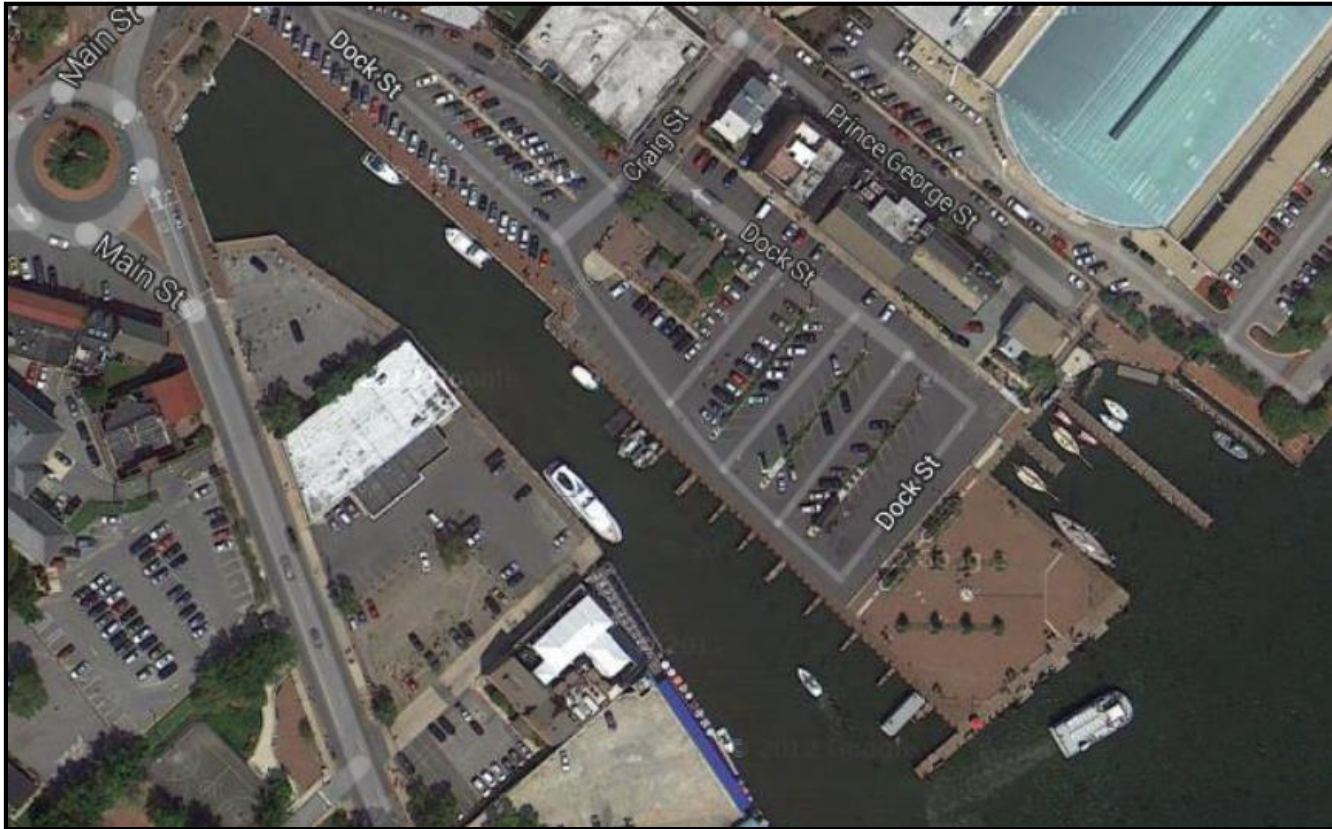


City of Annapolis Tidal Flood Mitigation

Environmental Matters Committee Meeting

May 19, 2016



Tidal Flood Mitigation Project – Looking Backward

NOAA Technical Report “Sea Level Rise and Nuisance Flood Frequency Changes around the United States” reported:

- Annapolis saw the greatest increase in nuisance flooding during the last 50 years
- Nuisance flooding, in average flood days per year, increased by 925% in Annapolis, from an average of 3.8 to 39.3 per year.
- Of the top ten areas based on percentage increase, Annapolis had largest number of nuisance flood events, with Washington, DC a distant second at 29.7 floods per year.

NOAA Technical Report NOS CO-OPS 073

Sea Level Rise and Nuisance Flood Frequency Changes around the United States



City Dock in Annapolis, Maryland. Photo Credit: Amy McGovern.

Silver Spring, Maryland

June 2014



noaa National Oceanic and Atmospheric Administration

U.S. DEPARTMENT OF COMMERCE
National Ocean Service
Center for Operational Oceanographic Products and Services

Tidal Flood Mitigation Project – Looking Forward

“Encroaching Tides”, a 2014 report from Union of Concerned Scientists, predicted:

- Annapolis will have nearly 200 annual flood events by 2030
- Annapolis will have over 350 annual flood events by 2040

The Washington Post 22 31 A3

TICS & THE NATION

Study: Cities at risk of daily flooding

BY DARRYL FEARS

Daily flooding caused by high tides will occur in the District and Annapolis within three decades as sea levels continue to rise due to global warming, a new study says.

The study by the Union of Concerned Scientists predicts that by 2045 the nation's capital and the capital of Maryland will experience about 400 floods per year, sometimes twice in a single day, and several other cities and towns on the Atlantic coast will have tidal flooding almost as bad.

Miami, Atlantic City, Cape May, N.J., and Lewisetta and Windmill Point, both on the Chesapeake Bay in Virginia, can expect at least 240 days of flooding by 2045.

High-tide floods along the Atlantic coast in Baltimore, Norfolk, Philadelphia, Charleston, S.C., Key West, Fla., and Sandy Hook, N.J., will happen less frequently, with about 180 events or more per year, according to the study released Wednesday.

Tidal flooding is sometimes

Tidal flooding today, in 2030 and in 2045

By 2030, the 15 coastal locations below can expect about 50 or more tidal floods per year, on average. By 2045, more than half can expect 240 or more tidal floods per year.

Location	Current events per year	In 2030	In 2045
Washington, DC	~50	~150	~380
Lewisetta, VA	~50	~150	~350
Annapolis, MD	~50	~180	~350
Wilmington, NC	~50	~150	~300
Windmill Point, VA	~50	~150	~280
Cape May, NJ	~50	~150	~280
Reedy Point, DE	~50	~150	~280
Atlantic City, NJ	~50	~150	~280
Cambridge, MD	~50	~150	~280
Miami, FL*	~50	~150	~280
Baltimore, MD	~50	~150	~240
Lewes, DE	~50	~150	~240
Key West, FL	~50	~150	~240
Sandy Hook, NJ	~50	~150	~240
Philadelphia, PA	~50	~150	~240

*Data for these locations are represented by nearby tide gauges.

Source: Union of Concerned Scientists

THE WASHINGTON POST

anic and Atmospheric Admin- frequently due to decades of sea level rise" that they are normal

change in the federal National Climate Assessment and explored how it would impact the Atlantic and Gulf coasts within a relatively short time frame. The authors realized that their choice could open the study to criticism that its findings are too narrow.

Analyst Erika Spanger-Siefried and Kristina Dahl, a consultant, are the other authors. Wednesday's release of the report coincided with the start of the "king tide," an especially high seasonal tide that occurs yearly along the Atlantic and Gulf coasts between Oct. 8 and Oct. 10.

The District and Annapolis now have fewer than 50 days of tidal flooding. In 15 years, according to the study's prediction, that will rise to 150. After another 15 years, flooding will more than double to 400, with multiple floods in one day.

Flooding will also be the norm for cities in New Hampshire, Delaware, North Carolina and Florida.

On the Atlantic coast, flooding is especially worrisome because land is sinking by a few millime-

Flood Mitigation Project – Initial Concept

Concept was developed as part of the Annapolis Sea Level Rise Study completed in 2010.

Concept includes two phases:

1. Storm water system: Realignment of storm drains, installation of backflow preventers and storm water pumping station(s)
2. “Seawall”: Benches and planters with infill structures





Annapolis Marine Art Gallery / John...

Annapolis City Dock

City of Annapolis - Harbormaster's Office

Watermark Cruises

National Sailing Hall of Fame

Watermark

Ego Alley

Spa Creek

Fleet Reserve Association Annapolis

Pusser's Caribbean Grille

Annapolis Waterfront Hotel...

Schooner Woodwind Sailing Cruises

Spa Creek

Google

Market Space

Main St

Main St

Annapolis Summer Garden Theatre

s Fine Wine & Spirits

y School

Compromise St

Compromise St

Newman St

Newman St

St Marys St

Craig St

Prince George St

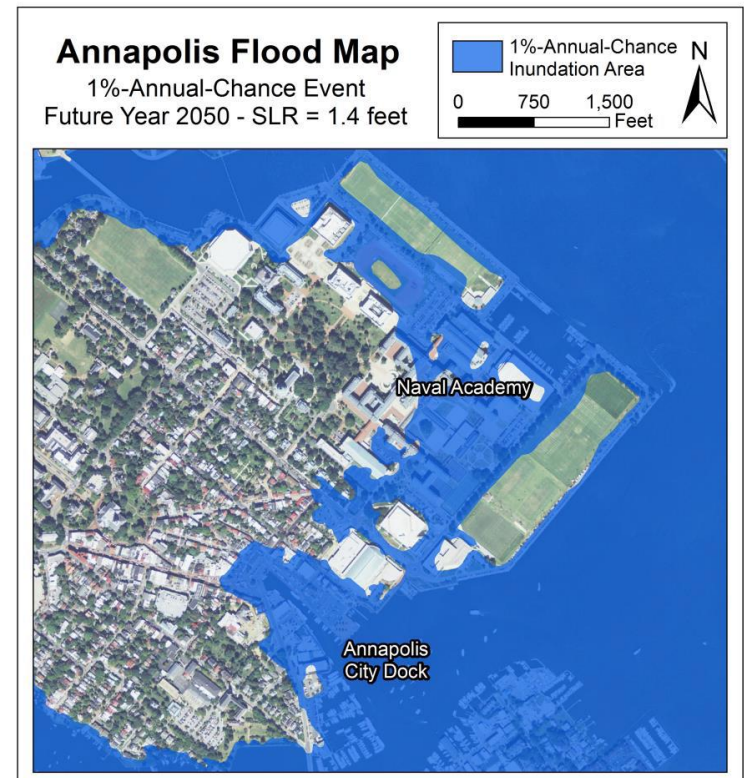
Tidal Flood Mitigation Project – Funding Opportunities

State Funding – approved by Legislature

- Engineering and Design - \$1,000,000
- Focus on storm drain project

FEMA HMA Subgrant Project Application – grant was not approved this year, will resubmit next year

- Engineering - \$225,000
- Construction - \$3,000,000
- Federal Share – 75% with 25% match



City Dock Flood Elevations

Elevation		
MLLW (feet)	NAVD 88 (feet)	
7.83	7.11	High water during Tropical Storm Isabel - Sept 2003
7.80	7.08	100 year base flood elevation for City Dock
5.42	4.70	Elevation of wall at new bulkhead
4.92	4.20	Elevation of Market House floor
4.62-4.72	3.90-4.00	Elevation of wall at old bulkhead being replaced
4.20	3.48	City Dock boardwalk under water
3.72	3.00	Water flow out of Kunta Kinte Park - "over the top" flooding
3.15	2.43	Crest of Compromise Street - street flooded
2.92	2.20	Partial closure of Compromise Street
2.62	1.90	Water first reaches Compromise Street
2.50	1.78	Ponding in Dock Street parking areas
2.40	1.68	Water over dingy dock - Kunta Kinte Park flooded
1.50	0.78	Water in storm drains
1.44	0.72	Mean Higher High Water (MHHW)
1.19	0.47	Mean High Water (MHW)
0.72	0	Mean Sea Level (MSL)
0.22	-0.5	Mean Low Water (MLW)
0	-0.72	Mean Lower Low Water (MLW)

Annual High Water Levels		
MLLW (feet)	NAVD 88 (feet)	
3.42	2.70	High water in 2015
4.09	3.37	High water in 2014
3.13	2.41	High water in 2013
3.99	3.27	High water in 2012
4.04	3.32	High water in 2011
3.60	2.88	High water in 2010
3.10	2.38	High water in 2009

Compromise Street Impacts

	<u>Times on road</u>	<u>Times road closed</u>
2014	38	9
2013	46	2
2012	49	4
2011	56	12
2010	54	2
2009	60	7

Comprehensive Flood Risk Management Study

- Conducted by US Army Corps of Engineers

Key Tasks

1. Data Compilation and Review

- Compile and review existing studies, models, and data
- Review USNA plans

2. Identify Flood Risk and Needs

- Identify flood risk - riverine, coastal, climate change/sea level rise, nuisance flooding and major storms
- Identify areas at risk and establish project goals and objectives
- Determine design level of protection

Comprehensive Flood Risk Management Study

Key Tasks (continued)

3. Develop and Evaluate Flood Mitigation Alternatives

- Identify structural (such as floodwall/sea wall, pumping station), non-structural (flood proofing measures), permanent and temporary alternatives
- Coordinate to ensure any City plans are compatible with USNA plans
- Develop concept plans and costs for various alignments/projects/heights of protection
- Conduct economic analysis and determine benefits and costs of the various alternatives (benefits are the future reduction in damages)
- Evaluate and compare alternatives using various criterion

4. Public Involvement

- Hold public meetings to obtain input from residents/business owners/stakeholders on flood risk and alternative plans

Flood Mitigation Project – Next Steps

- 1. Receive approved State funding for storm drain mods**
- 2. Work closely and in coordination with Naval Academy and U.S. Army Corps of Engineers (USACE)**
- 3. Complete the USACE study**
- 4. Conduct flood mitigation study in phases, as funding is available:**
 - i. Historic District**
 - ii. Eastport Community**
 - iii. Other communities/areas within Annapolis**
- 5. Initiate planning and design of storm drain modification project when initial phase of USACE study is completed**