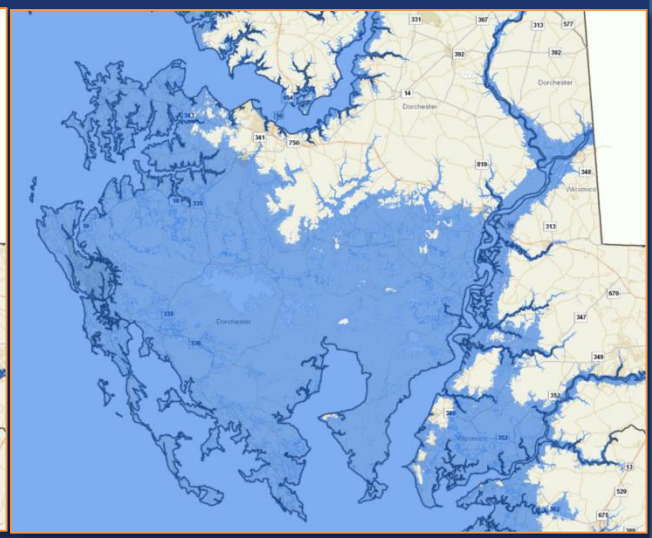
Maryland Adaptation and Vulnerability Assessment



Maryland State Highway Administration

October 4, 2016

Maryland Department of Transportation

SHA State Highway Administration
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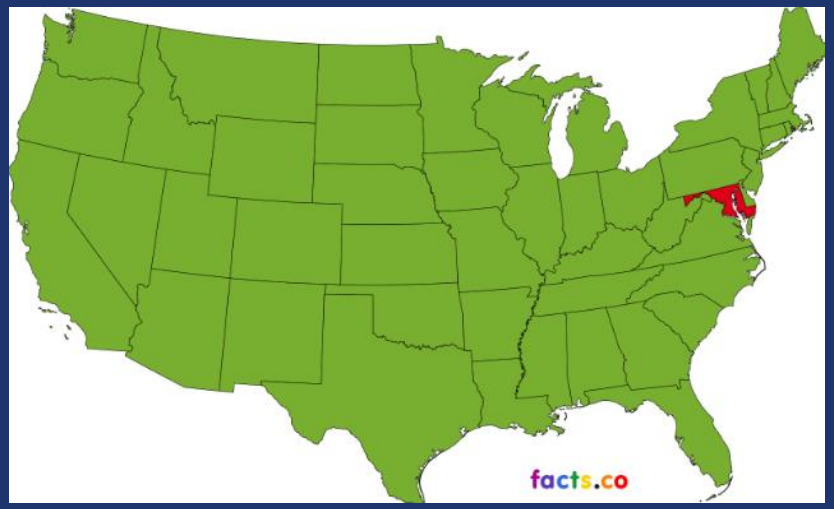
Introduction

Maryland:

- Atlantic Ocean and Chesapeake Bay
- 7,719 miles of shoreline
- Coastal in the East
  to Appalachian Mountains
  in the West
- Ranked 42nd in Area (12,407 sq. mi)
- Ranked 19th in Population (6,006,401)
- Average annual temperature 55.1^{o}F
  - Summer average 80°F
  - Winter average 20°F
- Increases in temperature, precipitation intensity/frequency, sea level change.
- Political environment supports resiliency planning



Climate Change Groups

Maryland:

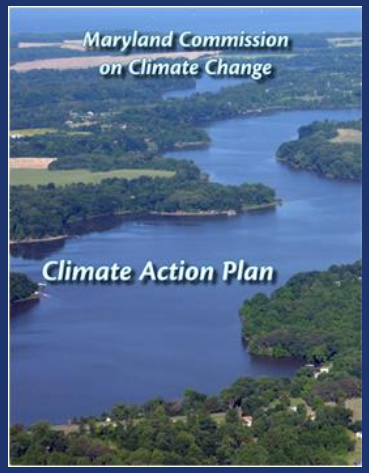
MD Commission on Climate Change Work Groups

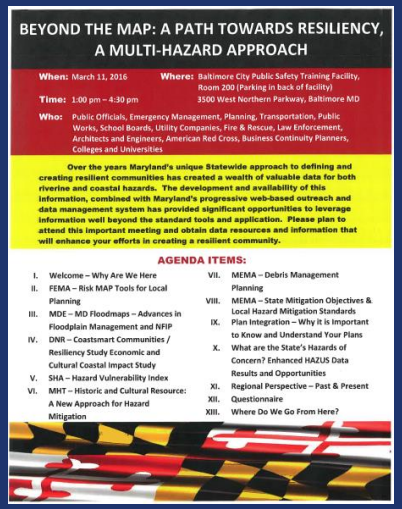
- *Steering Committee*
  - *2015 MD Commission on Climate Change Report Education, Communication and Outreach*
- *Greenhouse Gas Mitigation*
  - *2012 Greenhouse Gas Emissions Reduction Plan & 2015 Update*
- *Adaptation and Response*
  - *Comprehensive Strategy for Reducing Maryland's Vulnerability to Climate Change, Phase I: Sea-level rise and coastal storms*
  - *Comprehensive Strategy for Reducing Maryland's Vulnerability to Climate Change, Phase II: building societal, economic, and ecological resilience*
- *Scientific and Technical*
  - *Updating MD's Sea-level Rise Projections Report – 2013*

Coast Smart Council – 2014

Silver Jackets - Baltimore

Maryland Resiliency Partnership





BEYOND THE MAP: A PATH TOWARDS RESILIENCY, A MULTI-HAZARD APPROACH

When: March 11, 2016
Where: Baltimore City Public Safety Training Facility, Room 200 (Parking in back of facility)
Time: 1:00 pm – 4:30 pm
3500 West Northern Parkway, Baltimore MD
Who: Public Officials, Emergency Management, Planning, Transportation, Public Works, School Boards, Utility Companies, Fire & Rescue, Law Enforcement, Architects and Engineers, American Red Cross, Business Continuity Planners, Colleges and Universities

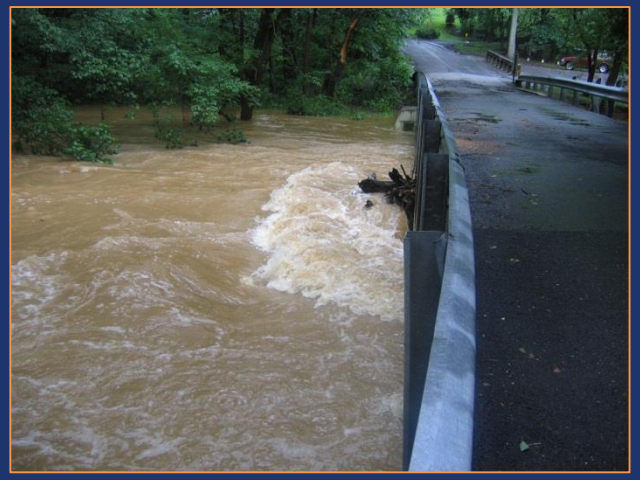
Over the years Maryland's unique Statewide approach to defining and creating resilient communities has created a wealth of valuable data for both riverine and coastal hazards. The development and availability of this information, combined with Maryland's progressive web-based outreach and data management system has provided significant opportunities to leverage information well beyond the standard tools and application. Please plan to attend this important meeting and obtain data resources and information that will enhance your efforts in creating a resilient community.

AGENDA ITEMS:

I. Welcome – Why Are We Here
II. FEMA – Risk MAP Tools for Local Planning
III. MDE – MD Floodmaps – Advances in Floodplain Management and NFIP
IV. DNR – Coastsmart Communities / Resiliency Study Economic and Cultural Coastal Impact Study
V. SHA – Hazard Vulnerability Index
VI. MHT – Historic and Cultural Resource: A New Approach for Hazard Mitigation
VII. MEMA – Debris Management Planning
VIII. MEMA – State Mitigation Objectives & Local Hazard Mitigation Standards
IX. Plan Integration – Why It is Important to Know and Understand Your Plans
X. What are the State's Hazards of Concern? Enhanced HAZUS Data Results and Opportunities
XI. Regional Perspective – Past & Present
XII. Questionnaire
XIII. Where Do We Go From Here?

Pilot Study Objectives

- Assess Vulnerability to SHA's Assets
- Develop Approaches to Address Current and Future Risk
- Provide Recommendations for Policy or Process Changes



Floating Debris Lodged in a Bridge during Flood Event at Seneca Creek in Germantown, MD
Photo Source: (FEMA/Skolnik 2006)

"Improve Resiliency of Maryland's Transportation System"

Identify Climate Stressors

Studied in Detail for Maryland

Sea Level Change

- USACE Procedures Established in Circular No. 1165-2-212 (2013)
- Newer LiDAR and Assign Nearest Tidal Station

Storm Surge

- HAZUS-MH 2.1 (Category 3 Storm Used)
- Stillwater Depth Grids Developed

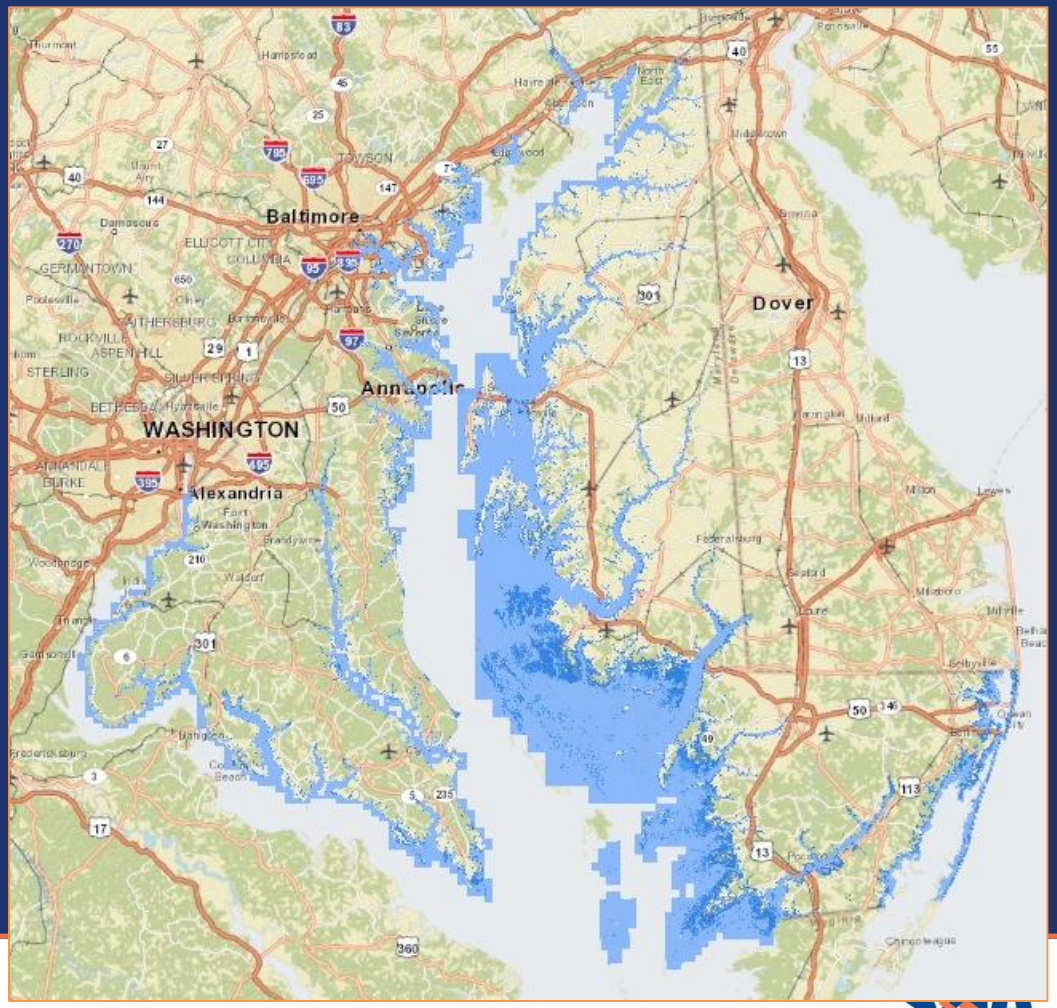
Precipitation

- Micro-scale Data Obtained from C-MIP
- Riverine Modeling in HAZUS-MH2.1 (future)

2050 & 2100 Sea Level Change

Eastern Shore Regional GIS Cooperative – Salisbury University

		2050		2100	
County	Tidal Station	MSL	MHHW	MSL	MHHW
Allegany	None	-	-	-	-
Anne Arundel	Annapolis	2.08	2.79	5.7	6.41
Baltimore	Baltimore	2.01	2.87	5.59	6.45
Baltimore City	Baltimore	2.01	2.87	5.59	6.45
Calvert	Solomons Island	2.1	2.82	5.76	6.48
Caroline	Cambridge	2.11	3.13	5.78	6.8
Carroll	None	-	-	-	-
Cecil	Chesapeake City	1.98	3.63	5.56	7.21
Charles	Washington DC	2.21	3.83	5.78	7.4
Dorchester	Cambridge	2.11	3.13	5.78	6.8
Frederick	None	-	-	-	-
Garrett	None	-	-	-	-
Harford	Baltimore	2.01	2.87	5.59	6.45
Howard	None	-	-	-	-
Kent	Annapolis	2.08	2.79	5.7	6.41
Montgomery	None	-	-	-	-
Prince Georges	Washington DC	2.21	3.83	5.78	7.4
Queen Annes	Annapolis	2.08	2.79	5.7	6.41
Somerset	Cambridge	2.11	3.13	5.78	6.8
St. Mary's	Solomons Island	2.1	2.82	5.76	6.48
Talbot	Cambridge	2.11	3.13	5.78	6.8
Washington	None	-	-	-	-
Wicomico	Cambridge	2.11	3.13	5.78	6.8
Worcester	Ocean City	2.06	3.25	5.86	7.05



Methodology – USACE: Sea-Level Change Considerations for Civil Works Programs, October 2013

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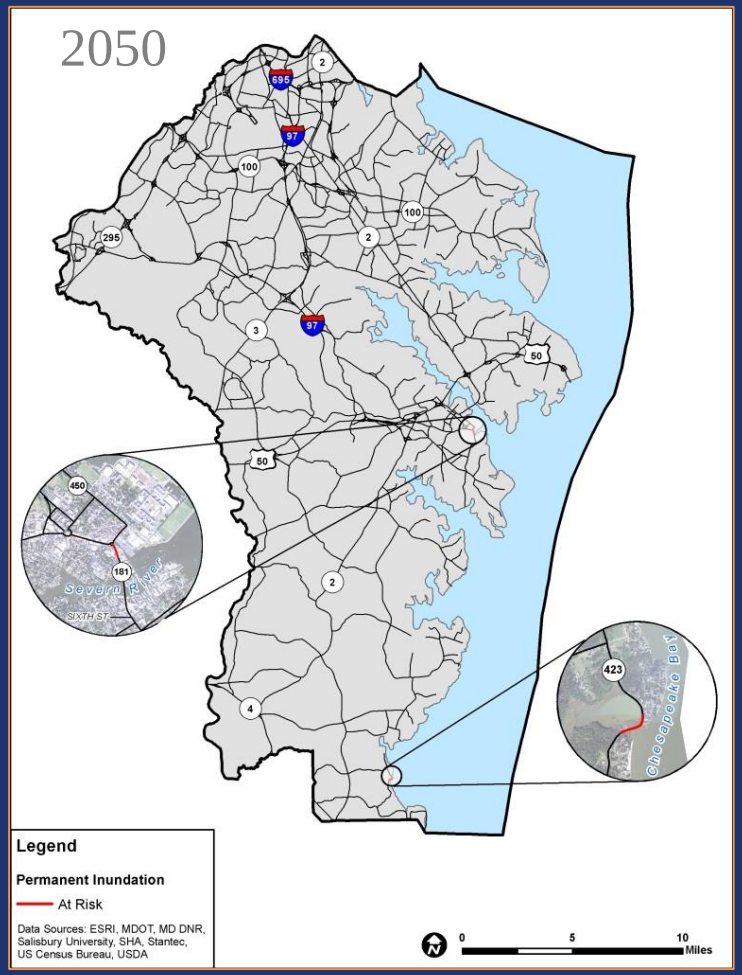
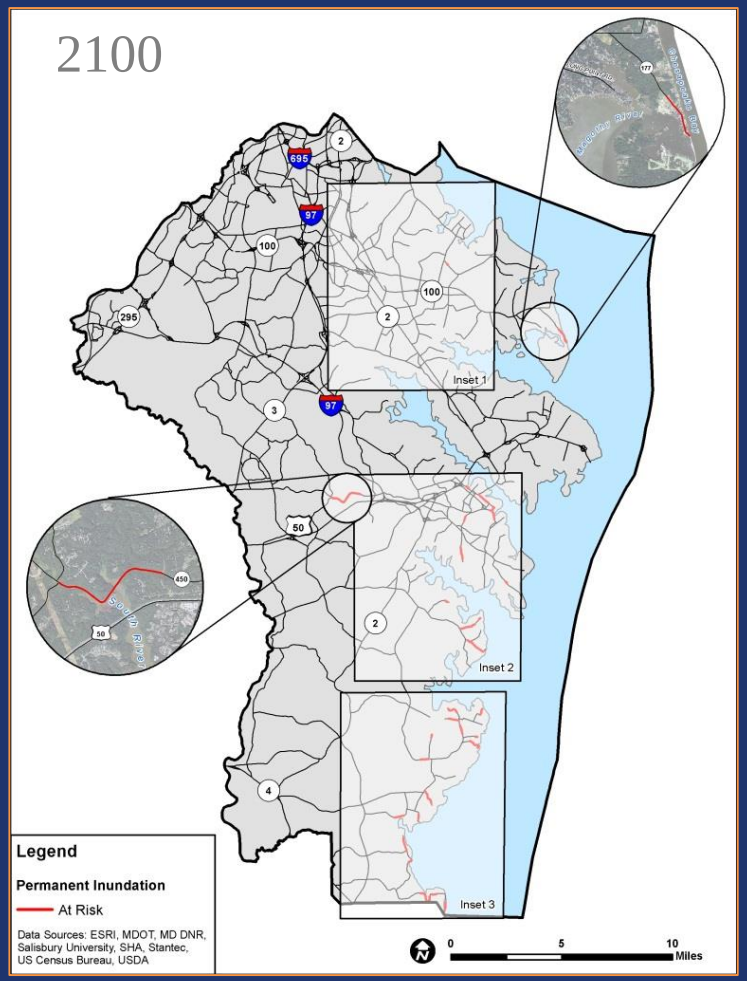
Permanent Inundation for Anne Arundel





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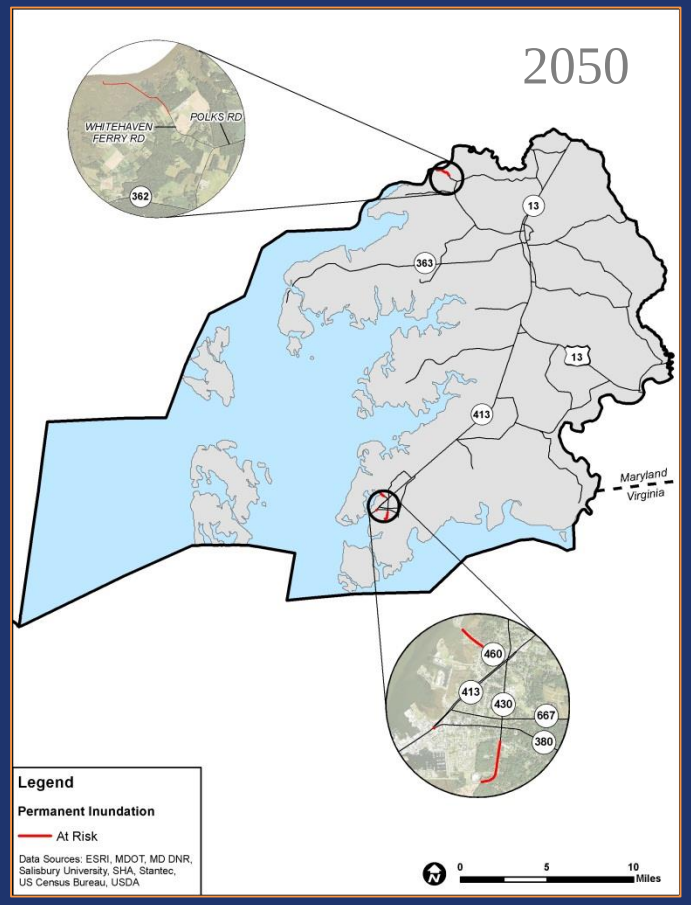
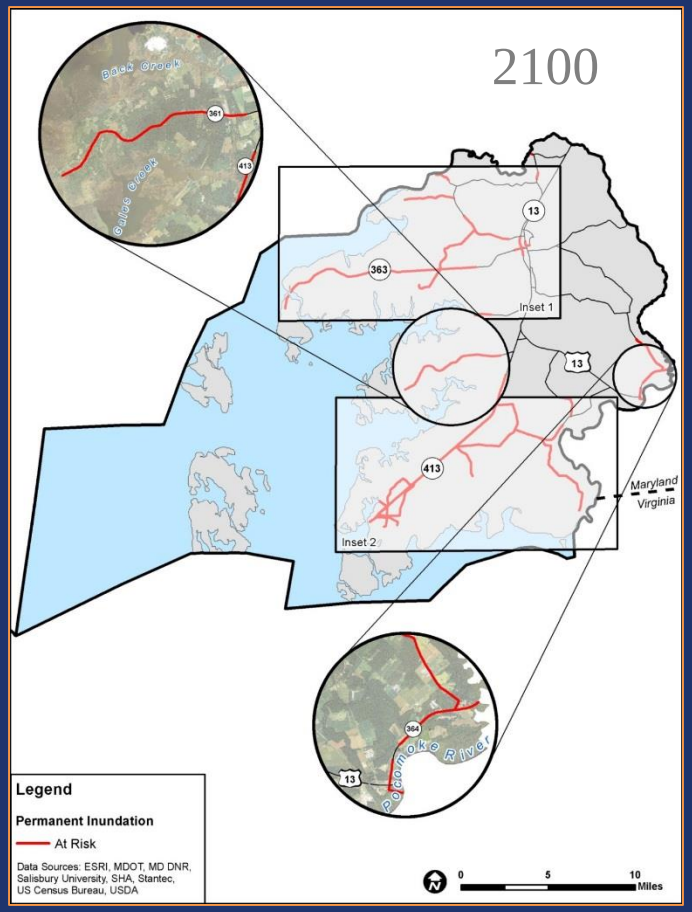
Permanent Inundation
Somerset County





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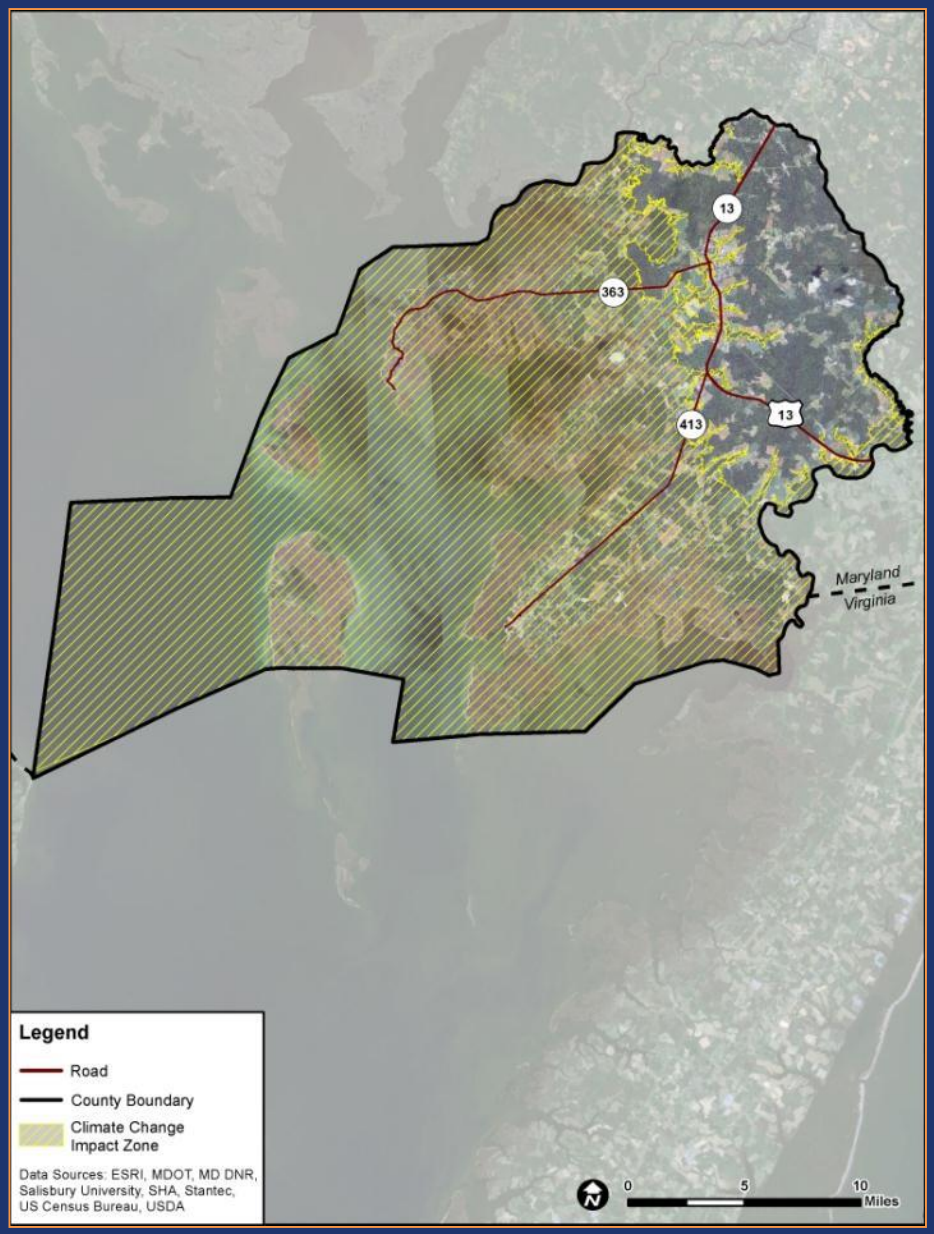
Key Step

Assess Vulnerability

- Two Pilot Counties
- Initial Screening of Assets
- Tools Used
  - Vulnerability Assessment Scoring Tool
  - Hazard Vulnerability Index



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Climate Change Impact Zone
Somerset County, MD

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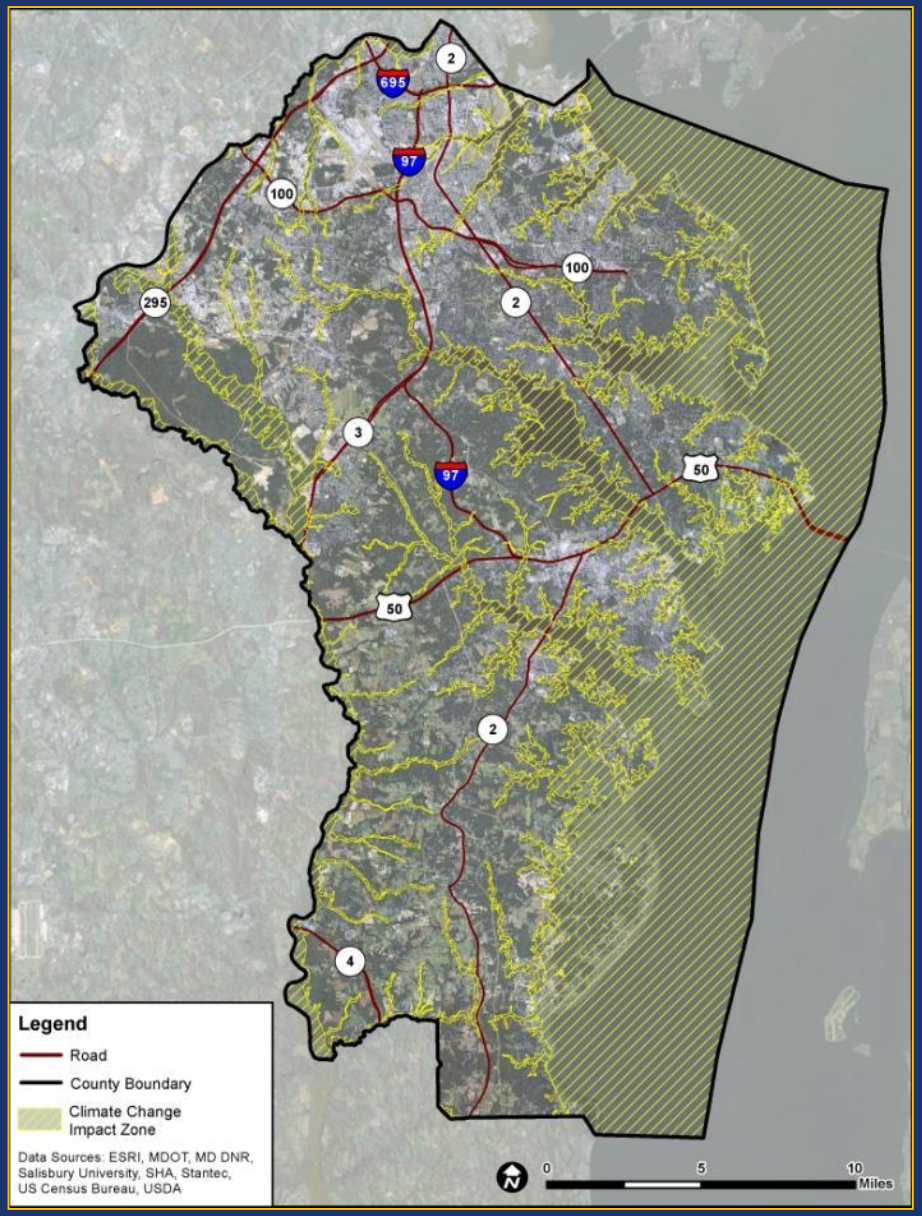
Initial Screening

- Climate Change Impact Zone Map Created Using GIS
- Eliminate assets at low to no risk prior to use of VAST
- Used SLOSH (Cat 3), 2100 MHHW, FEMA 100 year Floodplain, plus 50 ft buffer



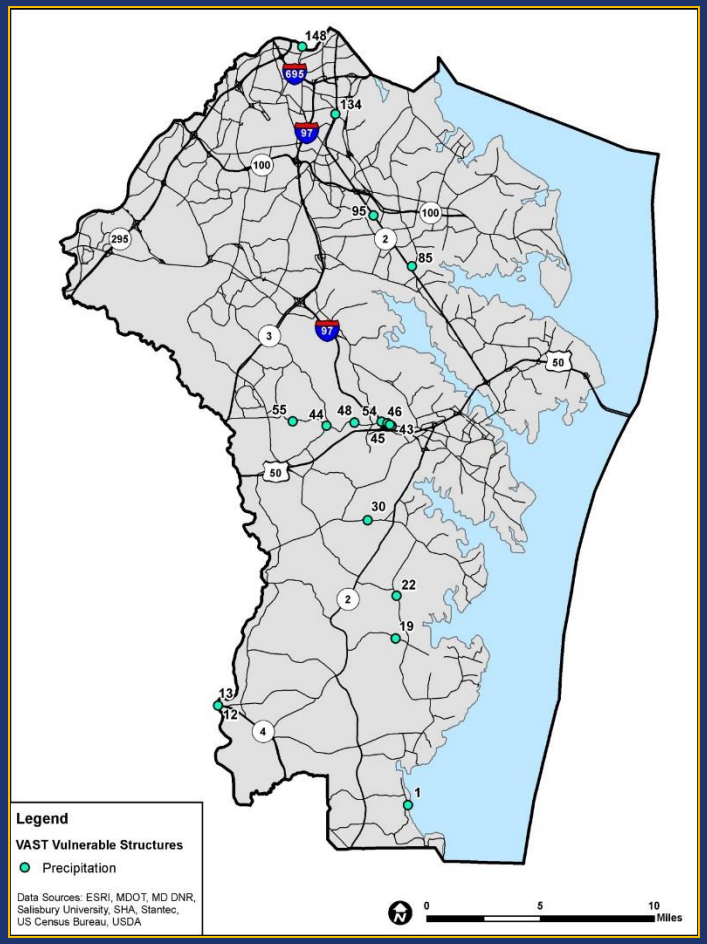
Results of Screening

Assets	Anne Arundel County		Somerset County	
	Number of Assets	Evaluated in More Detail	Number of Assets	Evaluated in More Detail
Bridges including large culverts	517	150	86	72
Small culverts and conveyances	Culverts- 12,024 Conveyances- 8,601	Culverts- 1,174 Conveyances- 843	Culverts- 1153 Conveyances 1135	Culverts- 739 Conveyances 847
Miles of roadway	2,554.28 miles	114.99 miles	503.92 miles	285.2 miles

VAST - Input and Results

- 150 bridge assets in Anne Arundel County
- 72 bridge assets in Somerset County
- Input Information
  - Asset data
  - Exposure data
  - Sensitivity data
  - Adaptive Capacity data
- Output
  - Vulnerability Score for all structures
  - 10 most vulnerable assets to each climate stressor
  - Maps and tables showing most vulnerable structures

FHWA Vulnerability Assessment Scoring Tool Results



Vulnerability to Precipitation		
Structure ID	VAST Score	Evacuation Route
134	3.1	Yes
44	2.8	No
30	2.8	No
43	2.8	No
45	2.8	No
46	2.8	No
1	2.6	No
22	2.6	No
95	2.5	Yes

Hazard Vulnerability Index (HVI)

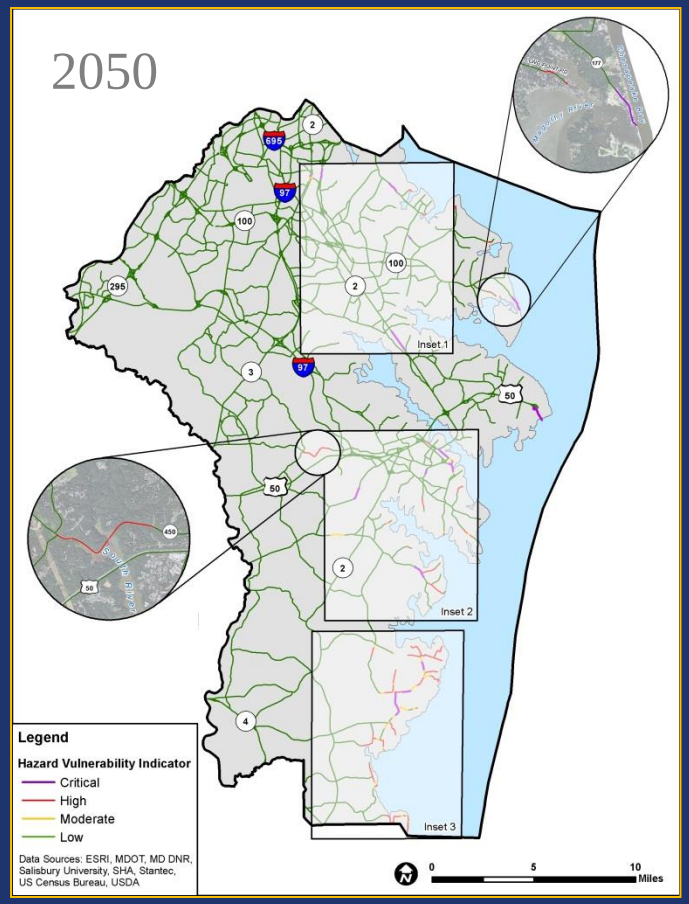
$$Risk = (Evacuation\ Code * 0.5 + 1) * \left(\frac{(Flood\ Depth\ Code + 0.01)}{4}\right) * \left(\frac{0.7}{Functional\ Classification}\right)$$

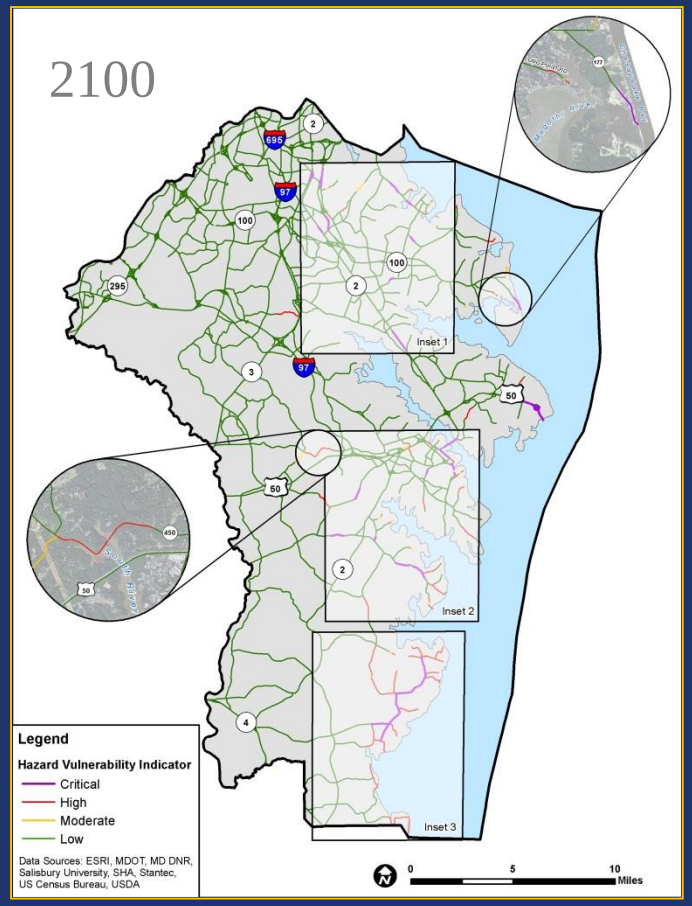
Evacuation	Code
No	0
Yes	1

Flood Depth (Feet)	Code
No Flood	0
0 – 0.5	1
0.5 - 1	2
1 - 2	3
>2	4

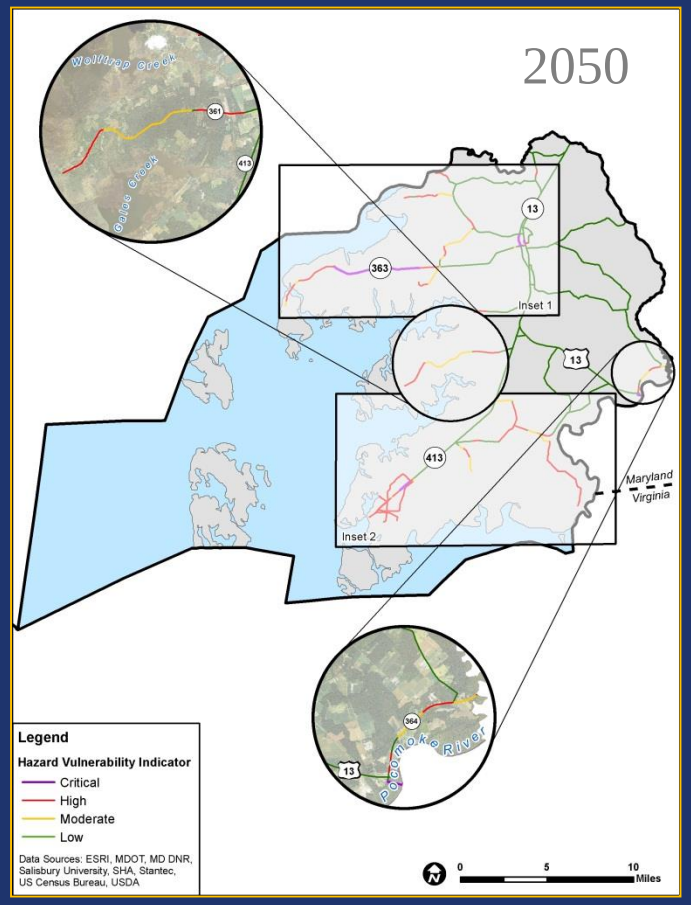
Value	SHA Functional Class
1	Interstate
2	Principal Arterial – Other Freeways and Expressways
3	Principal Arterial – Other
4	Minor Arterial
5	Major Collector
6	Minor Collector
7	Local

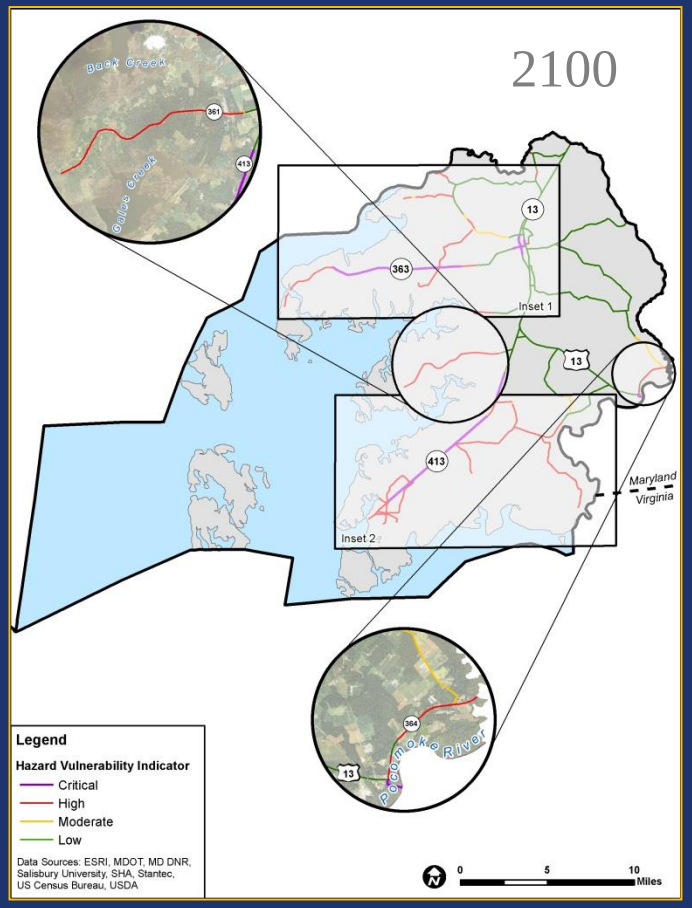
HVI for Anne Arundel County



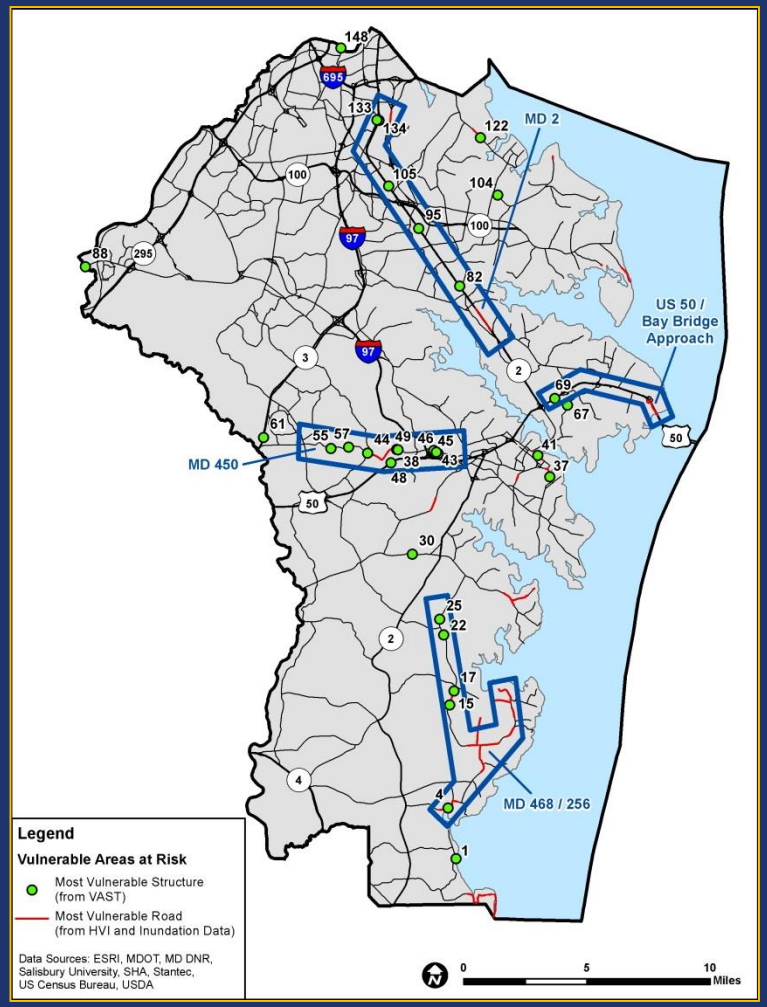


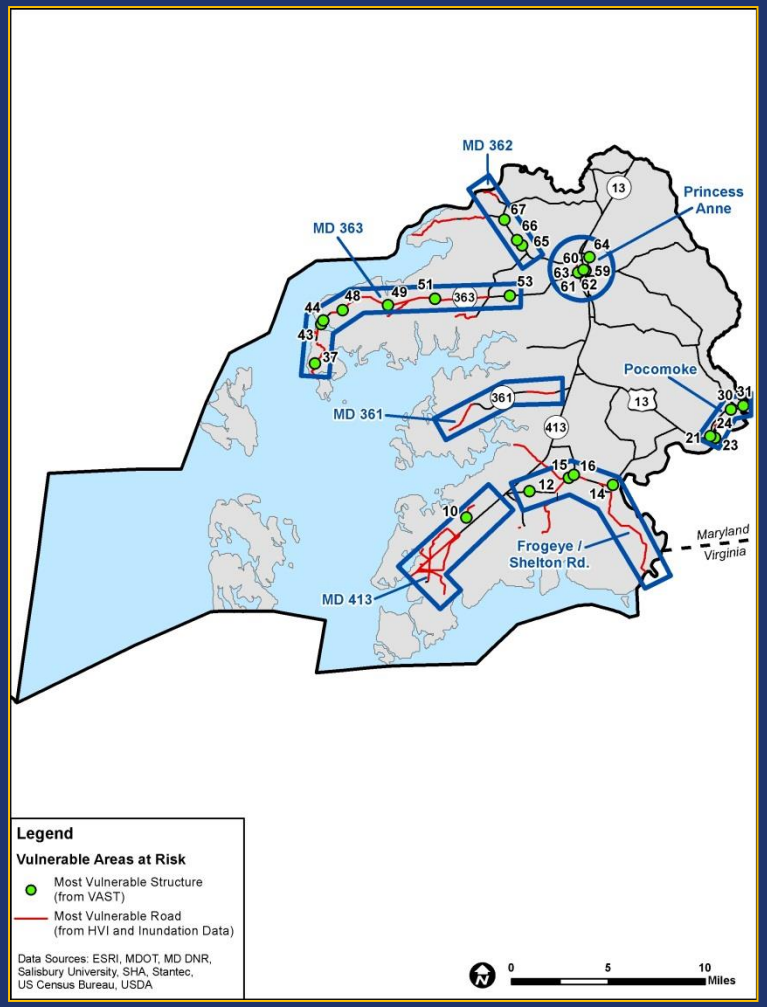
HVI for Somerset County





Vulnerable Areas at Risk





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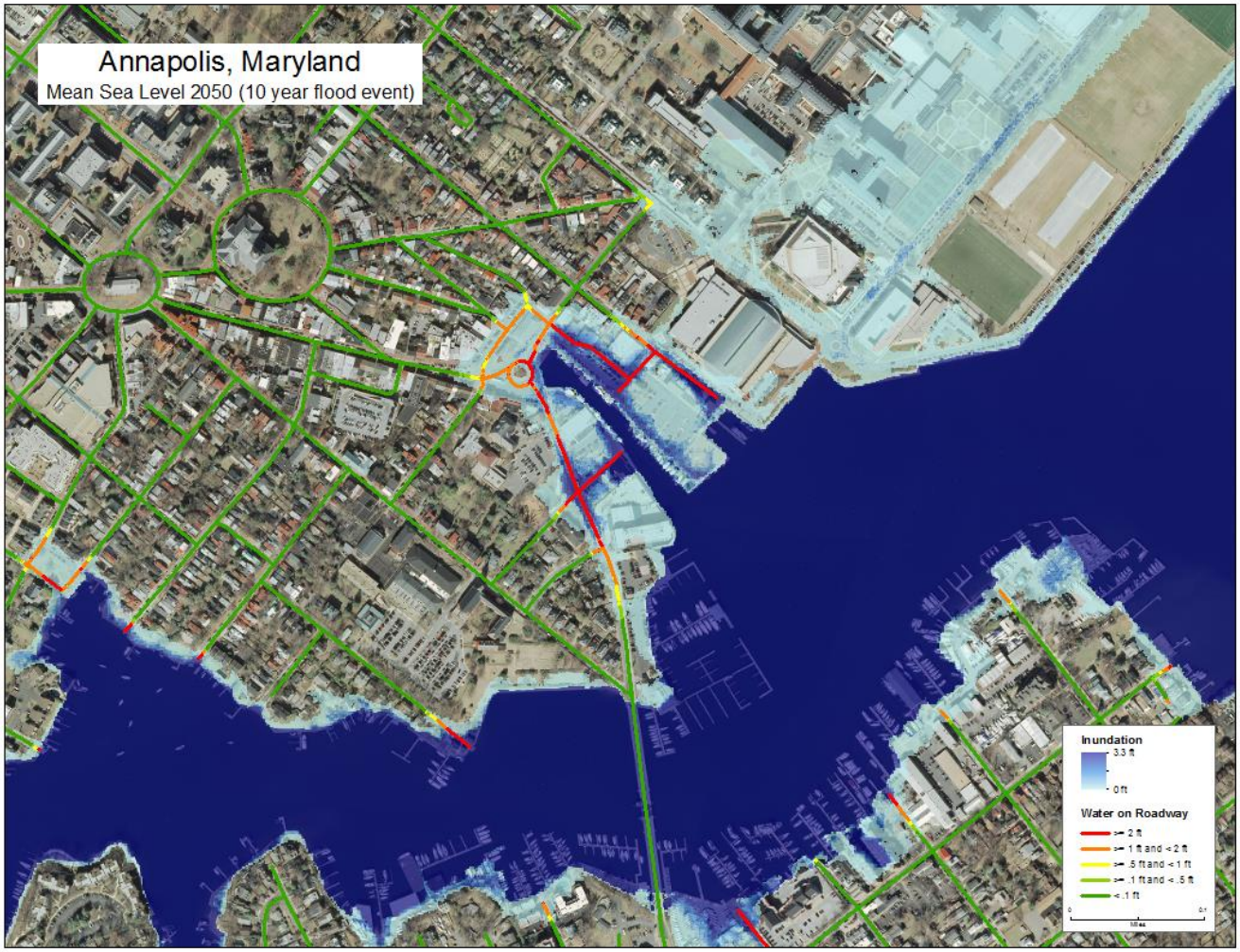
HVI for Annapolis 2050



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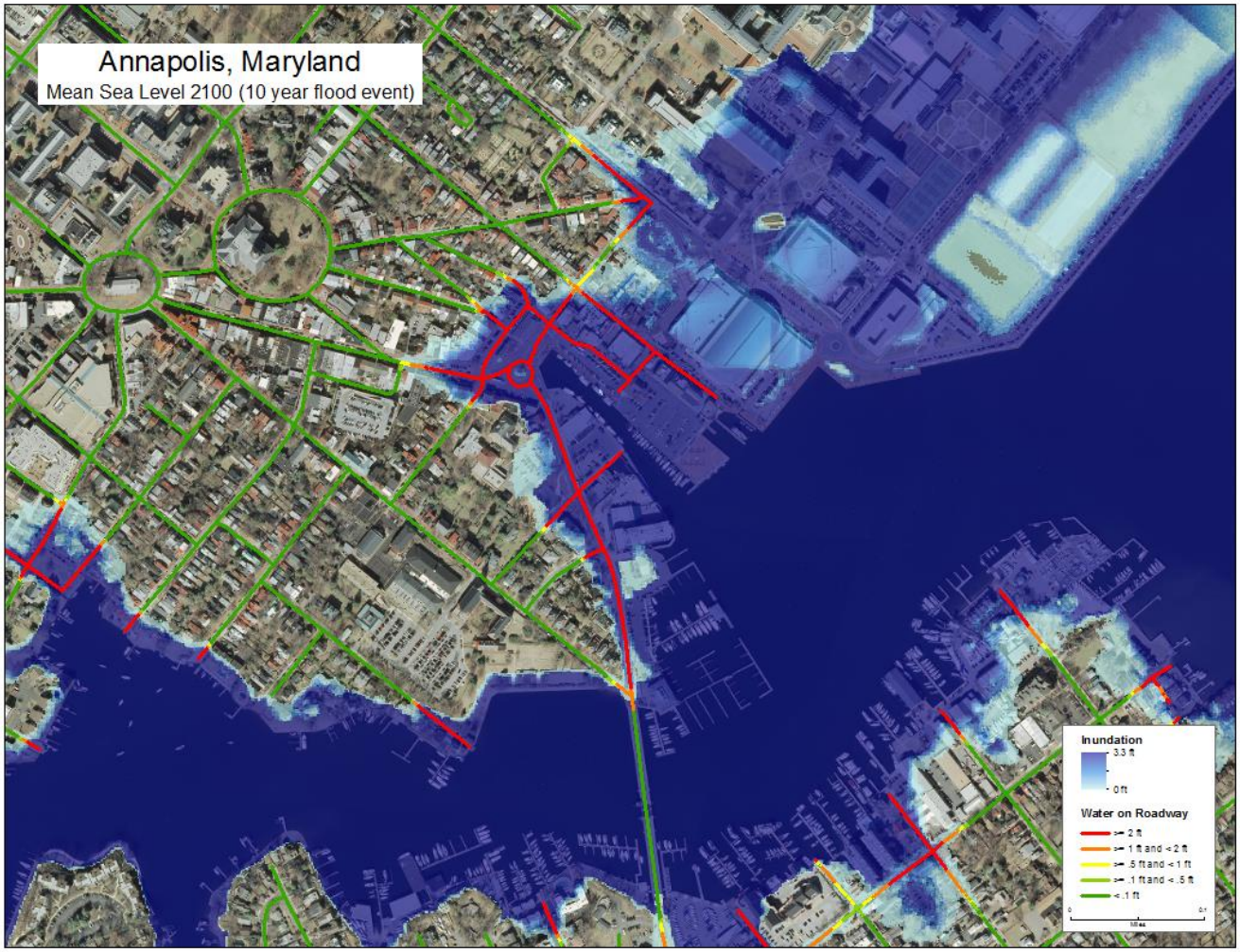
HVI for Annapolis 2100

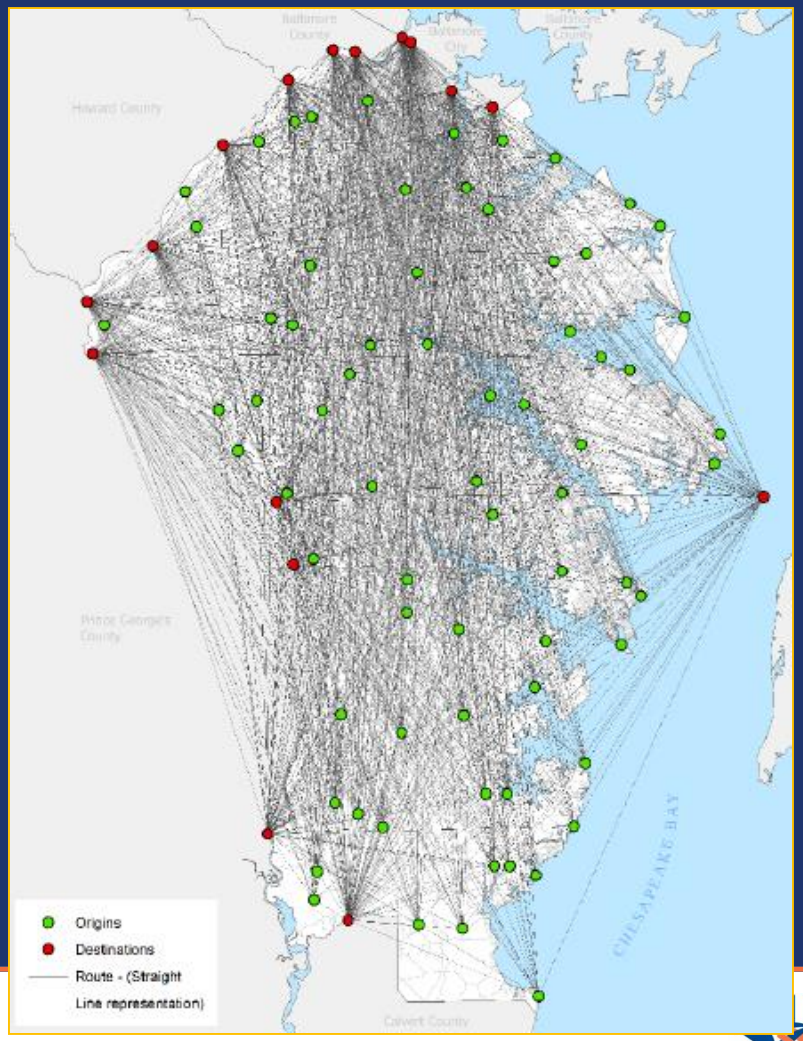


Results

- Anne Arundel County and Somerset County
  - Permanent Inundation
  - 2050 & 2100 Sea Level Change (USACE method)
  - 2050 & 2100 Sea Level Change with 100 Year Storm Event (HAZUS-MH)
  - Storm Surge Considerations (Still Water)
  - Hazard Vulnerability Index (HVI)
  - Vulnerability Scores from VAST for bridges
  - Vulnerable Areas at Risk

Example Origin/Destination Network

- Evaluate the travel times and access to random locations both before and after a flood event
- 69 Random but evenly distributed Origin and Destination points chosen



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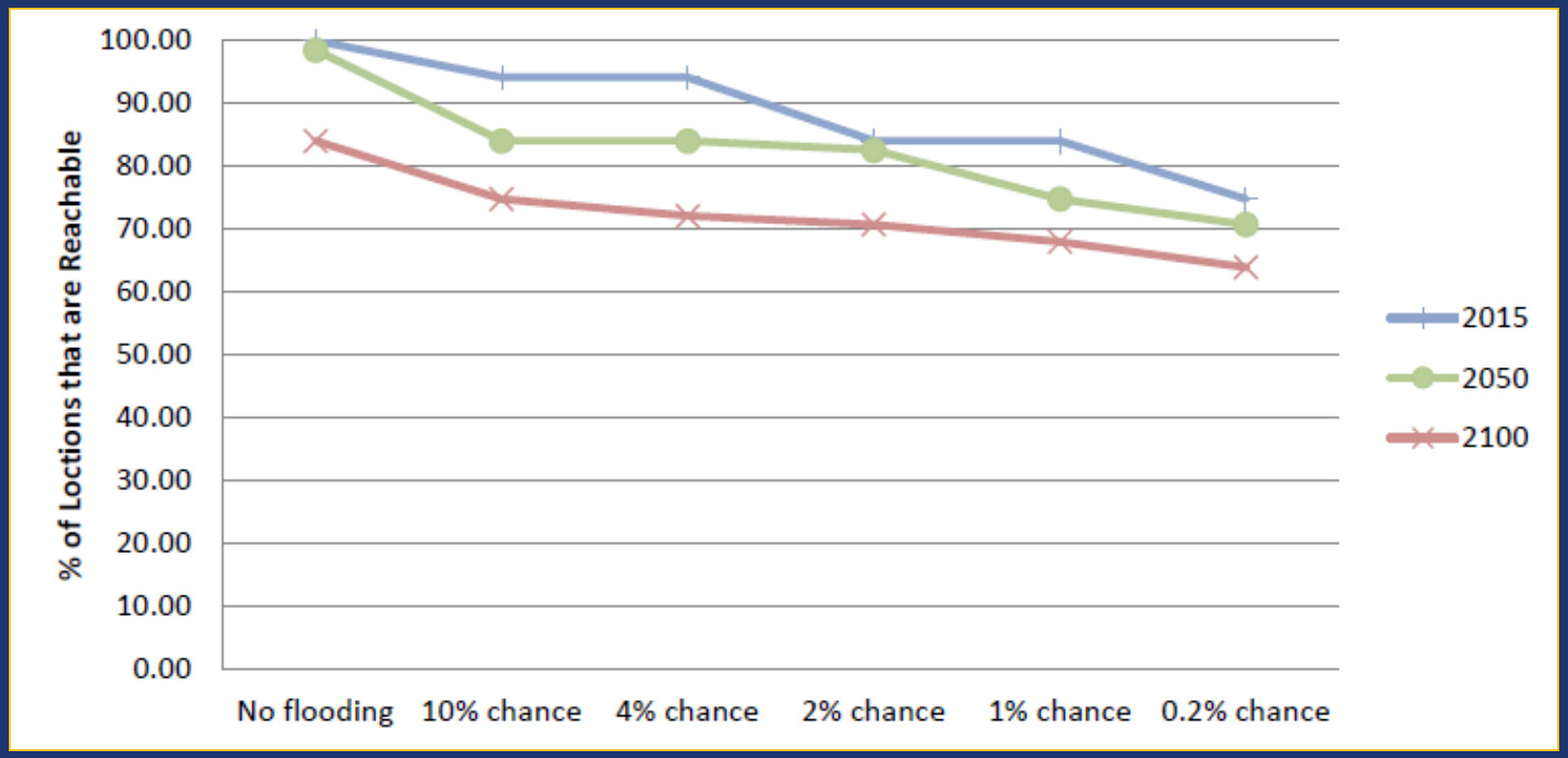
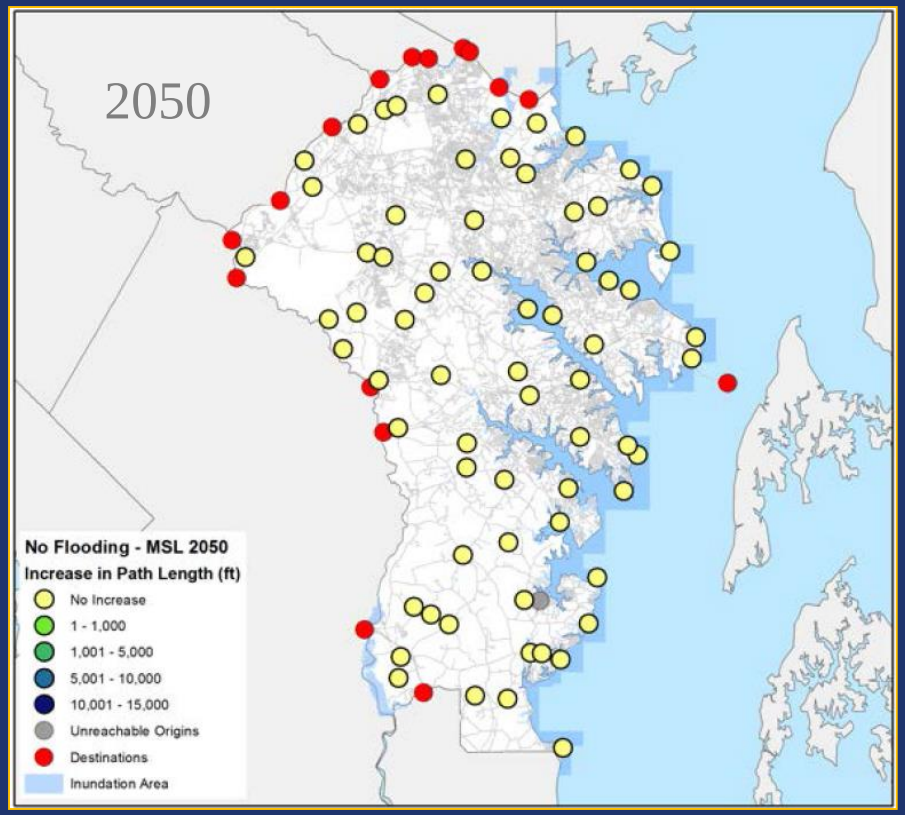
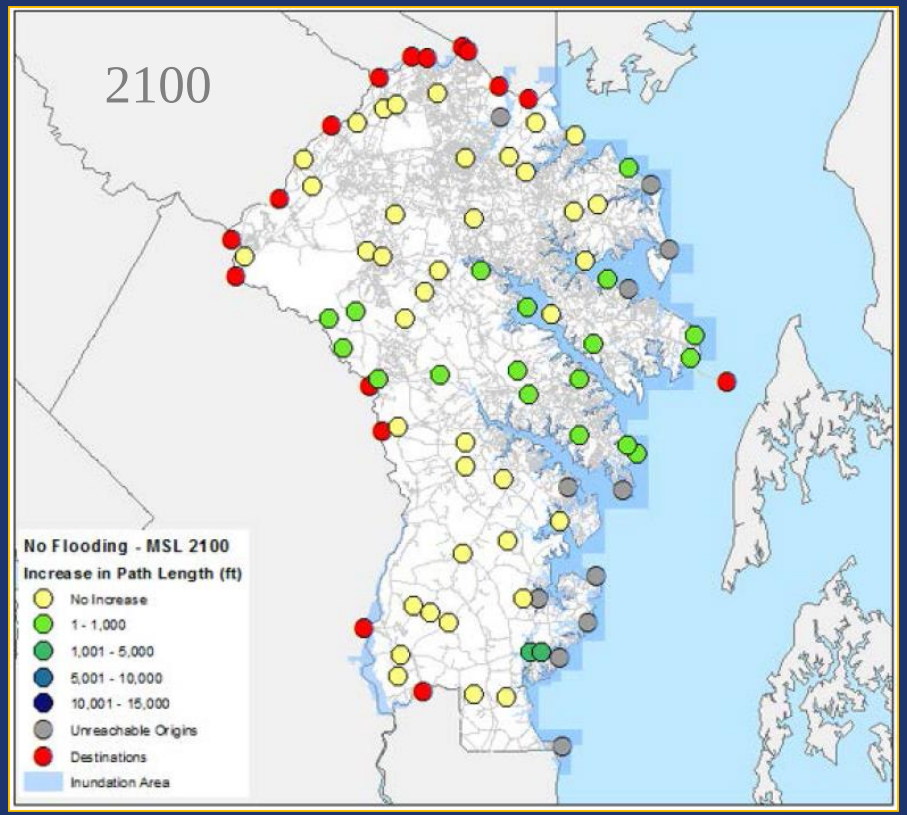
Percentage of Traversible Trace Paths in AA County with MSL SLC



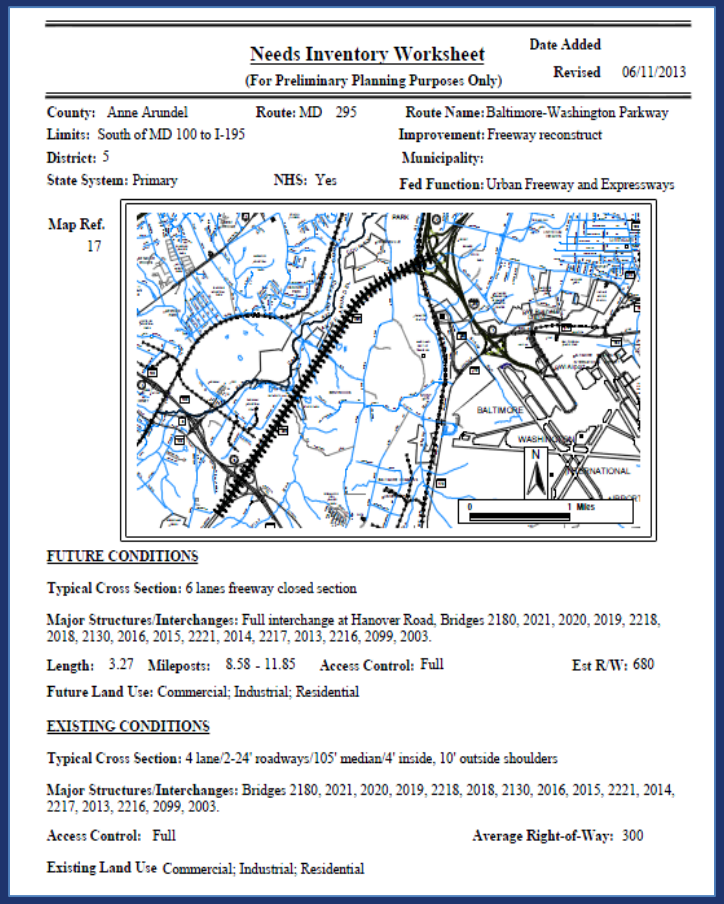
Origin to Destination Analysis





Highway Needs Inventory

- The HNI is planning document based on a technical evaluation of highway conditions.
- The general scope is based on reasonable design standards.
- Costs are approximate and based on likely improvement types.
- The HNI lists only major capital construction projects.
- Low cost or minor capital improvements, such as, “System Preservation Projects” are not included.



Needs Inventory Worksheet
(For Preliminary Planning Purposes Only)

Date Added
Revised 06/11/2013

County: Anne Arundel **Route:** MD 295 **Route Name:** Baltimore-Washington Parkway
Limits: South of MD 100 to I-195 **Improvement:** Freeway reconstruct
District: 5 **Municipality:**
State System: Primary **NHS:** Yes **Fed Function:** Urban Freeway and Expressways

Map Ref. 17

FUTURE CONDITIONS

Typical Cross Section: 6 lanes freeway closed section

Major Structures/Interchanges: Full interchange at Hanover Road, Bridges 2180, 2021, 2020, 2019, 2218, 2018, 2130, 2016, 2015, 2221, 2014, 2217, 2013, 2216, 2099, 2003.

Length: 3.27 **Mileposts:** 8.58 - 11.85 **Access Control:** Full **Est R/W:** 680

Future Land Use: Commercial; Industrial; Residential

EXISTING CONDITIONS

Typical Cross Section: 4 lane/2-24' roadways/105' median/4' inside, 10' outside shoulders

Major Structures/Interchanges: Bridges 2180, 2021, 2020, 2019, 2218, 2018, 2130, 2016, 2015, 2221, 2014, 2217, 2013, 2216, 2099, 2003.

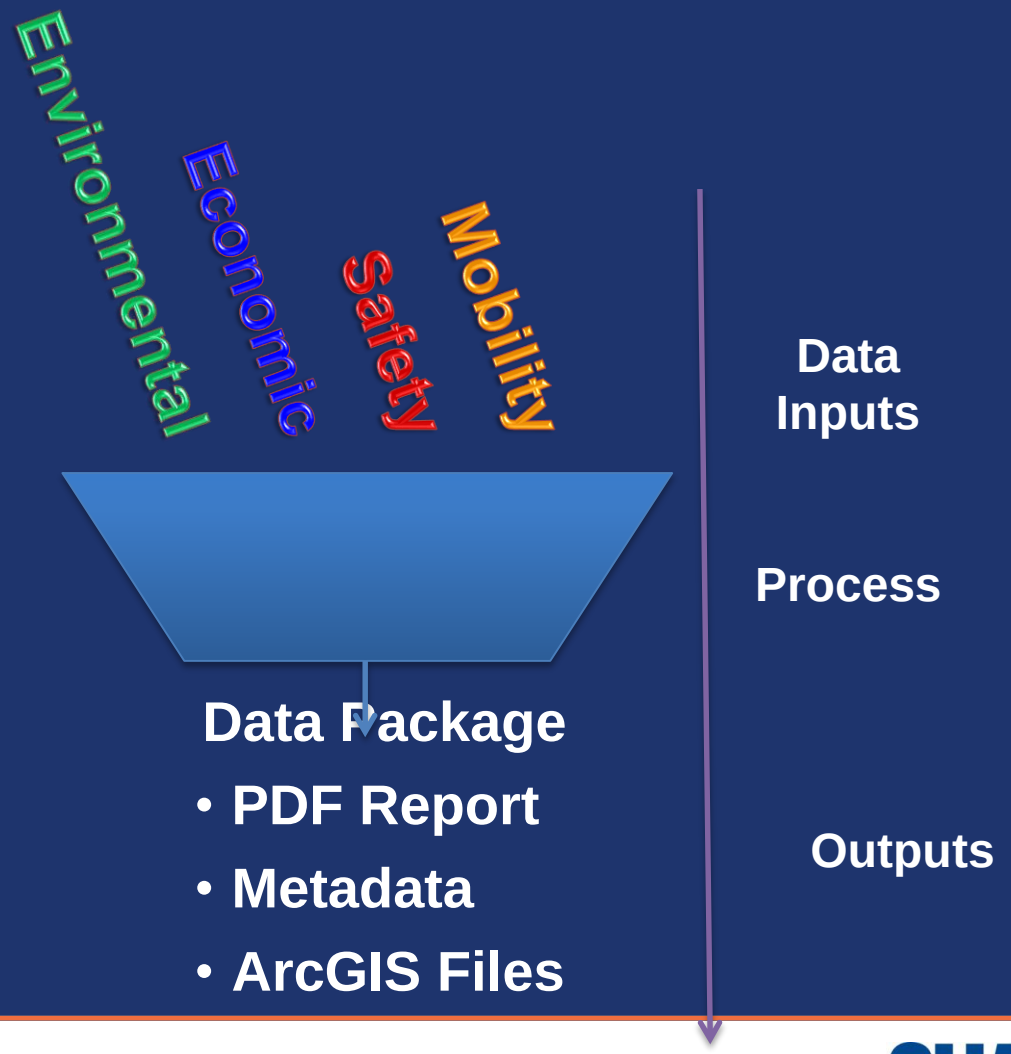
Access Control: Full **Average Right-of-Way:** 300

Existing Land Use Commercial; Industrial; Residential

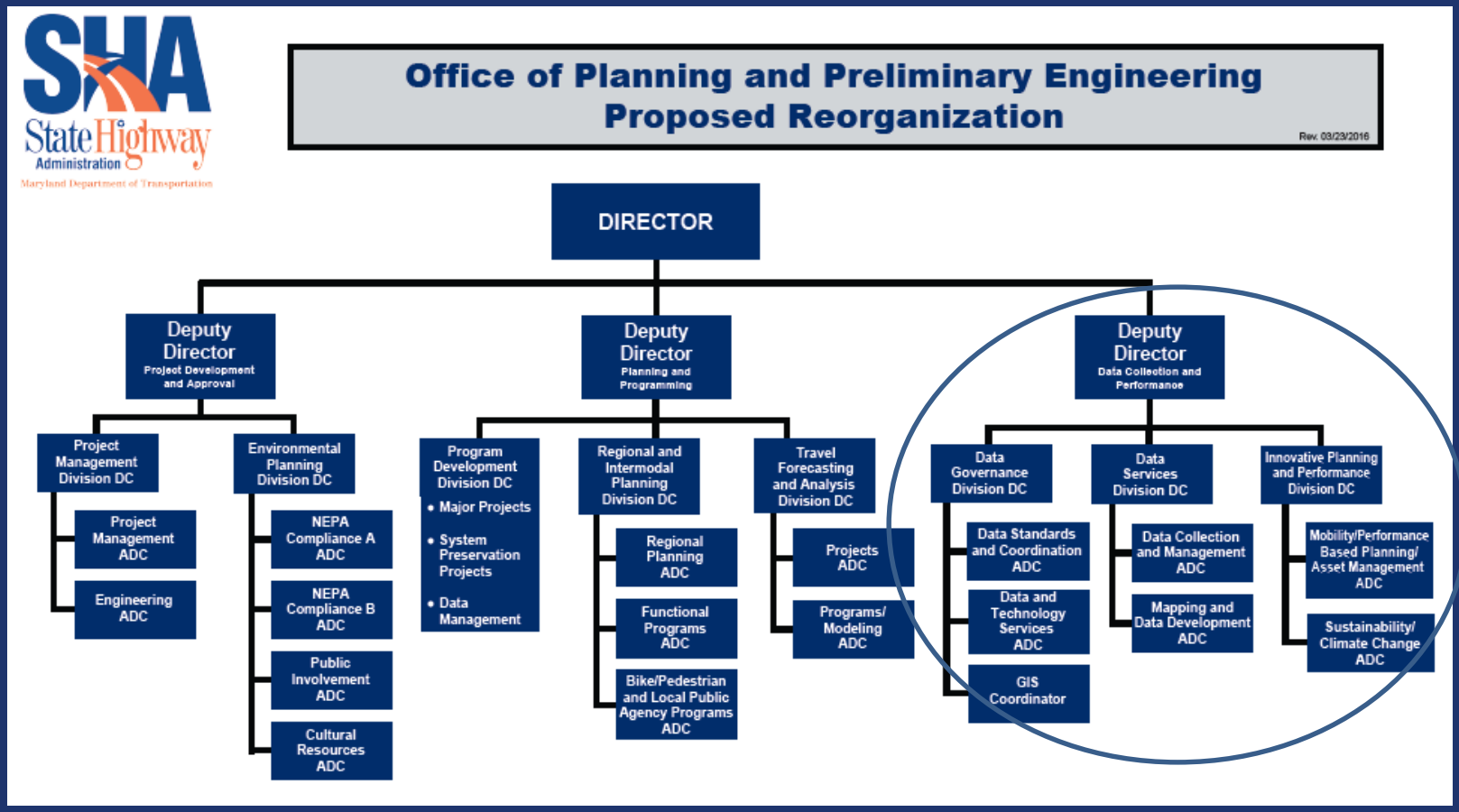
MOSAIC

The MOSAIC tool will allow SHA to:

- To take a data driven approach to the Highway Needs Inventory (HNI) and inform a discussion with the Counties.
- Analyze different project improvement alternatives at the long-term planning stage.
- Develop outputs to assist in project prioritization, asset management and funding decisions.



Integrate Into the Organization



Takeaways

Lessons Learned:

- NEPA is a good place to document adaptation but too late to identify the need for it
- Encourage other divisions to conduct climate studies

Tools/Resources:

- VAST and HVI are helpful for vulnerability assessments
- Many different vulnerability data will need to be collected and updated

Recommendations:

- Involve multidisciplinary teams as much as possible in studies and scoping tasks

Questions

Elizabeth Habic
Office of Planning and Preliminary Engineering
ehabic@sha.state.md.us
410-545-8563

Climate Change Adaptation Plan with Detailed Vulnerability Assessment, October 2014

http://www.fhwa.dot.gov/environment/climate_change/adaptation/ongoing_and_current_research/vulnerability_assessment_pilots/2013-2015_pilots/index.cfm