



Impacts of Sea Level Rise at the U.S. Naval Academy

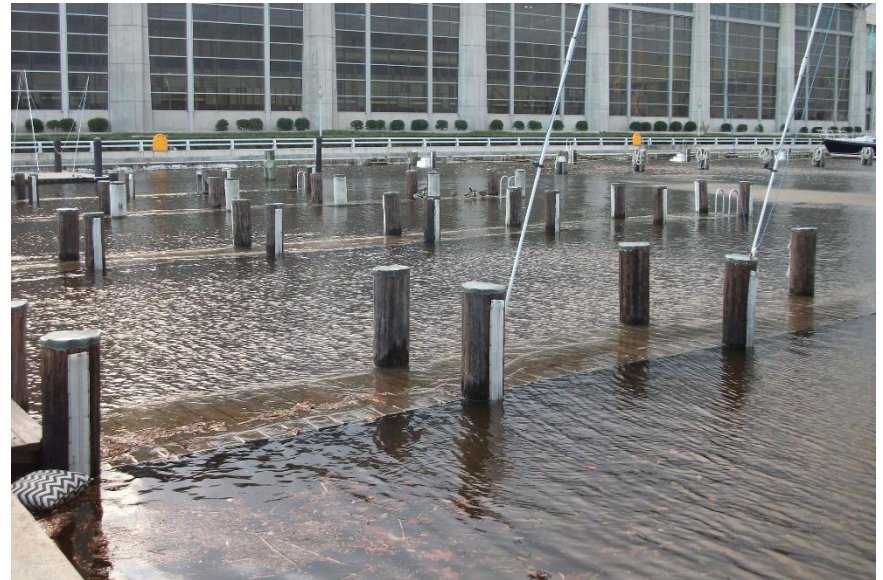
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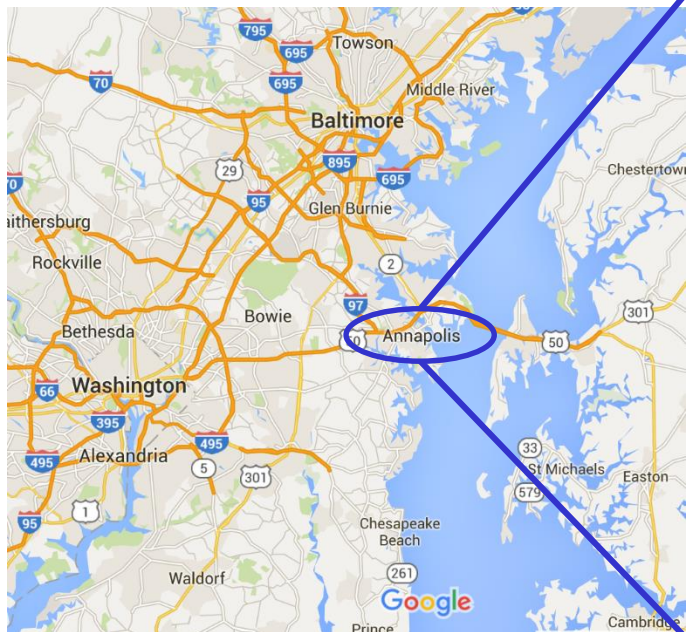
Overview

- **History of USNA**
- **Extreme Floods**
- **Nuisance Floods**
- **Future Floods**
- **Flood Protection and Adaptations**





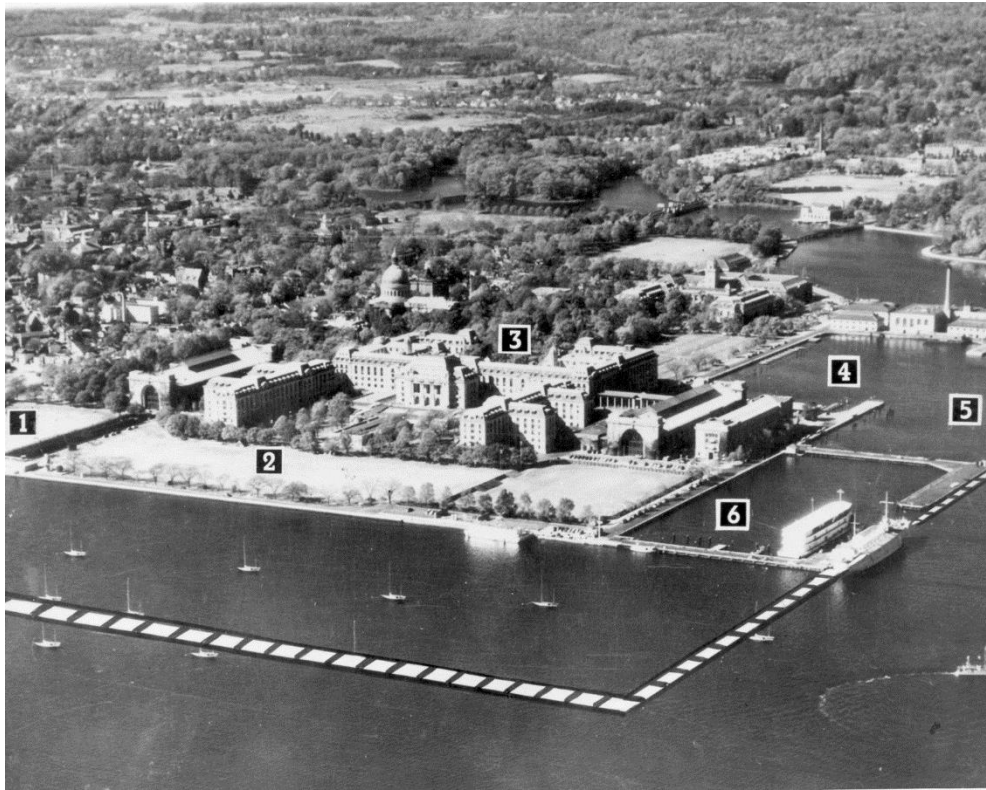
U.S. Naval Academy Location





USNA - Growth

1956-1960: added 60 acres



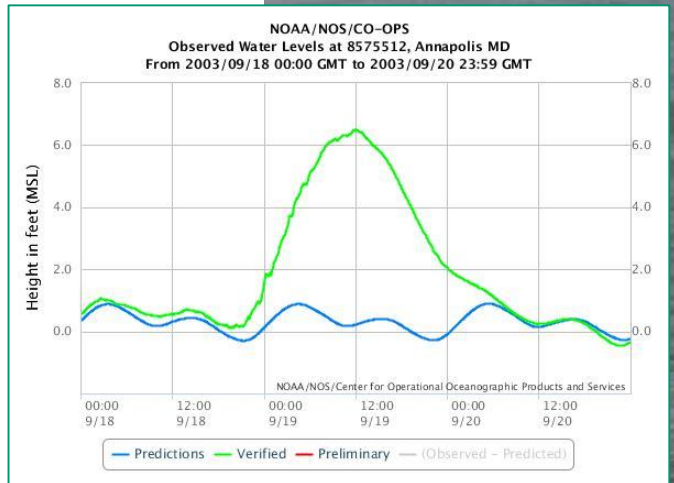
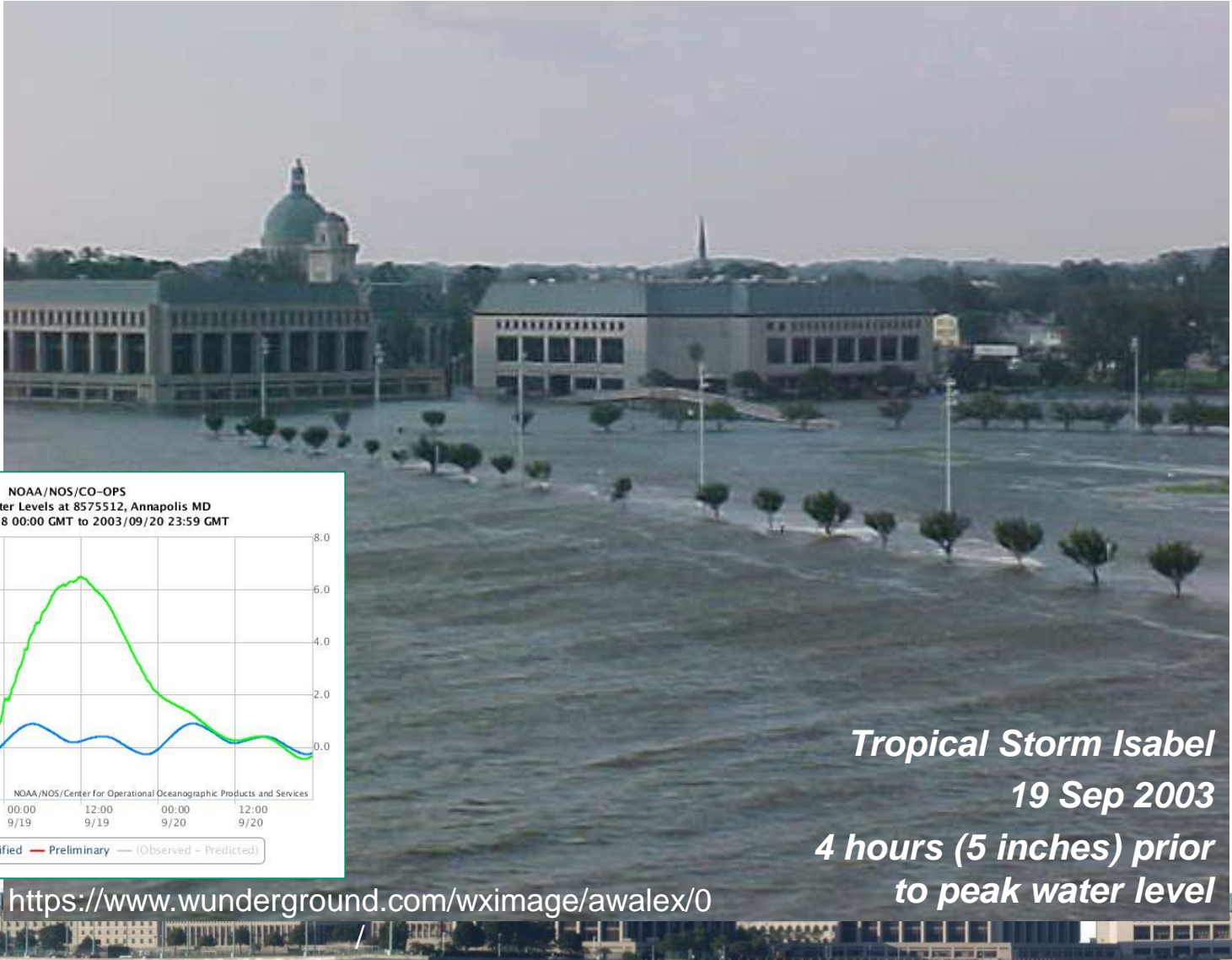


USNA - Growth





USNA - 2003 TS Isabel



Tropical Storm Isabel
19 Sep 2003
4 hours (5 inches) prior
to peak water level

<https://www.wunderground.com/wximage/awalex/0>

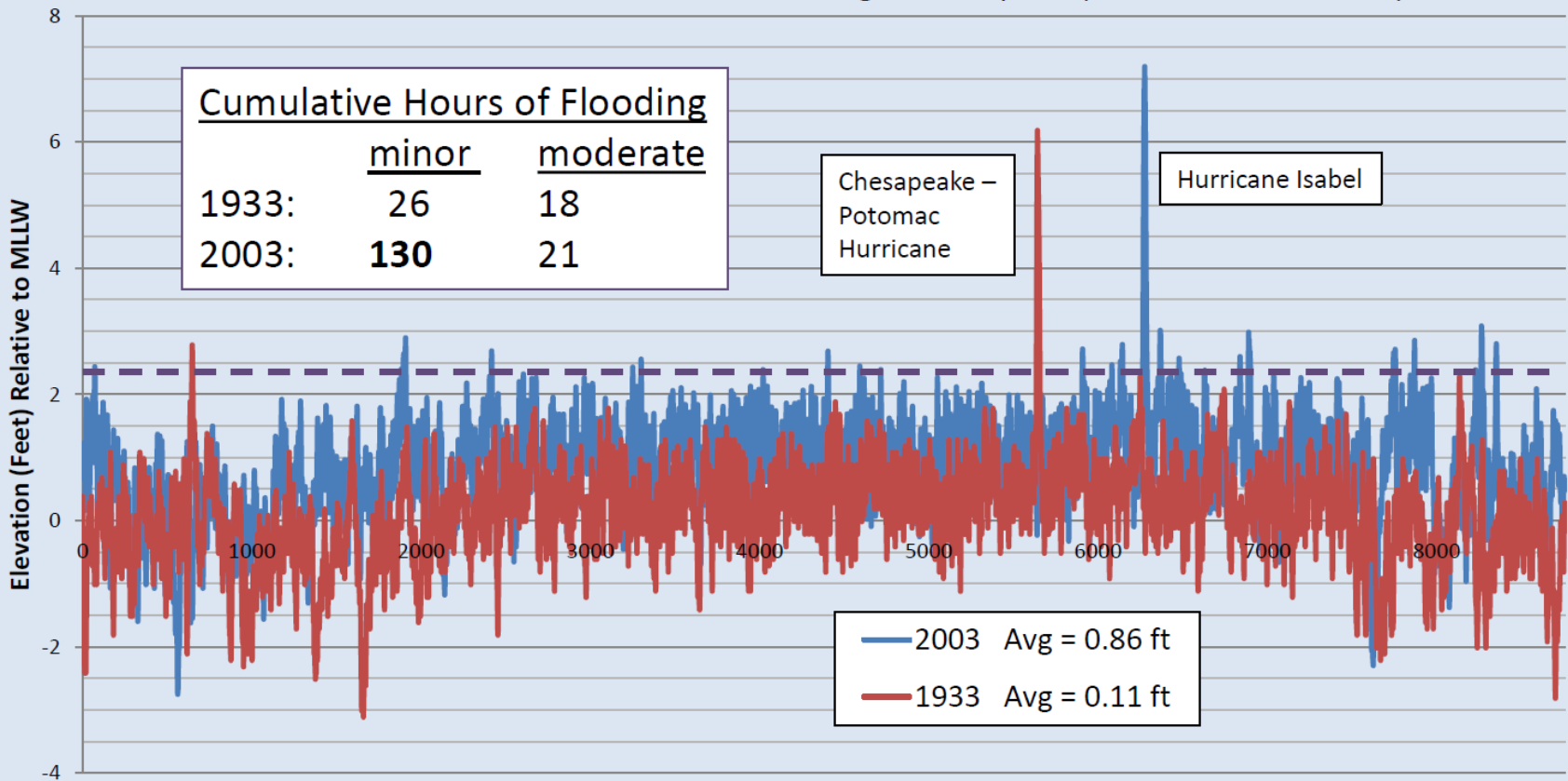


Nuisance Floods in Annapolis

Annapolis Hourly Sea Level Data for 1933 and 2003

Referenced to Mean Lower Low Water

Dashed line indicates level of minor flooding in Annapolis (2.38 ft above MLLW)





Nuisance Floods in Annapolis

- Averaged 3.6 minor flood days per year during 1957-1963
- ~ 34 days per year during 2006-2010
- ~ 40 days per year during 2010-2016 (max of 66 in 2011)



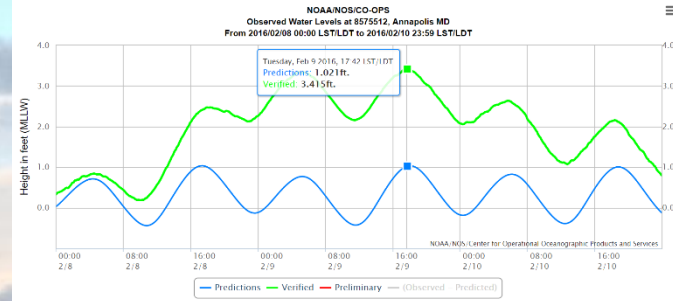
Source: Sweet et al. (2014), NOAA (2017)





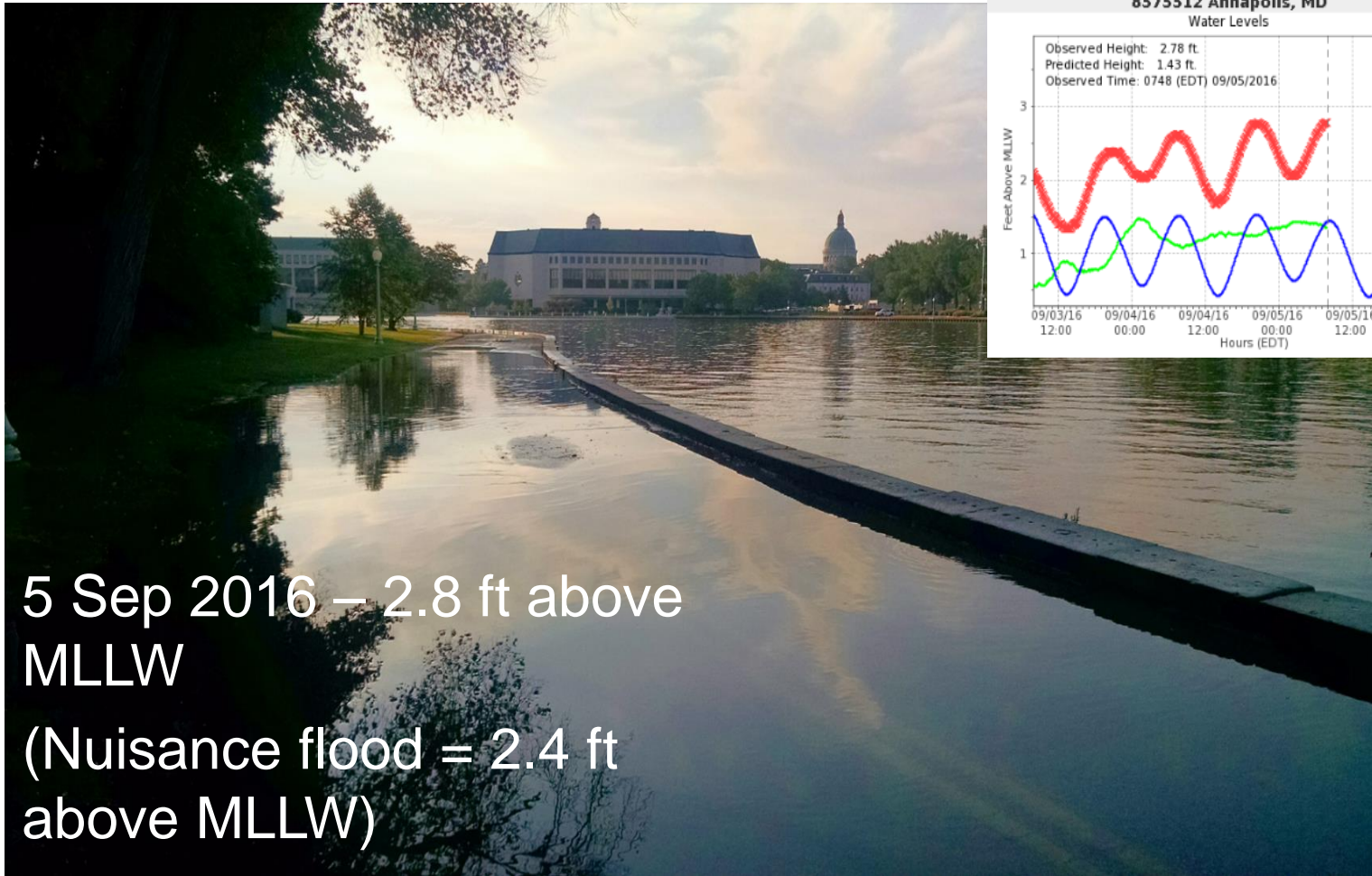
Nuisance Floods at USNA

9 Feb 2016 - 3.4 ft above
MLLW
(Nuisance flood = 2.4 ft
above MLLW)

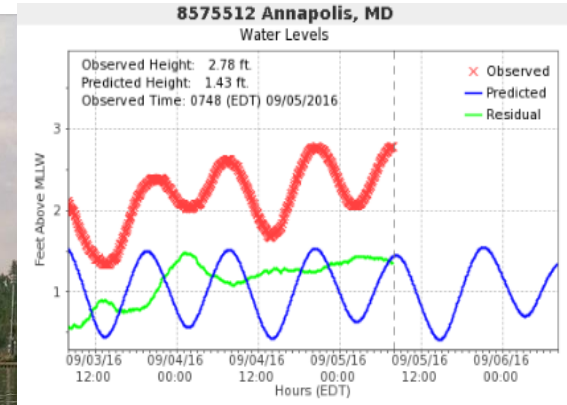




Nuisance Floods at USNA



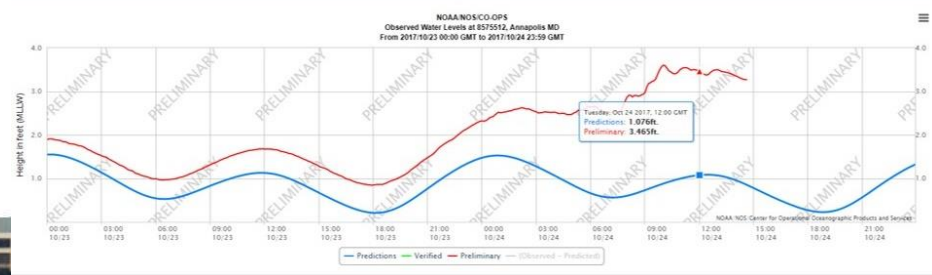
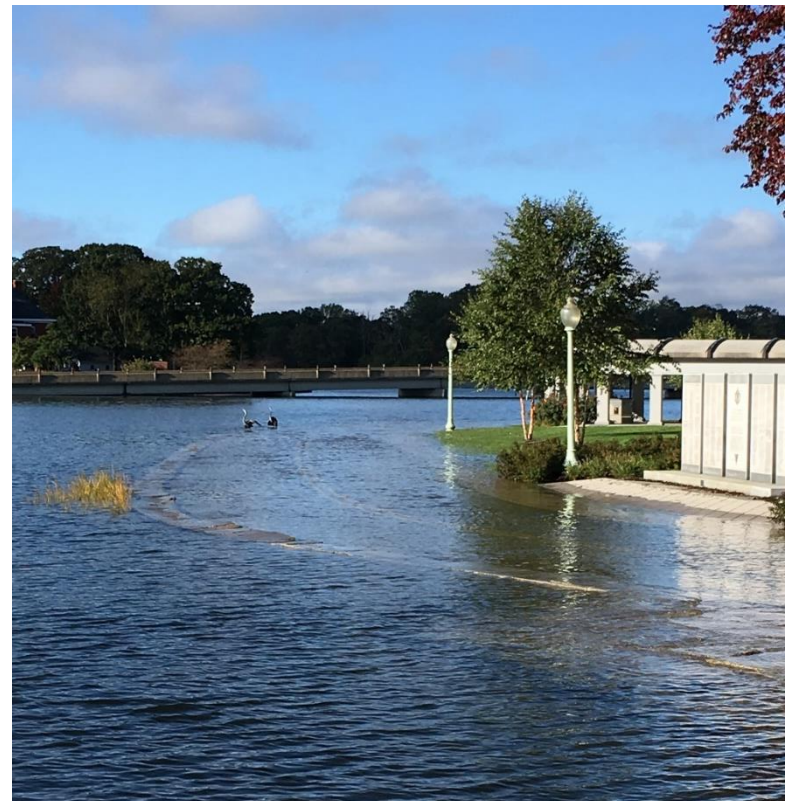
5 Sep 2016 – 2.8 ft above
MLLW
(Nuisance flood = 2.4 ft
above MLLW)





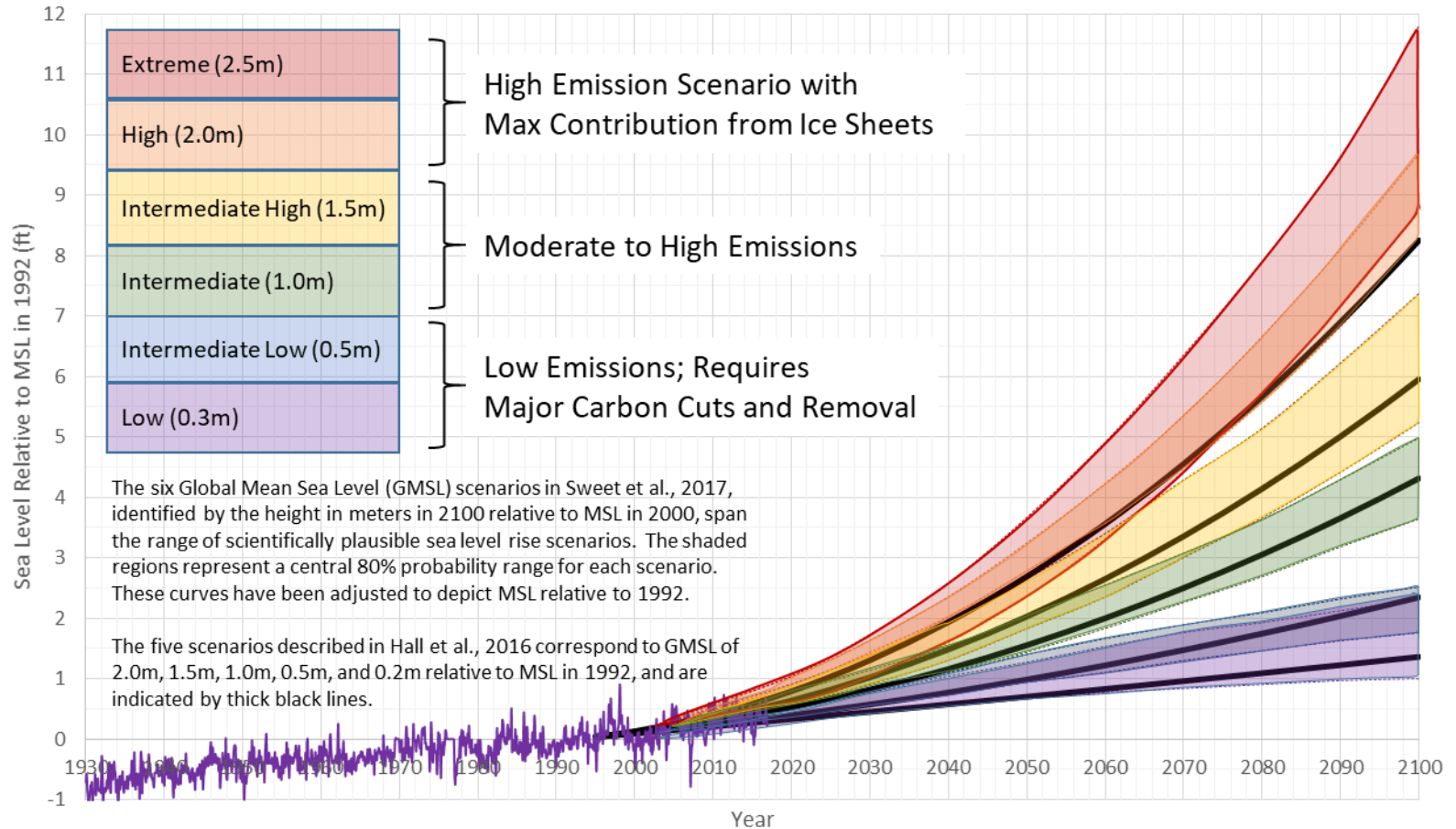
Nuisance Floods at USNA

23 Oct 17 - 3.6 ft above MLLW
(Nuisance flood = 2.4 ft above MLLW)





Local Sea Level Rise Scenarios



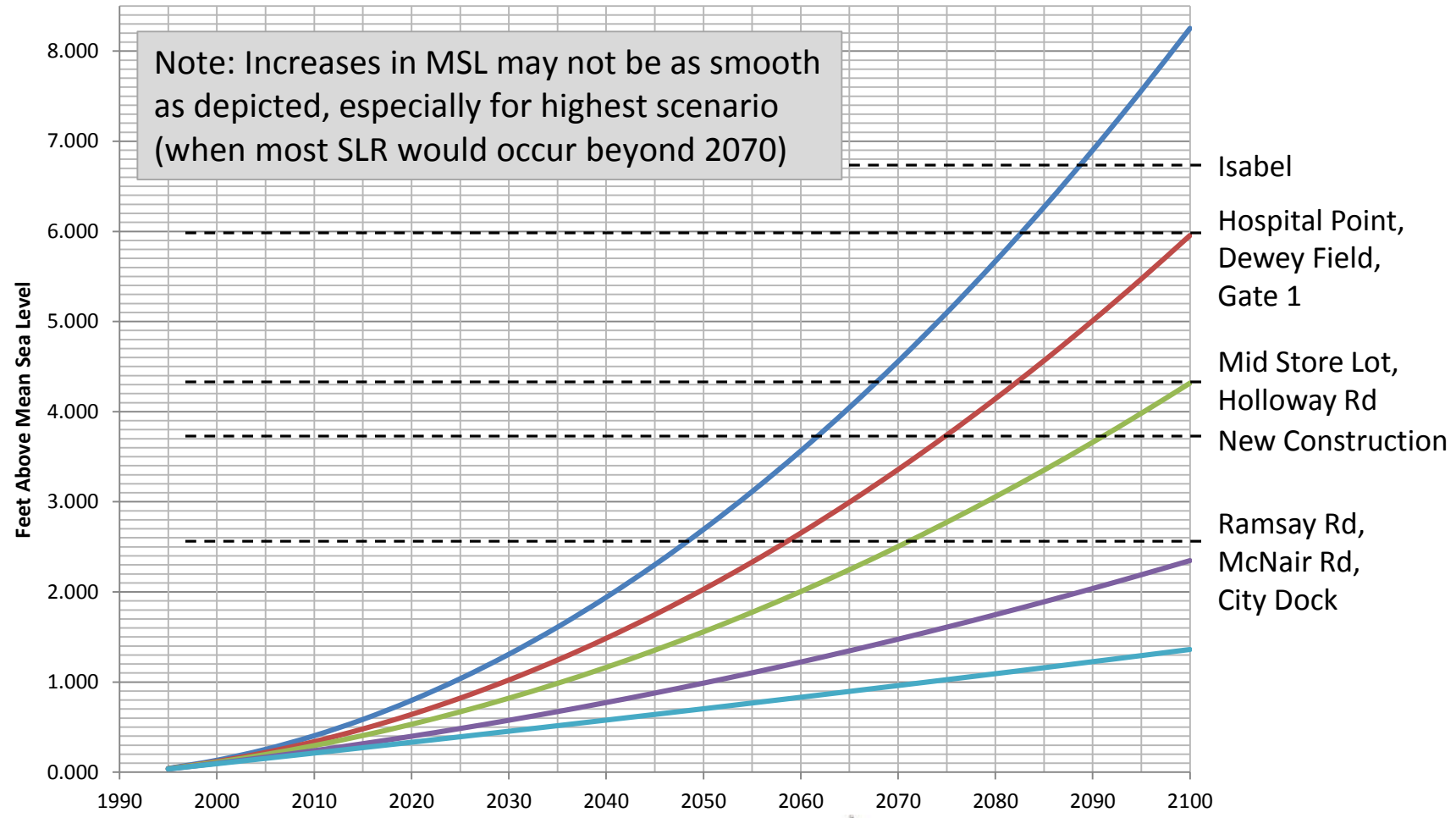
Source: Hall et al. (2016) and Sweet et al. (2017)
NOAA Annapolis Monthly Mean Sea Level Data for 1930-2016

Graphic by E.T. Petrucio





Local Sea Level Rise Scenarios



Source: Hall et al. (2016). Referenced to MSL for 1986-2001 (MSL = 0 in 1992)





Current USNA Flood Protection





Examples of USNA Adaptation



- Field House with indoor track built in 2008
- Elevated entrances and first-floor openings





Examples of USNA Adaptation

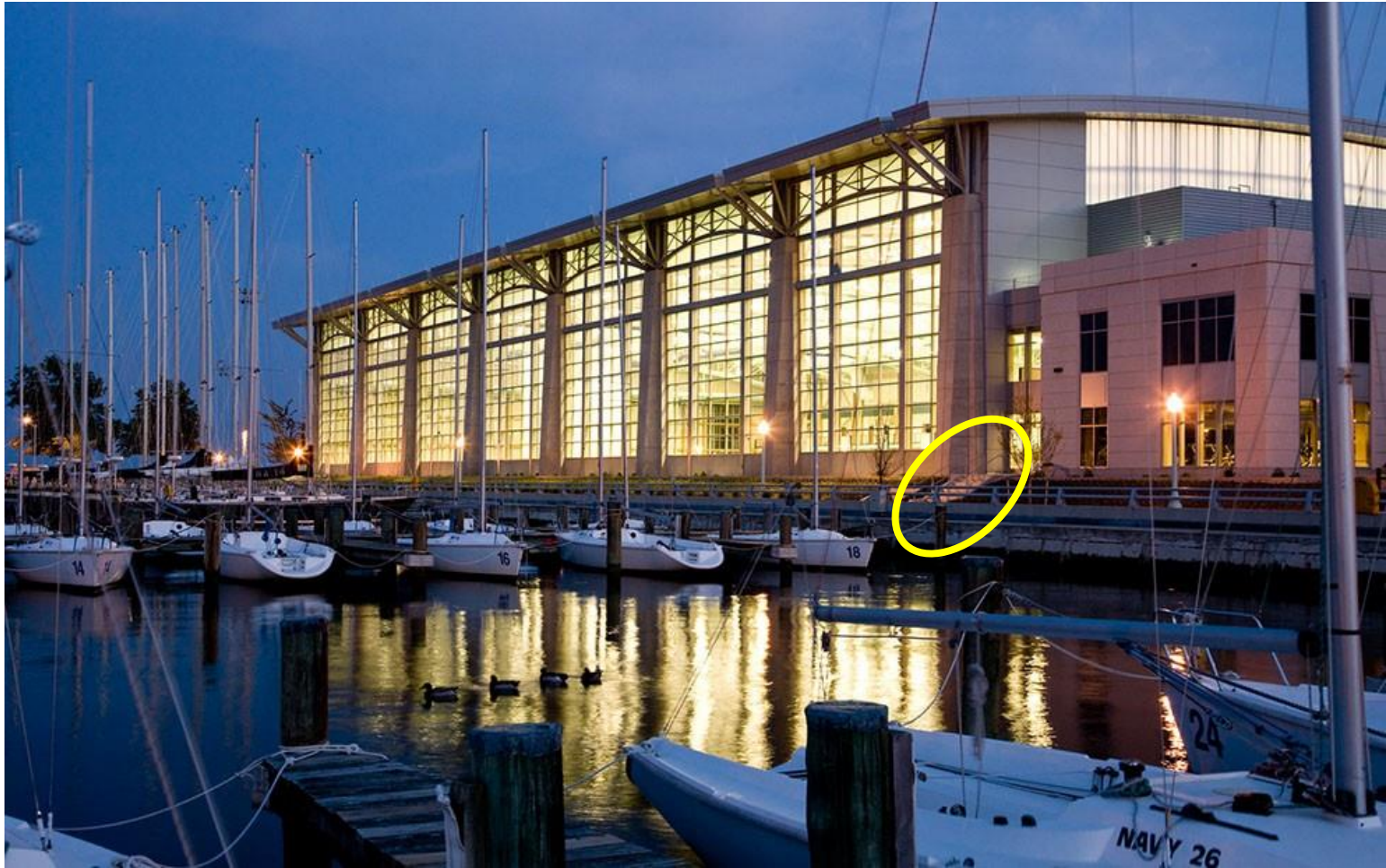


- Elevated entrances and first-floor openings





Examples of USNA Adaptation





Examples of USNA Adaptation

- New academic building under construction
- Elevated main entrances
- Minimal first-floor openings





Pilot Project - Columbarium

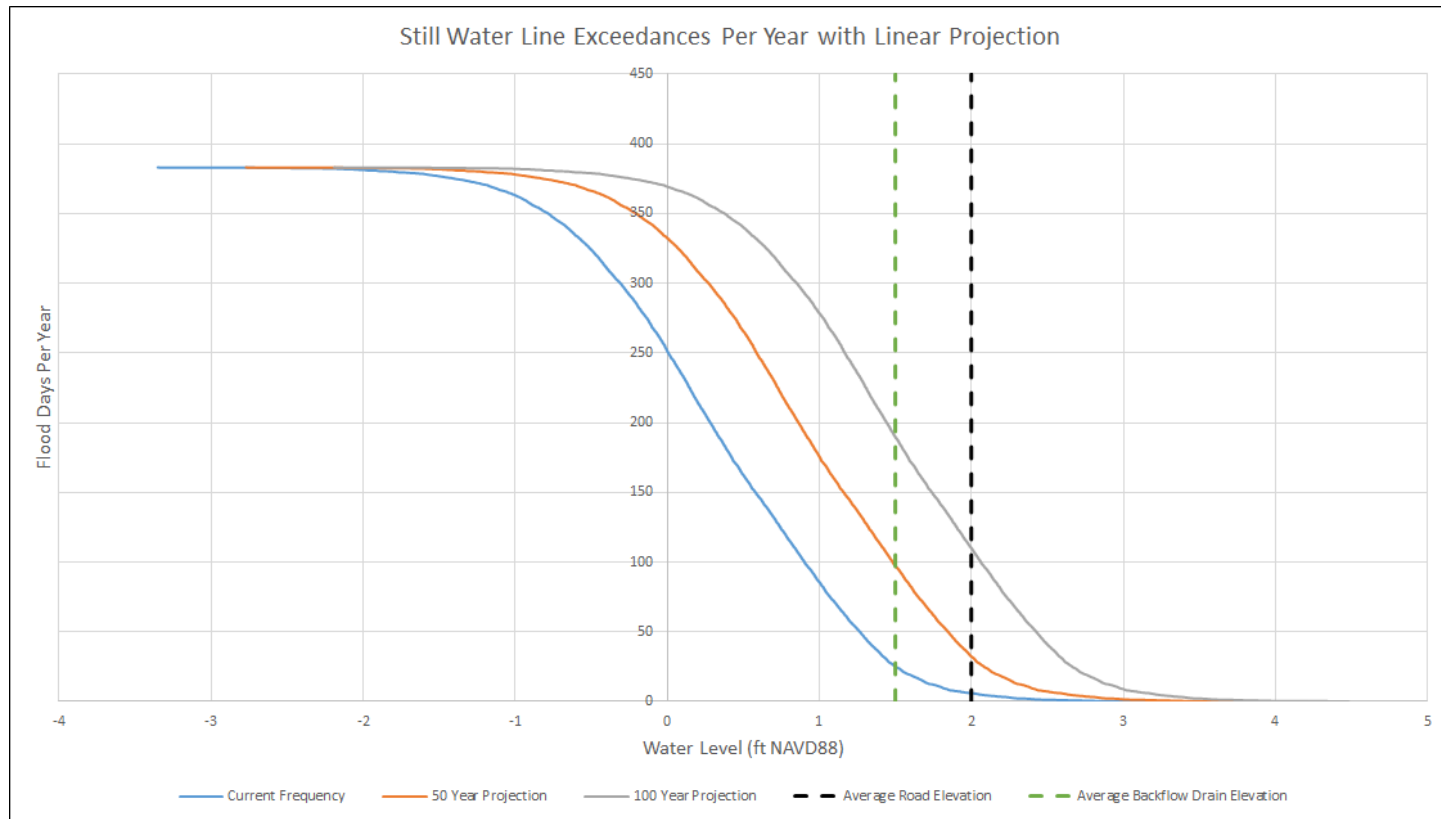
- Conceptual design in work by students
- Reduction of nuisance floods
- Various alternatives





Pilot Project - Columbarium

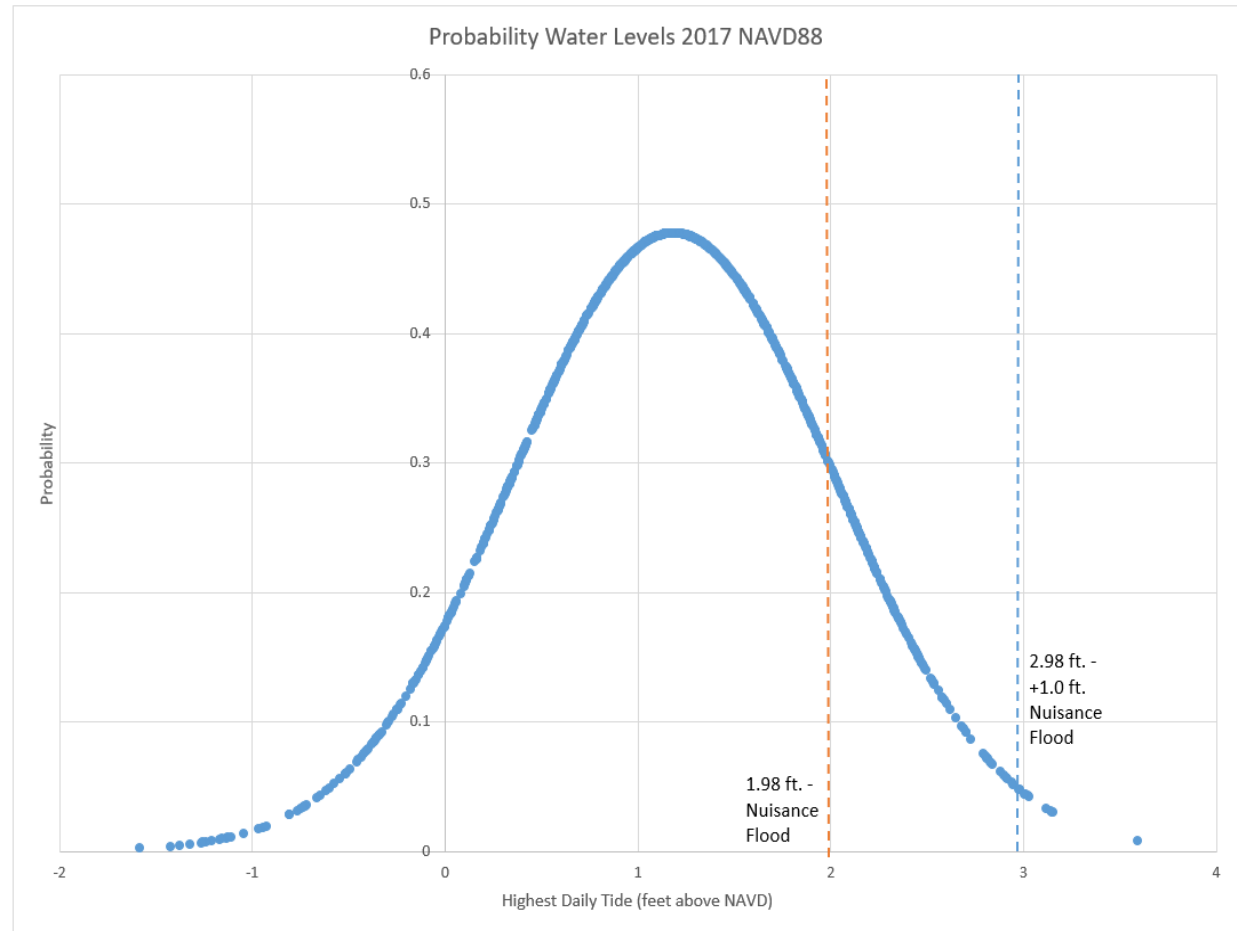
Current road elevation could potentially have 217 occurrences of nuisance flooding by 2100.





Pilot Project - Columbarium

Raising the road just 1.0 ft would reduce flooding to only 10 occurrences per year by 2100





Pilot Project - Columbarium

Roadmap Of Design Alternatives

CHOOSE ONE

Raise the Road by:

1 Foot

1.5 Feet

2 Feet

2.5 Feet

CHOOSE ONE

Wave Protection:

Living Shoreline

Seawall

CHOOSE ONE

Protect Columbarium by:

Raise Structure
and Surroundings

Drains and Pumps

Raise the Road 1.5 Feet + Seawall + Drains and
Pumps = Potential Proposed Solution





Questions?



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