Challenges and Lessons Learned from Coastal Flood Resilience Planning in Virginia Beach, VA

Brian Batten, Ph.D., CFM, Dewberry

Greg Johnson, PE, City of Virginia Beach, VA

Shanda Davenport, PE, AICP, City of Virginia Beach, VA

Outline

- Overview
- Motivation
- Approach
- Strategies
- Public Engagement
- Lessons Learned

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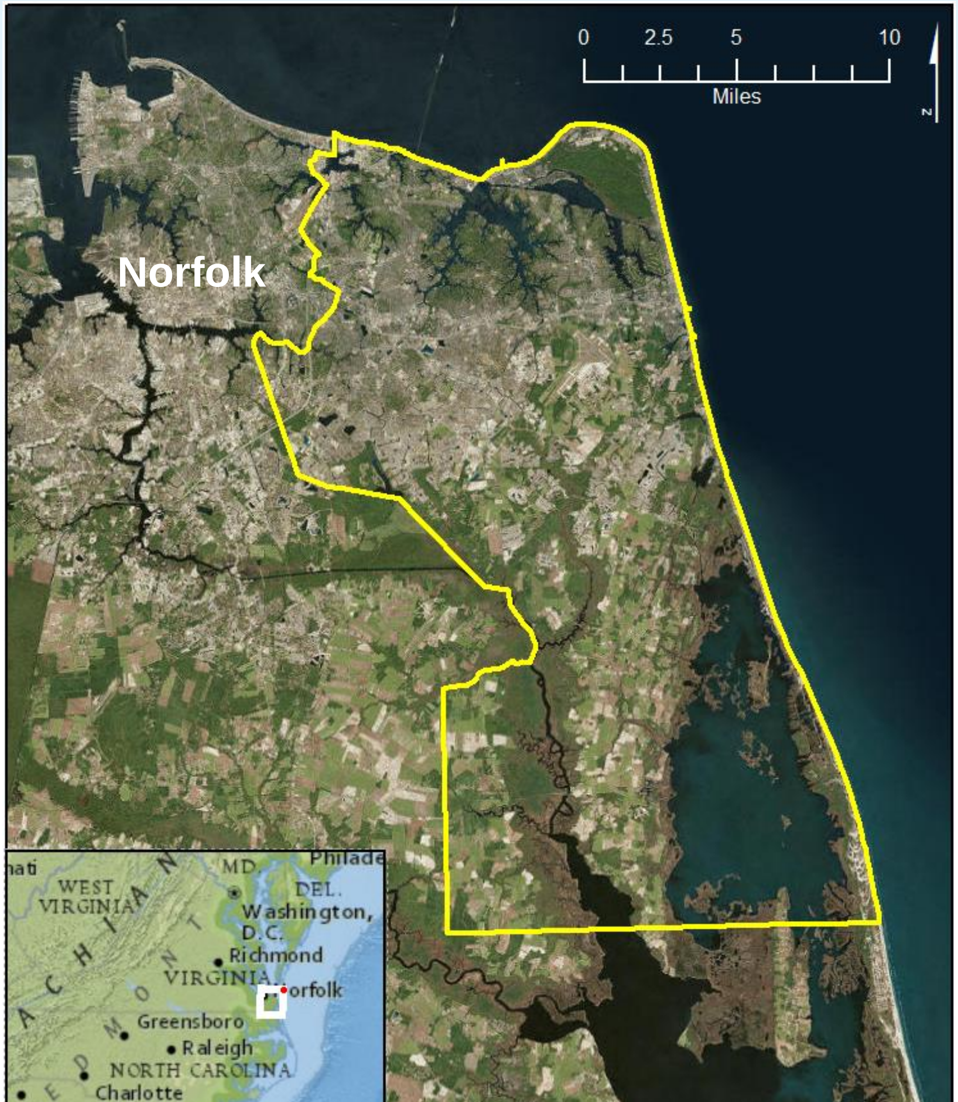
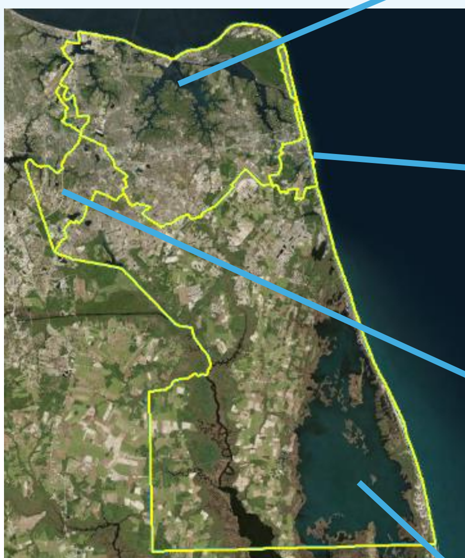
City of Virginia Beach

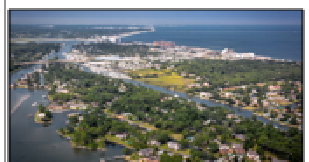
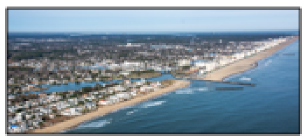
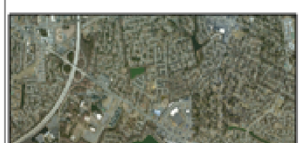


Fast Facts

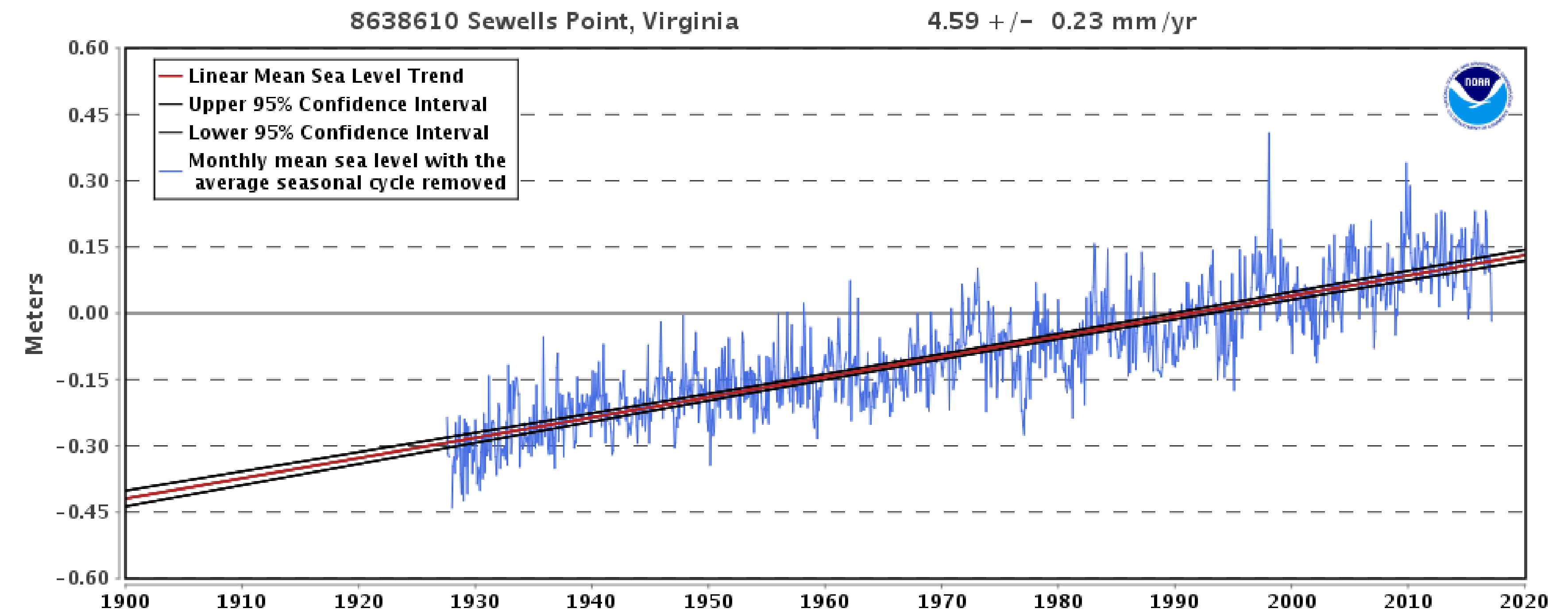
- Largest City in Virginia
  - Population: 440k
- Growth from 1970s-1990s
- 4 military bases
- Tourism and Defense Economy
- Top-ranked US city

Environmental, Land Use, Economic Diversity



Planning Area/ Natural Resources	Defining Characteristics	Challenges
Lynnhaven / Tidal sheltered bay, estuarine, fringing marsh 	Mixed residential, military, commercial, lower elevation properties with high tax base. High quality natural resources. Assets at vulnerable elevations.	Addressing repititive losses from recurrent flooding and preservation of low-lying natural resources.
Oceanfront / Ocean, headland beaches, tidal inlet, bay 	Dense commercial and residential development. Tourism as primary economic driver. Redevelopment opportunities. USACE Civil Works flood risk reduction project.	Protecting existing development and economic base while instilling resilience as a keystone in redevelopment.
Elizabeth River / Estuarine, fringing marshes 	Dense residential, commercial, industrial development. Aging infrastructure.	Upgrading infrastructure and maintaining water-based industrial economy with higher sea levels.
Southern / Ocean, barrier beaches, back bays and extensive marshes 	Light residential, military, rural, recreational, waterfowl and land preserves. Agriculture important economic concern. Low elevation gradients.	Establishing land use strategies that preserve resources and limit new development and infrastructure in areas susceptible to future flooding.

SLR and Recurrent Flooding



Last 50 years = ~0.9 ft increase in Hampton Roads

Acceleration and Future Trends

Boon et al. 2018

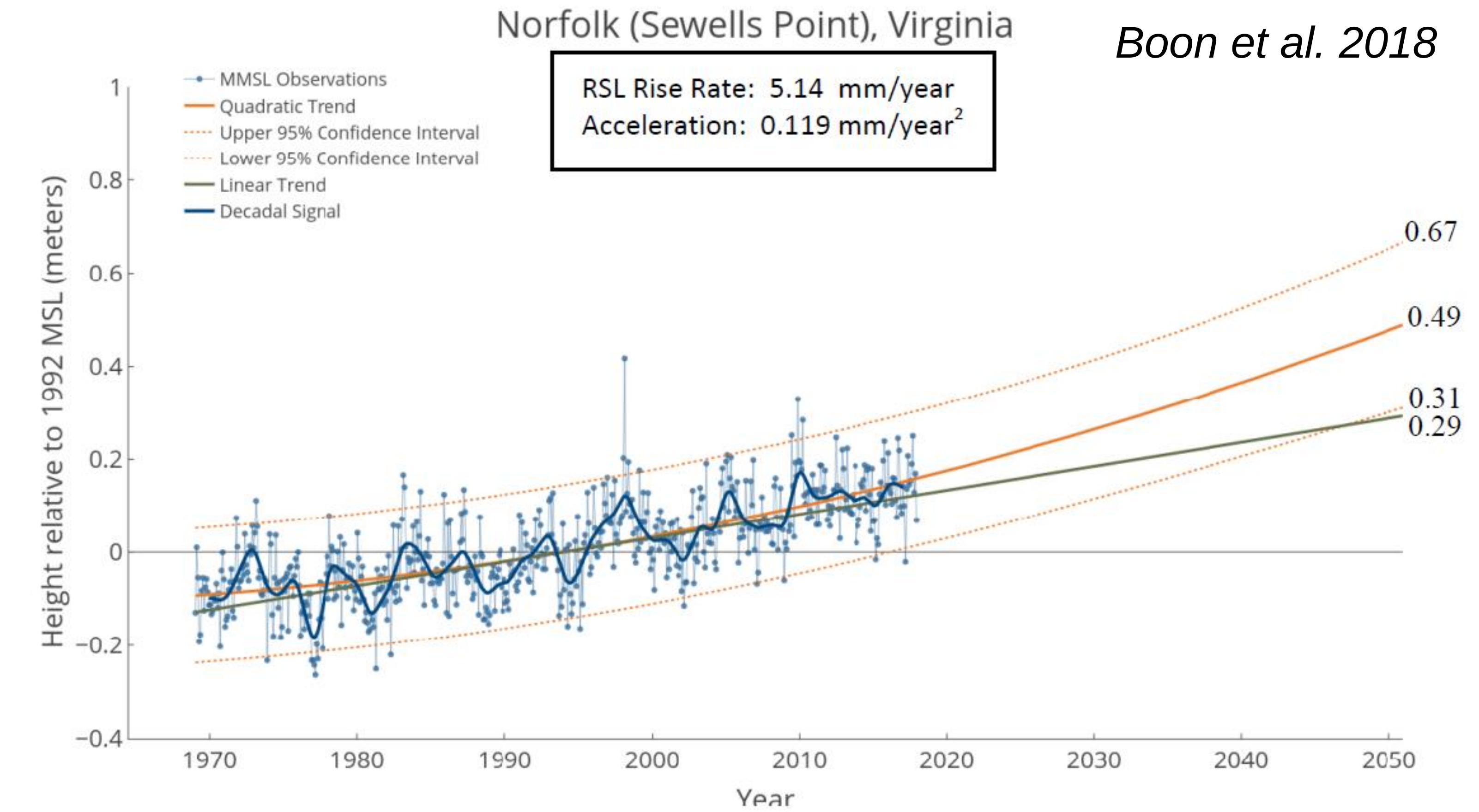
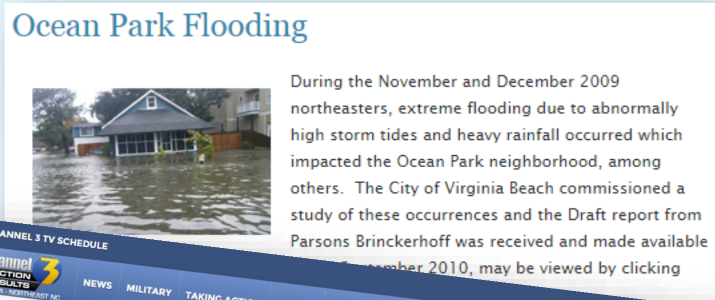


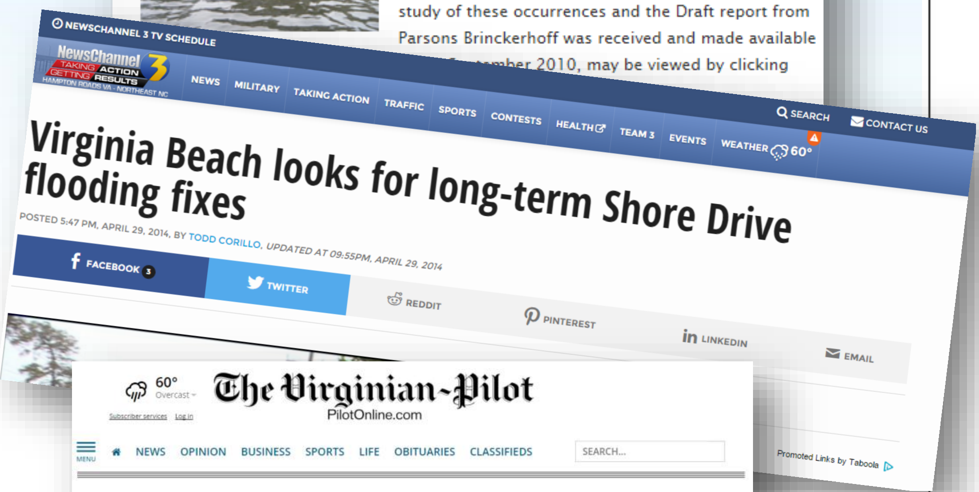
Figure III-4. Relative sea level trends, Norfolk, Virginia, 1969-2017 series

Flood Complaints



Ocean Park Flooding

During the November and December 2009 northeasters, extreme flooding due to abnormally high storm tides and heavy rainfall occurred which impacted the Ocean Park neighborhood, among others. The City of Virginia Beach commissioned a study of these occurrences and the Draft report from Parsons Brinckerhoff was received and made available …tember 2010, may be viewed by clicking



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Virginia Beach looks for long-term Shore Drive flooding fixes

POSTED 5:47 PM, APRIL 29, 2014, BY TODD CORILLO, UPDATED AT 09:55PM, APRIL 29, 2014

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Va. Beach residents seek answers about flooding

Selene D. Guerrero

Dec 3, 2012

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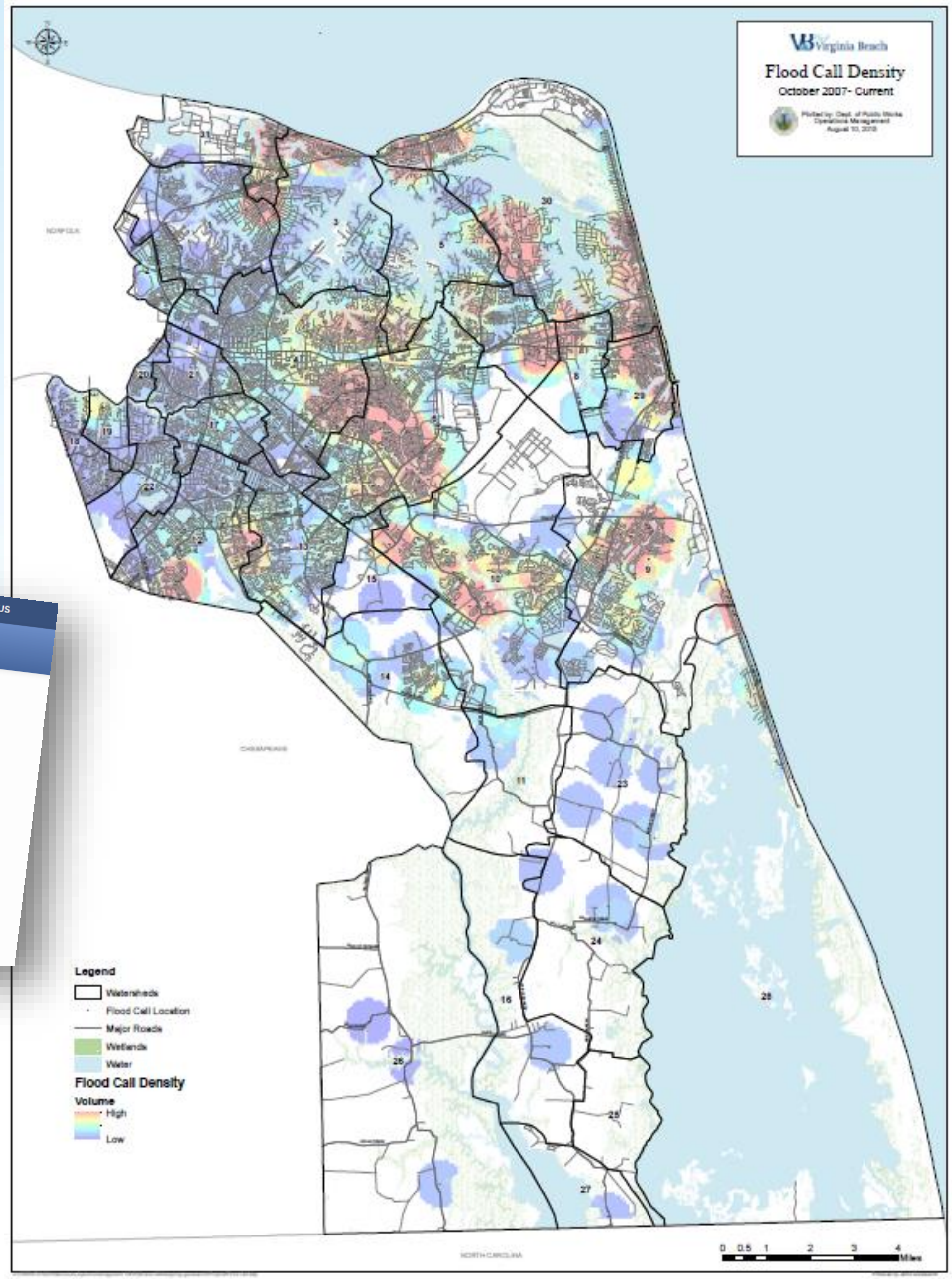

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Moody's Questionnaire to VB

- Does the existing/future CIP include spending for mitigation or resiliency?
- Has your governing body discussed the capital or financial implications of rising sea levels?
- Has there been an estimate on potential impacts from rising sea levels or flooding?
- Please discuss how flooding has impacted the city's budget and may impact future budgets?
- Have there been any zoning /long-term planning adjustments downtown and along the waterfront to mitigate future flooding impacts?
- What is management's current view on the potential impact/vulnerabilities in your community from rising sea levels and a heightened risk of extreme weather events?


Moody's Update/Coastal VA Credit Focus Review

Virginia Beach, VA

Analyst:

Bloomberg

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Moody's Warns Cities to Address Climate Risks or Face Downgrades

By Christopher Flavelle
November 29, 2017 4:00 AM
From Climate Changed

→ Communities in Texas, Florida, other coastal states at risk
→ Credit rating agency says it's adding climate to credit risks

VB Sea Level Wise
A vibrant future for Virginia Beach

Virginia Beach SLR Study

Goal:
Produce information and strategies that will enable Virginia Beach to establish long-term resilience to sea level rise and associated recurrent flooding

Objectives:

- **Establish** a full understanding of flood risk and anticipated changes over planning and infrastructure time horizons
- **Develop** risk-informed strategies, including engineered protection and policy to reduce short and long-term impacts
- **Produce** City-wide and watershed "action plans" for strategy implementation
- **Engage** in public outreach process to advance resilience initiatives

Comprehensive SLR Study Approach

3. Implementation
Planning the actions

2. Adaptation Strategies
Tailoring the solutions

1. Sea Level Rise/ Recurrent Flooding Impacts
Defining the problem

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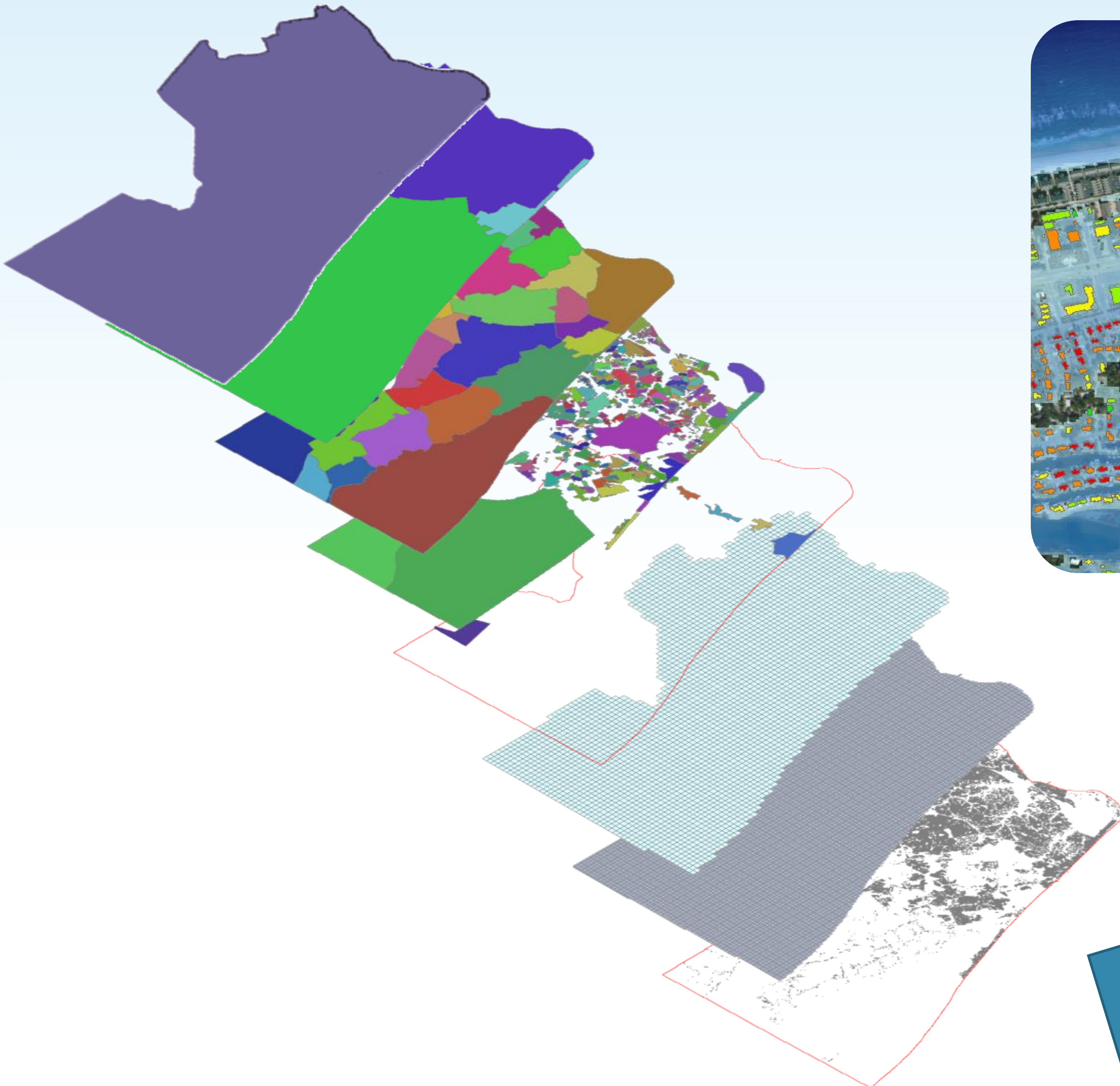
Risk communication to stakeholders



VB Sea Level Wise
A vibrant future for Virginia Beach

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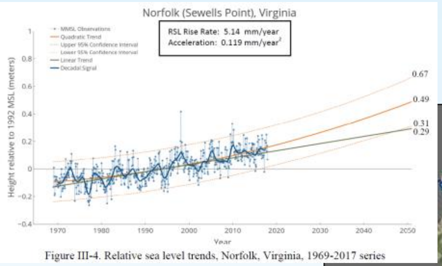
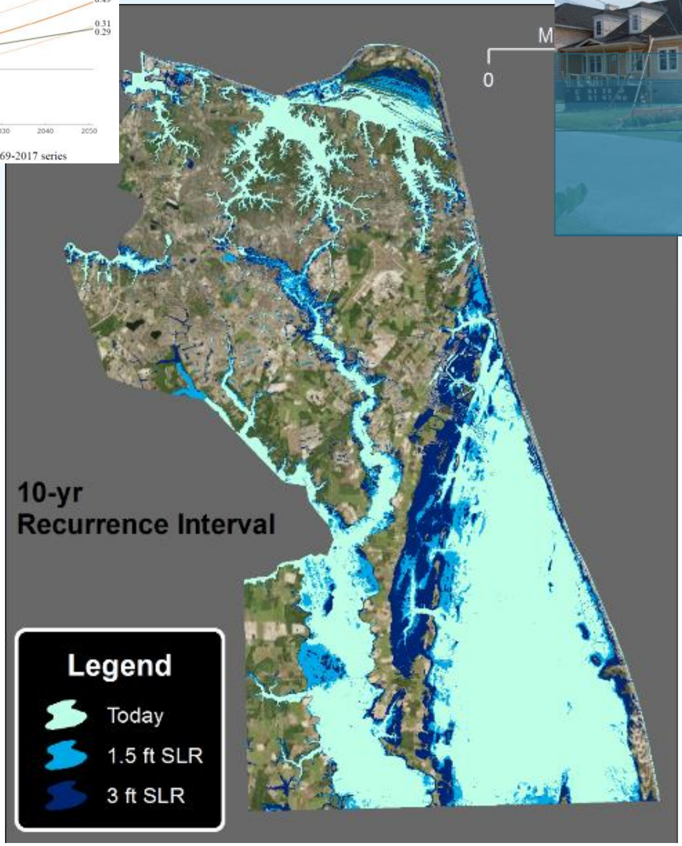
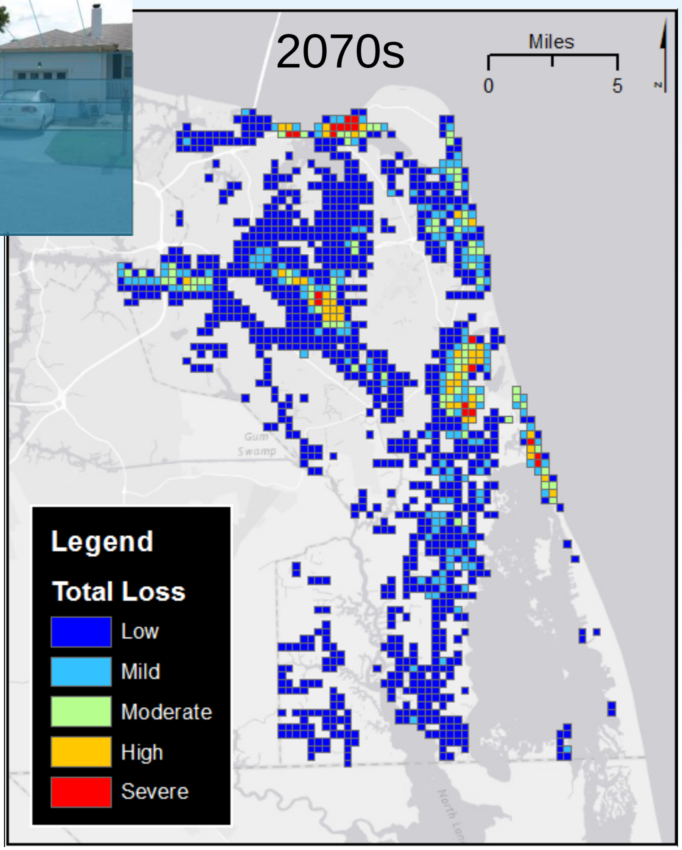
Hazard and Risk Assessment



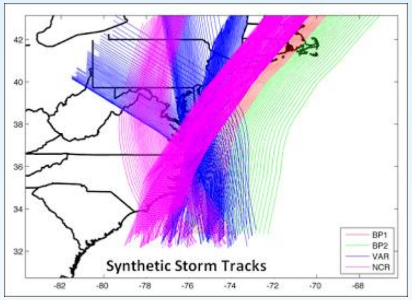




Hazard and Risk-driven Decision-Making

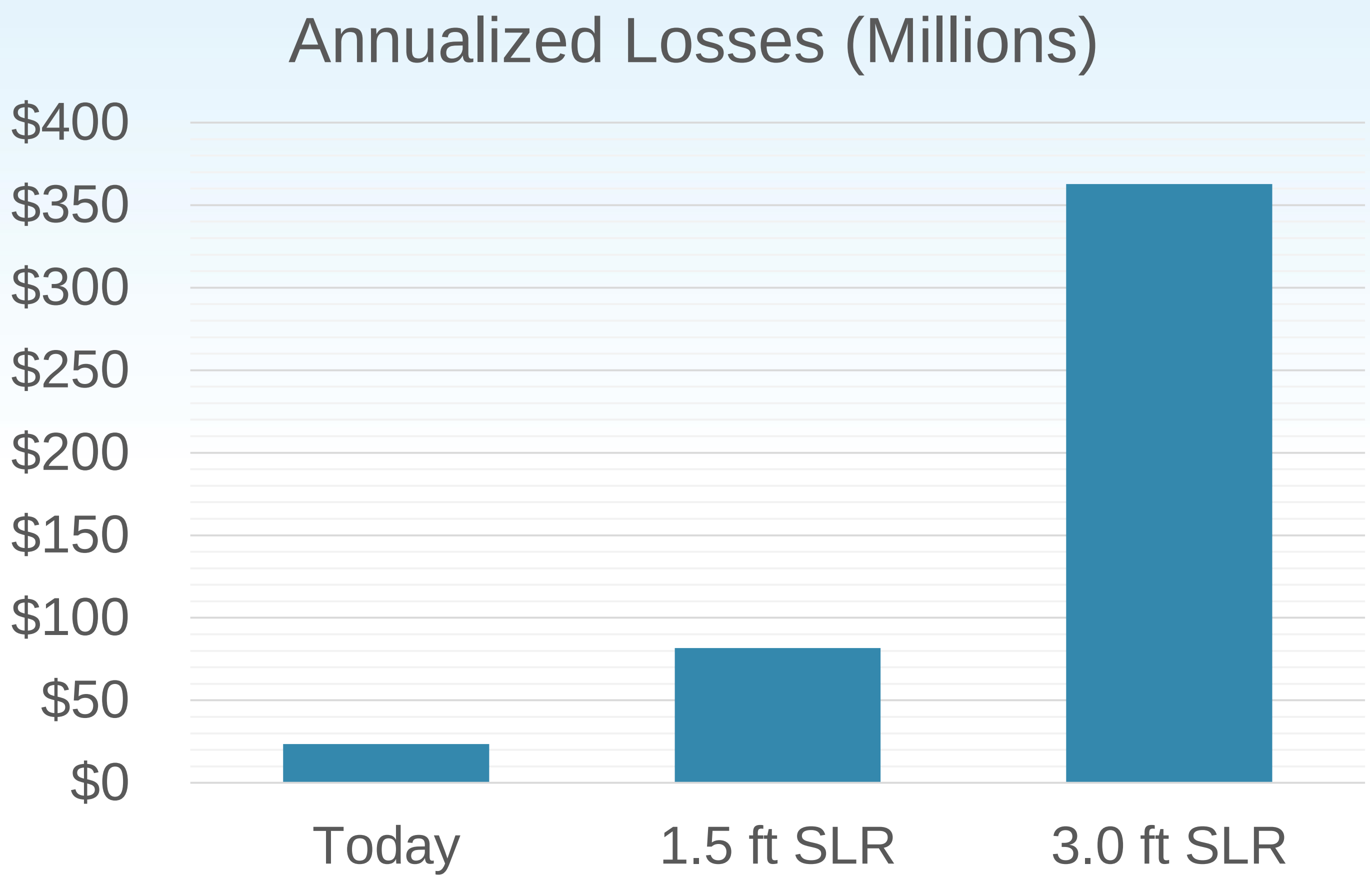
Risk Metric – Annualized Losses

- Expected monetary loss for any given year
- Based on event analysis, examined probabilities



Frequency	Impact	Loss Expectancy (Millions)	Annual Event Probability
Very High	Low	$52	10%
High	Moderate-Low	$133	4%
Moderate	Moderate	$240	2%
Low	Severe	$414	1%
Very Low	Catastrophic	$1,558	0.2%
			Total:

Projected Changes in Flood Loss



3.5x increase **15x increase**

4.4x increase over 1.5 ft

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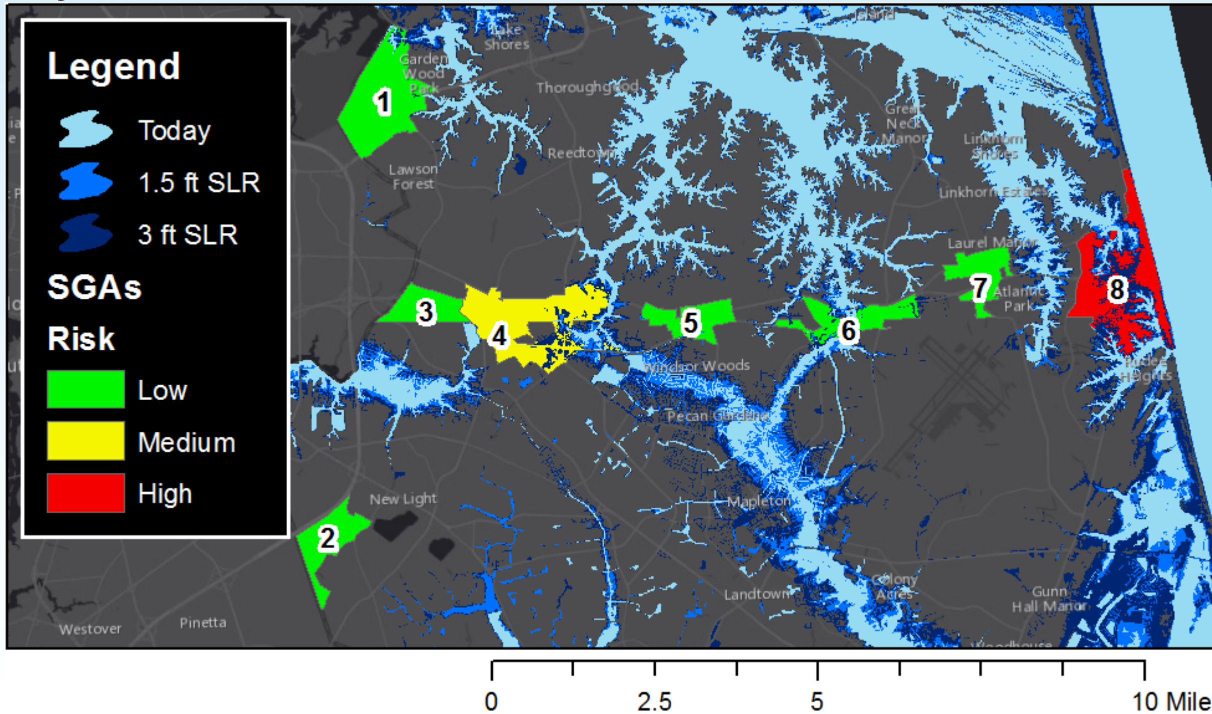
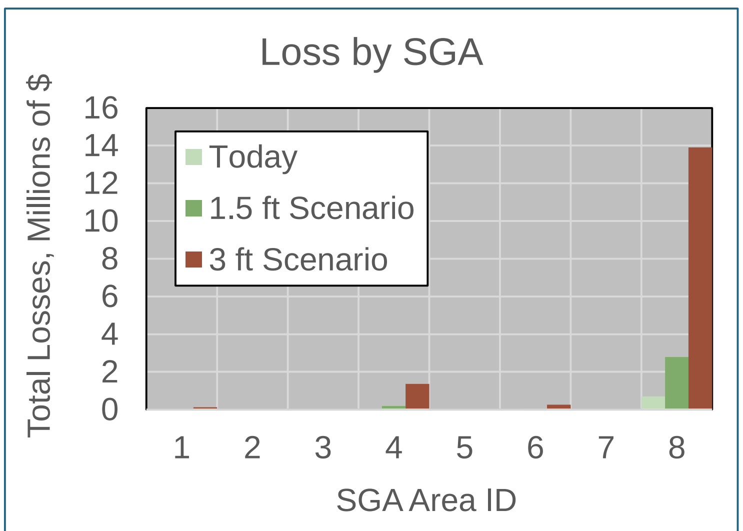
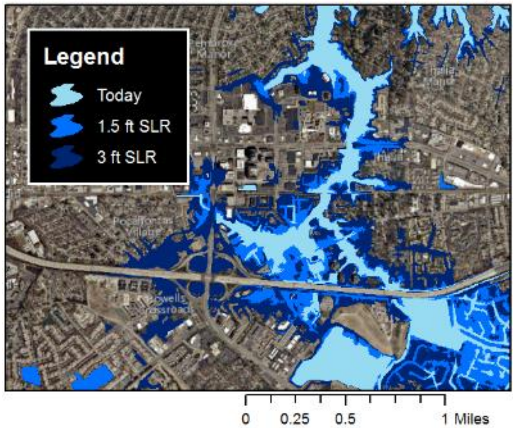
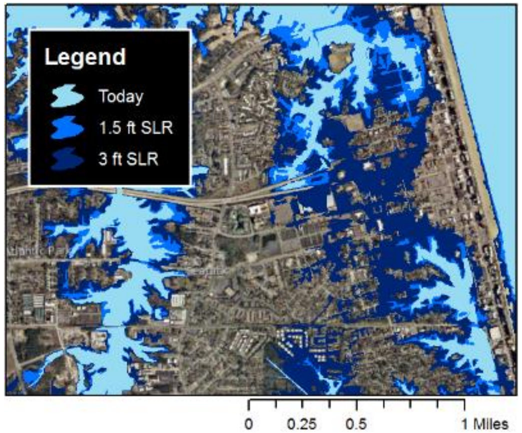
Strategic Growth Areas

50-yr recurrence interval flood, 3 ft SLR Scenario









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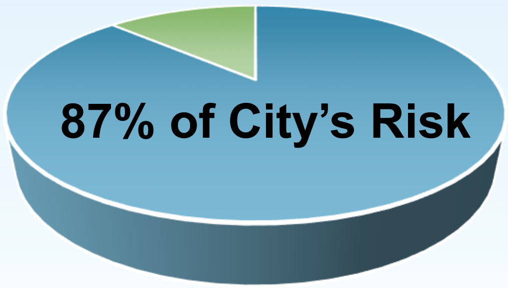
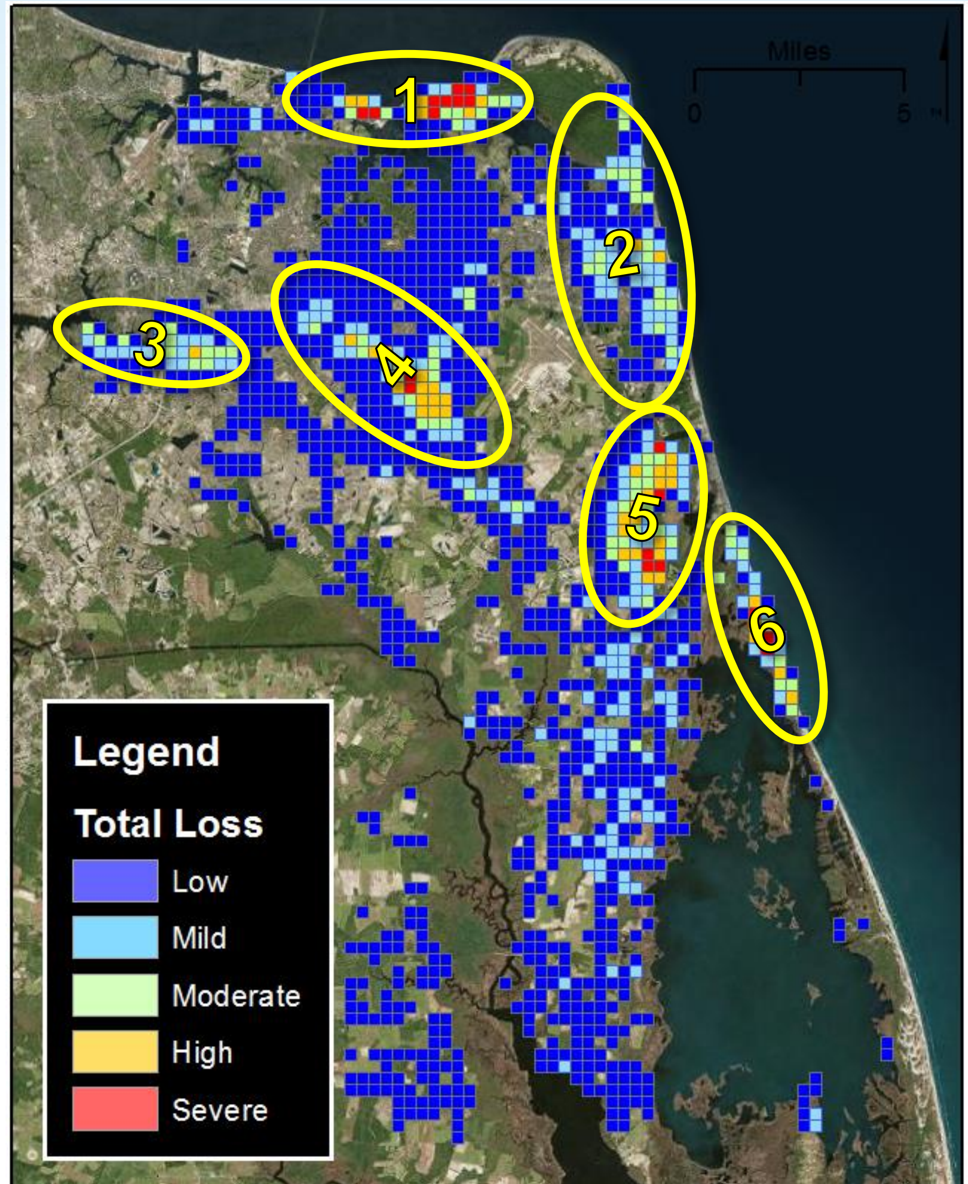
“Action Areas” for flood risk management

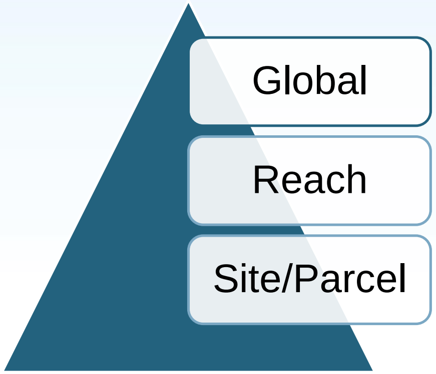


Percent of Total Loss		
Focus Area	Today	In 50 years
1	40%	15%
2	11%	12%
3	11%	6%
4	18%	18%
5	0%	22%
6	8%	9%



Structural Strategies

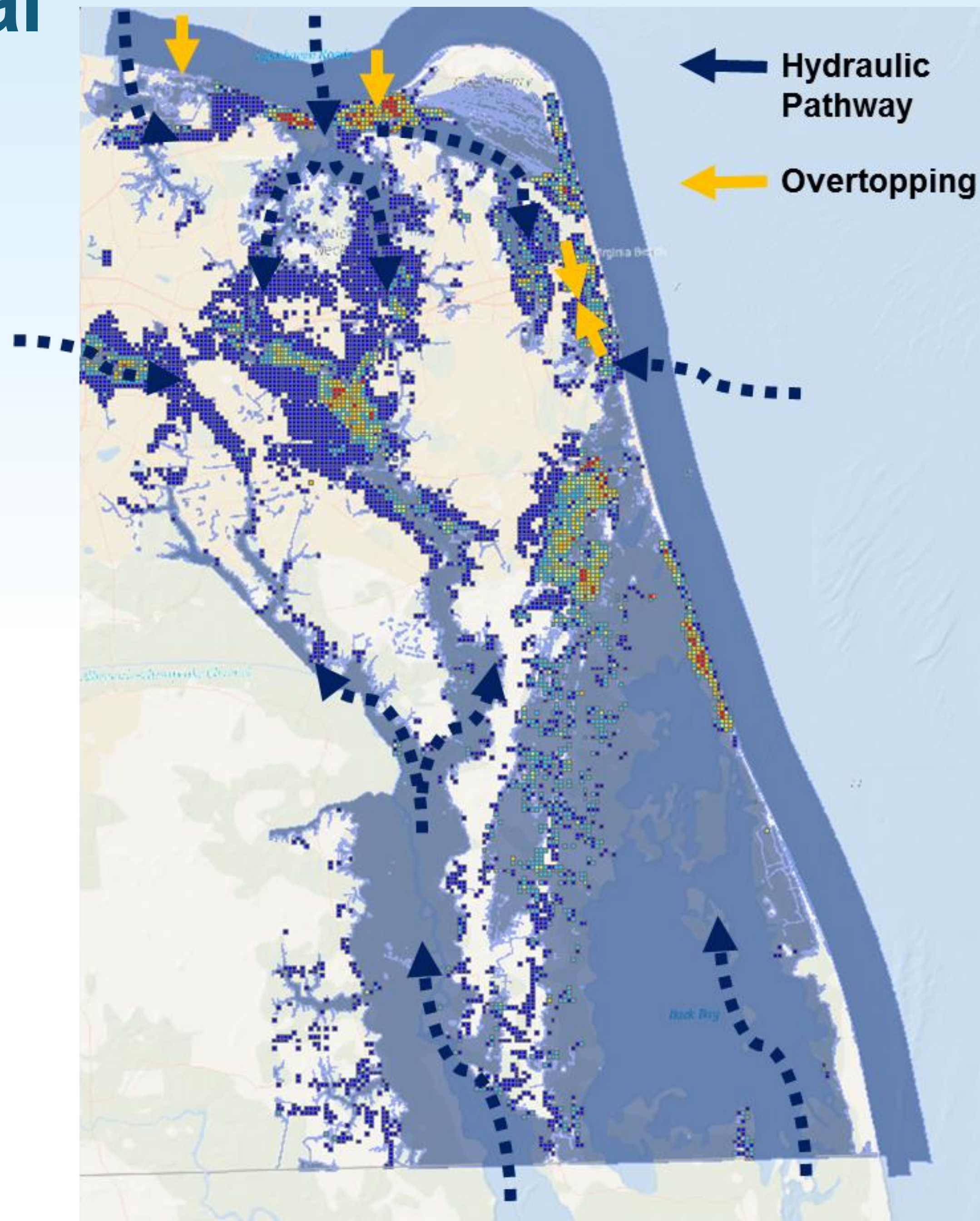
- **Identify**
  - Hydraulic Pathways Resulting in Inland Flooding
  - Suitable Locations for Flood Risk Reduction Benefits
- **Develop**
  - Flood Risk Reduction Alternatives at 3 Levels:



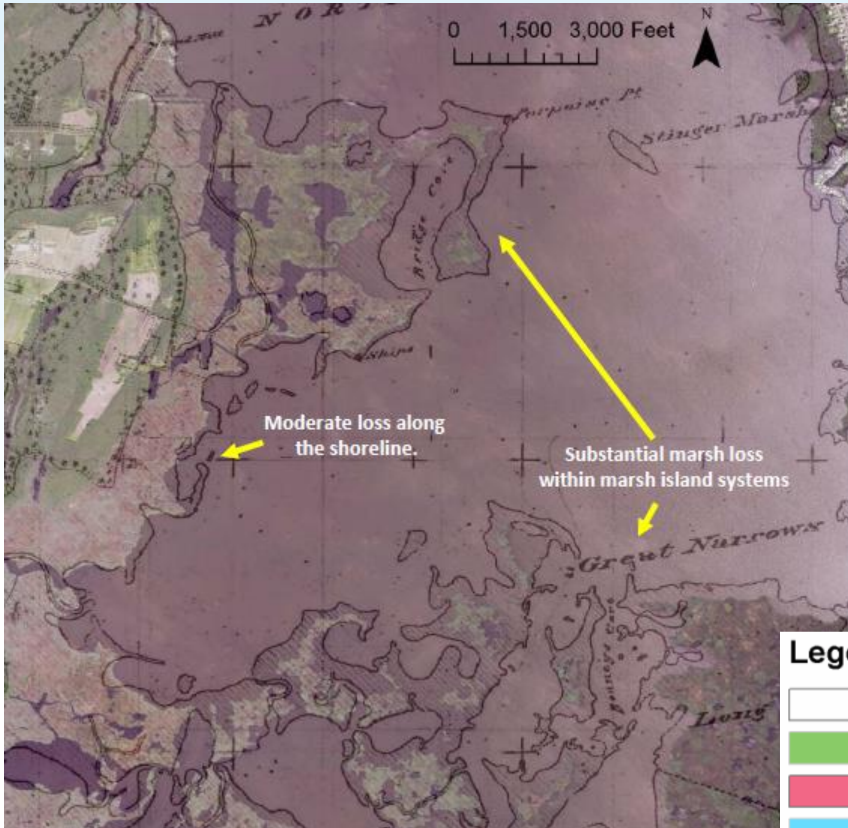
- **Evaluate**
  - Multi-disciplinary Qualitative Analysis of Alternatives
  - Numerical Modeling Evaluation – benefits and impacts
- **Produce**
  - Recommendations for Implementation

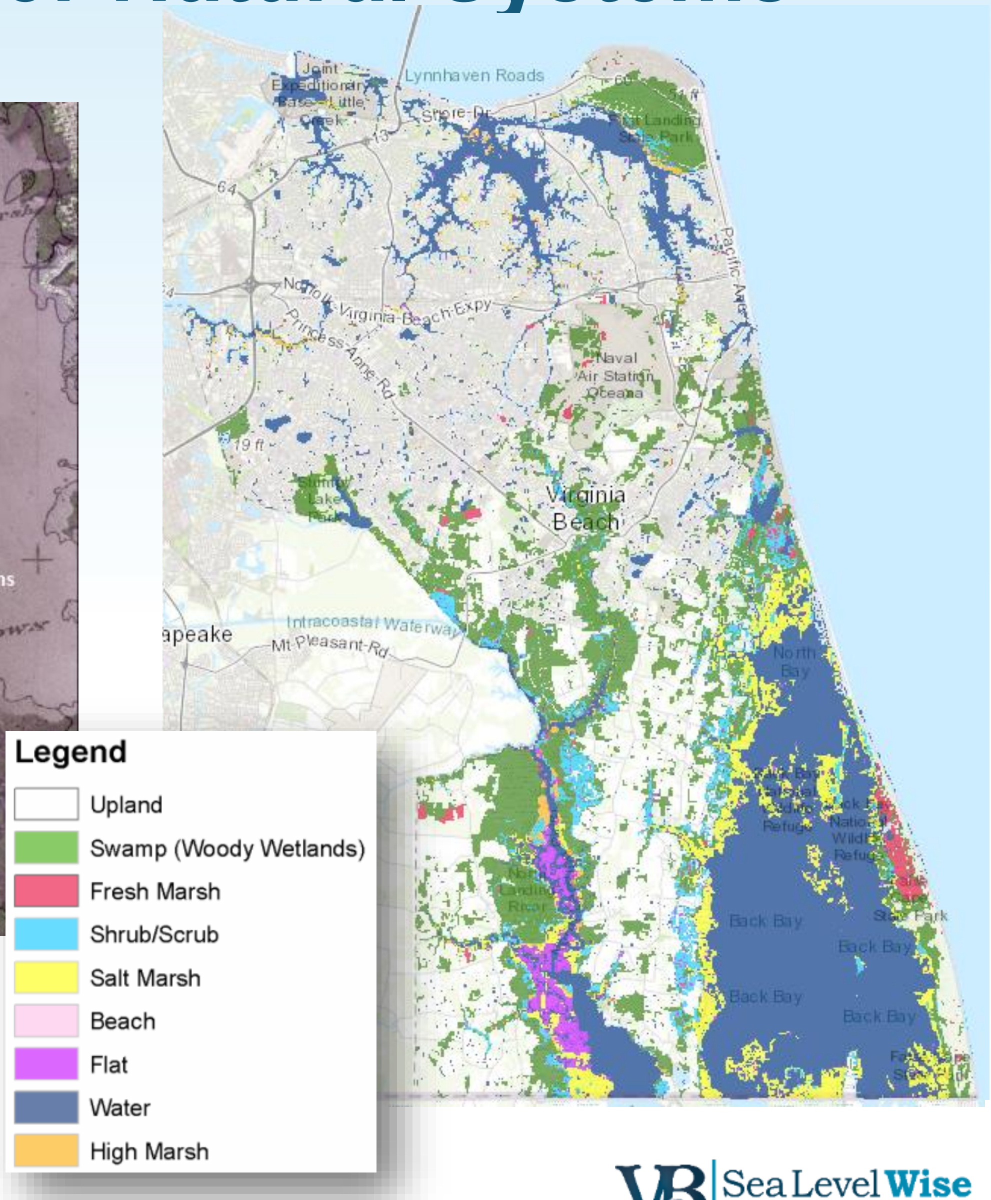
City-wide Structural Alternatives

- 13 perimeter and interior conceptual solutions
- Largest = 68k linear feet of structures
- 31 flood gates/surge barriers
- Hard/soft costs range $1-4B
- MIKE21/Flood Evaluation (rainfall/surge)
- Final selection based on mutli-criteria feasibility, benefit/cost



Considerations for Natural Systems





Planning and Policy Goals

1. Plan for a future with more frequent and intense flooding
2. Enhance the flood resilience of critical infrastructure and invest in capital improvements to reduce community flood risk
3. Enhance the flood resilience of buildings and neighborhoods
4. Protect and enhance the local economy
5. Preserve and enhance natural flood buffers and open space
6. Limit new development and redevelopment in harm's way
7. Improve City coordination and responsiveness to community flood concerns
8. Advocate for changes in state and federal law and policy to support local resilience initiatives

Reduce Residual Risk/Protect Residents

What Level of Flood Insurance Policy Penetration are we Trying to Achieve?

<u>Penetration Statistics</u>

1. Across NFIP – "good penetration" is ~50%
2. City - existing ~36%

<u>Virginia Beach Penetration Goals</u>

1. 25% Increase in Policy Count city-wide
2. Full policy penetration in high-risk areas
3. 50% Increase in Content Policy Count within the renter population

Example Strategy/Action Items

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2.4 Design Guidelines: Update the City's sea-level rise engineering guidelines for retrofitting or replacing existing facilities and building new capital projects. [PLA-2]

Priority: High

Time frame: Immediate Action

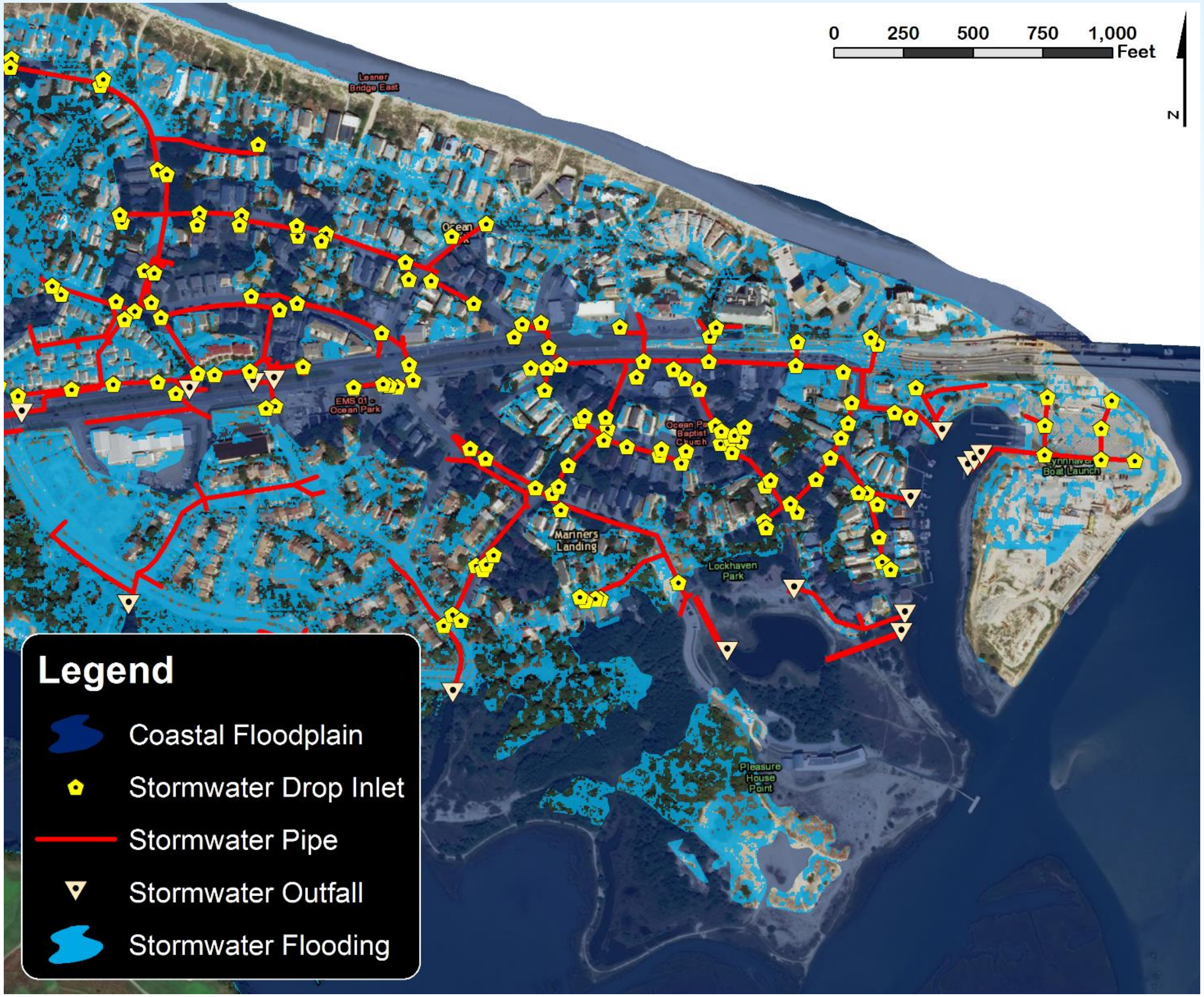
Current status: Virginia Beach's 2014 "Initial Engineering Considerations for Capital Project Design" report recommended that designs for "critical or sensitive infrastructure" take into account 1.5 feet of relative sea-level rise (RSLR) over 50 years. For "major infrastructure projects where sensitivity to sea level rise is high," such as arterial highway expansions, flood control structures, and new city buildings, the report recommends considering the impacts of 3 feet of RSLR over 50 years. The report focuses primarily on the projected impacts on the stormwater-management system but also recommends consideration of options such as increasing project elevation. It is not clear that the CIP process systematically identifies all potential climate impacts on city-funded projects, as it could through the application of a rigorous climate checklist. The City Council also has a policy on maintenance and repair of aging facilities.

Action Items: In updating the City's Engineering Guidelines, the City should:

- Update and provide guidance on the sea-level rise and precipitation estimates that engineers should use based upon the asset's full life cycle and criticality.[8]
- Identify adaptation options (including increased maintenance, elevation, flood-proofing, relocation, etc.) for critical assets that engineers should consider at different stages in an assets life cycle
- Ensure that relocation and realignment are considered for aging and end-of-life facilities that are not water-dependent in the 100- and 500-year floodplain or in areas identified as susceptible to SLR impacted.
- Ensure that green and nature-based approaches are considered as strategies for adapting to changing precipitation patterns and increasing sea levels.

Stormwater Master Plan

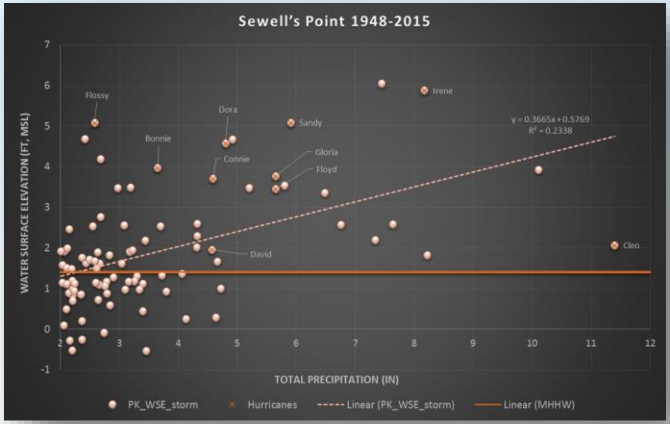
- Higher coastal water levels diminish stormwater system performance

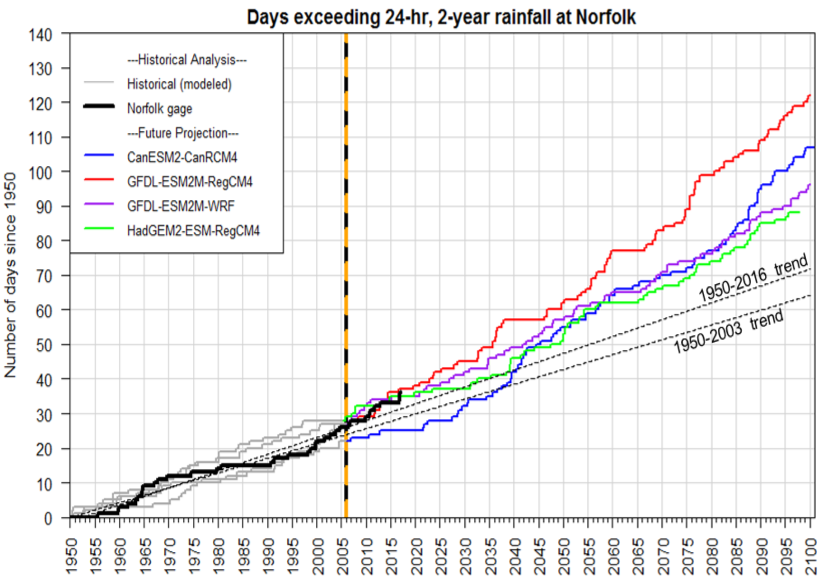


- Key exchanges to:
  - Tailwater boundary conditions
  - Existing and future precipitation inputs
- Key exchanges from:
  - Discharge into MIKE21/MIKE Flood
  - Pump sizing
  - Combined flood representation
  - Combined loss and benefit cost estimates

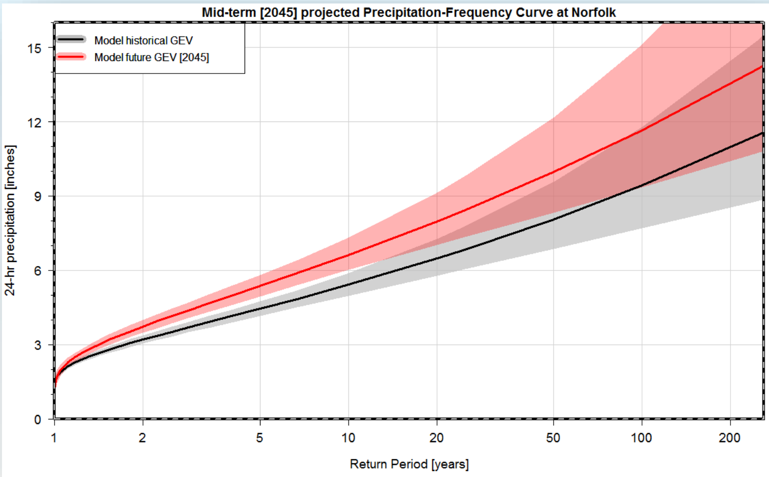
Design Standard Foundational Research

- Rainfall/surge correlation
  - >50% of rainfall events occur during elevated water levels
- Joint-probability of rainfall/storm surge
  - Concurrent rainfall/surge design values
- Regional Precipitation Trends
  - Heavy rainfall increasing
- Future precipitation conditions
  - Potential 20% increase in design rain
- Probable maximum event precipitation
  - Design “check storm”





Stormwater Design Standards



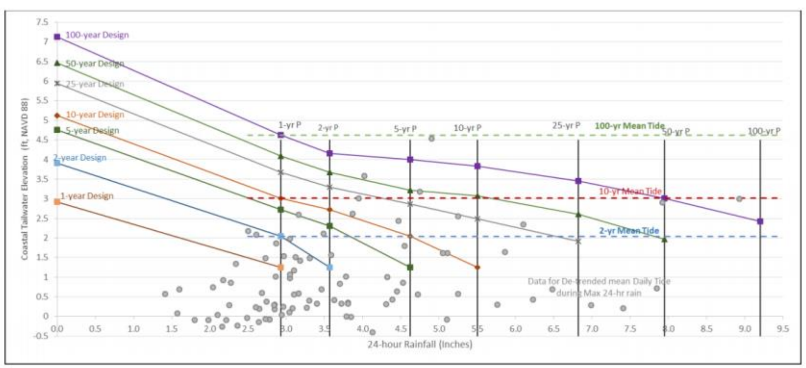


Figure 17. Tailwater design curves showing the data points and rainfall and tide threshold levels.

Table VIII-0
Design Rainfall Depths for City of Virginia Beach (in.)

Design Frequency	NOAA Atlas 14 Rainfall	Design Rainfall (NOAA Atlas 14 + 20%)
1-YR	3.00	**3.60**
2-YR	3.65	**4.38**
10-YR	5.64	**6.77**
25-YR	6.99	**8.39**
50-YR	8.16	**9.79**
100-YR	9.45	**11.34**

Note: NOAA Atlas 14 precipitation depths do not vary significantly across the City (generally < 0.1” difference). The NOAA 14 rainfall values shown above represent the area northeast of Naval Air Station Oceana.

Table VIII-1A
Design Storm/Tide Joint Probability Pairs for Determining Controlling Tailwater Elevation

10-YR Design		25-YR Design		50-YR Design		100-YR Design	
Tide	**Rain**	**Tide**	**Rain**	**Tide**	**Rain**	**Tide**	**Rain**
10-YR	1-YR	25-YR	1-YR	50-YR	1-YR	100-YR	1-YR
1-YR	10-YR	2-YR	25-YR	2-YR	50-YR	3-YR	100-YR

Note: Refer to ***Table J-12*** *Design Tidal Elevations for Virginia Beach* in ***Appendix J*** for corresponding tide elevations. Refer to ***Table 8III-0*** *Rainfall Depths for City of Virginia Beach* for corresponding rainfall depths and ***Table J-13*** *24-Hour Rainfall Distributions for Virginia Beach* in ***Appendix J*** for corresponding rainfall distribution.

Note: Joint probability pairs represent the highest-frequency tide with the lowest-frequency rainfall and the highest-frequency rainfall with the lowest-frequency tide for each design frequency, as informed by joint probability studies undertaken by the City. Please refer to the City of Virginia Beach study titled “Joint Occurrence and Probabilities of Tides and Rainfall,” dated October 2017 (CIP 7-030, PWCN-15-0014, Work Orders 2 and 5A) for additional information.

Public Engagement

Action Oriented Stakeholder Engagement for a Resilient Tomorrow

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As sea rises, Virginia Beach residents ask city for better protection from storms

By Joe Fisher and Rico Bush

Published: December 4, 2017, 4:16 am | Updated: December 4, 2017, 10:28 pm

RISING CONCERNS

OLD DOMINION UNIVERSITY

Resilience Collaborative

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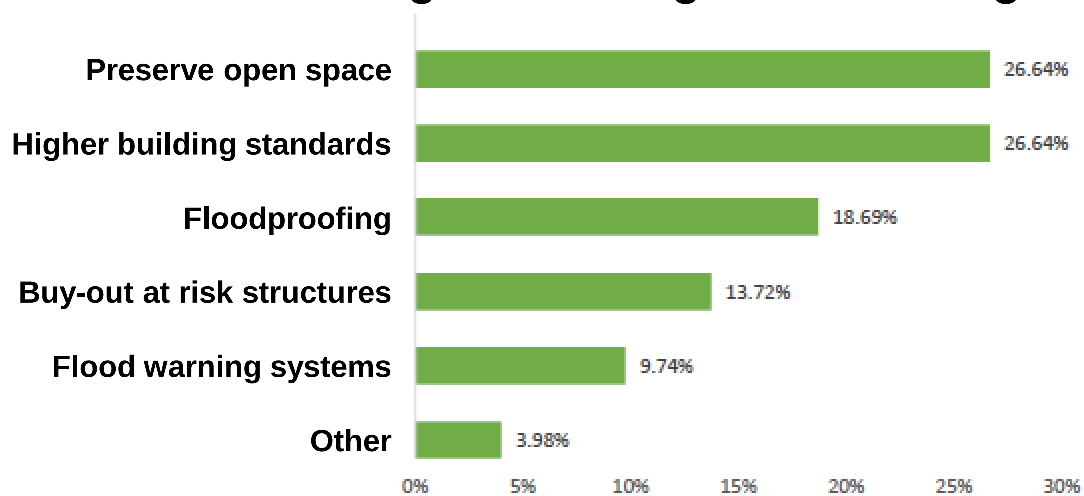
Public Input

Tolerance of Flood Issues

Tolerable

Not Tolerable

Preferred Planning and Management Strategies



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Starting to make a difference?

April 21, 2018

City Says "No" to Development Because of Flood Risk - First of a Kind!

flooding issues, stormwater solutions, adaptation actions

Road Near Proposed Development - Virginian Pilot/Ron Stubbins photo

For the first time that we can find, a local government has said "no" to a development proposal due to flood risk. The City of Virginia Beach, hammered by increasing rainfall, has been more sensitive to the flooding potential, especially in the low-lying southern part of the City. But lots of localities are concerned about and planning for flooding, but still

Tweet

ASFPM
@FloodsOrg

Very cool! While state and federal authorities use decades-old data to set stormwater standards and practices. Virginia Beach would be the first locality in the Nation to build future flood risk from rainfall into its codes and ordinances.

> **Wetlands Watch** @wetlandswatchVA
> Replying to @wetlandswatchVA
> @FloodsOrg - VA Beach doing really interesting work!

4/16/18, 11:37 AM

Tweet your reply

Takeaways

- Risk conflation efficiently served multiple stakeholders
- Limitations of FEMA Flood Insurance Study model
- Solutions must address changing coastal and rainfall flooding
- Public/Stakeholder engagement effective at raising awareness
- Coordination, coordination, coordination

Questions?

Dewberry
Study Manager
Brian Batten, Ph.D., CFM
804-823-6981
bbatten@dewberry.com

City of Virginia Beach
Department of Public Works
Greg Johnson, P.E.
757-385-4131
gjohnson@vbgov.com

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ASERT Public Engagement led by Dr. Michelle Covi at Old Dominion University