussion in any more than an occasional ad hoc manner. The reasons for this are a good example of the challenges other regions and communities throughout the United States may face when managing sea level rise and climate change topics:

- Climate change, while increasingly acknowledged by the world's scientific community, was, and continues to be greeted with suspicion, doubt and outright denial in some political, commercial or economic realms.
- While available data provided increasing evidence of rising waters, current projections of water levels are uncertain beyond 30-50 years.
- Because of the difficulty of predicting water levels, and wary of political and commercial obstruction, members of the scientific and planning communities have not felt it was time to bring citizen and other stakeholders into the conversation about sea level rise.

By the time the IPP was under way, more Hampton Roads residents were aware from personal experience and observation that flooding once associated with rare storms was becoming more frequent and that the water level was rising.

That there was concern that "It is not time to bring the public into the conversation" was refuted by the fact that such public and media events as have been held to invite and share data or invite conversation—including events sponsored by Cox Communications, WHRO, individual business, civic groups and others—have been well attended, with audiences sometimes in the hundreds or more.

When the CEWG was convened in late 2014, the time to develop a serious and authentic public deliberation on the topic of sea level rise had long passed.

Experts bring the depth of their study to a problem. Officials are accountable for finding solutions. Given this, one might ask why engage citizens and risk uninformed opinions?

1. What citizens bring to the table is a sense of what they value. Solutions that don't align with citizens' values will encounter active opposition and passive inertia. With more information citizens may be persuaded that a particular solution is in their best interest. But with citizen engagement in developing solutions there will

be much stronger public acceptance and committed support.

2. Experts and government officials can have blind spots, especially if they are only talking to like-minded people in-house. Sometimes it takes people with some distance from the issue to see the obvious or ask fresh questions. Meaningful public participation early on leads to better results - more buy-in, easier implementation, higher quality plans and policies. This is why ultimate authority is vested in we, the people.
3. Trust is critical to the effective implementation of solutions and transparency is critical to trust. When the issues are discussed openly before decisions are made, it builds trust.
4. Citizens need to believe they can have an effective voice and to know how to be heard on public policy issues. Merely voting for or against officials is too blunt a form of communication.
5. There are useful actions that individuals can take without waiting for the government to act, if they have the information. And people always feel more confident and less dependent when they can take action.
6. When citizens come together to discuss a problem, they often learn that other citizens don't see it the same way. Structured, facilitated discussion can help them find common ground while they develop an understanding of the issue's complexity. Asking them to confront trade offs – what will we give up and who will lose something to get this – and to consider the potential for unintended consequences brings greater appreciation for representative government.

Methods of Citizen Engagement

- Structured & facilitated small group conversation, e. g. deliberative dialogue, house party, book club, etc.
- Virtual town hall-type online interactive communication with government.
- Residents developing a neighborhood plan, for emergencies and/or long-term adaptation.
- Interested volunteers framing the regional problem and creating options for community-wide discussion.
- Activities, e. g. citizen science like observing & recording seasonal changes, telling one's personal story to urge official action, rallies & public demonstrations, shoreline protection, recycling & using renewable energy, etc.

Briefing: December 2014 ODU event

Background: The FEMA National Exercise Program held an event at Old Dominion University on December 2, 2014. This meeting served as a starting point for the CEWG.

Briefing: This event was the first attempt by the CEWG to invite and engage members of the region's non-governmental community—aka the "whole of community" in the Pilot Project's "whole of government" structure. Initial attendees came from local civic leagues, environmental advocacy groups, social justice groups, and other community organizations identified by the IPP leadership that responded to the invitation.

Learning: The CEWG set short-term, near-term and long-term goals for the group, focusing on having a better understanding of the existing networks for communication and engagement in planning processes. The groups set the goal to try to better understand how the region is currently engaging on similar issues, with the long-term goal of finding methods to better communicate risk of sea level rise and engage residents in preparedness and planning.

Briefing: HRTPO Guidance on Reaching Minority Audiences

Background: The Hampton Roads Transportation Planning Organization (HRTPO) is Southeast Virginia's regional transportation planning agency. As such, HRTPO communicates with a wide variety of regional stakeholders, ranging from elected municipal leaders, city and county managers, state and federal agencies and, increasingly, "grassroots" citizens. HRTPO is held to a high standard of environmental justice, which is the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies.

Briefing: HRTPO is vitally concerned with engaging low income, low literacy and limited English proficiency members of the region's citizenry, particularly those who are vulnerable to social and economic disruption by natural conditions and local and planning decisions.

Learning:

1. Recognize the imperative to give attention to the most vulnerable.
2. Recognize that there is likely much more illiteracy than you believe.
3. Engaging citizens where they are. Do not assume they will come to us or use the same media and channels of communication you use.
4. Make it possible for people to take part in an initiative. Recognize that a great many low-income people work second and third shifts. They are not available for public meetings designed to meet the convenience of people who work traditional daytime hours.
5. Recognize that social structures—e.g. the importance of local church leaders in the African American community—does not necessary apply to today's younger African Americans.
6. Create alliances with organization within or working with minority audiences.
7. Outreach can include: events and festivals, apply to residents of minority communities.
8. Street level. Grocery stores, laundromats, retail shops, ball fields and other local gathering places.
9. Schools – communicate through children.

Briefing: City of Hampton Waterways Project and Civic Engagement Meetings

Background: The City of Hampton, Virginia has been recognized as one of the nation's leading municipalities in terms of engagement with its citizens. Deliberations have been convened on topics as varied as waterways usage and participatory budgeting. The goal of Hampton's civic engagement initiatives has been to make local government process and decision making more transparent and to engage more citizens in this process.

Project: In 2009 the City of Hampton commissioned the Hampton Roads Center for Civic Engagement to conduct a public deliberation on waterways usage. The result of this year-long project was a re-visualization of the city's waterways planning.

Learning:

1. Civic engagement initiatives take time. They are not convened and settled in a single day or event.
2. Civic engagement initiatives much have specific goals.
3. Expectations must be established at the outset to avoid disappointment later on.
4. Civic engagement is not just grassroots citizens, but also businesses, civic and social groups, churches, schools and institutional stakeholders.
5. Citizens and other stakeholders must have well-defined roles.
6. It is critical that youth be engaged.
7. Most decisions have multi-generational impact, so it is important to recognize the different and sometimes competing values and expectations of different residents of different generations.
8. Successful civic engagement initiatives are careful to include a post-deliberation communications program to let participants and other residents and stakeholders know what happened as a result of their work.
9. Hampton created a Unity Commission to address sensitive issues that no one else wanted to tackle.

Briefing: Lynnhaven River Now

Background: Lynnhaven River NOW is a water protection group established in Virginia Beach in 2002. One of the group's main goals is to educate and engage the community in restoring and protecting the Lynnhaven River. They have a number of restoration projects and try to engage a variety of groups including property owners, children, faith communities and private businesses.

Project: Lynnhaven River NOW engages the Virginia Beach community through meeting people where they are and engaging people to become involved through workshop and events. They have three primary programs: Pearl Homes aimed at property owners, Pearl Schools aimed at K-12 schools and Pearl Faith Communities aimed at faith groups. They are developing a Pearl Businesses program. They learned early on that they needed to figure out their message and boil it down to a 45 second elevator speech and choose terminology carefully to make the message accessible to non-technical community members. They have community events, citizen science programs, and an active volunteer program. The program has been very successful cleaning up the Lynnhaven so that 45% of the river now meets shellfish standards and they have reduced pollution and marine debris.

Learning:

1. Keep the messaging simple, clear, concise, consistent and appropriate for all levels.
2. Empower people to take action, emphasize the positive, successes and how people can make a difference.
3. Use print, website, talks with groups to spread ideas and reward positive actions through recognition – Pearl programs that make an individual or group feel that they are part of a movement.
4. Engage different sectors where they are, create programs for people that are very active and for those who can be involved through another group, such as a church or school.

Briefing: Chesterfield Heights Project (Wetlands Watch)

Background: The Chesterfield Heights Project (funded by Virginia Sea Grant) is a collaboration between Wetlands Watch, an environmental advocacy group, the Architecture faculty at Hampton University and Old Dominion University Engineering faculty, to address the needs of a historic, low/middle income neighborhood in Norfolk. Bounded by the Elizabeth River and Interstate 264, Chesterfield Heights is a mostly African American neighborhood of roughly five hundred single-family homes, some of which have been divided into smaller dwelling units. Most of the neighborhood is no more than a few feet above mean high water level.

Project: The project sought to engage the neighborhood in a discussion of how it could adapt to increasing frequent tidal flooding and overall rising waters. Residents were introduced to landscape, hardscape and nature-based design solutions that could make residences in the neighborhood more resilient.

Learning:

1. Engaging residents of Chesterfield Heights required that the project's partners first earn trust and credibility and avoid the perception that they were pandering. This required giving respect to the neighborhood's elders, faith based and other institutional leaders and showing respect for the broader history, family histories and the overall social fabric of the neighborhood.
2. The project's partners learned that it is best to engage members of the community in the initiative before introducing science, engineering, municipal and design "professionals."
3. Changing the way residents think and act regarding rising waters requires making an abstract and seemingly distant issue relevant and *personal* by focusing on the inconveniences caused by the increasing frequency of storm and tidal flooding.
4. The project sought to create community consensus on "design ready" solutions so that Chesterfield Heights can be "at the front of the line" when resources become available.
5. Challenges faced by the project illustrate how valuable it is for neighborhoods to have strong neighborhood social links in place. The Chesterfield Heights Project recognized the following ranking of social hierarchy: Elders, Biological family/household members, non-related household members, Church "family, Street "family."

Briefing: Mothers Out Front

Background: Virginia Organizing Hampton Roads Environmental Justice team has been leading a collaboration of organizations including the League of Women Voters and others to bring attention to climate change and sea level rise issues in the Hampton Roads area. They are using a program developed by Mothers Out Front, a Boston-based group that uses house parties among social networks to spread information and encourage engagement in climate issues.

Briefing: This project is designed to build a local network / movement with a core team that assesses local needs to work on. The topic the local group is working in is fossil fuel-driven climate change and for Hampton Roads, the working assumption is that it will involve sea level rise. The method is to share personal stories, response to videos and images in slide show, interview another participant, ask for a commitment to proceed, and an evaluation of changes

Learning;

1. The focus is on relationships and network building.

2. The presentation is very structured, but seems to be accepted by the participants. We are adapting the materials to reflect our coalition and the needs of Hampton Roads.

3. Evening works better than weekend.

Case Study: Resilient Region Reality Check (March 17, 2015)

Project: The Hampton Roads Resilient Region Reality Check event was held on March 17, 2015 at Old Dominion University. The event was built on three key themes: a region-wide, multi-sectoral, and whole-of-community approach that is oriented toward actions to address SLR and flooding. This event was a collaboration between the Urban Land Institute Hampton Roads (HRULI), Old Dominion University (ODU), and the Community Engagement Working Group of the Hampton Roads Sea Level Rise Preparedness and Resilience Intergovernmental Planning Pilot Project.

Approximately 130 residents and stakeholders across government, non-profit, business, and civil society sectors within the Hampton Roads region participated in the event. The event focused on encouraging discussion concerning three items: (1) how flooding affects citizens, (2) what can citizens do about flooding, and (3) what resources are needed to address flooding? For each question, participants were also asked to discuss and identify two regional priorities.

Learning: From these discussions, six key themes arose:

1. The impacts of sea level rise and flooding are multi-faceted;
2. Sea level rise and flooding need to be incorporated into planning and decision making;
3. Land use planning plays an important role in building resilience;
4. Regional collaboration and regionally-adopted solutions are needed;
5. Financial and non-financial resources are needed;
6. Civic engagement and outreach are important.

In an end-of-the day prioritization activity, all attendees were asked to rank order the top priorities, selecting from a list of discussion items that had surfaced during this event. Across attendees, the following top priorities appeared:

1. Pursue regional collaboration;
2. Revise zoning and land use;
3. Pursue public education/outreach;
4. Reduce carbon emissions;
5. Pursue natural solutions (e.g. coastal engineering, wetlands preservation).

Case Study: Little Creek/ Pretty Lake Research Study

Project: The demonstration project used the Action-Oriented Stakeholder Engagement for a Resilient Tomorrow (ASERT) framework, to facilitate discussion of, knowledge about, and action to adapt to flooding and SLR. The foundation of this engagement framework is the presentation of relevant and accessible information, dialog and two-way communication, and deliberative and participative mechanisms. The goal of the project is to demonstrate the efficacy of the engagement framework as a tool for facilitating community resilience building through engagement .The ASERT framework incorporates several key principles: (1) an inclusive process that engages stakeholders across multiple social dimensions and across the whole-of-community spectrum; (2) a strong emphasis on surfacing local context and knowledge; (3) integrated engagement where social and cultural factors are integral to the process of engagement; and (4) explicit consideration of change mechanisms, such as structured conversations, deliberative dialogue, and participatory mechanisms.

Learning: Conclusions from this initiative included:

1. Residents of the neighborhoods surrounding Little Creek base identified several cultural and social elements in their community as assets, such as parks, churches, community centers, restaurants and shops. Residents also identified the Base itself as an important asset to the community that should be protected as well as the Norfolk Airport and several other roads and bridges. The inability to access these important places and flooded streets in general is a major challenge.
2. Property losses such as vehicular loss and damage to residential properties were identified as being widespread throughout the community.
3. Preferred adaptation solutions among focus group participants included natural solutions such as beaches and dunes, flood warning and preparedness floodplain policy management.
4. In post-group evaluations, participants responded that they found both the participatory mapping and focus group discussions valuable. Residents were extremely grateful to have the opportunity to have their needs and concerns heard, but wanted more specific action items that they could implement for resilience.

Case Study: Southeast Care Coalition Project

Making Allies for Southeast: leveraging our differences to build resilience, dignity, and the strength to create together the Southeast Community where we all want to live.

Background: As the Southeast Community of Newport News, VA looks to the future, it must consider another reality: climate change and sea level rise. The City of Newport News conducted an analysis of sea level rise impacts affected by a 2 foot rise and found that only about 0.5% of real estate parcels in the City would be impacted; however, the City confirmed that those parcels were primarily located in the Southeast Community. Through a long term effort of capacity building, empowerment and relationship building between the Southeast Community and the City of Newport News, this project seeks to create solutions that become cornerstones in the foundation for greater community resiliency.

Project: This collaborative project seeks to create a realistic and equitable evacuation plan for the people of Southeast Newport News as the city, and this community of primarily lower-income African American residents, prepare for weather events in this time of climate crisis. The main objective is to create today, the relationships and dialogue between city and community that will enable a positive collaboration for an evacuation plan before it is needed tomorrow in a crisis. Specifically, the "most connected" from the city of Newport News and the "most affected" in the Southeast Community are being brought together to build the relationships and trust necessary to create an equitable evacuation plan for the community (and City at large) and to foster greater resiliency overall. This collaborative effort can serve as a model for similar communities in the Hampton Road region who seek solutions to weather events and climate resiliency through dialogue between government and the communities themselves.

Learning: To date, what we have learned is that the idea and creation of a more meaningful evacuation response for the Southeast community is an excellent topic around which we can bring together the "most connected" and the "most affected" The possibility of a new and equitable evacuation response has created a new willingness to better address social justice issues and relationships between the City and the Southeast Community

Resources for Citizen Engagement with Respect to Climate Change

National Coalition for Dialogue & Deliberation http://ncdd.org/rc/item/tag/environ-sustainability

Public Agenda http://www.publicagenda.org/media/facing-the-challenges-of-climate-change

National Issues Forum deliberation https://www.nifi.org/en/issue-guide/climate-choices

Mothers Out Front house party http://www.mothersoutfront.org/

Tabletop Presentations https://app.box.com/s/qej7ygwo2yodc2q05eox

League of Women Voters http://participate.lwv.org/c/9217/p/salsa/web/common/public/content?content_item_KEY=3770

Community Resilience Building http://www.communityresiliencebuilding.com/#!crbworkshopguide/c192n

Extreme Weather Challenge http://www.psr.org/chapters/arizona/assets/pdfs/guiding-group-conversation.pdf

Human Impact on Climate Change http://www.interactivityfoundation.org/discussions/human-impacts-on-climate/

Climate Fiction http://switchboard.nrdc.org/blogs/rmoore/climate_fiction_provides_a_win.html

Project Aspect UK http://www.projectaspect.org/

Climate Witness Instruction Cards http://ejfoundation.org/sites/default/files/public/Instruction%20Cards%20Filming.pdf

Nature's Notebook https://www.usanpn.org/natures_notebook

Examples and papers

Alberta Climate Dialogue http://www.albertaclimatedialogue.ca/

Ready for Next time? http://www.newsworks.org/index.php/blogs/centre-square/item/56502

The use of public engagement in tackling climate change (UK) http://www.involve.org.uk/blog/2012/01/18/the-use-of-public-engagement-in-tackling-climate-change/

Improving Public Engagement with Climate Change http://pps.sagepub.com/content/10/6/758.full

Climate Geoengineering and the Role of Public Deliberation http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2710088

TED How Can We Talk about Climate Change? http://ideas.ted.com/how-can-we-talk-about-climate-change-or-can-we/

Connecting on Climate http://ecoamerica.org/wp-content/uploads/2014/12/ecoAmerica-CRED-2014-Connecting-on-Climate.pdf

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APPENDIX G-1

Public Health Working Group Report and Recommendations

Public Health Working Group

Chair: Steven M. Becker, PhD, *Professor of Community and Environmental Health, College of Health Sciences, Old Dominion University*

Public Health Working Group Members:

Name	*Organization*	*Position*
Demetria Lindsay, MD	Norfolk Health Department	Director
David Chang, MD	Portsmouth Health Department	Director
Cynthia Jackson, REHS/RS, AOSE	Chesapeake Health Department	Environmental Health Onsite Supervisor
Bob Engle	Virginia Beach Department of Public Health	Emergency Coordinator
Joshua Behr, PhD	Virginia Modeling, Analysis & Simulation Center	Research Associate Professor
Muge Akpinar-Elci, MD, MPH	Center for Global Health, ODU	Director
Norman Grefe	Norfolk Health Department	Environmental Health Manager
Brian C. Martin, Ph.D., MBA	Eastern Virginia Medical School	Director, Graduate Program in Public Health
Linda Botts, MPH	Norfolk Medical Reserve Corps	Coordinator
Steven M. Becker, PhD	Old Dominion University, College of Health Sciences	Professor of Community and Environmental Health

Date of Working Group Formation: April 2015

Membership Development/Stakeholder Engagement: Area health agencies, including health departments, public health higher education programs, and public health research organizations, were contacted in 2015 and invited to participate in the join the newly-established Public Health Working Group. An initial roster of founding members was created, and has continued to expand in 2016.

Scope of Work:

The aim of the Public Health Working Group is to make public health an integral part of sea-level rise planning, adaptation and resilience efforts in the region. Specific areas of focus include analyzing potential public health impacts of sea level rise in Hampton Roads; identifying ways to incorporate public health issues into planning, adaptation and resilience efforts; engaging the public health community in sea-level rise projects; identifying special areas of expertise that public health can contribute (e.g., public health emergency preparedness, health and environmental risk communication, health-related community outreach, epidemiology, industrial hygiene, and working with vulnerable/special needs populations); identifying new and innovative ways of incorporating sea-level rise issues into public health education and training in the region; and developing new and innovative solution-oriented projects to address public health aspects of sea-level rise locally and around the nation.

Activities and Accomplishments

The Public Health Working Group's initial activities have been focused in three broad areas: (1) working to integrate sea-level rise preparedness and resilience issues into graduate public health education in the region, (2) creating new linkages and collaborations for information exchange, practice and research on sea-level rise and public health, and (3) assessing the public health implications of sea-level rise in the region.

Integrating Sea-Level Rise Preparedness and Resilience Issues into Graduate Public Health Education. Members of the Public Health Working Group have been working with faculty at area institutions of higher education to better integrate sea-level rise issues into graduate public health education.

Curriculum. The effort began with the foundational course in environmental health that is taken by all first-year students in the Masters of Public Health (MPH) program jointly offered by Eastern Virginia

Medical School (EVMS) and Old Dominion University (ODU). The three-credit course, entitled Principles of Environmental Health (ENVH 600/MPH 613), now includes a two-part module on climate and sea-level rise issues. Topics include health impacts of sea-level rise, storm surge and coastal flooding; vulnerable populations; challenges for public health and healthcare system preparedness; and implications for public health planning and training. Additional content on sea-level rise and health will

be added to other courses in the 2016-2017 academic year. Furthermore, ODU is in the process of adding faculty positions specifically focused on Climate and Health. These will be based in the School of Community and Environmental Health in the College of Health Sciences. Thus, in the near future, entire courses should be available on climate, sea-level rise and health.

Practicum: A particularly innovative step to create links between public health professional education and sea-level rise was taken in 2016 when a "community practicum" focusing specifically on sea-level rise was created. All second-year MPH students are required to complete a 3-credit graduate course entitled Community Practicum (MPH 750). The practicum is intended to provide students with an in-depth supervised experience in an approved organization. Under the guidance of an on-site preceptor and an academic advisor, students work on real-world public health issues using the knowledge and skills gained in academic courses. Students are expected to work on the project for a minimum of 200 hours during the semester, which is the equivalent of 14.3 hours per week. In addition to the on-site work, practicum students are expected to prepare monthly progress reports, submit a longer report summarizing what was learned during the practicum experience, write a major project paper, and give an oral presentation based on the paper. The 2015-2016 academic year saw the completion of the first community practicum on sea-level rise. MPH student Christina Gumina was based at the Hampton Roads Sea Level Rise Preparedness and Resilience Pilot Project (IPP), where she worked under the

direction of practicum supervisor Emily E. Steinhilber, Esq. (Assistant Director of Coastal Resilience Research) and academic advisor Dr. Steven M. Becker (Chair of the Public Health Working Group). Ms. Gumina's multi-part project involved carrying out an overall literature review on public health impacts of sea-level rise, focusing in on a smaller subset of those impacts, and relating the findings to the Hampton Roads area. In addition, the practicum paper offered a series of recommendations for follow-work on public health and sea-level rise. The oral presentation was given on May 3, 2016. The paper is included as an appendix to this report.

Creating New Linkages & Collaborations for Practice and Research on Sea-Level Rise and Public Health

Another major area of emphasis for the Public Health Working Group involved the creation of new linkages and collaborations for practice and research. A notable example of this effort involved a special program that was held at ODU in March 2016. Co-sponsored by the Public Health Working Group, the Program featured a special six-person delegation from the U.S. Environmental Protection Agency (EPA). The delegation discussed a new interactive mapping tool for better understanding links between the environment and human health. Called EnviroAtlas, the tool enables users to access, view, and analyze local and regional environmental data to better understand how individual and community decisions can affect sustainability and resilience. Users can access, view, and analyze hundreds of local and regional environmental data layers to better understand the potential impacts of various decisions on sustainability and resilience. EnviroAtlas covers the contiguous U.S. at 30-meter and watershed resolutions, and selected urbanized areas at one-meter and census block-group resolutions. EnviroAtlas will include the greater Norfolk area as a featured community in 2017. Although the initial focus of the tool has been on basic environmental features and health, future additions will include climate change metrics, land use scenarios, runoff and recharge metrics, and flood plain information. As such, EnviroAtlas has enormous potential to be helpful in understanding links between ecosystem services (benefits provided by nature and valued by people), flooding and related sea-level rise issues, and

human health. To help acquaint current and future professionals with EnviroAtlas and its potential uses, and to preview how it can be used in research, practice and decision-making, the EPA delegation gave a 2 ½ hour training seminar at ODU. Three top experts spoke at the seminar:

- Anne Neale, who has been with EPA since 1991, and who is currently a research scientist with EPA's Office of Research and Development. She is the Project Lead for EnviroAtlas.
- Laura Jackson, PhD who has developed and led interdisciplinary ecosystem-based research at the U.S. Environmental Protection Agency for 25 years.
- Barbara Walton, PhD, Board-certified toxicologist whose 39-year career in environmental toxicology has involved positions in research, policy, and teaching. Walton has been Assistant Laboratory Director at the U.S. EPA for the past 16 years.

In addition, three other EPA specialists were there to give additional insights, talk with participants, and answer questions:

- Regina Poeske, Senior Ecologist and the Climate Adaptation Coordinator for US EPA Region III. In 2014, she received the Edward T. "Red" Heinen Wetlands Award, EPA's most prestigious national award recognizing superior work to protect wetlands.
- Rochelle Araujo, TITLE, National Exposure Research Laboratory, U.S. EPA, Research Triangle Park, NC.
- Andrew Wynne, an Environmental Protection Specialist and lead for university outreach programs at EPA Region III.

Caption: US EPA Delegation (from left to right) – Regina Poeske, Andrew Wynne, Laura Jackson, Barbara Walton, Anne Neale, Rochelle Araujo

The following day, the EPA scientists also participated in a networking meeting with ODU sea-level rise researchers and others studying links between environment and health. The aim was to find new ways of linking EPA's EnviroAtlas tool with current and future research projects at ODU and in Hampton Roads more generally. Topics of discussion included green infrastructure, climate change, sea level rise, sustainability and resilience. Among those participating in the lunch discussion were Dr. Shelley Mishoe, Dean of the College of Health Sciences; Dr. Deanne Shuman, Chair of the School of Community and Environmental Health; Ray Toll, Emily Steinhilber and Christine Gumina, who were representing the Hampton Roads Sea Level Rise Preparedness and Resilience Intergovernmental Planning Pilot Project; Drs. Larry Atkinson and Michelle Covi from the Climate Change & Sea Level Rise Initiative at ODU; Dr. Becker, representing the Public Health Working Group; and several faculty researchers from the College of Health Sciences. The lunch meeting was facilitated by the Public Health Working Group and the School of Community and Environmental Health.

Assessing the Public Health Implications of Sea-Level Rise in the Region

Because some of the most serious impacts of sea level rise are those affecting public health, and because these impacts are likely to be an important focus of concern across a wide variety of sectors involved in a Whole of Government/Whole of Community approach, public health issues need to be an

integral part of sea-level rise adaptive planning efforts. Toward this end, the Public Health Working Group has been carrying out a case study of potential SLR public health impacts and issues in the Pretty Lake Watershed. This work is being carried out as part of a broader project funded by the Blue Moon Fund. To date, the project team has been working to identify the range of potential public health impacts associated with SLR alone (1.5' and 3.0' Sea Level Rise) and with Storm Surge situations (1.5' Sea Level Rise + 100 year storm surge and 3.0' Sea Level Rise + 100 year storm surge). Potential public health impacts are being identified by drawing on the scholarly literature about SLR and public health, consulting documents about the Watershed, utilizing infrastructure maps and other map products of the area, and via actual visits to parts of the Watershed. An example of an SLR alone impact is a significantly increased problem with pools of standing water, which can enable the rapid growth of mosquito populations and result in the spread of infectious diseases. An example of an SLR + Storm Surge public health impacts is water from flooding causing the growth of mold, resulting in an increase in allergic reactions and asthma. In addition to such traditional public health concerns, the case study is devoting attention to less-known potential impacts. This includes contamination of the environment with hazardous materials that are found in a surprising number of facilities and locations, and that may be released under certain circumstances. Once the analysis of public health impacts has been completed for the Pretty Lake Watershed case study, key insights will be expanded to include the Hampton Roads region more generally.

Future Directions and Recommendations

1. Some of the most serious impacts of sea level rise are those affecting public health.
2. Consequently, there will be a continuing need for public health issues to be an integral part of current and future sea-level rise adaptive planning efforts.
3. In the Hampton Roads region, it will be essential to continue and further expand the activities and the membership of the Public Health Working Group.

APPENDIX G-2

Climate Change & Public Health: A Literature Review focusing on the coastal region of Hampton Roads, Virginia, United States

Climate Change & Public Health: A Literature Review focusing on the coastal region of Hampton Roads, Virginia, United States

Hampton Roads Sea Level Rise Preparedness and Resilience Pilot Project (IPP)

April 2016

Climate Change & Public Health: A Literature Review focusing on the coastal region of Hampton Roads, Virginia, United States

Christine Denise Ortiz Gumina

An Academic Review submitted in partial fulfillment for the degree of Masters in Public Health in the Concentration of Global Environmental Health

Faculty Advisor: Dr. Steven M. Becker
Eastern Virginia Medial School/ Old Dominion University

Preceptor: Emily E. Steinhilber, Esq.

April 2016

Outline

1. Introduction- applying public health context to climate change
2. Key concepts of climate science
3. Indication of Climate Change/Public Health Challenges
    a. Heat
    b. Heavy Precipitation
    c. Sea Level Rise and Extreme Weather
4. Adverse Public Health issues from Climate Change
    a. Vector-Borne Disease
        i. Mosquito vector diseases
        ii. Ticks vector diseases
    b. Mold and Endotoxin
    c. Water borne Disease
    d. Harmful Algal Blooms
    e. Immediate Health Effects caused by Deluges and Extreme Storms
    f. Chemical Contamination in Water
5. Actions to address Climate Change and Promote Public Health
    a. Public Health System Readiness
    b. Public Health Policy and Assessment
        i. BRACE Framework (Building Resistance Against Climate Effects)
6. Conclusion
7. Endnotes

Introduction

"*Climate change is happening, humans are causing it, and I think this is perhaps the most serious environmental issue facing us*", Bill Nye.

Climate and weather have always been interlocked with human health. Cold temperature and extreme heat can cause hypothermia, displacement or death from flooding, famine as a result of drought, tropical disease expansion by vectors, and increased foodborne/waterborne illness due to poor sanitation *(22)*. Change in climate have given rise to Ebola hemorrhagic fever, Malaria, West Nile, Hantavirus, Cholera, and Encephalitis Virus through vectors such as mosquitos, ticks, and rodents *(20, 30,31,32, 34)*.

Deforestation of our most precious and ancient forests in Brazil and Indonesia are reducing the earth natural ability to recycle atmospheric CO_2 *(29)*. The melting of the polar ice caps are causing the seas to rise; leaving thousands of people who live on the coast or on islands displaced. In a recent article written by Coral Davenport of the New York Times, residents of the Marshall Islands are currently experiencing encroachment by rising seas and 17% of the island nation will be submerged by 2050 *(56)*. Violence due to drought and other extreme weather events are triggering waves of climate migrants to be deprived of basic human rights in poor corrupt countries. Changes in weather patterns and climate are spreading communicable and vector-borne diseases at alarming rates.

Although challenging to directly link the public health challenges above to climate change, studies are beginning to find striking connections between the two. In this literature review, climate change as it relates to public health will be analyzed. The review will begin with an overview of climate science and current indications of climate change. This will then be followed by a global focus of adverse public health issues relating to specific climate change events such as heat, heavy precipitation, and sea level rise; ultimately concentrating on public health issues within the Hampton Roads region in the Commonwealth of Virginia. Lastly, the paper will conclude with a brief discussion of actions to promote public health through addressing climate change.

Key Concepts of Climate Change

Climate change as defined by Patz and Levy (2011) is " *a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods*" *(30).* The evidence of climate change has become an overwhelming truth *(17)*. Climate change is not a local event or only impacts a small few; it is an international crisis that is restructuring our environment and the way we live. The public often confuses the difference between weather and climate. Weather is the state of the atmosphere at a place and time as regards to heat, dryness, rain, sunshine or wind.

Climate is the weather conditions prevailing in an area in general or over a long period of time *(30)*. Weather is unique to certain areas due to their place latitudinal and vicinity to large bodies of water or terrain (ex. mountains) *(31).* Changes in climate are caused by the retention of heat on the surface of the earth by increased concentrations of CO_2, methane, nitrous oxide, and other greenhouse gases. Impacts of climate change include ocean acidification, polar ice cap melt, rising sea levels, air pollution, and global food insecurity. Additionally, in the last couple of decades extreme weather phenomenon such as heat waves, wildfires, drought, super storms (hurricanes, typhoons, and tornadoes) and storm surge have increased dramatically *(29).*

In 1988, the World Meteorological Organization (WMO) and the United Nations Environment Program (UNEP) created the United Nations Intergovernmental Panel on Climate Change (IPCC) and tasked the IPPC's with producing international assessments on scientific works on climate change *(30)*. Since its inception, the IPCC has released five assessments on climate change. The 2007 report indisputably gave concrete evidence that humans are responsible for the changing climate *(31).* These assessment reports have provided action and validation to global climate change response. The 2007 IPCC stated that Greenland and Antarctica, which contains most of the world's frozen water, were melting faster than expected due to increasing temperatures in the atmosphere *(29).*

Basics of Climate Science

Scientist studied greenhouse effect for over a century *(29).* The sun emits radiation toward the earth in the shape of ultraviolet light, infrared and visible light. This energy hits the outside of the atmosphere with one-third of it reflecting back into space *(29).* The rest of the energy from the

sun is absorbed by the surface of the earth, mostly by the oceans. This results in the earth heating up and then reradiates the energy it has absorbed in the form of infrared radiation *(29).*

Greenhouse gases such as water, CH_4, and CO_2 can trap the reradiated heat and allow for the earth to maintain an ample 60° F warmer than it normally would without the gases acting as a blanket *(29).* CO_2 can be emitted naturally into the atmosphere through volcanic eruption and human/animal respiration *(31).* Even though CO_2 is naturally occurring, humans have increased its volume in the atmosphere through the burning of fossil fuels (coal, natural gas, and oil), solid waste and deforestation *(31)*. In 2012 the United States emission of greenhouse gas consisted of 82% CO_2. About 90% of Co_2 gas emitted is from fossil fuel burning and cement making with the remainder attributable to land-use change such as deforestation *(29).*

Plant photosynthesis and ocean-atmospheric interactions absorb CO_2 from the atmosphere *(31).* Plants and trees take in the CO_2 from our atmosphere to make oxygen, additionally, converting sunlight into energy. Vegetation acts as a carbon sink causing a net reduction in the amount of CO_2 in the atmosphere *(29).* Removal of trees and plants through land-use projects and deforestation reduces the capacity of the carbon sink. In some cases trees are burned in the removal process adding to the amount of CO_2 emitted *(29)*.

The 2007 the IPCC assessment stated that 17% of CO_2 emissions originated from the destruction of large carbon sinks such as the Amazon Rainforest of Brazil and the tropical forests of Indonesia (*29,30,31).* Brazil alone has seen 80% of the rainforests devastated in the last decade *(29).* GHGs concentrations are three times higher now, than in the past 800,000 years *(30).* From 1880 to 2012 the average surface temperature of the Earth has increased 0.85°C (1.53°F), most of which occurred since 1970 *(29,30)*.

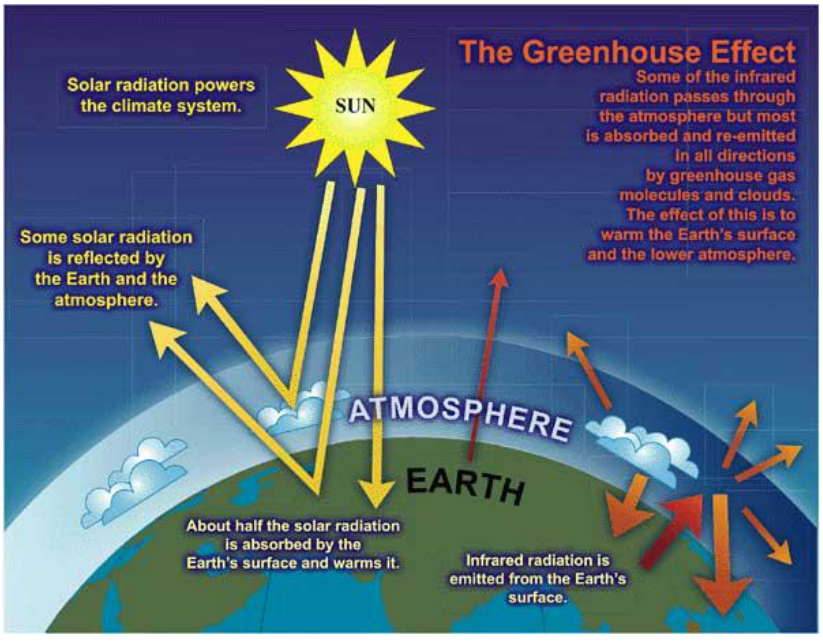


Figure 1: A diagram of the greenhouse effect. (*Source*: Adapted from Solomon S, Qin D, Manning M, et al. [eds.]. Climate change 2007: The physical science basis. Cambridge, UK: Cambridge University Press, 2007.)

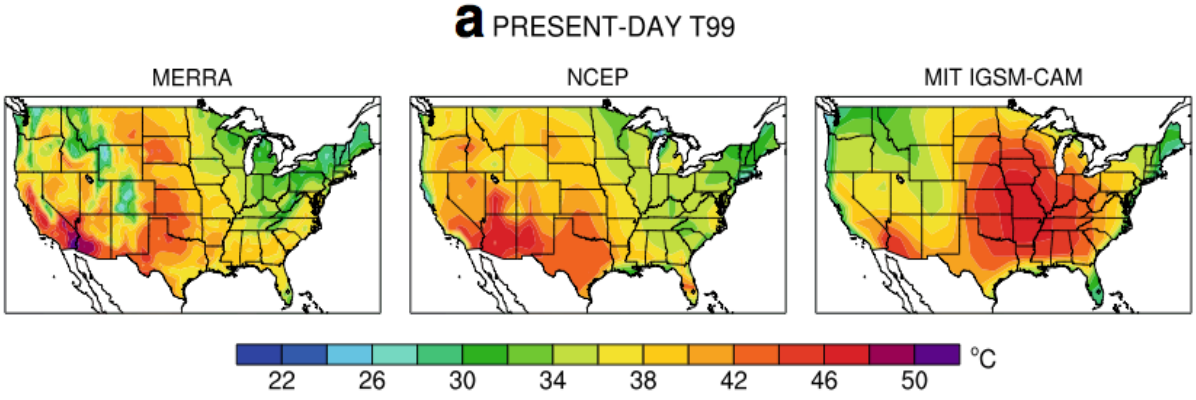
Indications of Climate Change/ Public Health Challenges

Extreme Heat

Climate temperatures are increasing *(29,30)*. The 1980s was previously the warmest decades on record *(29,30,31).* However, that record was broken in the 1990s with the heat wave of 1998 and shattered in 2005, 2010, and 2014 *(29,30,31)*. Temperature changes are not experienced uniformly around the globe. Areas closet to the northern Polar Regions have seen a dramatic change in temperature compared to other areas *(30,31)*. Air temperatures have increased over land in comparison to the oceans because of the oceans' ability to store heat.

Modern forms of measuring daily and annual temperatures were not established until the late 19th century *(31)*. Tree rings, ocean/lake microorganism, ice cores, and pollen are closely linked with physical environmental properties and scientists have been able to collect data on climate changes within these mediums. Biologically seasonal events are occurring at different times and the duration of time has shortened. For example, in areas where there is a seasonal frost the start has begun later on and ended earlier. This is important in the control of insects such as ticks, roaches and mosquitos and pollination of plants and trees. Moreover, the extreme heat has amplified ocean temperature allowing for high levels of evaporation to occur resulting in intensification of rainfall, deluges, and super storms *(29,31).*

Table 1: Annual 99th percentile of maximum daily temperature in the United States (1981-2010)



(38) Monier, E., & Gao, X. (2015). Climate change impacts on extreme events in the United States: an uncertainty analysis. *Climatic Change*, *131*(1), 67-81.

Changes in Precipitation and Extreme Weather Events

Precipitation events in the United States are reducing in frequency, but increasing in intensity *(30).* Heavy rainfall increased about 20% due to the warmer temperatures holding more water vapor, which in turn cause heavy deluges, and storms *(30)*. These events greatly impact human health causing injuries, drowning's, and water contamination issues. River floods from 1980-2009 have resulted in 500,000 deaths globally. Similarly, intensity of hurricanes and cyclones are also increasing due to warmer surface temperatures of the ocean, which allow for these storms to intensify in strength causing massive destruction such as Hurricane Katrina in 2005 and Hurricane Sandy in 2012 *(30)*.

In the Untied States, heavy rainfall and severe storms have increased in the Northeast and Midwest of the country *(1)*. In the coastal areas of the country, sea level rise and increased precipitation have lead to extreme flooding due to over-saturation of the soil. In Hampton Roads during the October 2015 storm, areas of Ghent, Downtown Norfolk, and Oceanview were under water due to sewer systems being backed-up with debris and an increased storm surge *(authors personal experience)*. The long-term issues of sea level rise can compound heavy flooding due to a storm seriously compromising water quality and exposing the community to immediate health effects.

Sea Level Rise

One-fifth of the world's population lives in coastal areas and could be severely impacted by rising seas in the coming years. Thermal expansion of oceans and the melting of polar ice caps and glaciers cause sea level rise *(24, 30, 31)*. In the last 100 years globally the seas have risen about 20cm (8 in.), greater than the previous 2,000 years. The IPCC projects that sea levels will rise another 26-63cm (10.1-26.4i in.) by the year 2100 *(30)*. Globally, sea level rise could decimate coastal cities and island nations. Rising seas will cause erosion, inundation of low-lying areas, increased salinity in aquifers, higher water tables, and compound storm damage. About 80-90% of sandy beaches in the United States are already seeing heavy erosion due to sea level rise around the country's coastline.

Greenland and Antarctica encompass enough water that if fully melted could raise sea levels by 25-80 meters (80-260 feet). In the last two years, researchers have found that the ice sheets in Greenland and Antarctica are becoming less stable than previously believed and believe that polar cap melting could be irreversible *(29)*. This increase in volume is resulting in sea level rise throughout the globe and soon some coastal locations and island countries will cease to exist.

Low-lying areas along the coast will be greatly impacted by sea level rise. The disappearance of island nations and coastal cities will displace thousands of people to different regions or to neighboring countries *(30)*. Saltwater intrusion in coastal groundwater will cause death to crop and aquifer will become saline, resulting in food and water shortages. There will be an intensification of international stressors on countries that are already experiencing huge migrant waves due to violence and civil war *(20)*.

In 2009, the UN Refuge Agency estimated that currently there are about 20 million climate refuges (storms, floods and drought) and this number could increase to 50-200 million by 2050 *(30)*. People who are forced to migrate due to sea level rise, drought, flooding, and extreme weather events are internally displaced, have less access to food and water, sanitation, and medical/public health services and are susceptible to human rights violations *(30)*. Currently, an estimated 162 million people are at risk of displacement due to sea level rise; 31 million in island nations, 26 million in Bangladesh, 73 million in China, 20 million in India, and 12 million in Egypt *(30).*

Sea level rise intensifies the impacts of storm surge. Global warming is creating super storms at greater frequency *(26,29).* In a 2013 study on Hurricane Sandy, NOAA researchers discovered that most of the destruction caused by the storm was due to massive storm surge *(29).* The NOAA study stated that sea level rise will increase conservatively 2-4 feet and worse case scenario to 4-7 feet by 2100 *(29)*. Human-induced climate change has doubled the risk for a Sandy –type storm surge compounded by inches of sea level rise occurring today, even in minor storms *(29).*
NOAA stated:

"*climate-change related increases in sea level have nearly doubled today's annual probability of a Sandy-level flood recurrence as compared to 1950. Ongoing natural and human-induced forcing of sea level ensures that Sandy-level inundation events will occur more frequently in the future from storms with less intensity and lower storm surge than Sandy."*

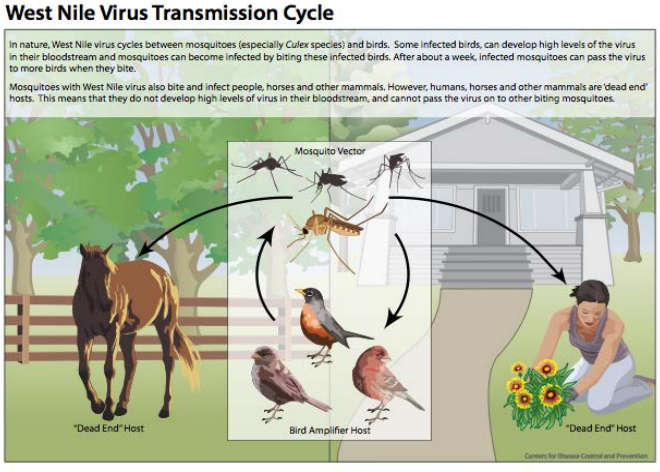
NOAA researchers recently have stated that a rise in sea levels can increase the prevalence of vector-borne diseases in coastal areas *(42).* Sea level rise causes a higher water table in coastal regions, allowing for pooling of water to occur due to high tide or during rain events. Pooled water creates a breeding ground for mosquitoes to populate in numbers allowing for the spread of vector-borne disease, which will be later discussed in greater depth *(42)*.

Vector-borne diseases

Mosquito vector diseases

Mosquitoes are one of the most aggressive vectors contributing to the spread of endemic or unfamiliar disease *(48).* People fear the unknown. They fear terrorism, nuclear power, acts of god, but a mosquito? To most in the western world a mosquito is an annoying insect that crashes summer barbeques. However, mosquitos are vectors to some of the most dangerous and mysterious diseases in the world. Vector-borne diseases are caused by zoonoses, which means the transmission of disease from vertebrate animals to humans *(30).* Climate change has changed ecosystems and vegetation allowing vectors to migrate and infect new populations. This has resulted in North Americans contracting West Nile Virus, Nepalis at risk of Japanese encephalitis, and Zimbabweans in the African Highlands being exposed to falciparum malaria *(30).* Dengue hemorrhagic fever is the most common human arbovial disease globally *(42).* It affects about 50 million people in over 100 countries necessitating hospitalization for 50,000 persons and has a fatality rate of 2.5% *(42).*

Mosquito species Aedes aegypti, Aedes albopictus, and the Culex populate along the eastern seaboard of the United States, but they are not native to the continent. Global travel and trade has allowed for species to proliferate new environments. Aedes aegypti was brought to the U.S during the 1500s slave trade from Africa. It is know as the yellow fever mosquito because it carries yellow fever along with other vector diseases such as dengue, chikungunya, West Nile virus and most recently Zika *(41).*



Center for Disease Control. (2015). *West Nile Virus: Transmission.* http://www.cdc.gov/westnile/resources/pdfs/13_240124_west_nile_lifecycle_birds_plainlanguage_508.pdf. Accessed March 20, 2016.

Aedes albopictus or the tiger mosquito arrived on the continent in the mid-1900s through tire trade with Asia. The tires would accumulate water during travel allowing for mosquitos to breed along the journey *(41)*. Once the tires arrived in the United States, the mosquitos flourished in their new environment spreading across the country. Aedes albopictus is the most invasive species of mosquito worldwide and is found in every continent except Antarctica *(48)*. A persistent biter the tiger mosquito has an

elevated potential of spreading disease *(48)*. The species has caused a re-emergence of diseases such as chikunguya, dengue, and West Nile *(48).* In the United States the albopictus northern most reach is currently New York and parts of New Jersey *(48).*

CDC Global. "Aedes albopictus." February 17, 2016. Online image. CDC Global on flickr. https://www.flickr.com/photos/cdcglobal/25067277666/in/album-72157664805141145/

Mosquito-borne vector diseases are sensitive to climate and changes in weather. Dengue fever is especially sensitive to changes in climate and by 2080;an estimated 6 billion people globally are at risk of contracting the disease *(37).* Heavy rains caused by increased temperatures and humidity allow for pooling of water (*37)*. Malaria cases peak following monsoon season in tropical countries such as Sri Lanka *(42).* Urban dwellers are at greater risk because of trash and discarded tires *(47)*. In the United States, extreme precipitation has increased the Northeast and Southeast regions of the country *(38).* The southeast of the United States is susceptible to an increase in mosquito population because of the diverse marsh ecosystem. Marshlands and heavy rains combine to provide optimal breeding ground *(47)*.

Sea level rise is a contributing factor to the spread of mosquito borne disease. As previously mentioned, sea level rise increases the water table in coastal regions allowing for severe pooling during rain events. Although, most mosquito species breed in predominantly fresh water because of their inability to osmoregulate salt water and lack of rectal anal salt glands *(41).* About 5% of species can breed in high saline water *(41).* However, recent studies suggest that freshwater dominant species such as the *Aedes* and *Culex* mosquito are adapting in brackish water and higher saline water *(41, 43)*. Sea level rise will cause bodies of fresh water close to the coast mix with ocean water creating more brackish environments, increasing available breeding ground and allowing for increased cases West Nile virus in North America *(41,43)*.

First discovered in 1937 in the tropical country of Uganda, the West Nile Virus was limited to the tropical Africa region till about the mid-1950s when it began to creep its way up through the Mediterranean and then the Western Hemisphere *(30).* West Nile virus goes through a zoonotic cycle, passing from birds to mosquitoes to large mammals such as horses and humans *(30)*. *Culex* mosquitoes, which carry West Nile, populate urban areas during dryer summer weather. In 1999, New York City recorded warmest summer in 15 years. Leading to the first documented case, the heat wave was a public health nightmare that disguised the largest mosquito-borne encephalitis outbreak in the Western Hemisphere and West Nile outbreak in the world *(30, 39).*

Prior to the 1999 cases, most northeastern metropolitan areas had no need for mosquito control programs, which were initially in coastal areas as a response to salt marsh species *(48)*. In about 5 years, West Nile virus spread all over the United States and into Canada. The United States documented approximately 37,000 cases from 1999-2013, though 70-80% people who contract the disease do not display any symptoms. Less than 1% of cases end up developing a neuroinvasive disease such as meningitis, encephalitis or myelitis *(39)*. Maps of case incidence overlaid with temperature anomalies compared the spread of the disease in the western United States. The maps showed that disease balloned from 10 cases to 100,000 cases between the months of June to September when temperatures averaged 1-3°C (1.8-5.4°F) higher than between 1971-2000 *(30).*

In 2015 the CDC reported that the Commonwealth of Virginia had 14 cases of West Nile cases with neuroinvasive disease, 7 non-neuroinvasive disease, 1 death and 3 presumptive viremic blood donors *(49).* The Virginia Department of Health reported 2 cases in the eastern portion of the state, which includes the Hampton Roads region *(50).* Testing of pooled water found that in 2015 the city of Chesapeake had 4 positive tests with mosquito with West Nile, Norfolk reported 12 positive cases, Suffolk 5 and Virginia Beach 20 *(50)*. In addition to West Nile Virus, dengue fever (18 imported cases) and chikungunya (22 imported case, mostly South America and Puerto Rico) have also emerged in the state *(50).* At the start of 2016 we saw the global health crisis of Zika virus arise. Easy travel to and from the Caribbean by tourists could possible spread the disease like wildfire by the end of the year.

Tick Vector Diseases

Tick-borne diseases are a rising problem in Europe and the United States. The expansion of tick population facilitated by climate change has encouraged the spread of diseases such as tick-borne encephalitis, Lyme Borreliosis, rocky mountain spotted fever and others *(45)*. Ticks rely on warm temperatures throughout their lifecycle. Warmer temperatures during the winter months have allowed for ticks to grow at a faster rate and survive during periods of seasonal frost *(30)*. Ticks cannot fly; they are parasitic and attach themselves to a host. Ticks move from south to north on bird through migratory patterns *(30)*.

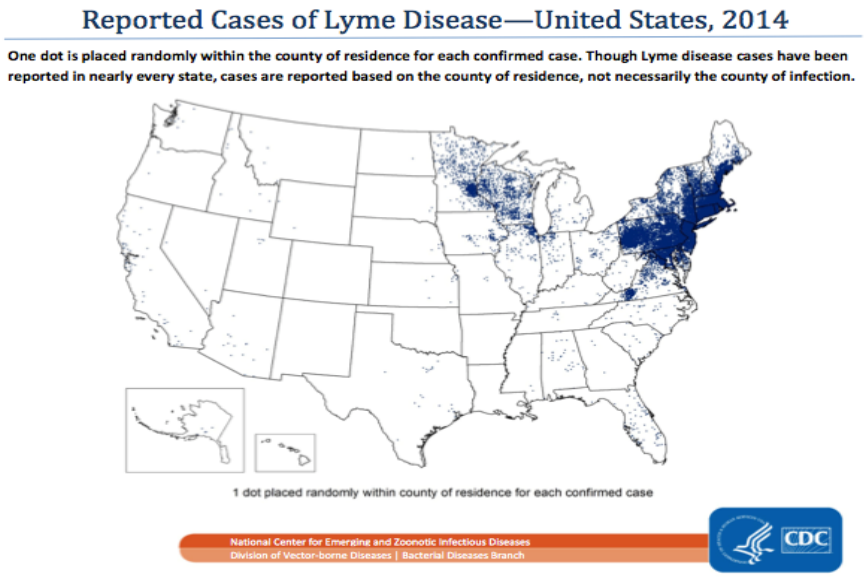
Precipitation plays a huge role in the growth of the tick population, especially the Black-Legged tick (*Ixodes scapularis*) that transmits Lyme disease, in the United States *(44).* Ticks need a humidity level of about 85% with temperature greater than 7°C (45°F) to survive *(45).* A study done in Northern Illinois found that during periods of significant rainfall there was a higher density of the black-legged tick and infection rates *(44).* Nymph ticks, after feeding on their infected host, lose their ability to control their water content. In years when there is little rainfall many of these

nymphs die out and never reach adulthood. In the Northeastern United States the increase in precipitation has brought on more cases of people infected with Lyme disease *(44)*.

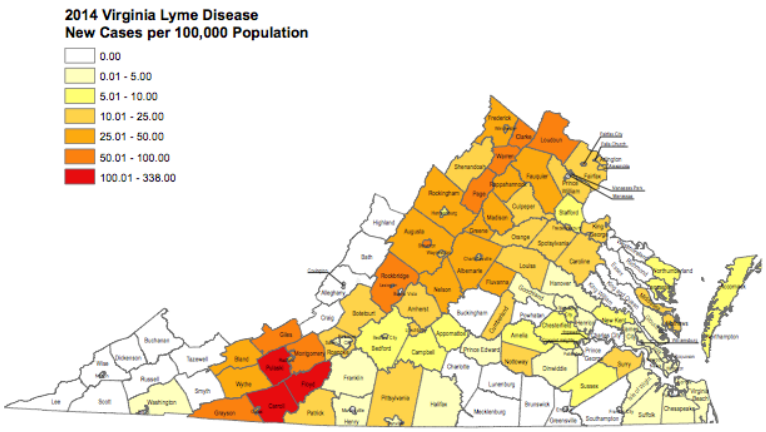
Fairfax County. "Ticks on Finger". May 14, 2012. Online image. Fairfax County on flickr. https://www.flickr.com/photos/fairfaxcounty/7209178448/in/photolist-bZ3VA9-aaijVm-aafwdn-aafwbV-7P6Dbn-7PaCVW-aqSnat-fc5rTW-a69vav-aafwjB-aaijWG-aafwhD-f1xPjZ-f1N8zS-aaik7G-cdnNaY-aafwox-nQVDQQ-aaikbQ-aafwu8-aafwkZ-aafwmp-aaikaq-aafwgX-aaiWoy-7PaD2o-aafwe2-cPgA9q-aafwoV-aaiWv1-9GgFgV-aaiWuf-aaikb3-aafweV-aaiWp1-aafwnR-aag92B-aag8XF-aaik5u-9GgEKe-7ZfAFn-aaik1q-aaiWvN-9GgENv-aaiWxd-9GgF4r-aaiWpw-aag912-aaikeu-aaikcU

Lyme disease is caused by *B. burgdorferi* a spirochete that is carried by the black-legged tick *(44)*. This specie of tick has a life cycle of two years from egg to adulthood. In the northeastern U.S. ticks begin to lay their eggs in early May and larvae begin to emerge some time in the middle of summer *(44)*. Two-thirds of people who contract Lyme disease in the northeastern U.S. do so between the months of June and July because people are outdoors more *(44)*. Lyme disease symptoms include fever, headache, fatigue and skin rash know as erythema migrans *(51)*. If the infection is not treated it can spread to other parts of the body causing deliberating pain and reduction in quality of life. Lyme disease can be recognized through laboratory testing and if found quickly can be easier treated with an antibiotic regiment lasting a few weeks *(51)*.

New species of ticks are being introduced to new environments due to the warmer weather, which can alter stains of tick-borne diseases and host species in a region *(30)*. *B. burgdorferi* strains can be transformed when bacterial expansion occurs in naïve host populations *(30)*. Alterations in pathogenicity in humans may have different susceptibilities to cause severe dissemination of Lyme disease *(30)*. The map first map on the next page shows where reported cases of Lyme disease are concentrated in 2014. According to the CDC, Virginia reported 357 cases of Lyme disease in 2003 increasing drastically in 2014 to 976 confirmed cases *(52)*. The map second map shows the number of new cases of Lyme disease in Virginia per 100,000 people. In 2014, the Hampton Roads region averaged about 0.01-5.00/100,000.



Source from: http://www.cdc.gov/lyme/stats/maps.html. Retrieved on March 23, 2016.



Source from: http://www.vdh.virginia.gov/epidemiology/DEE/Vectorborne/documents/pdf/Lyme%20Case%20Rate%202014.pdf. Retrieved on March 23, 2016.

Mold and Endotoxin

Illness associated with airborne mold and endotoxins are problematic post a severe flooding event. Severe flooding and sea level rise can increase mold issues, present a major public health challenge for the region. When Hurricane Katrina hit on August 29, 2005, water breeched the levees flooding approx. 120,000 homes in New Orleans *(11)*. Homes sat under water for several weeks and flooded again when Hurricane Rita hit on September 22, 2005 *(9)*.

A survey conducted by the Center for Disease Control (CDC) in late October discovered that 46% of homes in the New Orleans had visible mold growth and 17% had heavy mold exposure *(11).* Mold species such as *Alternaria, Apergillus, Cladosporium, Curvularia, and Penicillium* are allergenic and hazardous to human health; producing a toxic chemical known as mycotoxins *(10,11)*. Endotoxin-containing bacteria flourish in indoor damp environments. Endotoxin indicates to the soluble lipopolysaccharide fragments that create the cell wall of a gram-negative bacterium. When endotoxins are inhaled in high doses they can cause flu-like symptoms such as fever, headache, cough, and respiratory difficulties. Chronic exposure escalates the risk for chronic bronchitis, pneumonia, and asthma *(11).*

A study conducted in New Orleans from October through November 2005; post Katrina and Rita, measuring mold and endotoxin growth. Mold spore concentration was found to be high to very high based on national benchmarks. Spore concentration ranged from 21,000-102,000 spore/m^3 in outdoor air concentration to 11,000-645,000 spores/m^3 in indoor concentration. During the October sampling period, 30 minute concentrations periods were conducted as well and found that spore concentration was 26-251% higher than the mean (59,706spore/m^3) for the entire study. Increased mold from flooding events can increase asthmatic cases in children and adults if not resolved *(11)*. Public health officials need to monitor and provide education to the public about negative effects associated with mold growth.

Water-borne Disease

Most people in the United States associate water-borne diseases with third world countries. However, in the U.S. about 9 million cases of water-borne diseases are estimated to occur each year. In the United States more than 200 million residents obtain disinfected public water through supply systems. Gastrointestinal illness is typically associated with water-borne contamination. Symptoms are short lived and often go unreported making it difficult to quantify the actual amount of cases associated with water-borne disease each year *(2)*. After Hurricane Katrina, New Orleans experienced an increased number of cases of water-borne infectious conditions. Those who were injured due to floating debris saw wound infection and airborne sewage caused respiratory

infections or diarrhea *(3).* Outbreaks of *Cholera* and *Hepatitis A*, although uncommon in the U.S., have also been link to post flood contamination from sewage, standing water and garbage *(3).*

A Milwaukee case study on climate and water quality was conducted on the Milwaukee River Basin consisting of rural, agricultural, suburban, and urban land uses. The basin watershed drains into three rivers that all meet up in downtown and discharge into Lake Michigan *(5).* This hydrology parallels that of Hampton Roads where tributaries of the Elizabeth River as well as the James River all pour into the Chesapeake Bay. The study found that after major storms the elevated levels of *Escherichia coli* with 2000-7000 colony forming units (CFU)/ 100ml of water, which is 10 times higher than the EPA recommended levels for recreational waters *(5).* The fecal pollution could have come from agricultural runoff, urban storm water, or sanitary sewage *(5).*

In 2014, Creeds Elementary School in the southern watershed of Hampton Roads had recurrent incidences of coliform bacteria including E.coli detected in the schools drinking water. Students were required to use a portable water sink to wash their hands and given bottled water costing the school system nearly $200,000. The only Virginia Beach school out of the 81 schools in the district to use well water, Creeds Elementary uses two 77-ft deep wells that were installed in 2003 and also sits in between farms and horse pastures *(4)*.

Even though school officials never attributed escalated E. coli levels to run-off water from the farms due to heavy rains occurring that month in September 2014, the case study done in Milwaukee discussed

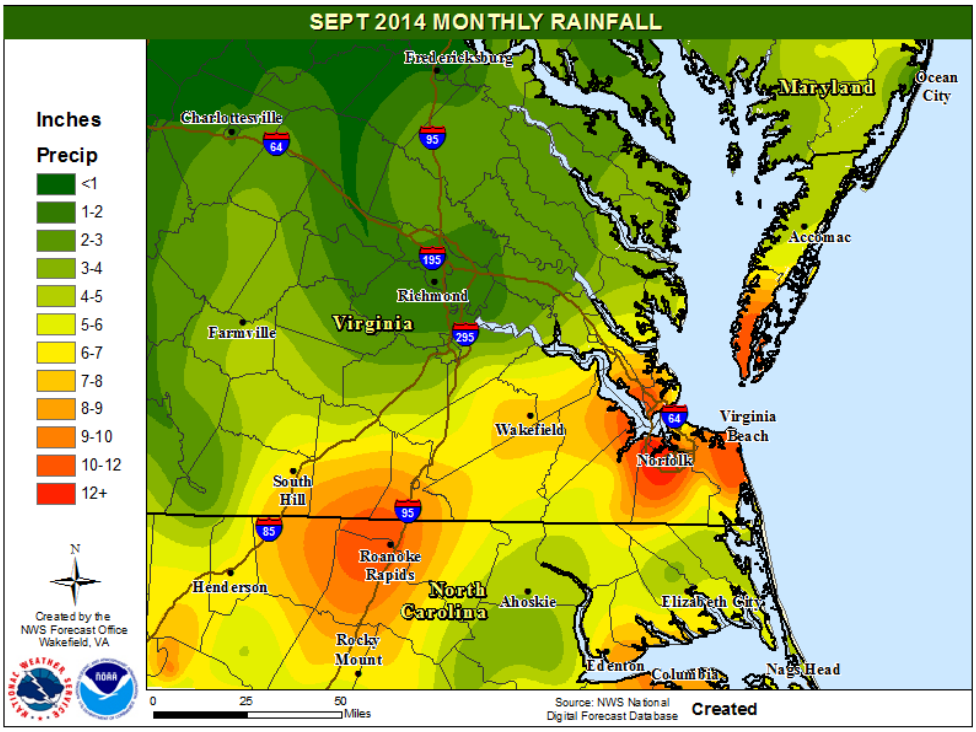
Table 1: Studies examining the role of weather in waterborne diseases.

Waterborne health risk	Location (reference)	Findings
Drinking water contamination	Milwaukee (*20*); Oxford/ Swinden, UK (*174*)	Cryptosporidium outbreak; associated with a rainfall event
	Delaware River (*32*)	*Cryptosporidium* and *Giardia* concentrations in river; positively correlated with rainfall
	Red Lodge, Montana (*28*)	Two outbreaks of waterborne giardiasis; associated with heavy precipitation runoff
	Peru (*121,123*); Nepal (*175*)	*Cyclospora* infections in children; associated with increasing ambient temperatures
		Above-average temperatures in Peru during the 1997/1998 El Niño were associated with a significant increase in the number of hospital admissions of children with severe diarrhea in Lima, Peru. During the El Niño period, admissions increased by 8% for every 1°C rise in ambient temperature.
Coastal-related diseases	Florida (*130*)	*V. vulnificus* reached a high concentration in conditions of low salinity associated with increased freshwater flow to estuaries.
		In addition, human enterovirus was detected in a significantly greater than normal percentage of water samples during heavy rainfall events associated with El Niño between December 1997 and February 1998.

Rose, Joan B., et al. "Climate variability and change in the United States: potential impacts on water-and foodborne diseases caused by microbiologic agents." *Environmental Health Perspectives* 109.Suppl 2 (2001): 211.

suggest the link between the two to seems very plausible *(5)*.

Deeper wells are not a solution since the water is too saline at lower levels, which will only increase with sea level rise affecting water contamination in wells for property owners *(4)*.



Source from: http://www.weather.gov/images/akq/monthly_RF_analysis/COOP_MONTHLY_RAIN_IMAGE_SEP2014.png. Retrieved on February 20, 2016.

During a flood event in Hampton Roads, shelters could also be a source of communicable disease spread. In an emergency shelter situation, overcrowding creates the ideal environment for disease. Access to sanitation and hygiene is often limited *(3)*. Toilets may overflow and clean water for washing may not be easily accessible. This climate exacerbates diarrheal disease potentially causing a public health crisis.

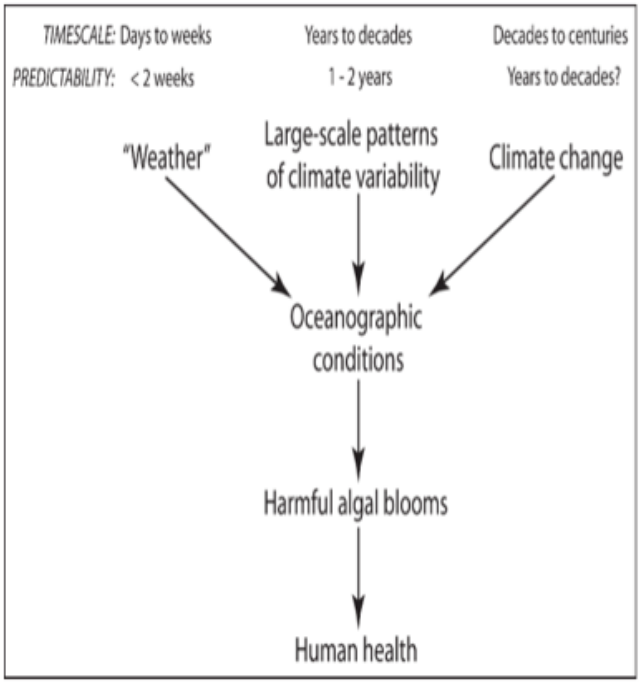
Harmful Algal Blooms (HABs) related Sickness

Although harmful algal blooms known as cyanobacteria extensively studied for 130 years, recent research suggests that the increase in surface temperature due to global climate change could be contributing to the abundance of cynobacterial blooms *(16)*. The rising temperature decreases in surface water viscosity and increases nutrient diffusion making it advantageous for cyanobacteria to find nutrients amongst competition from other species *(16)*. For example, cyanobacteria release toxins that are incredible harmful to human health *(15)*. In Florida, brevetoxins, which are linked with red tides, have been know to cause severe health effects associated respiratory irritants *(15)*. Beach goers, lifeguards, and those with respiratory illness such as asthma are the most vulnerable populations during these types of algal bloom events *(15)*.

Hampton Roads waterfront can be at risk of a similar event. Many people in the region live along the waterways and may breathe in aerosol toxin released by these harmful blooms.

Emergency rooms visit will increase with many patients suffering from pneumonia, bronchitis and asthmatic episodes *(15)*. Harmful Algal Blooms not only negatively affected human health, but estuaries and aquatic life within the region *(16)*. Oyster and commercial fishing are important industries within the Hampton Roads region *(15,16)*. Cyanobacteria can cause mass deaths and poisoning within the local fish population devastating this industry. Ecosystems can be altered causing local fishermen to lose their livelihood. During the summer months the Virginia Beach Oceanfront is a major tourist destination. Closings of the beaches due to algal blooms and bacterial contamination can cause the oceanfront to lose thousands to millions of dollars in revenue. This is another economic and health impact associated with algal blooms that could negatively affect the area.

Figure 1: Prediction timescale for climate impact on HABs and Human Health



Moore, S. K., Trainer, V. L., Mantua, N. J., Parker, M. S., Laws, E. A., Backer, L. C., & Fleming, L. E. (2008). Impacts of climate variability and future climate change on harmful algal blooms and human health. *Environmental Health*, *7*(2), S4.

Immediate Health Effects caused by Deluges and Extreme Storms

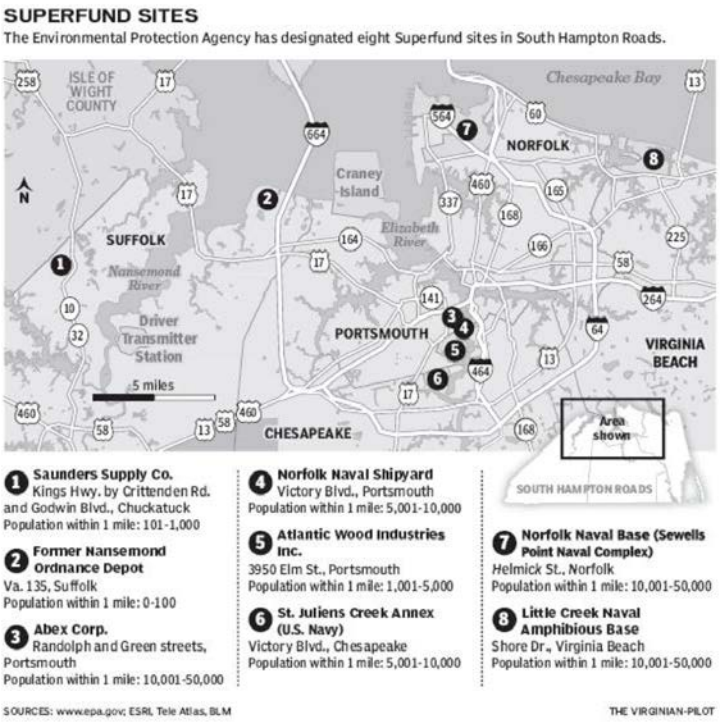
Immediate Health effects normally occur during or directly after a major flooding event. Drowning is the leading cause of death in major flooding events and is usually caused by flash floods. Often these drowning can be prevented through awareness and education since most happen because individuals underestimate the power of the currents or depth of water.

Residents may try to escape their homes when nearby waters rise putting themselves in harms way. Injuries such as lacerations that may become infected, broken bones, and electrical burns or electrocution may result from floating debris. Additionally, more injuries may occur during the recovery period when individuals return home or to their business to cleanup. Residents in the region could experiences a higher risk of burns or explosions due to natural gas lines, tanks, and chemical storage being damaged or disturbed by floodwaters *(10)*. Hyperthermia is another immediate health effect associated with severe flood events. Some people assume that hyperthermia only occurs during the cold seasons, but most floodwater is below human core body temperatures all year *(10)*.

Flooding also disrupts health services. During a hurricane or a nor'easter, severe damage may be incurred by medical facilities in the Hampton Roads region that can displace patients. Flooding can prevent medical services from reaching patients or the ability of staff to reach facilities. During Hurricane Katrina, the Louisiana Department of Health and Hospitals were unable to maintaining surveillance of illnesses, injuries, and toxic exposures due to the widespread damage caused by the floodwaters *(10).* Emergency management crews in Hampton Roads may be increasingly at risk of electrical injuries due to collapsed overhead power lines that can come in contact with rescue boats or vehicles.

Chemical Contamination

As previously mentioned, runoff from agriculture, urban, suburban, and rural land use can contribute to communicable disease spread, but it can also contribute to chemical contamination spread as well. When severe flooding occurs, household chemicals, warehouses, landfills and agricultural pesticides can mix with the rising waters contaminating acres of land *(11,12)*. Storm waters bring run-off from motorways containing heavy metal or pesticides pollutants to watersheds. Hydrocarbons, oils, and grease cover surfaces and spilled petrol from gas stations also enters waterways during flooding events *(12).* Older sewer system can backup allowing wastewater sludge to enter residents' homes and businesses. *(12).*



Hampton Roads has 8 designated Superfund sites that require long-term federal cleanup assistance that CERCLA authorizes the Environmental Protection Agency (EPA) to place on the National Priorities List (NPL). In Hampton Roads most Superfund sites are located near the Naval Shipyard in Portsmouth and along major waterways. If these sites were to experience heavy flooding due to a storm or sea level rise, unknown chemicals could be deposited by floodwaters across Hampton Roads.

Researchers conducted a literature review on flood related chemical episodes spanning from 1960-2002 that had public health implications *(12).* Two events listed could be potential examples of a possible flooding event in Hampton Roads due to proximity. Hurricane Floyd hit the coast of North Carolina in 1999 causing 10 cases of carbon monoxide poisoning *(12)*. Tropical Storm Alberto in 1994 hit the Southeast United States; water samples were taken showing high levels of agricultural pesticides *(12).*

In the aftermath of Hurricane Katrina, several Superfund sites and oil storage tanks from the petrol companies flooded during the storm *(13)*. The combination of chemicals, open raw sewage flow in the street and decaying human and animal corpses in New Orleans created a Public Health calamity *(13)*. To add insult to injury, Lake Ponchartrain breached the canals flooding New Orleans re-depositing 30-40 years of hazardous waste material sitting in the sediment. This sediment consisted of toxic industrial and pesticide chemicals that were used in a time of little to no regulation *(13).* This event could potentially happen here in Hampton Roads. During and post World War II, Hampton Roads experienced huge industrial progression with the shipbuilding and military industry. There are still many sites of hazardous waste that have not been unearthed. A flooding event could expose these hazardous waste material causing serious health implications to the area and watershed.

Public Health addressing Climate Impacts

Public Health System and Climate Impact Response

Public heath departments are the life support of a community. They assist in the management of outbreaks, massive loss of human life, severe weather events and acts of terrorism. Furthermore, public health departments are responsible for responding to health events linked with climate change. Areas of the country such as California and the Gulf Coast have experienced climate change health events that strained their public health structure. Without adequate training and available resources public health structure cannot respond to an event effectively.

In 2009 the largest assessment of 133 randomly selected health department in the United States was conducted to gauge preparation for climate change *(30).* About 70% of departments stated that their region had faced events related to climate change in the last 20 years, 80% expected an event relating to climate change within the next 20 years, 60% stated that their region may have severe public health implications within the next 20 years as a result of climate change, and more than 50% of respondents saw that preparing for public health events linked to climate change as

urgent *(30)*. In addition, most public health department directors stated they felt that 45% of their staff knowledgeable of public health implications linked to climate change.

The study was replicated again four years later, after the 2008-2010 recession, when many government agencies' funding was cut drastically. Designated public health planning for climate change decreased from 50% in the initial study to 40% in the follow-up. Moreover, department director's evaluation of proficiency in the subject fell greatly *(30)*. The Great Recession caused many health departments across the country to put climate change health response on the back burner. Due to lack of resources many health departments no longer saw climate change as a priority of now. Resources were being allocated to events such as increased cases of influenza or chronic disease. Department had to worry about the now then the unsure possibility of climate events.

Levy and Patz (2015) state that there is seven features need to be instituted in order for a strong public health response to climate change. Most critical communities should have a grounded public health system that not only plans for usual health challenges, but plans for climate change as well. Secondly, public health organizations need to create assessments for probable health risk linked to climate change. Third, appropriate activities that emphasize all possible hazards accordingly.

Next, emphasis should be put on resiliency strategies that include physical (protection of infrastructure), Individual resiliency, and organizational (community- government interactions) *(30)*. Communities must build prospective co-benefits; an example is creating bike lanes, sidewalks, and more mass transit to reduce greenhouse gas emissions. The community should prioritize the creation of cross-sectoral partnerships with public health and other supporting climate agencies. Lastly, institutions of learning need to be involved in filling in the gaps of incomplete systems. This can be done through adaptive management by using models to help stakeholders prioritize input, organize data and respond to management decisions.

In 2014, Old Dominion University established the Hampton Roads Intergovernmental Pilot Project for Sea Level Rise Preparedness and Resilience (IPP). The pilot was designed to create a dialogue between community leaders to develop a sense of 'whole government' and 'whole community' framework for resilience against sea level rise. In Hampton Roads, sea level rise does not impact just one part of the community; it impacts residents, municipalities, the economy of the region and unique to the area, it impacts military readiness. The pilot involves many working groups and volunteers consisting of federal, state, local agencies and academic partners. It is sponsored by the White House Center on Environmental Quality; National Security Council and the Office of Science Technology Policy, Senator Tim Kaine (Virginia), Duty under Secretary of Defense, Assistant Secretary of the Navy for Energy, Installation and Environment, and Rear Admirals of the Navy. The

project implemented a Public Health working group in late 2015 to give recommendations on potential public health hazards associated with sea level rise and storm surge. The working group is currently collecting data on the case study area of Pretty Lake in Hampton Roads. The area is unique in the sense that multiple government entities that have jurisdiction, there is a diverse social economic community from both side of the extremes, and it flood consistently *(54)*. This diversity can amplify challenges to public health.

Hampton Roads is not your standard mid-sized region with just a healthcare, financial and private sectors supporting the local economy. It is home to the largest military community in the United States with about 190,000 active military service member plus their families *(54)*. The Navy's Mid-Atlantic Fleet dominates the region along with the Army, Marine Corps, and Air Force. Aside from the huge federal presence, Hampton Roads consist of many cities and county comprising of the city of Norfolk, Virginia Beach, Chesapeake, Suffolk, Portsmouth, Hampton, Newport News, Williamsburg, Poquoson, York County, Mathews County, James City County, Isle of Wight County, and Gloucester County. There are also several academic institutions in the region to include Old Dominion University, Eastern Virginia Medical School, College of William and Mary, Norfolk States University, Hampton University, and Christopher Newport University to just name a few. All these different government jurisdictions and institutions of higher learning clearing emphasized the need for central point of communication.

The Norfolk Medical Reserve Corps (NMRC) is another party involved in creating a stronger public health system here in the area. The NMRC works under the authority of the Norfolk Health Department to assist in providing public health to the community. It is an organization that is composed of non-medical and medical volunteers whom are trained in emergencies and strengthen local public health support. The NMRC mission is to augment the public health structure in the region with additional support in emergency/disaster events *(55)*. Trained MRC volunteers provide support for immunization clinic, Points of Dispensing (PODs), Health outreach, emergency shelters, first aid stations, community health events, local and regional exercises, and logistical support (55). In addition, volunteers are given training in CPR/ First Aid, CERT (Community Emergency Response Team, Mass Casualty Incident Triage, and Virginia Department of Health state training.

The augmentation of the MRC to a public health structure allows for a well coordinated response to major health events because of a pool of volunteers who are informed and well-trained. One of the main objectives that came from the creation of the MRC was to provide PODs as mention before. Points of dispensing are portable location that can provide medical services in a biological event. This can range from a major outbreak to bioterrorism. This is a vital public health support structure in dealing with communicable diseases caused by vectors or water.

Public Health System Evaluation

Climate change has long been a factor in public health. Challenges such as vector diseases shift, extreme heat, severe storms, and migration due to food and water shortages is familiar to public health officials. However, events such as extreme weather and sea level rise are unfamiliar territory to public health and frameworks need to be put in place in order to promote resilience. Globally, a small percentage of countries have developed strategies for adaptation of climate change, most being high-income countries.

In 2009, President Barack Obama issued an executive order that mandated promotion of a variety of preparedness activities *(30).* Numerous frameworks were created in order to assess vulnerabilities. One framework, BRACE (Building Resilience Against Climate Effects), proposed by the CDC characterizes, prioritizes, models, and develops evidence-based response to public health challenges associated with climate change *(30)*. The BRACE framework allows health department to use atmospheric science to develop and implement strategies to reduce health challenges associated with climate change *(30)*. The framework through a 5 step process addresses the top three health threat; extreme heat, extreme precipitation, and vector-borne and zoonotic disease.

The BRACE framework first step anticipates climate impacts and assessing vulnerabilities. Key components are stakeholder input and systemic review of identification of likely climate change impacts and potential outcomes that effect vulnerable populations, such as increased heat-related illnesses and deaths of outdoor workers and older urban residents *(30)*. Step two projects disease burden through quantitative modeling by using projected disease outcomes identified through global circulation models projections of climate change that determined fluctuating exposures *(30)*. Step three logically reviews intervention literature that results in the decrease of projected impacts such as a meta-analysis of intervention strategies for the reduction of heat related illnesses and death *(30)*. Step four develops and implements a climate action plan by using evidence-based public health methodologies forming an applicable intervention addressing the health impact and gaps in public health. The last step of the BRACE framework evaluates the impacts and continuous quality improvement *(30)*. Evaluations of outcomes analyzed give feedback to stakeholders for input for the next phase of planning. At this time models and projections are updated if necessary *(30)*.

Developing a Strong Public Health Structure

Communities must come together in order to create strong and climate resilient public health systems. These changes will negatively impact the global population until governments and communities unite together. It is our responsibility as a community to help each other in establishing resiliency from the evitable effects of climate change. Based on the analysis of the potential public health issues associated with sea level rise and extreme weather in this report, the following are recommendations that can be incorporated by the Hampton Roads region to develop a strong public health structure that can be expanded to other regions.

The first recommendation in increasing resiliency of the public health system is the creation of climate change programs at institutions for higher learning. This can increase the pool of graduates educated in public health and climate change challenges. Public Health departments within the region will have a greater pool of knowledgeable staff able to implement appropriate climate interventions. New research conducted by academic professionals in this field can expand on the Hampton Roads Sea Level Rise Preparedness and Resilience Pilot Project and other current case study projects.

In order to have a strong public health structure, surveillance systems consisting of databases should not only include a federal component such as the Center for Disease Control and Prevention, but local public health must meet the needs of the immediate community. Monitoring the expansion of new vector borne diseases is essential in reducing cases and preventing outbreaks. Sea levels rise and precipitation increases in Hampton Roads will allow for mosquitoes and tick populations to flourish. Cohesion in surveillance systems needs to be addressed. As mentioned previously, Hampton Roads consists of many cities and counties, each having different departments managing mosquito surveillance programs. In order to obtain an accurate number of vector-borne disease cases their needs to be cohesiveness between the localities. Mosquitoes and ticks do not abide by fences or borders; do not discriminate by race, gender, or social economic status. A mosquito carrying Zika that infected a resident in Chesapeake can fly to Virginia Beach and infect some one else.

Third the community needs to establish a public health assessment framework to manage changes in regional climate. This can involve an academic advising component, which would provide recommendations to localities. Resiliency strategies from climate change must be science-based in order to ensure proper application. Assessments of effective techniques for mosquito control, water/waste management during storm surge, and shoreline protection are imperative in maintaining a strong public health structure.

Emergency management in coordination with the local public health departments may wish to consider incorporating climate change activities into their current training program. This can be done in partnership with local MRCs. Since many MRC volunteers are trained in disaster response ranging from active shooter to disease outbreaks, adding a climate change component would benefit emergency management departments. Training could improve upon current guidance on storm surge evacuation or shelter safety during a major hurricane.

A continuation of communication between all sectors, agencies and the community has to be maintained in order for appropriate strategies to be implemented. Responsive communication will allow for a quick reaction during an emergency event or disease outbreak. Maintaining dialogue between the various agencies in the region will avoid duplication of strategies. In addition, communication can also allow for the share use of resources during a major disaster event. Prior coordination and plans involving the multiple municipalities will allow for a strong public health structure in times of crisis.

Lastly, funding programs that augment the public health structure. Supporting organizations like the MRC allows for the availability of well-trained volunteer during an emergency/disaster event. State and local government need to provide local public health department with adequate resources in order to respond to major public health crisis associated with climate change. Past focus on climate change were once well funded, but post recession many public health departments across the country are lacking resources, functioning with limited staff and unable to fully respond. It is crucial that support is given to public health structures in order to maintain a vibrant healthy community.

There are many challenges posed by climate change that face public health. However, with these challenges comes opportunity to establish innovative interventions that can be used by various regions around the world. Adaptive strategies will move cities forward and protect them against rising seas and destructive storms. In order to build health systems there must be support from the community, government, and regional agencies.

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APPENDIX H-1

Science Committee Membership

Science Committee Membership

COMMITTEE CHAIR(S) & AFFILIATION(S): Co-Chairs – Larry Atkinson (ODU) and Carl Hershner (VIMS)

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APPENDIX H-2

LAND SUBSIDENCE MONITORING in HAMPTON ROADS
Progress Report

LAND SUBSIDENCE MONITORING in HAMPTON ROADS

Progress Report

March 1, 2016

Jack Eggleston, USGS Virginia Water Science Center, jegglest@usgs.gov

SUMMARY

This progress report presents options for monitoring of land subsidence in Hampton Roads.

Land subsidence, or sinking of the land surface, has occurred and is still occurring in Hampton Roads. Land subsidence is important because it can cause increased flooding, alter wetland and coastal ecosystems, and damage infrastructure and historical sites. Rates and locations of land subsidence are not well known throughout the Hampton Roads area because monitoring has been insufficient in recent decades. Monitoring data are needed to better understand rates and locations of land subsidence and to plan for preventing or mitigating its potentially damaging effects. Scientists at federal agencies (US Geological Survey, National Oceanic and Atmospheric Administration, National Aeronautics and Space Administration) are currently analyzing survey and satellite data to determine historical rates of subsidence. Additional monitoring of future land subsidence by Hampton Roads Planning District Commission (HRPDC) will help ensure that land subsidence monitoring efforts best serve the needs of Hampton Roads communities.

Potential HRPDC priorities for monitoring land subsidence in Hampton Roads are discussed in more detail in the following pages.

- Establishment and surveying of a benchmark network

  100 $K *initial cost*
  20 to 40 $K *annual surveying and data analysis cost*

- Installation of extensometer stations

  700 to 2,500 $K *one-time cost depends on number and depths of extensometers*
  20 $K *annual O&M and data analysis and presentation cost*

IMPORTANCE OF LAND SUBSIDENCE MONITORING

Recurrent flooding problems have prompted concern about land subsidence in Hampton Roads (Sweet and others, 2014). These concerns are compounded by evidence that groundwater pumping and associated aquifer depressurization have caused past land subsidence (Pope and

Burbey, 2004; Holdahl and Morrison, 1974) and measurements showing that relative sea-level rise is faster in Hampton Roads than elsewhere on the Atlantic Coast (Sallenger and others, 2012). Rates and locations of land subsidence are not well known throughout the Hampton Roads area because monitoring has been insufficient. Therefore, risks commonly associated with coastal land subsidence – increased flooding, alteration of wetland and coastal ecosystems, and damage to infrastructure and historical sites – cannot be accurately assessed. More frequent monitoring at multiple locations using multiple complementary methods is needed to build an understanding of subsidence and to plan how to avoid or mitigate the effects of subsidence.

HRPDC and the US Geological Survey (USGS) have undertaken this study with the help of a multi-stakeholder advisory group to assess options for land subsidence monitoring. This progress report is designed to provide direction for future monitoring efforts by describing HRPDC's monitoring needs, listing current monitoring efforts, identifying promising technologies, and estimating costs.

Subsidence in Hampton Roads

Land subsidence has been observed since the 1940s in Hampton Roads at rates of 1.1 to 4.8 mm per year (Holdahl and Morrison, 1974) and subsidence continues today (National Geodetic Survey, 2013). In coastal areas such as Hampton Roads, land subsidence contributes to relative sea-level rise and increases the risk of coastal flooding. Available data indicate that land subsidence has been responsible for more than half the relative sea-level rise measured in Hampton Roads in the past 80 years (Eggleston and Pope, 2013). Because land subsidence increases the risk of flooding in low-lying areas, it has important economic, environmental, cultural, security, and human health consequences for the heavily populated and ecologically important Hampton Roads area.

Need for Monitoring Data

Before land subsidence can be understood it must be monitored. Monitoring data provide the foundation for understanding why, where, and how fast land subsidence is occurring, both now and in the future. Because rates of land subsidence change over time and vary from one location to another, monitoring should be done at multiple locations for multiple years.

How monitoring data are used

- To avoid or mitigate problems caused by land subsidence - Urban planners, resource managers, and politicians use monitoring data to guide their decisions.
- To answer questions, such as – Why is subsidence occurring?
- To predict future land subsidence - Predictive models that can test mitigation strategies require monitoring data for accuracy and reliability.
- To make maps - Maps showing critical areas for mitigating land subsidence are based on monitoring data.

What land subsidence monitoring measures

- land surface motion
- bedrock surface motion
- changes in aquifer system thickness

Monitoring Methods

Land subsidence is detected by measuring land surface positions over time and calculating rates of change by subtraction. There are several reliable and accurate techniques for measuring land subsidence in Hampton Roads (table 1 and figure 1). Detailed discussion is provided in Appendix A.

Table 1. Land subsidence monitoring methods.
[GPS, Global Positioning System; InSAR, interferometric synthetic aperture radar]

Method	Type of data	Measures aquifer-system compaction independently	Spatial coverage	Temporal detail
Borehole Extensometer	Aquifer-system thickness at one location, continuous record	Yes	Low	High
Tidal Station	Sea elevation at one location, continuous record	No	Low	High
Geodetic Surveying	Land elevations at one or several locations, multiple times or continuous record	No	Low to moderate	Low to high
Remote Sensing (InSAR)	Land elevations over a wide area, at multiple times	No	High	Moderate

Borehole Extensometers

Borehole extensometers (figure 1) are wells designed for measuring compaction or expansion of an aquifer system (Galloway and others, 1999). Extensometers typically are paired with monitoring wells so that correlation between groundwater-level changes and aquifer compaction can be determined.

Geodetic Surveying

Geodetic surveying is the measurement of land surface position. Global positioning system (GPS) technology is now widely used to perform geodetic surveying. Permanent GPS stations, such as the network of Continuously Operating Reference Stations (CORS) operated by NGS, provide continuous information about land surface motion at single locations. CORS stations typically achieve centimeter scale accuracy for absolute vertical position measurement and

millimeter scale accuracy for differential vertical position measurement. Permanent geodetic stations, such as CORS, also provide valuable information for calibrating remote sensing measurements of subsidence.

Survey networks, consisting of multiple high integrity monuments (benchmarks) that are installed on land and periodically occupied with GPS antennas to measure land surface position, can also provide valuable regional estimates of land subsidence. Dr. Philippe Hensel (NGS) has offered his expertise to help design and implement such a survey network for Hampton Roads.

A separate type of geodetic surveying that would be valuable for understanding land subsidence in Hampton Roads is using GPS antennas on bedrock wells to measure bedrock surface motion (figure 1). This can be done at any new extensometer that is constructed. Existing bedrock wells, such as those at Franklin and Suffolk, may also be available as platforms for this type of monitoring.

Remote Sensing

Interferometric Synthetic Aperture Radar (InSAR) is a remote sensing technique used to measure land surface elevation changes over wide areas, for example over the entire Hampton Roads area. InSAR can be used to determine and map critical areas of land subsidence, select locations for detailed geodetic surveying, and plan strategies for preventing and mitigating land subsidence (Bawden and others, 2003). Accuracy of InSAR subsidence estimates will be important in Hampton Roads, because subsidence rates in the area have been measured at 1.1 to 4.8 millimeters, as compared to typical error for InSAR of 5-10 mm. The high atmospheric humidity and dense vegetation found in Hampton Roads can reduce InSAR accuracy. Problems with error can be overcome by analyzing a large number of satellite scenes, applying persistent scatter analysis techniques, using InSAR data collected over multiple years, and by using L-band or X-band rather than C-band InSAR data.

ONGOING MONITORING ACTIVITIES in HAMPTON ROADS

Borehole Extensometers - Ongoing Monitoring 2016

No borehole extensometers were active in Hampton Roads from 1996 to 2016. However historic extensometer data are available, covering the period 1979 to 1995 for an extensometer located at Franklin, Virginia and 1982 to 1995 for an extensometer located at Suffolk, Virginia, (Pope and Burbey, 2004).

The older existing extensometers at Franklin (55B 60) and Suffolk (58C 52) (figure 2) have recently been equipped by the USGS with digital potentiometers, dial gages, and satellite telemetry (figure 3) to provide aquifer compaction measurements with sub-millimeter (0.01 mm)

accuracy. Data are being collected to test if the extensometer stations can be reactivated to detect aquifer compaction and expansion. The extensometers will be monitored for several months and, if monitoring results are successful, the extensometers may be reactivated on a long-term basis. The possibility of installing GPS antennas on the extensometers, to determine contributions to subsidence from glacial isostatic rebound, will also be investigated.

Michelle Sneed, a USGS expert on subsidence and extensometers was brought in to consult on land subsidence monitoring options in Hampton Roads. She described how, in California, extensometers provide the basis for understanding how land subsidence is related to groundwater withdrawals, for calibrating InSAR estimates of land subsidence, and for calibrating predictive models of land subsidence. Extensometers there provide data used for water-resource planning and subsidence-mitigation planning.

Geodetic Surveying - Ongoing Monitoring 2016

The NGS, the lead US federal agency for surveying and geodetic science, operates the CORS network of benchmark stations that continuously record land surface positions in fine detail in 3-dimensions. The CORS network includes five benchmark sites in Hampton Roads. Data from these stations can be downloaded at http://www.ngs.noaa.gov/CORS_Map/.

Various other organizations have established continuous monitoring GPS antennas at benchmark stations in Hampton Roads that are not part of the CORS network. For example, the NASA Langley Research Center in Hampton, Virginia, established four benchmark sites with GPS antennas in 2015. In some cases, data from these non-CORS stations are available and, if a site has been constructed and operated following NGS guidelines (NGS, 2013b; Floyd, 1978), the resulting data can be of high quality and useful for subsidence calculation.

The NGS is currently (2016) analyzing historic surveys of first-order benchmark sites on the Atlantic Coast, including in Hampton Roads, to determine rates of subsidence over the past century. This study will produce maps of subsidence rates over multiple time periods.

Tidal Stations - Ongoing Monitoring 2016

Tidal stations operated by the National Oceanic & Atmospheric Administration (NOAA) have provided continuous water-level data for many decades at four sites in Hampton Roads (Appendix A). Data are publically available at no cost from NOAA's website. Additional tidal stations are operated by the USGS and other agencies.

Remote Sensing - Ongoing Monitoring 2016

Remote sensing data are valuable because they enable detailed mapping of regional subsidence rates over time. The type of remote sensing data used to map subsidence, interferometric synthetic aperture radar (InSAR), has been collected for Hampton Roads by various satellites

since 1992 (table 2) and is currently collected by several international satellites. In 2017 a new US satellite, NISAR, will collect InSAR data over Hampton Roads.

It appears that NOAA and perhaps other federal government agencies (NASA and USGS) will analyze historic InSAR data for Hampton Roads, including a NOAA effort planned for 2016 to to analyze InSAR data collected in 2008-2011. This work is beneficial and hopefully will be conducted on a regular basis in the future.

Table 2. Satellites with InSAR data collection capabilities and coverage of Hampton Roads

Satellite	Origin	Active Period	Hampton Roads Data Period	InSAR Data Type	Horiz. Resolutn.	Vertical Precision	Number of Frames / Scenes	Cost to Project
JERS	Japan	1992-1998	1993-1998	L-Band	18m	> 15 mm	many frames 1 scene each	free/$
ALOS	Japan	2006-2011	2006-2011	L-Band	40 m	> 15 mm	5 frames, >10 scenes each	free/$
ALOS-2	Japan	2014-	2014-2015	L-Band	10-100 m	> 15 mm	2 frames 2 scenes each	free/$
SOACOM	Argentina	planned 2015	n/a	L-Band	-	-	-	$$
NISAR	US-India	planned 2020	n/a	L / S-band	-	-	-	free
RISAT-1	India	2012 -	-	C-Band	>20m	5-10 mm	-	$$
RISAT-2	India	2009 -	-	X-Band	<10m	<5 mm	-	$$
Radarsat-1	Canada	1995-2013	2006-2008	C-Band	30 m	5-10 mm	>20 scenes	free
Radarsat-2	Canada	2007-	2008-2015	C-Band	30 m	5-10 mm	>400 frames	$$
ERS-1	Europe	1992-2000	1992-1996	C-Band	30 m	5-10 mm	2 frames (E-W) 14/16 scenes	free
ERS-2	Europe	1995-2011	1995-2001	C-Band	30 m	5-10 mm	2 frames (E-W) 24/30 scenes	free
Envisat-ASAR	Europe	2002-2012	2007-2008	C-Band	30 m	5-10 mm	2 frames >5 scenes each	free
Sentinel-1A	Europe	2014-	2014-2015	C-Band	5 m	5-10 mm	1 frame, 3 scenes	free
Cosmo-SkyMed	Italy	2010-	2011-2015	X-Band	15 m	<5 mm	>200 scenes	$$
TERRASAR-X TanDEM-X	Germany	2010-	2011	X-Band	10 m	<5 mm	1 frame, 3 scenes	$$
KOMPSAT-5	Korea	2013-	-	X-Band	3 m	<5 mm	-	$$
PAZ SAR - SeoSAR	Spain	planned 2015	-	X-Band	-	-	-	$$

POTENTIAL LAND SUBSIDENCE MONITORING PRIORITIES FOR HRPDC

Potential HRPDC priorities for land subsidence monitoring are as follows:

Priority 1 - Extensometers

Extensometers are a key component of land subsidence monitoring programs because they provide accurate data needed to understand aquifer compaction and to calibrate other types of subsidence measurements. The need for extensometers in Hampton Roads is particularly high because no extensometers are currently operating there. Extensometers would ideally consist of one or more wells with potentiometers, a GNSS (Global Navigation Satellite System) receiver, groundwater-level monitoring wells, satellite telemetry and, where applicable, a tidal gage.

High potential sites for new extensometers in Hampton Roads are shown in figure 2. The estimated risk of subsidence in response to groundwater pumpage shown in figure 2 is based on the product of three variables: sediment compressibility, thickness of silt and clay layers, and predicted groundwater level declines. Predicted groundwater level declines are taken from Masterson and others (2016) in which actual groundwater withdrawals in 2008 were simulated as continuing at the same rates through the year 2043. The actual risk of future land subsidence may differ from predicted risk (shown in figure 2) because aquifer conditions are not perfectly known and actual groundwater level declines may differ from predicted declines. Existing tidal stations are high priority locations for new extensometer stations because they permit multiple complementary data types to be collected at one location.

> **Cost:** The cost to install a single extensometer station in Hampton Roads is likely to be in the neighborhood of $1 million, with final costs depending mostly on the depth to bedrock. Annual recurring costs for site maintenance, operation, and data analysis are estimated at $20,000

Priority 2 - Benchmark Surveying

Establishment of a benchmark network would tie regional land surface motion in Hampton Roads to more stable land surface elevations in areas of Piedmont bedrock. For this proposed effort, mobile GPS antennas would be stationed for a week or more at multiple locations between the Piedmont and the Coastal Plain (e.g. Richmond to Virginia Beach). Mobile GPS antennas would be stationed annually at the benchmark sites for multiple years. The establishment of the network and annual collection of positional data could be a cooperative effort of regional partners (e.g. HRPDC, Old Dominion University, Virginia Institute of Marine Science, and others) and federal partners (e.g. USGS, NGS, NASA-Langley, and others). NGS has offered to coordinate establishment of the network study and to provide mobile GPS antennas for temporary use during the annual surveys.

Cost: The cost to establish and initially survey a benchmark network is estimated to be $120,000. Annual recurring costs for repeat surveys and data analysis are estimated at $20,000-40,000

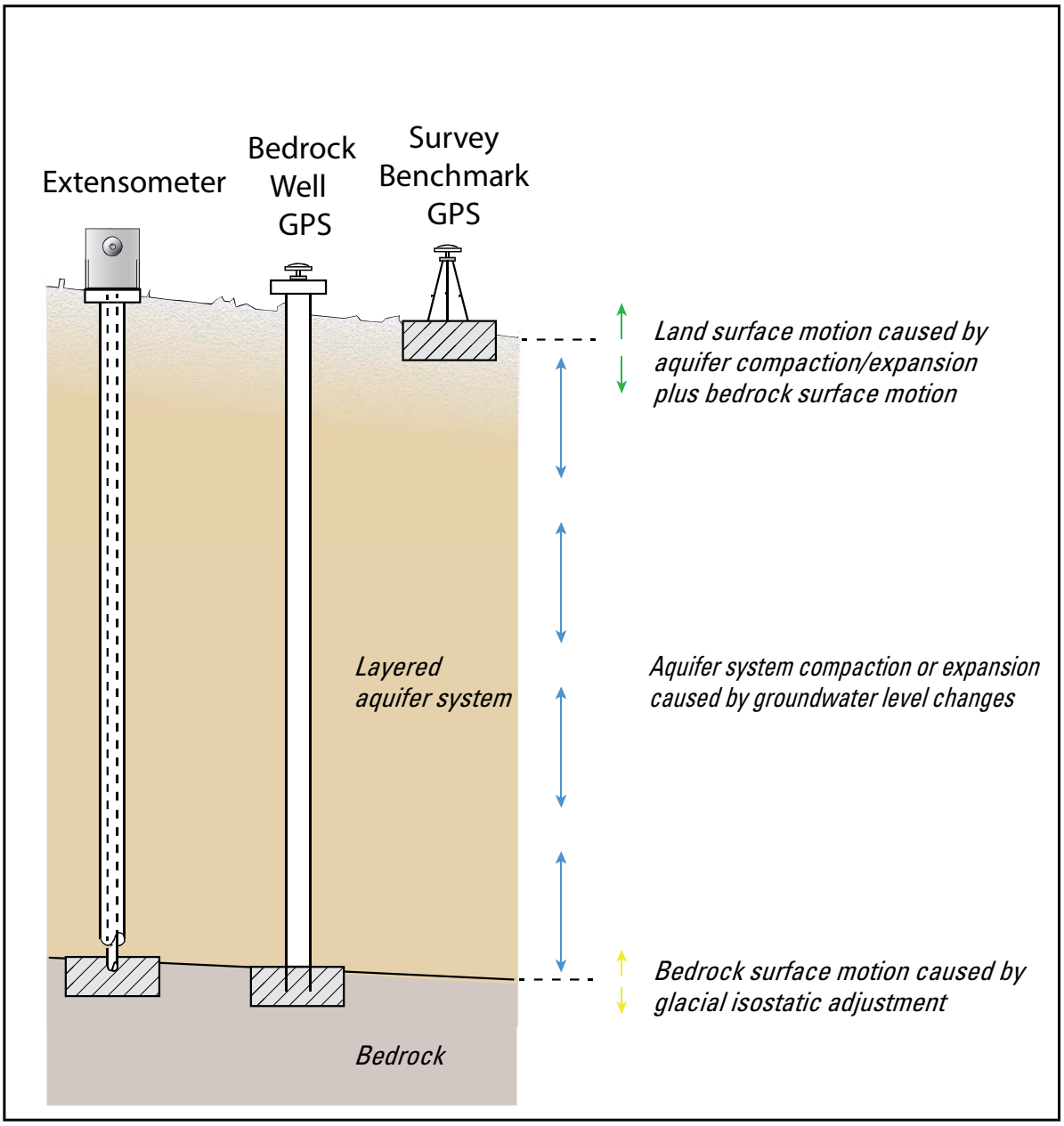

Figure 1. Illustration of subsidence monitoring methods: Survey Benchmark GPS to measure land surface motion, Bedrock Well GPS to measure bedrock surface motion, and Extensometer to measure aquifer system compaction or expansion.

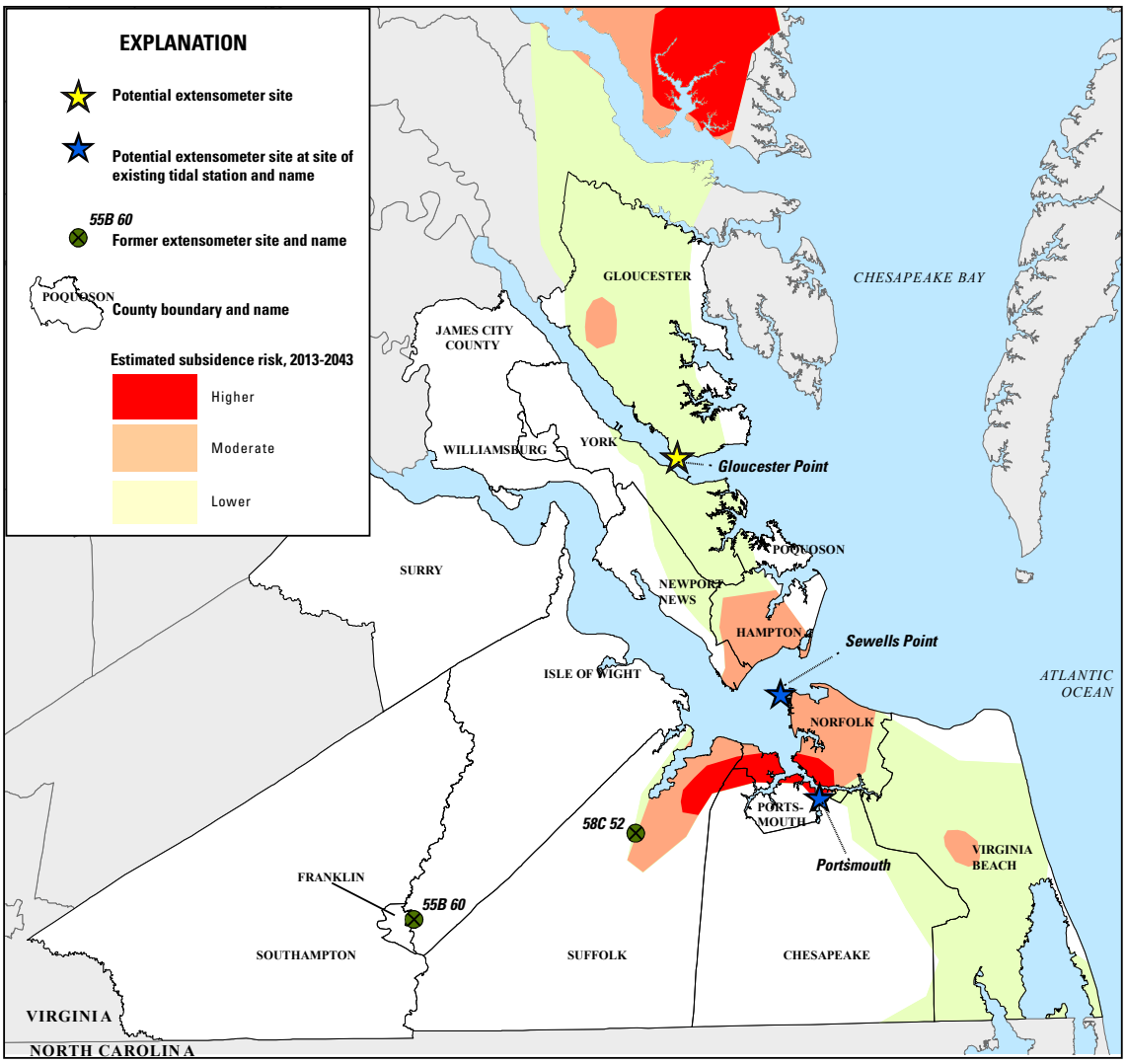

Figure 2. Map of estimated risk of land subsidence due to aquifer compaction 2013-2043 and locations of high potential sites for installation of extensometer stations to measure aquifer compaction and land subsidence. Risk of land subsidence at any location is determined by three factors: predicted groundwater level decline, thickness of silt and clay layers, and sediment compressibility. Groundwater level declines were predicted for 2013-2043 – future actual declines and risk may differ from predicted.

Figure 3. Installation of new equipment and a digital potentiometer on the Suffolk extensometer (58C 52). *Photograph by David Nelms, February 18, 2016*.

ABBREVIATIONS

CORS	-	Continuously Operating Reference Station
GNSS	-	Global Navigation Satellite System
GPS	-	Global Positioning System
HRPDC	-	Hampton Roads Planning District Commission
InSAR	-	Interferometric Synthetic Aperture Radar
NASA	-	National Aeronautics and Space Administration
NGS	-	National Geodetic Survey
NOAA	-	National Oceanic and Atmospheric Administration
USGS	-	United States Geological Survey

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APPENDIX A

USGS Circular 2013-1392, Land Subsidence and Relative Sea-Level Rise in the Southern Chesapeake Bay Region

APPENDIX I-1

Private Infrastructure Committee Technical Report

Table of Contents

Executive Summary

The Hampton Roads Intergovernmental Pilot Project (Pilot Project) had an official public kick off on December 10, 2014 at a Federal Emergency Management Agency National Exercise Division Event to identify local businesses and citizens that were interested in advancing resiliency in the region. During this event the Infrastructure Working Group (IWG) and Private Infrastructure Committee (PIC) were formed from participants pertinent to the critical public (IWG) and private (PIC) infrastructure sectors, and firms that support these sectors.

During the two-year project, the PIC focused on identification and engagement of privately owned critical infrastructure, identification of current practices and barriers to implementation of sea level rise (SLR) adaptation measures, sharing of best practices related to SLR adaptation, identification of resources available for companies to plan for SLR adaptation and outlining of recommendations related to privately owned infrastructure for SLR adaptation. Based on the work completed during this study, adaptive planning was completed for one infrastructure project case study, the Little Creek/Pretty Lake Case Study area, to gain better insight and understanding of the challenges related to whole of government and community SLR adaptation planning. The IWG selected SLR and storm surge scenarios that were evaluated as part of the case study.

The Pilot Project was focused on process, not final solutions and seven items were assessed and explored as part of the process for developing whole of government SLR adaptation planning:

1. Identification and Engagement of Privately Owned Critical Infrastructure

2. Identification of Current Practices for the Electrical Substations, Healthcare and Maritime Industries

3. Identification of Business Risk Related to SLR and Coordination with Emergency Management Services

4. Identification of resources

5. Action/Vision Statement from New Orleans and Southeast Florida Applicable to Hampton Roads

6. Barriers to implementation of SLR infrastructure adaptation measures

7. Solutions to barriers to implementation of SLR infrastructure adaptation measures

This process resulted in the development of recommendations that include:

- Federal agencies are going to be instrumental partners in SLR planning and adaptation moving forward.

- Funding for adaptation in Hampton Roads should be sought from public and private sources.
- Interdependencies between private infrastructure and public infrastructure systems will require collaborative problem solving across all infrastructure systems
- Private infrastructure systems need information and guidance in planning for SLR; specifically, regionally recognized science based SLR scenarios for private industry to incorporate in long range planning.
- The region should develop or adopt a tool for evaluation of SLR impacts on critical infrastructure, including internal and external dependencies.
- Develop building code strategies that can be implemented on a regional basis for construction and substantial improvements to existing structures to mitigate against flooding, severe wind, and SLR.
- Ensure business and industry (and related trade groups) are active participants in shaping regional strategies and methods to address SLR and related risks and concerns and the development of any regional organization that may facilitate planning and/or implementation efforts.
- Incent business and industry action and innovation to address SLR and related risk and concerns through financial and public recognition mechanisms.
- The region should develop a business and industry outreach program that would increase awareness among business and industry sectors as to the concerns and risks associated with SLR, storm surge and coastal flooding trends and develop toolkits or portals to toolkits that would serve the specific needs of business and industry in addressing such risks and concerns.

History, Objectives & Strategy

The Hampton Roads Intergovernmental Pilot Project (Pilot Project) had an official public kick off on December 10, 2014 at a Federal Emergency Management Agency National Exercise Division Event. This event was an opportunity to identify local businesses and citizens that were interested in advancing resiliency in the region. It was during this event that some of the members of the Private Infrastructure Committee (PIC) met for the first time. Participants at the event pertinent to the critical private infrastructure sectors, and firms that support this sector, engineering, consulting and construction, were present and expressed support in moving forward as part of the PIC. While it is important to have a broad cross-section of participation and include critical infrastructure support companies, it was necessary to ensure that all private critical infrastructure sectors pertinent to the region were included in either the PIC or the Infrastructure Working Group (IWG) that include public infrastructure entities.

An excellent resource for determining what critical infrastructure sectors should be included is the Department of Homeland Security (DHS) Critical Infrastructure Sectors (https://www.dhs.gov/critical-infrastructure-sectors). While not all sectors will be important to every geographic area, because of its broad overview of national infrastructure, it can guide localities and ensure that sectors are not overlooked. Table 1 is a summary of the national critical infrastructure sectors identified by Homeland Security, and a matrix used to determine if they are critical to the Hamptons Roads Region, whether they would be representatives on the IWG or the PIC, and the list of entities that were originally considered for or asked to participate on the PIC.

Table 1. Critical Infrastructure Sectors

Department of Homeland Security Critical Infrastructure Sectors	**Pertinent to Region (Y/N)**	**Membership to IWG or PIC**	**Specific Private Companies in Region considered for PIC**
Chemical	N		No major manufacturers in region
Commercial Facilities	Y	PIC	Hampton Roads Association for Commercial Real Estate, Hampton Roads Realtors Association
Communications	Y	PIC	Cox Communications & Verizon
Critical Manufacturing	N		
Dams	Y	IWG	
Defense Industrial Base	Y	IWG	

Emergency Services*	Y		Not included in either PIC or IWG
Energy	Y	PIC	Dominion Virginia Power, Virginia Natural Gas, Colonial Pipeline
Financial	Y	PIC	BB & T
Food and Agriculture	N		
Government Facilities	Y	IWG	
Healthcare and Public Health	Y	PIC	Sentara
Information Technology	Y	PIC	Cox Communications & Verizon
Nuclear Reactors, Materials and Waste	N		
Sector-Specific Agencies	Y	IWG	
Transportation Systems	Y	IWG/PIC	Virginia Maritime Association, Norfolk International Airport, Norfolk Southern Corporation and regional rail companies
Water and Wastewater Systems	Y	IWG	

*Emergency Services as a critical sector is much further ahead in planning for events than other critical infrastructure sectors. For that reason, they were not included in the Pilot Project Working Groups or Committees. Representatives from the emergency services sector were included on the Steering Committee.

Once the critical sectors and pertinent companies were identified for the PIC, then it became a matter of developing contacts within those organizations. Many times the initial contact was not the correct contact and the PIC would be referred to a different person. Sometimes it was contacts from other working groups or committees within the Pilot Project that provided the information that resulted in contacting an individual who was interested. The key to success in contacting the correct individual can be a combination of networking and persistence. In many cases, the correct person is a risk manager, facilities manager, or engineer within the organization. These are the people that will be tasked with solving problems related to sea level rise (SLR) and they have a vested interest in participation.

Not every organization contacted was interested in participating in the Pilot Project. For example, the banking industry declined to participate but, the PIC determined that it was not imperative that the banking industry be represented. Another example is Colonial Pipeline in the energy sector. In this case there were two other participants from the energy sector, Virginia Dominion Power and Virginia Natural Gas, so it was not imperative that Colonial

Pipeline participate as part of the PIC. Norfolk International Airport was also asked to participate during Phase 1 and Phase 2 and declined both times. The final outcome/deliverables are not impacted by the missing critical infrastructure sectors or companies; however, if a different case study area is chosen, it could impact the results.

The PIC was chaired by Carol Considine, Associate Professor, Engineering Technology, Old Dominion University and Pete Perritt, President, Building Constructive Solutions was a co-chair. Table 2 shows the PIC membership.

Table 2. Private Infrastructure Committee Membership Year 2

Name	*Organization*	*Position*	*Email*
Carol Considine	Old Dominion University	PIC Chair/Associate Professor	*cconsidi@odu.edu*
Andrew Hadsell, PE, CFM	AMEC Environmental & Infrastructure	Senior Associate Engineer, Unit Manager	*andrew.hadsell@amecfw.com*
Stuart (Pete) Perritt	Building Constructive Solutions, LLC	President & PIC Co-Chair	*pperritt@buildingconstructivesolutions.com*
David Pryor, PE	Clark Nexsen	Structural Engineer	*dpryor@clarknexsen.com*
Lisa Quintero	FEDEX Trade Networks	Supervisor - Transportation	*lisa_quintero@ftn.fedex.com*
John Gillespie	Fort Monroe Authority	Director of Heritage Assets & Historic Preservation Officer	*jgillespie@fmauthority.com*
Ann Crenshaw	Hampton Roads Association for Commercial Real Estate	President	*amyrhodes@williamewood.com*
Ron Lovell	Hampton Roads Realtors Association	Local Government Affairs Director	*rlovell@hrra.com*
Bob Fallon	Huntington Ingalls, Newport News	Director of Facilities	*bob.fallon@HII-NNS.com*
Maura Boswell	Old Dominion University	Coastal Engineer	*mbosw002@odu.edu*
Donna Coleman	Norfolk & Portsmouth Belt Line Railroad	Vice President	*donna.coleman@nscorp.com*

Jacque Mitchell	Sentara Norfolk General Hospital	Risk Manager	*JLMITCH1@sentara.com*
Larry Smith	Sentara Norfolk General Hospital	Director of Facilities	*lhsmith1@sentara.com*
Wayne M. Hixenbaugh	Verizon	Manager Network Planning & Design	*wayne.m.hixenbaugh@verizon.com*
Mark McVey	Virginia Dominion Power	Electrical Engineer	*mark.mcvey@dom.com*
Robert L Allison	Virginia Dominion Power	Electrical Engineer	*robert.l.allison@dom.com*
David White	Virginia Maritime Association	Vice President	*david@Vamaritime.com*
Jonathan Blackwell	Virginia Natural Gas (AGL Resources)	Manager, Engineering Services	*jblackwe@aglresources.com*
William Bounds	Weston Solutions	Engineer	*william.bounds@WestonSolutions.com*
Tom McNeilan	McNeilan & Associates	Engineer	*tom@mcneilan.com*

The PIC used the Pilot Project Charter (Charter) to guide their work. A scope of work was developed from the Charter in the spring of 2015 and work was completed based on that scope.

The only change to the scope of work was that adaptive planning was completed for one infrastructure project instead of two infrastructure projects. The original intent was to have one of the adaptive planning projects come from private infrastructure, specifically the electrical sector; however, it was determined that Virginia Dominion Power had already hardened their substation facilities for hurricane preparedness to a level beyond the SLR and storm surge scenarios adopted by the IWG.

Scope of Work

The PIC was responsible for providing support to the IWG regarding critical private infrastructure for the Pilot Project. Support included identification of: critical private infrastructure, dependencies & interdependencies between private and public infrastructure, best practices of SLR adaptation by industry sector and identification of restrictions and limitations (administrative, managerial, jurisdictional, or legal) to private/public SLR preparedness infrastructure planning. In Phase II of the Pilot Project, the PIC supported IWG in the adaptation planning for one (1) selected infrastructure project in the Hampton Roads region.

List of Deliverables:

For Phase 1 (July 2014 – June 2015)

- Identify restrictions and limitations (administrative, managerial, jurisdictional or legal) to private/public SLR preparedness infrastructure planning.
- Identify critical private infrastructure for the Hampton Roads region.

For Phase 2 (July 2015 – June 2016)

- Identify dependencies and interdependencies between public and private infrastructure for projects selected for analysis.
- Identify best practices for SLR adaptation by industry sector.
- Identify actions being taken by private infrastructure and planned solutions for possible emergencies related to SLR.
- Formulate recommendations (resiliency strategies) for privately owned infrastructure.

The PIC organized their work to meet the list of deliverables noted above and during the two year project focused on identification and engagement of privately owned critical infrastructure, identification of current practices and barriers to implementation of SLR adaptation measures, sharing of best practices related to SLR adaptation, identification of resources available for companies to plan for SLR adaptation and outlining of recommendations related to privately owned infrastructure for SLR adaptation. There were minor changes to the deliverables for the PIC. Adaptive planning was completed for one infrastructure project instead of two infrastructure projects.

During Phase II of the Pilot Project the PIC decided that it would be helpful in developing recommendations (resiliency strategies) to review the resiliency planning documents that have been completed in other regions of the United States. The New Orleans region and Southeast Florida region have both made significant progress in developing resiliency plans that are being implemented in their regions. It is significant to note that while neither region has legislated action related to these resiliency plans, the strategies and visions laid out in their regional documents are being implemented voluntarily by local governments to strengthen their regions resiliency. There are additional coastal resiliency strategies that could be reviewed for guidance such as San Francisco, Boston, New York, and New Jersey.

New Orleans “Resilient New Orleans” document provides visions for the region to guide their work in developing a thriving city. The document is comprehensive, extending the visions beyond infrastructure, with three main themes: Adapt to Thrive; Connect to Opportunity; and Transform City Systems. In reviewing the document, the PIC focused on strategies/visions related to infrastructure; however, this report is an excellent resource for those that want to develop comprehensive resiliency strategies for the city/region.

The Southeast Florida Regional Compact created a "Southeast Florida Regional Climate Action Plan" which was developed over two years with a five year planning horizon. The document lays out 110 action/vision items related to Sustainable Communities and Transportation Planning, Water Supply, Water and Infrastructure, Natural Systems and Agriculture, Energy and Fuel, Risk Reduction and Emergency Management, and Outreach and Public Policy. The report is comprehensive in nature and the PIC focused on action/vision items related to infrastructure. This is another excellent resource for the Hampton Roads region and other regions as they develop comprehensive resiliency plans.

PIC Methodology

The PIC organized their work to meet the list of deliverables noted in the previous section. This was accomplished primarily during scheduled meetings, using presentations and discussions. The following summarizes the significant presentations, meeting discussions and work product of the PIC.

1. Identification and Engagement of Privately Owned Critical Infrastructure:

Using the DHS Critical Infrastructure Sectors list, provided in Table 1 under the Membership Development section of this report, firms listed were contacted and asked to participate in the Pilot Project. The committee had representation from the commercial facilities/real estate, communications, energy, healthcare, information technology, and transportation sectors. There was no representation from the financial sector. The private transportation sector was represented by the maritime industry but, there was not representation of air or rail transportation. While the energy sector was represented by the electrical and gas industries, there was not representation from the oil transportation, coal, alternative energy, or storage industries.

The Pilot Project was focused on process, not final solutions. The lack of participation from all critical infrastructure sectors did not detrimentally impact the project but the process may have been enhanced by their participation. In addition, not all committee members attended every meeting or were fully engaged in the work of the committee. Recommendations for inclusion of private critical infrastructure in future SLR adaption planning include:

- Quarterly meetings may be more appropriate. Monthly meetings may require too much time from private companies.
- Education on SLR and storm surge impacts and risks, as well as how adaptive actions can be incorporated in operations and maintenance and capital improvement cycles, may increase interest in adaptation.
- Case studies looking at specific watersheds within the Hampton Roads region may make the SLR adaption planning more pertinent to firms. Case studies allow examination of

actual infrastructure in the case study area and demonstrate SLR scenarios, future impacts, and related risks of SLR.

- Municipalities may want to reach out to private critical infrastructure firms in their jurisdiction, encourage their participation, and educate them on the importance of their participation in regional resiliency efforts.

2. Identification of Current Practices for the Electrical Substations, Healthcare and Maritime Industries:

There were two strategies employed to identify current practices related to SLR adaptation/resiliency: private infrastructure companies participating in the Pilot Project were given the opportunity to present their resiliency/emergency planning efforts, and resources related to resiliency/adaptation standards for specific industries were researched and compiled.

Sentara Norfolk General Hospital and Virginia Dominion Power both provided presentations on their current efforts in resiliency/emergency management planning. Sentara Norfolk General Hospital specifically and the entire Sentara systems are proactive in severe weather and emergency preparedness. The hospital system must comply with the standards of the American Society for Health Engineering. Part of these standards include the development of Hazard Vulnerability Analysis which includes a matrix to determine risk exposure. Sentara is including adaptation/hardening of facilities in all capital improvement projects.

Dominion Power has been proactive in hurricane preparedness planning per Federal Energy Regulatory Commission (FERC) requirements. They have already elevated and hardened some of their facilities. They are active in CIGRE, the Council on Large Electrical Systems, which is an international non-profit association that promotes collaboration and knowledge sharing with experts around the world to improve electrical systems. They have contributed to the development of and use the "Air Insulated Substation Design for Severe Climate Conditions, B3.31", 2014, CIGRE publication which provides best practices for design of electrical infrastructure.

While neither Sentara nor Virginia Dominion Power are incorporating SLR into current resiliency/emergency management planning, both agreed that it could be incorporated in future planning. Other committee members noted that they also have emergency management planning in place, but they do not include SLR into this planning.

Virginia Maritime Association provided background on Virginia's ports including their importance and status nationally, as the second largest on the East Coast in tonnage and third in containers, and their impact on the Hampton Roads region, with over $60 billion in annual spending and contributing 6.9% of the gross state product. They outlined the components of the marine transportation system and the varied and extensive manufacturing and distribution

facilities in Virginia that are reliant on Virginia's port operations. They noted that the maritime industry appears to have a varied response to SLR based on size of company and resource availability. Larger companies recognize the risk and are starting to think in terms of capital reinvestment, but smaller firms do not have the capacity to move in this direction.

Williams Mullen provided background on the regional benefits of coastal/shoreline property, related industries, and the importance of the supporting infrastructure. They presented a summary of physical impacts and risk factors related to SLR, the need to consider the physical, operational, environmental, and legal ramifications of the impacts and risk. They discussed the financing needs to adapt to SLR risk and recognized the business opportunities that will be developed as companies implement resiliency/adaptive strategies.

Of importance to the Hampton Roads region as it moves forward in SLR planning, is the recognition that private and public infrastructure systems are coupled and cannot be separated, requiring collaborative problem solving across all infrastructure systems. An example of this related to the ports is that while the ports may be publicly owned and operated, they are served by the private operations of the terminals for transportation of goods. Both are necessary for economic success.

Recommendations to help the infrastructure sector include SLR in long range planning from Williams Mullen include:

- Provide regional SLR scenarios for private industry to incorporate in long range planning. This standardization will eliminate confusion across the region and enable companies and industries with facilities throughout the region to proactively adapt to SLR.
- Education and vulnerability messaging for coastal businesses is necessary and should include: the risk, assessment tools, planning strategies, resources, adaptation strategies, etc.
- Incentives for investment in capital improvements for resiliency/adaptive actions should be made available. (Resiliency enhancement = tax break)
- Industry associations are an excellent resource and should be leveraged for education on SLR and resiliency planning strategies.
- The maritime industry is lacking in resiliency planning resources when compared to other industry sectors and development of those resources would be beneficial.
- Federal, state, regional, and municipal governments should provide leadership to industry in terms of SLR planning scenarios.
- Environmental hazards and clean-up of environmental sites along the coastline needs consideration in regional SLR planning.
- Develop strategies and opportunities for new business development in the area of SLR adaptation. Examples: green infrastructure business, flooding applications, etc.

The identification of current practices noted above is limited in scope to three infrastructure sectors from three specific perspectives. Additionally, the region should conduct further research on current industry practices related to SLR planning to include all industry sectors and all business sizes.

3. Identification of Business Risk Related to SLR and Coordination with Emergency Management Services

Williams Mullen provided background on the operational, capital, financial and legal risk factors associated with SLR. The presentation highlighted the importance of the shoreline and water as a key factor in the regional economy and the reliance of that economy driver on other infrastructure that is compromised during flooding events. Physical impacts and economic impacts were discussed in terms of how they may create changes in land use planning, government and private funding available for investment, demographic shifts and lifestyle changes. These changes, if managed well, can create opportunities in the region. Local business enterprises need to evaluate business risk associated with SLR considering all risk factors and their impact to earnings, and liquidity property/assets market value. Evaluating risk is difficult when the risk, like SLR, is uncertain and the options to minimize or mitigate risk are complex, costly and evolving. Both public and private investment will be necessary for financing of infrastructure, resiliency costs, and for new business development in the areas of resiliency.

The City of Virginia Beach's Director of Emergency Management, Erin Sutton, joined the PIC to discuss critical infrastructure. She explained how critical infrastructure is prioritized in the Commonwealth of Virginia (Commonwealth) and introduced the DHS funded Port Security Risk Assessment that is underway to identify critical infrastructure, dependencies and interdependencies. She discussed the local emergency planning committee strategies and actions taken to engage private facilities in emergency planning and highlighted the partnerships that have been created with federal, Commonwealth, and private industry in the region.

4. Identification of resources:

The PIC has identified resources for private industry use that include best practices for adaptation to climate change and SLR. It is limited in scope and the listing of a resource is not a recommendation for use. It is recommended that the additional resources be identified and that a resource library be made available for the region.

During the process of resource identification, it was noted that individual industry sectors are developing their own best practices and updating industry regulations and requirements to incorporate resiliency/adaptation standards. Examples of this are the CIGRE publication, Air Insulated Substation Design for Severe Climate Conditions, B3.31, 2014 and the standards for

the American Society for Health Engineering. Additional resources by industry sector should be identified.

The U.S. Climate Resiliency Toolkit is a useful starting point for all industries. (http://toolkit.climate.gov/get-started/overview). This resource includes a five step process to build climate resilience: (1) Identify the Problem; (2) Determine Vulnerabilities; (3) Investigate Options; (4) Evaluate Risks & Costs; (5) Take Action. The toolkit provides a framework for individuals, businesses, and communities to respond to the challenges of climate change.

Resilience Plans from other regions:

- Southeastern Florida Compact- http://www.southeastfloridaclimatecompact.org/wp-content/uploads/2014/09/regional-climate-action-plan-final-ada-compliant.pdf
- New Orleans- http://resilientnola.org/
- San Francisco- http://resilience.abag.ca.gov/wp-content/documents/resilience/toolkit/Defining%20What%20San%20Francisco%20Needs%20from%20its%20Seismic%20Mitigation%20Policies.pdf
- Boston- http://www.abettercity.org/docs/resiliency%20report%20web%20FINAL.pdf
- New York- http://s-media.nyc.gov/agencies/sirr/SIRR_spreads_Hi_Res.pdf
- New Jersey- http://www.njfuture.org/wp-content/uploads/2015/10/NJFuture-In-Deep-10-15-WEB.pdf
- North Carolina- http://climateadaptationnc.nemac.org/Climate_Ready_North_Carolina_Building_a_Resilient_Future.pdf

Disaster Preparedness Plans:

- Baltimore Maryland-http://mitigationguide.org/wp-content/uploads/2013/07/Baltimore-HMP.pdf
- U.S. Climate Resilience Toolkit. http://toolkit.climate.gov/
- Louisiana's Comprehensive Master Plan for a Sustainable Coast
- Greater New Orleans Urban Water Plan,
- "Community Resilience Planning Guide for Buildings & Infrastructure Systems, Volume 1 & Volume 2", NIST Special Publication 1190. May be downloaded at http://www.nist.gov/el/building_material s/resilience/guide.cfm
- American Society of Civil Engineers white paper titled: "Adapting Infrastructure and Civil Engineering Practice to a Changing Climate"
- "Weathering the Nest Storm: A Closer Look at Business Resilience", Center for Climate and Energy Solutions. Accessible at: http://www.c2es.org/publications/weathering-next-storm-closer-look-business-resilience

- "Weathering the Storm: Building Business Resilience to Climate Change", Center for Climate and Energy Solutions. Accessible at: http://www.c2es.org/publications/weathering-storm-building-business-resilience-climate-change
- "Small Business Toolkit: Tools and Resources to Plan, Prepare, and Protect." FEMA. Accessible at http://www.fema.gov/small-business-toolkit-tools-and-resources-plan-prepare-and-protect
- "Air Insulated Substation Design for Severe Climate Conditions, B3.31", 2014, CIGRE publication.
- "Before and After the Storm", January 2013, Edison Electric Institute.
- OFB-EZ Toolkit, "Stay Open for Business", OFB-EX Program, Insurance Institute for Business & Home Safety. May be downloaded at http://DisasterSafety.org/open-for-business.
- "Strengthening Regional Economic Resilience through Business Continuity Planning" Presentation, by National Association of Development Organizations (NADO) Research Foundation, June 2014. May be downloaded at http://www.nado.org/wp-content/uploads/2014/06/Strengthening-Regional-Economic-Resilience-through-Business-Continuity-Planning.pdf
- "Enhancing Distribution Resiliency, Opportunities for Applying Innovative Technologies", June 2013, Electric Power Research Institute. May be downloaded at http://tdworld.com/site-files/tdworld.com/files/archive/tdworld.com/go-grid-optimization/distribution/1026889EnhanceDistributionResiliency.pdf
- "The Voluntary Private Sector Preparedness Program – PS-PREPTM & Small Business Preparedness", FEMA. May be downloaded at https://www.fema.gov/voluntary-private-sector-preparedness-program-ps-preptm-small-business-preparedness
- "Resilient Business". May be accessed at http://www.resilientbusiness.co.nz/
- Prepare My Business, may be accessed at http://www.preparemybusiness.org/planning

5. Action/Vision Statement from New Orleans and Southeast Florida Applicable to Hampton Roads:

The PIC reviewed climate action/resiliency plans from New Orleans and Southeast Florida to understand their strategies and to include action/vision statements from their plans that are applicable to Hampton Roads in the final recommendations. It is important to look to other cities and regions that are facing similar threats from SLR. Many of these same recommendations were discussed by various committees during the course of the Pilot Project.

These recommendations should be viewed as a preliminary framework to help guide policies in the region. It is important to emphasize that these recommendations do not serve as a

mandate for the region but rather options that a regional entity or municipality may adopt and utilize based on their interests and vision for the future. Moving forward, the region may enhance these recommendations as scientific data and projections are refined to develop best management practices for the region. The PIC and IWG both voted unanimously to include the following recommendations for Hampton Roads.

From Southeast Florida:

- Develop regionally consistent sea level rise planning scenarios for the coming decades. Require update every four years, immediately after United States National Climate Assessment update, to include rapidly changing body of scientific literature.
- Develop regionally consistent methodologies for mapping sea level rise impacts.
- Develop regionally consistent criteria for risk assessment related to sea level rise using jurisdiction unique risk factors.
- Develop land use strategies that may be implemented for sea level rise that consider adaptation, restoration and growth. These strategies support Virginia Code 15.2-2223.3 that require comprehensive plans to incorporate strategies to address projected sea-level rise and recurrent flooding.
- Develop regionally consistent flood maps reflective of risk assessment and mutually agreed upon suite of storm events under future sea level rise scenarios to inform planning.
- Identify regional infrastructure projects based on risk of flooding and tidal inundation to be used as a basis for identifying and prioritizing adaptation needs and strategies.
- Evaluate existing water management (stormwater and fresh water supply) systems and flood control/drainage structures under sea level rise and storm surge scenarios. Reflect the capacity and interconnectivity of the surface water control network and develop feasible regional adaptation strategies.
- Identify regionally consistent analytical methods for application in analysis of infrastructure design, water resource management (stormwater and fresh water supply) and hazard mitigation. Identify a common set of tools that consider both costs and consequences.

From New Orleans:

- Develop a Regional Urban Water Plan
- Develop Model Watershed Flood Plain Management Plans for the Hampton Roads Region
- Design and Implement a Regional Climate Action Plan
- Develop a Business Resilience Initiative
- Implement balanced use of Green Infrastructure and Blue Infrastructure Strategies Regionally

- Incentivize commercial & residential property owners to implement green and blue infrastructure on private property (stormwater fee reductions)
- Require new developments (>5000sf) and redevelopments to treat and or store first 1-1/4" of rainwater on site.
- Incentive commercial and residential property owners to adapt to SLR provide: resources, capacity and expertise.
- Develop a "Water Management" Economy in Hampton Roads

6. Barriers to implementation of SLR infrastructure adaptation measures:

During phase I of the Pilot Project, the PIC identified challenges and barriers to the regional infrastructure planning for SLR that included the following items: (1) identification of infrastructure, interdependencies between private and public infrastructure, and vulnerabilities; (2) private industry needs to know what SLR amount that they should be using for planning in short and long term; (3) uncertainty on how public and private organizations will work together; (4) proprietary information, how will it be shared and protected; (5) codes regarding construction standards related to SLR vary by city, a regional or Commonwealth code requirement should be implement to eliminate confusion; (6) underwriter insurance requirements may differ from code requirements causing confusion; and (7) financial/funding barriers.

Ekstrom and Moser in Chapter 6 Institutions (Ekstrom and Moser, 2013) as key element to successful climate adaption processes: results from the San Francisco Bay Area from "Successful Adaptation to Climate Change" outline 12 barriers to adaptation that include: (1) institutional governance issues; (2) attitudes, values & motivation; (3) resources and funding; (4) political; (5) leadership; (6) adaptation options/process; (7) understanding; (8) science; (9) expertise; (10) communication; (11) personality issues; and (12) technology (structural). Many of the barriers to regional infrastructure planning for SLR that were identified by the PIC fall into the first category of institutional governance. Ekstrom and Moser provide additional examples of institutional governance issues which include fragmentation, lack of formal interaction with government, stove-piped functionality of agencies (water supply, energy, sanitary sewer, stormwater, etc.), government department and sector based structures of agencies, legal barriers and limited spatial & functional extent of jurisdiction. During the process of working through the case study in the Little Creek/Pretty Lake area the IWG and PIC experienced these examples of institutional governance barriers:

- Fragmentation, lack of formal interaction with government – not all critical infrastructure entities were invested in participating in the Pilot Project and not all that did participate were invested in evaluating infrastructure interdependencies in the case study area. This included both public and private infrastructure entities.

- Stove-piped functionality of agencies – that is the nature of our infrastructure systems and the exercise of mapping of interdependencies between critical infrastructure systems had not been done previously in Hampton Roads (exclusive of Federal facilities).
- Government department & sector based structures of agencies – prior to the IPP the municipalities had not received infrastructure information (example: stormwater loading) from adjacent jurisdictions.
- Legal barriers – national security requirements prevent the sharing of information from federal facilities and Protection of Critical Infrastructure Information (PCII) also creates a legal barrier for sharing of critical infrastructure information.

While the region has exceptional scientific resources and support, including the strength of the Science Committee participation in the Pilot Project, science remains a barrier in the region. Specifically, the type of information that is needed in terms of more certainty in the rates of SLR or local data on storm intensity and frequency, flooding impacts and vulnerabilities.

The PIC also identifies resources and funding as barriers to infrastructure adaptation moving forward. A regional approach to funding will provide more opportunities for success. Individually only one city, Virginia Beach, is ranked in the top 50 cities in the United States (www.census.gov). By comparison the combination of the population in Virginia Beach, Norfolk, Newport News, Portsmouth, and Hampton puts the region in a comparable position with the top 10 cities in the United States.

7. Solutions to barriers to implementation of SLR infrastructure adaptation measures:

Ekstrom and Moser also outline the most common strategies to overcome adaptation barriers: (1) data gathering and monitoring; (2) research; (3) self-education and learning; (4) information sharing; (5) creating awareness among staff, public, stakeholders; (6) communication, networking/formalized partnerships; (7) political maneuvering; lobbying; (8) taking lead, assuming leadership; (9) waiting for leadership; (10) prioritization; (11) staffing changes; (12) funding, fundraising, financing; (13) policy and management changes.

It is important to note that Hampton Roads has been building regional capacity for adaptation to SLR, which provides a pre-existing advantage, based on the work of municipalities, agencies, non-profits, and universities. Entities involved in this work include but are not limited to: City of Norfolk, City of Virginia Beach, City of Newport News, City of Hampton, City of Portsmouth, Hampton Roads Planning District Commission (HRPDC), Hampton Roads Transportation Planning Organization (HRTPO), Wetlands Watch, Urban Land Institute (ULI), Old Dominion University (ODU), Virginia Institute of Marine Science (VIMS), and William and Mary.

The IWG and PIC committees found success using many of the strategies outlined by Ekstrom and Moser in their committee work as outlined below:

- Gathering data – the committees gathered data from many existing studies, national and from the Hampton Roads region, which were reviewed and referenced in the committee work. These references are outlined in the reference sections of both the IWG and PIC reports. This strategy also led into self-education and learning and information sharing strategies.
- Networking/formal partnerships – the IWG and PIC were able to break down institutional stove piping barriers using department and sector based structures of agencies to coordinate and share information (engineers/planner). This strategy was extremely successful and should be implemented in the future regional SLR organization. While formal partnerships were not developed, informal partnerships have been formed that will be beneficial for future infrastructure analysis and planning. In addition, the final recommendations from the Pilot Project will outline a governance structure for the region that can support continuing efforts of regional adaptation.
- Leadership – the IWG and PIC committees provided leadership in the Pilot Project by the selection of the case study area of Little Creek/Pretty Lake. This case study area was also adopted by the Community Engagement Working Group and the Public Health Working Group.
- Funding and Policy and Management Changes – Both the IWG and PIC final recommendations include recommendations that address funding and policy and management recommendations for the Hampton Roads region moving forward. It was beyond the scope of the Pilot Project to implement actions in either of these areas.

Actions & Accomplishments

The PIC met for the first time February 24, 2015. Monthly meetings were held on the last Tuesday of each month, with the schedule modified in November and December of 2015 based on the holiday schedule and other Pilot Project meetings. Committee meetings were held at ODU, Research I Building, 4111 Monarch Way, 2nd floor conference room at 3:30 pm. Meetings were typically limited to a one-hour duration but, in the last months of the Pilot Project, time extended to an hour and a half. Phone access was provided for any committee members that could not attend in person. During committee meetings presentations were made, discussion and action on deliverables occurred, and planning occurred for future committee meetings.

Interactions outside of monthly committee meetings were accomplished using e-mail and phone calls. Meeting agendas and minutes were distributed via e-mail. Box, a cloud-based file sharing and collaboration service, was used for document sharing and access, but there were issues of access to materials for some committee members based on firewalls/internet security at their places of employment. Interactions outside of committee meetings were limited and based on specific questions or concerns related to the Pilot Project. All committee business

was completed during monthly meetings. The following is a list of presentations that were given at monthly meetings, each of which has been summarized in PIC Methodology:

Sentara Hospital Resiliency/Planning Efforts
May 26th, 2015 by Larry Smith, Sentara Director of Facility Services

Dominion Power Resiliency Planning Efforts and Design for Restoration
June 30th, 2015 by Mark McVey, Virginia Dominion Power

SLR from the Maritime Perspective
July 28th, 2015 by David White, Virginia Maritime Association, and Speaker Pollard, Williams Mullen

Business Risk Related to SLR
February 23rd, 2016 by Speaker Pollard, Williams Mullen

Little Creek/Pretty Lake Inlet Coastal Flooding Resilience Concepts
March 29th, 2016 by Tom McNeilan (McNeilan & Associates)

Emergency Management Coordination with Private Industry
April 26, 2016 by Erin Sutton, City of Virginia Beach Director of the Office of Emergency Management

Case Studies

EIMA

The U.S. Department of Energy, Energy Infrastructure and Modeling and Analysis Division (EIMA) recently completed a study to assess the potential exposure of energy facilities in the Hampton Roads region to a general rise in sea level and from storm surge at these higher sea levels. The analysis focused on the risk in 2050 and 2100, and included electricity assets, natural gas assets, and petroleum assets. The results of the study indicate that these assets would not be inundated under the National Climate Assessment (NCA) Intermediate-High SLR Scenario in 2050. However, there is significant risk to these assets when a storm surge associated with a Category 4 Storm is considered. In addition, the NCA Intermediate-High Scenario predicts 5 feet of SLR by 2100, which would inundate multiple energy assets in Hampton Roads. A Category 1 storm in addition to the 5 feet of SLR would cause extensive inundation of energy assets. The results of this report are being shared with respective energy providers for their consideration in SLR planning and adaptation efforts.

Recommendation: Federal agencies are going to be instrumental partners in SLR planning and adaptation moving forward. The Department of Defense should be considered a partner with a vote equal to any municipality. This may require legislative changes at the Federal and State level.

Little Creek/Pretty Lake Case Study

The IWG conducted a thorough review of existing studies related to sea level rise impacts in the Hampton Roads Region, and considered other relevant studies that, while not specific to Hampton Roads, might contribute to gaining better insight and understanding of the challenges related to whole of government and community sea level rise adaptation planning. The IWG selected the Little Creek/Pretty Lake Case Study area and SLR and storm surge scenarios that were evaluated as part of the case study. The process is outlined in the IWG Phase II report (Phillips, 2016). A map of the case study is provided in Figure 1 and the scenarios are shown in Figure 2 through Figure 5.

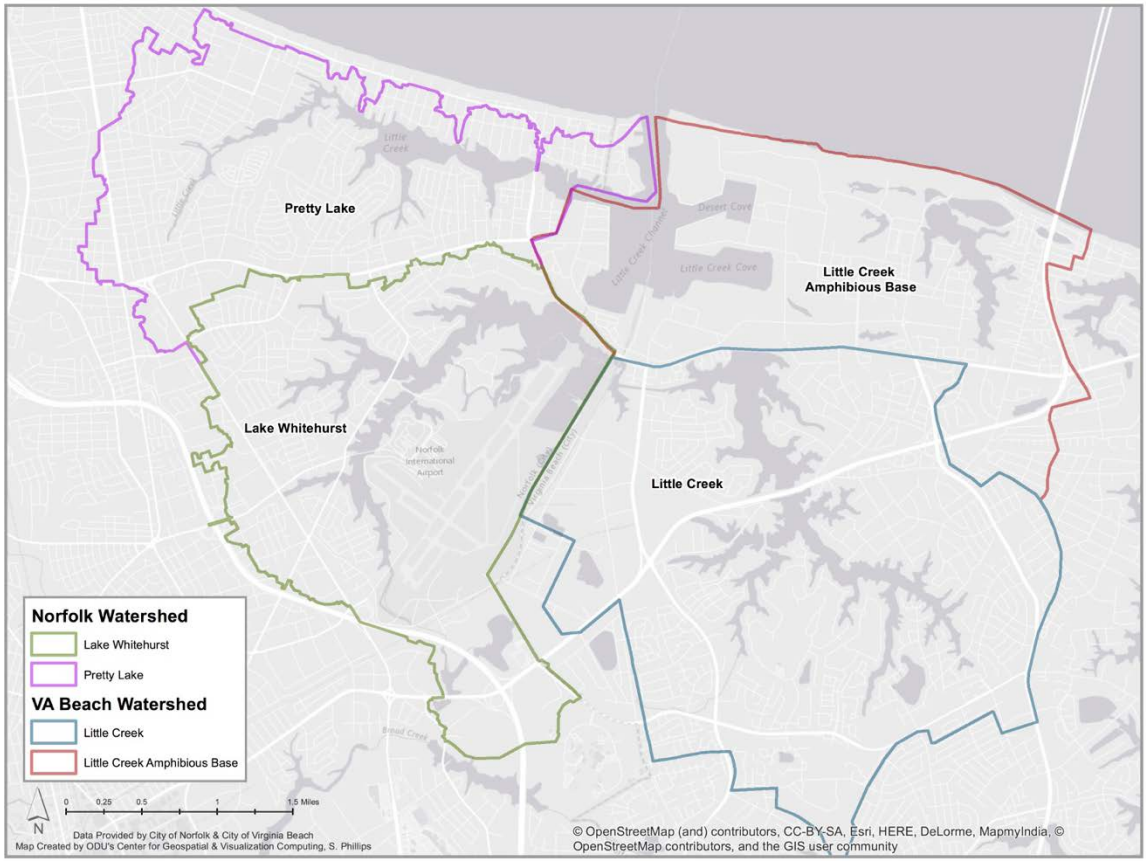


Figure 1. Little Creek/Pretty Lake Case Study Area

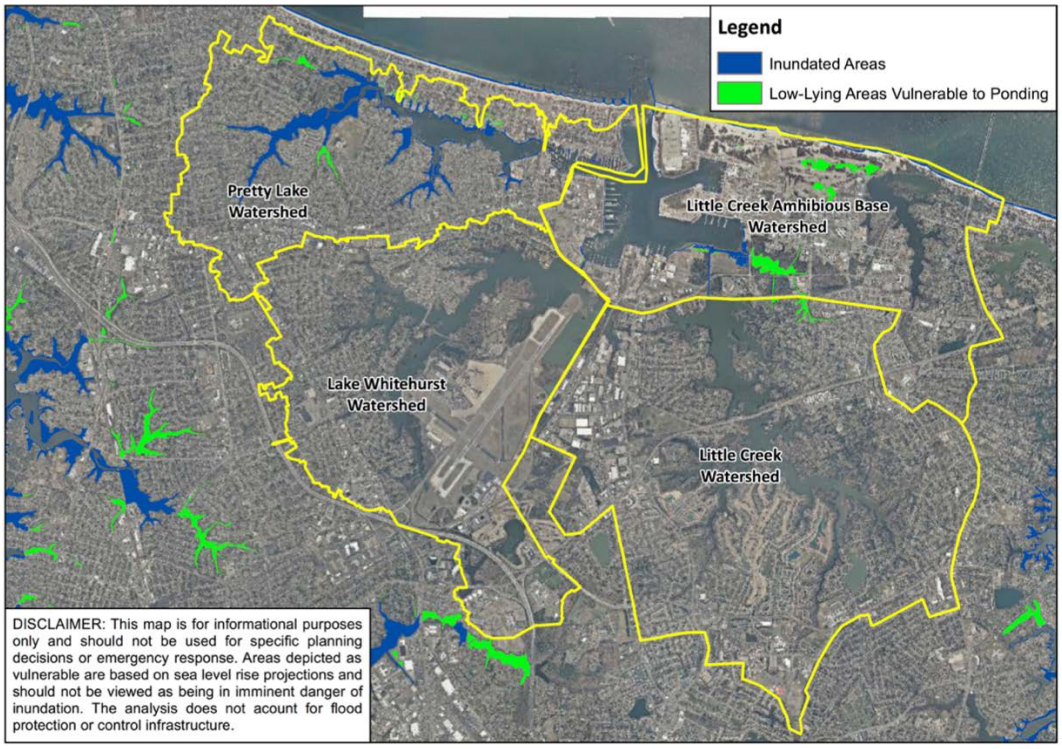


Figure 2. Case study area map, 1.5'of Sea Level Rise. Map produced by the staff of the Hampton Roads Planning District Commission, 2016.

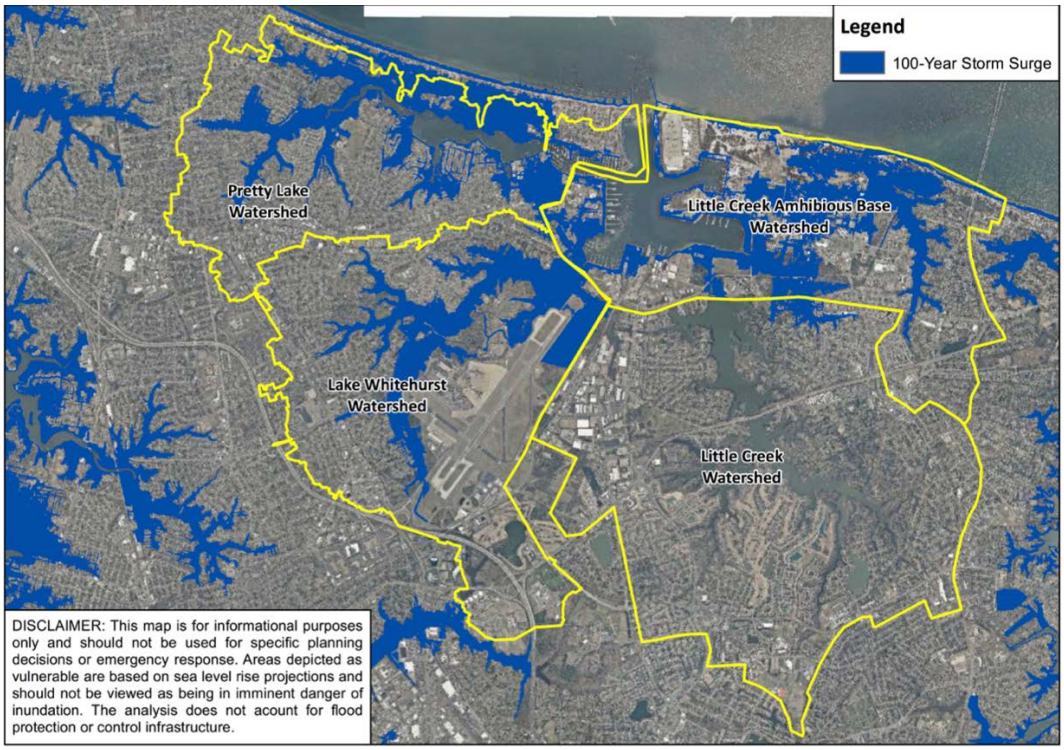


Figure 3. Case study area map, 1.5'of Sea Level Rise with 100-year Storm Surge. Map produced by the staff of the Hampton Roads Planning District Commission, 2016.

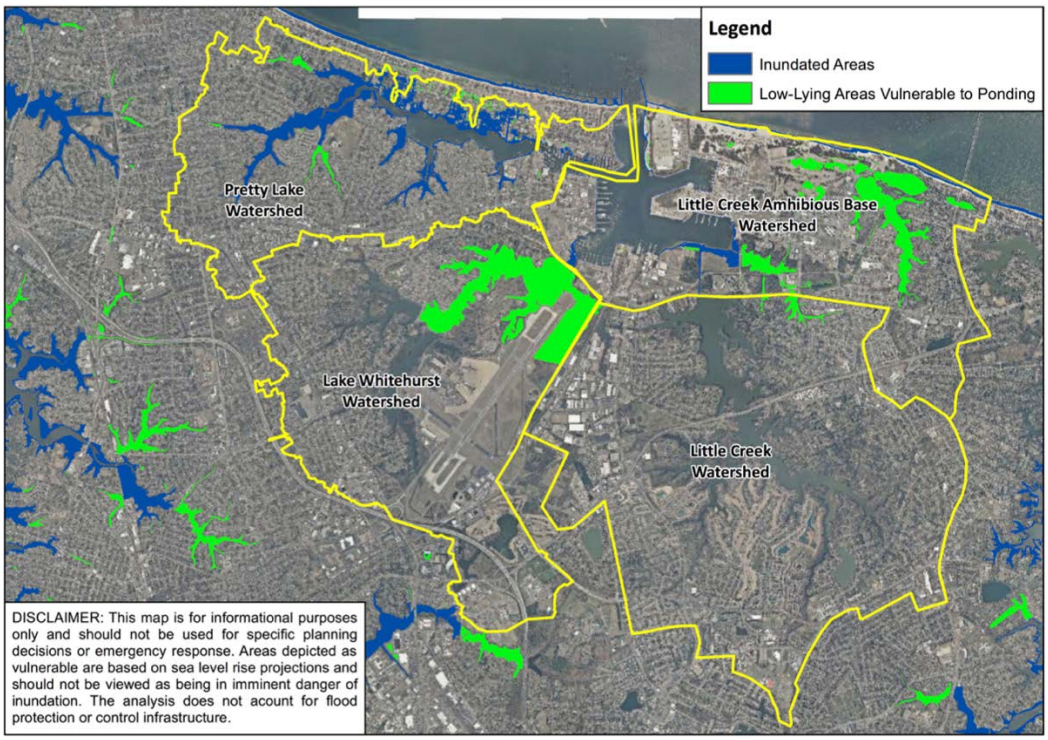


Figure 4. Case study area map, 3'of Sea Level Rise. Map produced by the staff of the Hampton Roads Planning District Commission, 2016.

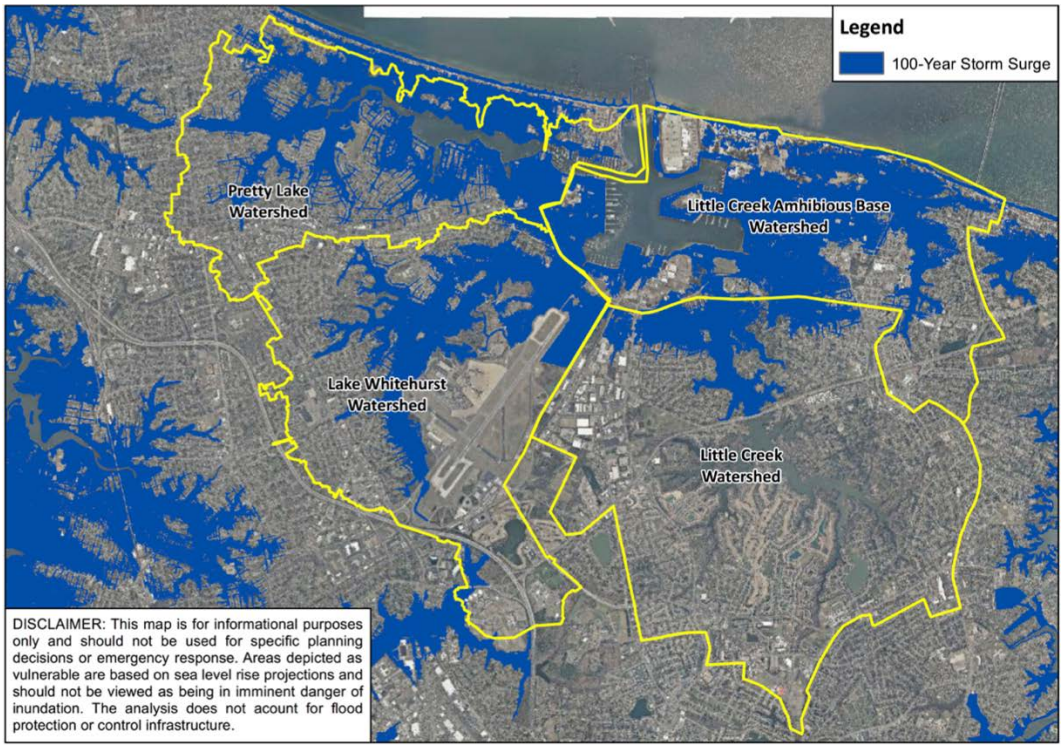


Figure 5. Case study area map, 3'of Sea Level Rise with 100-year Storm Surge. Map produced by the staff of the Hampton Roads Planning District Commission, 2016.

Tom McNeilan of McNeilan and Associates was involved in preliminary design work for the City of Norfolk Pretty Lake storm surge barrier. He provided a context of the study, including that it was completed prior to Superstore Sandy and also pre-dated the current thinking on incorporating blue and green infrastructure into solutions. He indicated that at the time of the study, the City of Virginia Beach was approached to see if they were interested in working together with the City of Norfolk on a solution to the Little Creek/Pretty Lake watershed and that they declined involvement at that time. He acknowledged that while a storm surge barrier at Shore Drive to protect Pretty Lake could increase flooding risk at Little Creek Amphibious base and Little Creek watershed, the impact is not likely to be significant.

He outlined the geological and subsurface conditions of the area highlighting that the area is relatively flat with a median elevation of nine feet and that 25% of the watershed is below 7 feet in elevation. It is not unusual for low ground in East Ocean View to be moderately inundated in severe storms and both storm surge and sea level rise are issues for the area. When considering protection of the Pretty Lake area, it is important to recognize that the watershed is relatively large in comparison to the outlet, and that flood protection is required at the outlet of Pretty Lake but also at the shore along the Chesapeake Bay.

The current Dutch water management perspective was discussed which includes consideration of water as where the environment meets the economy. While barriers are needed in some cases, you cannot depend on them exclusively. Hybrid solutions of gray and green infrastructure are necessary and can be an avenue for providing multiple lines of defense. Water strategies that are implemented should include options that slow the water down, store and use the water and then drain the water after an event is over.

Mapping Infrastructure Dependencies

In order to understand critical infrastructure internal and external dependencies, a spreadsheet was developed that enabled infrastructure systems to map internal dependencies, dependencies within their own systems, external dependencies, and dependencies on other infrastructure systems. Two spreadsheets, Internal Factors and External Dependencies, were developed and infrastructure sectors were asked to complete an analysis of their systems. These spreadsheets are shown in Table 3 and Table 4. The analysis was limited to the Little Creek/Pretty Lake area based on the scope of the Pilot Project; however, this should be done for the entire Hampton Roads Region.

The Internal Factors spreadsheet required each infrastructure system to develop a list of internal factors that they are dependent on for operations. For example, hospital systems internal factors might be: water, power, communications, staff, sanitary, HVAC, security, computer systems, medical gas, and sustenance and supplies. Once a list of internal factors was established, that list was evaluated within the selected geographic area based on SLR and storm

surge scenarios. The evaluation of internal factors was completed based on the questions of: are these internal factors vulnerable under this scenario; and how vulnerable are they under this scenario? The evaluation of vulnerability was based on a scale of: not vulnerable (no impact); low vulnerability (less than 33% of impact); medium vulnerability (less than 66% of impact) and high vulnerability (system impact greater than 66%).

Each system was then evaluated based on the dependencies of the internal factors on external infrastructure systems. For example, a hospitals internal factors would be evaluated against the following external infrastructure systems: city water, electric, gas, communications (data/internet), communications (voice), transportation (air), transportation (roads), transportation (rail), transportation (vessel), sanitary, sanitary treatment, medical facilities, federal facilities, emergency services and, vehicle fuel. The evaluation of internal factor dependency on external infrastructure was completed based on the question of: how dependent are your internal factor operations on the external infrastructure system? The evaluation of threat to internal operations was based on a scale of: no threat (no impact); low threat (less than 33% impact); medium threat (less than 66% impact) and high vulnerability threat (system impact greater than 66%). In evaluating threat to internal operations, the existence of emergency planning was taken into account. For example, hospital systems may have a 72-hour emergency electrical supply or sanitary pumping stations may have a 24-hour emergency power back up system.

The Little Creek/Pretty Lake Case Study includes the example and results of the infrastructure internal and external dependencies evaluation that was completed as part of the Pilot Project. As noted earlier, the results of the evaluation of critical infrastructure will vary based on the location in which the analysis is done within the region and the vulnerability of the area to SLR and flooding. The following are a summary of the impacts to infrastructure systems evaluated in the case study area:

- The scenario of 1.5’ of SLR will have no threat to critical infrastructure systems. Systems have already been hardened or are located at elevations at which there is not an impact.
- The scenario of 1.5’ of SLR + 100-year storm surge will have some threat to all infrastructure systems evaluated. There is a low threat to the medical facility, and City of Norfolk water supply and water distribution systems. There is a medium threat to electrical infrastructure and City of Norfolk sanitary and a low threat to City of Virginia Beach sanitary and water distribution.
- The scenario of 3.0’ of SLR will have relatively low threat to City of Norfolk water supply, water distribution and sanitary systems. The City of Virginia Beach has a low threat to the collection system of their sanitary but no threat to the other parts of the system.

- The scenario of 3.0’ of SLR + 100-year storm surge will have a high level or threat to a portion of infrastructure systems evaluated in the case study area except Sentara Independence which is located on relatively high ground just outside of the case study area.

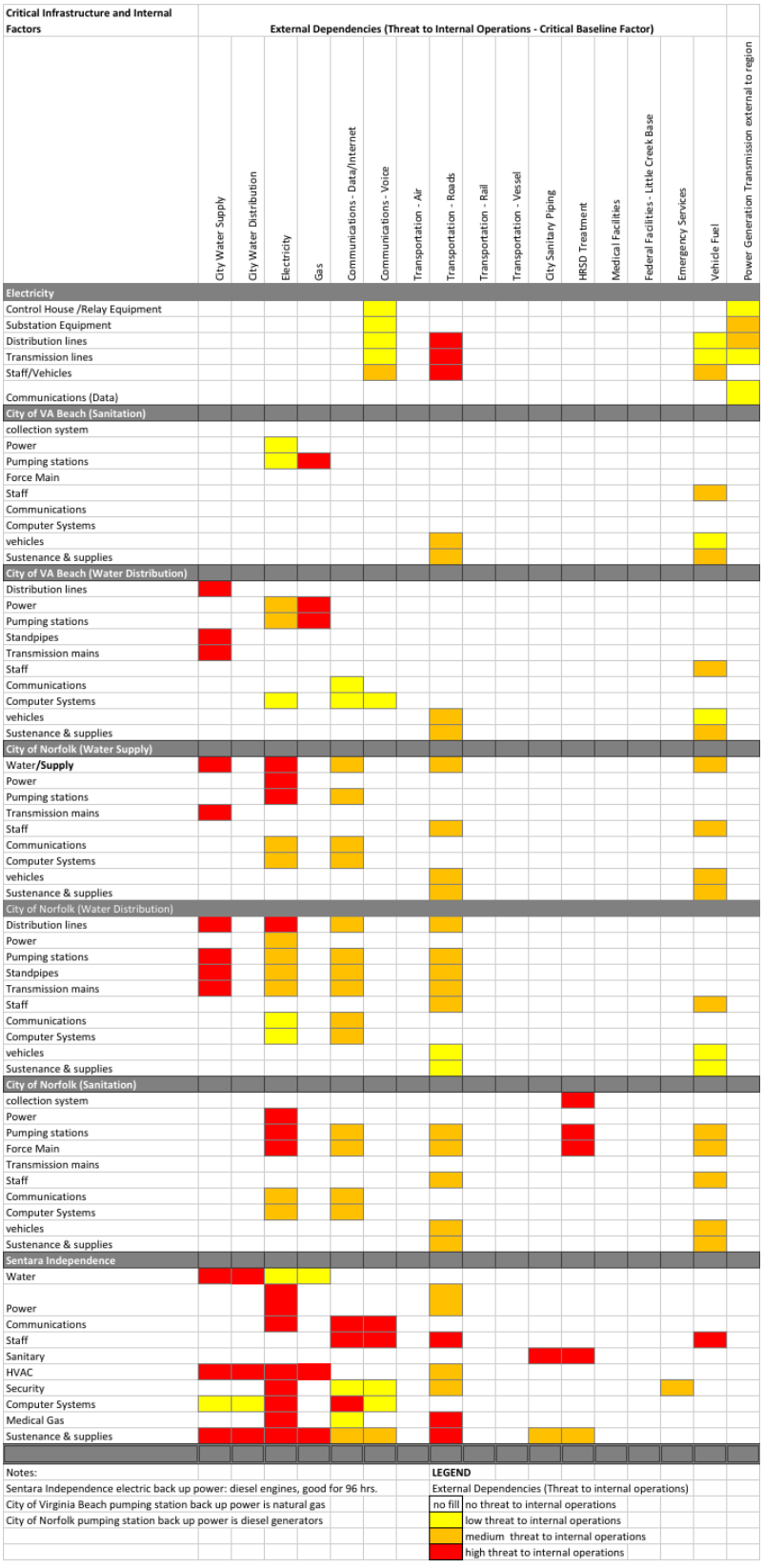
During the process of evaluating infrastructure systems in the case study area the following insights were noted:

- In the case study area, SLR (limited to 3 feet) will not have a major impact on infrastructure systems analyzed but the addition of storm surge in SLR will create significant problems. Additionally, low lying roads will be inundated which will impact residents significantly.
- Infrastructure evaluation results will vary based on the location within the region in which the analysis is completed and the vulnerability of the specific area to SLR and flooding related to storm surge.
- The City of Norfolk and the City of Virginia Beach use different power back up systems for pumping stations, with City of Virginia Beach using natural gas for back-up power and City of Norfolk using petroleum based back-up generators. This information was previously not shared between jurisdictions.

Table 3 Example of Infrastructure System Internal Factor Impacts due to SLR & Storm Surge

Scenario 4 - SLR 3.0' + 100-Year Storm Surge (~9.4')	**Electrical Transmission and Distribution**	**Vulnerability**	**City of Virginia Beach Water Distribution**	**Vulnerability**	**City of Norfolk Water Supply**	**Vulnerability**
	Communications (Data)		Communications		Communications	
	Staff		Staff		Staff	
	Vehicles		Vehicles		Vehicles	
			Computer Systems		Computer Systems	
			Sustenance & Supplies		Sustenance & Supplies	
			Power		Power	
			Pumping stations		Pumping stations	
	Transmission Lines		Transmission Mains		Transmission Mains	
	Distribution Lines		Distribution Lines			
			Standpipes		Standpipes	
					Water/Supply	
	Control House/Relay Equipment					
	Substation Equipment					
LEGEND						
Ranking of Internal Factors						
	not vulnerable					
	low vulnerability					
	medium vulnerability					
	high vulnerability					

Table 4 External Dependencies for Infrastructure Internal Factors



Critical Infrastructure and Internal Factors	External Dependencies (Threat to Internal Operations - Critical Baseline Factor)																	
	City Water Supply	City Water Distribution	Electricity	Gas	Communications - Data/Internet	Communications - Voice	Transportation - Air	Transportation - Roads	Transportation - Rail	Transportation - Vessel	City Sanitary Piping	HRSD Treatment	Medical Facilities	Federal Facilities - Little Creek Base	Emergency Services	Vehicle Fuel	Power Generation Transmission external to region
Electricity																	
Control House /Relay Equipment																	
Substation Equipment																	
Distribution lines																	
Transmission lines																	
Staff/Vehicles																	
Communications (Data)																	
City of VA Beach (Sanitation)																	
collection system																	
Power																	
Pumping stations																	
Force Main																	
Staff																	
Communications																	
Computer Systems																	
vehicles																	
Sustenance & supplies																	
City of VA Beach (Water Distribution)																	
Distribution lines																	
Power																	
Pumping stations																	
Standpipes																	
Transmission mains																	
Staff																	
Communications																	
Computer Systems																	
vehicles																	
Sustenance & supplies																	
City of Norfolk (Water Supply)																	
Water/**Supply**																	
Power																	
Pumping stations																	
Transmission mains																	
Staff																	
Communications																	
Computer Systems																	
vehicles																	
Sustenance & supplies																	
City of Norfolk (Water Distribution)																	
Distribution lines																	
Power																	
Pumping stations																	
Standpipes																	
Transmission mains																	
Staff																	
Communications																	
Computer Systems																	
vehicles																	
Sustenance & supplies																	
City of Norfolk (Sanitation)																	
collection system																	
Power																	
Pumping stations																	
Force Main																	
Transmission mains																	
Staff																	
Communications																	
Computer Systems																	
vehicles																	
Sustenance & supplies																	
Sentara Independence																	
Water																	
Power																	
Communications																	
Staff																	
Sanitary																	
HVAC																	
Security																	
Computer Systems																	
Medical Gas																	
Sustenance & supplies																	

Notes:
Sentara Independence electric back up power: diesel engines, good for 96 hrs.
City of Virginia Beach pumping station back up power is natural gas
City of Norfolk pumping station back up power is diesel generators

LEGEND
External Dependencies (Threat to internal operations)
no fill — no threat to internal operations
low threat to internal operations
medium threat to internal operations
high threat to internal operations

Summary of Recommendations

- Federal agencies are going to be instrumental partners in SLR planning and adaptation moving forward. The Department of Defense agencies and other federal agencies should be considered as partners with a formal role in decision making. This may require legislative changes at the Federal and State level.
- Funding for adaptation in Hampton Roads should be sought from public and private sources. Every year NOAA compiles a list of currently available, climate-related funding opportunities. See Appendix B for funding list.
- Interdependencies between private infrastructure and public infrastructure systems will require collaborative problem solving across all infrastructure systems. Private critical infrastructure needs to be accounted for in these efforts for SLR adaption planning.
- Private infrastructure systems need reliable information and guidance in planning for SLR. Provide regionally recognized science based SLR scenarios for private industry to incorporate in long range planning. This standardization will eliminate confusion across the region and enable companies and industries with facilities throughout the region to proactively adapt to SLR.
- The region should develop or adopt a tool for evaluation of SLR impacts on critical infrastructure, including internal and external dependencies. A regional assessment by watershed is necessary to understand infrastructure dependencies and to develop resiliency plans for implementation.
- Develop building code strategies that can be implemented on a regional basis for construction and substantial improvements to existing structures to mitigate against flooding, severe wind, and SLR. Some strategies for consideration include: freeboard regional standard, 500-year flood plain management, etc.
- Ensure business and industry (and related trade groups) are active participants in shaping regional strategies and methods to address SLR and related risks and concerns and the development of any regional organization that may facilitate planning and/or implementation efforts.
- Incent business and industry action and innovation to address SLR and related risk and concerns through financial and public recognition mechanisms.
- The region should develop a business and industry outreach program that would:
    - Increase awareness among business and industry sectors, particularly small and mid-sized businesses, as to the concerns and risks associated with SLR, storm surge and coastal flooding trends;
    - Develop toolkits or portals to toolkits that would serve the specific needs of business and industry in addressing such risks and concerns (i.e., data gathering/management, risk evaluation and operational, capital investment

planning, economic opportunities arising from such risk and issues, and public policy notification and tracking). A resource that is useful is the U.S. Climate Resiliency Toolkit (http://toolkit.climate.gov/get-started/overview).

From Southeast Florida:

- Develop regionally consistent sea level rise planning scenarios for the coming decades. Require update every four years, immediately after United States National Climate Assessment update, to include rapidly changing body of scientific literature.
- Develop regionally consistent methodologies for mapping sea level rise impacts.
- Develop regionally consistent criteria for risk assessment related to sea level rise using jurisdiction unique risk factors.
- Develop land use strategies that may be implemented for sea level rise that consider adaptation, restoration and growth. These strategies support Virginia Code 15.2-2223.3 that require comprehensive plans to incorporate strategies to address projected sea-level rise and recurrent flooding.
- Develop regionally consistent flood maps reflective of risk assessment and mutually agreed upon suite of storm events under future sea level rise scenarios to inform planning.
- Identify regional infrastructure projects based on risk of flooding and tidal inundation to be used as a basis for identifying and prioritizing adaptation needs and strategies.
- Evaluate existing water management (stormwater and fresh water supply) systems and flood control/drainage structures under sea level rise and storm surge scenarios. Reflect the capacity and interconnectivity of the surface water control network and develop feasible regional adaptation strategies.
- Identify regionally consistent analytical methods for application in analysis of infrastructure design, water resource management (stormwater and fresh water supply) and hazard mitigation. Identify a common set of tools that consider both costs and consequences.

From New Orleans:

- Develop a Regional Urban Water Plan
- Develop Model Watershed Flood Plain Management Plans for the Hampton Roads Region
- Design and Implement a Regional Climate Action Plan
- Develop a Business Resilience Initiative
- Implement balanced use of Green Infrastructure and Blue Infrastructure Strategies Regionally
- Incentivize commercial & residential property owners to implement green and blue infrastructure on private property (stormwater fee reductions)

- Require new developments (>5000sf) and redevelopments to treat and or store first 1-1/4" of rainwater on site.
- Incentive commercial and residential property owners to adapt to SLR provide: resources, capacity and expertise.
- Develop a "Water Management" Economy in Hampton Roads

References

Ekstom, J. A., & Moser, S. C. (2013). Institutions as key element to successful climate adaptation processes: results from the San Francisco Bay Area. In S. C. Moser & B. T. Maxwell (Eds.), Successful Adaptation to Climate Change. New York, NY: Routledge.

Phillips, Ann C. (Ed.). *Hampton Roads Sea Level Rise Preparedness and Resilience Intergovernmental Planning Pilot Project: Infrastructure Working Group Report and Recommendations*. Norfolk, 2016.

Appendix A: Critical Infrastructure Internal and External Dependencies

Complete Tables

Table 5. Infrastructure System Internal Factor Impacts due to SLR & Storm Surge

Scenario	Critical Infrastructure and Internal Factors	Vulnerability	Critical Infrastructure and Internal Factors	Vulnerability	Critical Infrastructure and Internal Factors	Vulnerability	Critical Infrastructure and Internal Factors	Vulnerability	Critical Infrastructure and Internal Factors	Vulnerability	Critical Infrastructure and Internal Factors	Vulnerability	Critical Infrastructure and Internal Factors	Vulnerability
	Electrical Transmission and Distribution		City of Virginia Beach Water Distribution		City of Virginia Beach Sanitary		City of Norfolk Water Distribution		City of Norfolk Sanitary		City of Norfolk Water Supply		Sentara Independence	
Scenario 1 - Sea Level Rise (SLR) 1.5'	Communications (Data)		Communications		Communications		Communications		Communications		Communications		Communications	
	Staff		Staff		Staff		Staff		Staff		Staff		Staff	
	Vehicles		Vehicles		Vehicles		Vehicles		Vehicles		Vehicles			
	Computer Systems		Computer Systems		Computer Systems		Computer Systems		Computer Systems		Computer Systems		Computer Systems	
	Sustenance & Supplies		Sustenance & Supplies		Sustenance & Supplies		Sustenance & Supplies		Sustenance & Supplies		Sustenance & Supplies		Sustenance & Supplies	
	Power		Power		Power		Power		Power		Power		Power	
	Pumping Stations		Pumping stations		Pumping stations		Pumping stations		Pumping stations		Pumping stations			
	Transmission Lines		Transmission Mains				Transmission Mains		Transmission Mains		Transmission Mains			
	Distribution Lines		Distribution Lines				Distribution Lines							
	Standpipes		Standpipes				Standpipes				Standpipes			
	Force Main				Force Main				Force Main					
	Collection system				Collection system				Collection system					
	Water										Water/Supply		Water	
	Control House/Relay Equipment													
	Substation Equipment													
	Sanitary												Sanitary	
	HVAC												HVAC	
	Security												Security	
	Medical Gas												Medical Gas	
Scenario 2 - SLR 1.5' + 100-Year Storm Surge (~7.8')	Communications (Data)		Communications		Communications		Communications		Communications		Communications		Communications	
	Staff		Staff		Staff		Staff		Staff		Staff		Staff	
	Vehicles		Vehicles		Vehicles		Vehicles		Vehicles		Vehicles			
			Computer Systems		Computer Systems		Computer Systems		Computer Systems		Computer Systems		Computer Systems	
			Sustenance & Supplies		Sustenance & Supplies		Sustenance & Supplies		Sustenance & Supplies		Sustenance & Supplies		Sustenance & Supplies	
			Power		Power		Power		Power		Power		Power	
			Pumping stations		Pumping stations		Pumping stations		Pumping stations		Pumping stations			
	Transmission Lines		Transmission Mains				Transmission Mains		Transmission Mains		Transmission Mains			
	Distribution Lines		Distribution Lines				Distribution Lines							
			Standpipes				Standpipes				Standpipes			
					Force Main				Force Main					
					Collection system				Collection system					
											Water/Supply		Water	
	Control House/Relay Equipment													
	Substation Equipment													
													Sanitary	
													HVAC	
													Security	
													Medical Gas	
Scenario 3 - SLR 3.0'	Communications (Data)		Communications		Communications		Communications		Communications		Communications		Communications	
	Staff		Staff		Staff		Staff		Staff		Staff		Staff	
	Vehicles		Vehicles		Vehicles		Vehicles		Vehicles		Vehicles			
			Computer Systems		Computer Systems		Computer Systems		Computer Systems		Computer Systems		Computer Systems	
			Sustenance & Supplies		Sustenance & Supplies		Sustenance & Supplies		Sustenance & Supplies		Sustenance & Supplies			
			Power		Power		Power		Power		Power		Power	
			Pumping stations		Pumping stations		Pumping stations		Pumping stations		Pumping stations			
	Transmission Lines		Transmission Mains				Transmission Mains		Transmission Mains		Transmission Mains			
	Distribution Lines		Distribution Lines				Distribution Lines							
			Standpipes				Standpipes				Standpipes			
					Force Main				Force Main					
					Collection system				Collection system					
											Water/Supply		Water	
	Control House/Relay Equipment													
	Substation Equipment													
													Sanitary	
													HVAC	
													Security	
													Medical Gas	
Scenario 4 - SLR 3.0' + 100-Year Storm Surge (~9.4')	Communications (Data)		Communications		Communications		Communications		Communications		Communications		Communications	
	Staff		Staff		Staff		Staff		Staff		Staff		Staff	
	Vehicles		Vehicles		Vehicles		Vehicles		Vehicles		Vehicles			
			Computer Systems		Computer Systems		Computer Systems		Computer Systems		Computer Systems		Computer Systems	
			Sustenance & Supplies		Sustenance & Supplies		Sustenance & Supplies		Sustenance & Supplies		Sustenance & Supplies			
			Power		Power		Power		Power		Power		Power	
			Pumping stations		Pumping stations		Pumping stations		Pumping stations		Pumping stations			
	Transmission Lines		Transmission Mains				Transmission Mains		Transmission Mains		Transmission Mains			
	Distribution Lines		Distribution Lines				Distribution Lines							
			Standpipes				Standpipes				Standpipes			
					Force Main				Force Main					
					Collection system				Collection system					
											Water/Supply		Water	
	Control House/Relay Equipment													
	Substation Equipment													
													Sanitary	
													HVAC	
													Security	
													Medical Gas	
LEGEND														
Ranking of Internal Factors: Are they vulnerable under this scenario?														
	not vulnerable													
	low vulnerability													
	medium vulnerability													
	high vulnerability													

Table 6. External Dependencies for Infrastructure Internal Factors

Critical Infrastructure and Internal Factors	External Dependencies (Threat to Internal Operations - Critical Baseline Factor)																
	City Water Supply	City Water Distribution	Electricity	Gas	Communications - Data/Internet	Communications - Voice	Transportation - Air	Transportation - Roads	Transportation - Rail	Transportation - Vessel	City Sanitary Piping	HRSD Treatment	Medical Facilities	Federal Facilities - Little Creek Base	Emergency Services	Vehicle Fuel	Power Generation Transmission external to region
Electricity																	
Control House /Relay Equipment																	
Substation Equipment																	
Distribution lines																	
Transmission lines																	
Staff/Vehicles																	
Communications (Data)																	
City of VA Beach (Sanitation)																	
collection system																	
Power																	
Pumping stations																	
Force Main																	
Staff																	
Communications																	
Computer Systems																	
vehicles																	
Sustenance & supplies																	
City of VA Beach (Water Distribution)																	
Distribution lines																	
Power																	
Pumping stations																	
Standpipes																	
Transmission mains																	
Staff																	
Communications																	
Computer Systems																	
vehicles																	
Sustenance & supplies																	
City of Norfolk (Water Supply)																	
Water**/Supply**																	
Power																	
Pumping stations																	
Transmission mains																	
Staff																	
Communications																	
Computer Systems																	
vehicles																	
Sustenance & supplies																	
City of Norfolk (Water Distribution)																	
Distribution lines																	
Power																	
Pumping stations																	
Standpipes																	
Transmission mains																	
Staff																	
Communications																	
Computer Systems																	
vehicles																	
Sustenance & supplies																	
City of Norfolk (Sanitation)																	
collection system																	
Power																	
Pumping stations																	
Force Main																	
Transmission mains																	
Staff																	
Communications																	
Computer Systems																	
vehicles																	
Sustenance & supplies																	
Sentara Independence																	
Water																	
Power																	
Communications																	
Staff																	
Sanitary																	
HVAC																	
Security																	
Computer Systems																	
Medical Gas																	
Sustenance & supplies																	

Notes:	LEGEND	
Sentara Independence electric back up power: diesel engines, good for 96 hrs.	External Dependencies (Threat to internal operations)	
City of Virginia Beach pumping station back up power is natural gas	no fill	no threat to internal operations
City of Norfolk pumping station back up power is diesel generators		low threat to internal operations
		medium threat to internal operations
		high threat to internal operations

Appendix B: NOAA Climate-Related Funding Opportunities

Every year the National Oceanic and Atmospheric Administration (NOAA) compiles a summary of climate-related funding opportunities. The following document provides a snapshot of what was available as of January 15, 2016 across the government agencies and non-governmental organizations.

APPENDIX I-2

NOAA Climate Funding Opportunities

Climate Funding Opportunities*

This document provides a snapshot of what is currently available (as of January 15, 2016). Future grant opportunities are contingent upon funding appropriations.

National-Scale Opportunities

National Science Foundation (NSF)

Science, Engineering, and Education for Sustainability (NSF-wide investment area)

The National Science Foundation's Science, Engineering, and Education for Sustainability (SEES) program addresses the challenge of building a sustainable future through promoting research and education. This sustainability program is expected to extend into Fiscal Year (FY) 2016, with continuing research efforts to include global community sustainability; sustainable energy; modeling; vulnerability, resilience, and sensitivity to regional change; and public engagement. Since the program is an NSF-wide investment area rather than an individual program, applicants are encouraged to check for updates to the collection of new and existing activities. Programs of interest include the Climate Change Education Partnership Program, the Ocean Acidification program, the Coastal SEES program, and the Water Sustainability and Climate program.

Eligibility: Unrestricted

nsf.gov/funding/pgm_summ.jsp?pims_id=504707

National Science Foundation

Long Term Research in Environmental Biology

Program Solicitation: NSF 14-507

The Long Term Research in Environmental Biology program, through the National Science Foundation, addresses a problem faced by many investigators, which is that typical funding awards do not have time frames long enough to address long-term, data-driven research proposals. These awards are designed to provide funding to maintain an ongoing, long-term research project for a period of a decade or even longer. The solicitation includes a list of potential thematic areas for research proposals. This list includes, but is not limited to, research relating to external forcing functions such as climatic cycles that operate over long-return intervals. Awards are not to exceed $90,000 total per year and $450,000 over a five-year effort. The foundation anticipates making six awards annually, pending availability of funds. The solicitation outlines renewal procedures following the initial award.

The application deadline for 2016 full proposals is **5:00 p.m. proposer's local time on August 2, 2016**.

nsf.gov/funding/pgm_summ.jsp?pims_id=13544

National Science Foundation

Paleo Perspectives on Climate Change program

Program Solicitation: 13-574

The National Science Foundation's Paleo Perspectives on Climate Change program uses key geological, chemical, and biological records of climate system variability to provide insight on rates of change that characterized Earth's historical climate variability, the responses of key Earth system components, and the sensitivity of Earth's climate system to forcing changes. The scientific objectives are to 1) provide comprehensive paleoclimate data sets that can serve as model test data sets analogous to instrumental observations; and 2) enable transformative syntheses of paleoclimate data and modeling outcomes to understand the response of the long-term variability of Earth's climate system. The foundation will award 35 grants, with a typical award duration of three years. Approximately $11 million will be available each year, pending funding availability.

Eligibility: Unrestricted

The application deadline is **5:00 p.m. proposer's local time on October 17, 2016**

nsf.gov/funding/pgm_summ.jsp?pims_id=5750

National Science Foundation

Infrastructure Management and Extreme Events

Program Solicitation: 15-1638

The National Science Foundation's Infrastructure Management and Extreme Events program supports fundamental, multidisciplinary research on the impact of hazards and extreme events upon civil infrastructure and society. The program's research portfolio focuses on four core areas: mitigation, preparedness, response, and recovery. In addition, community and societal resilience, as well as sustainability, are important to the research portfolio of the program. The program does not support day-to-day operation of infrastructure systems. Examples of activities eligible for funding under each core area are included in the website.

Eligibility: Unrestricted.

The full proposal window is **February 1 to February 16, 2016**.

nsf.gov/funding/pgm_summ.jsp?pims_id=13353

National Science Foundation

Environmental Engineering

Funding Opportunity Number: PD-14-1440

The Environmental Engineering program encourages research applying scientific and engineering principles to avoid or minimize the impacts of solid, liquid, and gaseous discharges on land, inland and coastal waters, and air. The priority funding areas include 1) enhancing the availability of high quality water supplies; 2) developing innovative biological, chemical, and physical water treatment processes; 3) investigating processes that remove and degrade contaminants, remediate contaminated soils and groundwater, and convert waste waters into water suitable for reuse; 4) investigating environmental engineering aspects of urban watersheds, reservoirs, estuaries, and stormwater management; and 5) investigating biogeochemical and transport processes driving water quality in the aquatic and subsurface environment.

Eligibility: Unrestricted

The full proposal is due on **October 20, 2016.**

nsf.gov/funding/pgm_summ.jsp?pims_id=501029

National Science Foundation

Environmental Sustainability

Funding Opportunity Number: PD-15-7643

The Environmental Sustainability program promotes sustainably engineered systems that support human well-being and that are also compatible with sustaining natural systems. This program has four principal research areas, including industrial ecology, green engineering, ecological engineering, and Earth systems engineering. Climate change adaptation research is a component of the Earth systems engineering research area. Proposals should involve at least one graduate student as well as undergraduates. Proposals that incorporate aspects of social, behavioral, and economic sciences into these engineering research areas are welcomed.

Eligibility: Unrestricted

The full proposal is due on **October 20, 2016**.

nsf.gov/funding/pgm_summ.jsp?pims_id=501027

Department of Commerce: National Oceanic and Atmospheric Administration

Climate Program Office FY2016

Federal Opportunity Number: NOAA-OAR-CPO-2016-2004413

The NOAA Climate Program Office manages a program in which NOAA funds high-priority climate science to advance understanding of Earth's climate system. The research funded through this program contributes to the scientific understanding of how climate variability affects our health, economy, and well-being. The grant activities managed by this office are organized into four programs, including climate observation; Earth system science; modeling, analysis, predictions, and projections; and climate and societal interactions. Potential applicants can access information through the website below.

While the deadline for letters of intent has passed, interested applicants should reference the Climate Program Office website for updates on future funding availability.

cpo.noaa.gov/ClimatePrograms.aspx

Department of Commerce: National Oceanic and Atmospheric Administration

Strengthening the Public's or K-12 Student's Environmental Literacy for Community Resilience

Funding Opportunity Number: NOAA-SEC-OED-2016-2004737

The NOAA Office of Education's Environmental Literacy Grants supports projects that help to educate a diverse pool of educators and students on using Earth systems science to improve ocean and coastal stewardship and increase hazard resilience. The target audiences for this funding opportunity include the public, K-12 students, and informal educators (e.g., interpreters and docents). All projects must be implemented in the U.S. and its territories and must have a detailed evaluation plan, including metrics to measure the project's progress toward meeting project goals and objectives. NOAA anticipates approximately $2 million will be available for funding four to eight projects in the form of cooperative agreements.

Eligibility: institutions of higher learning; nonprofits (including museums, zoos, aquariums); K-12 public and independent schools; and state, local, and tribal governments.

Application deadline is **February 8, 2016 at 11:59 p.m. Eastern time**.

grants.gov/web/grants/view-opportunity.html?oppId=280298

Department of the Interior: Bureau of Indian Affairs

Program to Identify and Address Tribal Climate Change Science Needs for Improved Climate Change Adaptation – Tribal Climate Science Liaisons

Funding Opportunity Number BIA-CLIMATE-16-0001

Recognizing the need for climate information to improve resilience-based decision making by tribal organizations, the Department of the Interior is soliciting cooperative agreement proposals to hire tribal climate liaisons to address tribal climate change science needs. The Bureau of Indian Affairs will evaluate all proposals and will select tribal organizations to hire five to seven tribal climate science liaisons to be housed in one of the seven U.S. Geological Survey Climate Science Centers.

Eligibility: Tribal nongovernmental organization or tribally-controlled college or university.

Application deadline is **February 12, 2016 at 5:00 p.m. Eastern time.**

grants.gov/web/grants/view-opportunity.html?oppId=280480

Department of the Interior: U.S. Fish and Wildlife Service

Competitive State Wildlife Grants Program

Funding Opportunity Number F16AS00038

The Competitive State Wildlife Grants Program offers states, the District of Columbia, and territories funding for the development of wildlife and habitat conservation planning and implementation. Planning and implementation activities must contribute directly to each state's Wildlife Action Plan (as approved by the U.S. Fish and Wildlife Service). Applicants are encouraged to align proposed conservation actions with recommendations from the U.S. Fish and Wildlife Service's Climate Adaptation Strategy. Only Hawaii, Alaska, and other insular jurisdictions of the U.S. are allowed to propose projects benefiting only one state. For all other states, the maximum award for multi-state projects is $500,000, with a minimum award of $50,000. Total funding for this program is dependent on appropriations.

Eligibility: Agencies with lead management responsibility for fish and wildlife resources in each of the 50 states, the District of Columbia, and U.S. territories.

Applications must be submitted by **11:59 p.m. Eastern time on February 19, 2016**.

grants.gov/web/grants/view-opportunity.html?oppId=280174

Department of the Interior: U.S. Geological Survey

Water Resources Research National Competitive Grants Program

Funding Opportunity Number: G16AS00016

The U.S. Geological Survey, in cooperation with the National Institutes for Water Resources, is requesting proposals for matching grants to support research on the topic of improving and enhancing the nation's water supply. This opportunity supports research to better understand the changes in quantity and quality of water resources in response to a changing climate, population shifts, and land use changes. Projects may be one to three years in duration and applicants may request up to $250,000 total in federal funds. Applicants must provide a 1:1 funding match.

Eligibility: Every Water Research Institute and Water Research Center is eligible; also eligible are U.S. investigators from higher learning institutes who apply through a Water Research Institute or Water Research Center. The application deadline is **February 25, 2016 at 5:00 p.m. Eastern time**.

grants.gov/web/grants/view-opportunity.html?oppId=280446

Department of the Interior: U.S. Fish and Wildlife Service

Cooperative Endangered Species Conservation Fund

Funding Opportunity Number: F16AS00074

Recognizing that more than half of all species listed as endangered or threatened spend at least part of their life cycle on private land, the U.S. Fish and Wildlife Service began working with private landowners to foster stewardship on private lands. To encourage this cooperation, the service has four grant programs available through the Cooperative Endangered Species Conservation Fund. These programs include Traditional Conservation Grants, Habitat Conservation Planning Assistance Grants, Habitat Conservation Plan Land Acquisition Grants, and Recovery Land Acquisition Grants. The service is receiving approximately $53.5 million for these four programs.

Eligibility: Participation in this conservation fund is only available to state agencies that have a current cooperative agreement with the U.S. Department of the Interior; however, individuals or groups (e.g., cities, land conservancies, counties, and others) may work with a state agency on conservation efforts as a sub-grantee.

Application deadline is **March 18, 2016**.

grants.gov/web/grants/view-opportunity.html?oppId=280853

U.S. Department of the Interior: U.S. Fish and Wildlife Service

Coastal Program

The U.S. Fish and Wildlife Service's Coastal Program is a voluntary, incentive-based program that provides technical and financial assistance to coastal communities for the purpose of restoring and protecting fish and wildlife habitat on public and private lands. The program periodically provides funding opportunities for technical assistance as well as for project work. Interested applicants should check the program's website regularly for funding opportunity updates.

fws.gov/coastal

Federal Emergency Management Agency

FY15 Flood Mitigation Assistance and Pre-Disaster Mitigation Grants

The Federal Emergency Management Agency administers grant programs that provide funding for mitigation activities aimed at reducing disaster losses and protecting life and property from future disaster damages. These programs include the Flood Mitigation Assistance Program (which provides funds to reduce the risk of flood damage to buildings that are insured under the National Flood Insurance Program) and the Pre-Disaster Mitigation Program (which provides funds for hazard mitigation planning and projects on an annual basis).

Eligibility: State and tribal governments (local governments must apply through their state).

The application deadlines for the FY 2015 Flood Mitigation Assistance and Pre-Disaster Mitigation opportunities have passed. Interested applicants should check the agency's website for updates regarding future funding through these programs.

fema.gov/hazard-mitigation-assistance

Georgetown Climate Center

Federal Funding Compendium for Urban Heat Adaptation – Published December 2013

The Georgetown Climate Center produced an in-depth document that collected and analyzed information relating to 44 separate federal programs that support cities and states in reducing the impacts of urban heat. While federal funding sources are often dependent on appropriations, this list provides interested applicants with a great resource for finding federal funding opportunities for climate-related work. Two sections of specific interest include the environment section (which focuses on monitoring and improving water quality, conserving habitats, protecting green or open spaces, and the effects of air pollution) as well as the public health section (which covers government programs providing resources to promote the health and safety of populations vulnerable to effects of climate change).

A full description and link to the document is available on the Georgetown Climate Center website:
georgetownclimate.org/federal-funding-compendium-for-urban-heat-adaptation

Florida Climate Institute

The Florida Climate Institute is a network of research and public organizations, scientists, and individuals supported by seven member universities throughout Florida. While the support stems from these universities, some programs and activities have a nationwide scope. The institute maintains a list of available funding opportunities for climate-related work on its website, which includes public sector and private sector funding opportunities.

floridaclimateinstitute.org/opportunities/funding

University of Oregon

The Tribal Climate Change Funding and Program Guide

This funding guide is an online inventory of information on grants and programs that can assist tribes in addressing climate change issues and impacts. The inventory provides information on grants originating from many different sectors, all of which include tribes or tribal organizations as eligible applicants. The online inventory is available through the link below.

envs.uoregon.edu/tribal-climate

Oregon State University

Funding Opportunity Database

The Oregon State University College of Agriculture Sciences hosts a database of agriculture-related research funding opportunities primarily culled from *Grants.gov*, foundations, and other grant compilation websites such as Grant Forward (*GrantForward.com*). Given that climate change is a multi-disciplinary issue, there are many funding opportunities listed in this up-to-date website that relate to climate change impacts on agriculture resources.

agsci.oregonstate.edu/research/fo

The Wildlife Conservation Society's Climate Adaptation Fund

In 2015, the Wildlife Conservation Society provided one- to two-year grants ranging from $50,000 to $250,000 for on-the-ground projects that focus on implementing conservation actions for climate adaptation at a landscape scale. The grants required a 1:1 match with a maximum of 50 percent of match funding from in-kind sources. The organization released its 2015 request for proposals in winter 2015 for the Climate Adaptation Fund. Additionally, the Climate Adaptation Fund also provides technical assistance through trainings, such as the training held in October 2015 named the "Climate Adaptation for Conservation Training and Coaching Session." Interested applicants should check the program's website for updates on future grant and training opportunities.

Eligibility: U.S.-based (all 50 states and six territories) nonprofit organizations with approved IRS 501(c)(3) status. Public agencies, tribal governments, and universities can partner with eligible nonprofits to submit proposals.

wcsnorthamerica.org/ClimateAdaptationFund

Climate Solutions University

The Climate Solutions University aids local rural communities connected through a peer-learning network by offering training, expertise, and support in climate adaptation planning. Through this training, expertise, and support, the organization strengthens local leadership, public engagement, and ecosystem protection efforts. In the past, the organization has offered two distance-learning programs: the Climate Adaptation Plan Development Program and Climate Adaptation Plan Implementation Program. The development program results in a local climate adaptation plan (focusing on forest and water resource resilience). The implementation plan supports participants in moving the plan into action. Each program typically has eight positions available. Each participating community receives ~$100,000 in training, mentoring, and access to tools and resources. However, communities must commit $5,000 of shared cost in the form of staff time and related resources.

Eligibility: Regional nonprofit organizations with (501 (c)(3) status; local, county, or municipal governments; and state or federal organizations (encouraged to participate with local agencies). Individuals cannot apply.

There is no strict application deadline, as applications are accepted on a continual basis.

mfpp.org/csu

The Lawrence Foundation

The Lawrence Foundation supports environmental and human services as well as other causes. The foundation offers both program and operating grants, with awards occurring twice per year.

Eligibility: Nonprofit organizations with 501(c)(3) status with the Internal Revenue Service as well as public schools and libraries.

The application deadline is **April 30, 2016** via the foundation's online grant portal.

thelawrencefoundation.org/grants/guidelines.php

The Doris Duke Charitable Foundation

The foundation's environmental program awards grants in four main areas. These areas include: 1) land conservation in an era of climate change; 2) wildlife and energy development; 3) strengthening the conservation field; and 4) environmental stewardship in the tri-state area of New York, New Jersey, and Connecticut. The foundation typically provides funding support through a series of invited proposals. Unsolicited proposals are not considered by the foundation. Information about future opportunities can be requested through a letter of inquiry, which is described on the webpage below.

Funding is limited to the U.S. Also, the foundation does not support green building projects (construction capital) or projects focusing on marine environments, toxics remediation, litigation, filmmaking, individual research, or scholarships

ddcf.org/what-we-fund/environment/

The Rockefeller Family Fund

This foundation's environment program is currently focusing on the challenges of climate change. The program emphasizes public education on the risks of global warming as well as the implementation of sound solutions. The program is striving to achieve these goals through its Climate Policy and National Coal Campaign initiatives. Grant applicants must first create an account to determine eligibility. Eligible applicants may then submit a letter of inquiry online through the fund's online application portal. The fund does not ordinarily consider projects pertaining to a single community, unless the project advances a national issue or can serve as a national model.

Eligibility: U.S. tax-exempt organizations engaged in activities of national significance. For-profit businesses are **not** eligible

Program information: *rffund.org/programs/environment*

The Kresge Foundation

This foundation's environment program launched an initiative that funds community-driven efforts directing support toward 1) climate resilience in coastal cities and regions; 2) climate resilience and urban opportunity; 3) sustainable water-resources management in a changing climate; and 4) urban energy resilience. The Kresge Foundation provides funding through invited applications as well as unsolicited proposals.

Eligibility: U.S. based 501(c)(3) organizations (and Canadian equivalents). Government entities are also eligible.

Interested applicants should check with the website to stay informed of future funding opportunities.

Information about the environment program: *www.kresge.org/programs/environment*

Available funding opportunities *http://kresge.org/opportunities*

Surdna Foundation

This foundation invests in projects that support their program areas of sustainable environments, strong local economies, and thriving cultures. An example of a previous grant award is $200,000 to the Coalition to Restore Coastal Louisiana in FY 2010 to increase and strengthen local and national collaboration for the benefit of Louisiana coastal protection. Additionally, through the Urban Water Management program, the foundation supports innovative stormwater management projects that utilize green infrastructure. Organizations are eligible for a maximum of three consecutive years of funding.

Eligibility: U.S. based nonprofit organizations.

Applications are accepted on a rolling basis through the online system and are assessed within 90 days.

surdna.org/grants/grants-overview.html

Alfred P. Sloan Foundation

This foundation offers grant assistance in six major program areas, funding high-quality, original STEM (science, technology, engineering, and math) research that benefits the scientific community and increases public understanding of relevant and complex scientific issues. Two of these program areas are "basic research" and the "public understanding of science, technology, and economics," which promotes using books, television, radio, film, theatre, and other media in order to engage the public in science and technology. A grant applicant must first submit a letter of inquiry that outlines the idea of the grant, since the foundation does not accept unsolicited grant proposals. If accepted, the applicant will receive notice to submit a full proposal for evaluation.
Eligibility: The foundation does **not** make grants to individuals, for-profit institutions, endowments, fundraising drives, political campaigns, or lobbying efforts for or against legislation. Institutions of higher learning and government entities have received project funding in the past.
There are no application deadlines. The foundation makes grants year-round.
Grant process information: *sloan.org/apply-for-grants*

Regional-Scale Opportunities

U.S. Department of the Interior: U.S. Geological Survey

Cooperative Ecosystem Studies Units

The Cooperative Ecosystem Studies Units provide research, technical assistance, and education to federal land management, environmental, and research agencies and their partners. These organizations are part of a national network of 17 ecosystem studies units, each composed of federal agencies, a host university, and partner institutions. Several of these units currently have open-funding opportunities, many of which have application deadlines in the month of February 2016. For example, the Gulf Coast unit, the Rocky Mountains unit, and the Chesapeake Watershed unit all have funding opportunities with a closing date in February 2016. Interested applicants should check the information on the national Cooperative Ecosystem Studies Units network website for future funding updates.

Information about the national network: *cesu.psu.edu/about/about_cesu.htm*

Information about currently open opportunities: Search *Grants.gov* using acronym "CESU"

U.S. Department of the Interior: Landscape Conservation Cooperatives

Landscape Conservation Cooperatives are a network of partnerships working for the sustainability of America's land, water, wildlife, and cultural resources. Partnerships include federal, state, and local governments, tribes, universities, nonprofits, landowners, and other stakeholders. These cooperatives (21 in total representing different areas of the country) build upon existing science and conservation efforts that preserve water and land resources as well as cultural partnerships. Periodically the cooperatives offer grants that support their core functions. Interested applicants should check the website below for any upcoming funding opportunities.

fws.gov/science/SHC/lcc.html

U.S. Department of the Interior: Climate Science Centers

Managed through the National Climate Change and Wildlife Center, the Climate Science Centers provide scientific information, tools, and techniques that natural resource managers can apply to anticipate, monitor, and adapt to climate change impacts. There are eight such centers around the country (Alaska and the U.S. Pacific Islands, Northwest, Southwest, North Central, South Central, Northeast, and Southeast). These centers are located at partner universities. The Climate Science Centers work closely with Landscape Conservation Cooperatives so that the two can provide the science to support decision-making and apply that science to specific management challenges. Periodically, the centers offer grants that support research, forecasting, and modeling priorities. Interested applicants should check the website for information regarding upcoming funding opportunities within their local center.

doi.gov/csc/index.cfm

U.S. Department of the Interior: Bureau of Land Management

California King Range National Conservation Area Funding Opportunities

Funding Opportunity Numbers: L16AS00011 and L16AS00010

The Bureau of Land Management will work cooperatively with a nonprofit organization to implement several management activities within the California coast and the King Range National Conservation Area. These activities include long range planning, project implementation, and monitoring of restoration activities designed to restore Pacific salmon populations (Funding Opportunity Number L16AS00010), as well as working with a nonprofit organization to regularly conduct invasive weed surveys, early detection and rapid response protocols, and post-treatment monitoring (Funding Opportunity Number L16AS00011). The Invasive Weed Eradication funding opportunity has a minimum award of $500, with an estimated total allocation of $500,000. The Plant Conservation Program has a minimum award of $500, with an estimated total allocation of $1.5 million.

Eligibility: Nonprofits having a 501(c)(3) status with the Internal Revenue Service, other than institutions of higher learning.

Application deadline for both funding opportunities is **February 22, 2016**.

Funding Opportunity Number: L16AS00011:
grants.gov/web/grants/view-opportunity.html?oppId=280689
Funding Opportunity Number: L16AS00010:
grants.gov/web/grants/view-opportunity.html?oppId=280666

U.S. Department of Commerce: National Oceanic and Atmospheric Administration

The National Coastal Zone Management Program

Authorized by the Coastal Zone Management Act of 1972, the National Coastal Zone Management Program strengthens the capabilities of each participating state to address coastal issues. Currently 34 states participate in this program. These states follow basic requirements but also tailor their programs to address local issues. Occasionally, these state programs offer funding for climate- and resilience-related work in coastal areas. Interested applicants should check with their state coastal zone management offices about future funding or partnership opportunities.

coast.noaa.gov/czm

List of participating states: *coast.noaa.gov/czm/mystate*

U.S. Department of Commerce: National Oceanic and Atmospheric Administration

National Sea Grant College Program

The National Sea Grant College Program is a network of 33 programs in coastal U.S. states and territories that conducts research, extension, and education in order to carry out its mission of enhancing the practical use and conservation of coastal, marine, and Great Lakes resources. The program's focus areas include healthy coastal ecosystems, sustainable fisheries and aquaculture, resilient communities and economies, and environmental literacy and workforce development. In addition to providing outreach and education, Sea Grant programs often provide research funding opportunities to address local priorities. Interested applicants should check with their local Sea Grant office if interested in research funding opportunities or technical assistance and outreach related to the focus areas noted above.

seagrant.noaa.gov

List of state Sea Grant programs: *www.seagrant.noaa.gov/WhereWeWork/SeaGrantPrograms.aspx*

Freshwater Future

2015 Healing Our Waters Grant Program

Freshwater Future implements the Healing Our Waters-Great Lakes Coalition grant making program, which focuses funding on aquatic restoration efforts in the Great Lakes. In 2016, Freshwater Future is currently offering two grant programs through the coalition. The first is a federal project support grants program, which provides funding of up to $15,000 to aid implementation of federal government proposals through the Great Lakes Restoration Initiative. The second grant program is the Community Engagement Grants Program, which provides funding of up to $5,000 to community-scale groups to improve community engagement in federally funded restoration activities. Priority will be given to projects in the coalition's eight focus areas (Saint Louis River, Green Bay, Chicagoland, Saginaw Bay, Huron-Erie Corridor, Western Lake Erie, Eastern Lake Erie and Buffalo, and Eastern Lake Ontario).

Eligibility: Community based organizations that have applied or will be applying for Great Lakes Restoration Initiative funds or other federal funding sources. Successful applicants will also be 501 (c)(3) environmental, conservation, or community organizations.

freshwaterfuture.org/grants/healing-our-waters-grant-program

Great Lakes Protection Fund

The Great Lakes Protection Fund is welcoming brief pre-proposals to test new regional actions to protect and restore the ecological health of the Great Lakes. There are three themes that the fund is currently exploring, including 1) prototypes of insurance, assurance, and financial products for the ecosystem; 2) performance-based green infrastructure competition; and 3) smarter water and healthier lakes. In addition to these broad themes, the fund is also interested in hearing innovative ideas that might not fit into one of these broad themes.

The fund does not have formal deadlines for submitting pre-proposals. Rather, the fund suggests that interested applicants contact them to begin a conversation about potential work before any pre-proposals are generated.

glpf.org/get-funding

State Planning and Technical Assistance Grants

Often, state government agencies provide grant funding to public entities for the development of comprehensive planning documents—such as asset management plans or water resource plans—and in support of technical assistance projects. Two examples of such grants are the planning and technical assistance grants program through the Massachusetts Office of Energy and Environmental Affairs and the technical assistance and high-unit-cost grants available through the North Carolina Department of Environmental and Natural Resources. Both of these programs offer funding or technical assistance to communities within their state for the purpose of constructing, planning, or improving public water and wastewater systems. Interested applicants should check with their state water resources office to see if similar programs are available in their states. Links to further information on the Massachusetts state program is included below.

Planning and Technical Assistance Grants through the Massachusetts Office of Energy and Environmental Affairs:
mass.gov/eea/agencies/massdep/water/grants/planning-and-technical-assistance-grants.html

Sustain Our Great Lakes

2016 Request for Proposals

Sustain Our Great Lakes is a public-private partnership between Arcelor Mittal, the National Fish and Wildlife Foundation, and several U.S. federal entities (such as NOAA, the U.S. Fish and Wildlife Service, U.S. Environmental Protection Agency, U.S. Forest Service, and Natural Resources Conservation Service). This organization offers grant programs to promote both in-the-water and on-the-ground restoration and enhancement projects. In 2015, grant funding was awarded in two categories: stream and riparian restoration and coastal wetland restoration. A further description of work supported through the two categories can be found in the request for proposals (available through the link below). Grants typically support two-year projects, with awards ranging between $50,000 and $1.5 million. Approximately $5 million to $7 million will be available for this opportunity.

Eligibility: Nonprofit 501(c)(3) organizations; local, state, tribal, and provincial governments; and education institutions. Federal agencies, individuals, and for-profit organizations are **not** eligible.

The 2016 deadline for pre-proposal submissions is **February 17, 2016**.
sustainourgreatlakes.org/apply/

Gaylord and Dorothy Donnelley Foundation

This foundation offers grant opportunities to advance work in land conservation and artistic vitality in the 13-county Chicago region of Illinois and the nine-county South Carolina Lowcountry. Eligible counties are shown on the regional maps link below. Land conservation efforts focus on 1) preserving, restoring, and protecting strategic lands that contribute to regional ecosystem health; 2) building and supporting constituencies that value land stewardship by sustaining appropriate land uses (such as limiting sprawl and fostering regional land use planning); and 3) engaging young people with the natural world. If applicants believe that their project fits the foundation's interests, they must submit an application (rather than a formal proposal or letter of inquiry). If unsure, contact the organization's grant manager.

Eligibility: The foundation does not typically make grants to public entities (therefore, unsolicited proposals are not accepted). Public entities should contact the foundation to discuss a project. Also, nonprofit groups, such as a Type III organization under 509(a)3), are not eligible.

Application deadline is **April 8, 2016** for review at the July 2016 board meeting.

Regional maps: *gddf.org/about/where-we-work*

Grant information: *gddf.org/land-conservation/lowcountry/guidelines*

The Fred A. and Barbara M. Erb Family Foundation

This foundation supports funding opportunities in the area of Detroit, Michigan (Wayne, Oakland, and Macomb counties). Funds award work to improve water quality in the watersheds affecting metro Detroit and Bayfield, Ontario. The foundation supports efforts to restore ecological integrity in these watersheds by emphasizing local implementation of regional Great Lakes strategies for reducing nonpoint source pollution and promoting water conservation and efficiency.

Letters of inquiry must be submitted through the foundation's website. The foundation's board meets four times per year to review grant requests (March, June, September, and December).

Eligibility: Nonprofit 501(c)(3) organizations

Application process: *erbff.org/application-process*

The Joyce Foundation

This foundation supports funding opportunities in Great Lakes protection and restoration that address the following areas: 1) the introduction and spread of invasive species in the Great Lakes basin; 2) polluted, nonpoint source runoff from agricultural lands and cities—and watershed-based investments such as green infrastructure for reducing nonpoint source pollution); and 3) funding of, and support for, Great Lakes restoration and protection policies (such as the implementation of the Great Lakes–St. Lawrence River Basin Water Resources Compact and work related to the Great Lakes Restoration Initiative). The foundation accepts grant inquiries throughout the year.

Eligibility: Nonprofit organizations

In order for the foundation's board of directors to consider a grant proposal at the July board meeting, the proposal submission deadline is **April 5, 2016**. Letters of inquiry must be submitted six to eight weeks before proposal deadline.

Application process: *joycefdn.org/apply*

Program information: *joycefdn.org/content.cfm/guidelines-3*

Bullitt Foundation

The mission of the Bullitt Foundation is to protect the natural environment through promotion of responsible human activities and sustainable development in the Pacific Northeast. The foundation's program areas include ecosystem services; energy, industry, and technology; urban ecology; and leadership and civic engagement. The foundation currently focuses grants on 10 different strategies: 1) fostering environmental coalitions and furthering collaboration; 2) encouraging strong partnerships between grantees and local groups in the private, public, and tribal sectors to achieve broad consensus on issues of public interest; 3) supporting state and regional offices of national environmental organizations whose resources lend expertise ensuring local efforts are coordinated with regional and national efforts; 4) supporting credible research, monitoring, and analysis to ensure advocacy campaigns are grounded in the best available science; and 5) developing and promoting appropriate messages for public education. Grant applicants must submit a letter of inquiry online.
Eligibility: Nonprofit organizations in the U.S. and Canadian Pacific Northwest (Washington, Oregon, Idaho, western Montana, British Columbia, and coastal Alaska from Cook Inlet to the Canadian border)
Letters of Inquiry are due by **March 15, 2016**. Grant applications are due by **May 1, 2015** through the online grantee portal.
bullitt.org/grants/grantmaking-process

Mary A. Crocker Trust

The Mary A. Crocker Trust is a charitable foundation located in San Francisco, California. The trust's environment program area supports waste management and recycling, water quality, land use management, and sustainable agriculture and forestry. The trust is primarily interested in Bay Area programs, with an annual award budget of approximately $500,000. Typical award amounts range between $10,000 and $25,000.
Eligibility: The trust does not fund individuals, annual campaigns, continuing support, deficit financing, or sectarian purposes.
The deadline for submitting a letter of interest is **February 19, 2016 at 5:00 p.m. Pacific Time**.
mactrust.org/home.html

The Russell Family Foundation

Environmental Education Program

The Russell Family Foundation Environmental Education Program aims to provide outdoor environmental education opportunities throughout their Puget Sound geographic focus area. Specifically, their geographic focus is on King, Kitsap, Thurston, and Pierce counties. This program targets students in grades 5 through 12 living in urbanized areas. Over the last 13 years, The foundation has contributed over $10.5 million to environmental education
Eligibility: Tax-exempt organizations as determined by the Internal Revenue Service.
A letter of inquiry must first be submitted and approved before a full proposal will be accepted. For the Environmental Education Program, letters of inquiry are due on July 18, 2016.
trff.org/apply

The George Gund Foundation

Based in Cleveland, Ohio, the George Gund Foundation has long-standing interests in the arts, economic development, community revitalization, education, human services, and the environment. The foundation pays special attention to climate change, noting that it "cuts across all of the foundation's programs." Through the environmental focus area, the foundation supports organizations that address environmental issues in Northeast Ohio as well as organizations that are working to preserve the Lake Erie ecosystem. Previous grants awarded through the environmental program in 2014 range from $5,000 to as much as $200,000 over two years.

Eligibility: 501(c)(3) organizations

Proposals are considered three times per year by the foundation's trustees. The proposal submission is **March 15, 2016** for consideration at the winter-spring trustee meeting.

gundfoundation.org/what-we-fund/program-guidelines

International Opportunities

The Rockefeller Foundation

One of the foundation's current initiatives is developing climate change resilience in the areas of Asian urban environments, African agriculture, and U.S. urban and environmental policies. As the foundation is a "proactive grantmaker," it does not accept proposals without staff member invitation. Grant seekers must submit a funding inquiry form.

Eligibility: The foundation partners with governments, foundations, donors, nongovernmental organizations, and private-sector groups.

rockefellerfoundation.org/our-work/initiatives/

The Kresge Foundation (reposted from National-Scale Opportunities section)

This foundation's environment program launched an initiative that funds community-driven efforts, directing support toward 1) climate resilience in coastal cities and regions; 2) climate resilience in low-income communities; 3) sustainable water-resources management in a changing climate; and 4) urban energy resilience. The Kresge Foundation provides funding through invited applications as well as unsolicited proposals.

Eligibility: U.S. based 501(c)(3) organizations (and Canadian equivalents). Government entities are also eligible. Interested applicants should check with the website to stay informed of future funding opportunities.

kresge.org/programs/environment

Federation of Canadian Municipalities

Green Municipal Fund

Through the Green Municipal Fund, the Federation of Canadian Municipalities funds the best examples of innovation in municipal sustainable development. The funded work must aim to achieve significant environmental impacts and have the potential to be replicated in other Canadian communities. The fund provides support for three types of initiatives (plans, studies, and projects) in five sectors of municipal activity (including brownfields, energy, transportation, waste, and air). For the "plans" and "studies" categories, the fund offers grants covering up to 50 percent of eligible costs to a maximum of $175,000. In the "projects" category, the fund offers below-market loans in combination with grants for capital projects, with a maximum loan amount of $10 milllion.

***Eligibility**:* Municipal governments and their partners (this includes cities, counties, regional governments, towns, townships, villages, local boards, regulatory authorities, and improvement districts).

Applications for funding are accepted on a rolling basis.

fcm.ca/home/programs/green-municipal-fund.htm

Environment and Climate Change Canada

Green Source Funding Database

Environment Canada hosts an online database of funding opportunities for organizations undertaking environmental projects. These opportunities include funding, in-kind donations, and labor-cost contributions. Through this database, Canadian communities and organizations can identify funding opportunities, which are organized by keyword, issue, and geography as well as by application deadline. The database contains opportunities for municipalities, academic institutions, nonprofit organizations, Aboriginal organizations, community groups, and individuals.

ec.gc.ca/financement-funding/default.asp?lang=En&n=768DAFB1-1

Environment and Climate Change Canada

EcoAction Community Funding Program

The EcoAction Community Funding Program is supported by Environment Canada and supports community groups completing projects that have measurable, positive impacts on the environment. The program supports project work addressing four main focus areas: 1) clean air (reducing emissions); 2) clean water (improving water quality); 3) climate change (reducing emissions as well as addressing impacts of climate change); and 4) nature (reducing biodiversity loss). Awards range up to $100,000, but Environment Canada requires that 50 percent of the total project value must come from non-federal sources. The maximum project length is 36 months.

Eligibility: Environmental groups, community groups, community-based associations, service clubs, and Aboriginal organizations. Businesses, academic institutions, individuals, and governments are **not** eligible.

The application deadline has passed, but interested applicants can check the website for future opportunities.

ec.gc.ca/ecoaction

APPENDIX J

Economic Impacts Working Group Membership

COMMITTEE NAME: Economic Impacts Advisory Group (EIAG)

COMMITTEE CHAIR(S) & AFFILIATION(S): Dr. Larry "Chip" Filer, Chair, Department of Economics at Old Dominion University and Associate Center for Economic Analysis and Policy (CEAP)

CURRENT COMMITTEE MEMBERSHIP:

Economic Impacts Advisory Group	June 6, 2017		
Larry Filer	Chair	lfiler@odu.edu	Chair, Department of Economics and Fellow, Center for Economic Analysis and Policy, Old Dominion University
Sarah Stafford	College of William and Mary	slfstaf@wm.edu	Professor of Public Policy, Economics and Law; Director of Public Policy Program
Bill Shobe	University of Virginia	Wms5f@eservices.virginia.edu	Professor of Public Policy
Ron Reck	George Washington University	rreck@email.gwu.edu	Director, Military and Veterans Affairs
Mark Rosenfield	Poseidon Capital	markr@poseidoncapitalllc.com	Partner
Walter Cole	Clark-Nexsen	wcole@clarknexsen.com	Department Director of Planning
David Pryor	Clarck-Nexsen	dpryor@clarknexsen.com	Director of Waterfront Engineering
Andy Hansz	Old Dominion University	jhansz@odu.edu	Robert M. Stanton Chair in Real Estate
Skip Stiles	Wetlands Watch	skip.stiles@wetlandswatch.org	Executive Director, Wetlands Watch
Kevin Sweeney	Hampton Roads Economic Alliance	KSweeney4@cox.net	Former Executive Director