



**Maryland Defense Forum  
Association of Defense Communities**

**Installation Resilience Planning Community  
Partnerships in Action**

**Military Installation Resiliency Review**

City of Annapolis | Anne Arundel County | NSA Annapolis

June 6, 2023



## **Moderator**

Cyrena Chiles Eitler, AICP  
Senior Principal | Strategic Planning Advisor  
Stantec Consulting Services Inc.  
Fairfax, VA

## **Panelists**

Zoë P. Johnson  
Community Planning Liaison Officer  
NSA Annapolis, MD

Jacqueline Guild, Esq.  
Deputy City Manager  
Resilience & Sustainability  
City of Annapolis, MD

Dan Nees, Director  
Policy and Finance  
Throwe Environmental, LLC  
Fulton, MD



# Military Installation Resilience

*“The capability of a military installation to avoid, prepare for, minimize the effect of, adapt to, and recover from extreme weather events, or from anticipated or unanticipated changes in environmental conditions that do, or have the potential to, **adversely affect the military installation** or essential transportation, logistical, or other necessary resources **outside of the military installation** that are necessary in order to **maintain, improve, or rapidly reestablish installation mission assurance and mission-essential functions.**”*

**Source: FY 2019 National Defense Authorization Act**

# Project Approach

- Resilience is about making our communities and installations stronger, now and in the future, for everyone
- Resilience planning framework will enable the region, together with NSA Annapolis, to **assess shared vulnerabilities and risks** with special attention given to **unique resilience requirements for NSA Annapolis**



## ADVANCING RESILIENCE FOR DEFENSE COMMUNITIES

A PLANNING FRAMEWORK





# NSA Annapolis/U.S. Naval Academy Military Installation Resilience Plan

*Maryland ADC Defense Forum*

06 June 2023



United States Naval Academy  
**INSTALLATION RESILIENCE PLAN**

February 2022

## Purpose

Develop a comprehensive plan, project portfolio, and year-to-year execution strategy to cohesively address and mitigate the combined effects of flooding caused by land subsidence, sea level rise, storm surge, and changes in groundwater elevations.

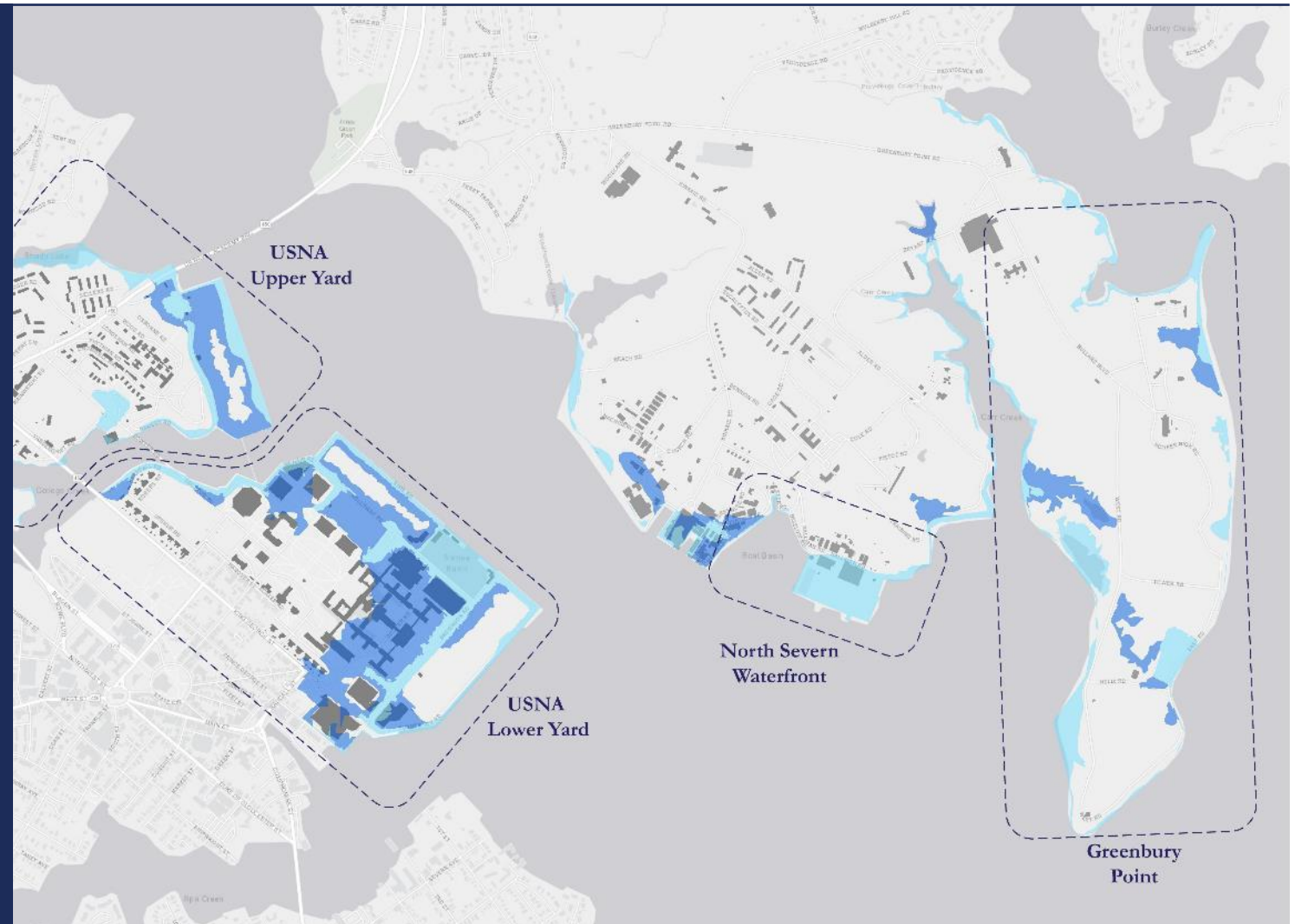
## Installation Resilience

The capability of a military installation to avoid, prepare for, minimize the effect of, adapt to, and recover from extreme weather events, or from anticipated or unanticipated changes in environmental conditions, that do, or have the potential to, adversely affect the military installation or essential transportation, logistical, or other necessary resources outside of the military installation that are necessary in order to maintain, improve, or rapidly reestablish installation mission assurance and mission-essential functions (10 U.S. Code §101).



# Problem Statement

What adaptation and resilience measures can be taken to address present-day and likely 2035, 2065 and 2100 impacts in order to protect Mission-Essential infrastructure and facilities.

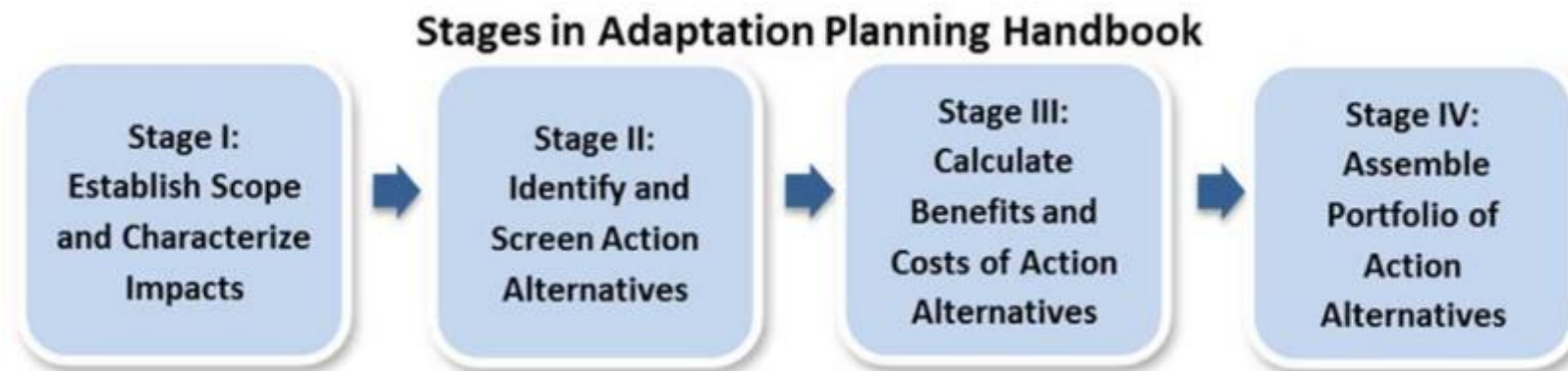






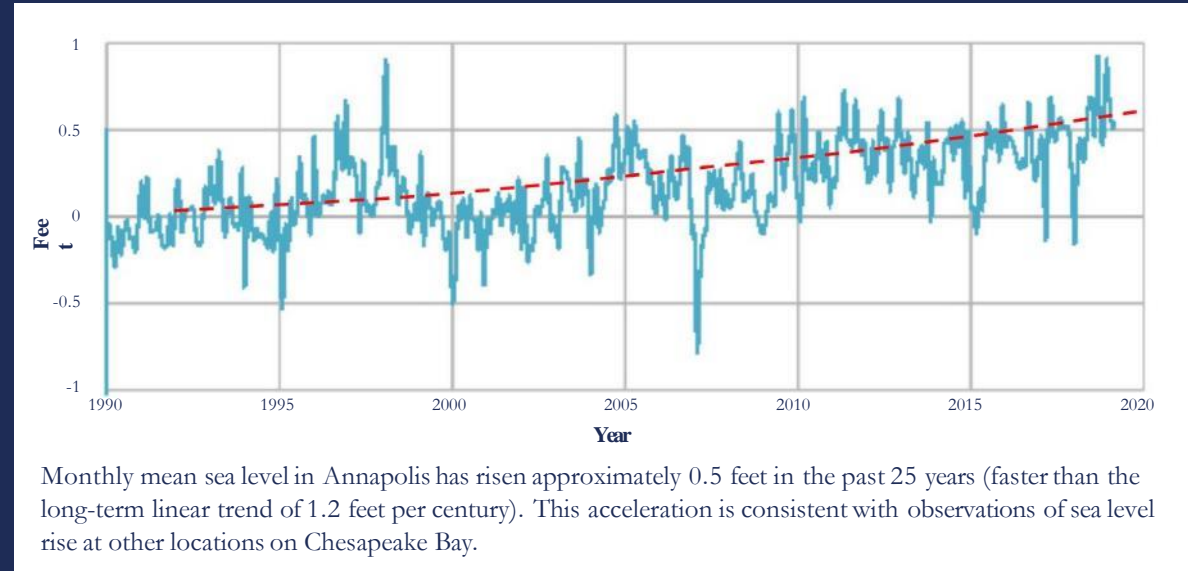
## Climate Change Planning Handbook

- The intent of this Handbook is to provide the analytical framework and methodology to help Navy Master Development Planners understand how to consider climate change in their plans and projects.
- A series of Stages are provided to help planners identify and assess adaptation action alternatives to manage potential impacts to current and planned infrastructure.
- Includes a detailed methodology for evaluating various scenarios, assessing potential impacts and developing adaptation action alternatives.



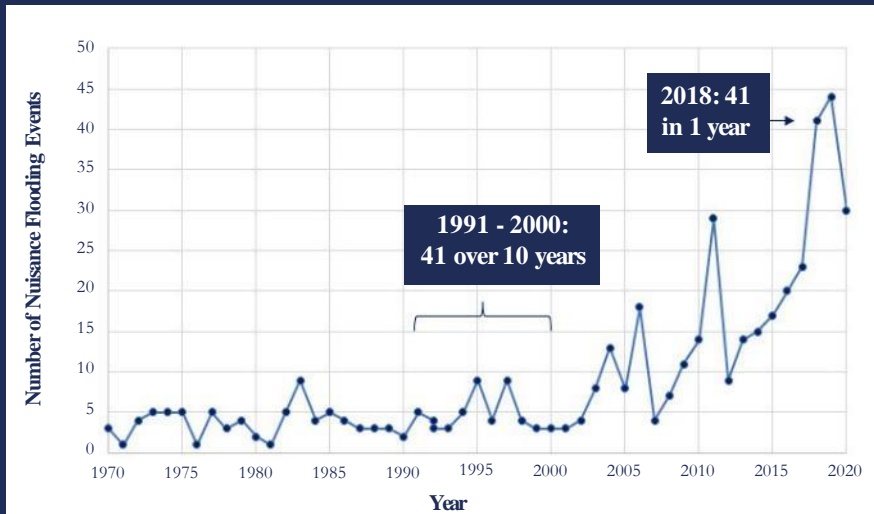
# Sea Level Rise Trends and Projections

## Relative Sea Level Trends (Annapolis, MD)



Source: USNA Sea Level Rise Advisory Council

## Annual Nuisance/High-Tide Flood Events at USNA



Nuisance or high tide flooding is defined as “flooding that leads to public inconveniences such as road closures (NOAA).” Nuisance flooding is often unrelated to a specific storm but is commonly influenced by sustained wind events, storm systems or astrological phases. Future sea level rise may increase these flood events at USNA: a 6-inch rise will likely result in approximately 90 events/year; and with a 12-inch increase, that number increases to about 340 events/year.

Source: USNA Sea Level Rise Advisory Council

## Future Sea Level Rise Induced Flood Levels (feet above NAVD88)

YEAR	MHHW	5-YR	20-YR	50-YR	100-YR
				R	YR
<b>*ARP</b>	<b>N/A</b>	<b>20%</b>	<b>5%</b>	<b>2%</b>	<b>1%</b>
<b>2022</b>	<b>0.7</b>	<b>3.7</b>	<b>4.6</b>	<b>5.6</b>	<b>6.3</b>
<b>2035</b>	<b>2.0</b>	<b>5.0</b>	<b>5.9</b>	<b>6.9</b>	<b>7.6</b>
<b>2050</b>	<b>2.7</b>	<b>5.6</b>	<b>6.6</b>	<b>7.6</b>	<b>8.3</b>
<b>2065</b>	<b>3.3</b>	<b>6.3</b>	<b>7.2</b>	<b>8.2</b>	<b>8.9</b>
<b>2100</b>	<b>5.1</b>	<b>8.1</b>	<b>9.0</b>	<b>10.0</b>	<b>10.7</b>

MHHW =Mean Higher High Water  
NAVD88 =North America Vertical Datum of 1988

\*Annual Recurrence Probability  
Source: DoD Regional Sea Level (DRSL) Database

# Projected Inundation

Sea-Level Rise Modeling Results



Current MHHW: 0.66 feet above NAVD88



Projected MHHW: 2.5 feet above NAVD88



Projected MHHW: 3.3 feet above NAVD88



Projected MHHW: 5 feet above NAVD88

MHHW =Mean Higher High Water  
NAVD88 =North America Vertical Datum of 1988

# Projected Inundation

Sea-Level Rise +  
5-Year Storm Event



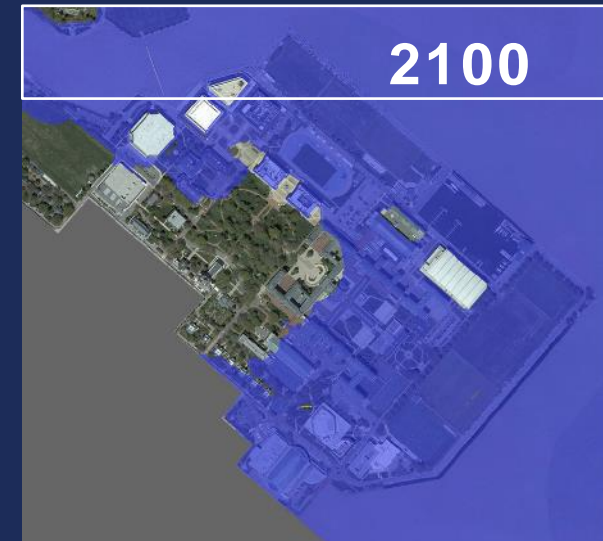
Current 5-Year Storm Water Level: 3.66 feet above NAVD88



Projected 5-Year Storm Water Level: 5.5 feet above NAVD88



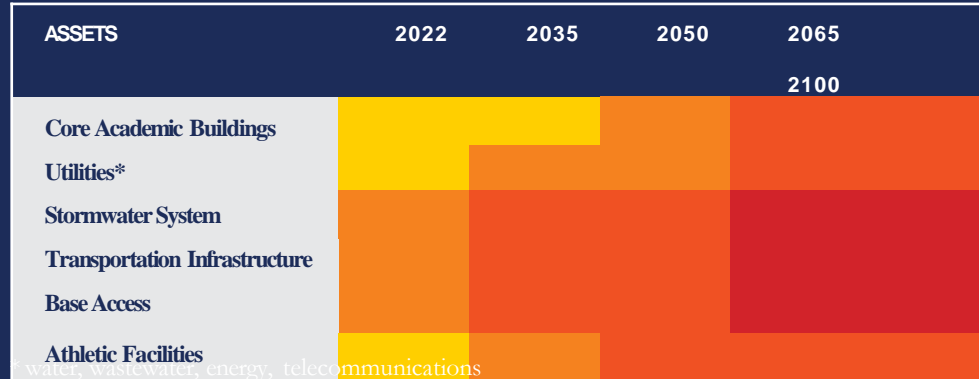
Projected 5-Year Storm Water Level: 6.3 feet above NAVD88



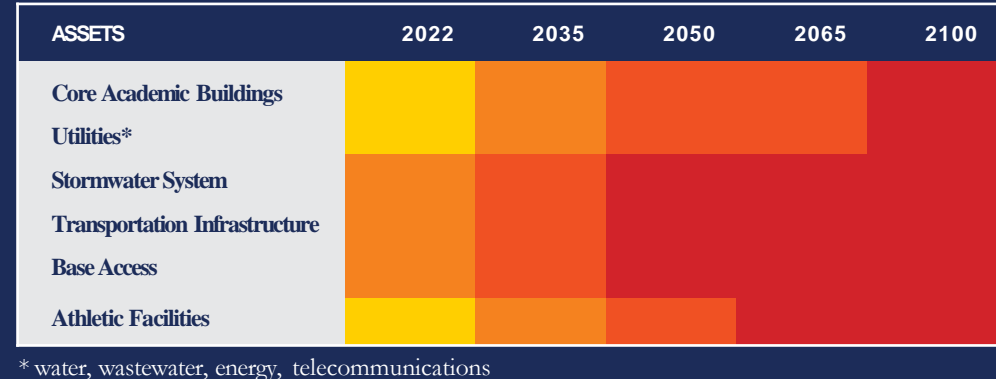
Projected 5-Year Storm Water Level: 8.0 feet above NAVD88

# Mission Vulnerability

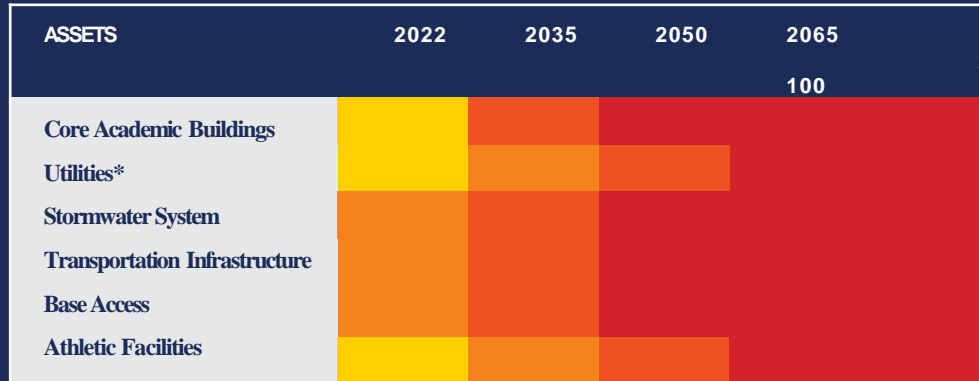
## NUISANCE FLOODING



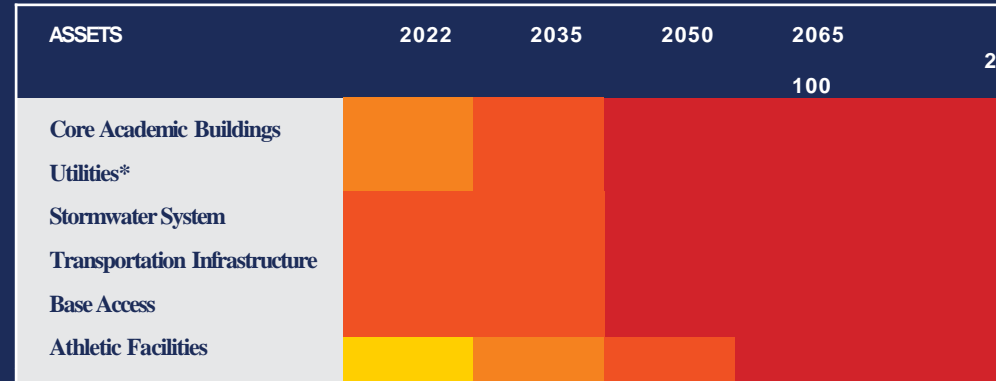
## 5-YEAR STORM



## 50-YEAR STORM



## 100-YEAR STORM



- Low Vulnerability: Localized infrastructure service disruption; no permanent damage
- Medium Vulnerability: Widespread infrastructure damage and loss of service; damage recoverable by minor repair

- High Vulnerability: Extensive infrastructure damage and loss of service; significant repairs required
- Extreme Vulnerability: Permanent damage and/or loss of infrastructure service



United States Naval Academy  
INSTALLATION RESILIENCE PLAN

# Integrated Adaptation Framework





Revetment



Waterfront Infrastructure

## Engineered Defenses

These permanent or deployable engineered flood risk reduction infrastructure can be designed to block specific flood pathways, preventing coastal or riverine floodwaters from passing into inland areas.



Wet and Dry Flood Proofing

## Adapted Structures

Buildings and infrastructure systems can be sited, built, and retrofitted to withstand a flood event, helping to manage the residual risk that exists even behind protective infrastructure.



Deployable Flood Barrier across Roadway





Living Shoreline



Stormwater Retention

## Green Infrastructure

Natural features both in the water and on land can directly reduce the magnitude of flooding across the installation by reducing wave action, stabilizing landscapes, and absorbing excess surface floodwater.

# Integrated Adaptation Framework

## Exterior Defense

- Wave Attenuation
- Pier Replacement

## Perimeter Protection

- Raised Bulkheads
- Flood Walls
- Earthen Berms

## Interior Adaptations

- Elevated Roadways
- Athletic Field Drainage Improvements
- Building Retrofits

## Sub-Surface Improvements

- Stormwater Upgrades



## Defense in Depth





Land Conservation

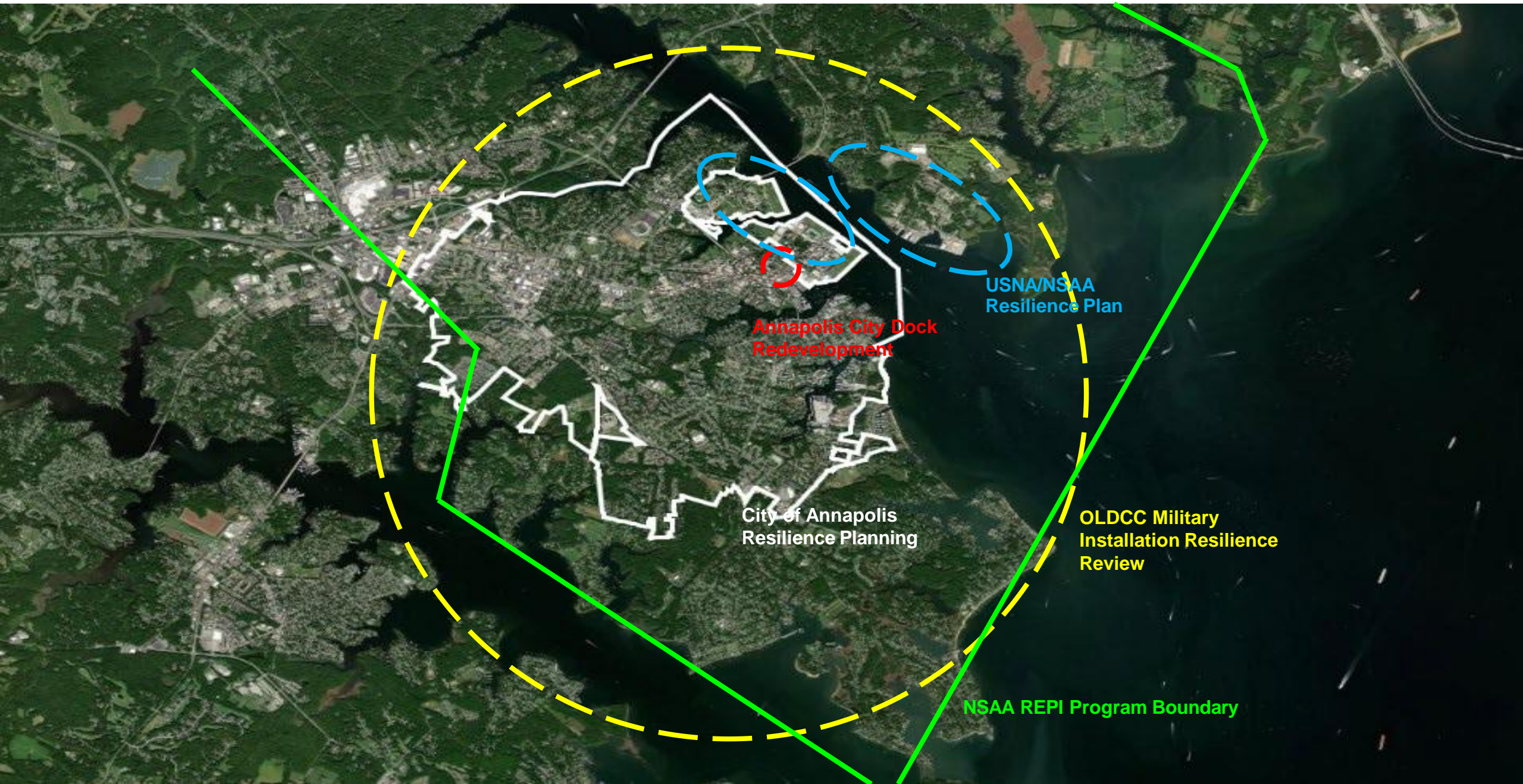
## Community Preparedness

Open communication with community, city, county and state leaders will enable coordination of resiliency efforts on all levels of local and regional government.



Community Engagement

# Community Resilience and Preparedness Planning



Annapolis City Dock Redevelopment

USNA/NSAA Resilience Plan

City of Annapolis Resilience Planning

OLDCC Military Installation Resilience Review

NSAA REPI Program Boundary



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Annapolis, MD 21402

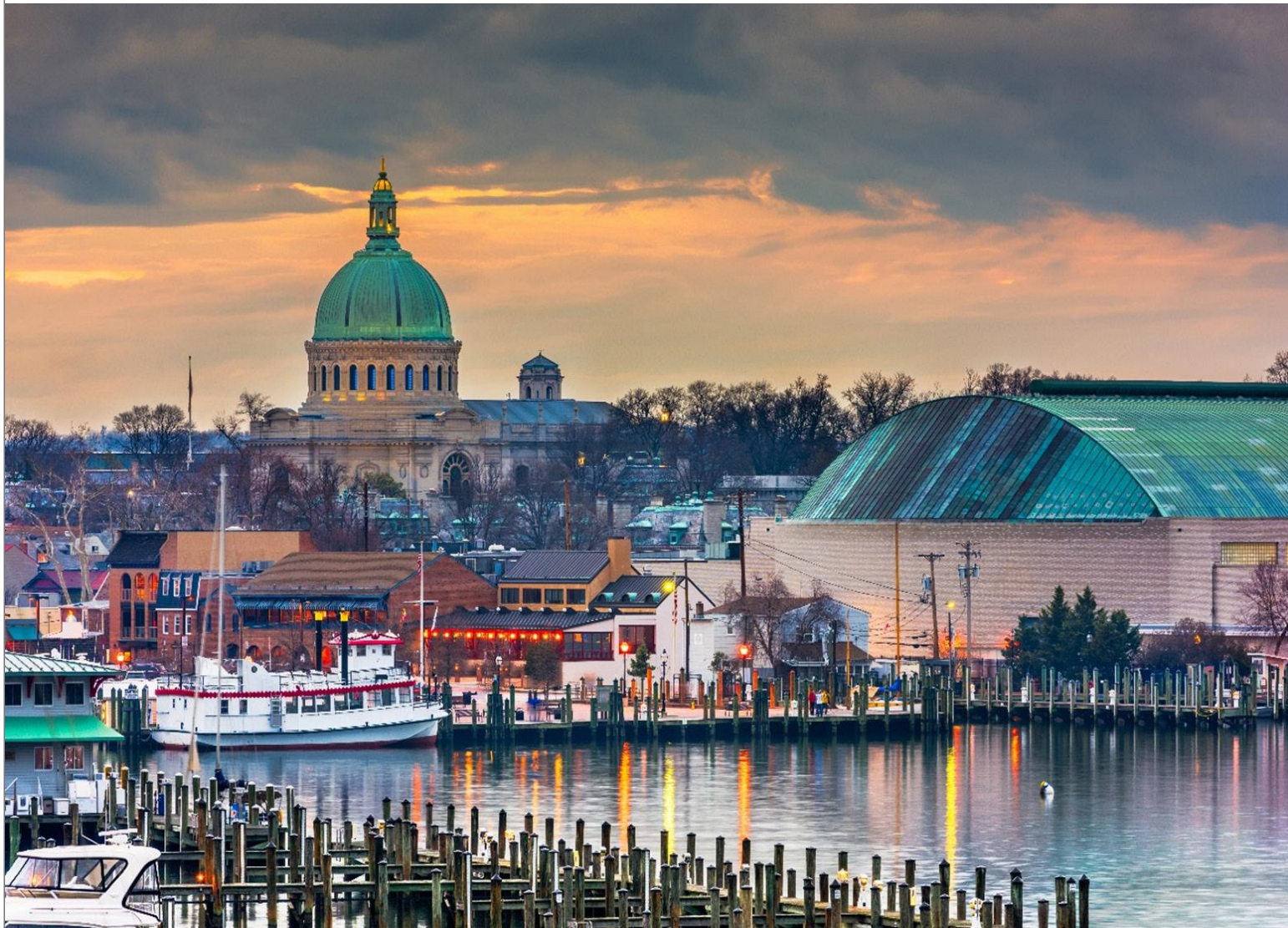
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# Military Installation Resiliency Review

City of Annapolis | Anne Arundel County | NSA Annapolis



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**Deputy City Manager**  
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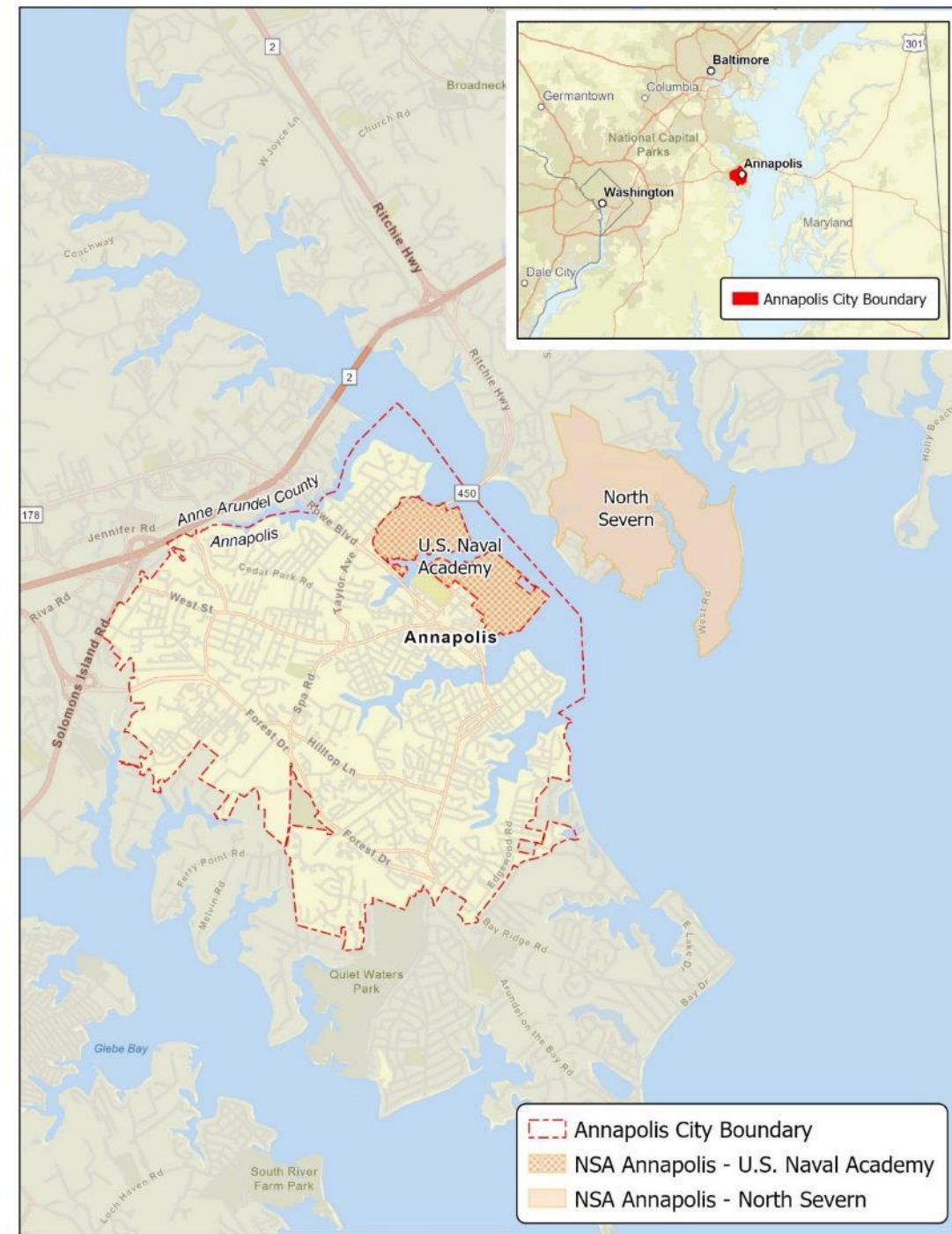


# Project Goal

- Identify critical assets that are at risk.
- Recommend actions that will increase resilience for NSA Annapolis, City of Annapolis and Anne Arundel County.



View of City Dock Flooding, Photo Provided by Susan Walsh





# Team Overview

## Resilience Consultant – Stantec

- Risk/resilience professionals
- Advance project along the resilience planning framework

## Project Sponsor – City of Annapolis

- Partners - Anne Arundel County and Naval Support Activity Annapolis
- Convene the right people to identify and address risks
- Serves as DoD Grantee

## Policy Committee – Municipal, County, Regional and Military Leaders

- Guide planning process, accept final project deliverables
- Define network of systems, infrastructure, services and people needed to maintain resilience

## Technical Committee – Community / Installation Experts

- Represent technical and subject matter experts
- Develop and recommend adaptation strategies and actions

## Working Groups

- Transportation Working Group
- Environmental Working Group







# Stantec Subject Matter Expert Team

## **Resilience Assessment**

- Rebecca Leitschuh, Resilience Technical Lead
- Paul Carrol, Senior Coastal Engineer
- Christina Hurley, Senior Hazard Mitigation Planner
- Norman Shippee, Senior Climate Scientist
- Matthew Moy, GIS Specialist

## **Coastal Shoreline Boundaries | City Dock**

- John Malueg, Vice President, Resilience Planning and Design
- Aaron Chen, Associate Senior Coastal Engineer
- John Menninger, Senior Principal, Sub-Sector Leader Urban Waterways

## **NSA Annapolis Access Roads | Traffic Signal Upgrade**

- Al Arnold, Senior Principal, Community Development
- Robert Milstead, Senior Traffic Engineer, Associate

## **County/City Water Treatment Facilities**

- Matthew Lieuallen, Principal, Planner
- Nicholas Anderson, Vice President, Wet Weather Flow
- Alexander Cropp, Urban Water Resources Engineer

## **Anne Arundel County Department of Health and Luminis Health Anne Arundel Medical Center**

- Matthew Lieuallen, Principal, Planner

## **Cybersecurity**

- Daniel Tannous, Senior Associate, Information and Communications Technology

## **Energy**

- Tennile Rubin, Senior Principal, Environmental Services
- Doug Sharpe, Regional Sector Lead, Power Delivery US-E
- Mohsen Shojaeion, Distribution and Grid Modernization Team Lead

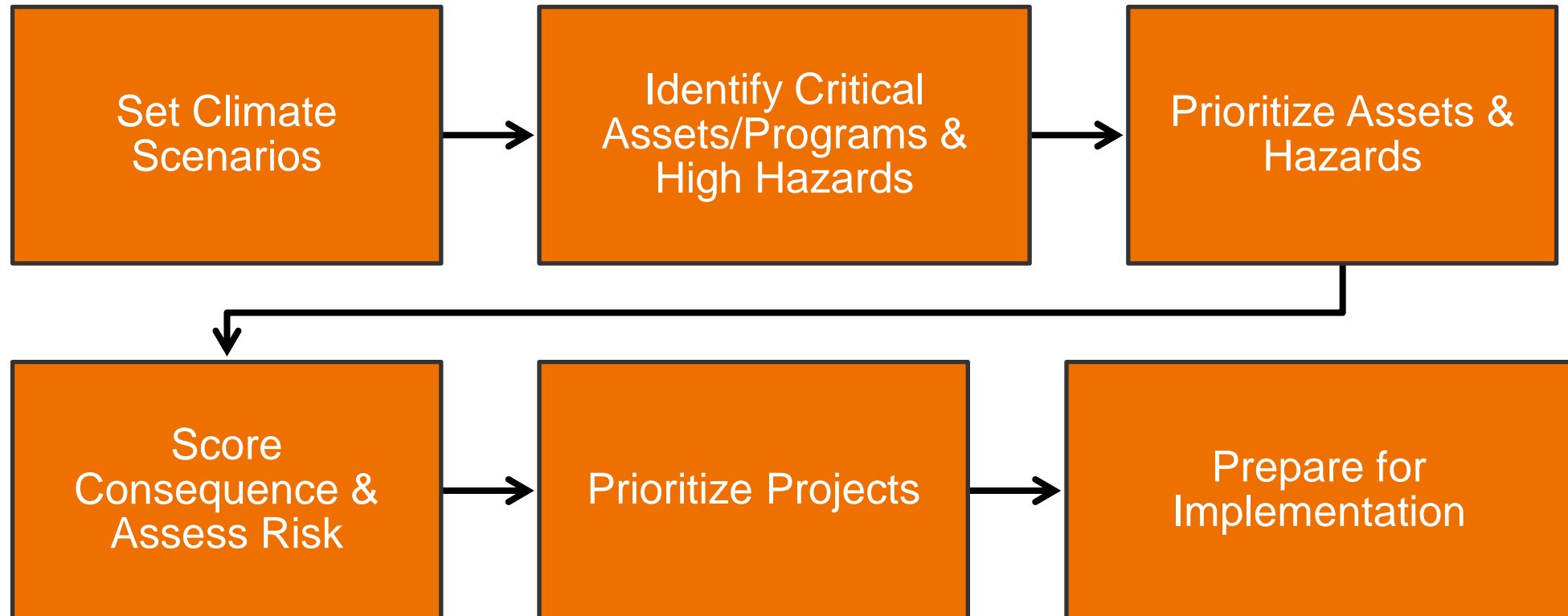
## **Annapolis Wastewater Conveyance and Reclamation Facility**

- Pat Coleman, Wastewater Practice Leader

## **North America Funding Team**

- Heidi Peper, Senior Funding Leader
- Kim Pugel, Ph.D., Associate, Policy & Funding Specialist
- Emily Snyder, Senior Manager

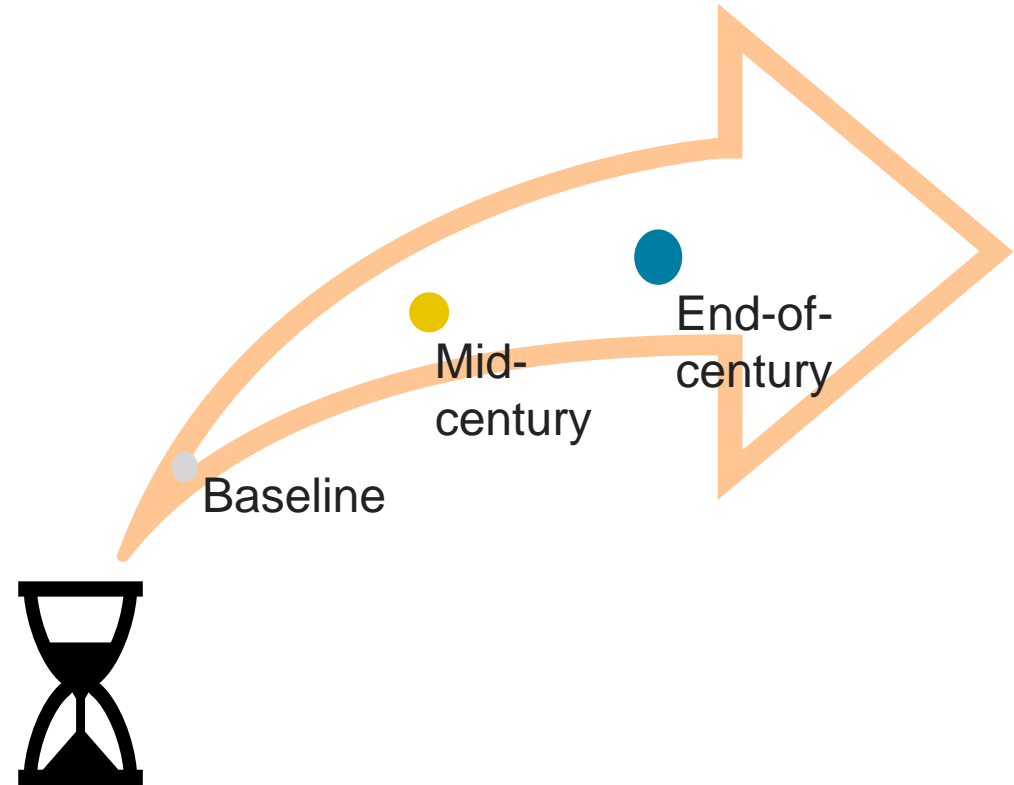
# Process for Military Installation Resilience Assessment





# Time Horizons

- **Climate:** ~30-year average
  - Current climate baseline
  - Mid-century
  - End of century





# Hazard Profiles

Focusing on the hazards ranked highest in the hazard survey.

Hazards were verified by the Staff Working Group and Stantec team.

Four hazards used in risk assessment process:

- Coastal Flooding (Includes SLR)
- Hurricanes and Tropical Storms
- Cybersecurity
- Infectious Disease



Hurricane Isabel, NASA/GSFC



# Sea Level Rise

Sea level rise (SLR) was included as a component to the coastal flooding hazard.

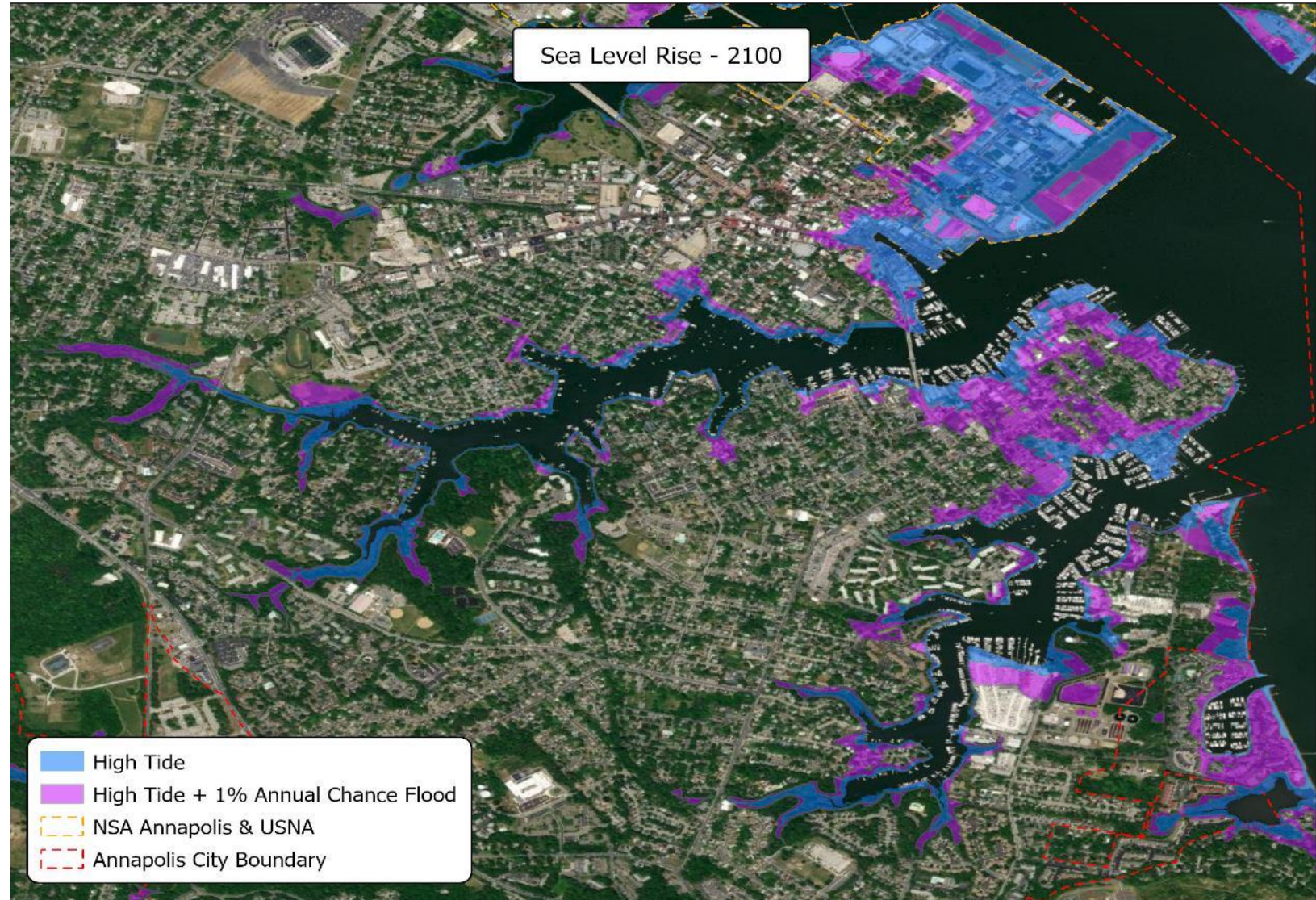
Our SLR projections are based on the NOAA 2022 Sea Level Rise Technical Report.

- Most recent and advanced SLR modeling
- Utilized the Intermediate High scenario projections.
- Uses 1992 Mean Sea Level (MSL) as the base level.

Annapolis SLR Projections		
Timeframe	Sea Level Height Change (SLR in FT)	Hightide Height Change (MHHW in FT relative to MSL)
2050	1.64	2.36
2065	2.54	3.26
2100	5.35	6.07



# Sea Level Rise Projections Spa Creek





# Sea Level Rise Projections US Naval Academy





# Community Lifelines



**Water:**  
Groundwater, Water/Wastewater Treatment Plants, Distribution



**Safety and Security:**  
Public Safety Building



**Health and Medical:**  
Hospital, Stormwater Park, Nature-Based Solution, Health System



**Education:**  
Schools, Colleges, Universities



**Energy:**  
Power Grid, Microgrids, Renewables



**Communications:**  
Communication Updates



**Transportation:**  
Road Elevation, Evacuation



**Food, Shelter:**  
Community Housing





# What makes an asset critical?

**Critical Assets** are those whereby loss of functionality could lead to:

- Loss of life
- Serious injury
- Threatened safety
- Public health impacts
- Quality of life reduction (e.g., long term economic impacts)
- **Adversely impacts installation, mission assurance, readiness**
- **Outside the installation boundary**

**High** **Medium** **Low**

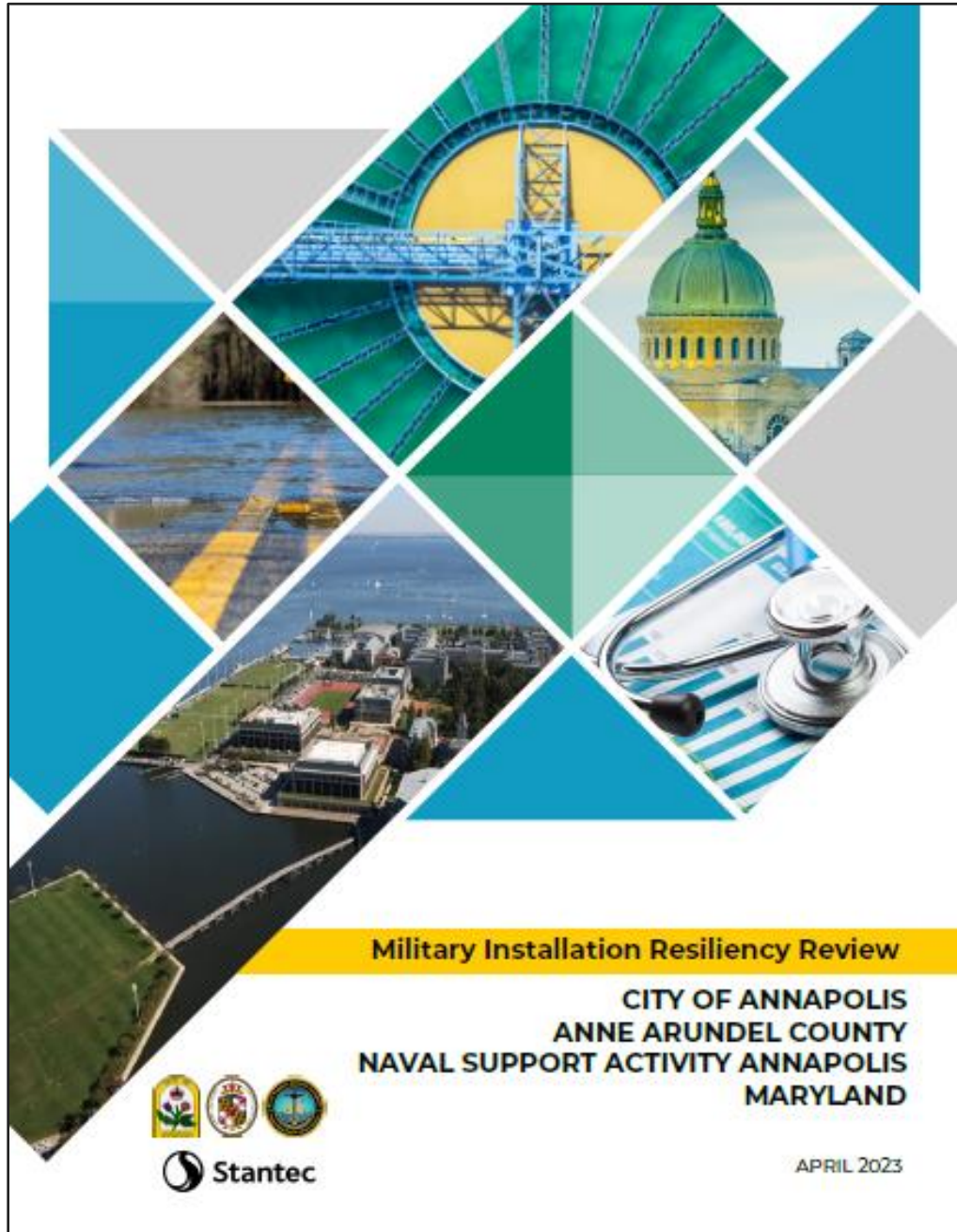




# Resilience Actions

- Coastal Shoreline Boundaries | City Dock
- Installation Access Roads | Traffic Signal Upgrades
- Annapolis Water Reclamation Facility
- Energy
- Cybersecurity
- County/City Water Treatment Facilities
- Anne Arundel County Health Department
- Luminis Health Anne Arundel Medical Center





# Military Installation Resiliency Review Report

- Executive Summary
- Technical Report
- Resilience Action Plan



# Funding Sources Alternatives Analysis

**Community  
Resilience Needs &  
Project Characteristics**

**Funding Sources  
Goals, Criteria,  
and Requirements**



**Eligibility  
and**

**Best Candidates for Success**



ASSET 3 COASTAL SHORELINES	
<b>Step 1: Background Information</b>	
TOC	
RAP	
Aspect	Response
Project Name	City Coastal Zone Resilience / Coastal Shoreline Boundaries
Project / Action Description	To identify, screen, and prioritize a network of perimeter coastal risk mitigation best management practices. These practices may include green-, grey-, and blue-infrastructure, temporary and permanent seawalls, living shorelines, and off shore breakwaters. These practices should be screened, prioritized and designed, in consultation with applicable stakeholders, with consideration of selected sea level rise and precipitation models. See Appendix G: Coastal Shoreline Boundaries – Resilient Action Assessment presentation.
Rationale for Project Action	Currently this community is very vulnerable to coastal risks, with consideration of climate change (SLR:Yr. 2100~ 5.35 ft.) without mitigation, future increases in coastal risks could threaten the long-term viability of the community.
Priority Level	High
<b>Step 2: Responsible Parties</b>	
Aspect	Response
Project Lead	City of Annapolis as lead, sponsored by NSA Annapolis
Project Support	Anne Arundel County Emergency Management and State of Maryland
Potential Partnerships or External Resources	DoD REPI Program, OLDCC, FEMA, Maryland Oyster Gardening Program
Capacity	TBD

ASSET 3 COASTAL SHORELINES	
<b>Step 3: Timeline</b>	
Aspect	Response
Estimated Time to Complete	Series of projects to be phased over the next 20-years
<b>Additional Notes</b>	
Aspect	Response
Potential Funding Model	Maximize federal partners, grant programs, leverage local funding to meet local match requirements.
Available Grants	IFEJA funding, complimented by FEMA HMGP and BRIC, DoD DCIP and REPI, NFWF Coastal Resilience Funds
Grant Requirements	Community to draft an overall financing (incl. grant funding) strategy with integrated benefit-cost analysis for various coastal segments, to assist in prioritizing project sequencing, to ensure maximum grant eligibility and competitiveness, to ensure federal grant eligibility, City to comply with all ZCFR 200 procurement requirements related to securing related outside consulting services related to grant writing, planning, design, and mitigation project implementation.

ASSET 3 COASTAL SHORELINES	
<b>COASTAL SHORELINE BOUNDARIES FUNDING SOURCES (Ranked):</b>	
<ul style="list-style-type: none"> <li>National Coastal Resilience Fund               <ul style="list-style-type: none"> <li>DoD Defense Community Infrastructure Pilot (DCIP) Program</li> <li>DoD Installation Resilience Program</li> <li>Building Resilient Infrastructure and Communities (BRIC) Program</li> <li>Hazard Mitigation Grant Program</li> <li>Readiness and Environmental Integration (REPI) Program</li> <li>Safeguarding Tomorrow through Ongoing Risk Mitigation (STORM) Revolving Fund Loan Program</li> <li>Flood Mitigation Assistance (FMA) Grant Program</li> <li>Resilience Authority of Annapolis and Anne Arundel County</li> </ul> </li> </ul>	<p><b>National Coastal Resilience Fund:</b></p> <p>AGENCY: National Fish &amp; Wildlife Foundation (NFWF)</p> <p>PURPOSE/GOALS: Restores, increases and strengthens natural infrastructure to protect coastal communities while also enhancing habitats for fish and wildlife.</p> <p>ELIGIBLE APPLICANTS: Non-profit 501(c) organizations, state and territorial government agencies, local governments, municipal governments, Native American tribal governments, educational institutions, or commercial (for-profit) organizations.</p> <p>ELIGIBLE USE OF FUNDS: Conservation projects that restore/expand natural features, i.e. coastal marshes &amp; wetlands, dune &amp; beach systems, oyster &amp; coral reefs, forests, coastal rivers &amp; floodplains, and barrier islands that minimize the impacts of storms.</p> <p>Four focus areas:</p> <ol style="list-style-type: none"> <li>Community Capacity Building and Planning</li> <li>Project Site Assessment and Preliminary Design</li> <li>Project Final Design and Permitting</li> <li>Restoration and Monitoring</li> </ol> <p>Need to select one of the four focus areas under which to apply.</p> <p>Proposed projects must address: Nature-Based Solutions, Community Resilience Benefit, and Fish and Wildlife Benefit. Further priority will be given to projects that demonstrate: Community Impact / Engagement and Innovation / Transferability / Sustainability.</p> <p>TERMS/REQUIREMENTS/NOTES: \$17 M total available; 11 non federal match; no maximum grant amounts, but average award ranges of:</p> <ol style="list-style-type: none"> <li>\$125,000</li> <li>\$75,000</li> <li>\$250,000</li> <li>flat \$1M - \$2M; Projects proposed here expected to have been prioritized through planning processes that address coastal resilience, completed design &amp; engineering plans for implementation, &amp; readiness to obtain permits &amp; approvals.</li> </ol> <p>FUNDING AMOUNT AND CYCLE: Annual program with pre-proposal typically due in April and full proposal, if invited, due June.</p> <p>TYPE: GRANT</p> <p>LINK: <a href="mailto:jessica.granillo@nfwf.org">jessica.granillo@nfwf.org</a> - 202-456-2664</p> <p><b>RANK AND REASONING: 4.</b> Good fit as long as project contains components of restoring or expanding natural features of wetland and/or floodplain to benefit habitat for fish and wildlife.</p>
<p>HEALTH/MEDICAL ENERGY SHORELINES CITY/COUNTY WTP            CYBERSECURITY ACCESS ROADS SEWER GENERAL</p>	

# Resilience Action Plan

## Funding Sources for Identified Priority Critical Assets

- Reviewed Federal and State of Maryland funding opportunities and criteria.
- Assessment of which funding programs were “best fit” and considerations for pursuing, such as packaging projects together.
- Some programs support multiple projects, others a single project.



# DELIVERING RESILIENCE

The Resilience Authority of  
Annapolis and Anne Arundel County

Matthew Fleming, Director  
[matthew.fleming@aacounty.org](mailto:matthew.fleming@aacounty.org)  
443.370.6951



# The warning

The pace and scale of climate action are insufficient to tackle climate change

Sixth Assessment Report from the International Panel on Climate Change

# The Resilience Authority of Annapolis and Anne Arundel County

Delivering Resilience | June 2023



With 530 miles of coast here in Anne Arundel County, storm surges and sea level rise are a threat to our public infrastructure and private property. That's why we created and funded the nation's first multi-jurisdictional Resilience Authority in 2021.

Steuart Pittman  
Anne Arundel County Executive, Maryland



There is no capital city in America that faces a more serious threat from sea level rise than Annapolis. The Resilience Authority adds another tool to our toolbox to help us meet the infrastructure needs of the next Century.

Gavin Buckley  
Annapolis City Mayor, Maryland



# How we

# Work

- ✓ As an independent body, The Authority is uniquely suited to tackle expensive, long-term infrastructure projects because we can operate outside of the county and city's budgets and debt ceiling restrictions.
- ✓ We have our own procurement policies and the ability to draw on a range of funding options for resilience projects.
- ✓ We can charge and collect non-tax related fees, issue or sell state or local tax-exempt bonds, and utilize local, state, nonprofit funding to provide capital for projects.
- ✓ We can also combine any of these funding mechanisms and are not restricted geographically, allowing for infrastructure investments to facilitate climate adaptation on a regional scale

# An opportunity to shape thinking and practice...



Accelerate project implementation



Provide equitable solutions



Reduce stress on local budgets



Scale investment



Integrate mitigation and adaptation

# Thank You

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Matthew Fleming, Director  
[matthew.fleming@aacounty.org](mailto:matthew.fleming@aacounty.org)  
443.370.6951





# References

## **Resilience Authority of Annapolis and Anne Arundel County**

<https://resilienceauthority.org/#>

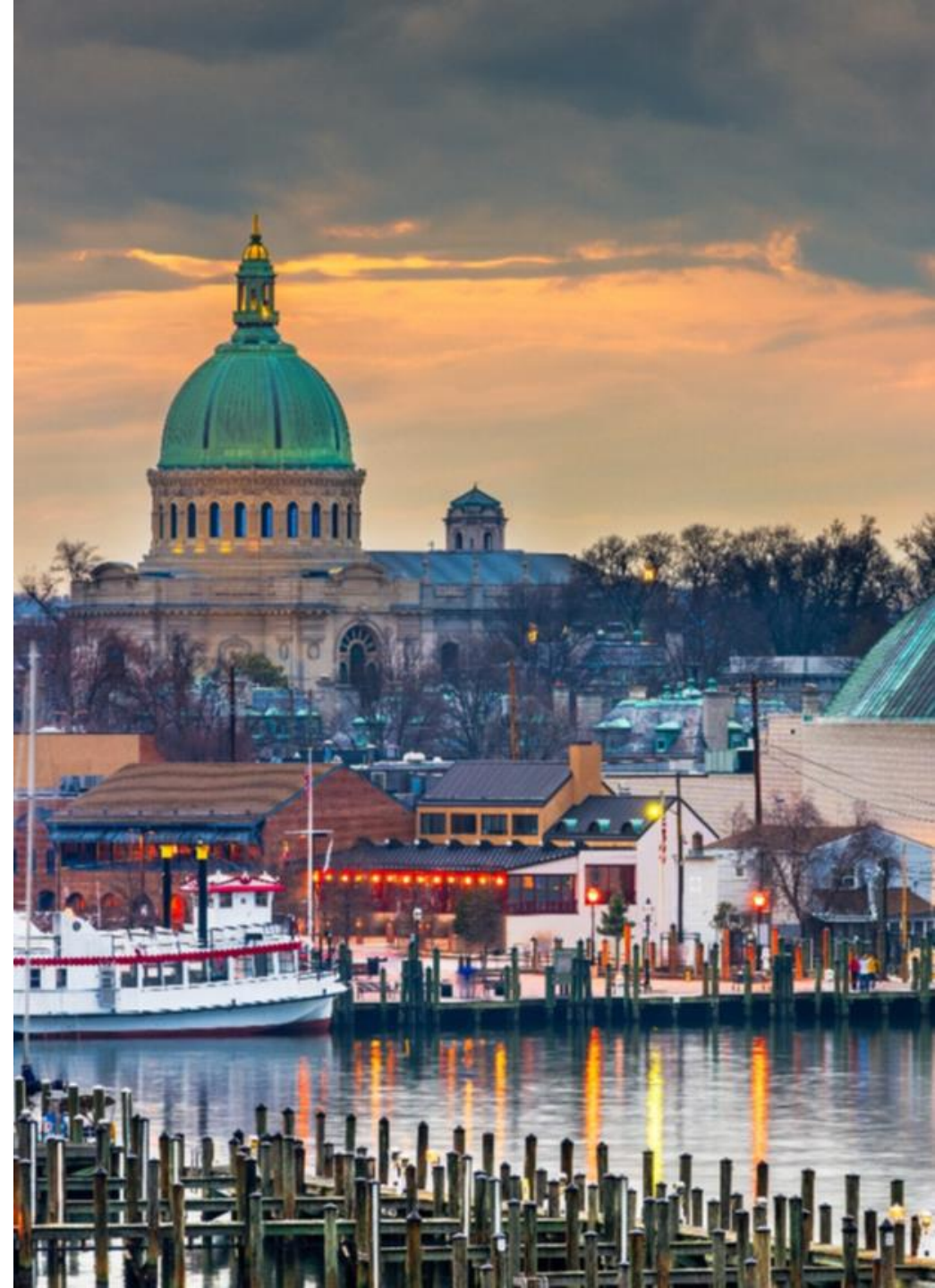
## **City of Annapolis Ordinance O-14-21**

[https://library.municode.com/md/annapolis/codes/code\\_of\\_ordinances?nodeId=TIT2AD\\_CH2.58REAUANANARCO](https://library.municode.com/md/annapolis/codes/code_of_ordinances?nodeId=TIT2AD_CH2.58REAUANANARCO)

## **Anne Arundel County Bill No. 31-21**

## **City of Annapolis NSA Annapolis Military Installation Resilience Study**

<https://www.annapolis.gov/1917/NSA-Annapolis-Military-Installation-Resi>





# Questions & Comments