# Roadway Vulnerability Assessment

## Maryland Department of Transportation
## State Highway Administration

July 25, 2017

MARYLAND DEPARTMENT OF TRANSPORTATION
STATE HIGHWAY ADMINISTRATION

# Climate Stressors

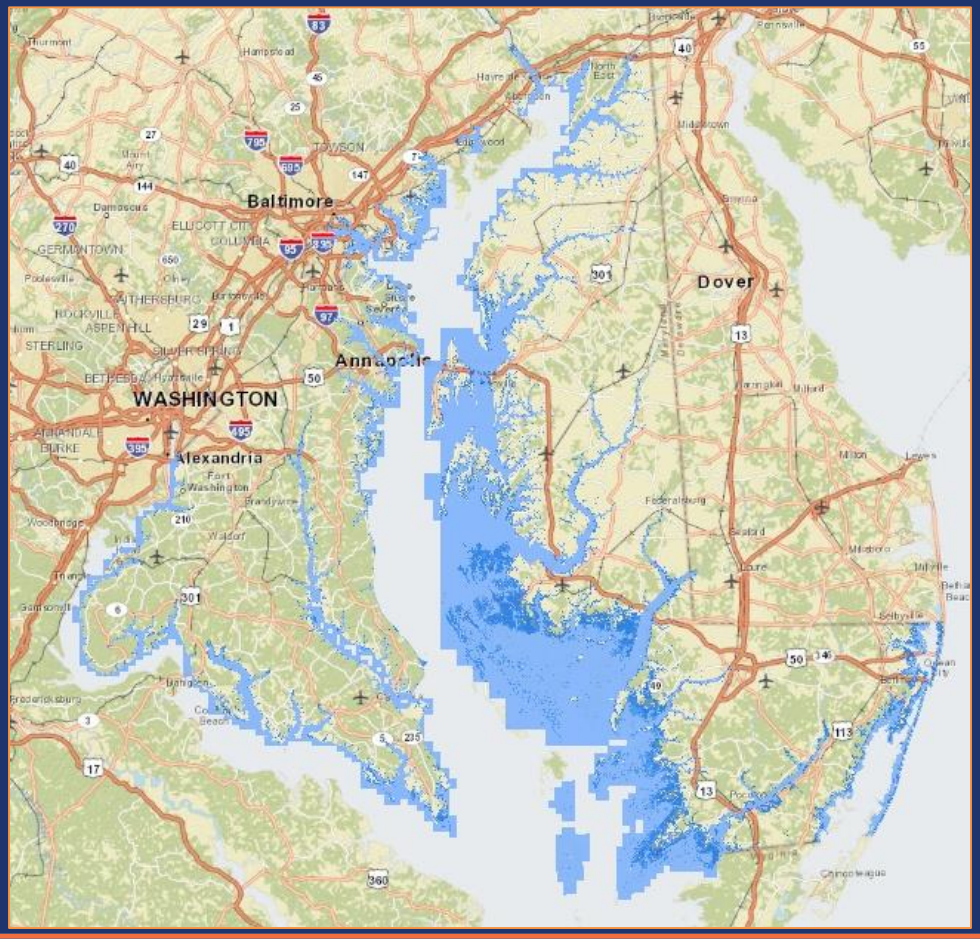
| | |
|---|---|
| **Sea Level Change** | • USACE Procedures Established in Circular No. 1165-2-212 (2013)<br>• Newer LiDAR and Assign Nearest Tidal Station |
| **Storm Surge** | • HAZUS-MH 2.1 (Category 3 Storm Used)<br>• Stillwater Depth Grids Developed |
| **Precipitation** | • Riverine Modeling in HAZUS-MH2.1 |

# 2050 & 2100 Sea Level Change

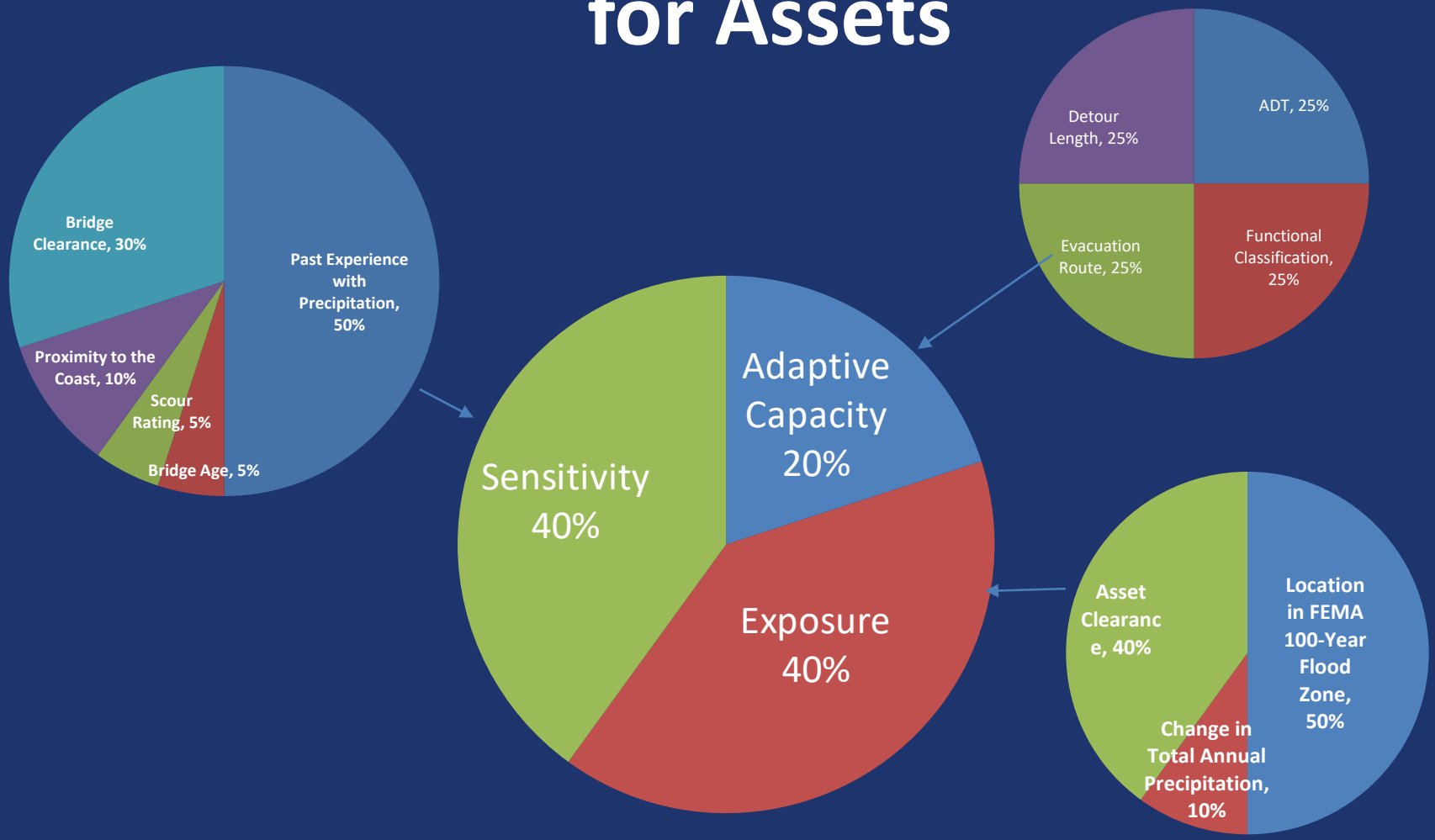
## Eastern Shore Regional GIS Cooperative – Salisbury University

| | | 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 |

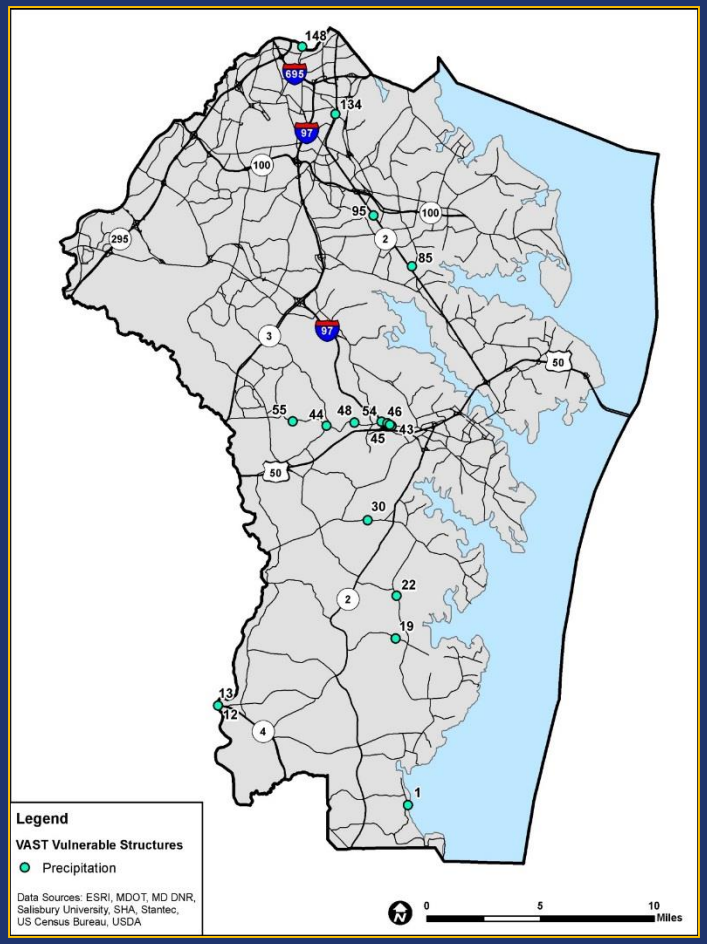
Methodology – USACE: Sea-Level Change Considerations for Civil Works Programs, October 2013



# Vulnerability Assessment Scoring Tool for Assets



# 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)

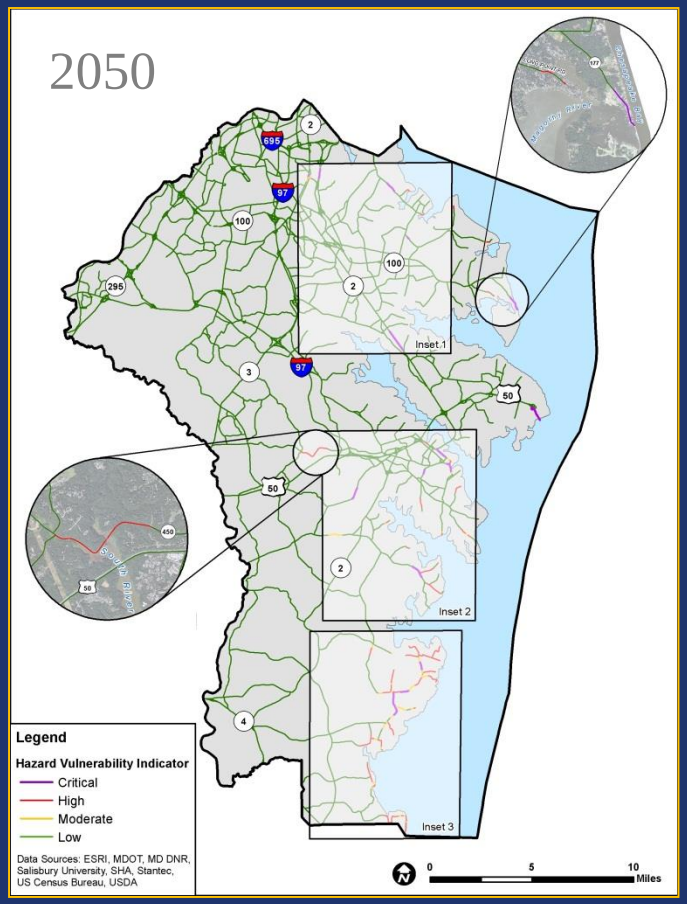
(Evacuation Code*0.5+1) + (Flood Depth Code+0.01)/4 + (0.7/Functional Classification)

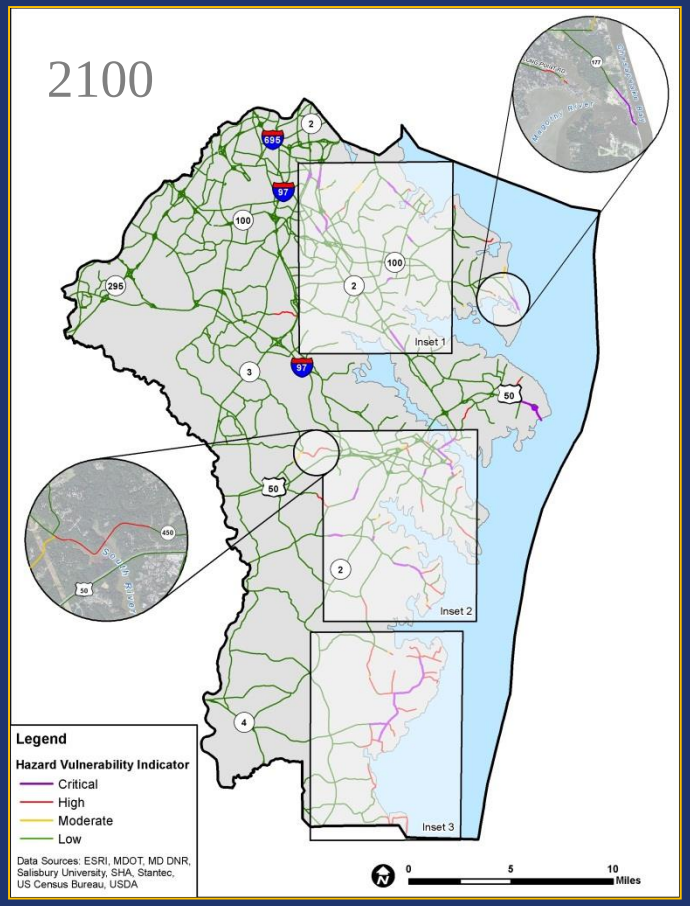
| Evacuation | Code |
|---|---|
| No | 0 |
| Yes | 1 |

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

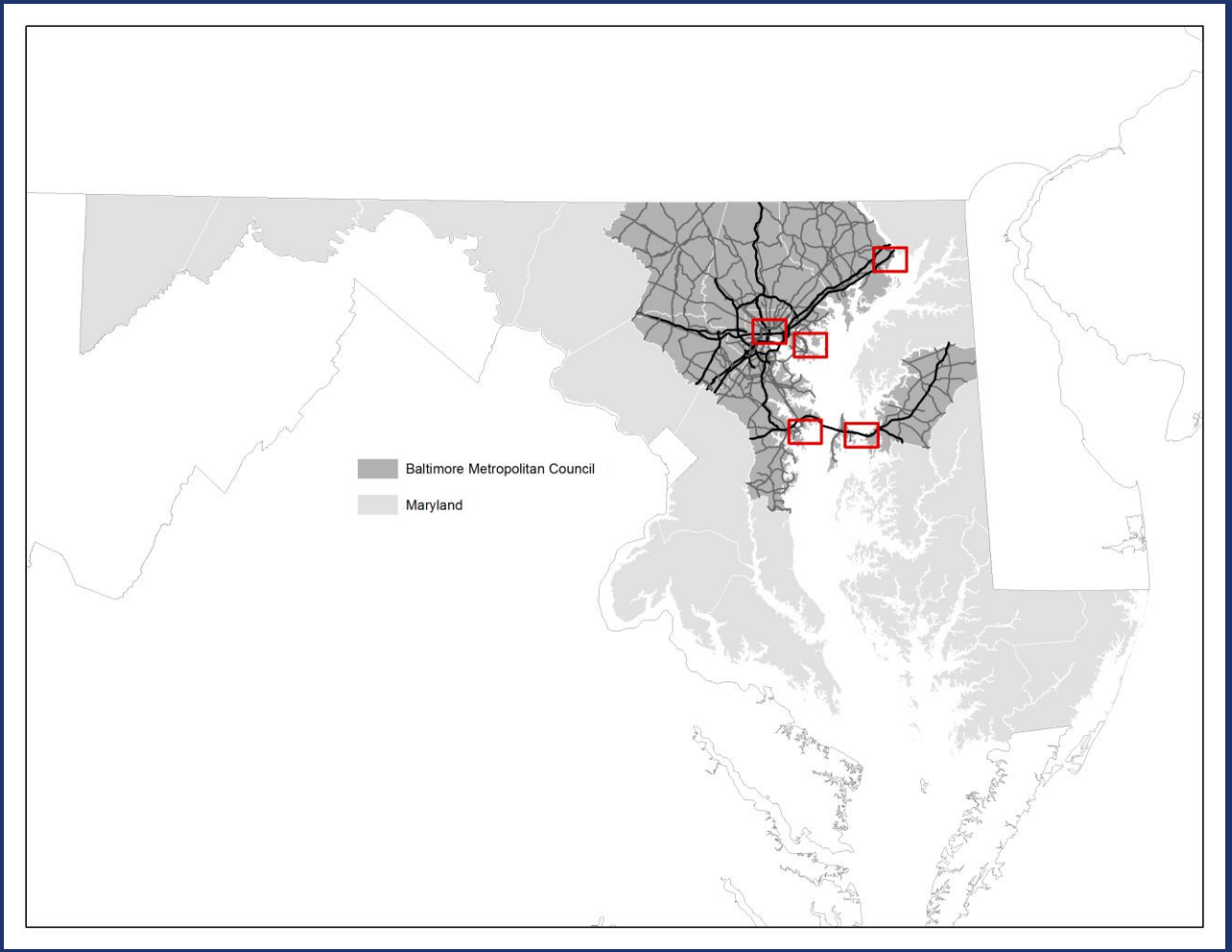
| Value | SHA Functional Class |
|---|---|
| 1 | Interstate |
| 2 | Principal Arterial – Other Freeways and Expressways |
| 3 | Principal Arterial – Other |
| 4 | Minor Arterial |
| 5 | Major Collector |
| 6 | Minor Collector |
| 7 | Local |

# HVI for Anne Arundel County

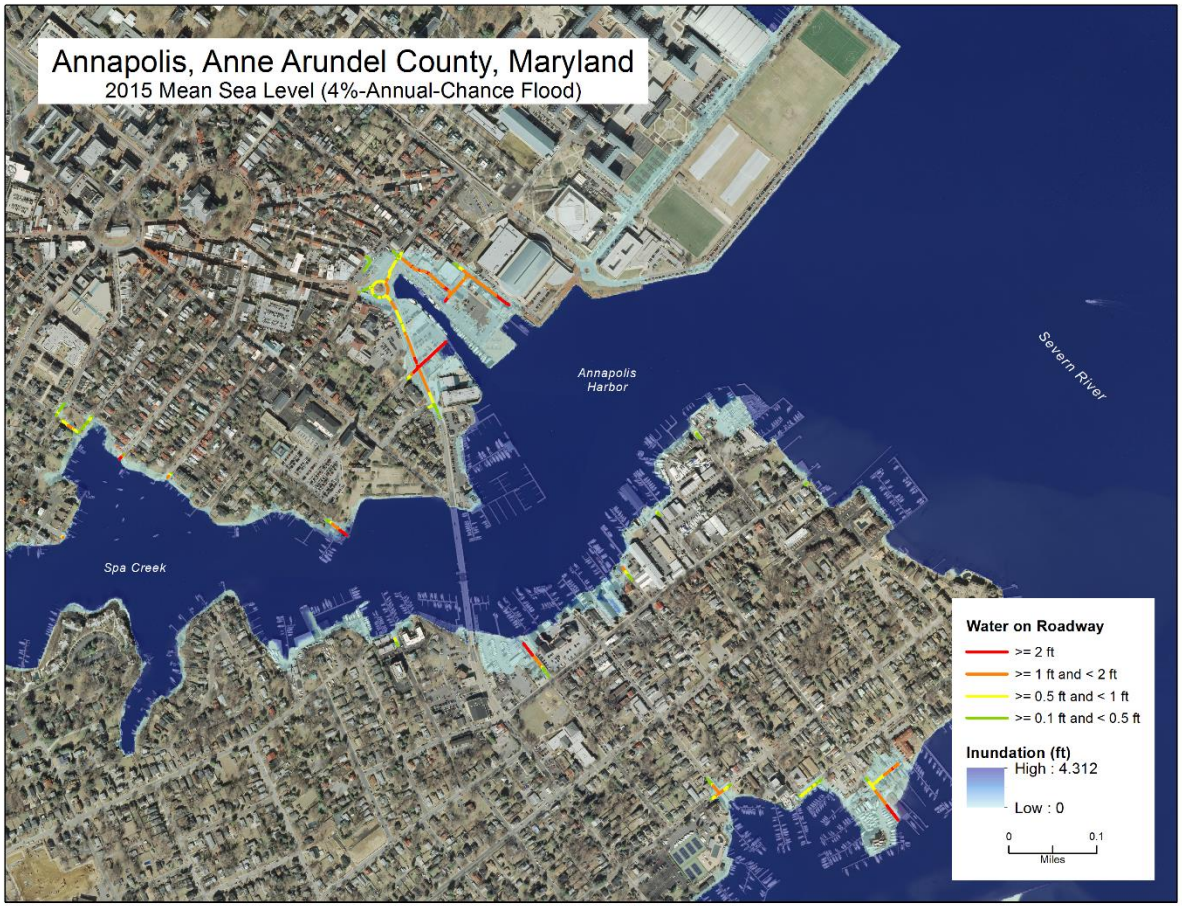


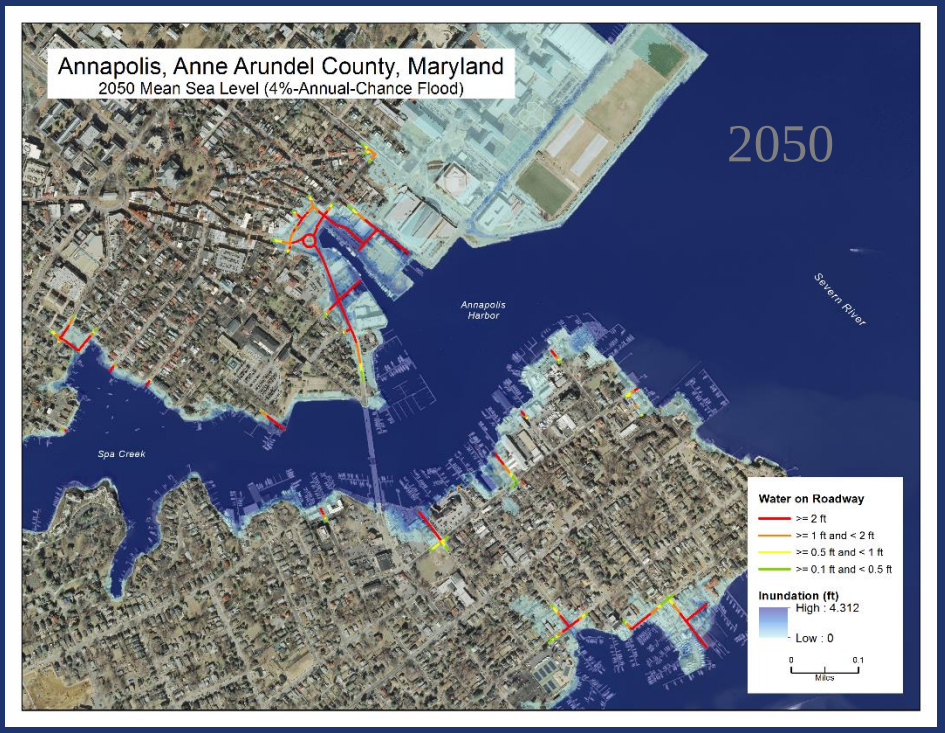
# Study Areas

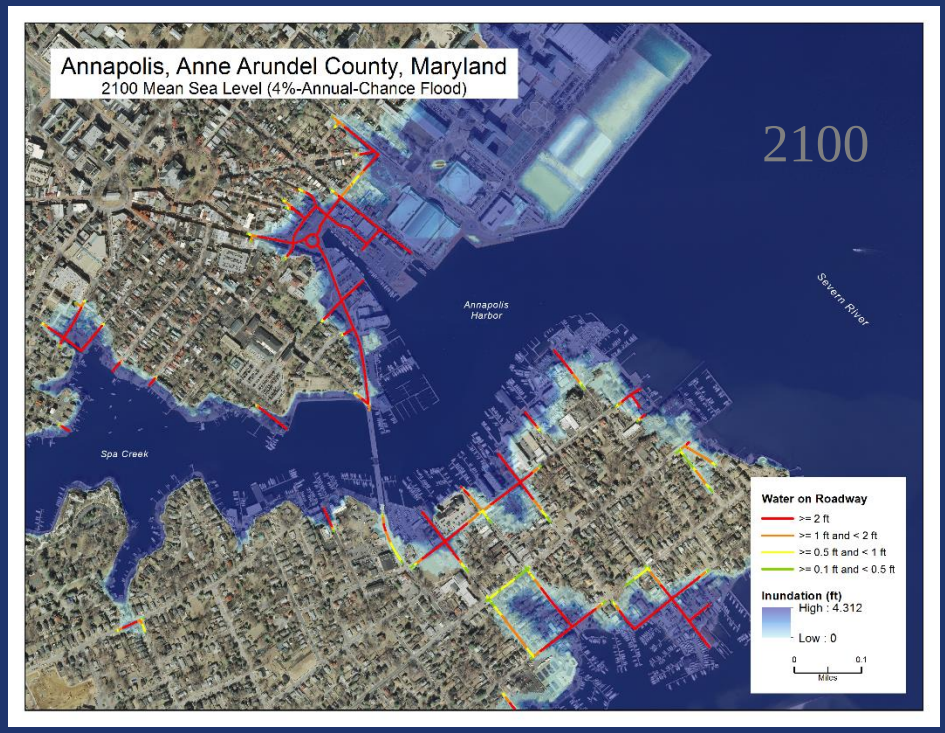


# 25-Year Storm in 2015
# Annapolis

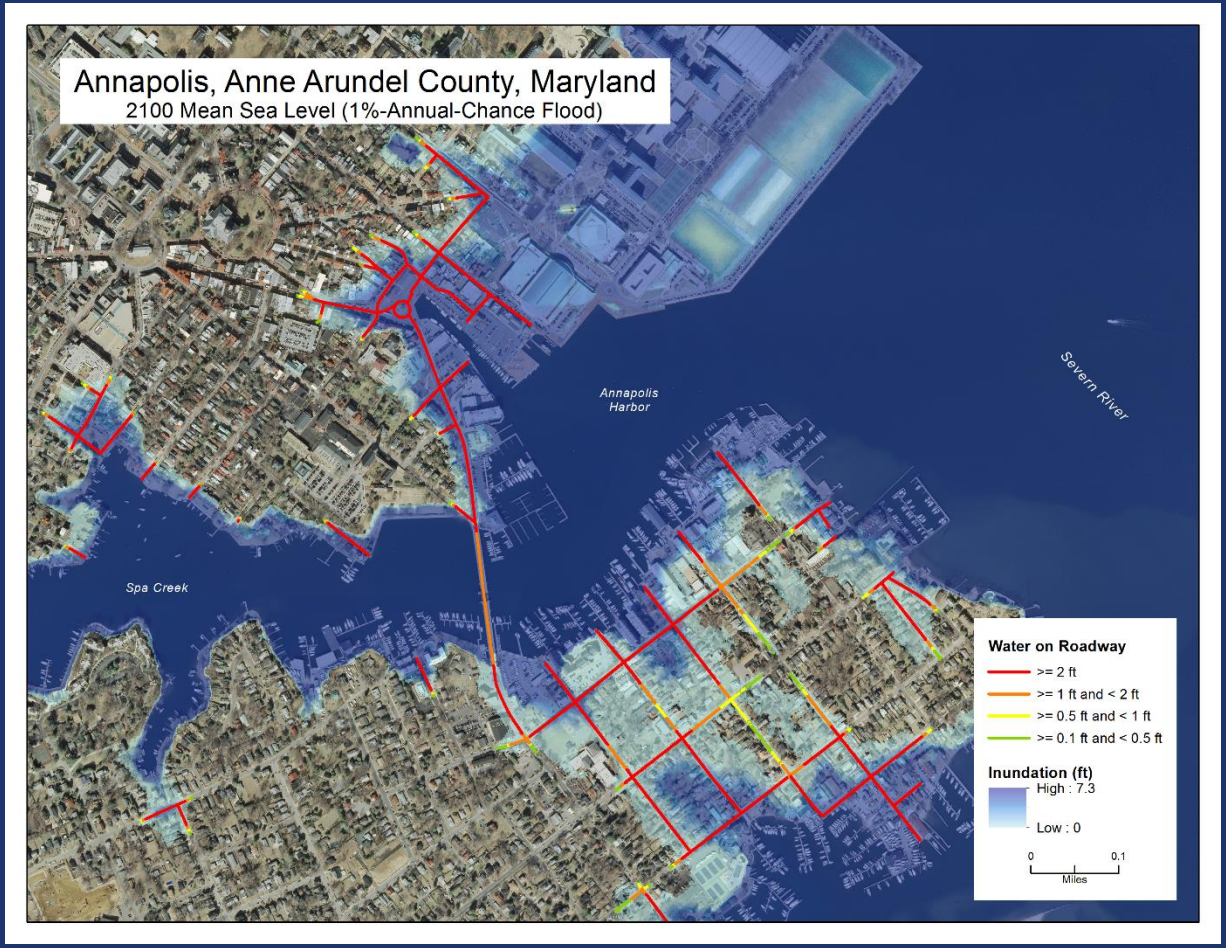


# 25-Year Storm in 2050 & 2100 Annapolis

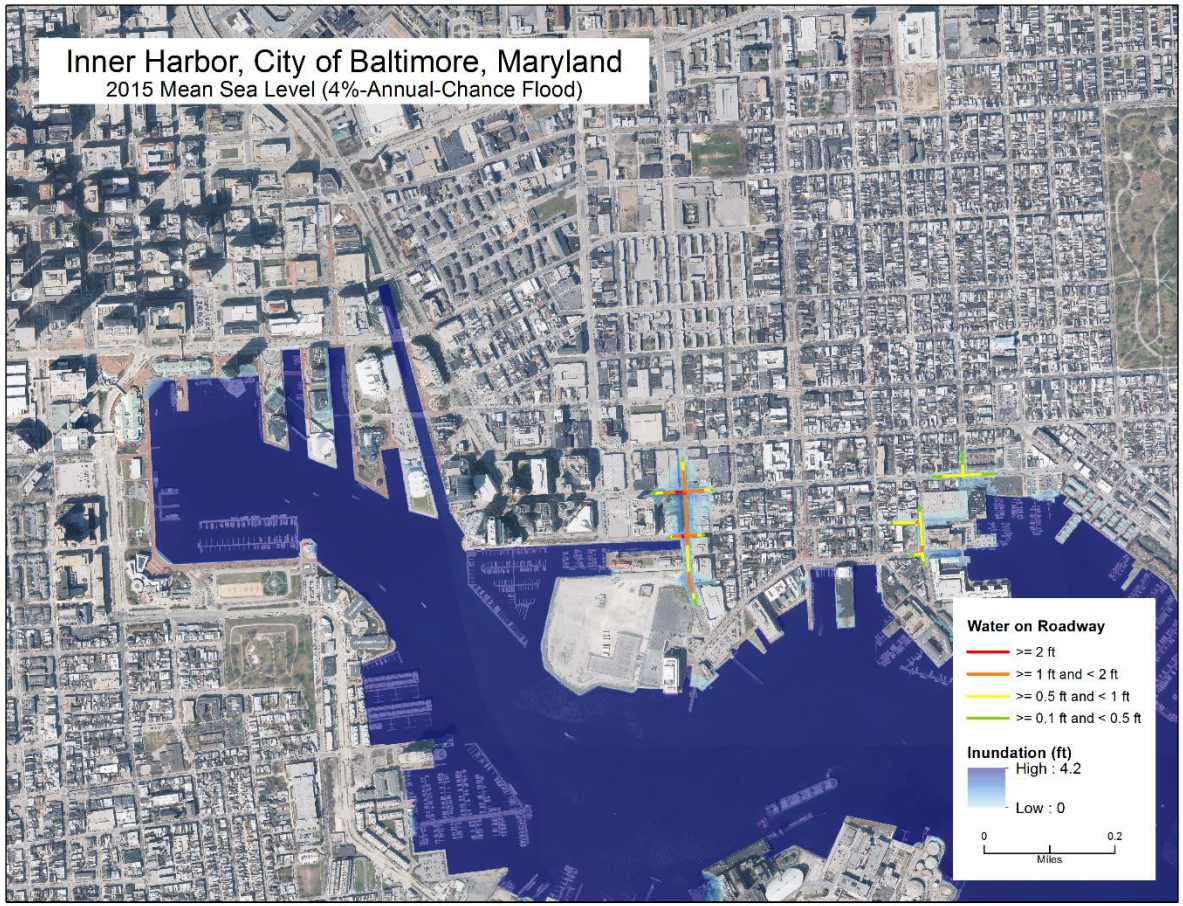


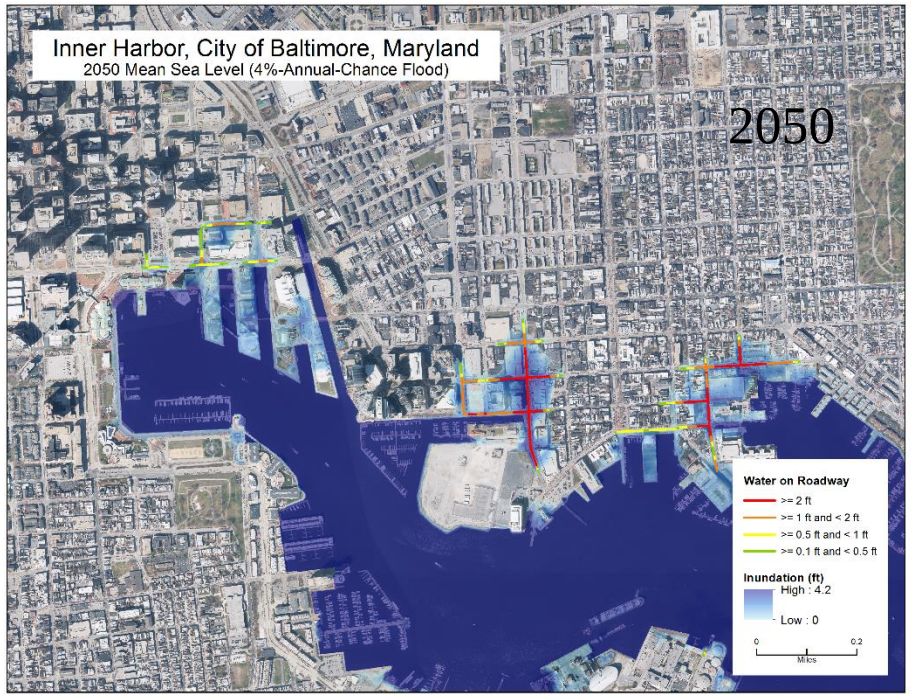
# 100-Year Storm in 2100
# Annapolis

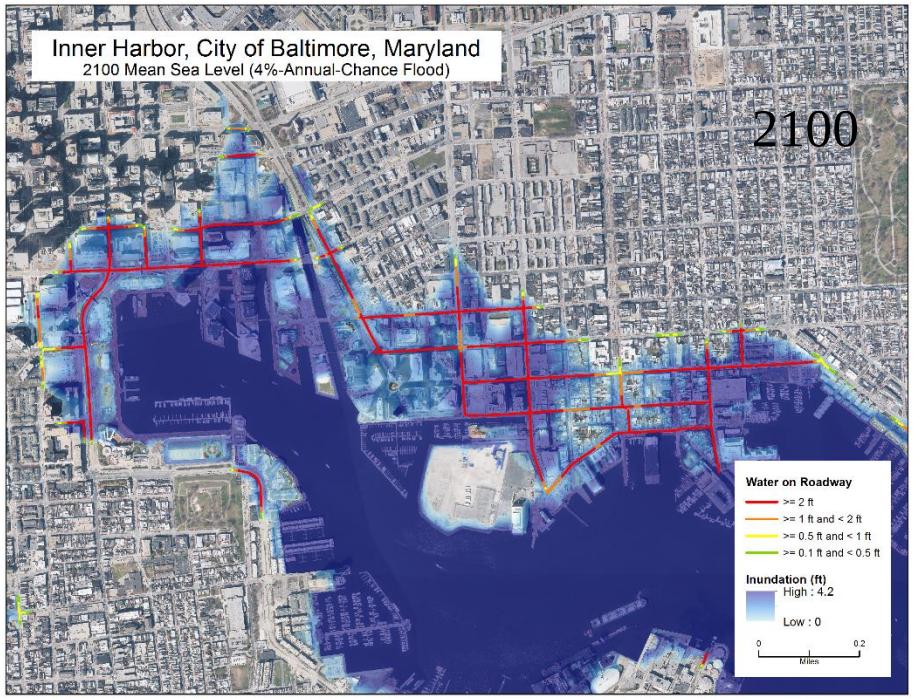


# 25-Year Storm in 2015
# Baltimore Inner Harbor



# 25-Year Storm in 2050 & 2100
# Baltimore Inner Harbor



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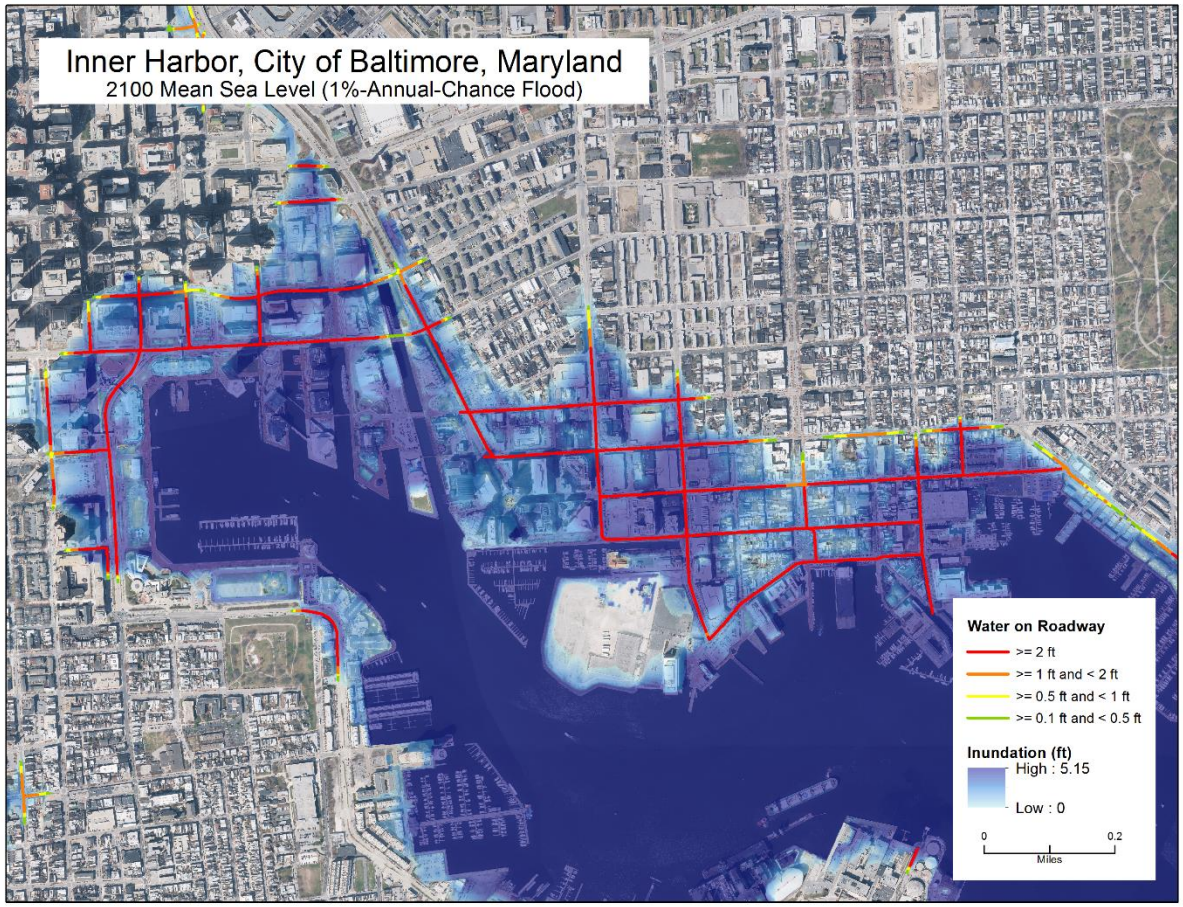


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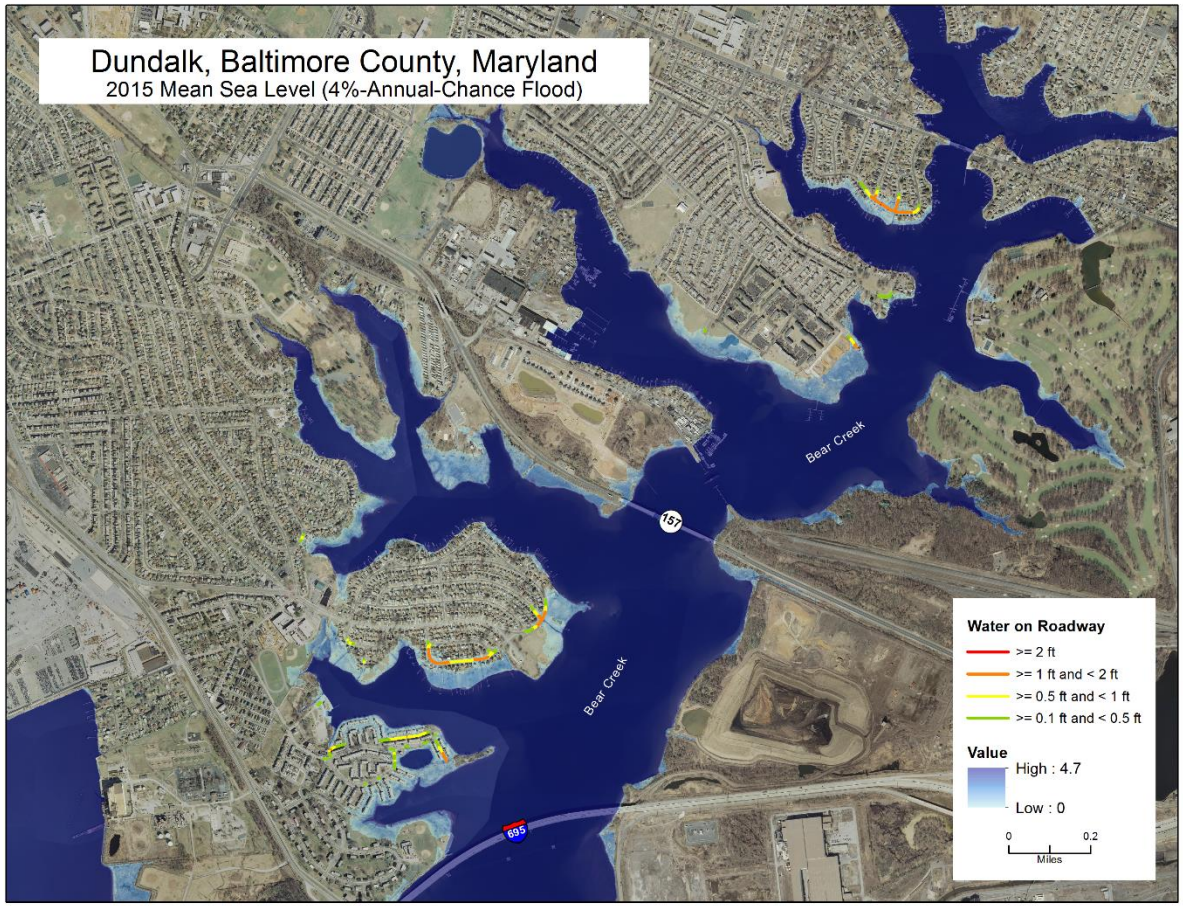
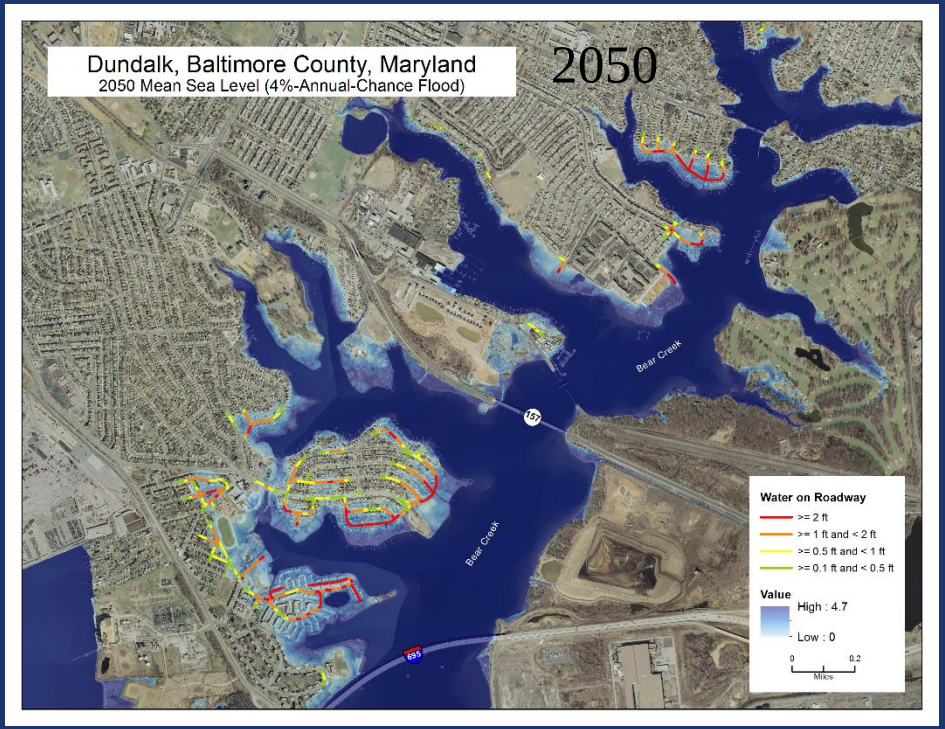
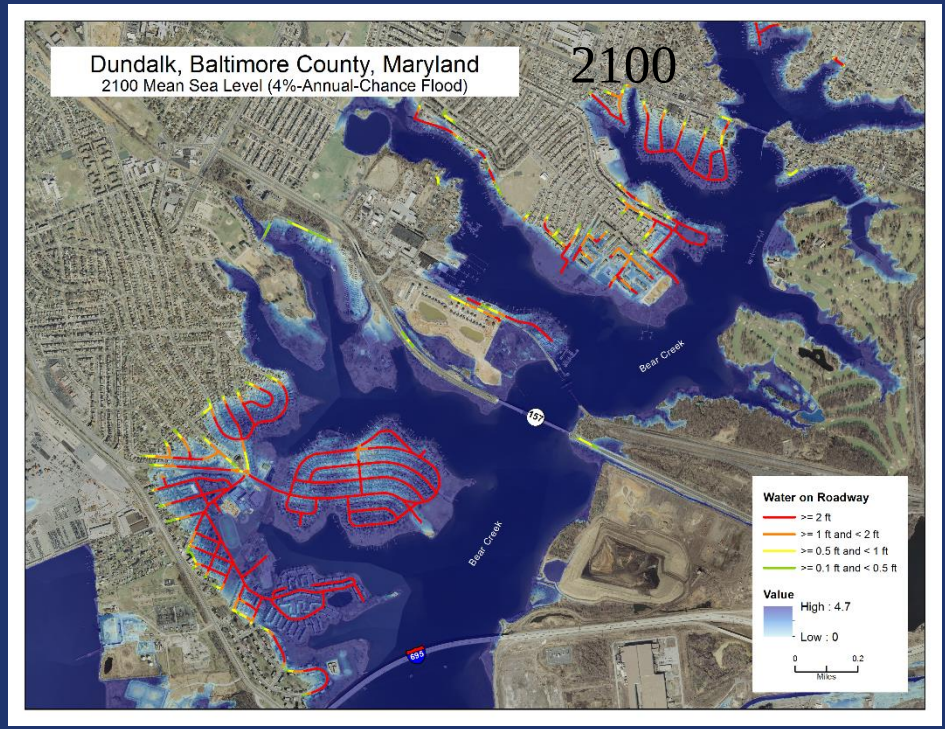
# 25-Year Storm in 2015
# Dundalk



# 25-Year Storm in 2050 & 2100
# Dundalk



# 100-Year Storm in 2100
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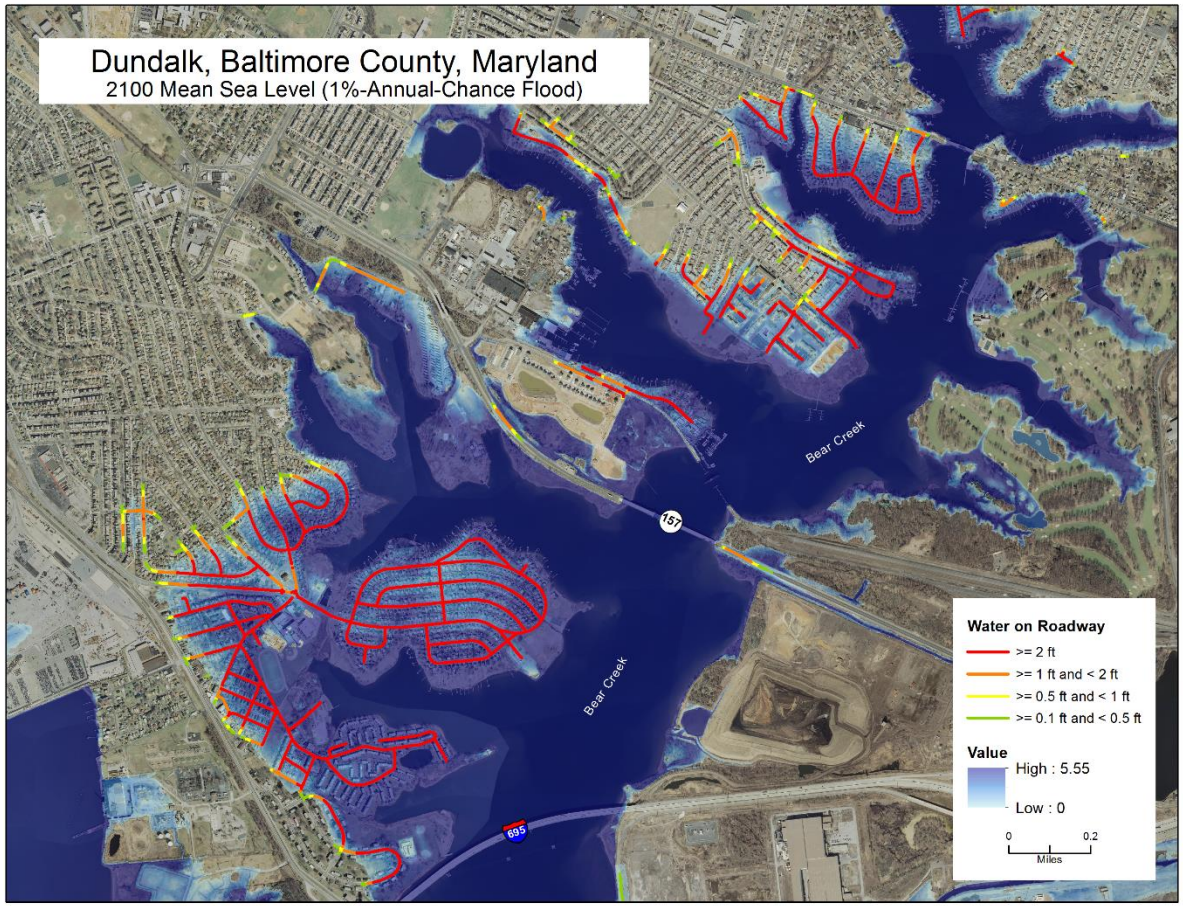
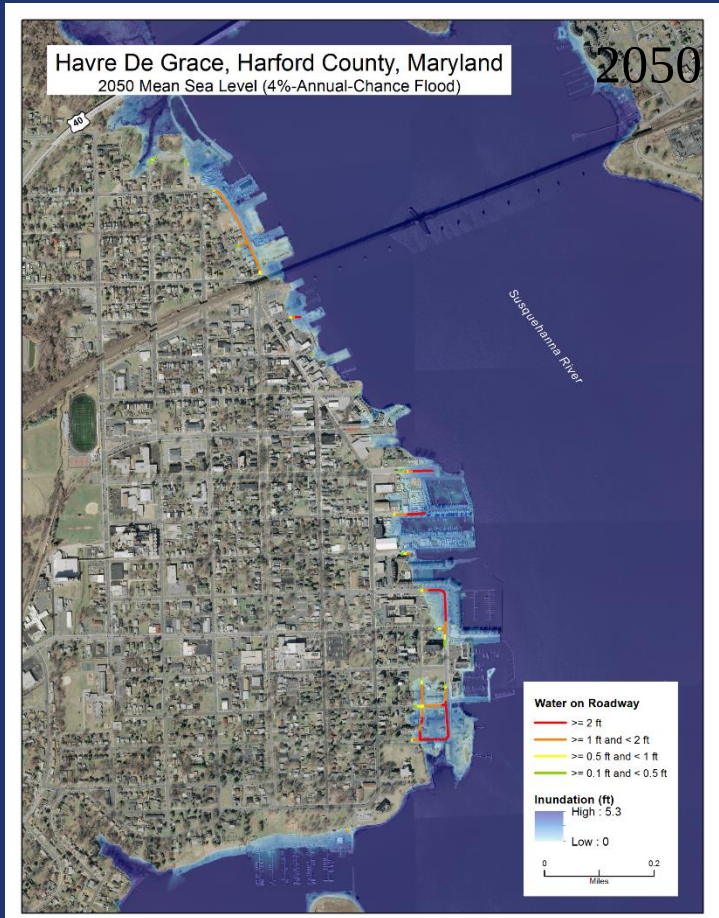
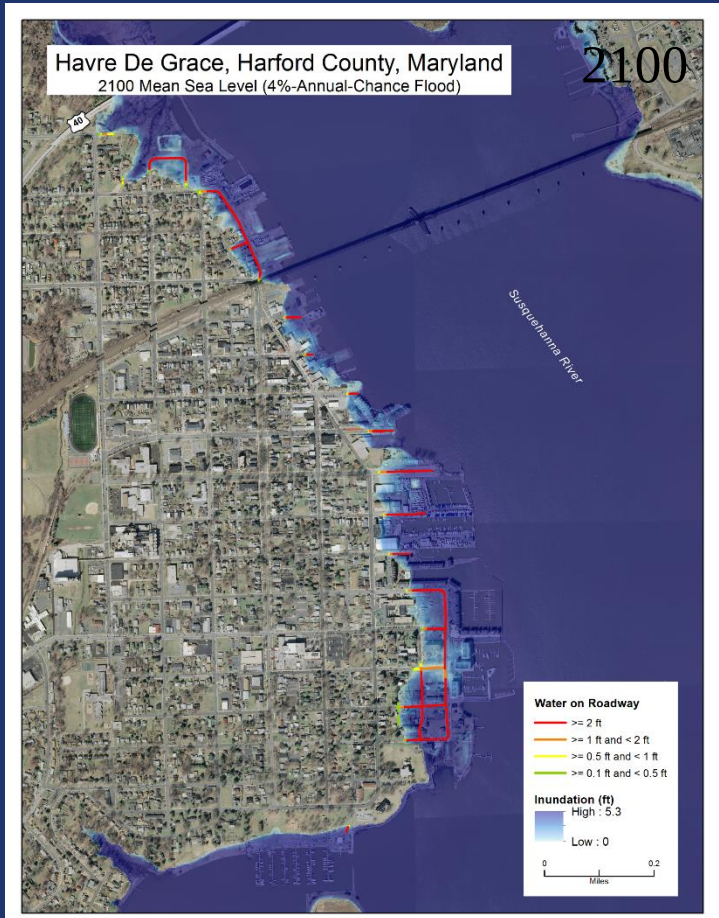


# 25-Year Storm in 2015
# Havre de Grace

# 25-Year Storm in 2050 & 2100
# Havre de Grace



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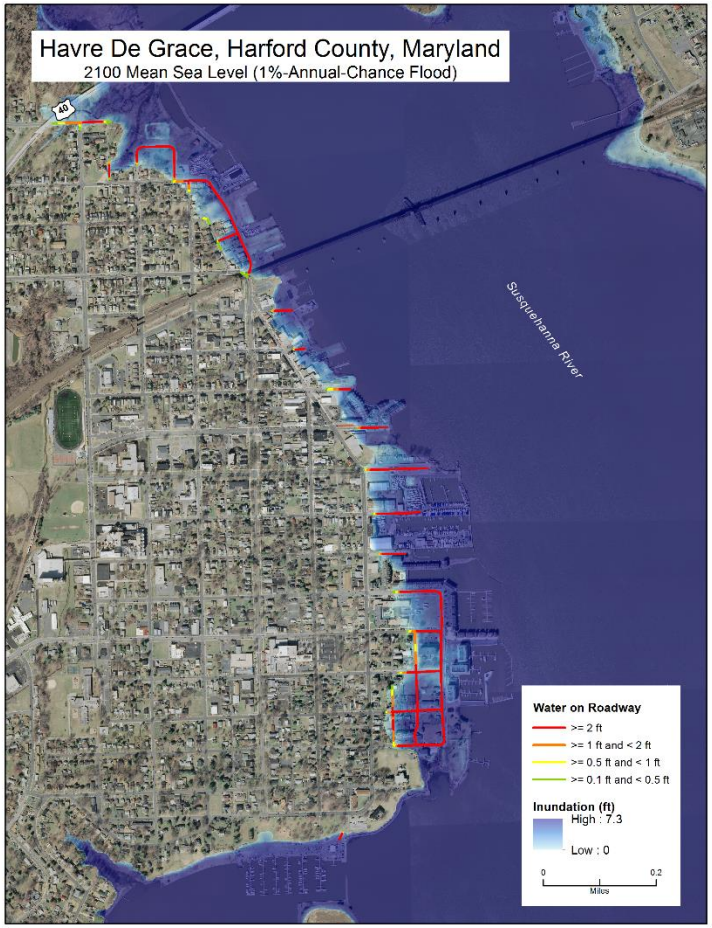
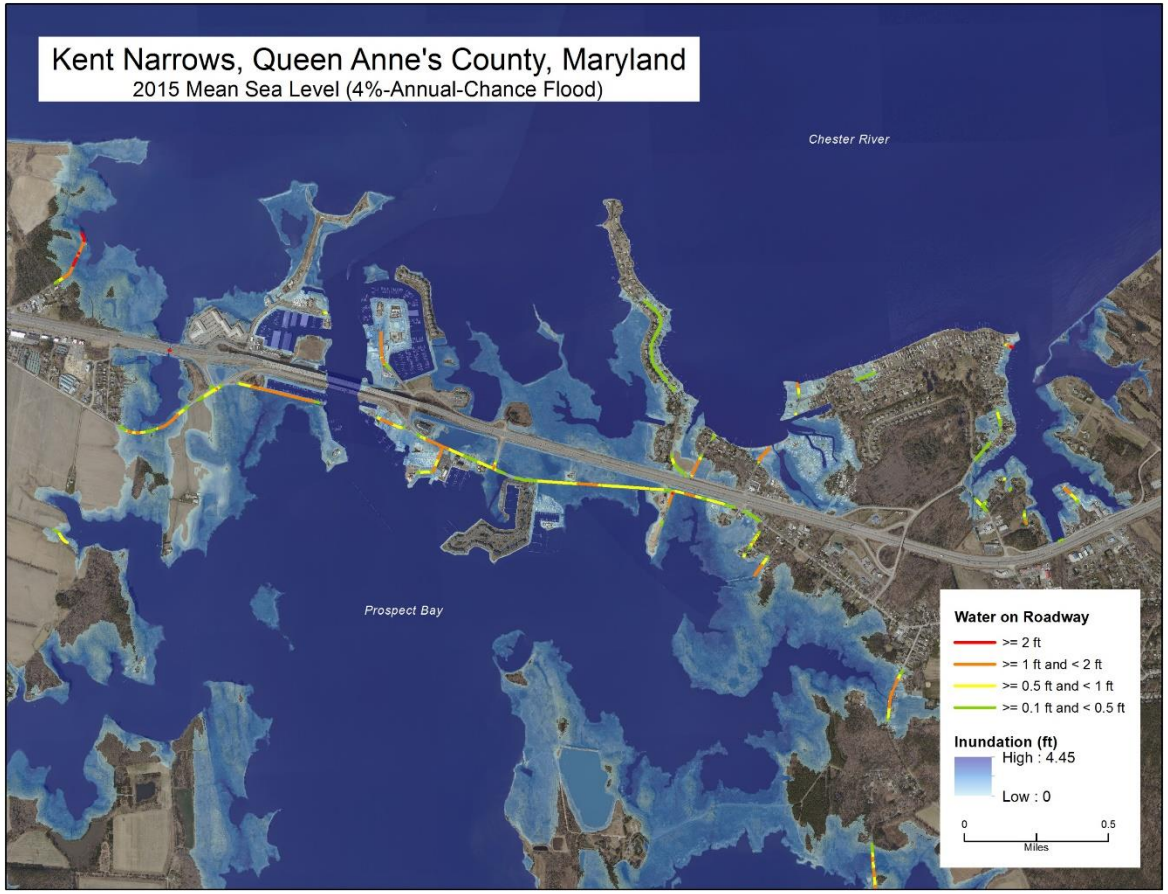
# Havre de Grace



# 25-Year Storm in 2015
# Kent Narrows



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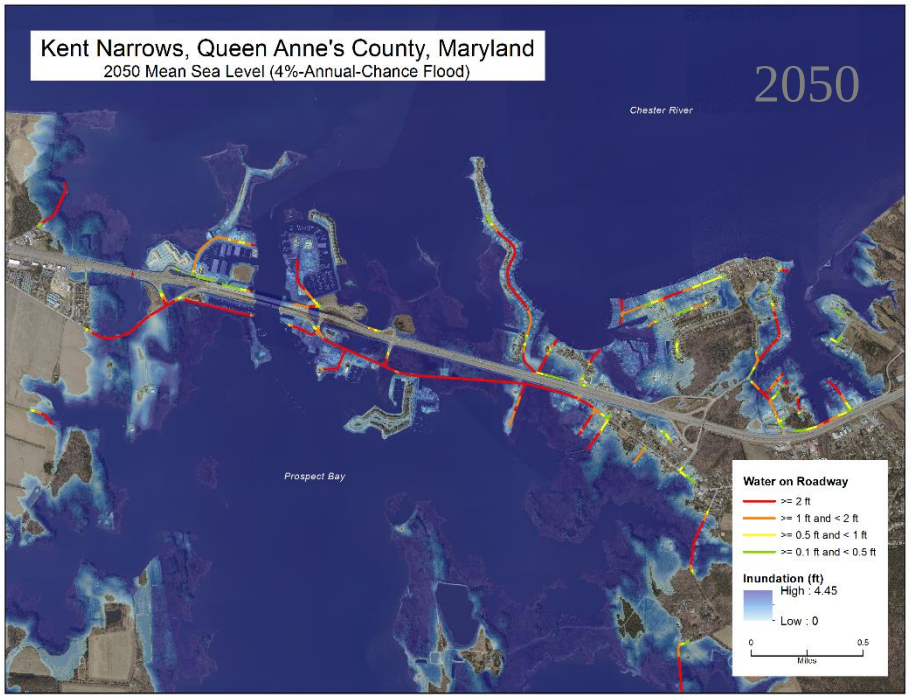


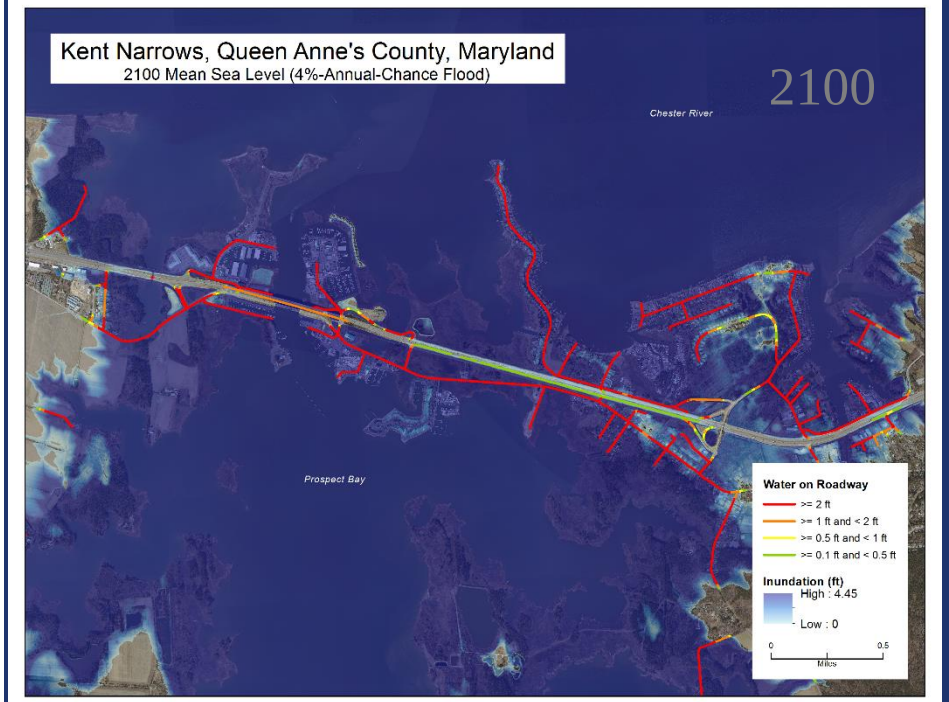

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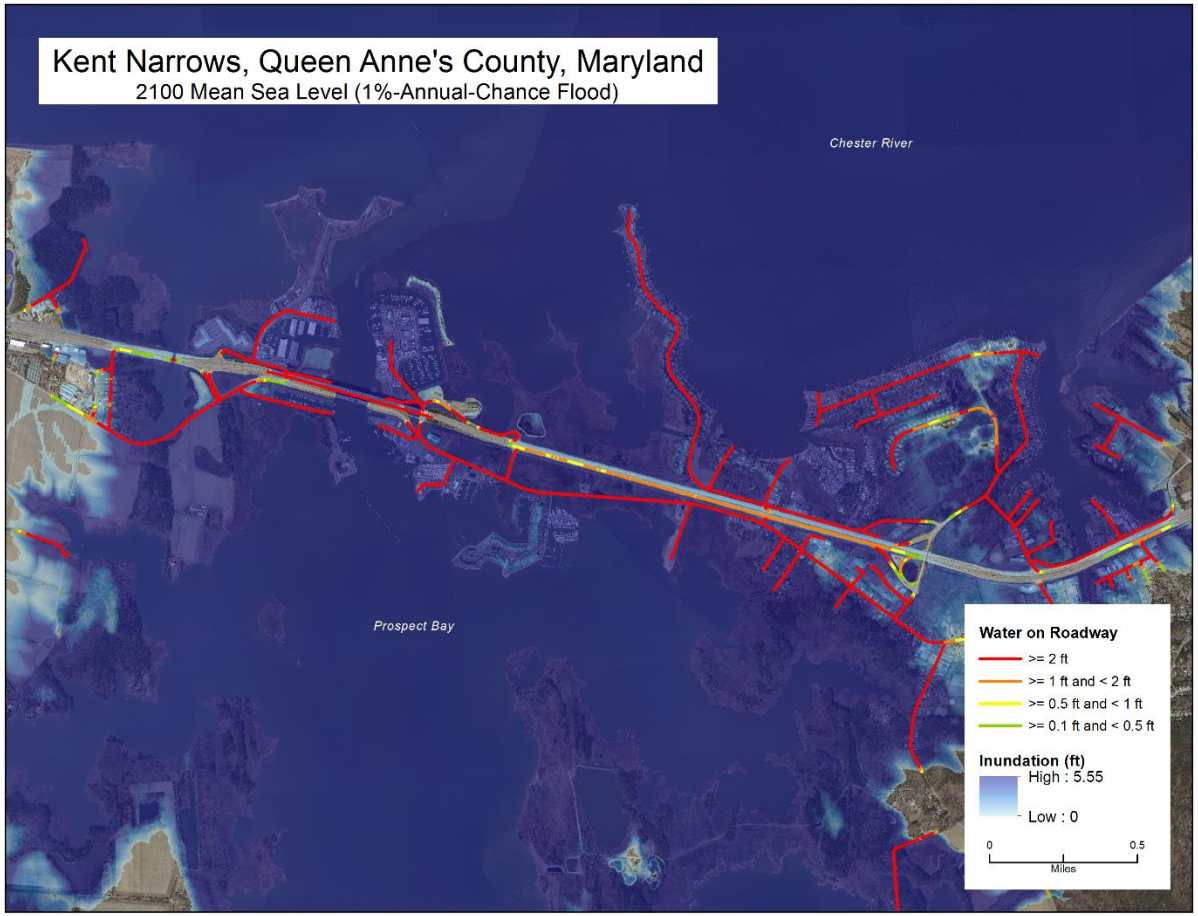

# Coastal Vulnerability

| BMC* Roadway Infrastructure at Mean Sea Level without Annual Chance Event | | | | | | |
|---|---|---|---|---|---|---|
| Water on Roadway | Roadway (ft) (2015) | % Total Roadway (2015) | Roadway (ft) (2050) | % Total Roadway (2050) | Roadway (ft) (2100) | % Total Roadway (2100) |
| > 0.1' and <= 0.5' | 0 | 0.00% | 3,443 | 0.01% | 70,555 | 0.15% |
| > 0.5' and <= 1.0' | 0 | 0.00% | 1,093 | 0.00% | 80,500 | 0.17% |
| > 1.0' and <= 2.0' | 0 | 0.00% | 377 | 0.00% | 150,596 | 0.32% |
| > 2.0' | 0 | 0.00% | 6,839 | 0.01% | 144,539 | 0.31% |

| BMC* Roadway Infrastructure at Mean Sea Level during 4-Percent Annual Chance Event | | | | | | |
|---|---|---|---|---|---|---|
| Water on Roadway | Roadway (ft) (2015) | % Total Roadway (2015) | Roadway (ft) (2050) | % Total Roadway (2050) | Roadway (ft) (2100) | % Total Roadway (2100) |
| > 0.1' and <= 0.5' | 48,037 | 0.10% | 80,872 | 0.17% | 113,795 | 0.24% |
| > 0.5' and <= 1.0' | 57,234 | 0.12% | 91,879 | 0.20% | 147,857 | 0.31% |
| > 1.0' and <= 2.0' | 72,536 | 0.15% | 162,711 | 0.35% | 315,753 | 0.67% |
| > 2.0' | 18,694 | 0.04% | 221,718 | 0.47% | 1,081,440 | 2.30% |

| BMC* Roadway Infrastructure at Mean Sea Level during 1-Percent Annual Chance Event | | | | | | |
|---|---|---|---|---|---|---|
| Water on Roadway | Roadway (ft) (2015) | % Total Roadway (2015) | Roadway (ft) (2050) | % Total Roadway (2050) | Roadway (ft) (2100) | % Total Roadway (2100) |
| > 0.1' and <= 0.5' | 79,513 | 0.17% | 119,810 | 0.25% | 103,589 | 0.22% |
| > 0.5' and <= 1.0' | 87,278 | 0.19% | 145,659 | 0.31% | 136,637 | 0.29% |
| > 1.0' and <= 2.0' | 147,196 | 0.31% | 256,718 | 0.55% | 263,134 | 0.56% |
| > 2.0' | 156,472 | 0.33% | 524,181 | 1.11% | 1,528,242 | 3.25% |

* Anne Arundel, Baltimore City, Baltimore County, Harford, and Queen Anne's Counties

# Questions

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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