Proposed Floodplain Regulation Updates

Workshop #2 - Mapping

DEPARTMENT OF ENERGY & ENVIRONMENT

April,29, 2021

Agenda – Workshop #2

- **Standard Design Flood Elevations**
  - Rationale for 100-year +2' / 500-year elevation
- **Tidal Shoreline Buffer (TSB)**
  - Underlying Sea Level Rise Projections
  - Horizontal Extent
  - Required Design Elevation in TSB
- **Map Maintenance Procedures**
  - Removing Property from TSB
  - Flood Protection Structures and their Ability to Remove Property from a Regulatory Floodplain

Standard Design Flood Elevations

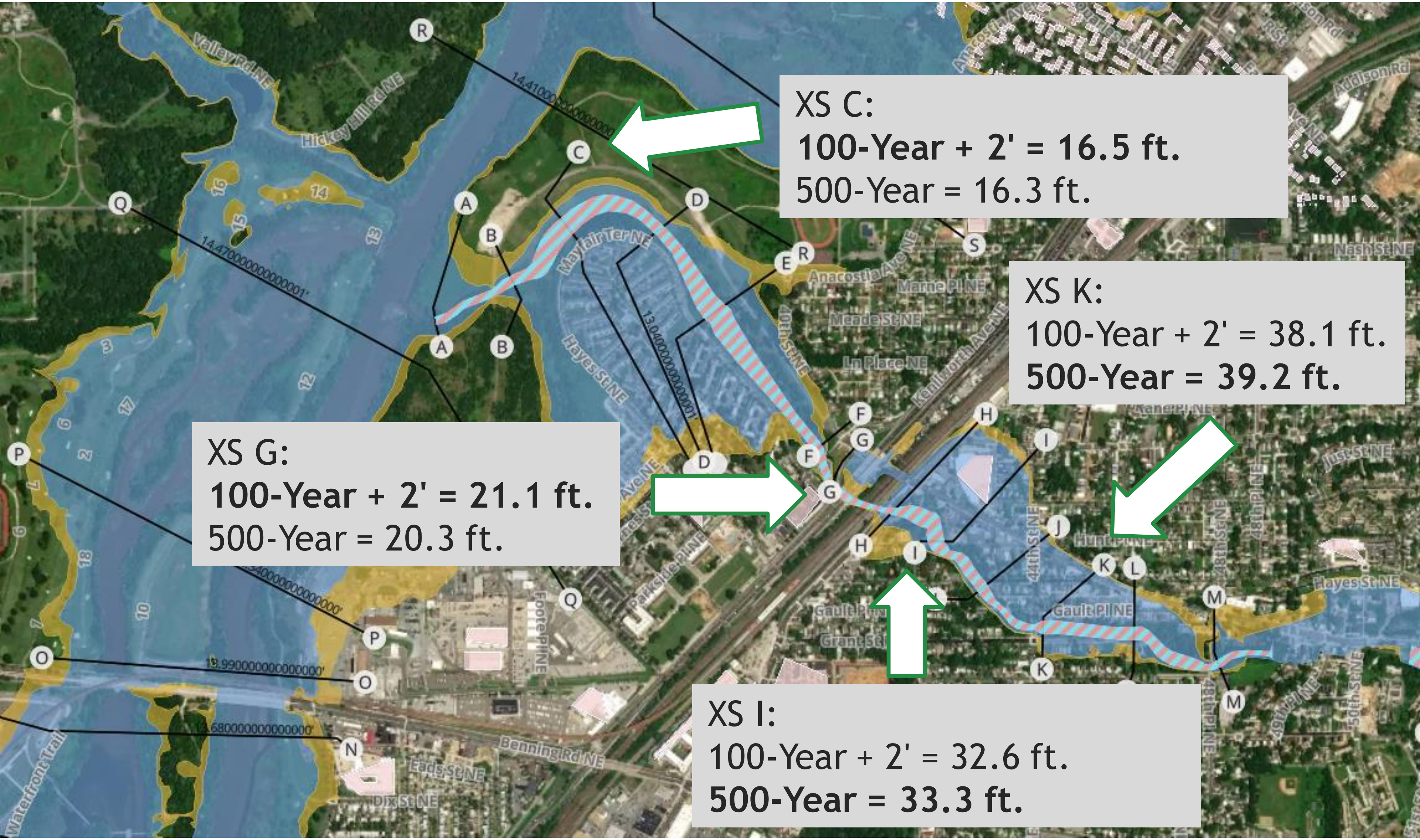
Summary – Required Elevations

Structure Type	*Regulations*	***Design Flood Elevation***	*Notes*
General	Current Flood Hazard Rules	**100-Year Flood Elevation + 1.5 feet**	Residential structures must be elevated, while nonresidential structures can be elevated or dry floodproofed.
General	Current DC Construction Codes and Proposed Updated Flood Hazard Rules	**Whichever is higher of:** • **100-Year Flood Elevation + 2 feet, or** • **500-Year Flood Elevation**	Residential structures must be elevated, while nonresidential structures can be elevated or dry floodproofed.
Critical Facility	Proposed Updated Flood Hazard Rules	**500-Year Flood Elevation + 2 feet**	Residential structures must be elevated, while nonresidential structures can be elevated or dry floodproofed.
Structure Located Within the Tidal Shoreline Buffer	Proposed Updated Flood Hazard Rules	**500-Year Flood Elevation + TBD feet**	Residential structures must be elevated, while nonresidential structures can be elevated or dry floodproofed.

Design Flood Elevations for Most Projects

- 100-Year + 2' or 500-Year can be higher depending upon location

- Community Rating System flood insurance discount program provides incentive in the form of greater credit for 100-Year + 2' than for 500-Year



Design Flood Elevations in Watts Branch

Tidal Shoreline Buffer

Initial Draft Tidal Shoreline Buffer Calculation

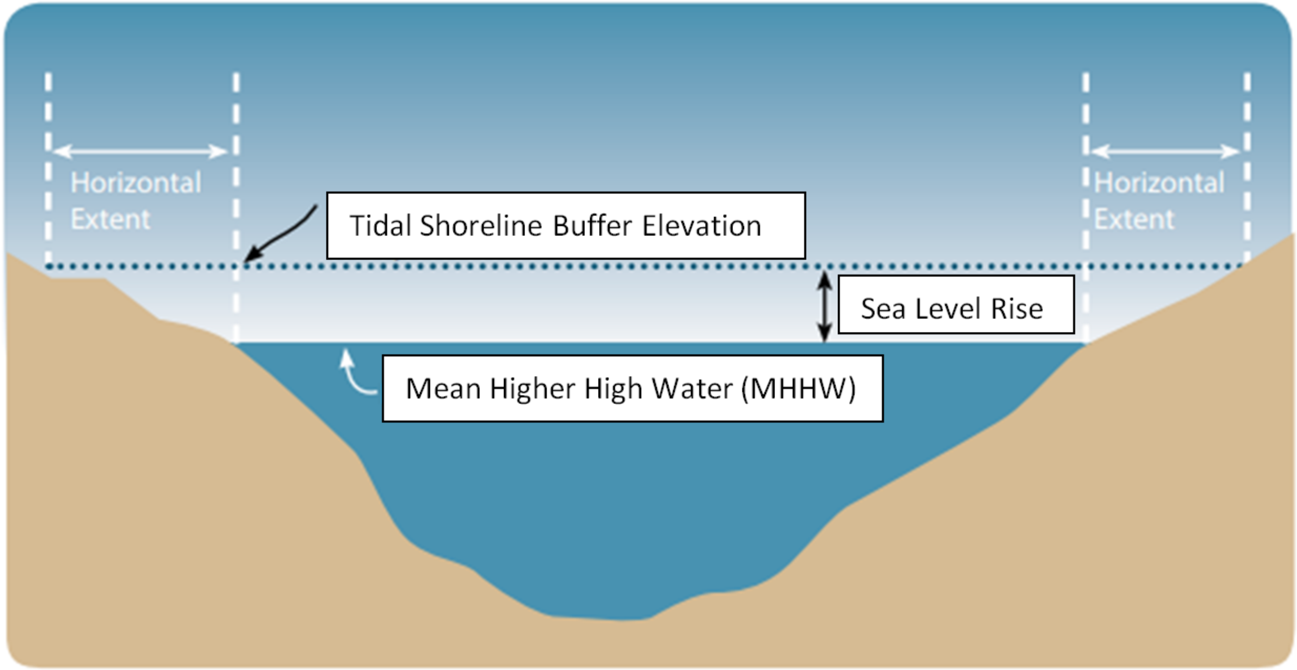
Mean Higher High Water (MHHW) in the year 2000: 2.2' NAVD88

+

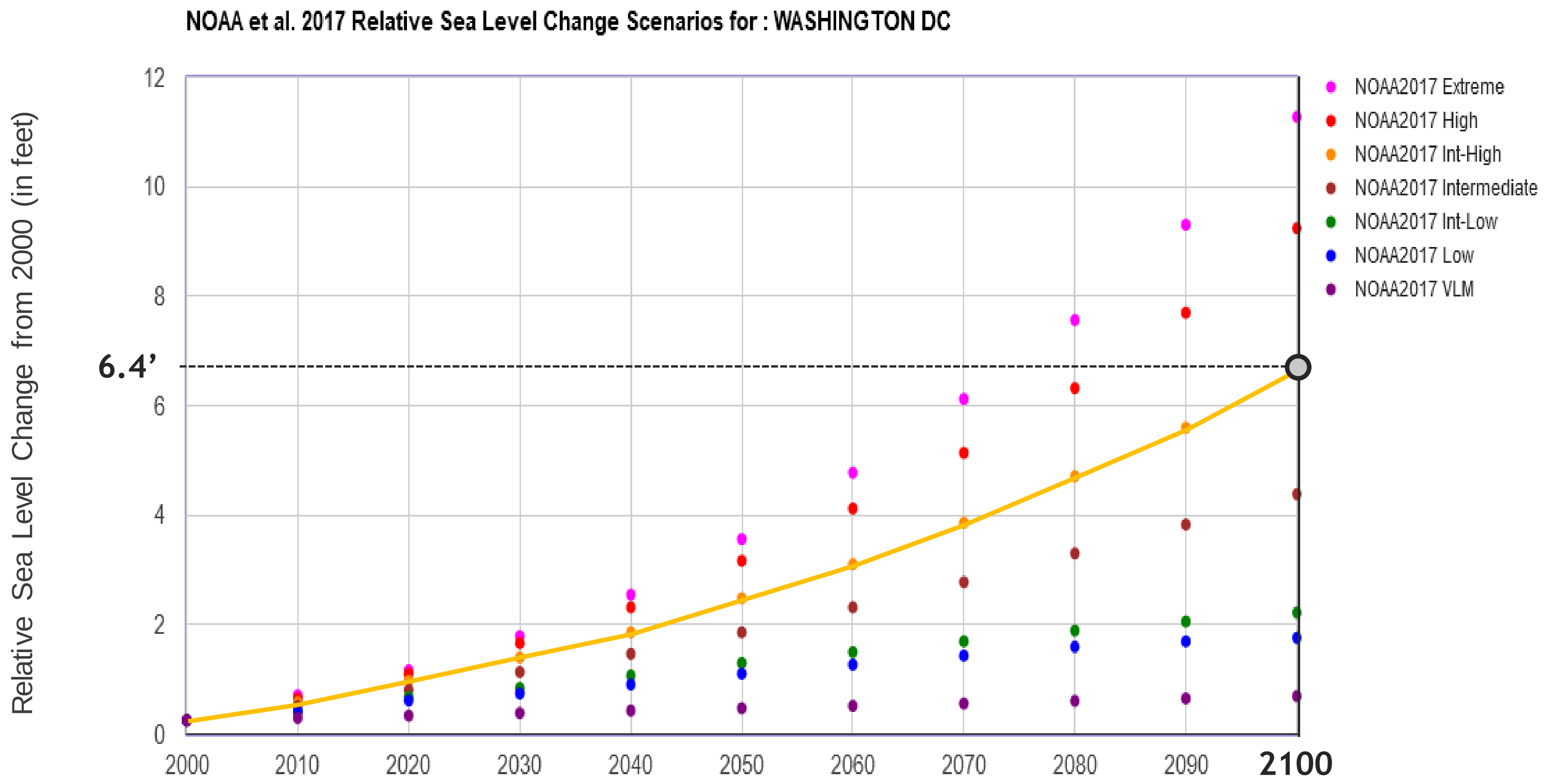
Relative Sea Level Rise between the year 2000 and 2100: 6.4'

=

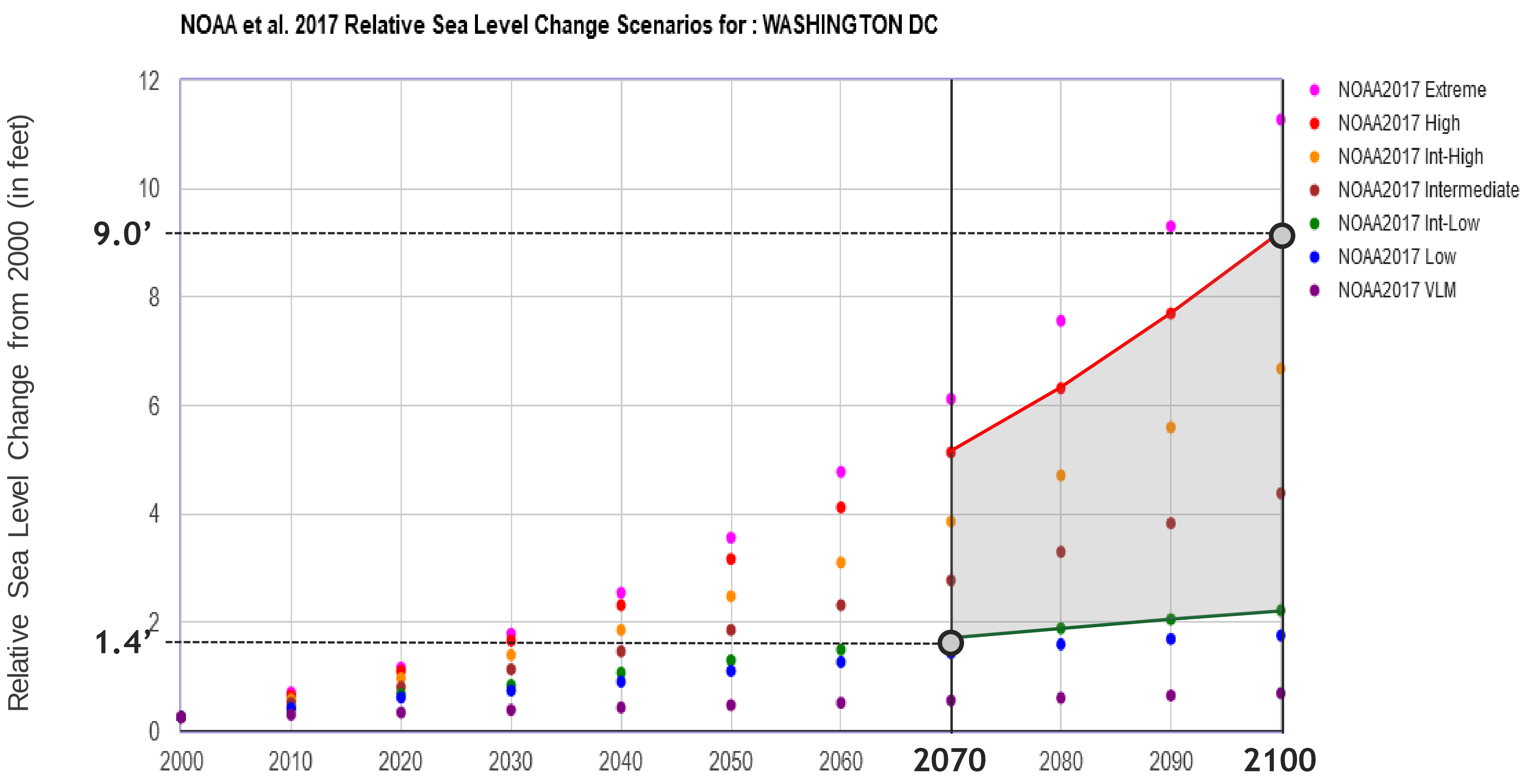
Tidal Shoreline Buffer Elevation (MHHW in the year 2100): **8.6' NAVD88**



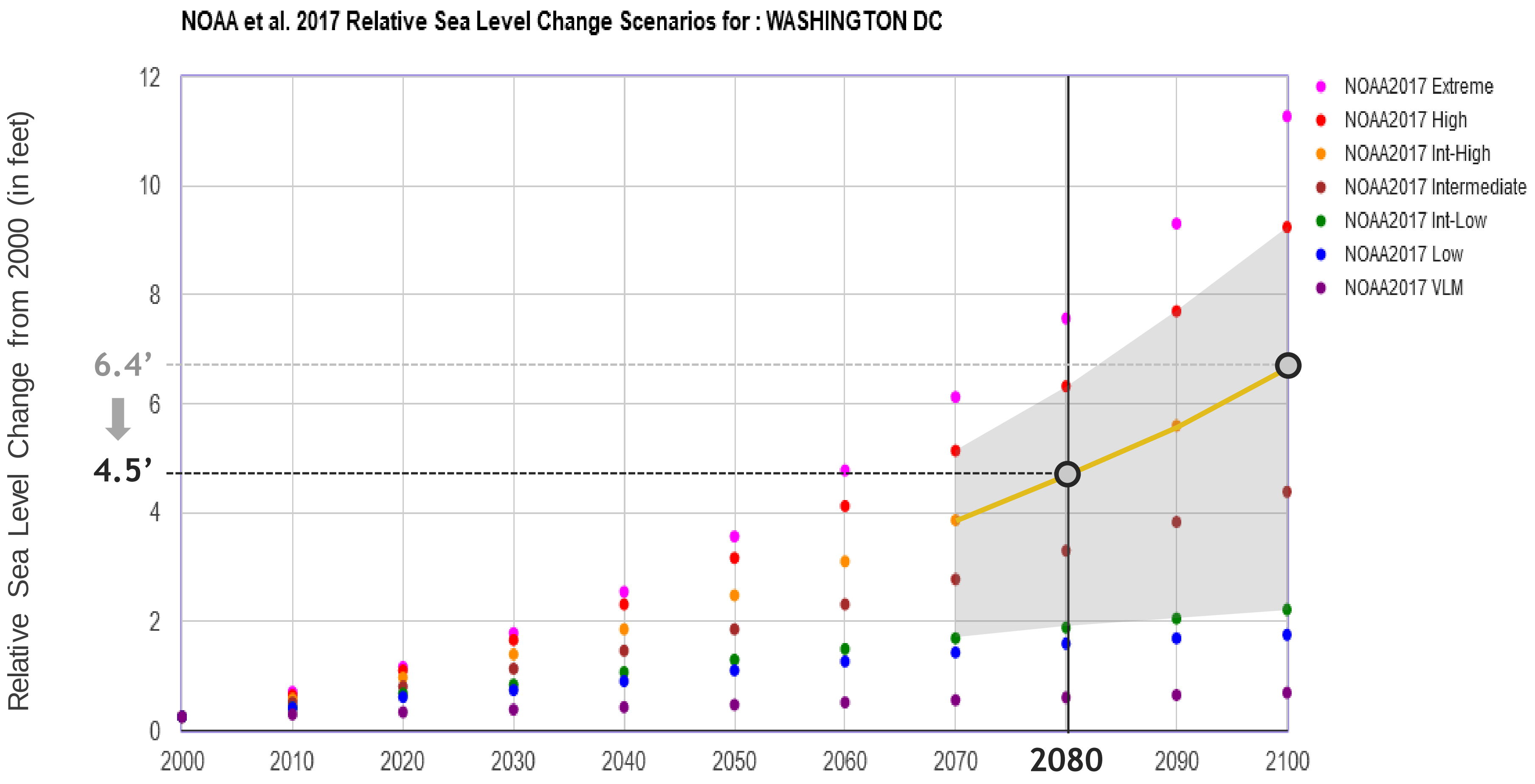
Where did 6.4' Come From?



Which Year, Which Curve?



Refined Proposal



Why 2080?

Service Life of Buildings

- Our research shows that a 60-year timeframe is a reasonable estimate of building lifecycle
- 60 years from today is ~2080

Service Life of Buildings – Research Summary

- Estimates cluster around **30-60** years from construction until substantial improvement.
  - Median age for many categories (e.g. homes, offices, schools, federal (DOE) facilities) is approximately 30 years

- Although some estimates were below 50 years, New York City Mayor's Office of Recovery and Resiliency, U.S. Green Building Council, and DOEE Resilient Design Guidelines use 60-year timeframe to promote sustainability in the built environment
  - Highest estimate reached 120 years

- State of NJ uses 75-year lifespan (2100 benchmark year), while VA uses 50-year lifespan

Polling Questions

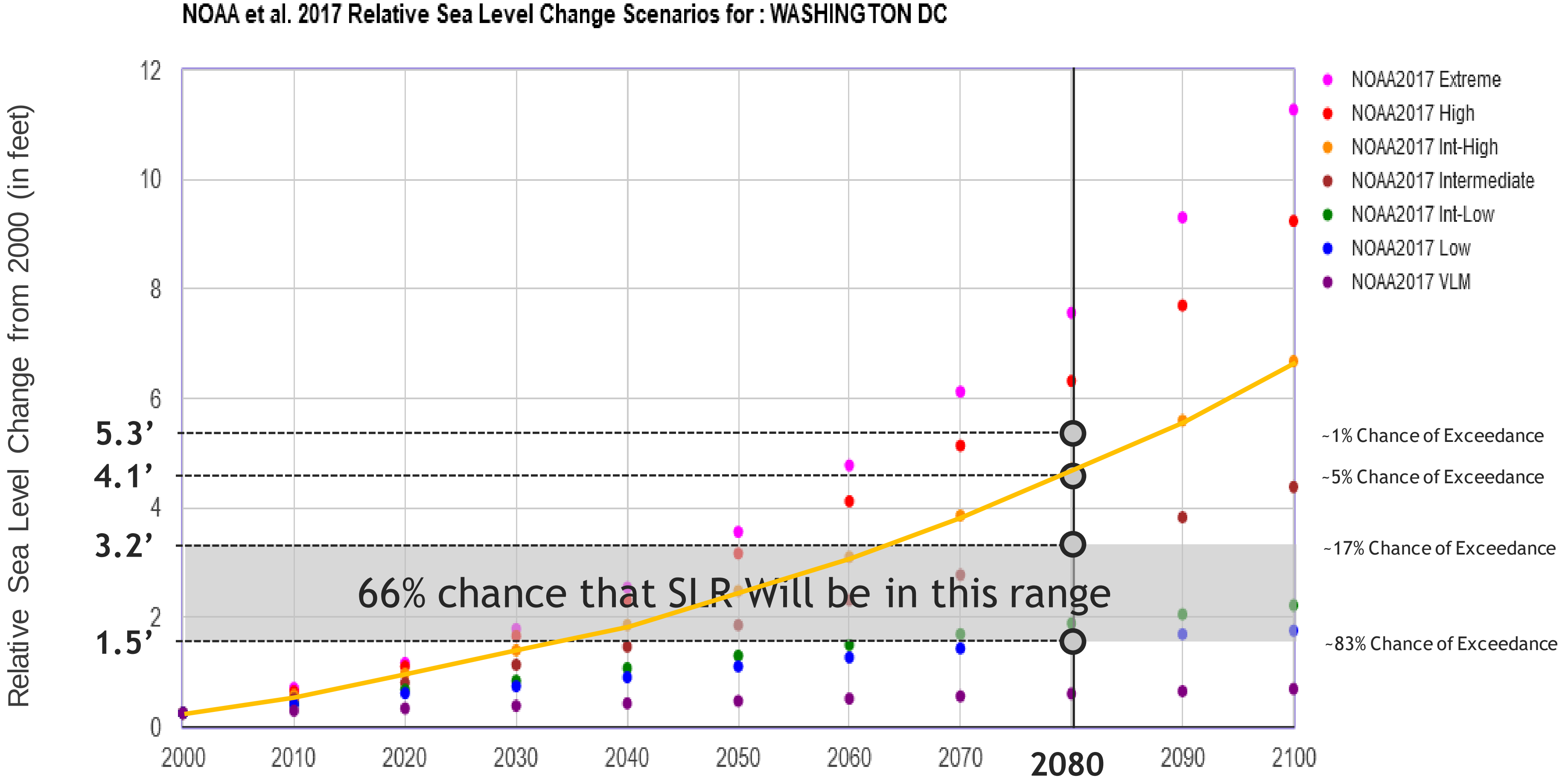
- In your experience, what is the typical design life (between substantial improvements) of the projects you work on?
- What service life range makes the most sense to you?

Why the Intermediate-High NOAA Curve?

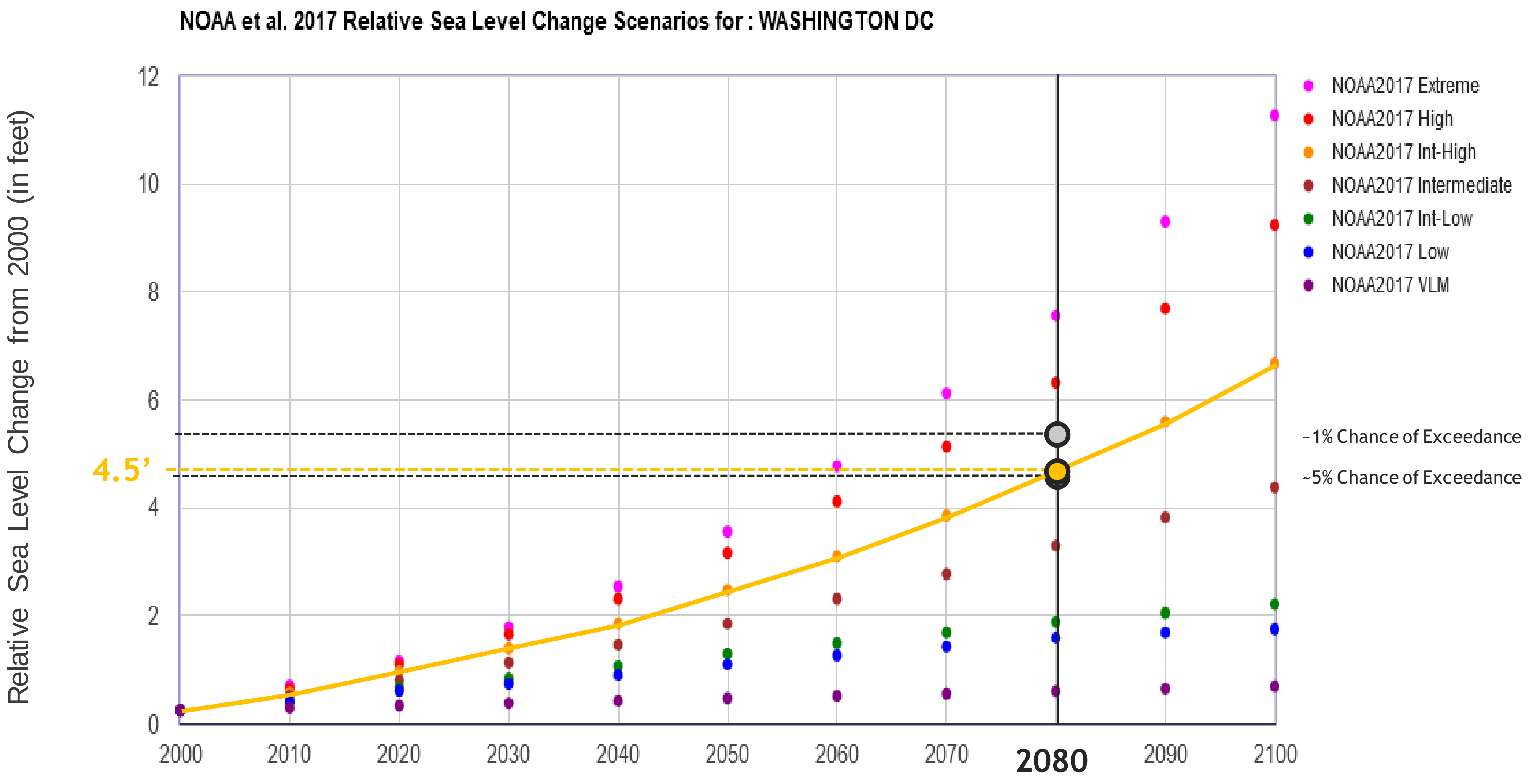
NOAA Intermediate - High Curve

- Since the curve creation in 2017, the rate of current global emissions, and ice sheet melting makes this seem like a highly probable scenario
- The numbers on this curve align with other "probabilistic" research from Bob Kopp and Rutgers University

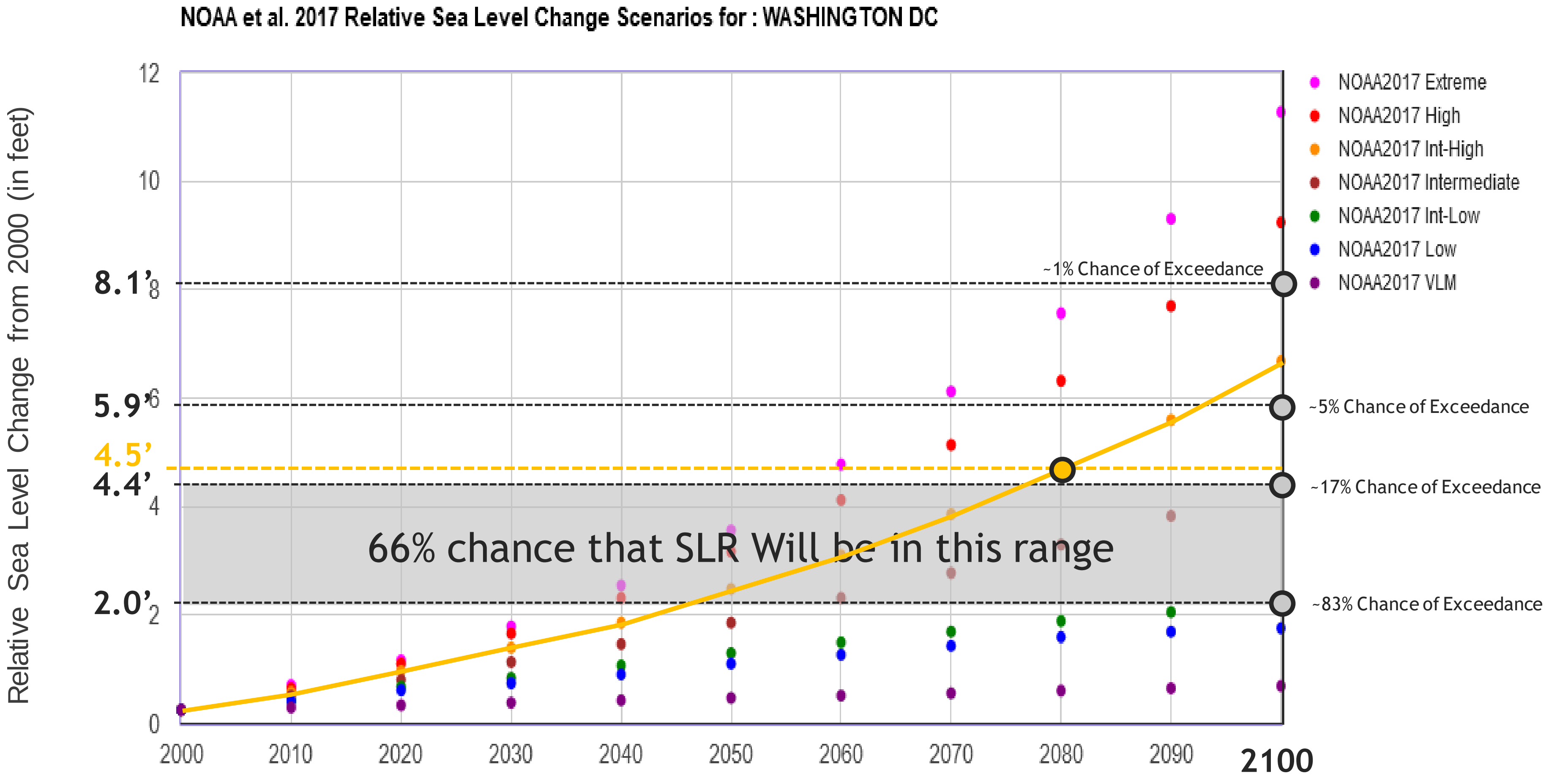
Probabilistic Ranges in 2080



Probabilistic Ranges in 2080



Probabilistic Ranges in 2100



Probabilistic Scenarios for DC

Probability that SLR Exceeds	2080	Closest NOAA Scenario (2080)	2100	Closest NOAA Scenario (2100)
> 95% Chance	1.1 feet	Low	1.3 feet	Low
> 83% Chance	1.5 feet	Intermediate-Low	2.0 feet	Intermediate - Low
~50% Chance	2.3 feet	Intermediate-Low	3.0 feet	Intermediate-Low
< 17% Chance	3.2 feet	Intermediate	4.4 feet	Intermediate
< 5% Chance	4.1 feet	Intermediate-High	5.9 feet	Intermediate-High
< 1% Chance	5.3 feet	Intermediate-High/High	8.1 feet	High

NOAA 2017 Sea Level Rise Scenarios (in feet)

Year	Low	Int-Low	Int	Int-High	High	Extreme
2000	0.0	0.0	0.0	0.0	0.0	0.0
2010	0.2	0.2	0.3	0.3	0.4	0.5
2020	0.4	0.4	0.6	0.7	0.9	0.9
2030	0.5	0.6	0.9	1.1	1.4	1.5
2040	0.7	0.8	1.2	1.6	2.1	2.3
2050	0.9	1.0	1.6	2.2	2.9	3.3
2060	1.0	1.2	2.1	2.9	3.9	4.5
2070	1.2	1.4	2.5	3.6	4.9	5.9
2080	1.3	1.6	3.1	4.5	6.1	7.3
2090	1.4	1.8	3.6	5.3	7.4	9.1
2100	1.5	2.0	4.1	6.4	9.0	11.0

See Appendix B in this document for an explanation on where these numbers came from: https://www.ncpc.gov/docs/Flood_Risk_Management_Planning_Resources_January_2018.pdf

**See Appendix for how this differs from the USACE SLR Caclulator*

Refined Tidal Shoreline Buffer Calculation

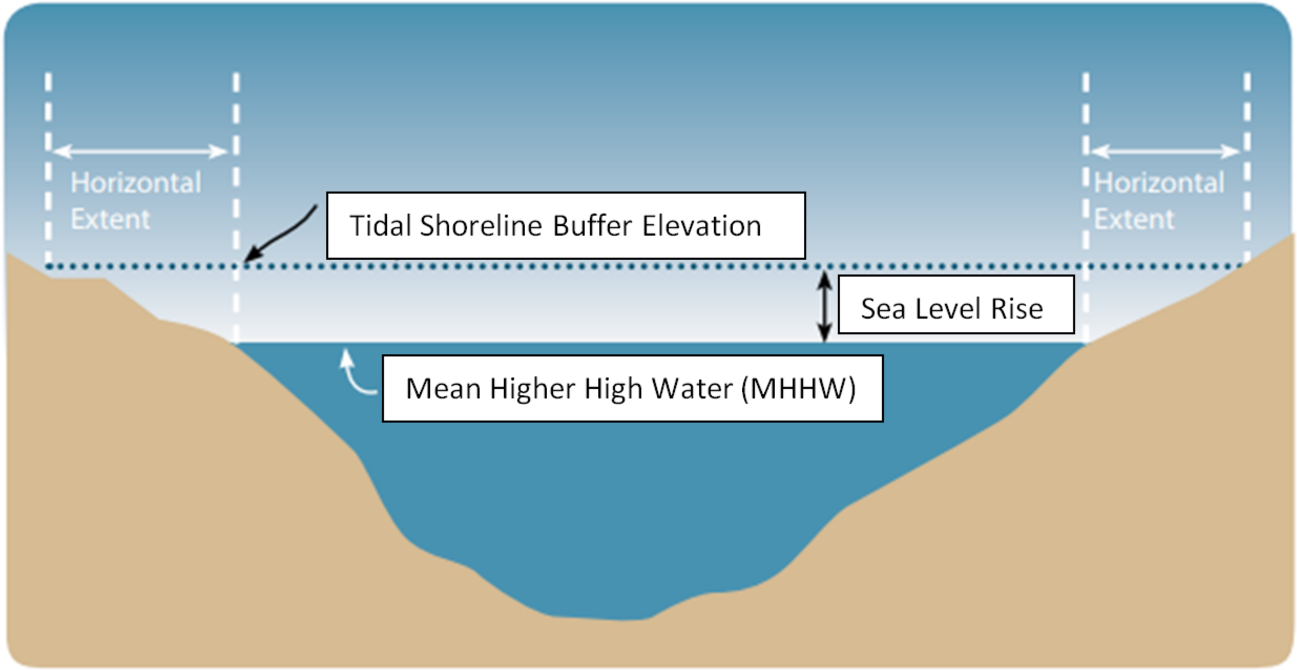
Mean Higher High Water (MHHW) in the year 2000: 2.0' NAVD88

\+

Relative Sea Level Rise between the year 2000 and 2100: 4.5'

=

Tidal Shoreline Buffer Elevation (MHHW in the year 2100): **6.5' NAVD88**



Initial Draft Tidal Shoreline Buffer Calculation

Mean Higher High Water (MHHW) in the year 2000: 2.2' NAVD88

+

Relative Sea Level Rise between the year 2000 and 2100: 6.4'

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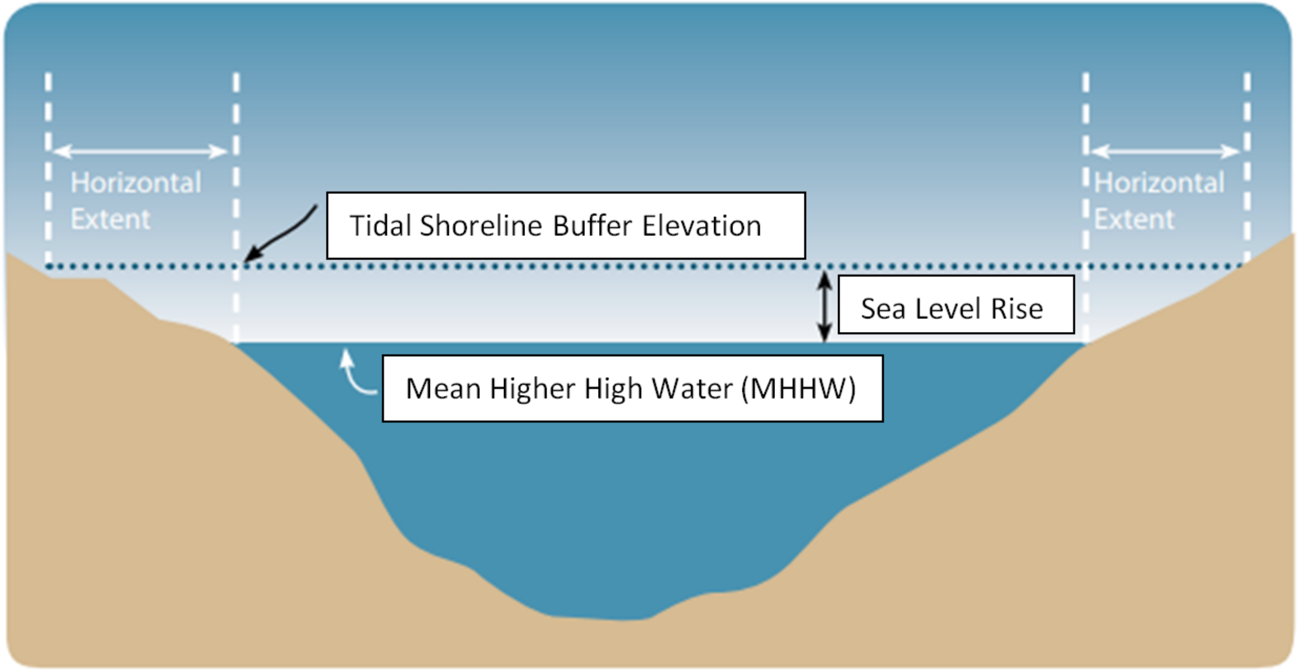
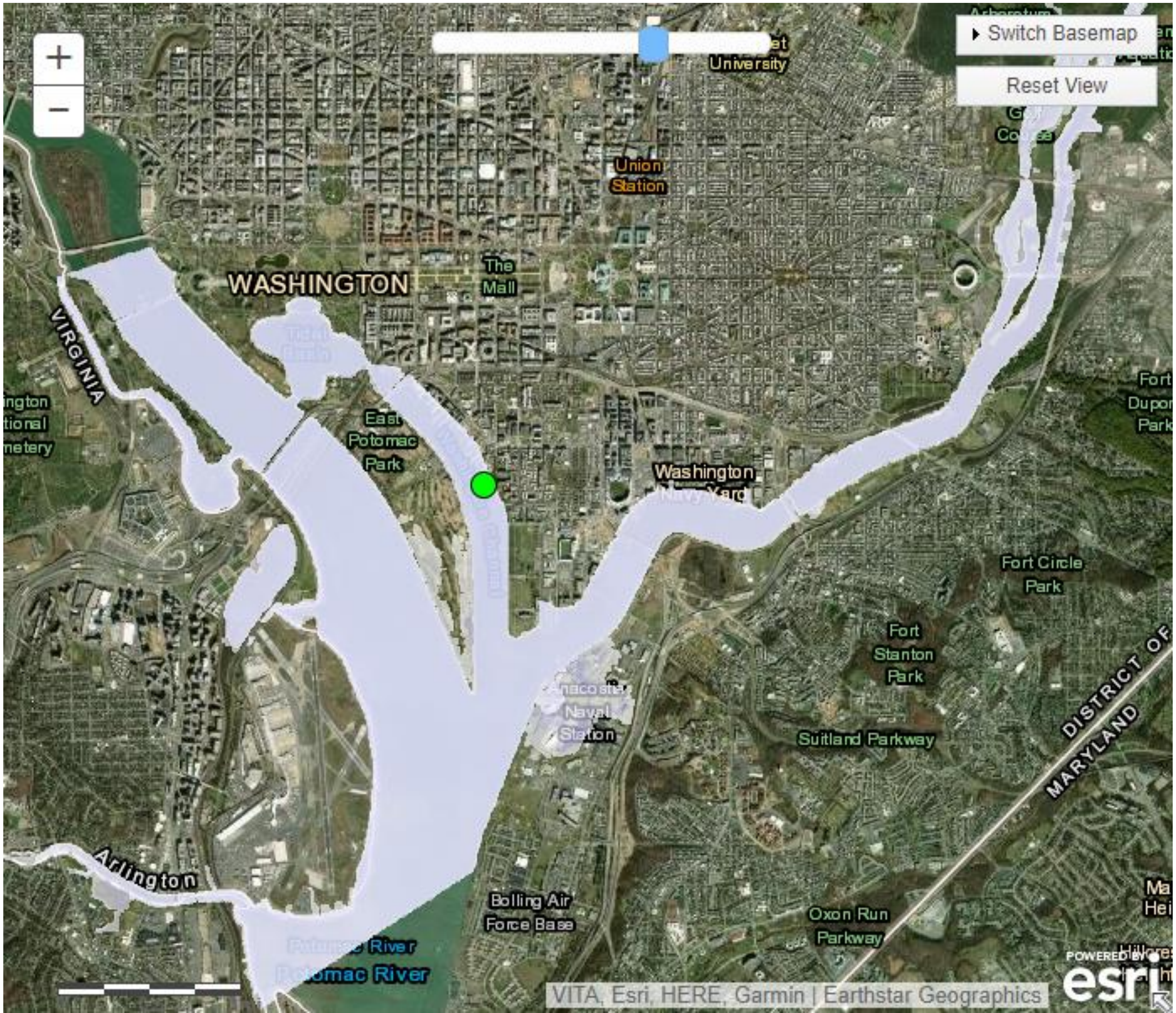
Tidal Shoreline Buffer Elevation (MHHW in the year 2100): **8.6' NAVD88**



5' NAVD88



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Suitland Parkway
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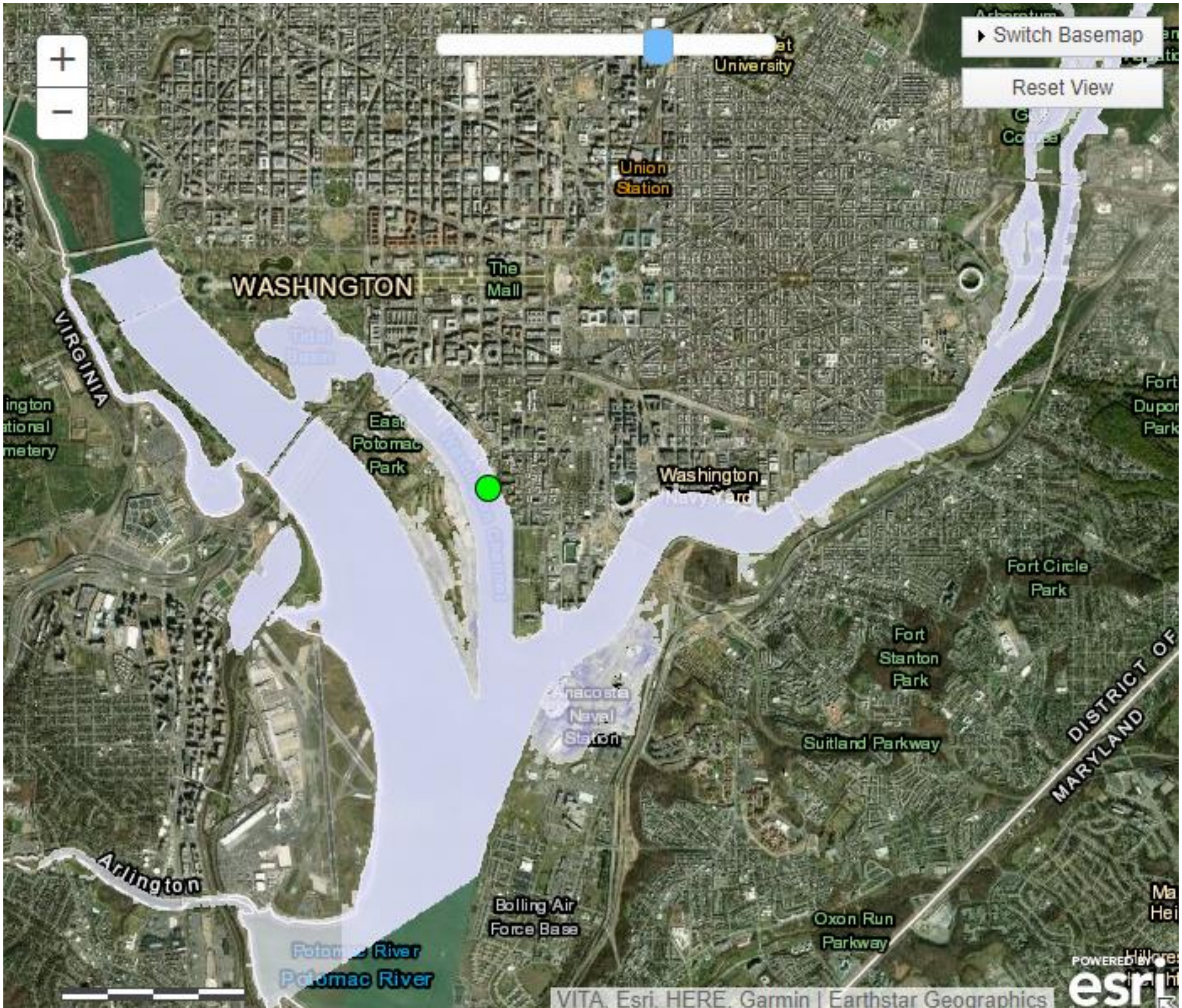
Bolling Air Force Base
Oxon Run Parkway
Potomac River
VITA, Esri, HERE, Garmin | Earthstar Geographics
esri

6' NAVD88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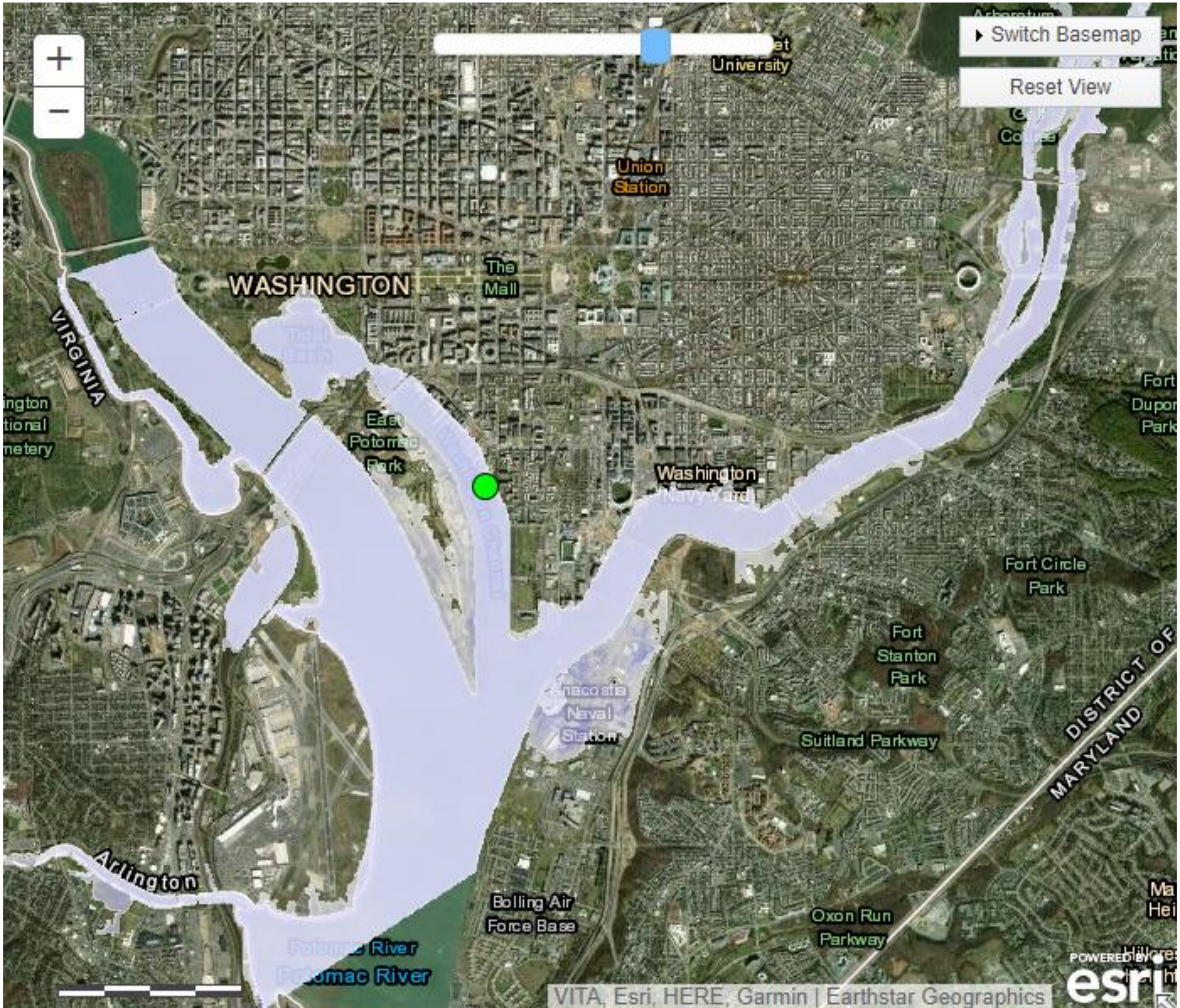
7' NAVD88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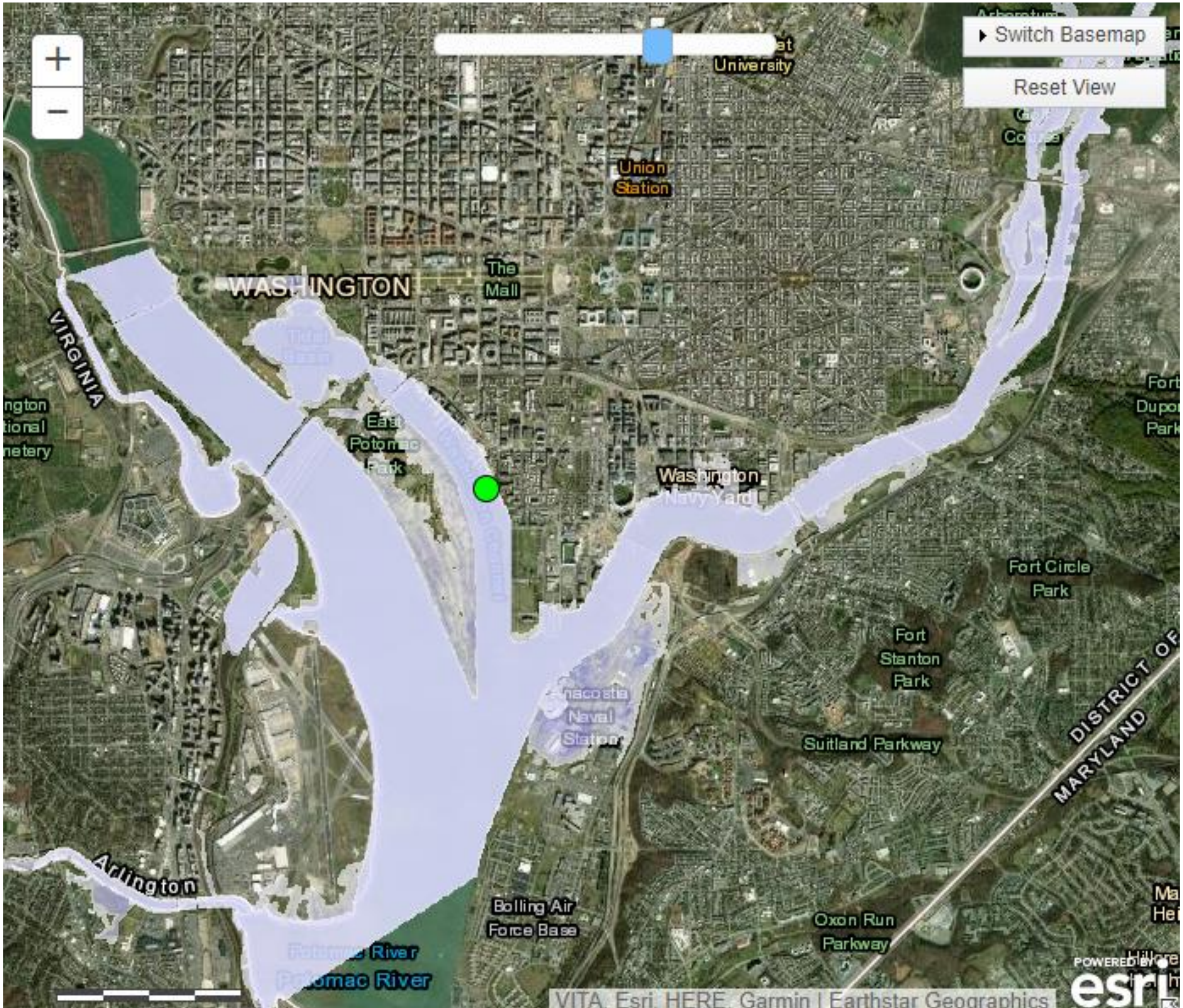
8' NAVD88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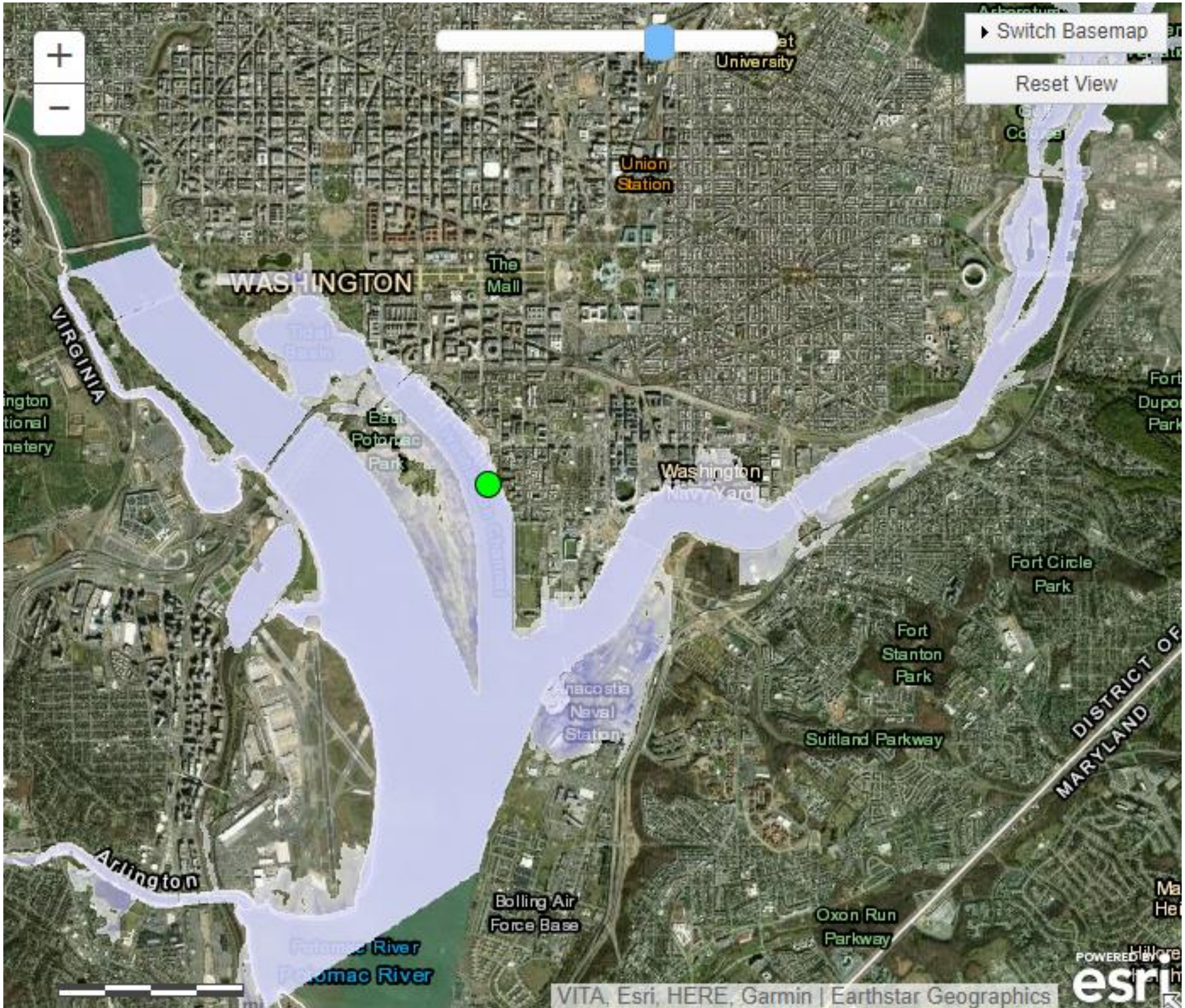
9' NAVD88



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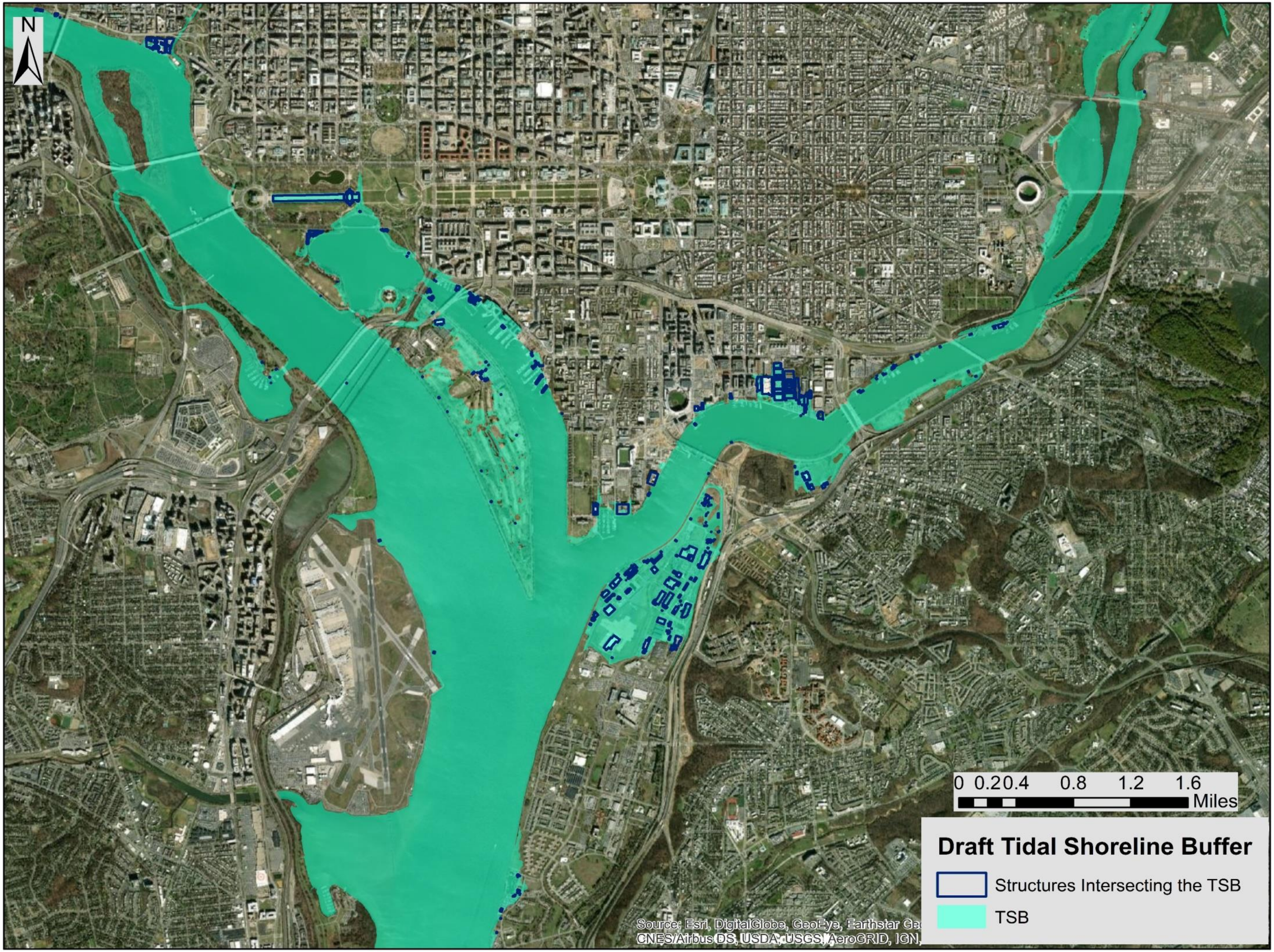
Miles
Draft Tidal Shoreline Buffer
TSB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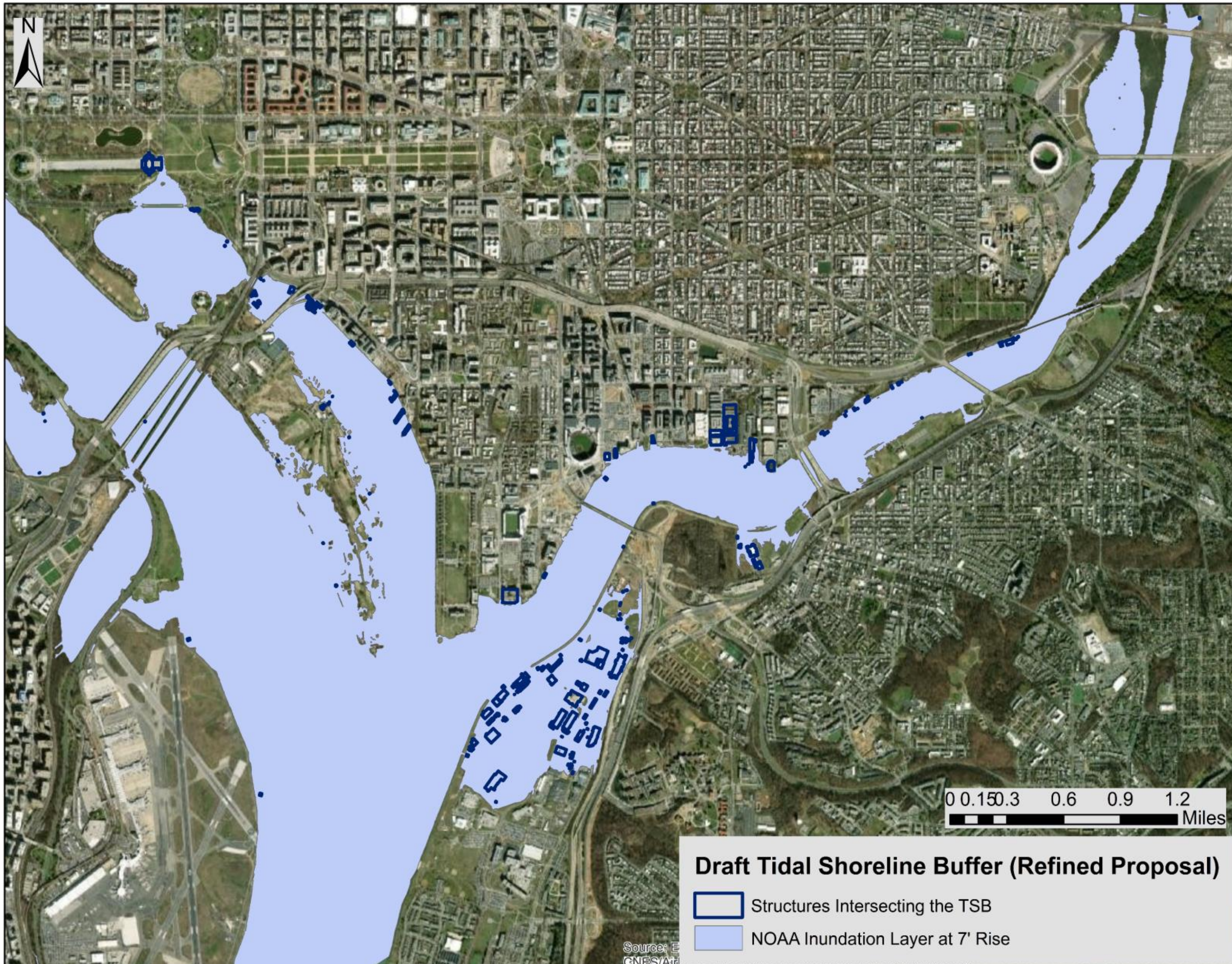
0 0.2 0.4 0.8 1.2 1.6
Miles
Draft Tidal Shoreline Buffer
Structures Intersecting the TSB
TSB
Source: Esri, DigitalGlobe, GeoEye, Earthstar Ge
CNES/Airbus DS, USDA, USGS, AeroGRID, IGN,

7' NAVD88 with Building Footprints



Statistics for Draft Tidal Shoreline Buffer

	Total in DC (Estimate)	Tidal Shoreline Buffer	% of Total in TSB	Source
Structures	162,648	295	0.18	DC Open Data: Planimetric 2017, "Building Footprints 2017"
Common Ownership Lots	137,099	263	0.19	DC Open Data
Acres	43,854	1681.3	3.83	DCfloodrisk.org

Statistics for Draft Tidal Shoreline Buffer

	Total in DC (Estimate)	Original TSB Proposal	% of Total in TSB (Original)	Refined TSB Proposal (Approximate Using NOAA Analogue)	% of Total in TSB (Refined)	Source
Structures	162,648	295	0.18	181	0.11	DC Open Data: Planimetric 2017, "Building Footprints 2017"
Common Ownership Lots	137,099	263	0.19	118	0.09	DC Open Data
Acres	43,854	1681.3	3.83	1124.3	2.56	DCfloodrisk.org

What would change? – Buffer Areas*

Current Flood Hazard Rule:

- No buffers

Proposed Update:

- Tidal Shoreline Buffer *
  - Areas to be inundated by Sea Level Rise in future decades
  - New development must be protected to **High flood + 4.5'** ft. to account for NOAA predicted sea level rise.
  - Review by OP for harmony with surrounding urban design

Polling Questions

- Which NOAA curve makes the most sense to you?
- Using the probabilistic framework, what amount risk (% exceedance) is appropriate for a building?

Map Maintenance Procedures

TSB Map Revisions

- Projects that are mapped within the horizontal extent of the TSB will be subject to the applicable regulations listed in 20 DCMR 31 unless proven otherwise.

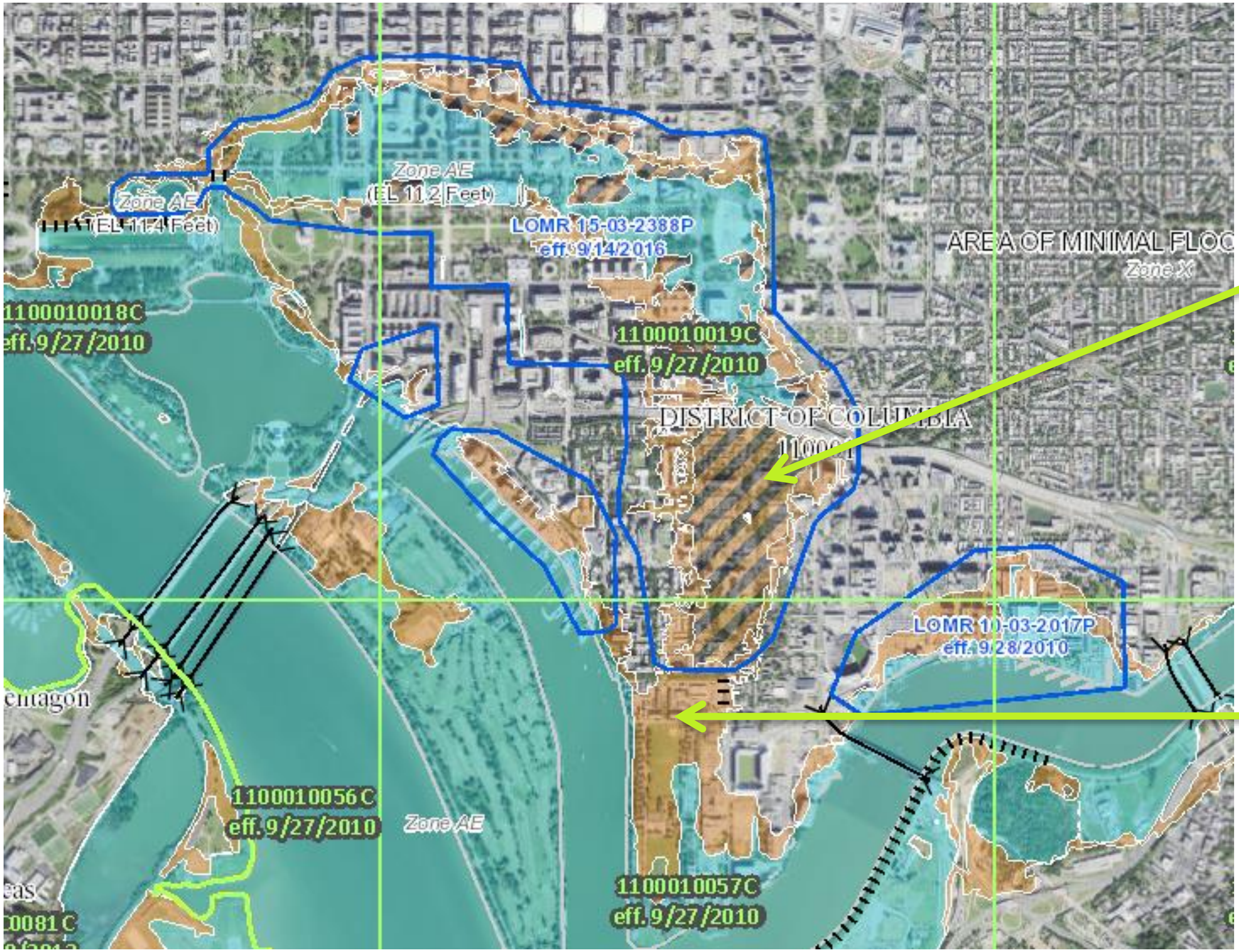
- Applicants who wish to apply for removal from the TSB shall submit elevation data for a site certified by a certified by a District-registered professional engineer or land surveyor.

- In order to qualify for removal, the lowest lot elevation within the site must be at or above the TSB Design Flood Elevation.

- Projects can qualify for removal based on either natural grade conditions or supplementary elevation through the addition of fill to a site.

- Projects can also qualify for removal if protected by a levee accredited by FEMA in accordance with 44 CFR 65.10 and providing a minimum flood protection elevation equivalent to the TSB Design Flood Elevation.

Levee Protected Areas



Cross-Hatch = "Area With Reduced Risk Due to Levee"

Solid Beige = "0.2% Annual Chance Flood Hazard"

Levee Protected Areas

- Flood protection structures need certification from a Professional Engineer in order to remove protected areas from the 500-year floodplain.

- Removal of areas from the 100-year floodplain using the 44 CFR 65.10 levee accreditation procedure will not be impacted; that process will continue as usual.

Example 1 – Existing Public Flood Protection Structure

- Consider a property located in shaded Zone X (500-year floodplain) due to protection offered by Potomac Park Levee
- Outside of Special Flood Hazard Area so exempt from federal mandatory flood insurance purchase requirement.
- Still subject to District floodplain regulations and mandatory purchase requirement.
  - Potential added flexibility for below-grade parking and storage and floodproofed ancillary residential uses; learn more at June 10 workshop.
- May be removed from 500-year floodplain and exempt from all District floodplain regulations only if Professional Engineer certifies that levee can protect against a 500-year event.

Example 2 – New Private/Agency Flood Control Structure

- Developers can remove areas from the 500-year floodplain by constructing a levee that is certified by a Professional Engineer to provide protection from the 500-year event.

- 44 CFR 65.10 standards and accreditation process should still be complied with to ensure that FEMA will remove property from SFHA.

- Removal from TSB requires both FEMA accreditation (to 100-year flood elevation) and PE-certified protection to the TSB flood elevation.

Discussion

Thank You!

Appendix

Design Flood Elevations – Watts Branch

Cross Section	100-Yr	100-Yr + 2	500-Yr	500-Yr Minus BFE + 2
A	14.5	16.5	16.3	-0.2
C	14.5	16.5	16.3	-0.2
E	14.6	16.6	16.3	-0.3
G	19.1	21.1	20.3	-0.8
I	30.6	32.6	33.3	0.7
K	36.1	38.1	39.2	1.1
M	40.5	42.5	42.3	-0.2
O	59.9	61.9	61	-0.9
Q	63.2	65.2	64	-1.2
S	72.9	74.9	74.6	-0.3
U	77.8	79.8	79.5	-0.3
V	81.2	83.2	82	-1.2
W	87.3	89.3	87.8	-1.5
X	87.9	89.9	88.7	-1.2
			Median Difference	-0.3

Design Flood Elevations – Anacostia River

Cross Section	100-Yr	100-Yr + 2	500-Yr	500-Yr Minus BFE + 2
A	10.5	12.5	14	1.5
C	10.5	12.5	14	1.5
F	10.5	12.5	14	1.5
H	11	13	14	1
J	12.7	14.7	14.1	-0.6
L	13.3	15.3	15	-0.3
N	13.8	15.8	15.4	-0.4
P	14.5	16.5	16.2	-0.3
R	14.5	16.5	16.4	-0.1
S	15.2	17.2	17.1	-0.1
			Median Difference	-0.1

Design Flood Elevations – Oxon Run

Cross Section	100-Yr	100-Yr + 2	500-Yr	500-Yr Minus BFE + 2
A	26.5	28.5	27.5	-1
C	39.2	41.2	39.8	-1.4
E	39.5	41.5	40.2	-1.3
G	51.1	53.1	53.2	0.1
I	61.4	63.4	61.8	-1.6
K	75.1	77.1	75.7	-1.4
M	77.4	79.4	78.6	-0.8
O	90.1	92.1	90.6	-1.5
Q	105.6	107.6	106.5	-1.1
			Median Difference	-1.1

100-year vs. 500-year Floodplain Statistics

	Current Structures	Proposed Structures	Current %	Proposed %
Ward 1	1	1	0.07	0.03
Ward 2	224	363	15.71	12.60
Ward 3	27	33	1.89	1.15
Ward 4	8	9	0.56	0.31
Ward 5	2	2	0.14	0.07
Ward 6	155	845	10.87	29.33
Ward 7	664	856	46.56	29.71
Ward 8	344	771	24.12	26.76
	1426	2881	0.88	1.78

100-year vs. 500-year Floodplain Statistics

	Total in DC (Estimate)	Current Regulated Area	Proposed Regulated Area	% of Total in Regulated Area - Current	% of Total in Regulated Area - Proposed	Source
Structures	162,648	1,354	2,471	0.8	1.5	DC Open Data: Planimetric 2017, "Building Footprints 2017"
Single-Family Homes	122,545	461	708	0.4	0.6	DC Open Data
Multi-Family Residential Structures	8,059	123	423	1.5	5.2	DC Open Data

Benchmark Year – Service Life of Buildings

- U.S. Energy Information Administration. "Commercial Building Energy Consumption Survey." 2015.

  ...the median age of [commercial] buildings [greater than 1,000 square feet] in 2012 was **32 years.**"

- U.S. Green Building Council. "Materials and Resources – Whole-Building Life Cycle Analysis." 2013.

  "The service life of the baseline and proposed buildings must be the same and at least **60 years** to fully account for maintenance and replacement."

- Rybczynski, Witold. "Short Life." University of Pennsylvania.

  "I read an amazing (for me) fact recently. A participant in a Getty Center colloquium on building preservation casually observed that the life cycle of conventionally built (masonry and wood) buildings is about **120 years** (before major repairs), whereas for modernist buildings it is only half that time—**sixty years**.

Benchmark Year – Service Life of Buildings

- O'Connor, Jennifer. "Survey on actual service lives for North American buildings" Forintek Canada Corp. 2014.
  - "For example, a large study of U.K. residential buildings found 46% of demolished structures fell in the **11-32 year** age class (3). Another large study, of office buildings in Japan, found the typical life span to be between **23 and 41 years** (4)."
  - For example, the U.S. Department of Energy had 10,707 buildings in 2002, with an average age of **31 years** (5). Public schools in the U.S. tend to undergo substantial renovations or additions to extend their service lives, thus the average age of the approximately 78,000 public schools in 1998 was **42 years;** most schools are abandoned by the age of 60 (6).
  - Other sources of data are agencies responsible for national statistics such as the U.S. Census Bureau. For example, in 2001 the United States had 119,117,000 residential buildings, with an average age of **32 years** (7). Statistics Canada reports that the average age of all non-residential buildings in Canada in 2003 was **17.9 years** (8)"

Benchmark Year – Service Life of Buildings

- Considine, Carol et al. *Recommendations for Freeboard Standards for State-Owned Buildings in the Commonwealth of Virginia.* Old Dominion University Batten College of Engineering and Technology. 2019. "...the ASCE Manual of Practice No. 140, Climate-Resilient Infrastructure: Adaptive Design and Risk Management, recommends that a mid-term outlook for the life of a project, approximately **50 years,** be used for climate change informed design."

- New York City Mayor's Office of Recovery and Resiliency. *Climate Resiliency Design Guidelines*. 2019.
  Table 1 – Facilities and components and associated climate change projections...
  - **2050s (2040-2069)**: Facility improvements, and components on a regular replacement cycle; Electrical, HVAC, and mechanical components• **Most building retrofits (substantial improvements)**• Concrete paving • Infrastructural mechanical components (e.g., compressors, lifts, pumps) • Outdoor recreational facilities• At-site energy equipment (e.g., fuel tanks, conduit, emergency generators)• Stormwater detention systems
  - **2080s (2070-2099): Long-lived buildings and infrastructure; Most buildings (e.g., public, office, residential)** • Piers, wharfs, and bulkheads • Plazas • Retaining walls • Culverts• On-site energy generation/co-generation plants

Emissions Scenario Modeling

- "The interpolated 'moderate' trajectory provides a reasonable estimate of potential future SLR…if current global climate mitigation policies are maintained but not strengthened…and no large, unexpected surprises amplify the expected effects of greenhouse gas emission....[It] roughly corresponds to a warming of about **3.5°C** by 2100."

- NJDEP "Moderate" scenario represents 3.5 degrees Celsius of warming since pre-industrial times, which is at the high end of the RCP 4.5 range (2.0-3.6 degrees)

Table 4. Probability of exceeding GMSL (median value) scenarios in 2100 based upon Kopp et al. (2014).

GMSL rise Scenario	RCP2.6	RCP4.5	RCP8.5
Low (0.3 m)	94%	98%	100%
Intermediate-Low (0.5 m)	49%	73%	96%
Intermediate (1.0 m)	2%	3%	17%
Intermediate-High (1.5 m)	0.4%	0.5%	1.3%
High (2.0 m)	0.1%	0.1%	0.3%
Extreme (2.5 m)	0.05%	0.05%	0.1%

NOAA Modeling (Sweet et. al 2017)

- "Each RCP represents possible underlying (though implicit) socioeconomic conditions and technological considerations, including a low-end member (RCP2.6) requiring strong mitigation (net-negative emissions in the last decades of the 21st century), a moderate mitigation member (RCP4.5) stabilizing emissions through 2050 and declining thereafter, and a high-end, fossil-fuel-intensive, 'business-as-usual' emission scenario (RCP8.5)."

- "In response, global mean temperatures are modeled as likely (>66% probability) to increase 1.9–2.3, 2.0–3.6 and 3.2–5.4 degrees Celsius, respectively, for RCP2.6, RCP4.5 and RCP8.5 over the 2081–2100 period relative to 1850–1900 levels (IPCC, 2013)." [For context, the goal of the Paris Accords is to limit warming to 2.0 degrees]

- "The Low and Extreme scenarios represent the scientifically plausible lower and upper bounds on 21st century GMSL rise, respectively, as defined in this report; the remaining four scenarios (from Intermediate-Low to High), while simply placed at 0.5-m intervals in between, can be shown to correspond to different likelihood levels under RCP2.6, RCP4.5, and RCP8.5"

Rutgers Modeling (Kopp et. al 2019)

- "This study replaced the original Antarctic ice-sheet mass loss projections of NOAA with those [that] incorporated...for the first time...the gravitational instability of ice cliffs and exhibited high sensitivity to increasing atmospheric temperatures."
- “The interpolated ‘moderate’ trajectory provides a reasonable estimate of potential future SLR…if current global climate mitigation policies are maintained but not strengthened…and no large, unexpected surprises amplify the expected effects of greenhouse gas emission....[It] roughly corresponds to a warming of about **3.5°C** by 2100.”

Using USACE Sea Level Rise Calculator??

!!! Must Subtract .25' from these numbers to account for SLR between 1992 and the year 2000 !!!

Scenarios for WASHINGTON DC
NOAA2017 VLM: 0.00443 feet/yr
All values are expressed in feet

Year	NOAA2017 VLM	NOAA2017 Low	NOAA2017 Int-Low	NOAA2017 Intermediate	NOAA2017 Int-High	NOAA2017 High	NOAA2017 Extreme
2000	0.25	0.25	0.25	0.25	0.25	0.25	0.25
2010	0.29	0.41	0.41	0.51	0.58	0.64	0.71
2020	0.34	0.61	0.68	0.81	0.97	1.10	1.17
2030	0.38	0.74	0.84	1.14	1.40	1.66	1.79
2040	0.43	0.91	1.07	1.46	1.86	2.32	2.55
2050	0.47	1.10	1.30	1.86	2.48	3.17	3.56
2060	0.52	1.27	1.50	2.32	3.10	4.12	4.78
2070	0.56	1.43	1.69	2.78	3.86	5.14	6.12
2080	0.60	1.60	1.89	3.30	4.71	6.32	7.57
2090	0.65	1.69	2.05	3.83	5.60	7.70	9.31
2100	0.69	1.76	2.22	4.38	6.68	9.24	11.27

4.71 - 0.25 = 4.5 feet

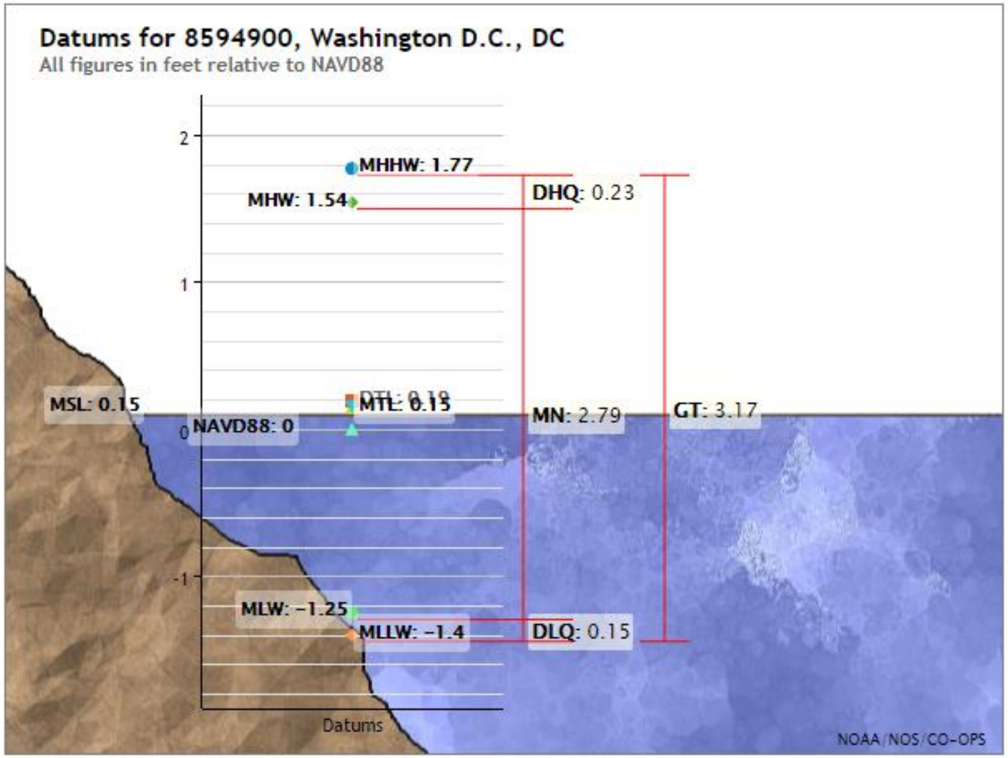
USACE Sea Level Rise Calculator: https://cwbi-app.sec.usace.army.mil/rccslc/slcc_calc.html

Calculating MHHW in Year 2000

Elevations on NAVD88

Station: 8594900, Washington D.C., DC
Status: Accepted (Apr 17 2003)
Units: Feet
Control Station:
T.M.: 75
Epoch: 1983-2001
Datum: NAVD88

Datum	Value	Description
MHHW	1.77	Mean Higher-High Water
MHW	1.54	Mean High Water
MTL	0.15	Mean Tide Level
MSL	0.15	Mean Sea Level
DTL	0.19	Mean Diurnal Tide Level
MLW	-1.25	Mean Low Water
MLLW	-1.40	Mean Lower-Low Water
NAVD88	0.00	North American Vertical Datum of 1988
STND	-5.95	Station Datum
GT	3.17	Great Diurnal Range



https://tidesandcurrents.noaa.gov/datums.html?datum=NAVD88&units=0&epoch=0&id=8594900&name=Washington+D.C.&state=DC