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Ensuring Living Shorelines for the Long-Term Through Biomimicry, Modeling, and Maintenance: An Alabama Design Example

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Ensuring living shorelines for the long-term through biomimicry, modeling, and maintenance: an Alabama design example

May 10th, 2019

Hampton Roads Sea Level Rise/Flooding Adaptation Forum: Resilient Shorelines for Multiple Benefits

Suffolk, VA

Acknowledgements

- ⚡ Engineering and Design and Construction funded by National Fish and Wildlife Foundation Gulf Environmental Benefit Fund (NFWF GEBF)
- ⚡ Phase 1 - \$5M for Acquisition and Engineering & Design for restoration
- ⚡ Phase 2 - \$16M Construction and Monitoring

Site tour

⚡ <https://youtu.be/tw7GDIJPvE4>

⚡ https://youtu.be/7GExaGsx_Cw

1916

Shell Belt Rd

Google earth

1056 ft

Imagery Date: 11/18/2017 lat 30.383552° lon -88.266392° elev 0 ft eye alt 4566 ft

Tour Guide 1997

1954

Shell Belt Rd

Google earth

1056 ft

Imagery Date: 11/18/2017 lat 30.383552° lon -88.266392° elev 0 ft eye alt 4566 ft

Tour Guide 1997

1997

Shell Belt Rd

Image U.S. Geological Survey

Google earth

1056 ft

Imagery Date: 2/10/1997 lat 30.383552° lon -88.266392° elev 0 ft eye alt 4566 ft

2006

Shell Bell Rd



Google earth

1056 ft

2011

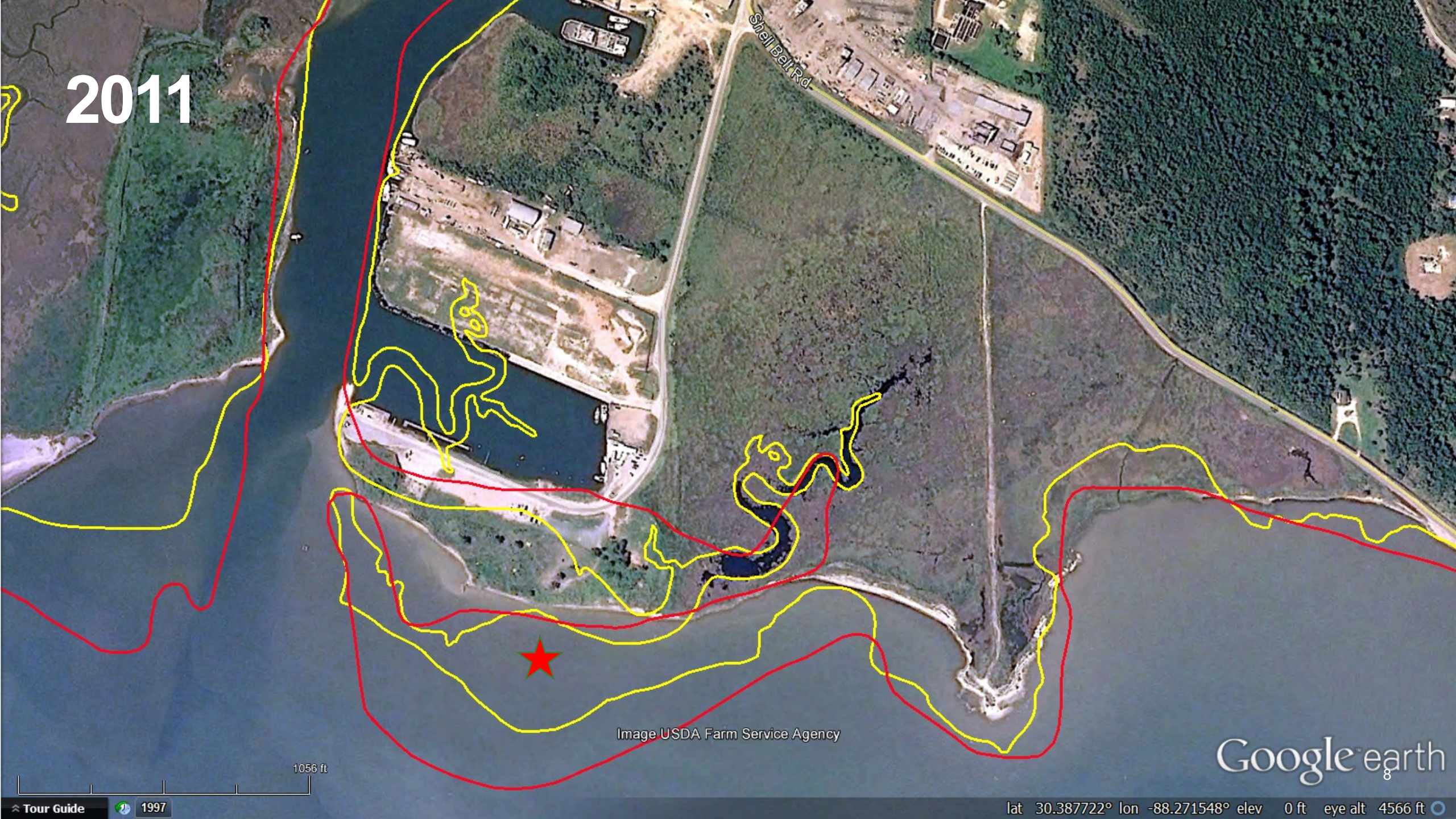
Shell Bet Rd



Image USDA Farm Service Agency

Google earth

lat 30.387722° lon -88.271548° elev 0 ft eye alt 4566 ft



2013

Shell Belt Rd

Google earth

1056 ft

Imagery Date: 11/2/2013 lat 30.387713° lon -88.274348° elev 0 ft eye alt 4566 ft

Tour Guide 1997



2017

Shell Belt Rd

Google earth
10

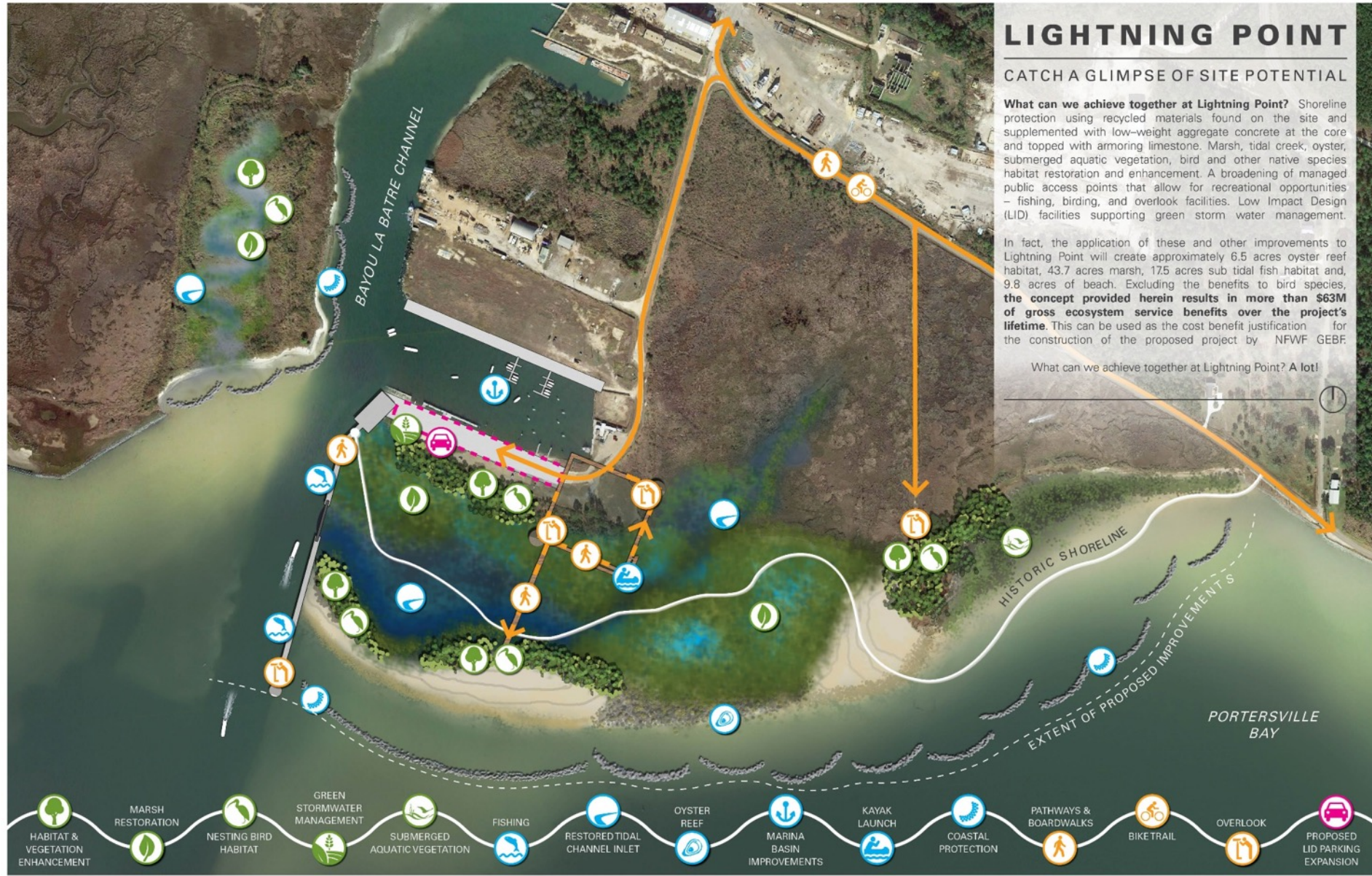
lat 30.387713° lon -88.271579° elev 0 ft eye alt 4566 ft

Tour Guide 1997

1056 ft



Conceptual Design



Phase 1 – Preliminary Scoping

- ⚡ Solidify client and key stakeholders scope
- ⚡ Held a Charrette
 - ⚡ State
 - ⚡ Mobile County
 - ⚡ City of Bayou La Batre
 - ⚡ Dauphin Island Sea Lab
 - ⚡ Mobile Bay National Estuary Program





“Revitalize the locally important waterfront area at Lightning Point by restoring, enhancing, and protecting the shoreline habitats, and by providing improved community access.”

– Mission Statement

TENETS

- ⚡ A Community Front Porch** – provide an enhanced experience for locals and visitor for boating, fishing, and site-seeing.
- ⚡ Resilient and Productive Shoreline** – restore a diverse system of coastal habitats that enhances recreational opportunities and provides shoreline protection for the long-term.
- ⚡ Enhance Accessibility** – provide a safe, enjoyable area for the community to arrive, park, walk, and connect with the waterfront while limiting impacts to restored habitats.

Key Project Components

1. Shoreline Protection

- 1.5 miles of breakwaters

2. Habitat Creation

- 40 acres of marsh, tidal creeks

3. Public Access

- Walking paths, look-out
- Parking lot improvements (LID/GI)

4. Beneficial Use of Dredge Material

5. Long-term Site Sustainability



Phase 2 – Investigations

- ⚡ Geotechnical
- ⚡ Cultural Resources
- ⚡ Natural Resources
- ⚡ Bathymetry and Hydrography



Phase 3 – Engineering and Design

⚡ Engineering and Modeling

- Gap Analysis
- Sea Level Rise
- Breakwater Dimensions
- Breakwater Configuration
- Dredge Material

⚡ Environmental

- Species of Interest
- Ecosystem Services Valuation

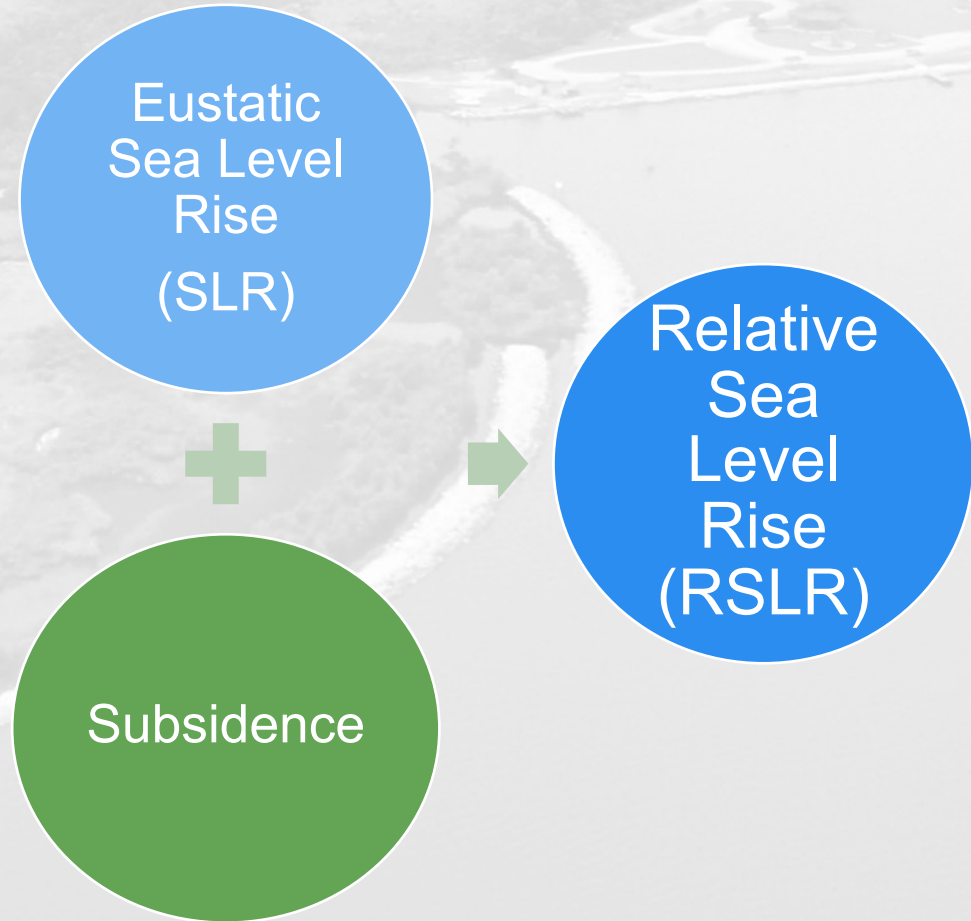
⚡ LID/GI Parking Lot

⚡ Opinion of Probable Costs

Relative Sea Level Rise

⚡ Relative Sea Level Rise takes into account:

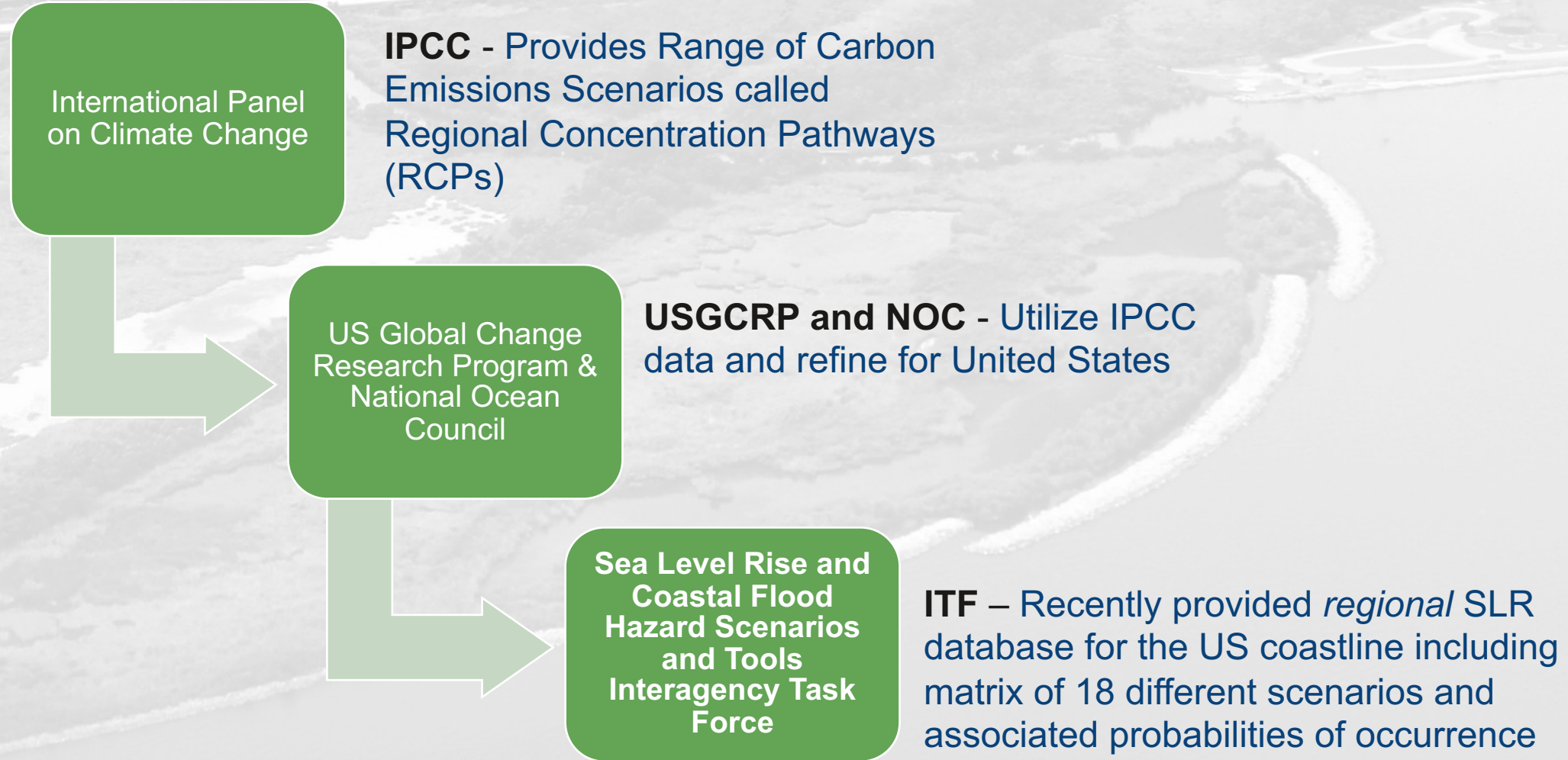
- Rising water surface elevations and
- Sinking ground elevations



Subsidence Data

- ⚡ Subsidence largely due to the extraction of water and fossil fuels as well as consolidation of coastal soils
- ⚡ Estimated from long term GPS observations at a fixed site
- ⚡ NASA Jet Propulsion Laboratory provides long term GPS measurements of Vertical Land Movement (VLM) at Fort Morgan, AL
- ⚡ USACE SLR Calculator provides ancillary estimates
- ⚡ **Range of estimates is -0.005 to -0.008 inches per year**

Relative Sea Level Rise Data



Probabilistic RSLR

Relative Sea Level Rise Scenarios and Probability of Exceedance [ft]

GMSL Scenarios	RCP 2.6 (strong emissions mitigation by 2100)	RCP 4.5 (moderate emissions mitigation by 2100)	RCP 8.5 (no emissions mitigation by 2100)
Low (0.3m)	0.33 (94%)	0.49 (98%)	0.62 (100%)
Intermediate-Low (0.5m)	0.46 (49%)	0.57 (73%)	0.69 (96%)
Intermediate (1.0m)	0.69 (2%)	0.83 (3%)	0.94 (17%)
Intermediate-High (1.5m)	0.93 (0.4%)	1.08 (0.5%)	1.24 (1.3%)
High(2.0m)	1.30 (0.1%)	1.43 (0.1%)	1.57 (0.3%)
Extreme(2.5m)	1.34 (0.05%)	1.69 (0.05%)	1.83 (0.1%)

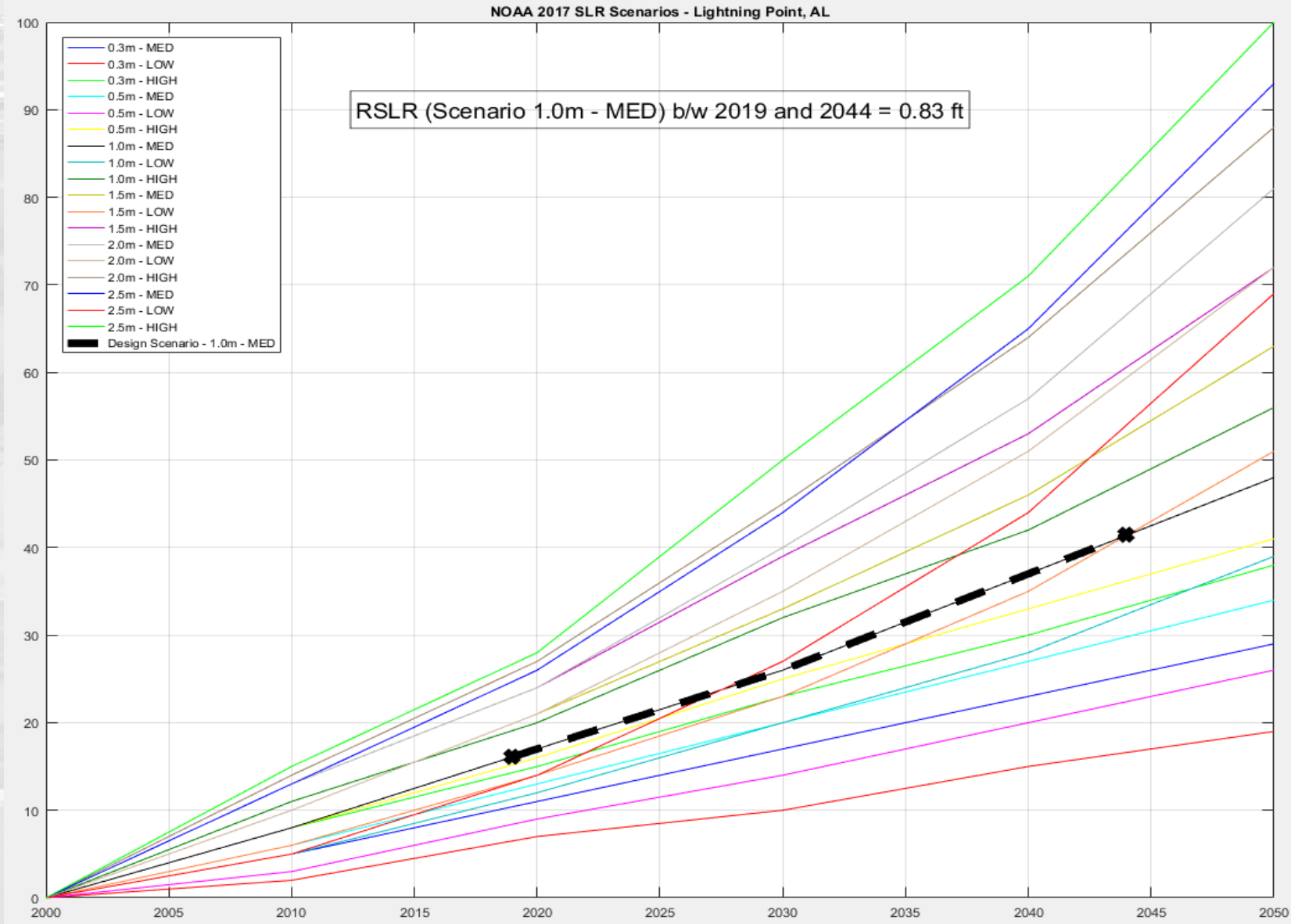
⚡ Relative Sea Level Rise between the years 2019 and 2044 (25 year project design life).
Scenarios and Probability of Exceedance data extracted at Grid Point 5952715

Sweet et al. 2017; NOAA Technical Report NOS CO-OPS 083

Probabilistic RSLR

⚡ Relative Sea Level Rise Scenarios and Probability of Exceedance data extracted at Grid Point 5952715 (Sweet et al. 2017).

⚡ Black Dashed line indicates the 1.0m – MED scenario during the 25 year project design life from 2019 to 2044.



Engineering and Design

⚡ Modeling for crest level

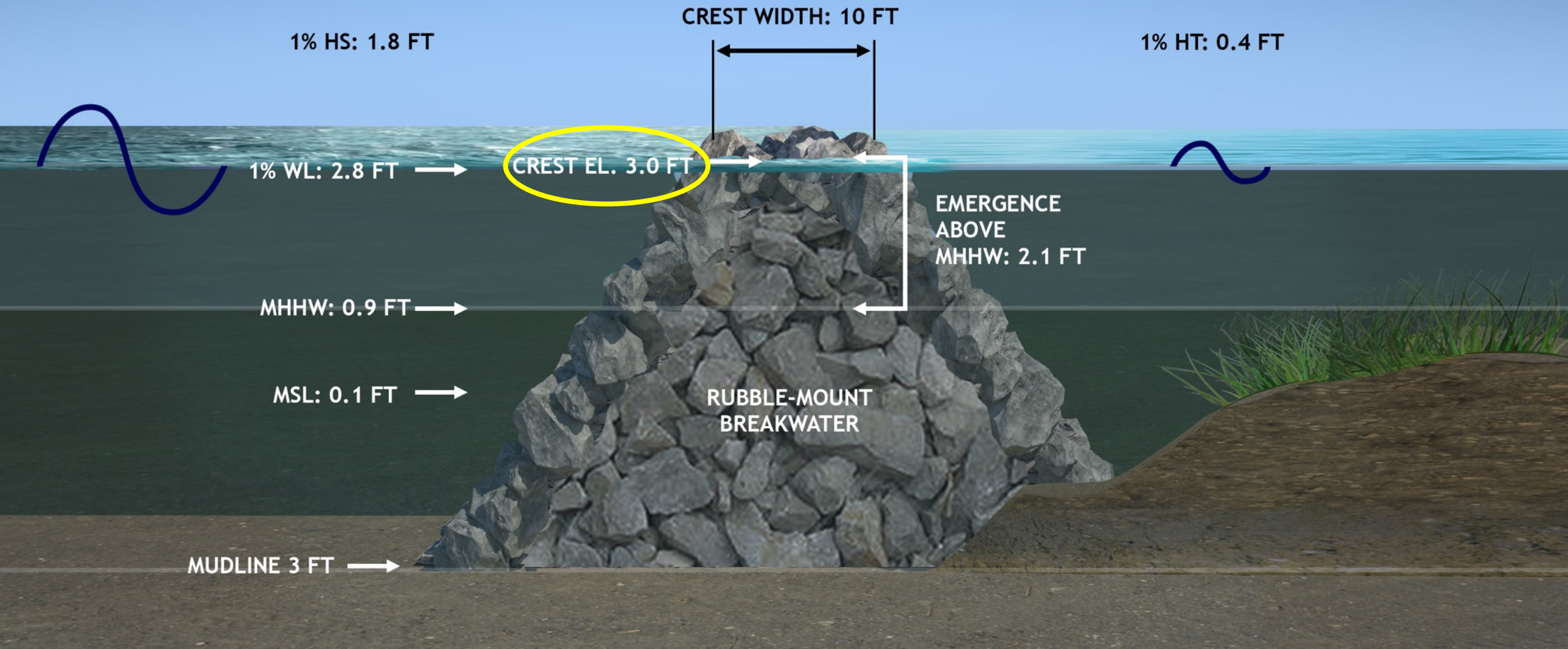
- Analysis of measured water levels with added SLR value (0.83ft)
- Mike21- Spectral Wave hindcast model
- Analyzed hindcast waves to determine operational and extreme wave heights,
- For varying crest elevations used the latest empirical equations for transmission over low-crested structures to determine the wave energy reaching the restored marsh.
- Approximately 0.5 ft are not expected to significantly damage the marsh shoreline
(Roland et al. 2005)

Engineering and Design

Marsh Threshold (assuming marsh erosion threshold is approximately 0.5ft)

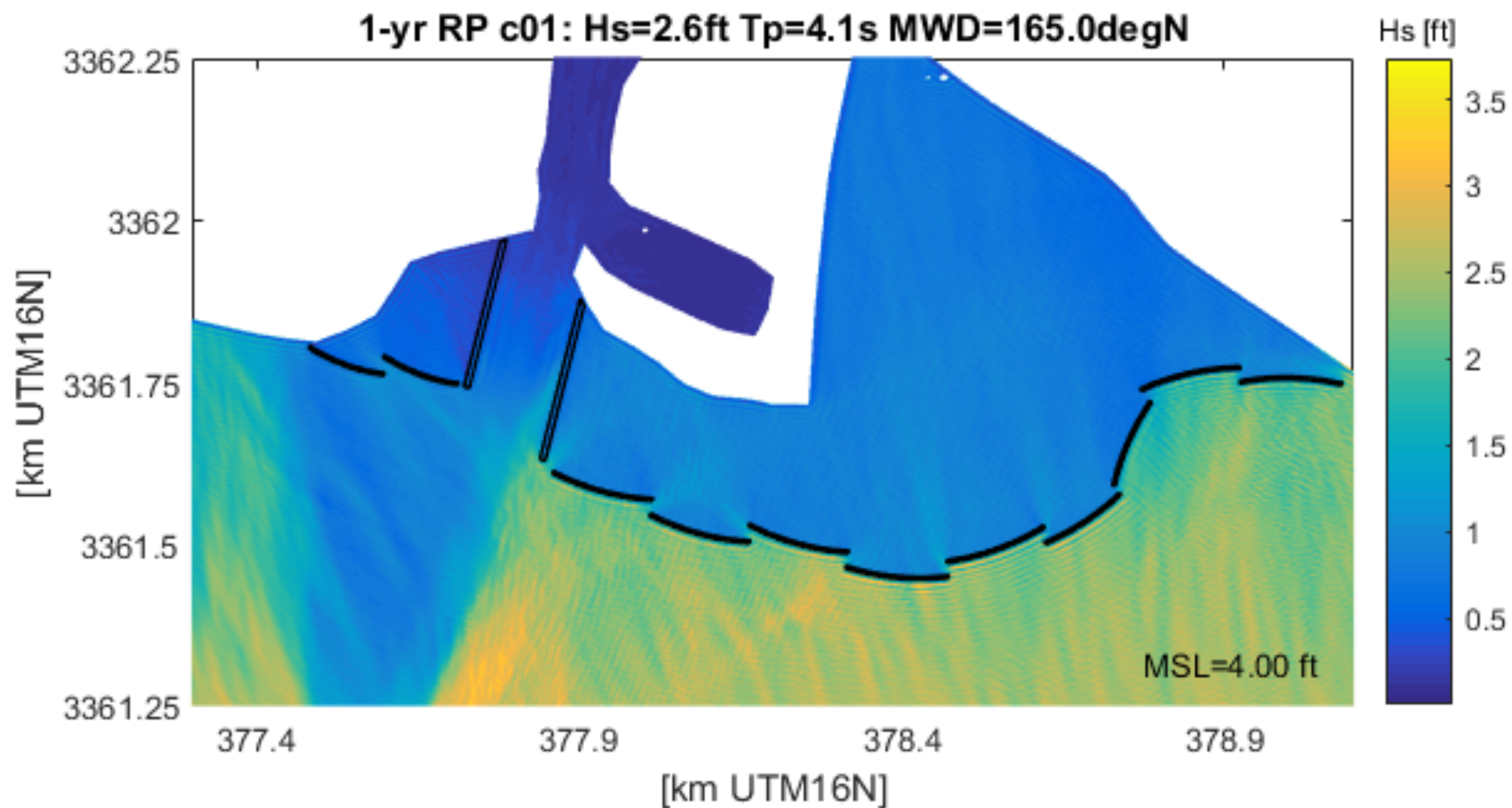
Type	Probability of Exceedance (%)	Return Period (Yr)	Water Level (ft, NAVD88)	Significant Wave Height (ft)	Crest Elevation (ft, NAVD88)	1.0	1.5	3.0	5.0	8.0
					Peak Wave Period (s)	Transmitted Wave Height (ft)				
Operational	50%		1.1	0.4	3.9	0.1	-	-	-	-
Operational	25%		1.6	0.7	3.9	0.4	0.2	-	-	-
Operational	10%		2.0	1.0	3.9	0.7	0.5	-	-	-
Operational	5%		2.3	1.2	3.9	0.8	0.6	-	-	-
Operational	1%		2.8	1.8	4.0	1.2	1.0	0.4	-	-
Extreme		1	4.0	2.8	4.1	1.9	1.7	1.1	0.3	-
Extreme		2	4.8	3.1	4.1	2.3	2.1	1.5	0.7	-
Extreme		5	6.1	3.7	4.1	3.0	2.8	2.2	1.4	0.2
Extreme		10	7.5	4.3	4.2	3.7	3.5	2.9	2.1	0.9
Extreme		25	9.9	5.4	4.3	5.0	4.8	4.2	3.4	2.2

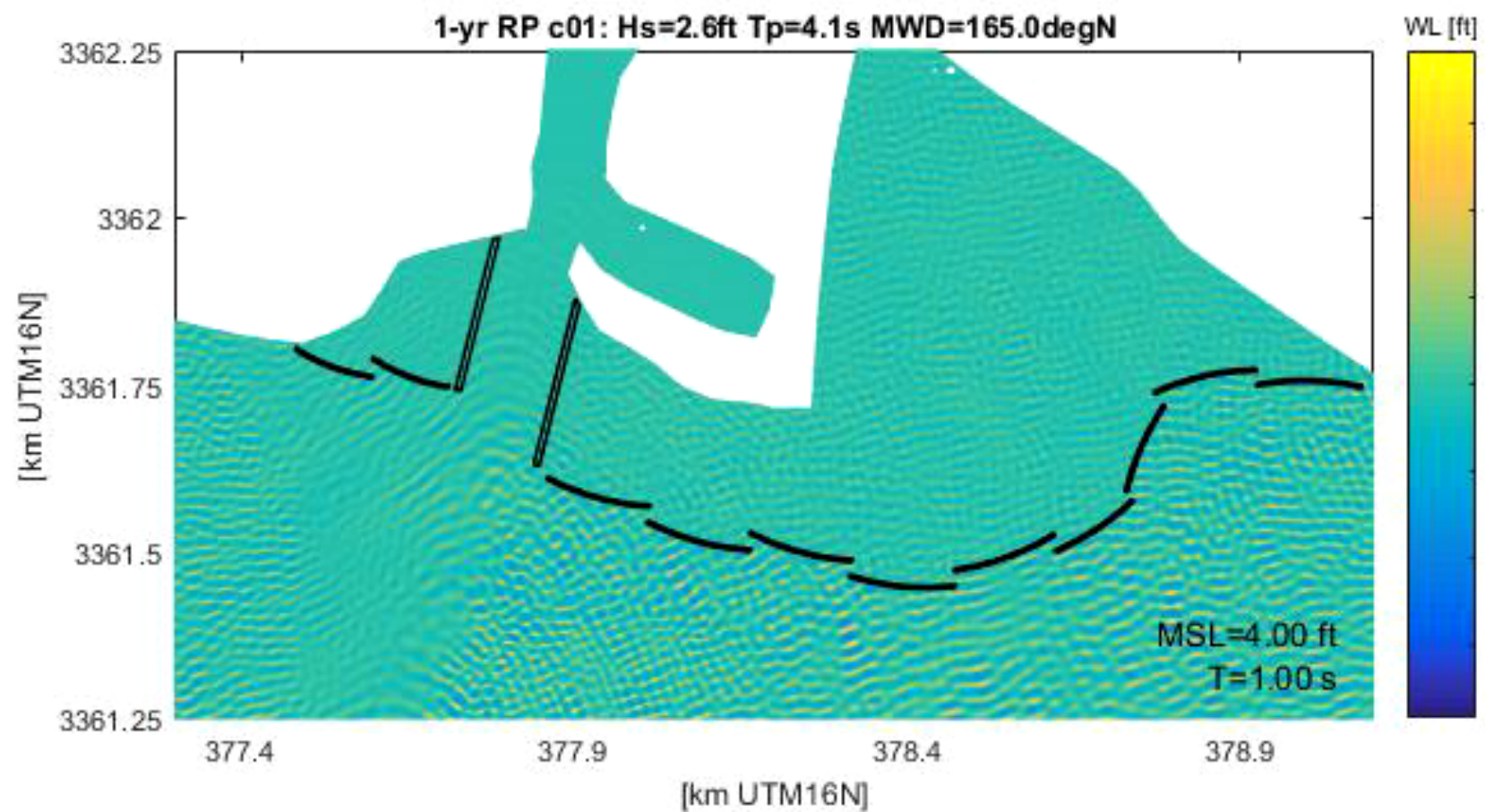
Breakwater Dimension



Breakwater Configuration



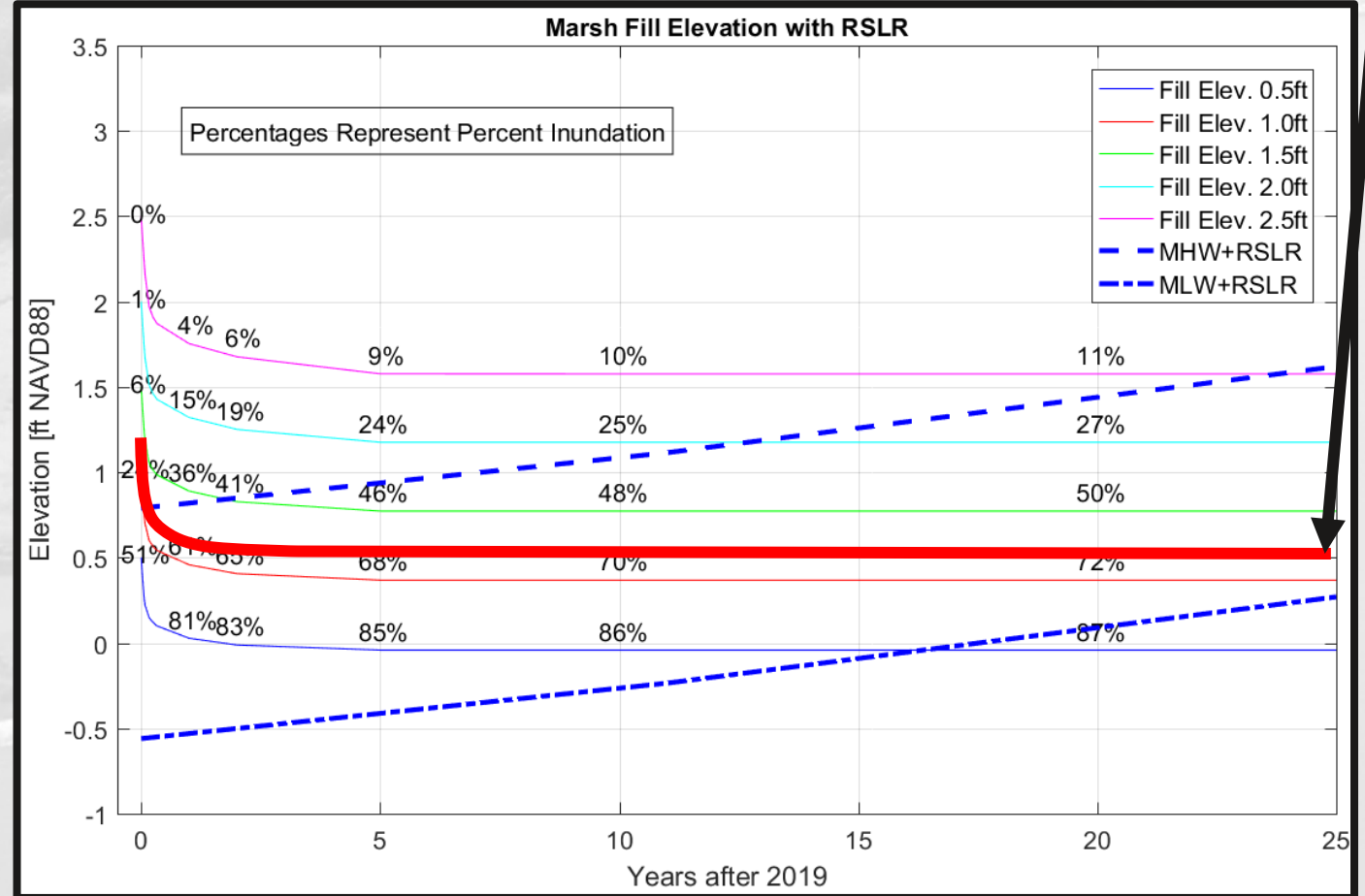




Marsh Platform Elevation

Adaptive management @
end of project life – thin
layer placement

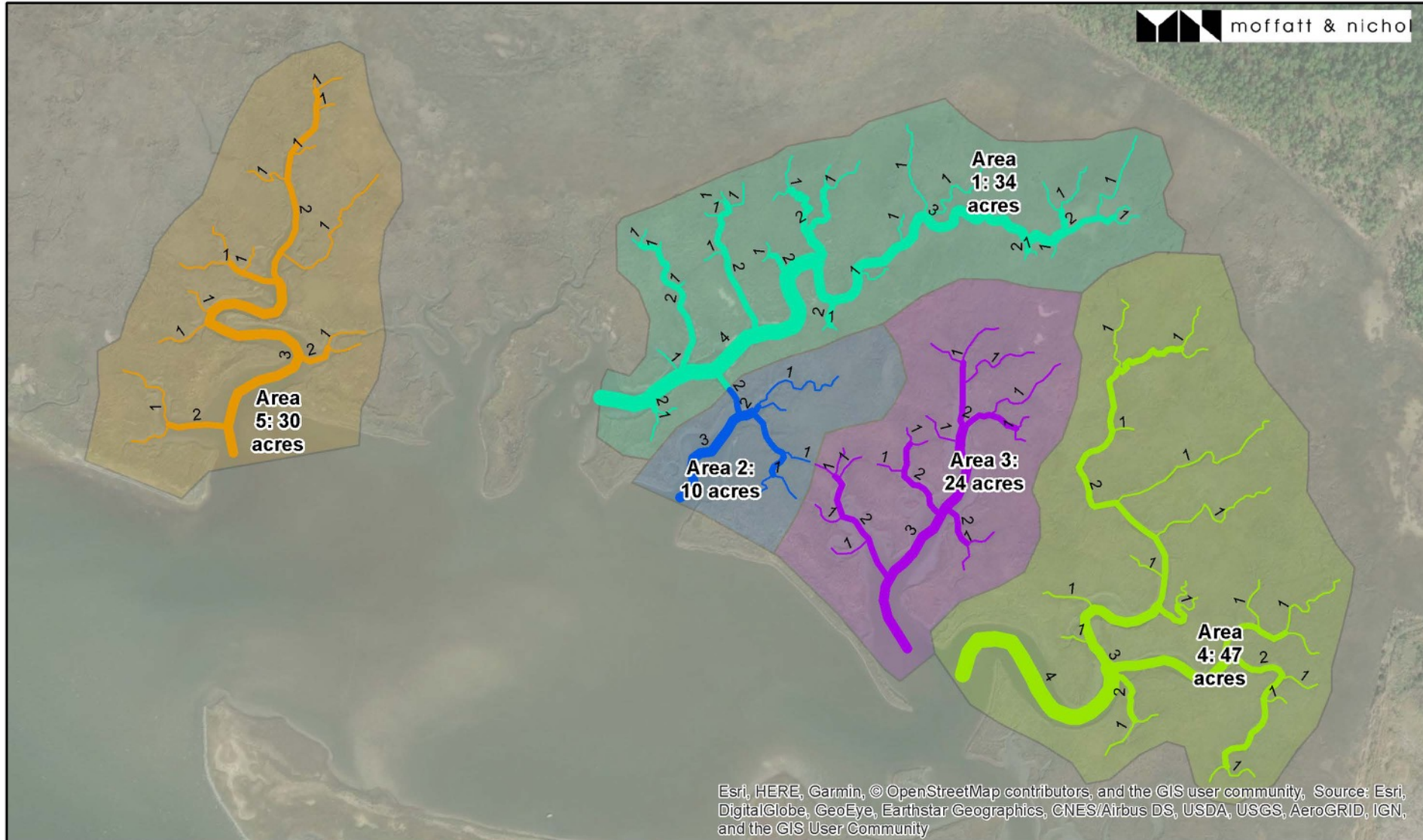
- ⚡ Marsh platform designed to be intertidal (elevation between MHW and MLW)
- ⚡ 2 main design factors
 - Settlement
 - Relative Sea Level Rise (RSLR)
- ⚡ Settlement function of:
 - Primary Consolidation
 - Secondary Compression
- ⚡ Relative Sea Level Rises
 - Eustatic SLR
 - Subsidence (minimal in project area)



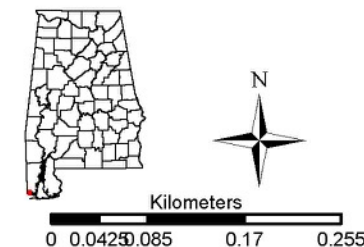
Tidal Creeks

Biomimicry

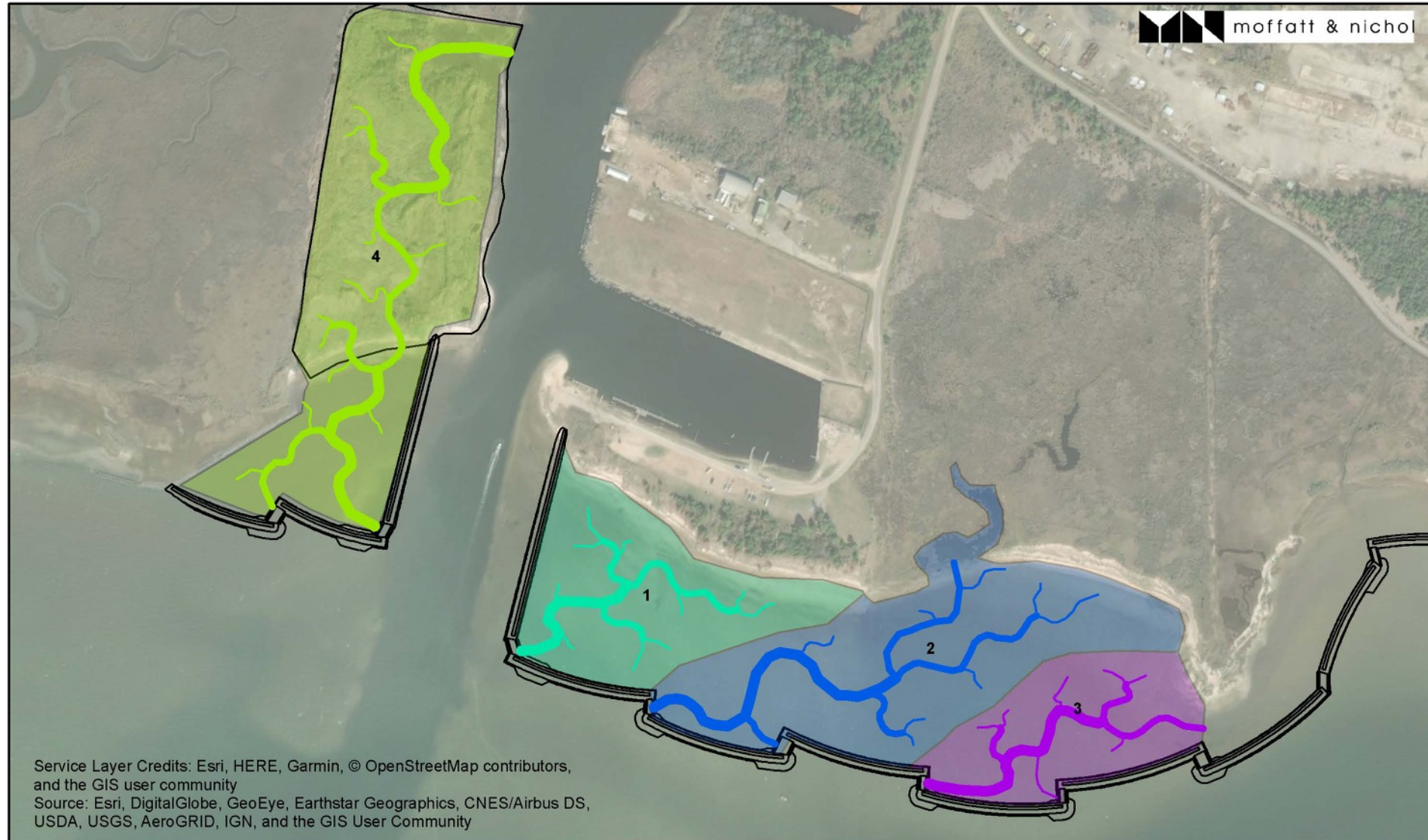
The design of systems that are modeled on biological entities and processes.



Legend



Tidal Creeks

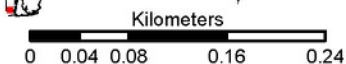


Legend

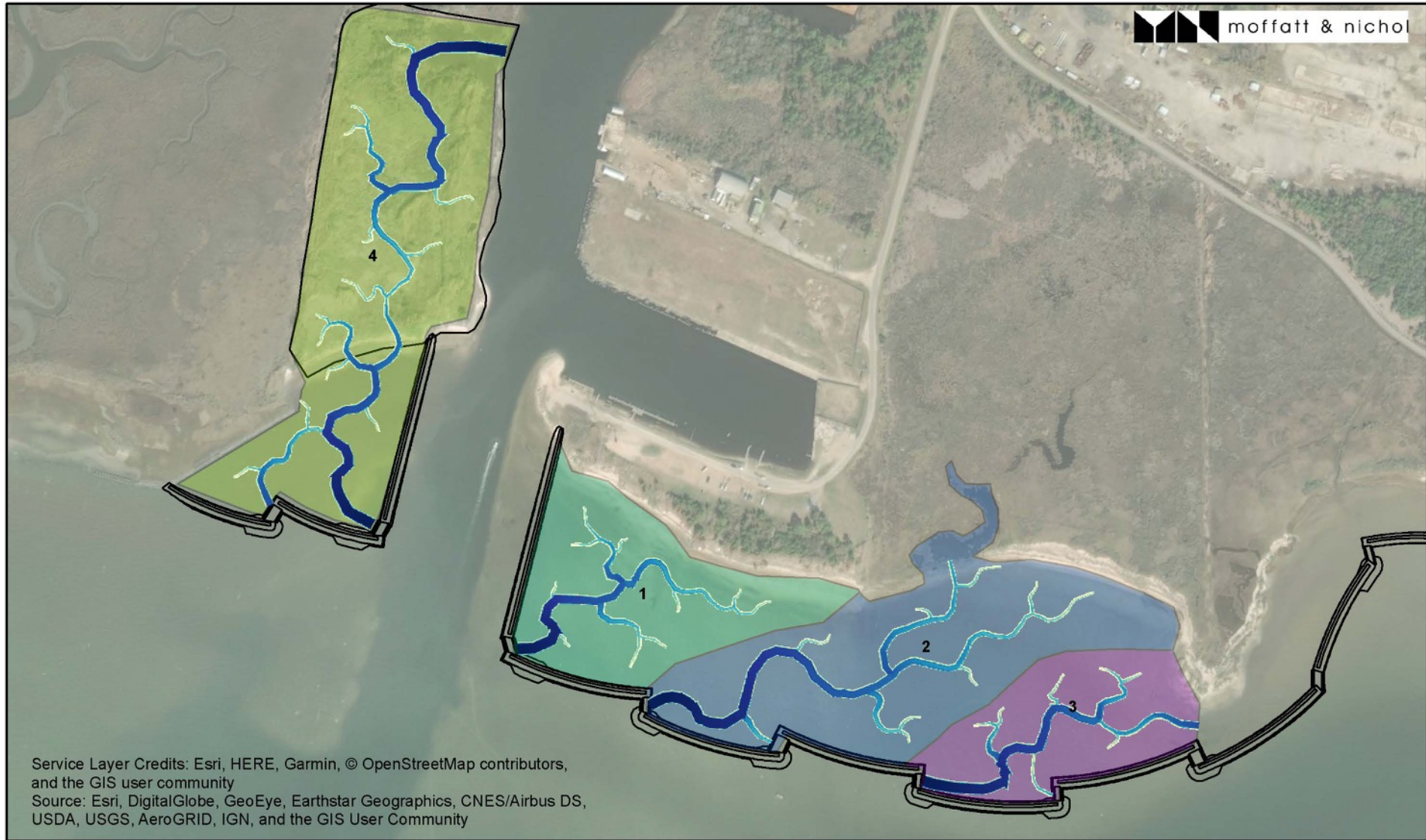
— Breakwaters

Marsh Creation Drainage Areas

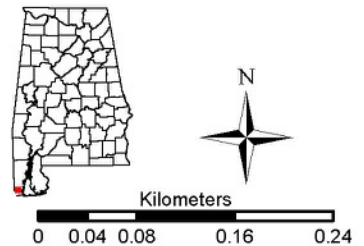
Tidal Creek Network



Tidal Creeks



Legend



Net Benefit Analysis



Habitat Type	Restored/Enhanced/ Created (Acres)
Beach Edge with SAV	8
Marsh Edge (tidal creeks)	15
Marsh	60
Oyster Reef (breakwater)	5
Scrub-scrub	6
Pine flatwood	3

Species of Interest

⚡ Diamondback Terrapins

⚡ Birds

- Oyster Catchers
- Least Terns
- Skimmers
- Heron
- Egrets
- Ibis



Manage Public Access

- ⚡ LID parking lot - pervious surface pavers for truck and trailer
- ⚡ Trails
- ⚡ Pavilion
- ⚡ Fishing jetty



Parking – single and trailer

Trails

Trails

Public Access Vision



- 1. Shoreline Protection
- 2. Habitat Creation
- 3. Public Access
- 4. Beneficial Use of Dredge Material

Permitting

⚡ USACE Individual Permit

- Pre, pre-app meeting – November 28th, 2017
- Pre-app meeting – February 9th, 2018
- Permit application submitted March 21st, 2018
 - Section 10, 404
 - Section 106 –cultural resource survey
 - ESA, EFH – NOAA, USFWS
- Public Comment period closed June
- Permit issued April 30th, 2019

⚡ ADCNR State Lands and Dredge Permits

⚡ Coast Guard – signage, navigation



Maintenance - Long-term Site Sustainability Plan

- ⚡ Proven successful techniques and methods;
- ⚡ Site specific design for placement;
- ⚡ Containment requirements and turbidity issues;
- ⚡ Marsh elevations required for SLR
- ⚡ Sequencing of maintenance dredging
- ⚡ Schedules for placement
- ⚡ Sediment characterization
- ⚡ Permitting requirements



Next Steps

- ⚡ Final Design Phase
- ⚡ Construction Specifications
- ⚡ Bid Documents
- ⚡ Construction Contractor on board – August 2019
- ⚡ Construction for 9 months



3D- Site Vision

⚡ <https://roundme.com/tour/269923/view/836853/>



Thank You

www.moffattnichol.com