Wind Tides, Sea Level Rise, and Recurrent Flooding in the Southern Watershed

October 4, 2018

Agenda

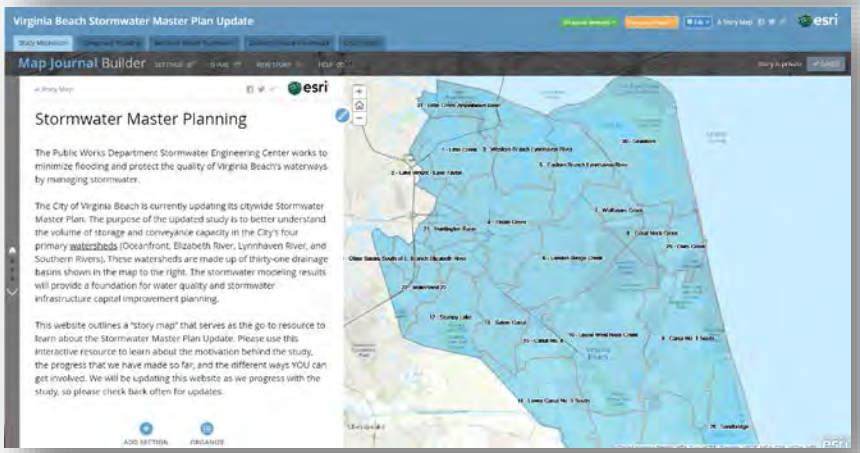
- Ongoing Studies/Resources
- Southern Watershed Challenges
  - Wind Tides
  - Drainage Issues
  - Great Bridge Lock
- Flood Risk Reduction Strategy Development

Ongoing Studies

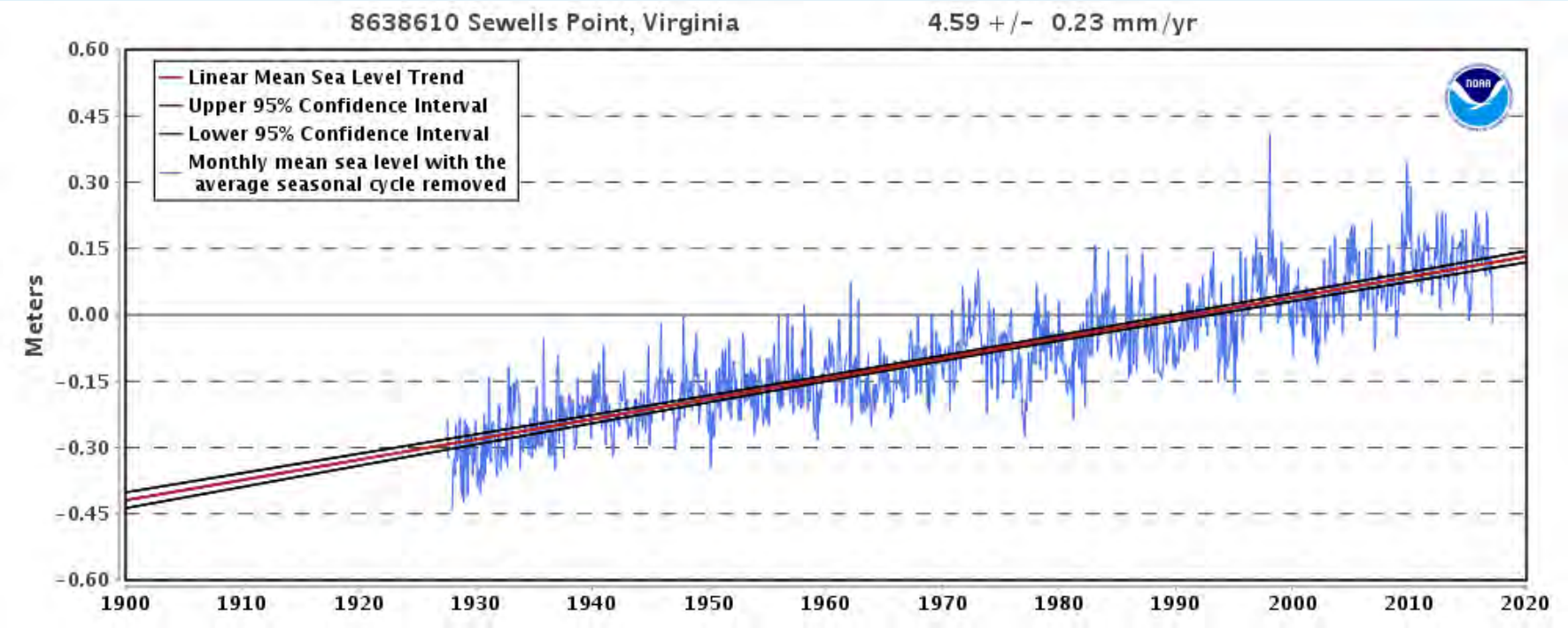
Project Website:
http://www.vbgov.com/pwSLR

- Comprehensive Sea Level Rise and Recurrent Flooding Study
  - Assessing existing and future flood vulnerabilities across the City's four unique watersheds
  - Identifying strategies to ensure our city is resilient to future flooding events

- Master Drainage Study
  - Detailed inventory of the City's stormwater system
  - Assessing the system's performance
  - Identifying deficiencies or needed improvements



SLR and Recurrent Flooding

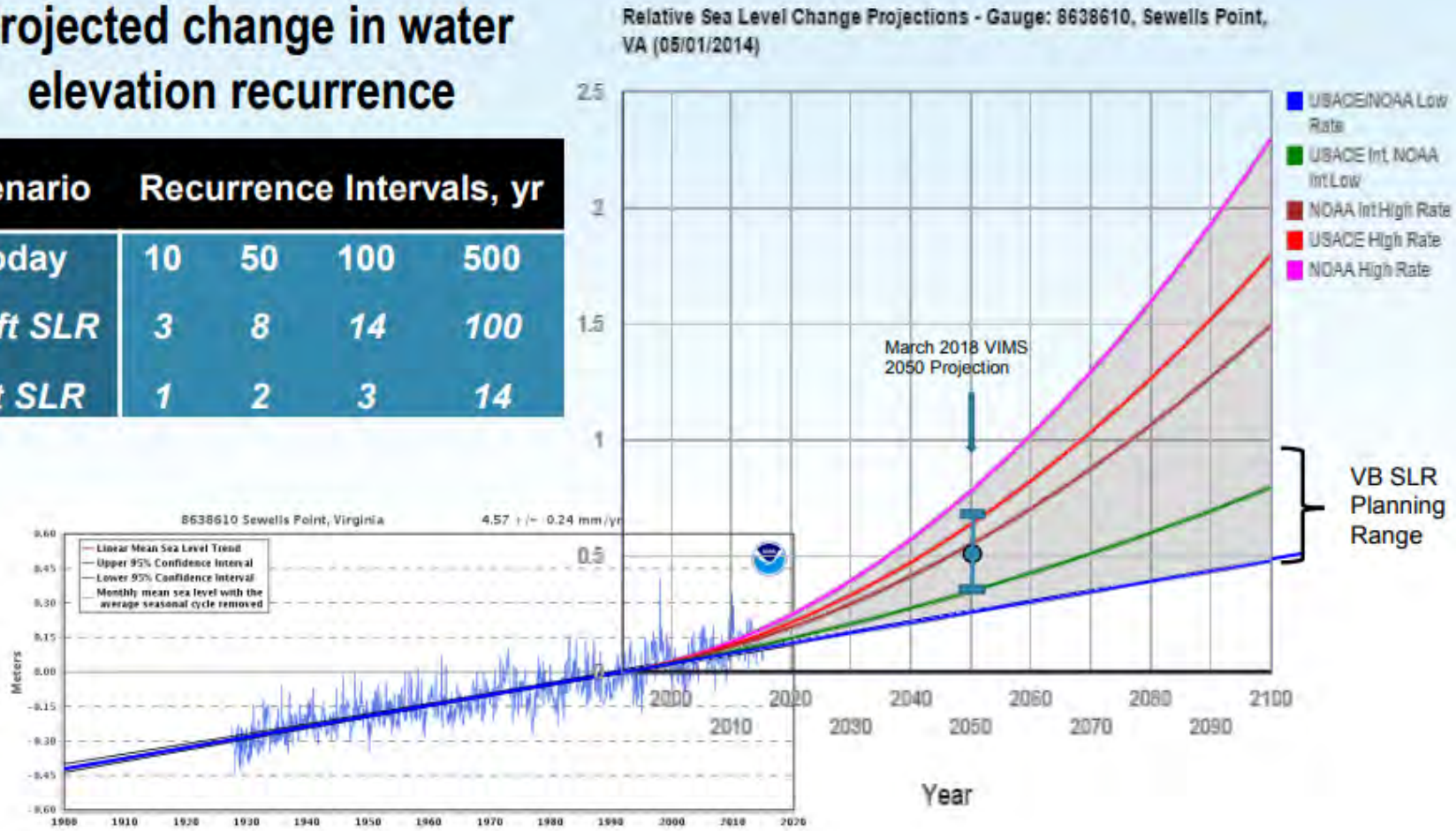


Last 50 years = ~0.75 ft increase

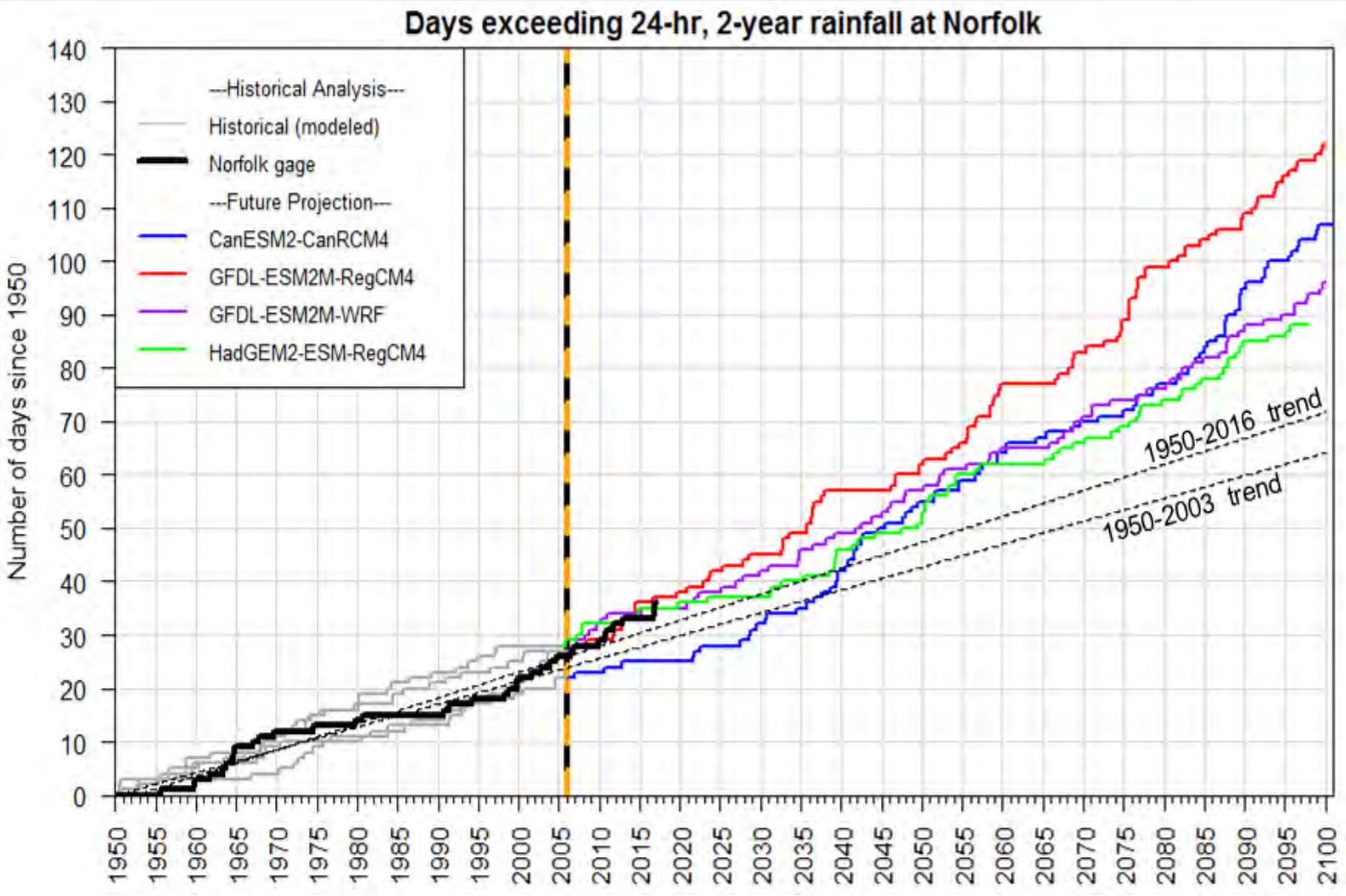
What the data says to expect:

Projected change in water elevation recurrence

Scenario	Recurrence Intervals, yr			
Today	10	50	100	500
1.5 ft SLR	*3*	*8*	*14*	*100*
3 ft SLR	*1*	*2*	*3*	*14*



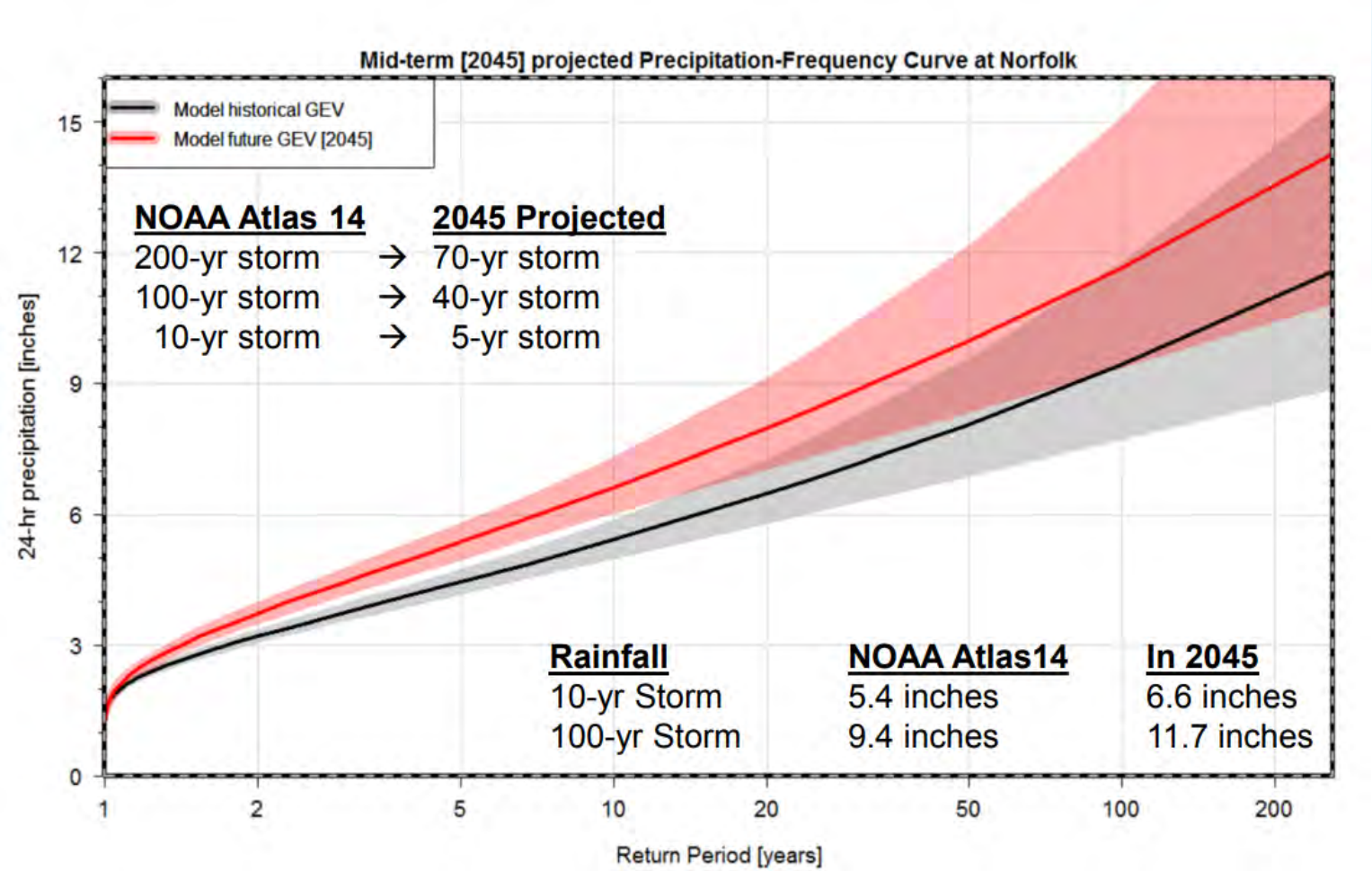
Rainfall Trends



- Upward trend of Annual Maximum Precipitation Series between 3-7% per decade.

NOAA Atlas 14

- Analysis of Historical and Future Heavy Precipitation NOAA Atlas 14 does not Represent Current Reality



Environmental, Land Use, Economic Diversity

Planning Area/ Natural Resources	Defining Characteristics	Challenges
Lynnhaven / Tidal sheltered bay, estuarine, fringing marsh	Mixed residential, military, commercial, lower elevation properties with high tax base. High quality natural resources. Assets at vulnerable elevations.	Addressing repititive losses from recurrent flooding and preservation of low-lying natural resources.
Oceanfront / Ocean, headland beaches, tidal inlet, bay	Dense commercial and residential development. Tourism as primary economic driver. Redevelopment opportunities. USACE Civil Works flood risk reduction project.	Protecting existing development and economic base while instilling resilience as a keystone in redevelopment.
Elizabeth River / Estuarine, fringing marshes	Dense residential, commercial, industrial development. Aging infrastructure.	Upgrading infrastructure and maintaining water-based industrial economy with higher sea levels.
Southern / Ocean, barrier beaches, back bays and extensive marshes	Light residential, military, rural, recreational, waterfowl and land preserves. Agriculture important economic concern. Low elevation gradients.	Establishing land use strategies that preserve resources and limit new development and infrastructure in areas susceptible to future flooding.

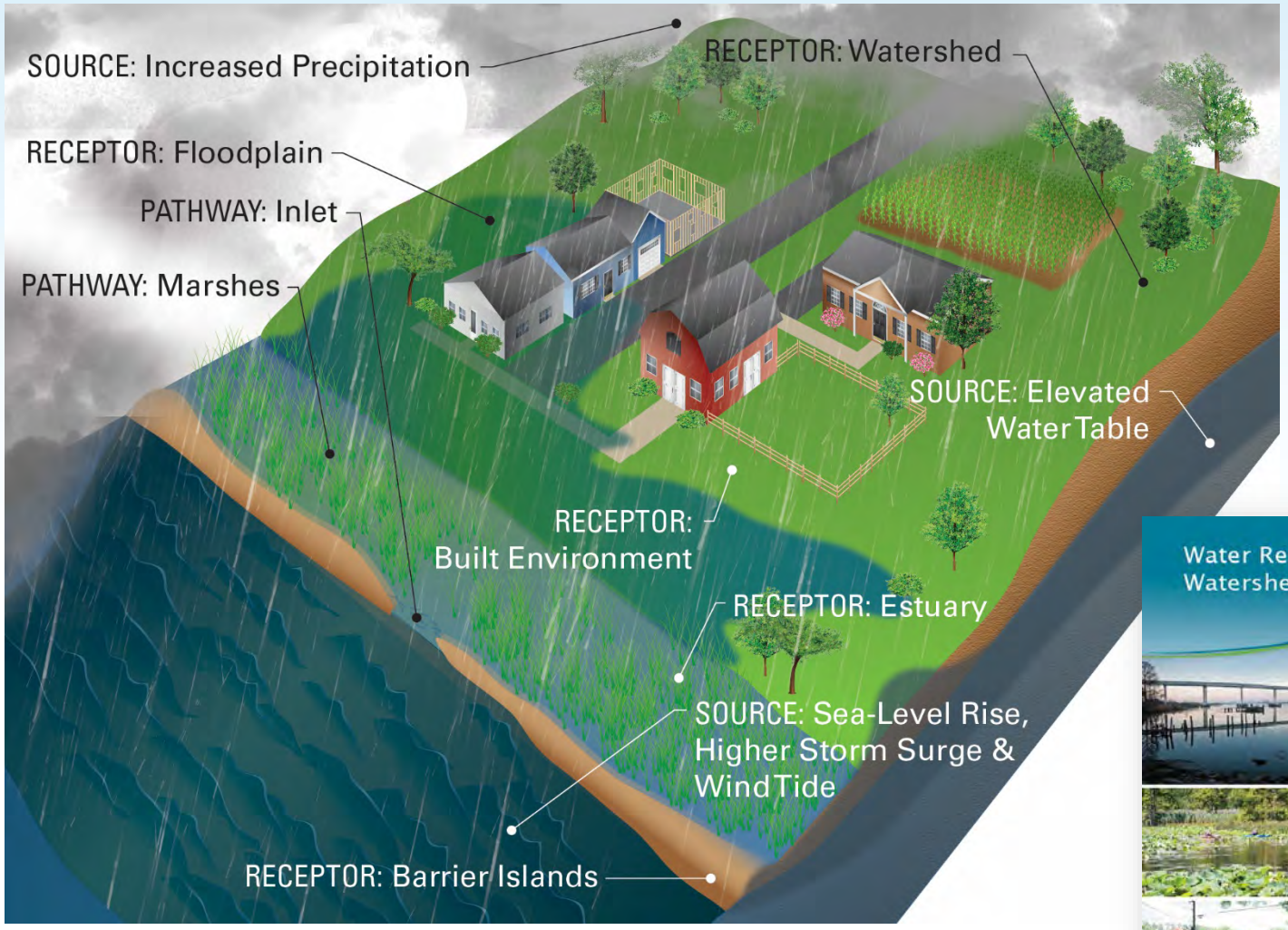
SLR Study Aspects in S. Watershed

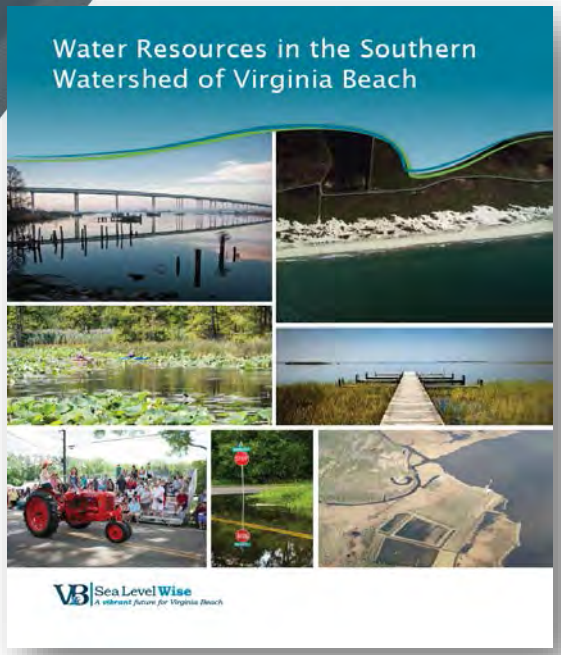
- Synthesis of water resources issues in the So. Watershed.
- Future floodplain mapping
- Future storm surge conditions considering landscape changes
- Return period analysis of Back Bay water levels
- Economic flood risk analysis
- Social vulnerability assessment
- Marsh response modeling

SLR Study Aspects in S. Watershed

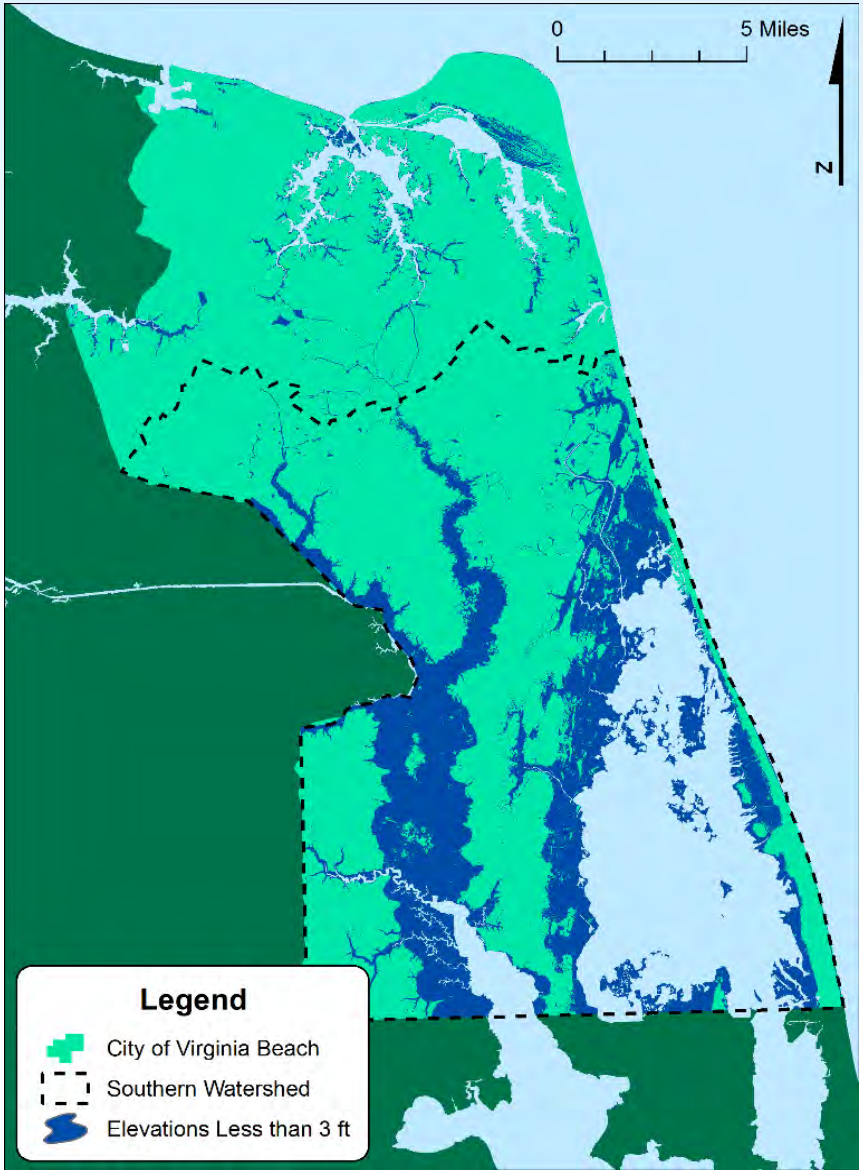
- Potential overtopping of dunes for future flood conditions
- Rural road flood monitoring
- So. Watershed wind-tide modeling
- Great Bridge Lock modeling
- Integrated coastal-rainfall modeling
- Design tailwater elevation assessment
- Flood risk reduction strategies

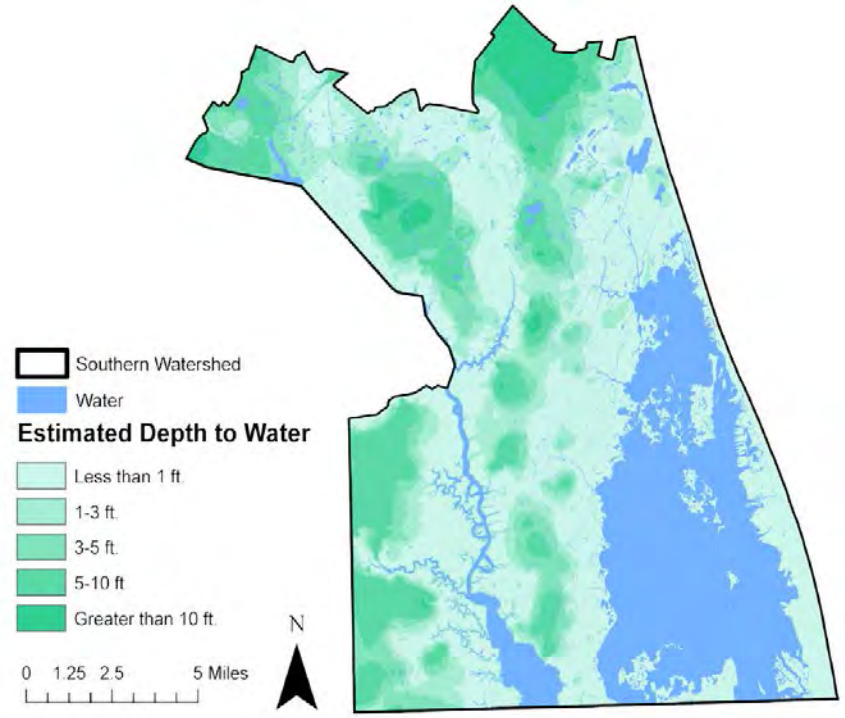
Southern Watershed Challenges





Low-Lying Land and High Water Tables





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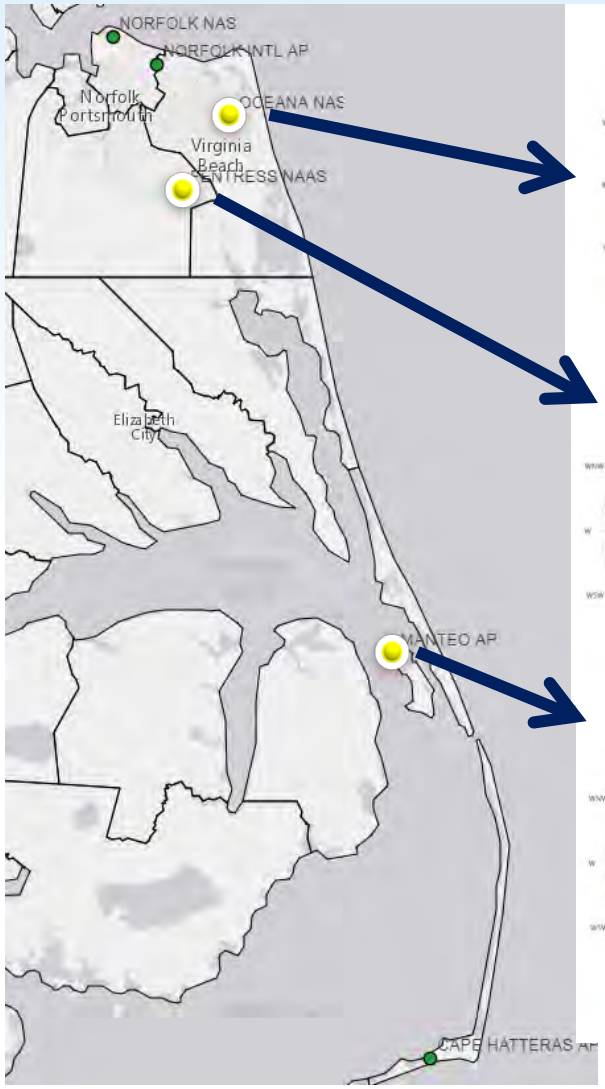
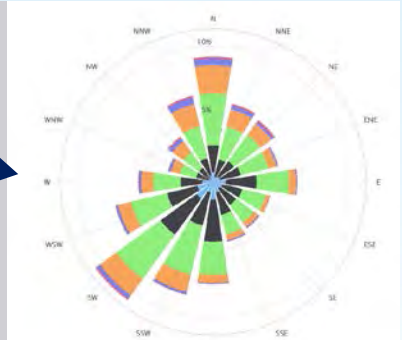
Wind Tides

- Southerly winds push water up from North Carolina into Back Bay and North Landing River

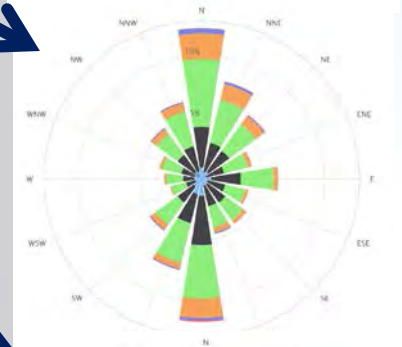
Wind Climatology





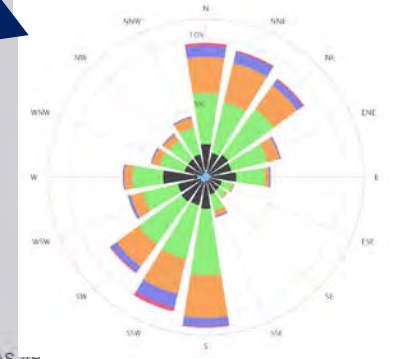
OCEANA NAS (VA) Wind Rose

Mar. 1, 1945 – Sep. 19, 2018
Sub-Interval: Jan. 1 – Dec. 31, 0 – 23



FENTRESS NAAS (VA) Wind Rose

Mar. 1, 1945 – Sep. 19, 2018
Sub-Interval: Jan. 1 – Dec. 31, 0 – 23



MANTEO AP (NC) Wind Rose

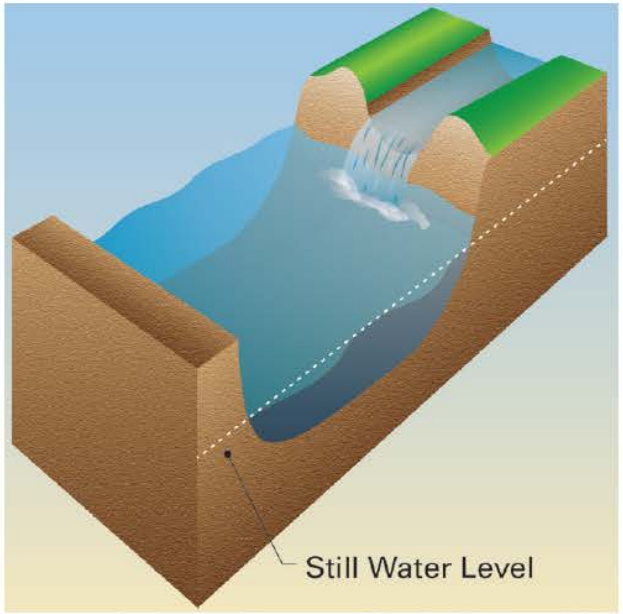
Mar. 1, 1945 – Sep. 21, 2018
Sub-Interval: Jan. 1 – Dec. 31, 0 – 23

Wind Speed (mph)

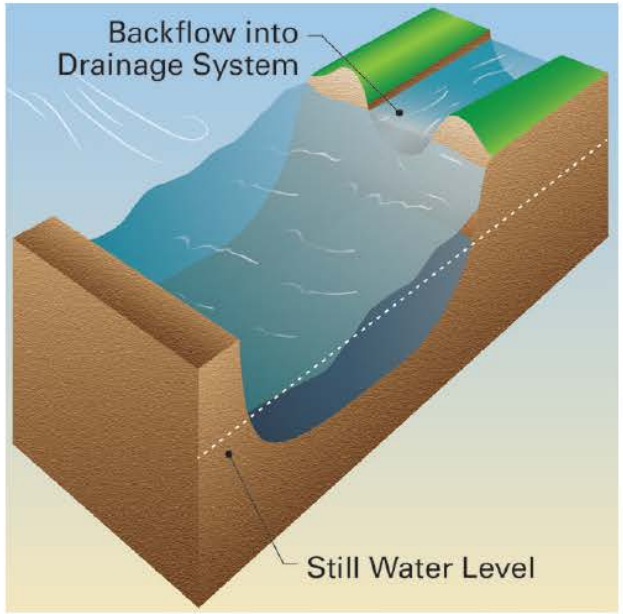
- 1.3 – 4
- 4 – 8
- 8 – 13
- 13 – 19
- 19 – 25
- 25 – 32
- 32 – 39
- 39 – 47
- 47 –

Drainage Issues

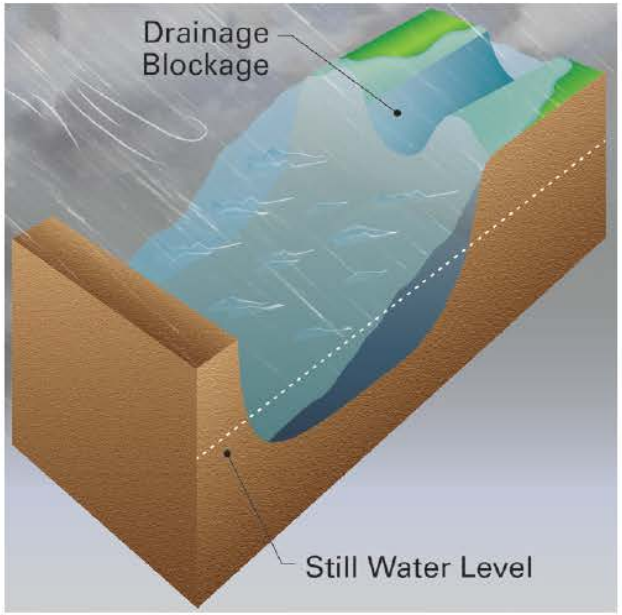
Normal Conditions



With Wind Tides



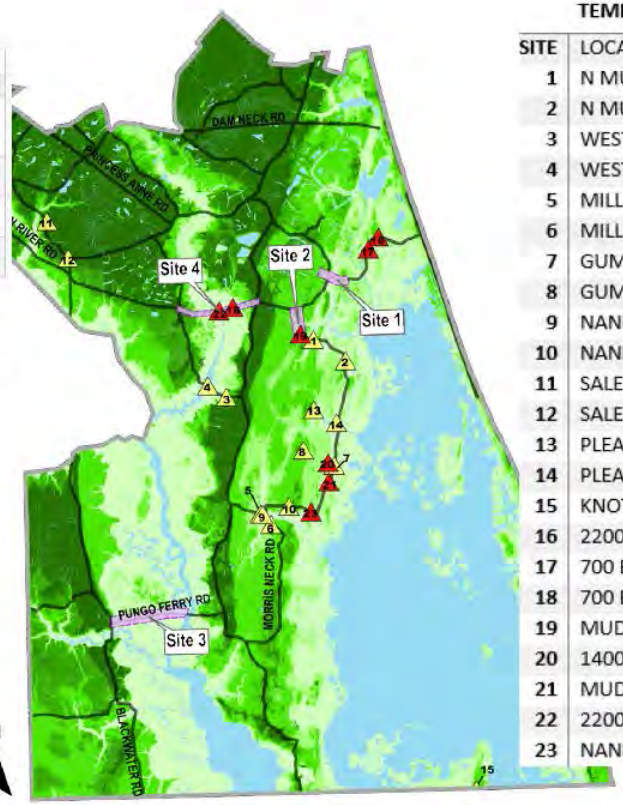
With Wind Tides & Rain



Monitoring Activities

- High water monitoring for road closures
- Rural Road Flood Study – September 2018
  - Evaluated Sites 1, 3 and 4

Flooding Area Sites	LOCATION
Site 1	Sandbridge Road from Flanagans Lane to Colechester Road including the intersection at New Bridge Road (0.65 Mile)
Site 2	Indian River Road between New Bridge Road and N Muddy Creek Road
Site 3	Pungo Ferry Road from Blackwater Road to west end of Pungo Ferry Bridge
Site 4	Indian River Road between West Neck Road and Princess Anne Road (1.94 Miles)



LOCATIONS OF PERMANENT AND TEMPORARY HIGH WATER SIGNS

SITE	LOCATION
1	N MUDDY CREEK RD
2	N MUDDY CREEK RD
3	WEST NECK RD
4	WEST NECK RD
5	MILL LANDING RD
6	MILL LANDING RD
7	GUM BRIDGE RD
8	GUM BRIDGE RD
9	NANNEYS CREEK RD
10	NANNEYS CREEK RD
11	SALEM RD
12	SALEM RD
13	PLEASANT RIDGE RD
14	PLEASANT RIDGE RD
15	KNOTTS ISLAND RD
16	2200 BLOCK INDIAN RIVER RD
17	700 BLOCK SANDBRIDGE RD (EB)
18	700 BLOCK SANDBRIDGE RD (WB)
19	MUDDY CREEK RD @ INDIAN RIVER
20	1400 BLOCK GUM BRIDGE RD
21	MUDDY CREEK RD @SHIPPS CABIN
22	2200 BLOCK INDIAN RIVER RD
23	NANNEYS CREEK RD AT MUDDY CREEK

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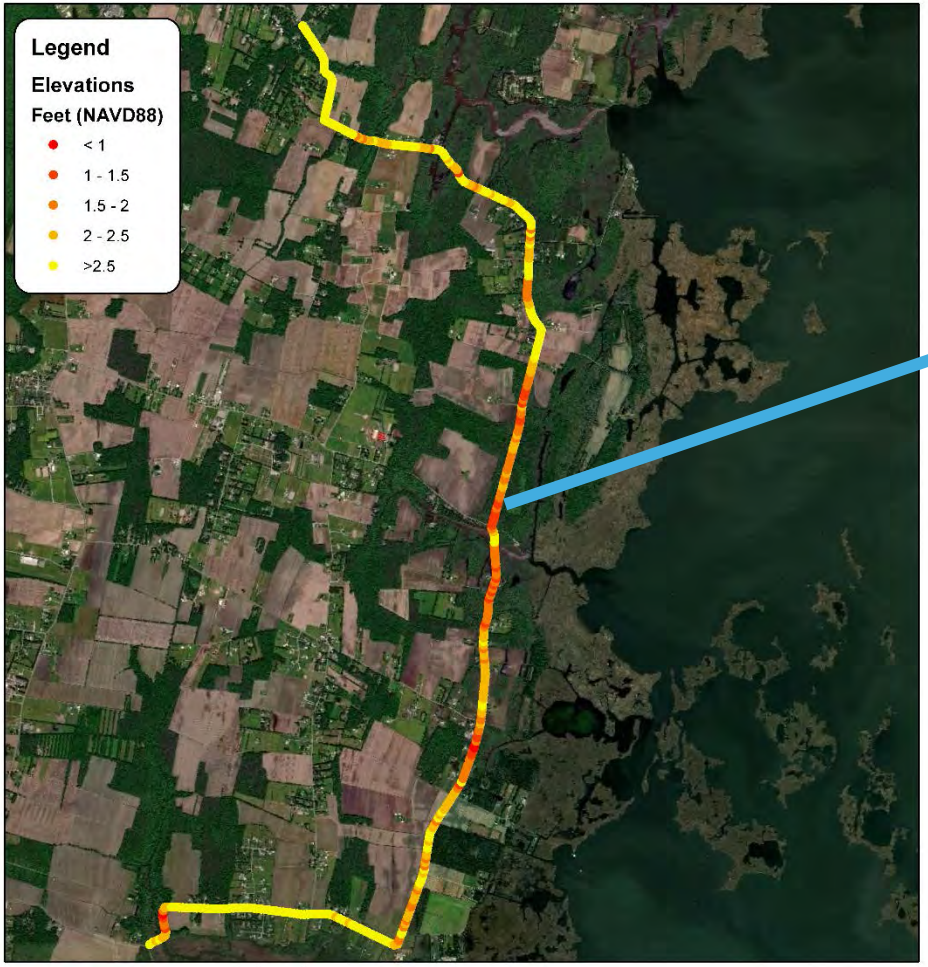
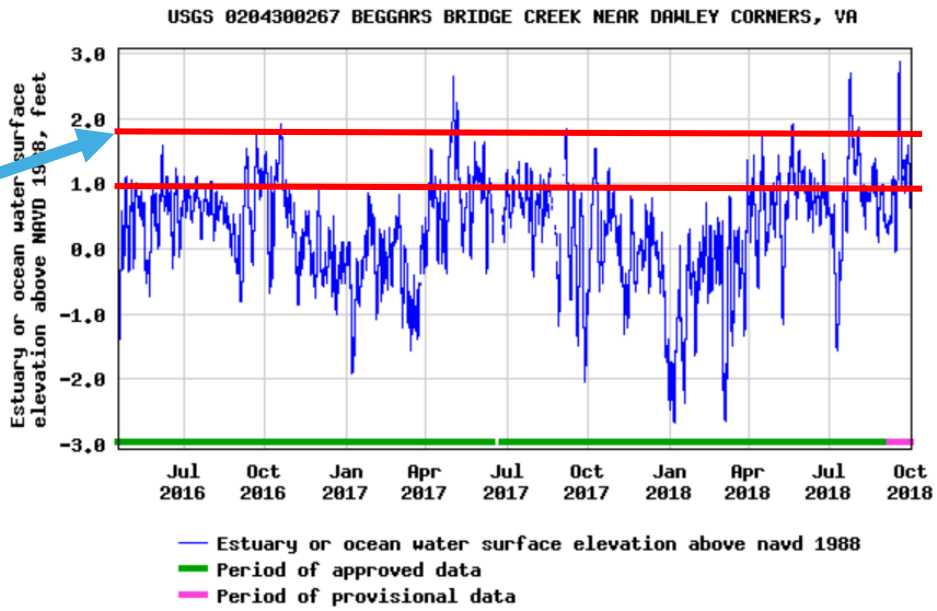
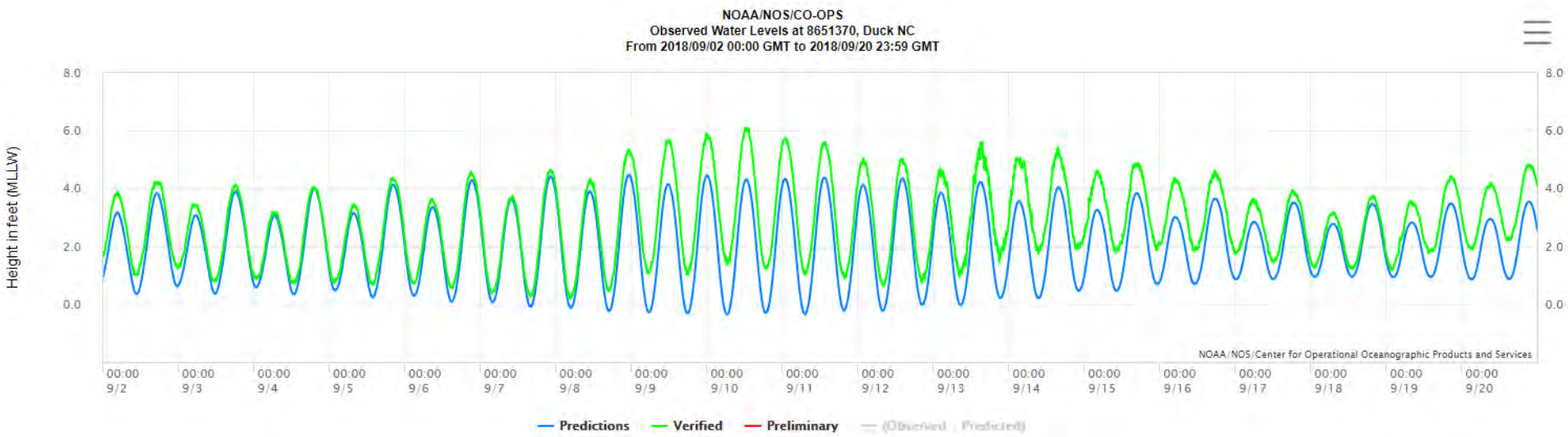
What have we seen recently?

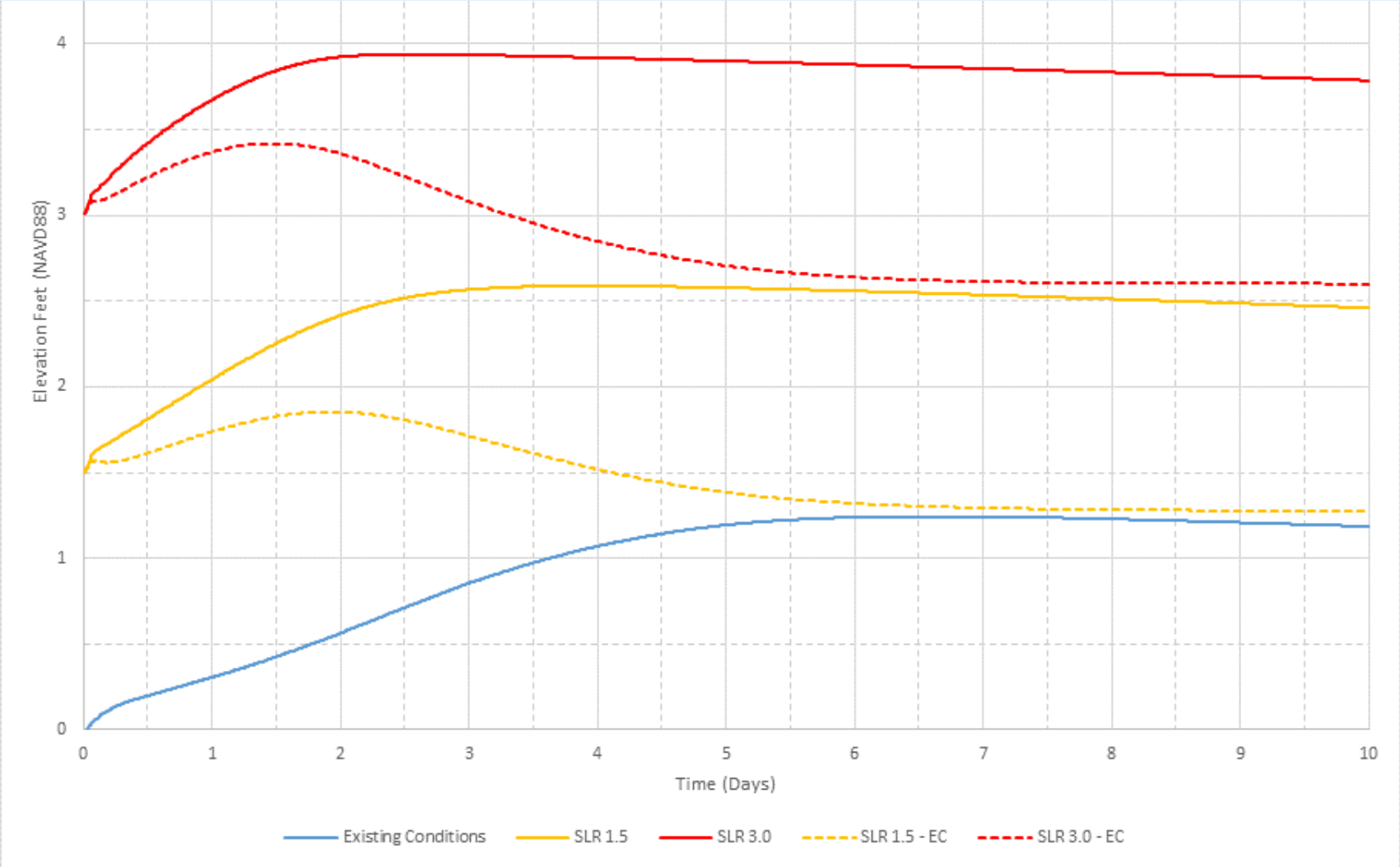




Florence

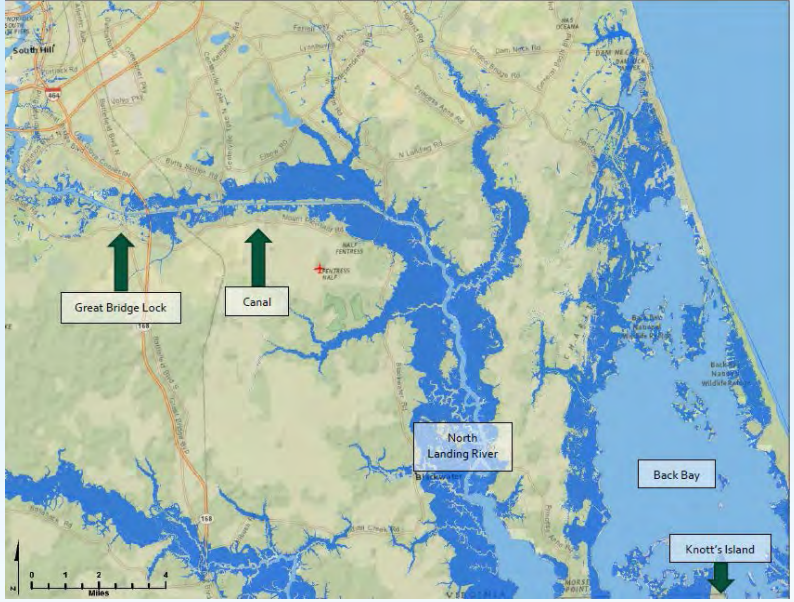

NOAA/NOS/CO-OPS
Observed Water Levels at 8651370, Duck NC
From 2018/09/02 00:00 GMT to 2018/09/20 23:59 GMT
Height in feet (MLLW)
8.0
6.0
4.0
2.0
0.0
NOAA/NOS/Center for Operational Oceanographic Products and Services
00:00 9/2
00:00 9/3
00:00 9/4
00:00 9/5
00:00 9/6
00:00 9/7
00:00 9/8
00:00 9/9
00:00 9/10
00:00 9/11
00:00 9/12
00:00 9/13
00:00 9/14
00:00 9/15
00:00 9/16
00:00 9/17
00:00 9/18
00:00 9/19
00:00 9/20
Predictions
Verified
Preliminary

Wind Tides with Sea Level Rise



Great Bridge Lock

- Question: Does it affect flooding?
- Assessment:
  - City simulated water levels with sustained southerly winds up to 35 mph over 10 days in a state-of-the-art computer model
- Answers:
  - Near Gate: Yes
  - North Landing River: Negligible by West Neck Creek
  - Back Bay: No effect

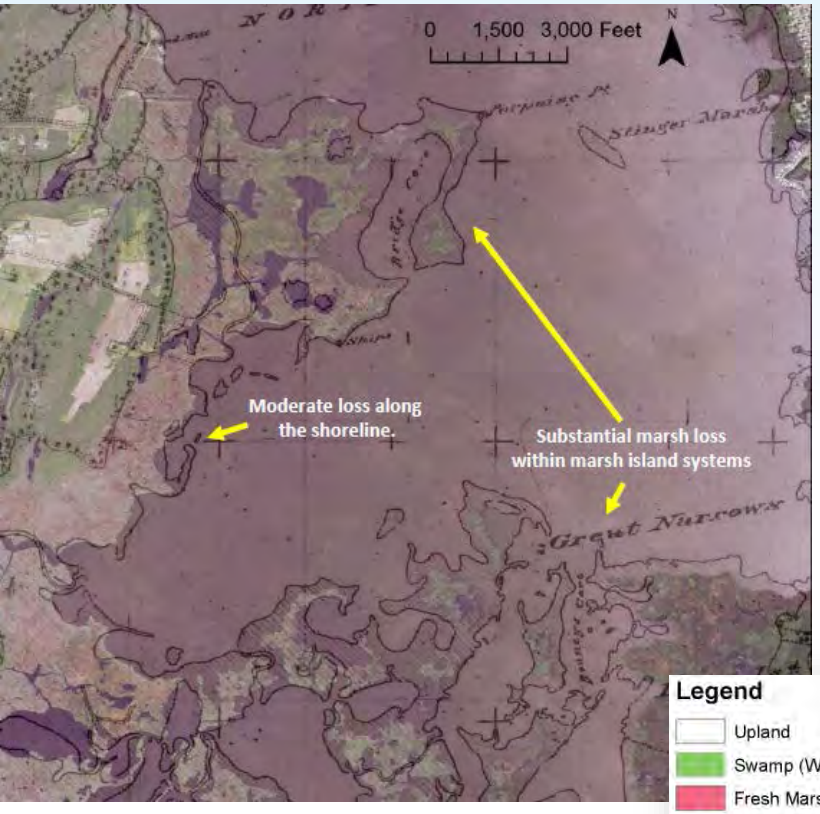


Credit: Marinas.com

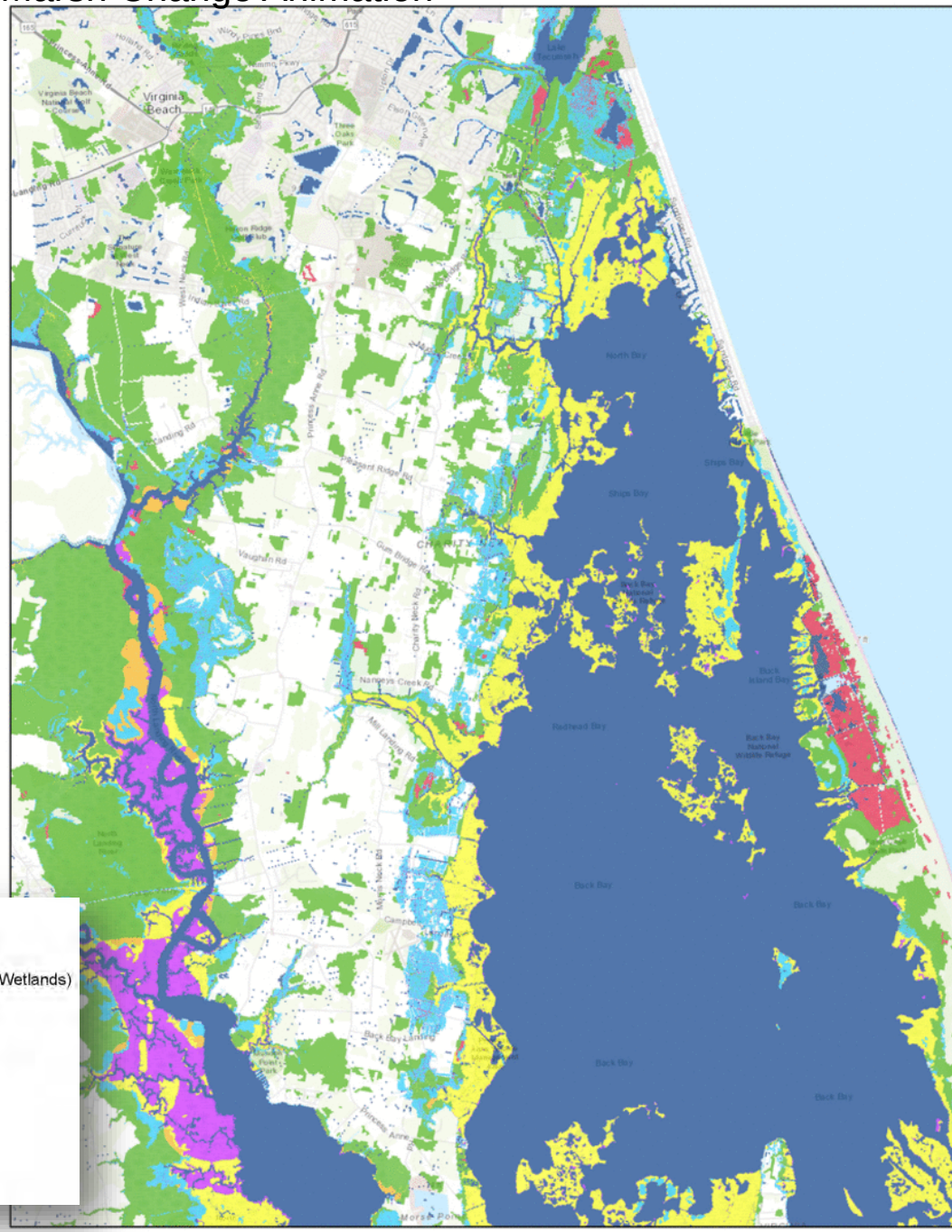
Wind Modeling Simulations

Wind Modeling Simulations

Marsh Considerations



Marsh Change Animation



Natural Lines of Defense

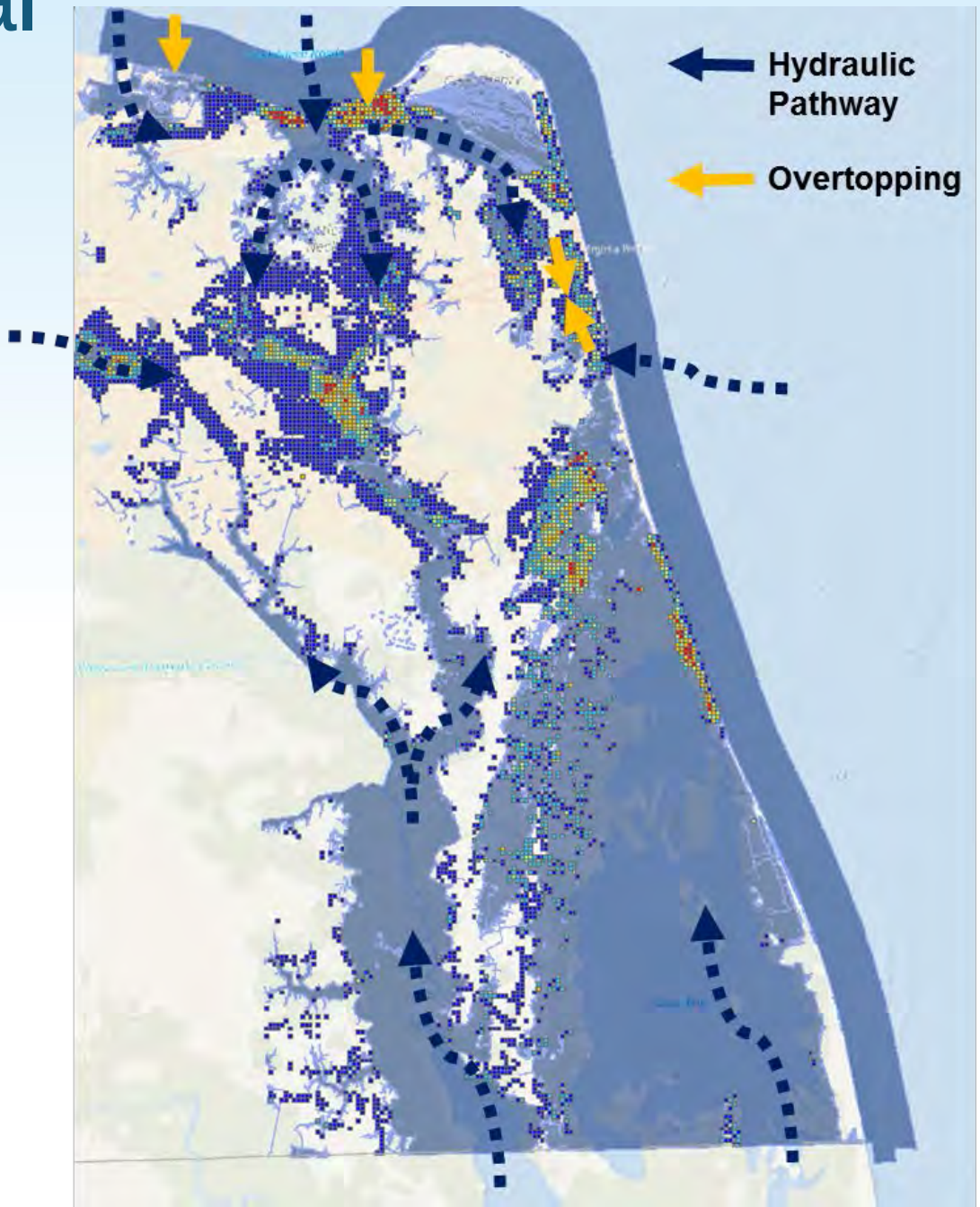
Credit: Bay Journal

Credit: nccoast.org

Credit: Emporia St. Univ.

City-wide Structural Alternatives

- Perimeter and interior conceptual solutions
- Thousands of feet of structures
- Flood gates/surge barriers
- Hard/soft costs range $1-4B
- Evaluated in integrated runoff/coastal surge model
- Final selection based on multi-criteria feasibility, benefit/cost



Protect against flooding

- FACT: The wind tides are not represented by the FEMA Flood Maps
- FACT: The City has determined that the FEMA Back Bay elevations are low compared to other studies
- FACT: The wind tide elevations are greater than the present FEMA 100-yr elevations in Back Bay

NATIONAL FLOOD INSURANCE PROGRAM

https://www.floodsmart.gov/

What do I need to know about flood insurance coverage?

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Points of Contact

City of Virginia Beach
Department of Public Works

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Consultant:

Dewberry
Project Manager:
Brian Batten, Ph.D., CFM
804-823-6981
bbatten@dewberry.com

http://www.vbgov.com/pwSLR

Stormwater/Flooding Projects in Southern Watershed

October 4, 2018

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Southern Canal/Lead Ditch & Culvert Improvements

- Drainage improvements to canals, lead ditches and culverts in the southern watershed
- Improvements may include pipe/culvert replacement, ditch cleaning /regrading or weir backflow preventer
- Construction is timed to avoid inconvenience to the agricultural community and residents

Total Project Cost	Appropriated to Date	FY19	FY20	FY21	FY22	FY23	FY24	Balance To Complete
$10,690,000	$2,350,000	$1,390,000	$1,390,000	$1,390,000	$1,390,000	$1,390,000	$1,390,000	$0

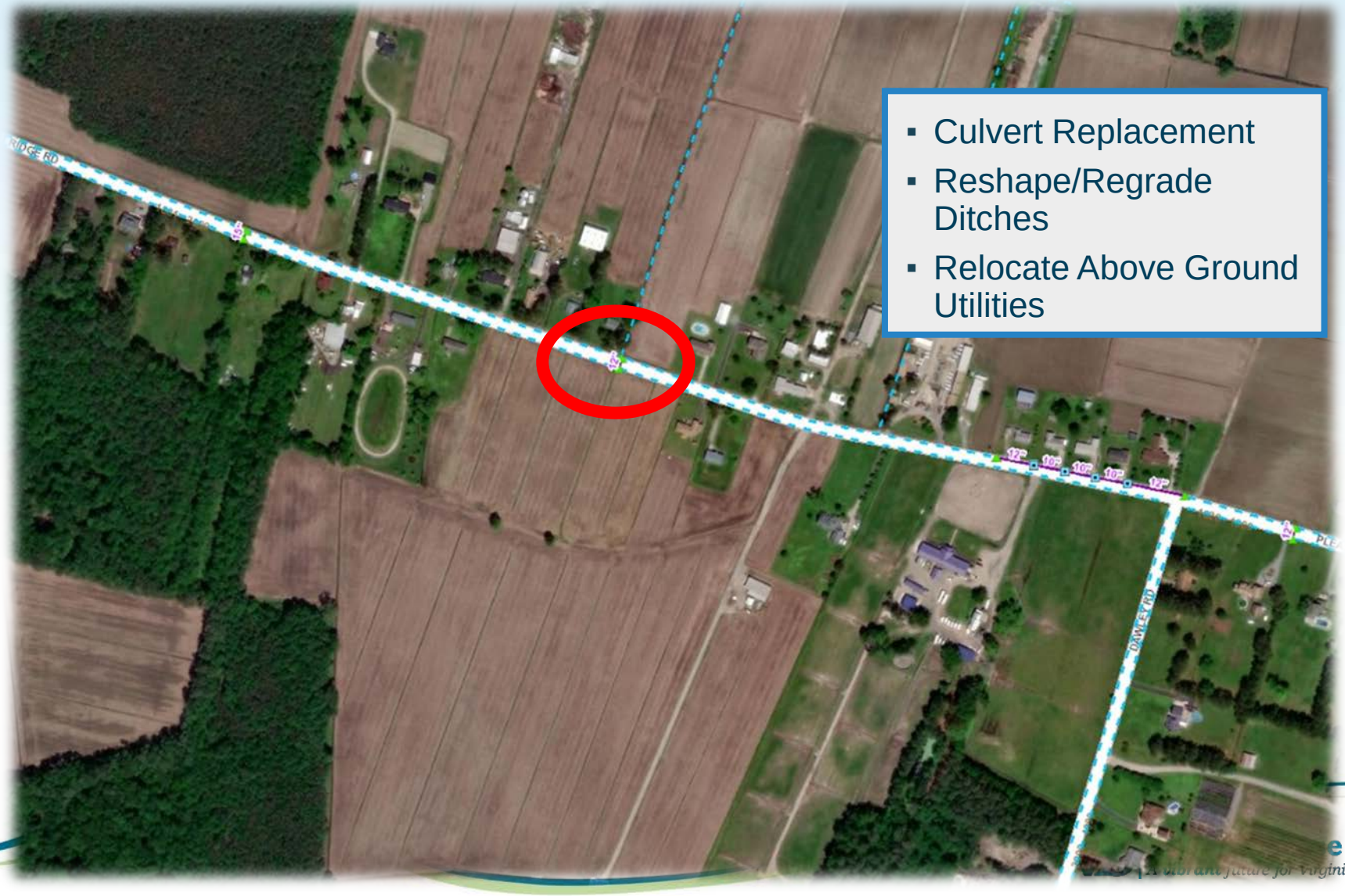
Dawley Road between Pleasant Ridge Road and Gum Bridge Road (Beggars Bridge Creek) (Site 5)

- Clean Culverts
- Excavate and Regrade Ditches

Gum Bridge Road between Dawley Road and Charity Neck Road (Site 9)

- Culvert Replacement
- Widen Ditches
- Relocate Above Ground Utilities

Pleasant Ridge Road west of Dawley Road (Site 6)



- Culvert Replacement
- Reshape/Regrade Ditches
- Relocate Above Ground Utilities

Southern Canal/Lead Ditch & Culvert Improvements

- August 24, 2018 – Joint Permit Application submitted for all 3 projects
  - Notification in Late October
- Notice to Proceed for the ditch work by the end of the year

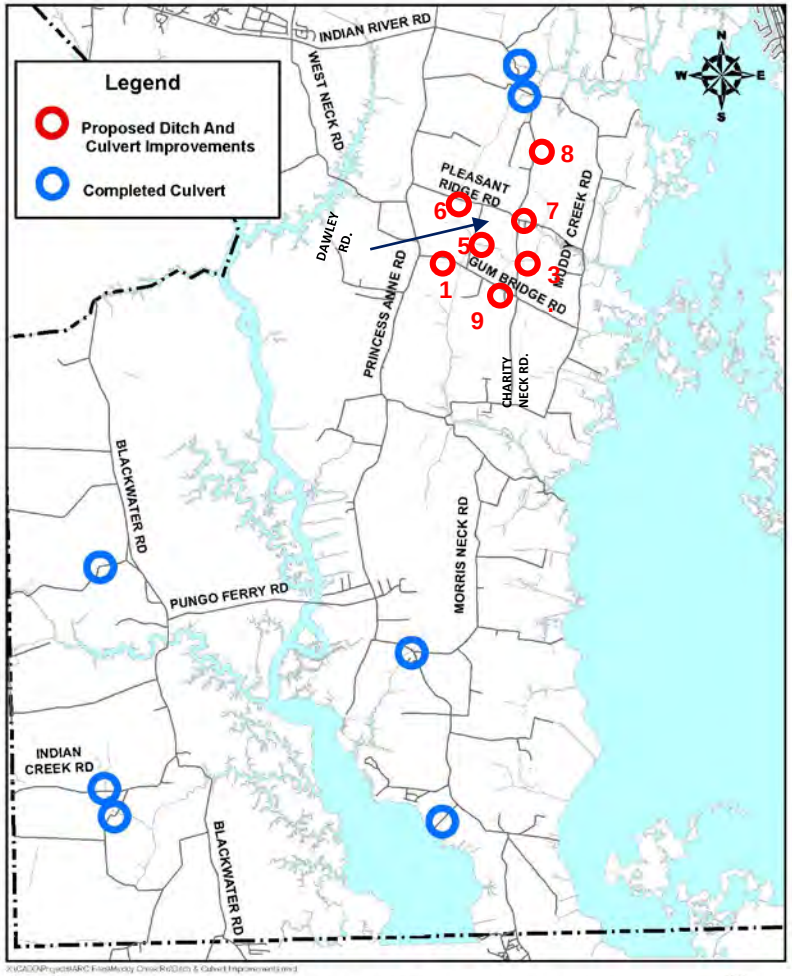
Southern Canal/Lead Ditch & Culvert Improvements

Ditch Work at Dawley Road between Pleasant Ridge Road and Gum Bridge Road (Site 5)

Ditch Work at Pleasant Ridge Road west of Dawley Road (Site 6)

Ditch Work at Gum Bridge Road between Gum Bridge Court and Charity Farm Court (Site 9)

Southern Canal/Lead Ditch & Culvert Improvements



Ditch And Culvert Improvements

SPENDING PLAN	DESIGN	CONSTRUCTION	TOTAL COST	BALANCE
Available Now				$685,644
New Funding July 2018 (FY19)				$1,390,000
Total				**$2,075,644**
PER Complete-July 2018				
Site 5-Dawley Road between Pleasant Ridge Road and Gum Bridge Road	$60,000	$300,000	**$360,000**	
Site 9-Gum Bridge Road west of Charity Neck Road	$110,000	$550,000	**$660,000**	
Off Road Ditch Program	$0	$1,390,000	**$1,390,000**	
Available June 2019				-$334,356
New Funding July 2019 (FY20)				$1,390,000
Total Remaining				**$1,055,644**
Site 6-Pleasant Ridge Road west of Dawley Road	$200,000	$1,000,000	**$1,200,000**	
Off Road Ditch Program	$0	$300,000	**$300,000**	
Available June 2020				-$444,356
New Funding July 2020 (FY21)				$1,390,000
Total				$945,644
New Funding July 2021 (FY22)				$1,390,000
Total Remaining				**$2,335,644**
Site 8-Charity Neck Road north of Pleasant Ridge Road (includes two sites)	$60,000	$300,000	**$360,000**	
Off Road Ditch Program	$0	$300,000	**$300,000**	
Available June 2022				$1,675,644
New Funding July 2022 (FY23)				$1,390,000
Total Remaining				**$3,065,644**
Site 4-Muddy Creek Road intersection with Gum Bridge Road	$40,000	$200,000	**$240,000**	
Off Road Ditch Program	$0	$300,000	**$300,000**	
Available June 2023				$2,525,644
New Funding July 2023 (FY24)				$1,390,000
Total Remaining				**$3,915,644**
Site 7-Intersection of Pleasant Ridge Road and Charity Neck Road	$80,000	$400,000	**$480,000**	
Off Road Ditch Program	$0	$300,000	**$300,000**	
Total Remaining				**$3,135,644**

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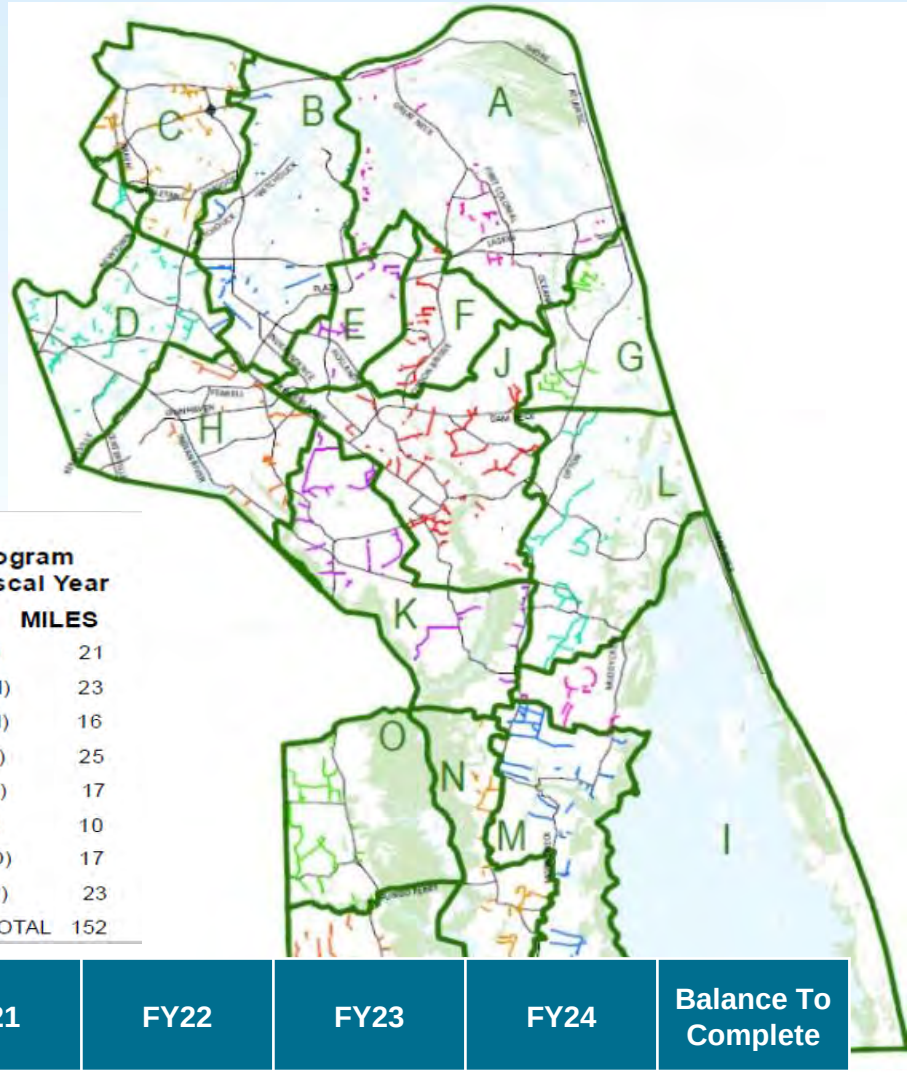
Off Road Ditch Program

- FY 15 Zone B&M
  - 13 Miles Completed
- FY 16 Zone C&N
  - 5.2 Miles Completed
- FY 17 Zone D & L
  - 21.6 Miles Completed
- FY 18 Zones E & K
  - 9.1 Miles Completed



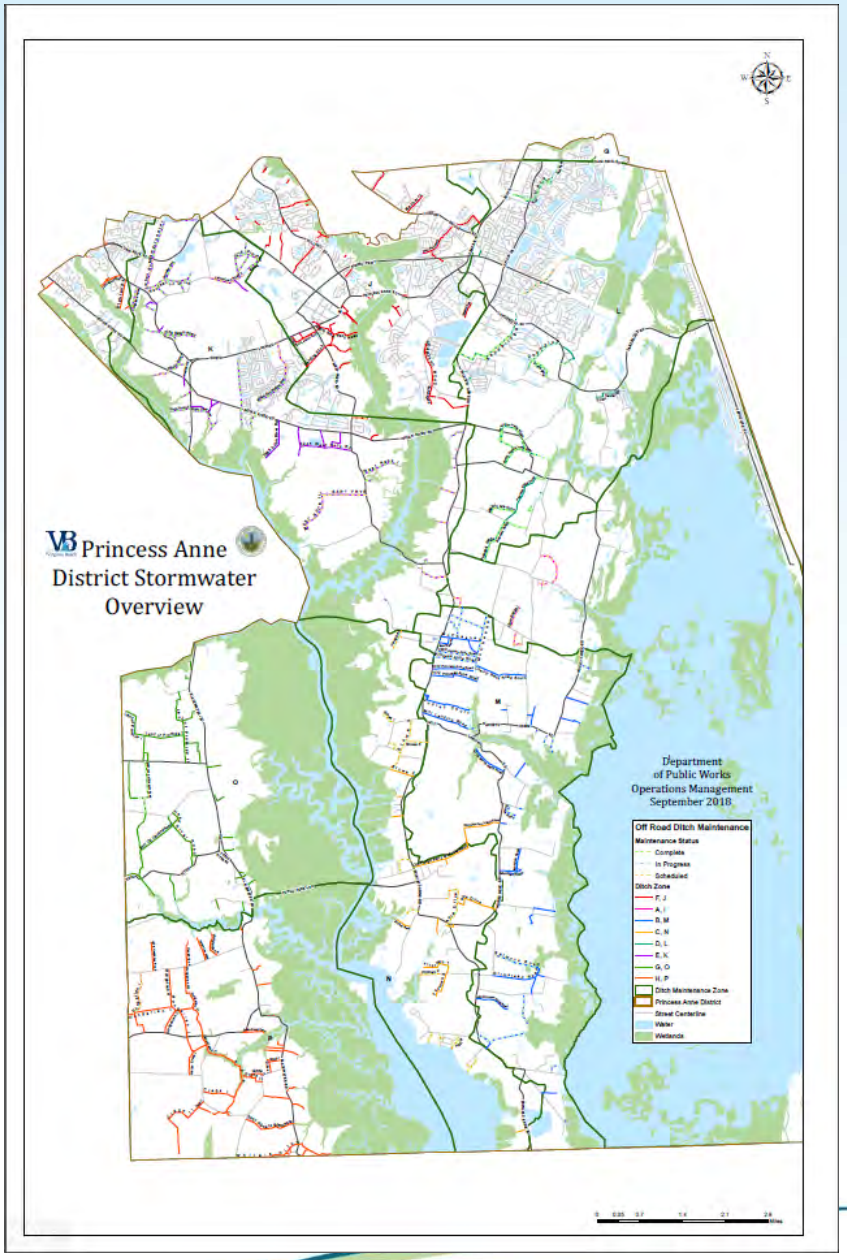
Off Road Ditch Maintenance Program with Miles by Fiscal Year

YEAR	(ZONES)	MILES
FY14:	(F, J)	21
FY15:	(B, M)	23
FY16:	(C, N)	16
FY17:	(D, L)	25
FY18:	(E, K)	17
FY19:	(A, I)	10
FY20:	(G, O)	17
FY21:	(H, P)	23
	TOTAL	152

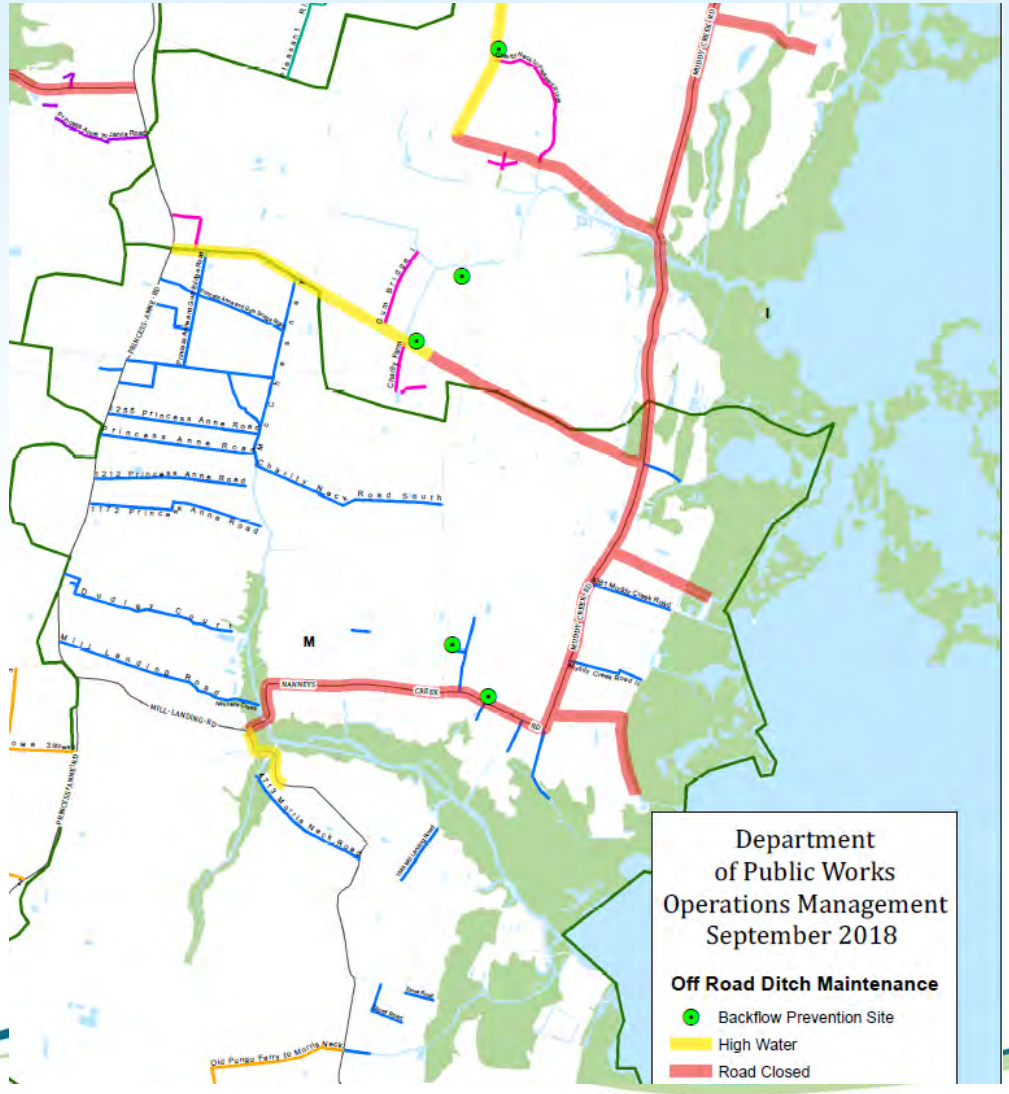
Total Project Cost	Appropriated to Date	FY19	FY20	FY21	FY22	FY23	FY24	Balance To Complete
$21,970,000	$8,350,000	$2,270,000	$2,270,000	$2,270,000	$2,270,000	$2,270,000	$2,270,000	$0

Off Road Ditch Program – Princess Anne District

- FY 17 Zone L
  - 7.57 Miles Completed
- FY 18 Zone K
  - 12.55 Miles Completed
- FY 19 Zone I
  - 1.92 Miles Completed (to date)



Potential Wind Tide Backflow Prevention Sites



- 5 potential sites selected for agricultural backflow prevention
- Prevention of “Sunny Day” wind tide
- Preliminary site evaluation coordinated with frequent road flooding in Princess Anne District

North Stowe Road

Before Construction

After Construction

During Construction

Community Canal Culvert Improvements

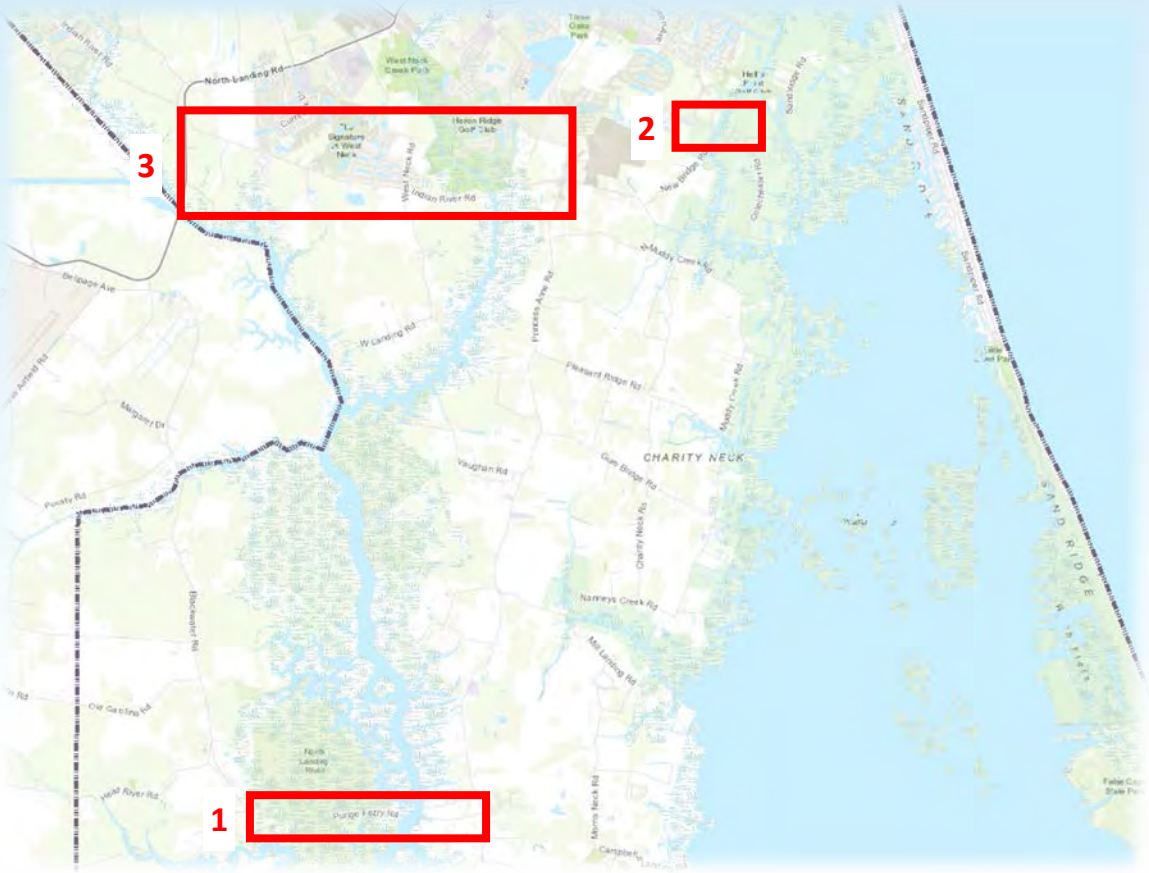
Before

After

- Drains Approximately 400 Acres to Back Bay
- Installed 3-48 inch Reinforced Concrete Pipes
- New Concrete End Walls
- Project Cost $164K

Rural Road Flooding Study

1. Pungo Ferry Road Estimated Cost: $15.1 M
2. Sandbridge Road/ New Bridge Road Intersection Estimated Cost: $6.7 M
3. Indian River Road Estimated Cost: $44.7M



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END OF PRESENTATION

PROCEED TO INFORMATION STATIONS

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