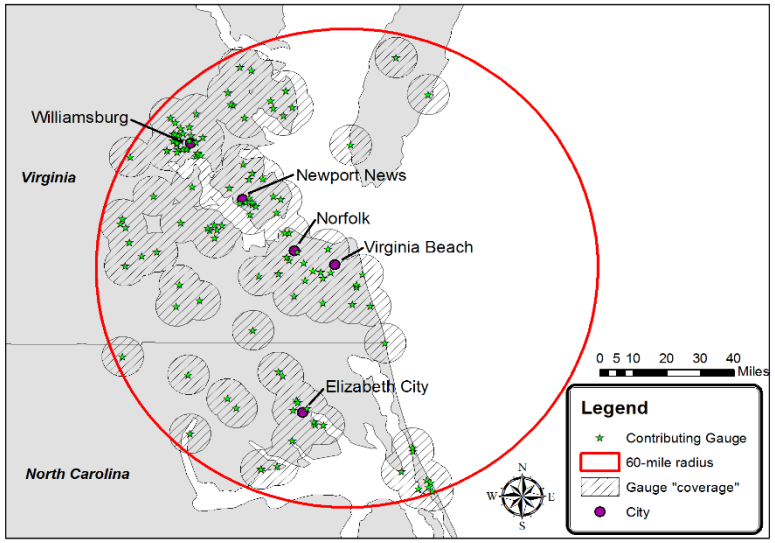
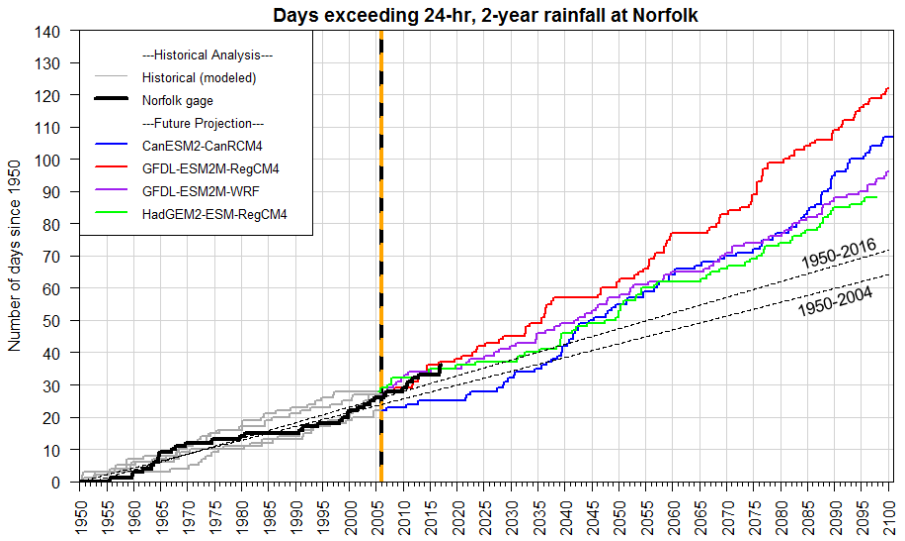
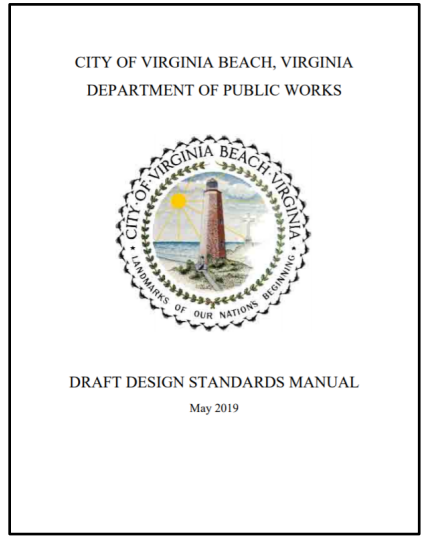






Increased precipitation, City of Virginia Beach Case Study

Brian K. Batten, Ph.D., CFM

Outline

- Motivation
- Approach
- Outcomes
- Thoughts

Comprehensive SLR and Recurrent Flood Study

Goal:

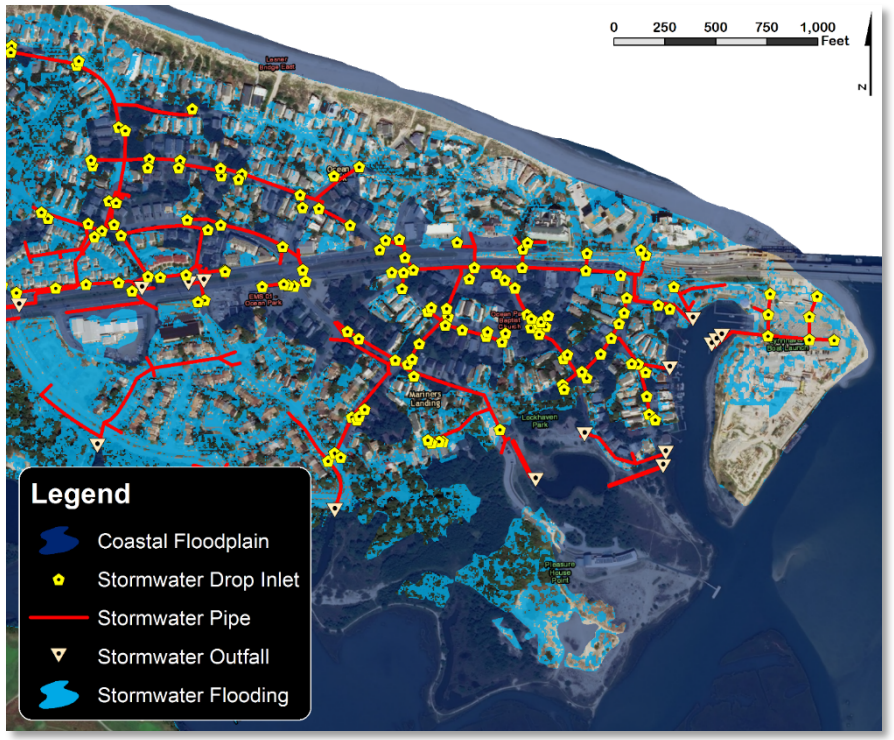
Produce information and strategies that will enable Virginia Beach to establish long-term resilience to sea level rise and associated recurrent flooding

Outcomes:

- A full understanding of flood risk and anticipated changes over planning and infrastructure time horizons
- Risk-informed strategies, including engineered protection and policy to reduce short and long-term impacts
- City-wide and watershed “action plans” for strategy implementation
- A fine-tuned public outreach process to advance resilience initiatives

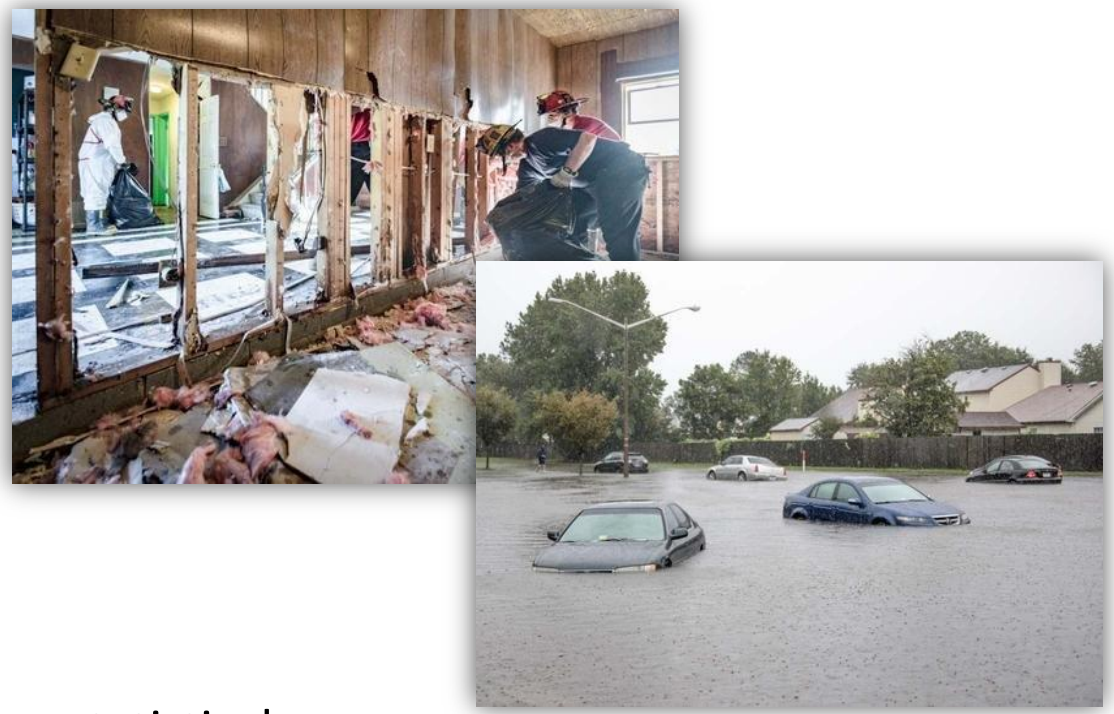
Informing Stormwater Design

- Rainfall/surge correlation
  - How often do they co-occur?
- Joint-probability of rainfall/storm surge
  - What are the statistical relationships for design?
- Regional Precipitation Trends
  - Do we have non-stationarity?
- Wind Tides
  - How to address “wind tide” events in the Southern Watershed design tailwater elevations?



Catalyst - 2016 Heavy Rainfall Events

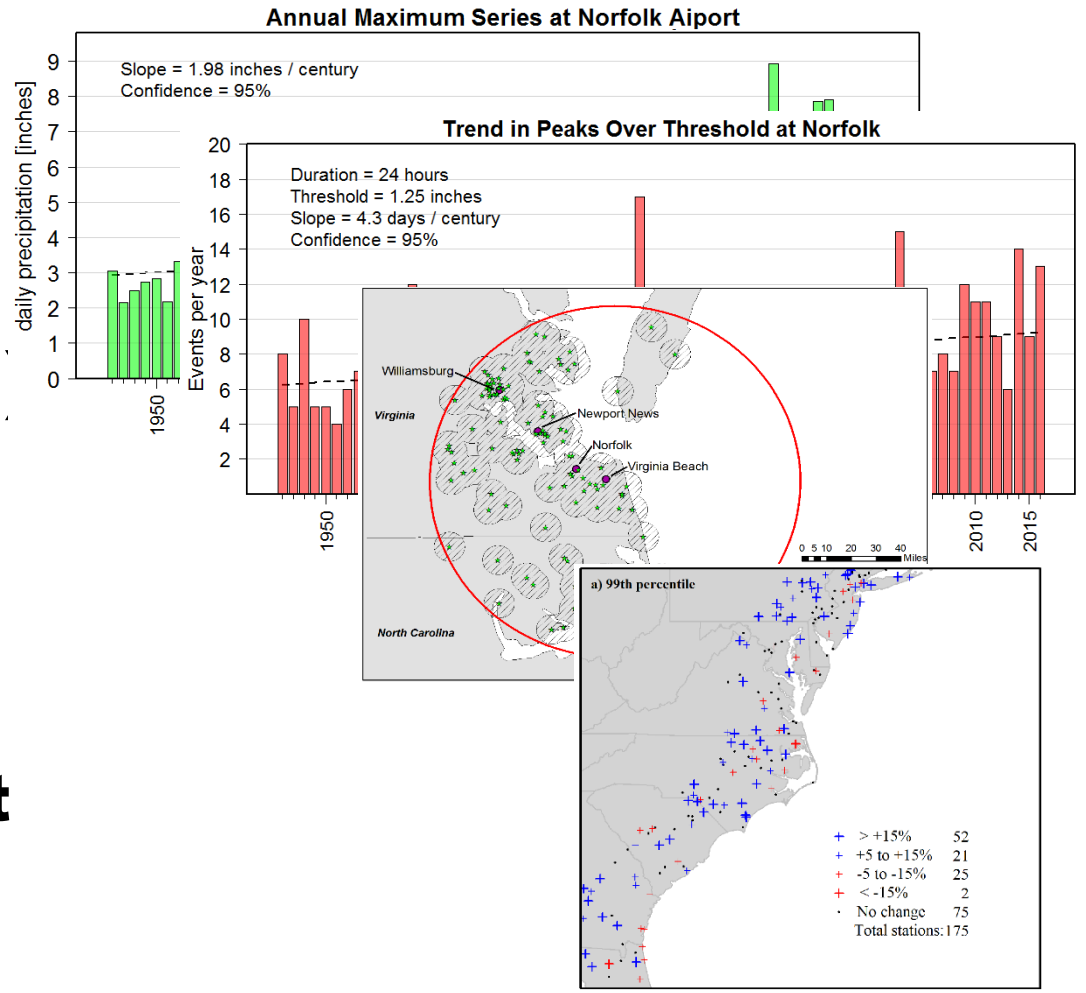
- July 31 - heavy rainfall
  - 500 to 1000-yr recurrence interval at the 2-hr duration
- September 19 – Julia
  - 100 to 200-yr event at the 24-, 48-hr durations
- October 8-9 – Matthew
  - 500 to 1000-yr event at the 24-hr durations



- Is the recent increase in heavy rainfall frequency short-term statistical noise or part of a long-term historical trend?
- What kind of future trend (if any) is being projected by long-range Global Climate Models?
- Does the City need to take steps now by increasing its design rainfall guidance?

Historical Rainfall Analysis

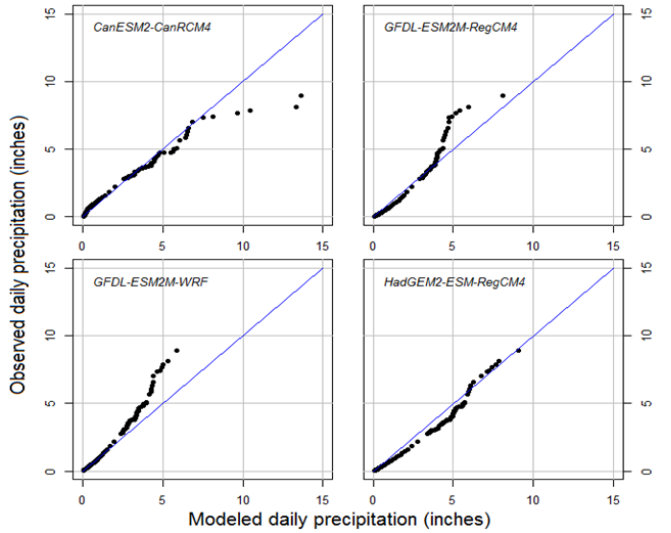
- Gage (Norfolk)
- Local (Hampton Roads)
- Regional (Mid-Atlantic Seaboard)

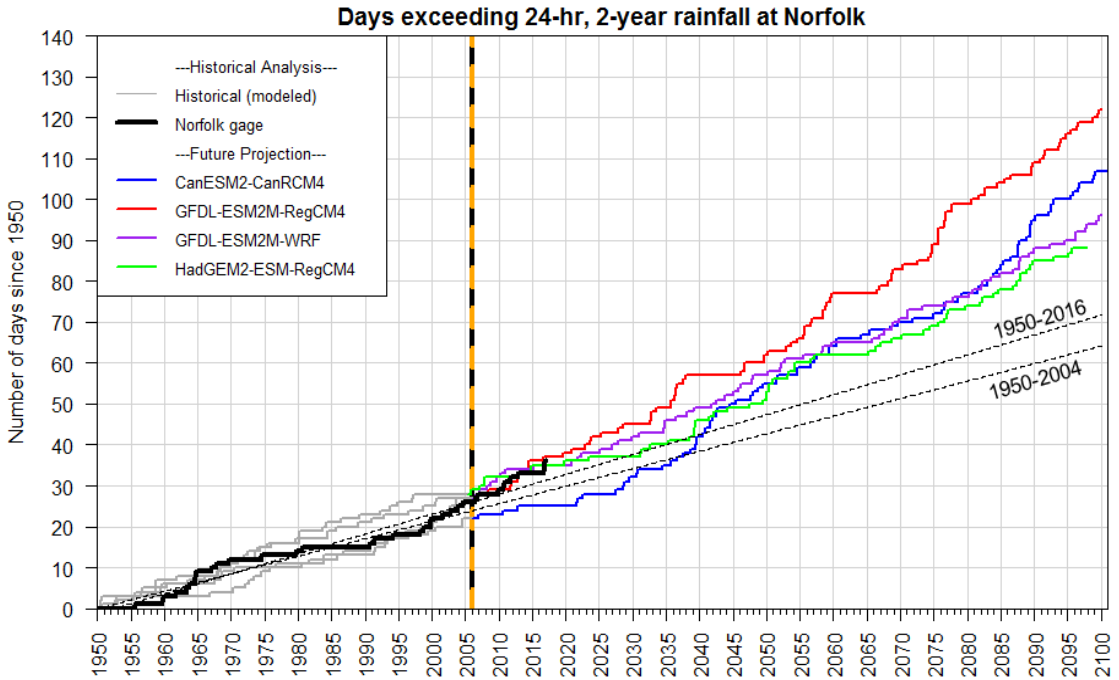


➢**Moderate/high confidence that frequency & intensity is increasing**

Future Rainfall Projections

- Approach:
  - NACORDEX - Medium and High emission scenarios RCP 4.5 and 8.5
  - Ensemble approach
  - Bias correction
  - Variable resolution (11 & 44 km)





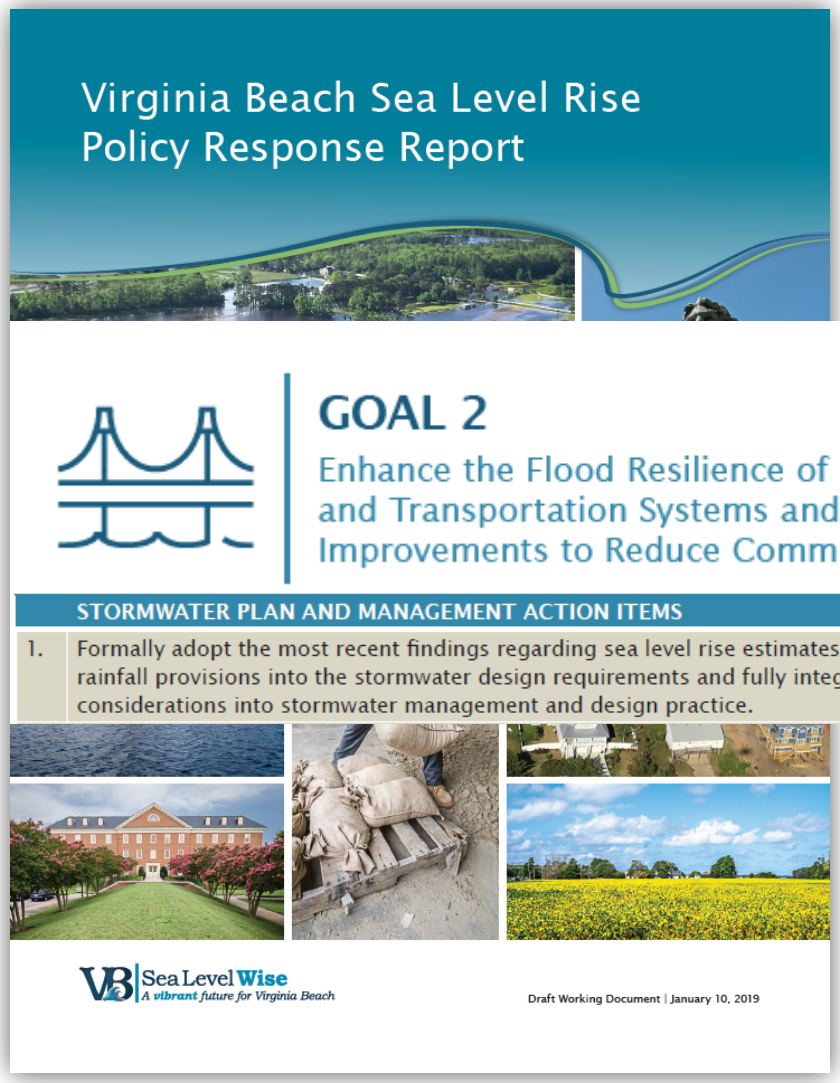
➢**Continued increases, in excess of historical trends**

Multiple lines of justification

- **Historically, precipitation Annual Maximum Series trended upward 3-7% per decade.**
- **Future projections support increases of 7% for the intermediate scenario or 24-27% in the high scenario by 2060.**
- **Current Atlas 14 guidance for the 10-year rainfall event may be 7-10% below the actual localized value based on analysis of two long-record rain gages in the area.**
- **Given these observations, an increase of the City's design guideline for rainfall intensity is justified.**

- Using an average of 5% would suggest a 20% increase given a 40-year horizon.
- A blend of the two to account for uncertainty in the actual outcome warrants a 15-16% increase.
- If such is the case, then even using the intermediate RCP 4.5 projections of 5% would already warrant a 12-15% increase in the Precipitation Frequency curve.
- **We recommend an increase of 20% over existing guidance for projects that have a typical lifecycle of 40 years.**

Incorporation into Design Standard



Design Ra

Design Frequer
1-YR
2-YR
10-YR
25-YR
50-YR
100-YR

Note: NOAA A
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above represent

Design St
Determin

10-YR Design	
Tide	Rain
10-YR	1-YR
1-YR	10-YR

Note: Refer to ***Table***
Appendix J for corre
Depths for City of Vi
J-13 *24-Hour Rainfa*
corresponding rainfa

Note: Joint probabili
lowest-frequency rai
frequency tide for ea
studies undertaken b
titled "Joint Occurre
2017 (CIP 7-030, PW
information.

CITY OF VIRGINIA BEACH, VIRGINIA

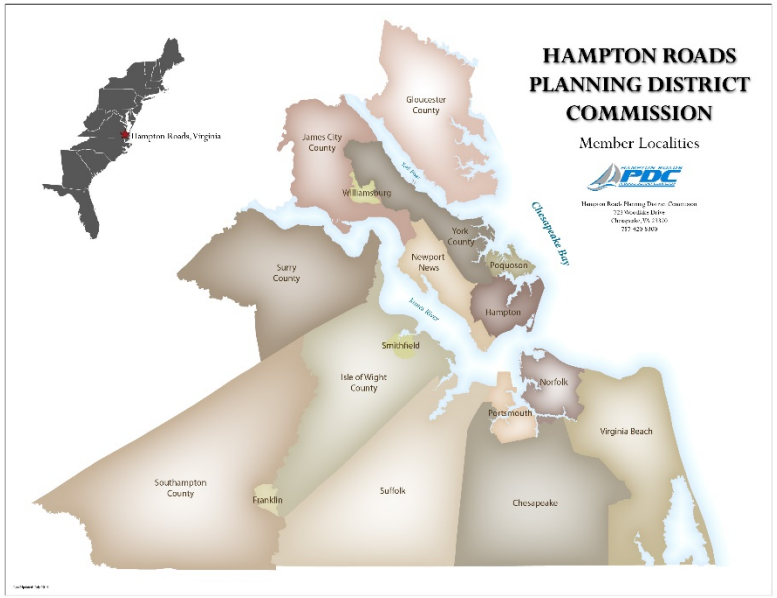
DEPARTMENT OF PUBLIC WORKS

DRAFT DESIGN STANDARDS MANUAL

May 2019

Informing Regional/State Issues

- Hampton Roads Planning District Commission



- Virginia Department of Transportation

Houston Atlas 14 Update

National Oceanic and Atmospheric Administration
U.S. Department of Commerce

Search NOAA sites

Home / News & Features

NOAA updates Texas rainfall frequency values

Data is used in infrastructure design and flood risk management

Weather | flooding rain

SHARE

Audio from the media teleconference is posted to the "resources" section below.

September 27, 2018 —

The study, published as NOAA Atlas 14, Volume 11 Precipitation-Frequency Atlas of the United States, Texas, found increased values in parts of Texas, including larger cities such as Austin and Houston, that will result in changes to the rainfall amounts that define 100-year events, which are those that on average occur every 100 years or have a one percent chance of happening in any given year.

In Austin, for example, 100-year rainfall amounts for 24 hours increased as much as three inches up to 13 inches. 100-year estimates around Houston increased from 13 inches to 18 inches and values previously classified as 100-year events are now much more frequent 25-year events.

Dewberry

Trends

Questions?

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Project Website:
http://www.vbgov.com/pwSLR

Report:
https://www.vbgov.com/government/departments/public-works/comp-sea-level-rise/Documents/anaylsis-hist-and-future-hvy-precip-4-2-18.pdf

Design Standards:
https://www.vbgov.com/government/departments/public-works/standards-specs/Documents/May%202019%20PWSSM/draft-design-stand-manual-5-1-19.pdf

Aspects of this effort were funded by National Oceanic and Atmospheric Administration Office of Coastal Management award number NA16NOS4730011.