RESILIENT DESIGN GUIDELINES UPDATE

HRPDC Coastal Resiliency Committee

June 25, 2021

Resilient Design Guidelines for Stormwater Management

TAILWATER ELEVATIONS

Draft analysis completed for coastal communities for 9 return periods.

PRECIPITATION

Draft analysis completed for all communities for six return periods.

JOINT PROBABILITY EVENTS

Recommendations based on Virginia Beach Public Works Design Standards Manual

TAILWATER ELEVATIONS

Goals

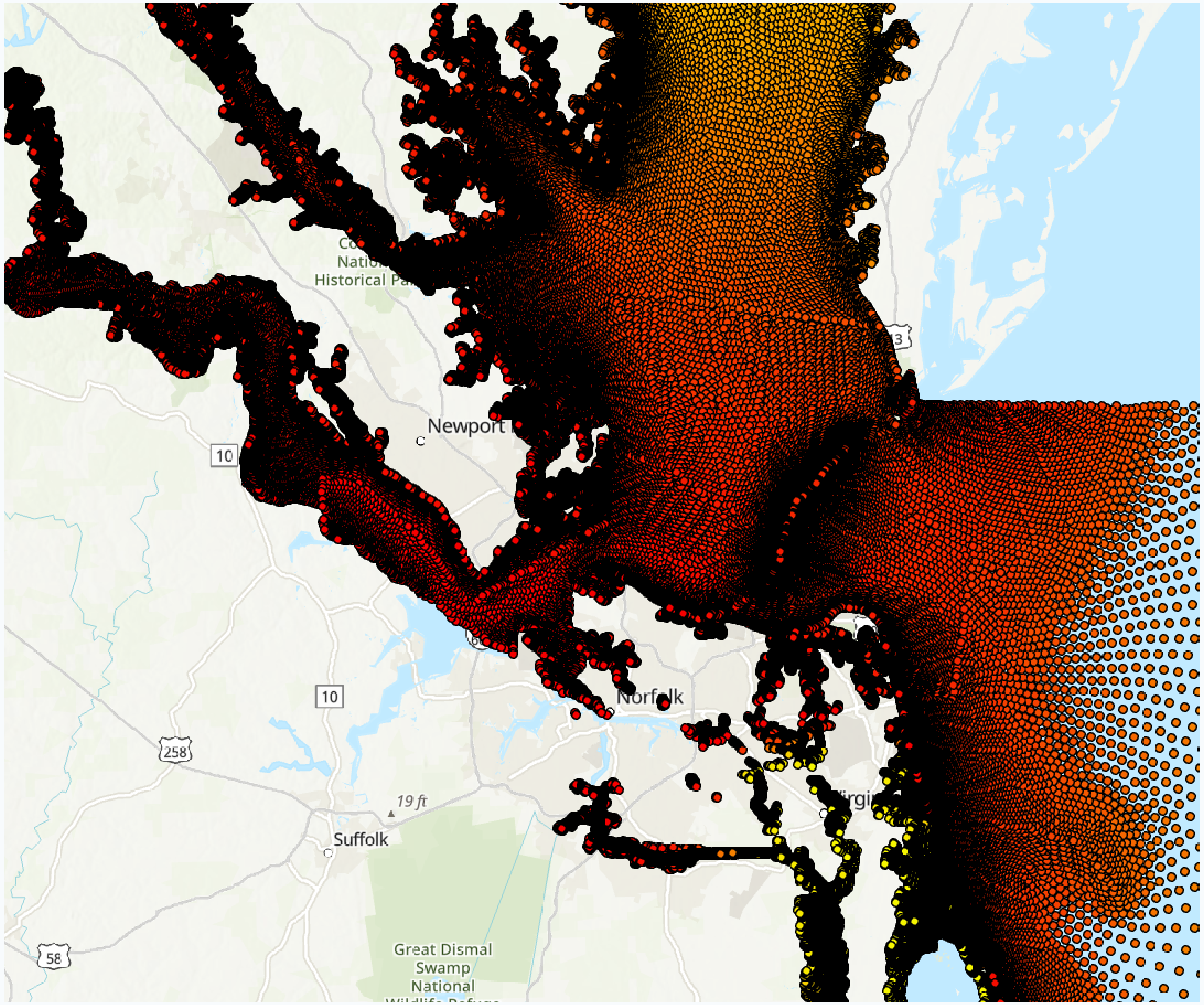
Calculate design tailwater elevations for individual tidal watersheds (HUC10, HUC12) across Hampton Roads for 1-year to 500-year return periods

Calculate tailwaters that include regional sea level rise planning scenarios

Status: DRAFT completed

Methodology

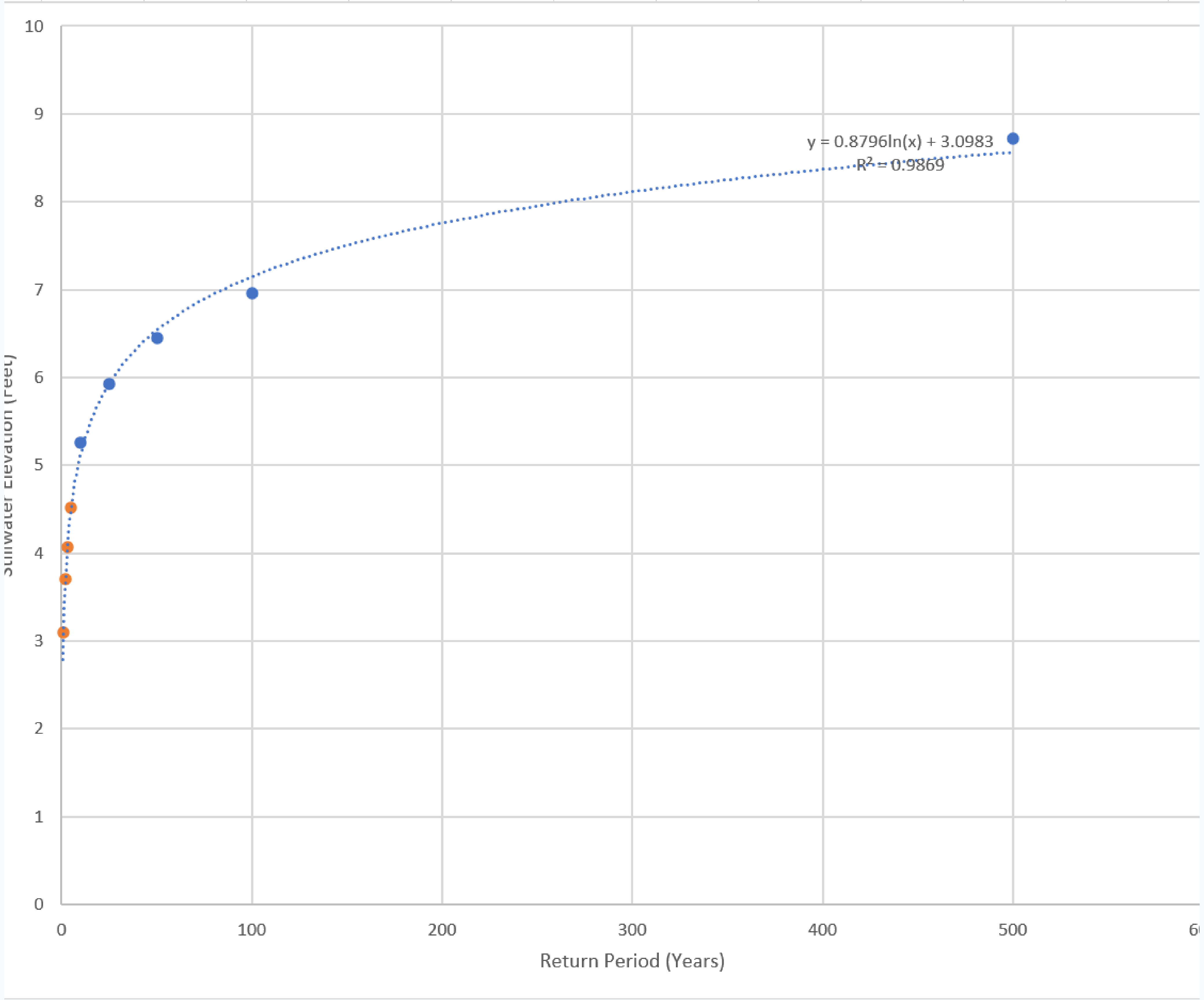
FEMA Region III Storm Surge Study ADCIRC grid contains values for **10-year, 25-year, 50-year, 100-year, and 500-year** storm surge stillwater elevations



Methodology

Log-linear extrapolation can be used to generate values for more frequent return periods (**1-year, 2-year, 3-year, 5-year**)

Tailwater values calculated for each return period based on the 95th-percentile for a given geography



Results

Tailwater values calculated for each return period based on the 95th-percentile for a given geography for various combinations of sea level rise and storm recurrence intervals

Design Tidal Elevations for Chesapeake

All elevations in feet relative to the North American Vertical Datum (NAVD) of 1988

HUC12	Watershed	Design Level	1-Year	2-Year	3-Year	5-Year	10-Year	25-Year	50-Year	100-Year	500-Year
020802080201	New Mill Creek-Southern Branch Elizabeth River	Existing Condition	3.9	4.5	4.8	5.2	5.8	6.6	7.2	7.8	9.2
		1.5 ft SLR	5.4	6.0	6.3	6.7	7.3	8.1	8.7	9.3	10.7
		3.0 ft SLR	6.8	7.4	7.7	8.1	8.7	9.5	10.1	10.7	12.1
		4.5 ft SLR	8.3	8.9	9.2	9.6	10.2	11.0	11.6	12.2	13.6
020802080203	Deep Creek-Southern Branch Elizabeth River	Existing Condition	3.4	4.1	4.5	5.1	5.9	6.7	7.3	8.0	10.0
		1.5 ft SLR	4.9	5.6	6.0	6.6	7.4	8.2	8.8	9.5	11.5
		3.0 ft SLR	6.4	7.1	7.5	8.1	8.9	9.7	10.3	11.0	13.0
		4.5 ft SLR	7.9	8.6	9.0	9.6	10.4	11.2	11.8	12.5	14.5
020802080204	Eastern Branch Elizabeth River	Existing Condition	2.9	3.7	4.2	4.8	5.9	6.6	7.3	8.0	10.4
		1.5 ft SLR	4.4	5.2	5.7	6.3	7.4	8.1	8.8	9.5	11.9
		3.0 ft SLR	6.0	6.8	7.3	7.9	9.1	9.8	10.5	11.2	13.6
		4.5 ft SLR	7.5	8.3	8.9	9.5	10.6	11.3	12.0	12.7	15.2
020802080205	Western Branch Elizabeth River	Existing Condition	3.7	4.5	4.9	5.4	6.1	7.0	7.9	8.6	10.3
		1.5 ft SLR	5.2	6.0	6.4	6.9	7.6	8.5	9.4	10.1	11.8
		3.0 ft SLR	6.9	7.7	8.1	8.6	9.3	10.2	11.2	11.9	13.6
		4.5 ft SLR	8.4	9.2	9.6	10.1	10.9	11.8	12.7	13.4	15.2
030102051104	Indian Creek-Northwest River	Existing Condition	0.1	0.5	0.7	1.0	1.4	2.0	2.4	2.8	3.8
		1.5 ft SLR	1.6	2.0	2.2	2.5	2.9	3.5	3.9	4.3	5.3
		3.0 ft SLR	3.2	3.6	3.8	4.2	4.6	5.2	5.6	6.0	7.1
		4.5 ft SLR	4.8	5.2	5.4	5.7	6.1	6.8	7.2	7.6	8.6
030102051201	Chesapeake Canal	Existing Condition	3.0	3.6	4.0	4.4	5.0	5.8	6.4	7.0	8.4
		1.5 ft SLR	4.5	5.1	5.5	5.9	6.5	7.3	7.9	8.5	9.9
		3.0 ft SLR	6.0	6.6	7.0	7.4	8.0	8.8	9.4	10.0	11.4
		4.5 ft SLR	7.5	8.1	8.5	8.9	9.5	10.3	10.9	11.5	12.9
030102051203	Upper North Landing River	Existing Condition	0.4	0.8	1.0	1.3	1.8	2.2	2.5	3.0	4.0
		1.5 ft SLR	1.9	2.3	2.5	2.8	3.3	3.7	4.0	4.5	5.5
		3.0 ft SLR	3.5	3.9	4.1	4.5	5.0	5.4	5.7	6.2	7.3
		4.5 ft SLR	5.1	5.5	5.7	6.0	6.5	7.0	7.3	7.8	8.8

Notes:

1. Sea level rise scenarios are based on HRPDC Sea Level Rise Planning Policy and Approach (2018).
2. All elevations sourced from statistical analysis of the distribution of water elevations in each watershed from the FEMA Region III Storm Surge Study conducted by the U.S. Army Corps of Engineers Engineer Research and Development Center (2013).
3. Conditions related to the 3-ft and 4.5-ft sea level rise design levels include non-linear increases derived from numerical modeling completed by the U.S. Army Corps of Engineers as part of the North Atlantic Coast Comprehensive Study.

DESIGN STORMS

Goals

Calculate design rainfall depths for each locality based on Chesapeake Bay Program/MARISA project for 2-year to 100-year return periods

Status: DRAFT completed

Methodology

Analysis downscales climate models to calculate climate-informed IDF curves using "ensemble of ensembles" for different scenarios

Change factors and IDF curves calculated for stations.

Change factors calculated for counties and county equivalents.

Return Periods

2-, 5-, 10-, 25-, 50-, and 100-year return periods

Emissions Scenarios

RCP 4.5 (Low)
RCP 8.5 (High)

Time Periods

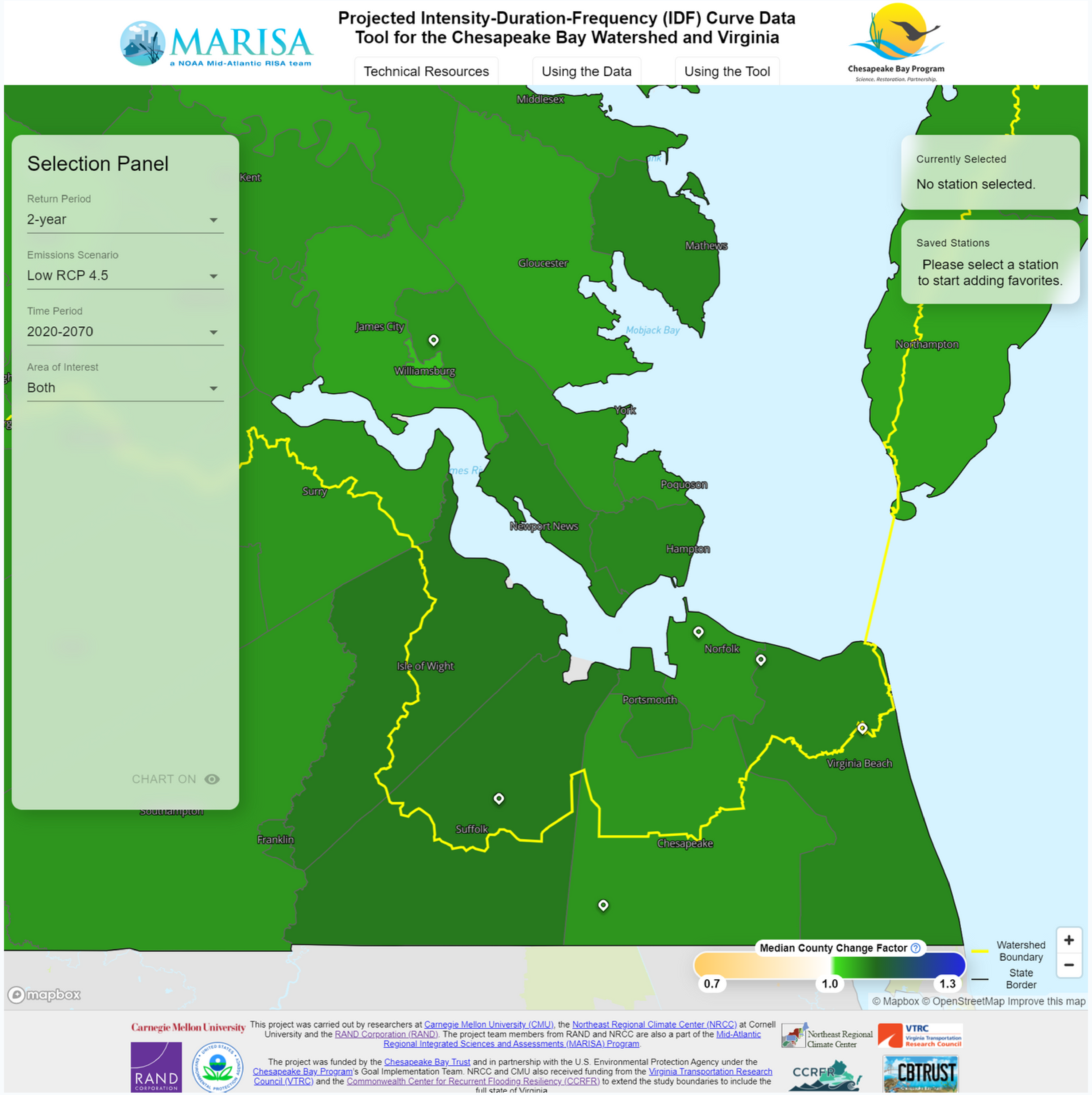
2020-2070
2050-2100

Duration (stations only)

5-minute to 7-day

Web Tool

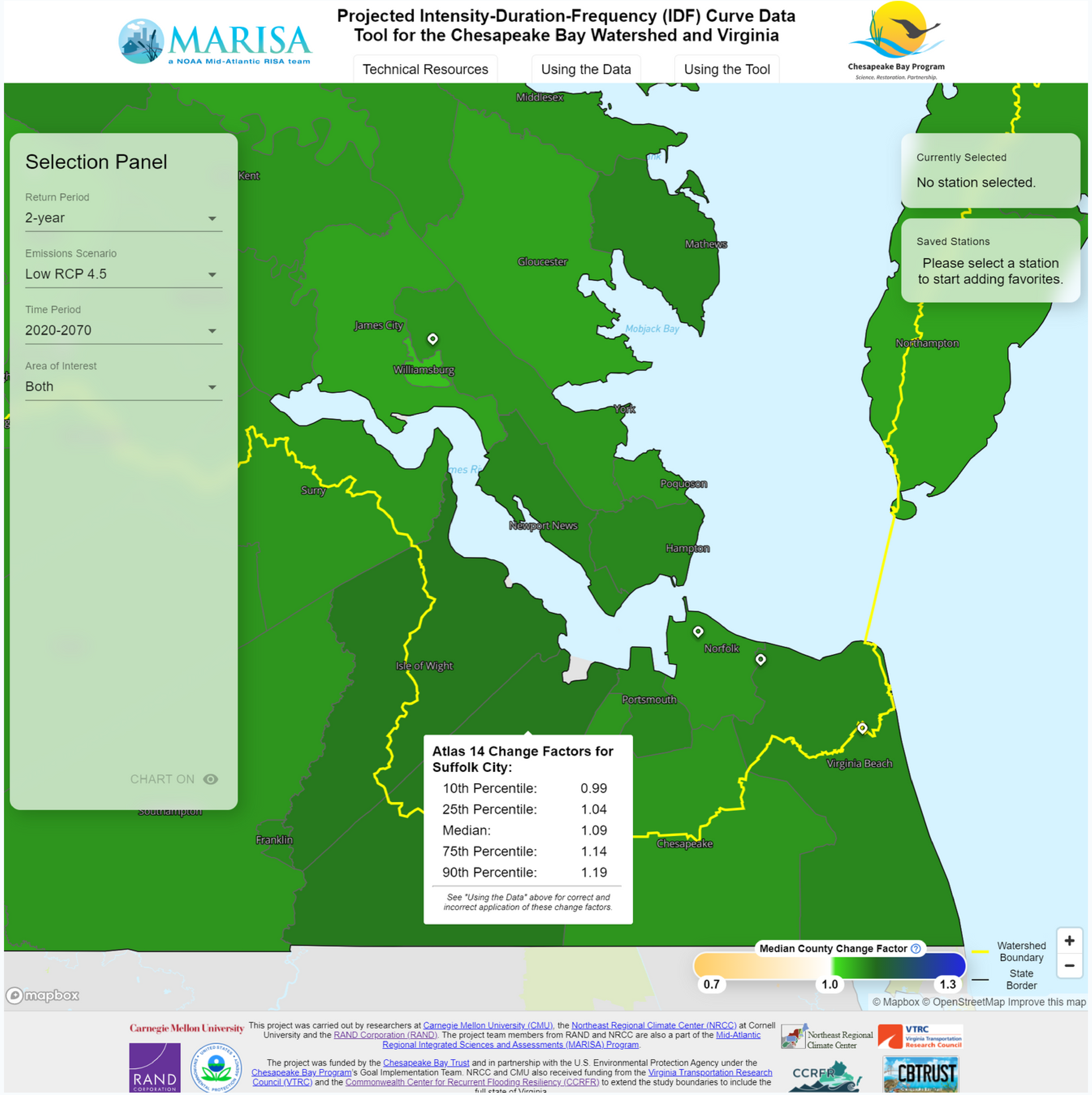
https://midatlantic-idf.rcc-acis.org/



Web Tool

County/county-equivalent change factors for selected return period, emissions scenario, and time period.

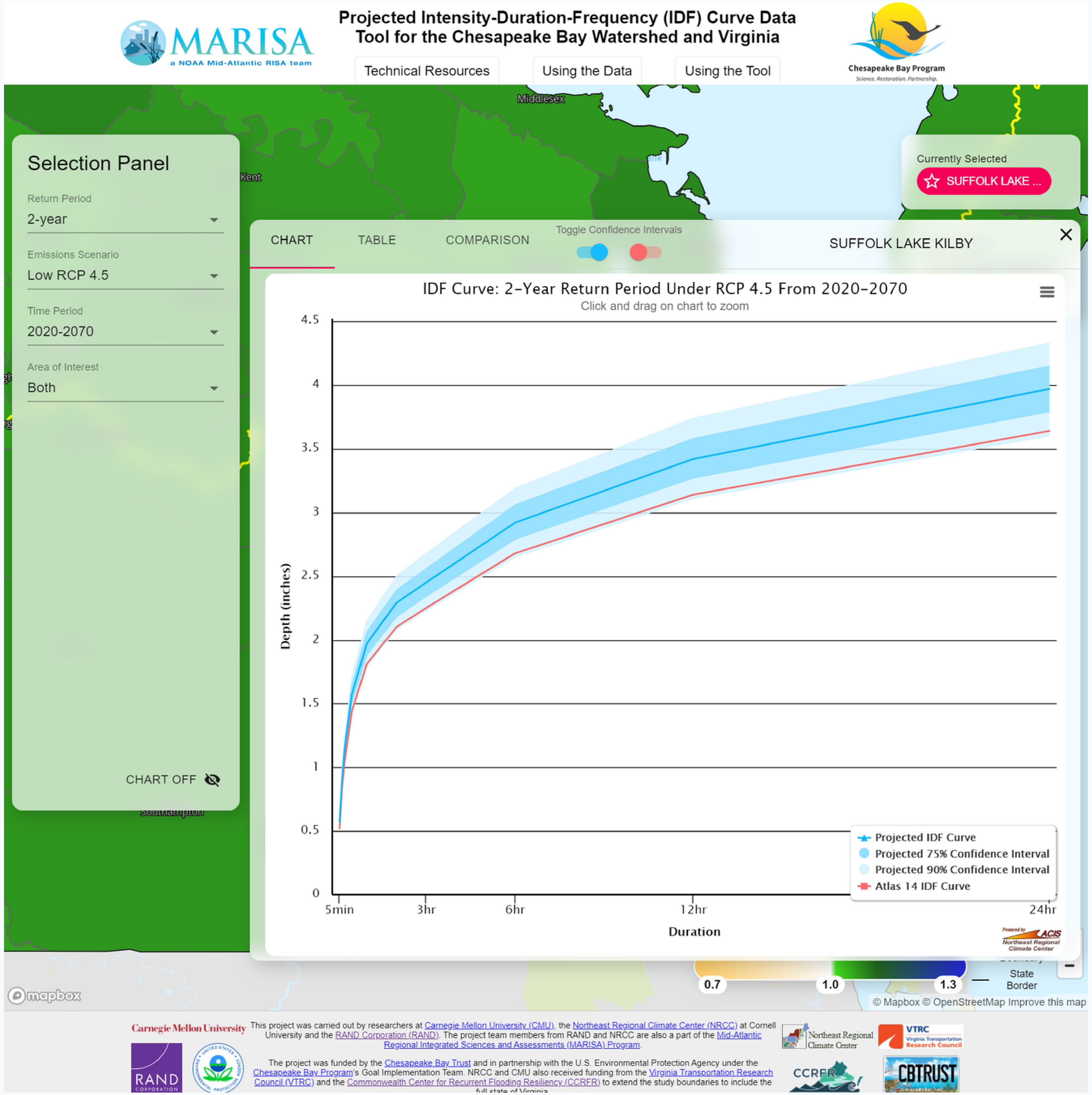
Change factors given for the 10th, 25th, 50th, 75th, and 90th percentiles.



Web Tool

Station Intensity-Duration-Frequency (IDF) curves for selected return period, emissions scenario, and time period.

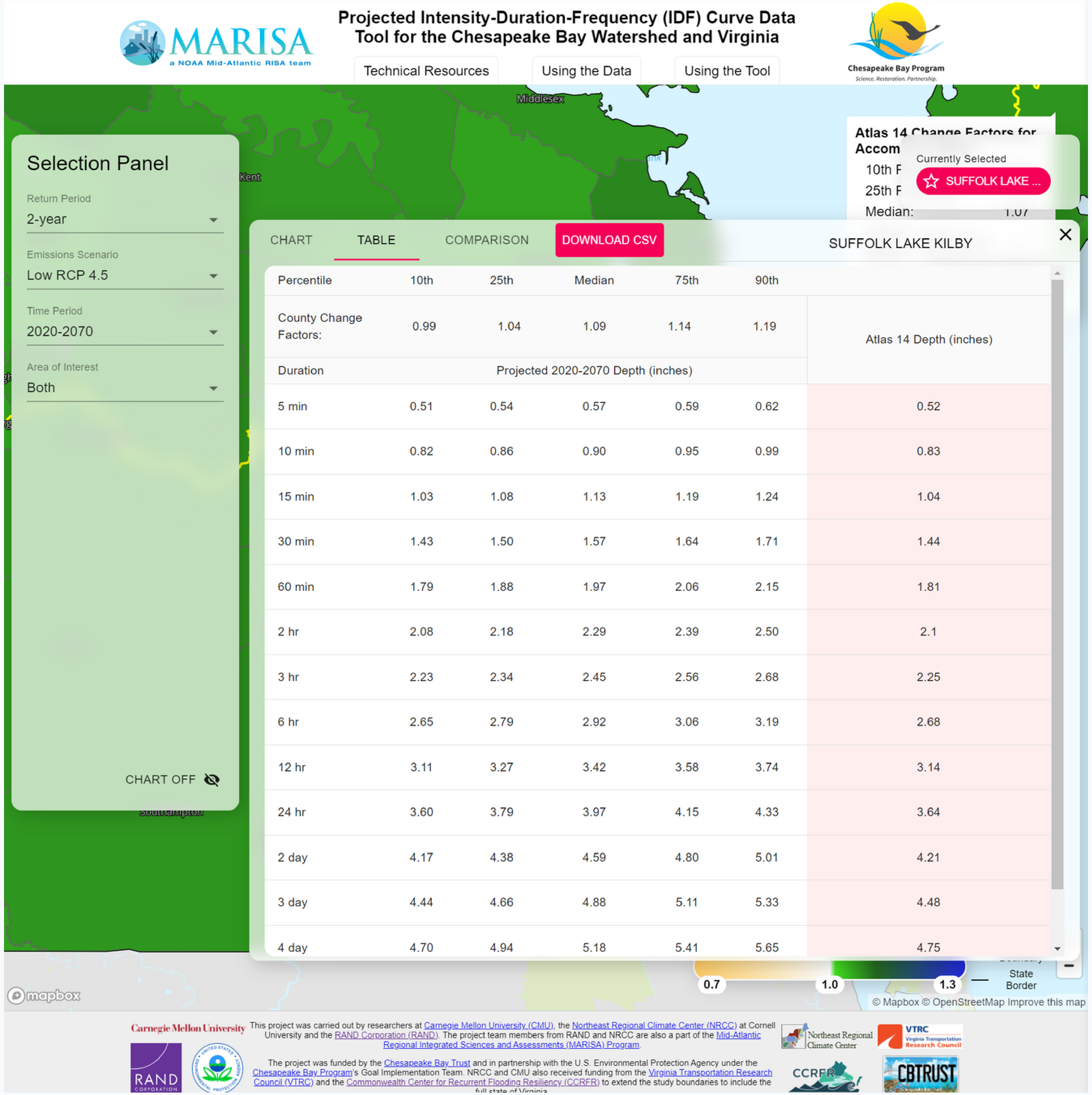
IDF curves include Atlas 14 and projected curves plus 75% and 90% confidence intervals



Web Tool

Station Intensity-Duration-Frequency (IDF) tables for selected return period, emissions scenario, and time period.

IDF tables include depths in inches for various durations for the selected scenario and Atlas 14



Percentile	10th	25th	Median	75th	90th	
County Change Factors:	0.99	1.04	1.09	1.14	1.19	Atlas 14 Depth (inches)
Duration	Projected 2020-2070 Depth (inches)					
5 min	0.51	0.54	0.57	0.59	0.62	0.52
10 min	0.82	0.86	0.90	0.95	0.99	0.83
15 min	1.03	1.08	1.13	1.19	1.24	1.04
30 min	1.43	1.50	1.57	1.64	1.71	1.44
60 min	1.79	1.88	1.97	2.06	2.15	1.81
2 hr	2.08	2.18	2.29	2.39	2.50	2.1
3 hr	2.23	2.34	2.45	2.56	2.68	2.25
6 hr	2.65	2.79	2.92	3.06	3.19	2.68
12 hr	3.11	3.27	3.42	3.58	3.74	3.14
24 hr	3.60	3.79	3.97	4.15	4.33	3.64
2 day	4.17	4.38	4.59	4.80	5.01	4.21
3 day	4.44	4.66	4.88	5.11	5.33	4.48
4 day	4.70	4.94	5.18	5.41	5.65	4.75

Discussion

Process

Local/regional action

Wait for state agencies

Applying MARISA tool to standards

Which emissions scenario?

Which time period?

Which change factors?

HRPDC draft calculations

RCP 8.5

2020-2070

50th and 75th percentiles; +20%

JOINT PROBABILITY EVENTS

Goals

Designate combinations of tailwater conditions and rainfall events to serve as design storms

Status: In Virginia Beach Policy

VB Standards

Joint probability pairs include two combinations of tidal and precipitation values

Development proposals must assess both scenarios and design for the higher hydraulic grade line

10-Year Design Storm

10-year tide & 1-year rainfall

1-year tide & 10-year rainfall

25-Year Design Storm

25-year tide & 1-year rainfall

2-year tide & 25-year rainfall

50-Year Design Storm

50-year tide & 1-year rain

2-year tide & 50-year rain

100-Year Design Storm

100-year tide & 1-year rain

3-year tide & 100-year rain

Next Steps

Distribute draft tailwater and rainfall depth values to localities for review

Coastal Resiliency Workgroup discussion in July/August

Present recommendation to Coastal Resiliency Committee in September 2021

Questions

Ben McFarlane
Senior Regional Planner
Hampton Roads PDC
bmcfarlane@hrpdcva.gov