CHESAPEAKE BAY
SENTINEL SITE COOPERATIVE

EA Engineering, Science, and Technology, Inc., PBC

Thin Layer Placement as a Tool to Address Impacts to Coastal Marsh Habitat due to Sea Level Rise – Case Studies and Future Considerations

Prepared for: Marsh Resilience Summit

Prepared by: Sam Whitin – EA Engineering, Science, & Technology, Inc. PBC

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WHAT IS THIN LAYER PLACEMENT?

- Aliases
  - Beneficial Reuse
  - Sediment Enrichment
  - Thin Layer Deposition
  - Marsh Enhancement

Who?

- USACE, USFWS, DoD
- State of NJ
- State of Delaware (DNREC)
- Rhode Island CRMC
- TNC (Rhode Island)

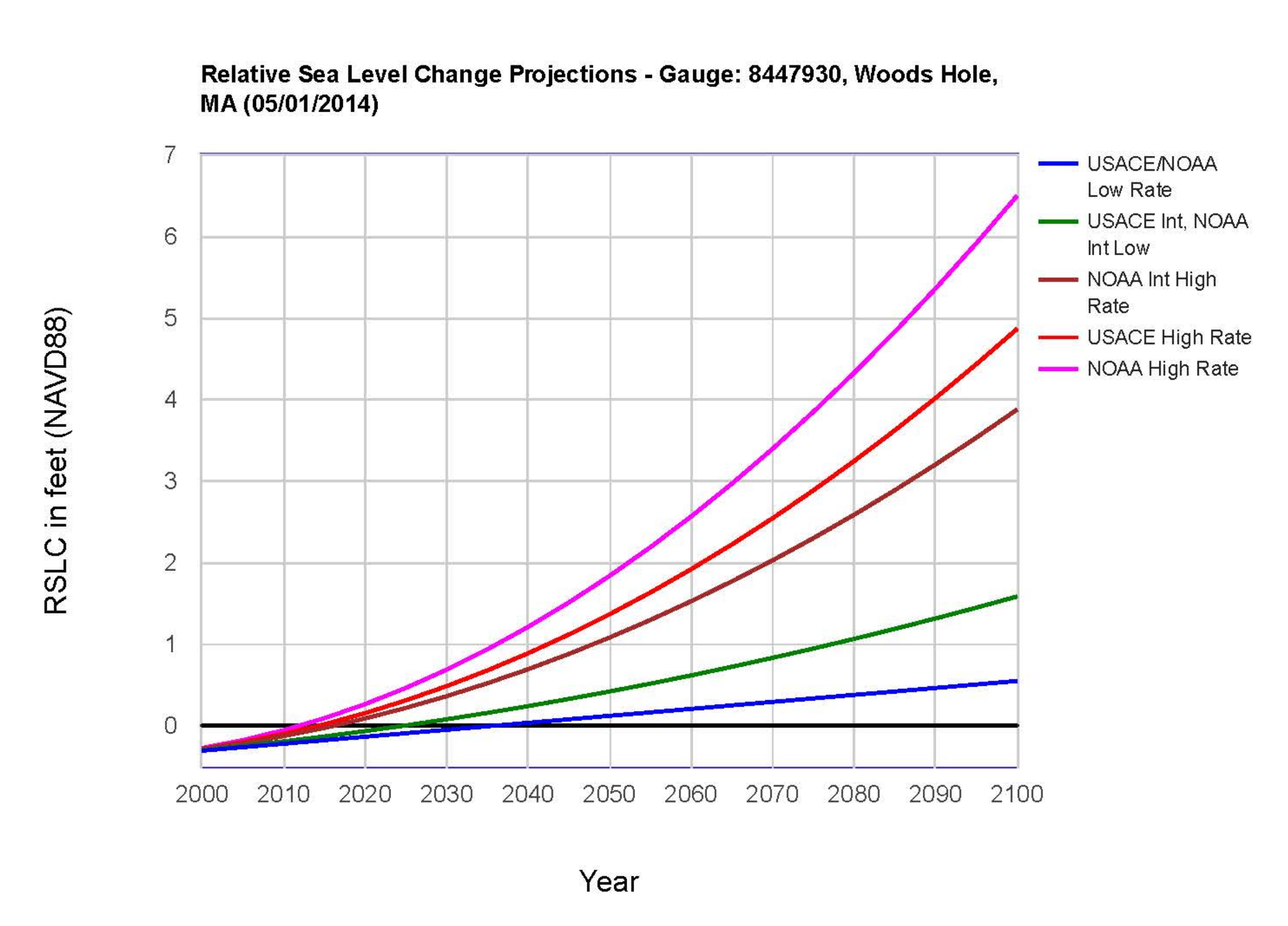
Initial Results

- Site Specific Success
- Future Re-Applications
- What are our choices?

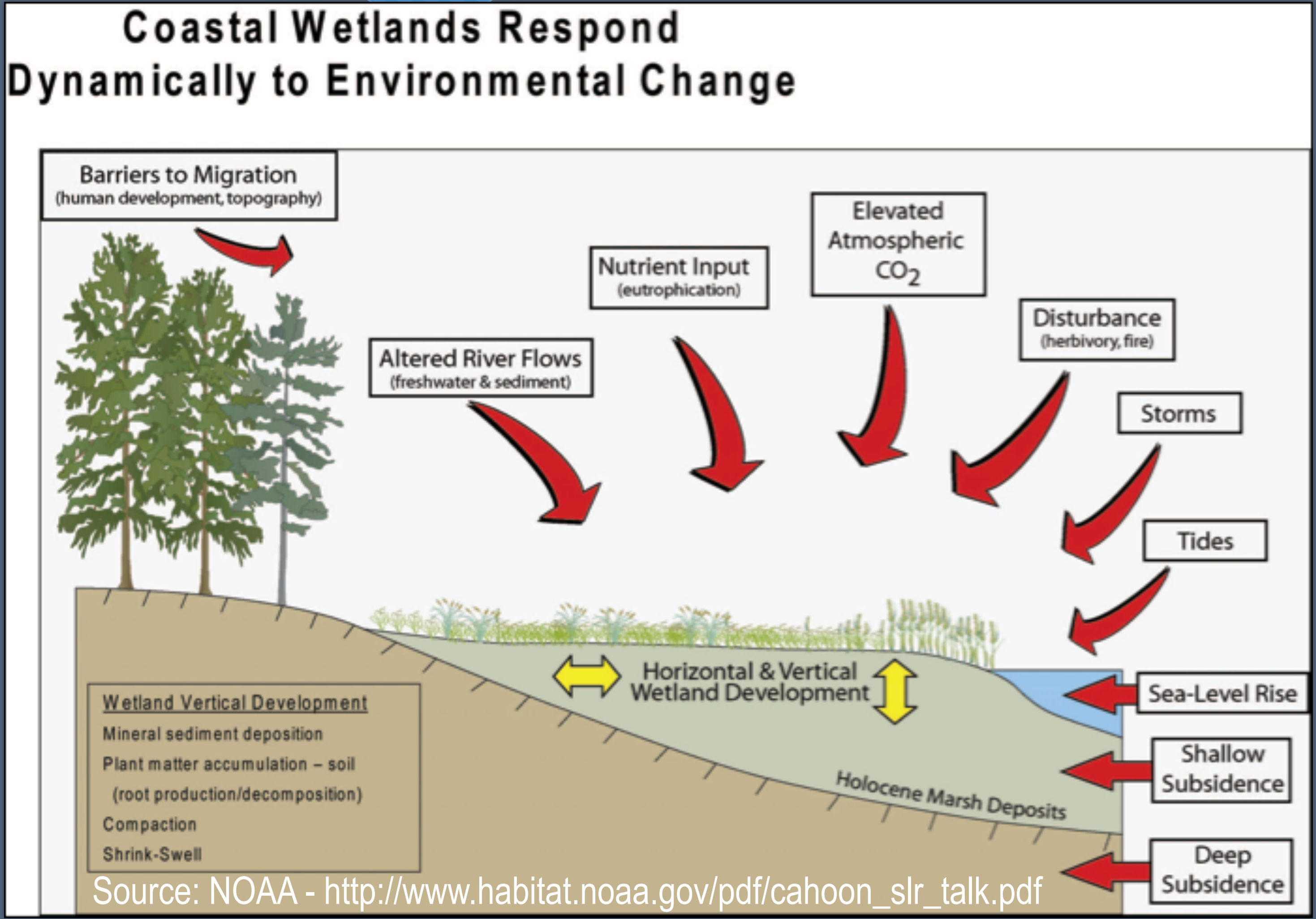
Challenges

- Permitting
- Subsidence
- What is “thin”?
- Bulking and consolidation
- Sediment loss
- How does SLR fit in?

Failure Mechanisms Tied to Sea Level Rise



Failure Mechanisms Tied to Sea Level Rise

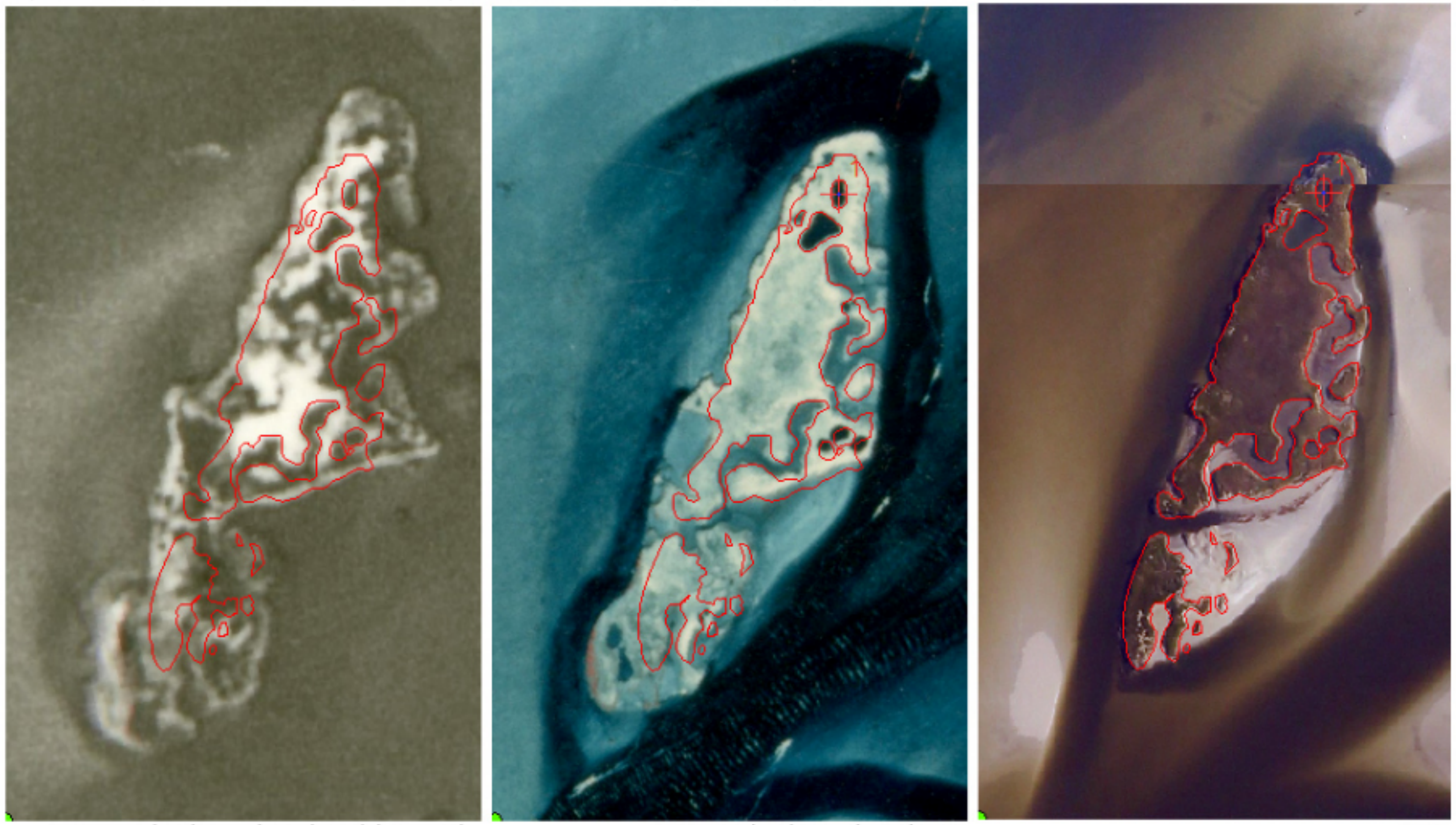


Salt marshes rely on a careful balance between multiple environmental factors

- Hydrologic Regime/elevation within tides range
- Salinity
- Nutrients
- Sediment Loading
- Surrounding Ecology
- A Host of Other Factors!

Failure Mechanisms Tied to Sea Level Rise

Bailey Flat imagery for three dates showing 2013 boundaries superimposed on each.
Prepared for Westport Fishermen's Association/Buzzards Bay Coalition salt marsh loss study by Joe Costa, 6/14/2016.



1938 aerial with 2013 boundaries(photograph taken 3 months after the hurricane of 1938) | 1990 aerial with 2013 boundaries | 2013

Source: Buzzards Bay Coalition: http://www.savebuzzardsbay.org/news/scientists-work-to-solve-westport-rivers-eroding-salt-marsh-mystery/

Toolbox of Restoration Techniques

Adding Thin Layer Placement to the Coastal Resiliency Toolbox

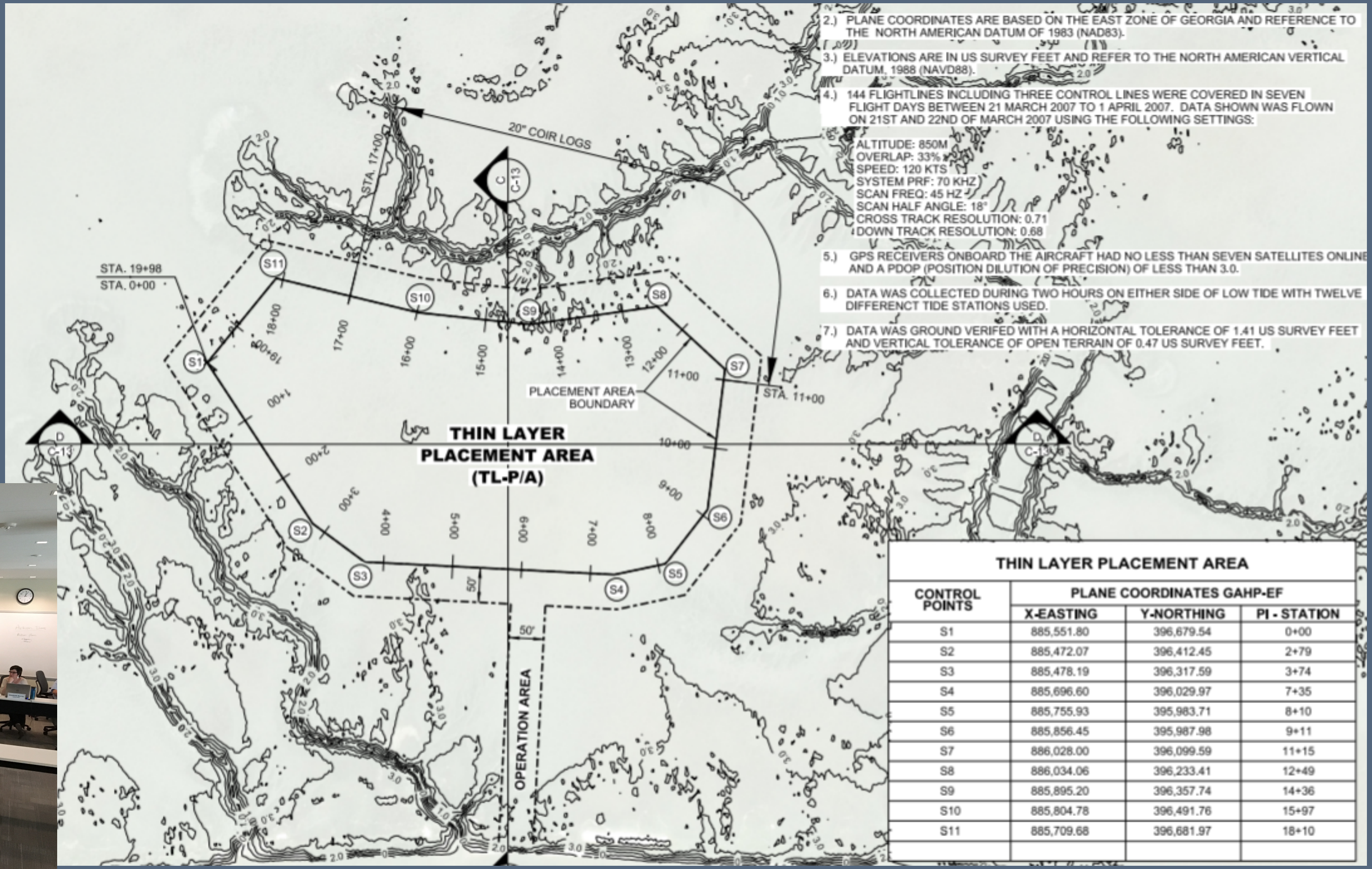
- Technique is certainly not applicable in all restoration scenarios

- Initial targets have been areas where marsh migration is not possible.

Photo source: http://www.seagrant.umaine.edu/research/projects/critical-leading-edge

Building and Transferring Knowledge

- Regional Workshops hosted by USACE South Atlantic District in 2017
- Local workshops in Delaware and Maryland
- USACE ERDC is developing guidance manual along with practitioners

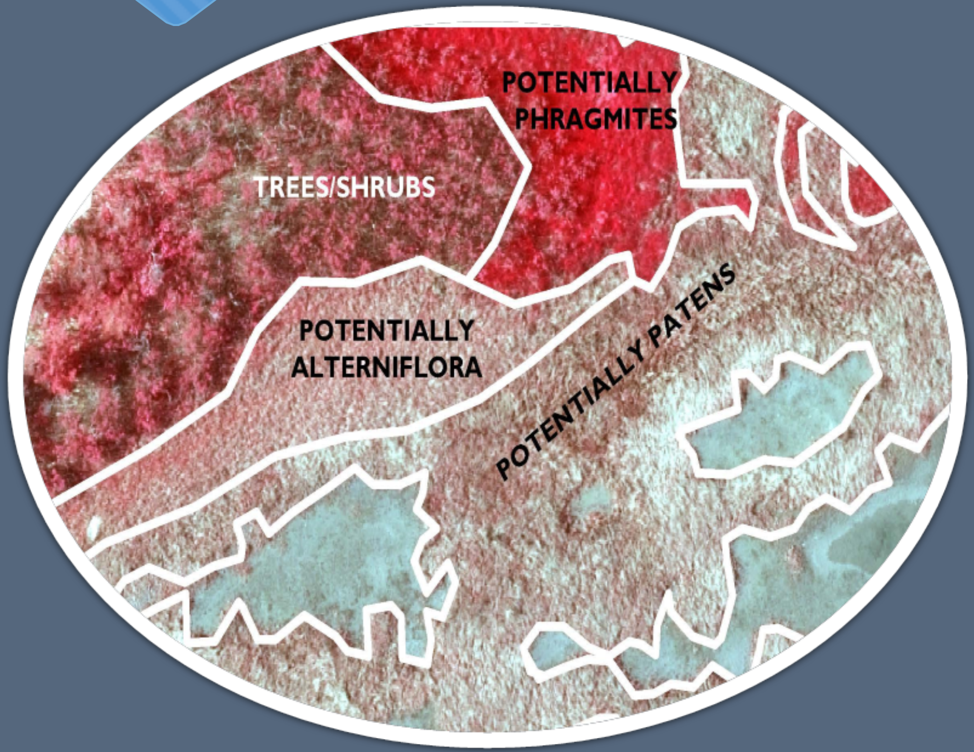


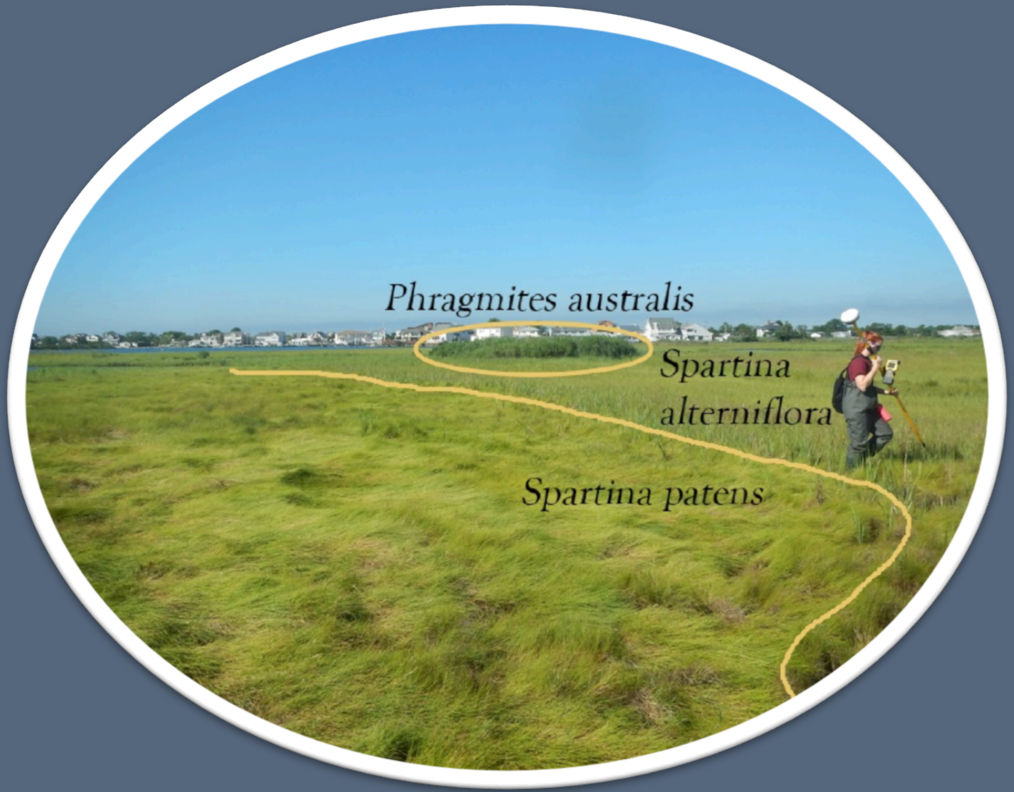
THIN LAYER PLACEMENT AREA

CONTROL POINTS	PLANE COORDINATES GAHP-EF		
	X-EASTING	Y-NORTHING	PI - STATION
S1	885,551.80	396,679.54	0+00
S2	885,472.07	396,412.45	2+79
S3	885,478.19	396,317.59	3+74
S4	885,696.60	396,029.97	7+35
S5	885,755.93	395,983.71	8+10
S6	885,856.45	395,987.98	9+11
S7	886,028.00	396,099.59	11+15
S8	886,034.06	396,233.41	12+49
S9	885,895.20	396,357.74	14+36
S10	885,804.78	396,491.76	15+97
S11	885,709.68	396,681.97	18+10

How to Execute Thin Layer Placement?

ESTABLISHING A BIOLOGICAL TARGET ELEVATION
INITIAL VEGETATION & ELEVATION SURVEYS

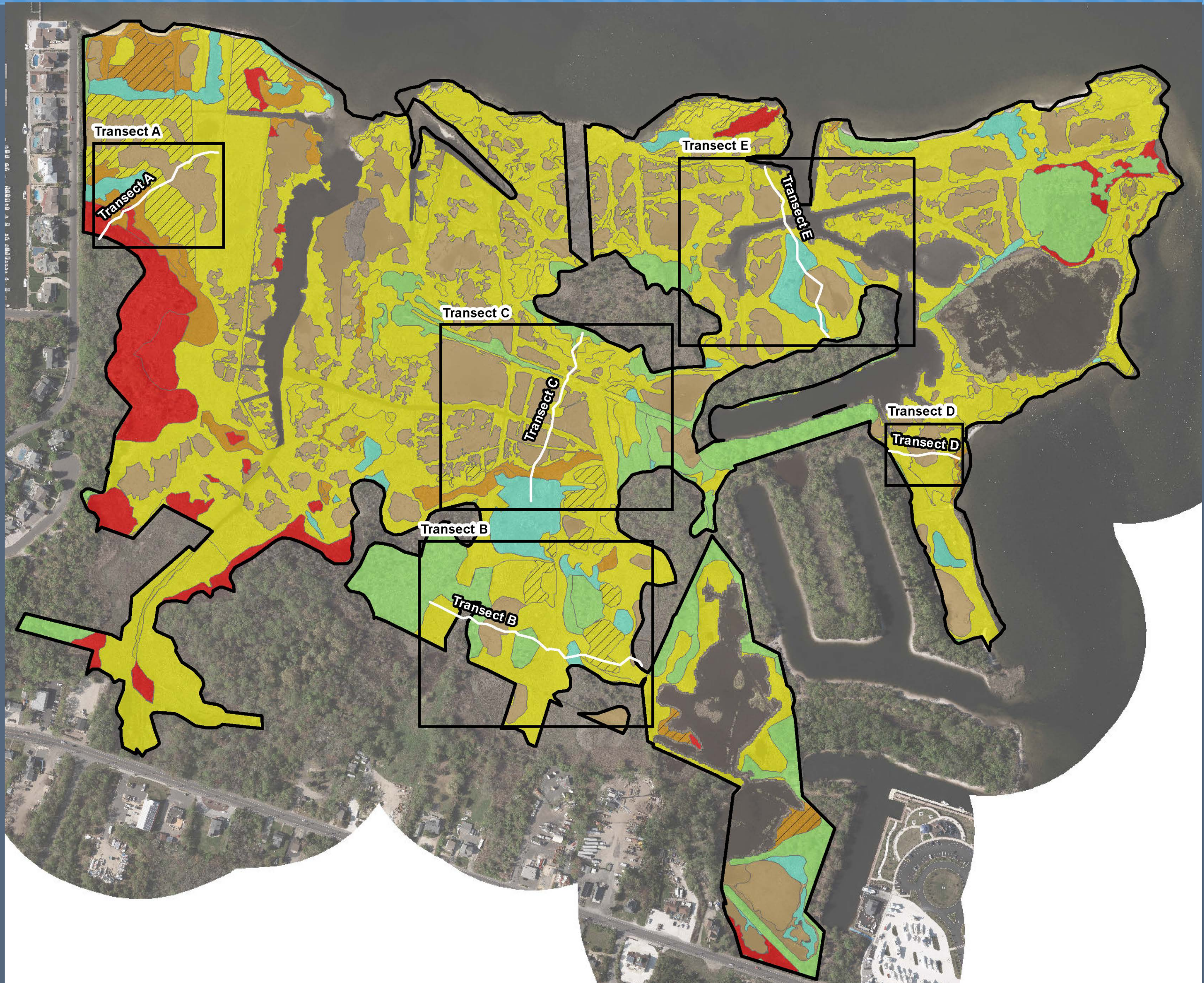




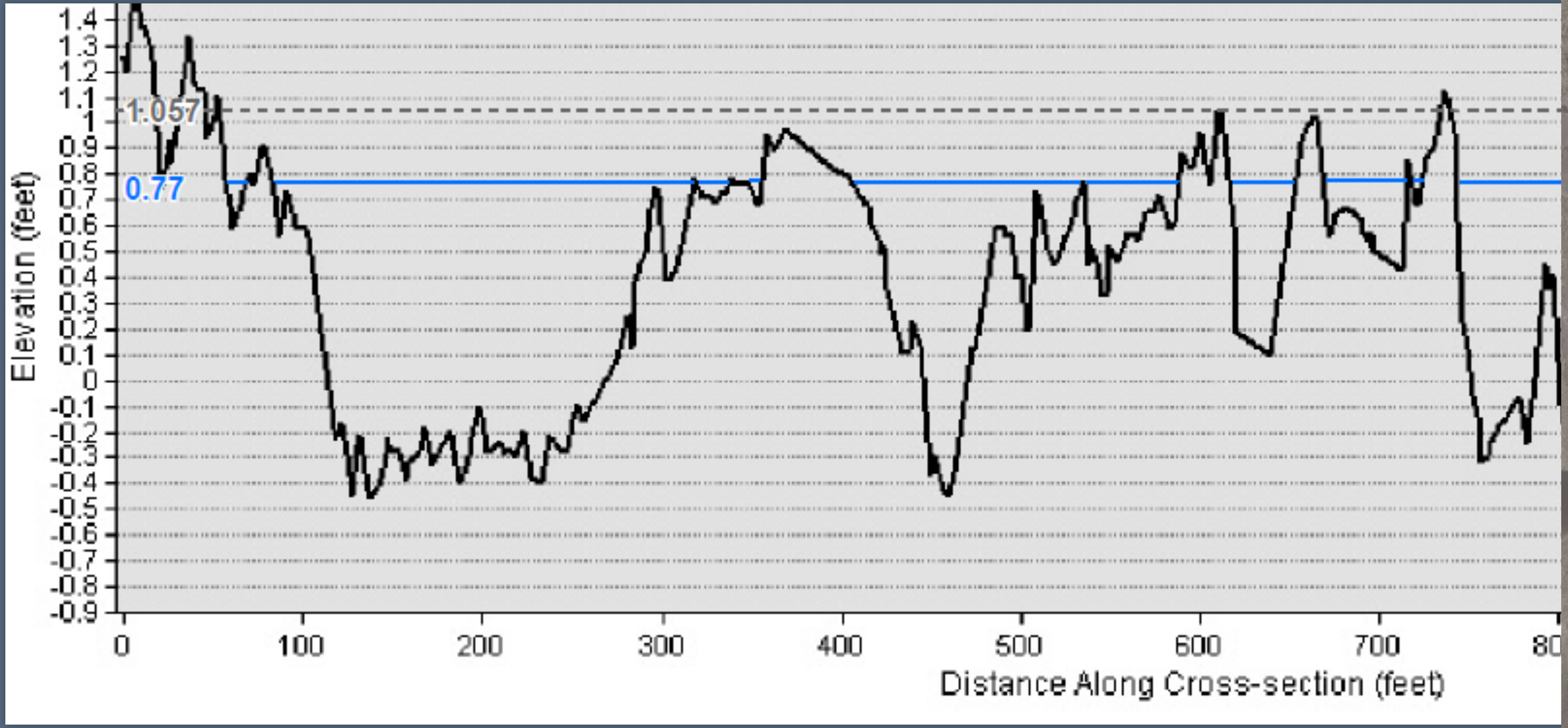
- Traditional aerial photointerpretation using infrared photography and LiDAR elevations
- Spatial and Temporal Scale and budget greatly influence approach
- Elevation and vegetation field-truthing is critical

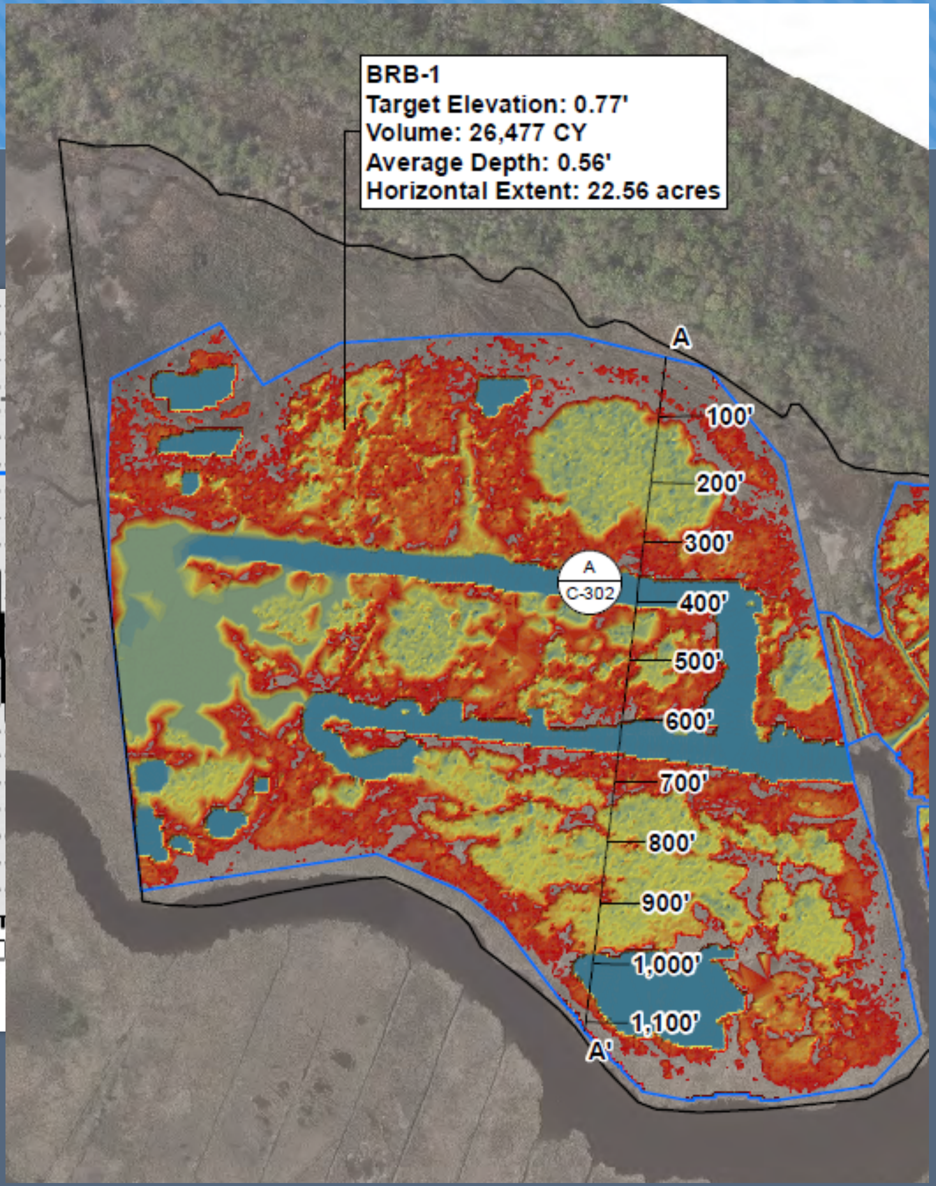
ESTABLISHING A BIOLOGICAL TARGET ELEVATION

- Verify vegetated marsh zones along with verification of local tidal datum
- Stakeholders to choose target biological elevation
- LiDAR and imagery is critical, and time/budget allocated for ground truthing should be a considerable part of the effort



ESTABLISHING A BIOLOGICAL TARGET ELEVATION





Establish Future Marsh Scenarios

1. Establish existing marsh elevations
2. Establish local sea level rise predictions
3. Predict new healthy marsh elevations

Habitat Type	Area A – 130 Acres				Brick 1 Transducer[1]
	Min[1]	Max[1]	Average[1,2]	Acreage	
MUDF	-0.94	0.59	-0.17	33.69	MLW 0.110
STRESSED LSM	-0.06	0.14	0.04	4.30	
LSM	-0.16	0.58	0.17	57.58	
LHSM	0.29	0.75	0.52	0.00	MHW 0.600
STRESSED HSM	---[3]	---[3]	---[3]	1.48	
HSM	0.53	0.79	0.66	3.61	
TPM	0.65	1.25	1.01	6.55	
SCRB	0.48	2.53	1.47	4.67	
SCRB/TPM	0.65	0.94	---[3]	---[4]	
UW	---[3]	---[3]	---[3]	13.10	
OPEN WATER	---[3]	---[3]	---[3]	4.91	
BH	---[3]	---[3]	---[3]	0.11	

Projected Year	USACE Low/NOAA Low	USACE Intermediate/NOAA Intermediate Low	NOAA Intermediate High	USACE High	NOAA High
	(ft relative to NAVD88)				
2015	0.5	0.55			
2020	0.57	0.64			
2025	0.63	0.73			
2030	0.7	0.83			
2035	0.76	0.93			
2040	0.83	1.03			
2045	0.89	1.14			
2050	0.96	1.26			
2055	1.03	1.38			
2060	1.09	1.5			
2065	1.16	1.63			

	2015 Elevation	2020 Elevation[1]	2025 Elevation[1]	2030 Elevation[1]
	-0.08[2]	-0.04[2]	0.06[2]	0.16[2]
El. Of LSM (ft)	0.17	0.21	0.30	0.40
	0.42	0.46	0.55	0.65
El. Of HSM (ft)	0.66	0.70	0.79	0.89
	0.84	0.88	0.97	1.07
El. Of TPM (ft)[2]	1.01	1.05	1.14	1.24
	1.24	1.48	1.82	2.09
El. Of SCRB (ft)	1.47	1.90	2.50	2.93

[1] Elevations of vegetation communities in the future were calculated by adding "USACE Intermediate Level" predicted rates of sea level rise equal to ~0.018' per year
[2] Elevations of the lower limit of the LSM range were not directly measured in the field, but were extrapolated from the elevation differences between vegetation communities

MULTI CRITERIA DECISION ANALYSIS (MCDA): APPLICATION TO THIN LAYER PLACEMENT

- In consideration of sea-level rise – how do you not end up upland or undesirable habitat
- How are habitat values and decisions made for the long term?

	Interests and Sub-Interests	Year 0 SLR Design	Year 5 SLR Design	Year 10 SLR Design	Year 15 SLR Design
Year 0					
	Mudflat	5	5	5	1
	Low Salt Marsh	1	1	5	2
	High Salt Marsh	5	5	2	1
	Phragmites	1	5	5	5
	Upland	5	5	5	5
Contruction Cost					
		3	3	3	3
Schedule Impacts					
		5	5	5	5

THIN LAYER PLACEMENT METHODS

- Target application of <6'' (typ.) of sediment can be used in order to restore marsh surface
- Typically coupled with a navigational channel dredging project
- Sediment application technique can be similar to methods utilized for remediation/capping efforts
- High pressure and low pressure dispersal systems have been utilized, but approach still seems to be project specific

Initial Challenges

- When resiliency is the driver (and not nav. channel improvements) – data collection and design/engineering is very different than traditional dredge material disposal efforts:
    - Building Sea-level rise into the equation becomes problematic – especially in micro-tidal areas
    - Typically there is much more dredge material to be disposed of than is needed for restoration

- Dispersal is problematic:
    - Existing marsh impacts (vegetation and peat/soils)
    - Grains size sorting leading to consolidated/hard pack surface
    - The larger the marsh – the greater the impact to adjacent marsh surface.

PEPPER CREEK (2013 ~ $125,000)
DAGSBORO, DE
PROJECT PARTNERS: CENTER FOR ISLAND BAYS & DNREC'S DIVISION OF WATERSHED STEWARDSHIP

- Restore 25 AC area of tidal marsh
- Dredge material hydraulically dredged and pumped to a barge for aerial application
- Approximately 35,000 CY of dredged material was sprayed on the marsh surface at a thickness ranging from 1 to 6 inches
- Marsh is showing signs of recovery, but lessons learned providing valuable tools for future efforts.



Photo Credit: Bart Wilson - USFWS

Prime Hook NWR ~ (2014-2016 $38M) Milton, DE

- 4,000 acre marsh restoration
- 20 miles of channel dredging
- Doesn't fit traditional TLP definition, but project is heavily studied, which will help us better understand impact of thin layering impacts

Blackwater National Wildlife Refuge
Milton, DE

- More details to come!

Photo Credit: https://tlp.el.erdc.dren.mil/case-studies-by-year/

STONE HARBOR, AVALON, AND FORTESCUE - NJ PROJECT PARTNERS: USACE, STATE OF NJ, TNC

- What
  - Stone Harbor: ~7,000 CY of reclaimed material over 0.5AC
  - Avalon: ~95,000 CY of sediment using aerial and ground applications
  - Fortescue (initial phase): ~15,000 CY of sediment to restore 10 AC of degraded salt marsh and 3 AC of beach
- Outcome
  - Still in long term monitoring, but initial vegetation response is somewhat positive;
  - Lessons learned in regard to elevation control and more lessons learned regarding containment.

Photo Credit: Joel Pecchioli, NJDEP (Avalon)

STONE HARBOR
STONE HARBOR, NJ

- ~7,000 CY of reclaimed material over 0.5AC
- Dredged material was pumped 1.5 miles
- Dredge material was 96% fine sand
- Created Black Skimmer habitat and still monitoring the transition back to healthy salt marsh

Photo Credit: NJ DEP and The Gazette of Middle Township (Stone Harbor)

AVALON (~ $1,500,000)
AVALON, NJ

- Developed biological target elevation
- Thickness ranged from 0.5 to 20 inches in pools
- Dredge material was 16% clay, 50% silt, and 34% fine sand
- Bulking, consolidation, and settlement rates indicate that that preference would be to model first, if possible

Photo Credit: Joel Pecchioli, NJDEP (Avalon)

FORTESCUE (~ $3,800,000)
FORTESCUE, NJ

- Thickness ranged from 0 to 48 inches in pools
- 33,000 CY material dredged (greater volume than was dispersed via thin-layer deposition)

Photo Credit: Phillip Tomlinson South Jersey Times (Fortescue)

SACHUEST POINT NATIONAL WILDLIFE REFUGE (2016 ~ $644,000) MIDDLETOWN, RI

PROJECT PARTNERS: U.S. FISH & WILDLIFE SERVICE & THE NATURE CONSERVANCY

- 11,000 CY of dredged material was applied to 11 AC
- Material was dredged hydraulically and placed on the marsh platform to dry out; placement occurred by means of spreading and grading the material with a lightweight amphibious excavator
- Encouraging results with deposition thickness from 1 to 12 inches across the marsh surface

Photo Credit: Anne Post/USFWS

NINIGRET POND SALT MARSH RESTORATION & ENHANCEMENT PROJECT NARRAGANSETT, RI (2016/2017)

PROJECT PARTNERS: RHODE ISLAND CRMC, USFWS, SAVE THE BAY

- 25 AC of degraded salt marsh
- 60,000 CY of dredge material was split in half between beach nourishment and marsh restoration
- $1.4M construction effort

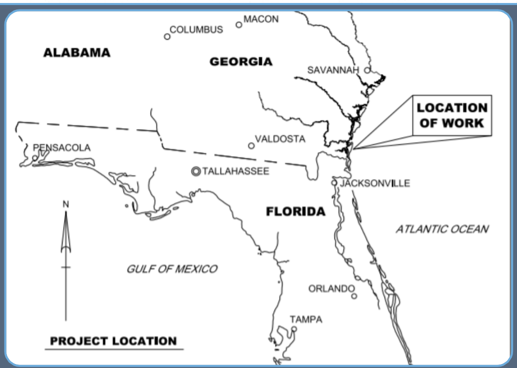
Photo Credit: J. F. Brennan

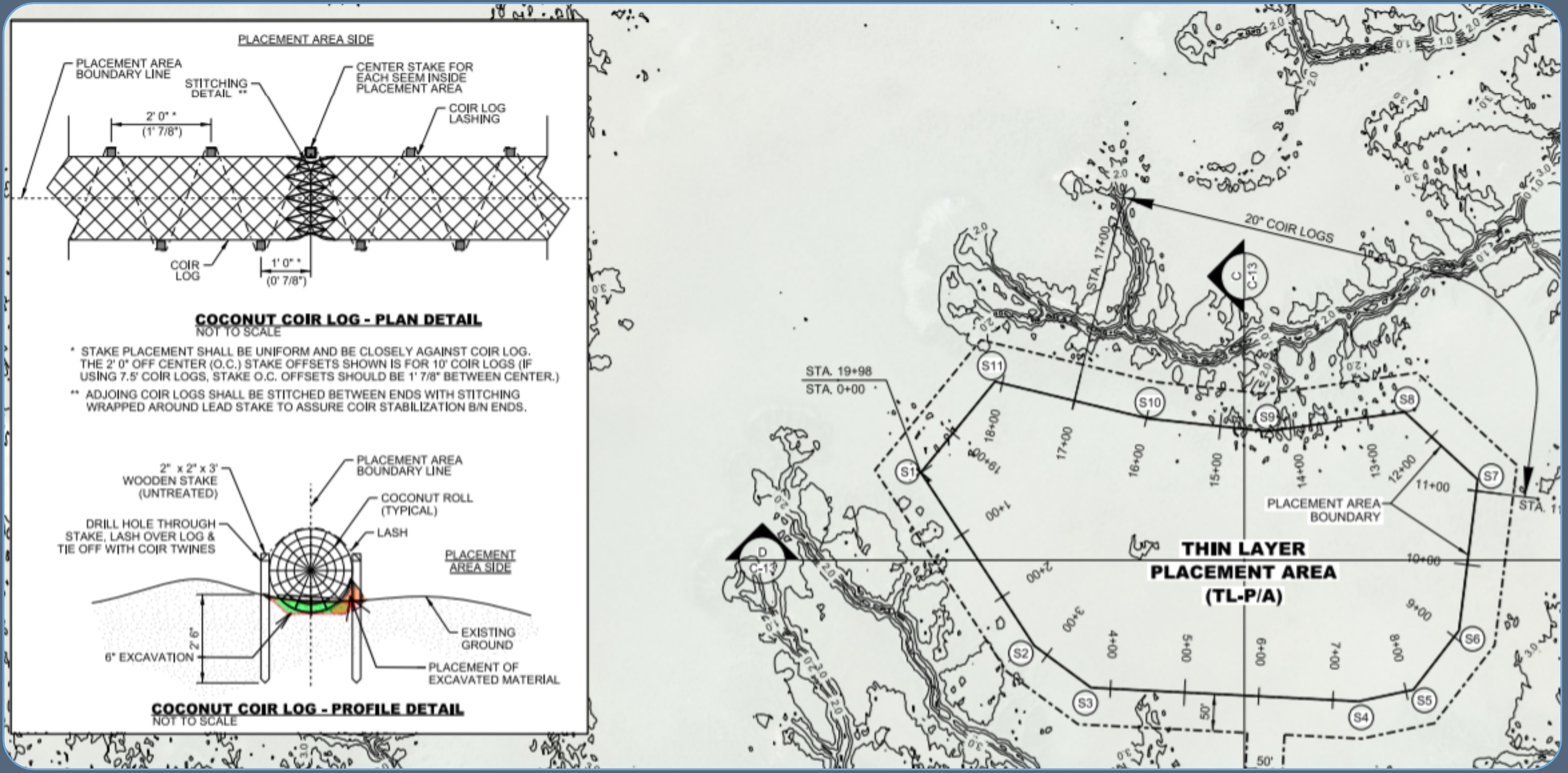
JEKYLL ISLAND NAVIGATIONAL AND HABITAT IMPROVEMENT PROJECTS
Project Partners: USACE Jacksonville District and State of Georgia (2019)

- $12M total bid for navigational improvements and thin layering project
- Awarded January 2019 and includes 225,000 yd^3 of dredging

US Army Corps of Engineers®
Savannah District

ATLANTIC INTRACOASTAL WATERWAY, GA & SC
JEKYLL CREEK BENEFICIAL USE OF DREDGED MATERIAL PILOT PROJECT AND SELECTIVE SITE MAINTENANCE DREDGING
FY18





Future Considerations

- Applicability of thin layer
  - Is it appropriate in general? What about for your site?
  - Implications of inaction

- Design considerations
  - Need more investigations regarding approach to estimating consolidation and grain size sorting
  - Elevation data is critical – over large areas minor deviations from true elevation can result in big cost/schedule impacts
  - Containment concerns and how best to deploy and remove
  - Permitting and especially Essential Fish Habitat and USACE concerns should be fully vetted
  - Is there a sediment source near-bye and is the material usable?
  - To plant or not to plant?

Future Considerations - continued

- Constructability
  - Constructability concerns need to be incorporated into initial project assessment phases
  - Placement methods and site access issues can be deal breakers, so keep them in mind (especially on larger sites)
  - Concerns related to construction contracting still being flushed out (i.e. impacts to adjacent marsh surfaces)

- Sea level rise scenarios and the potential for the need for reapplication during dredge maintenance cycles
- As always – Adaptive Management is essential to successful completion
- USACE is developing guidance manuals and there is an immediate need for thin layer practitioners to keep up with data sharing!

USACE Engineer Research Development Center – Guidance Manual

- Draft thin layer guidance manual is in development and will hopefully be released for public comment later in 2019
- Being developed with input from numerous federal, state, local, private, and non-profit entities
- Will provide engineering and construction guidance for projects where thin layer is appropriate
- Manual will cover an expanded definition of thin layer placement (i.e. inclusive of open water placement of thin layers of sediment)

Thank you and questions

Sam Whitin

EA Engineering, Science, and Technology

401-465-2549

swhitin@eaest.com