

Adapting a model of sediment consolidation for use in marsh thin layer placement projects

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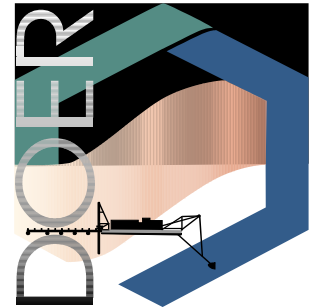
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Project: Quantification of DM Layer Thickness over Time as Applied in TLP Wetland Nourishment Projects

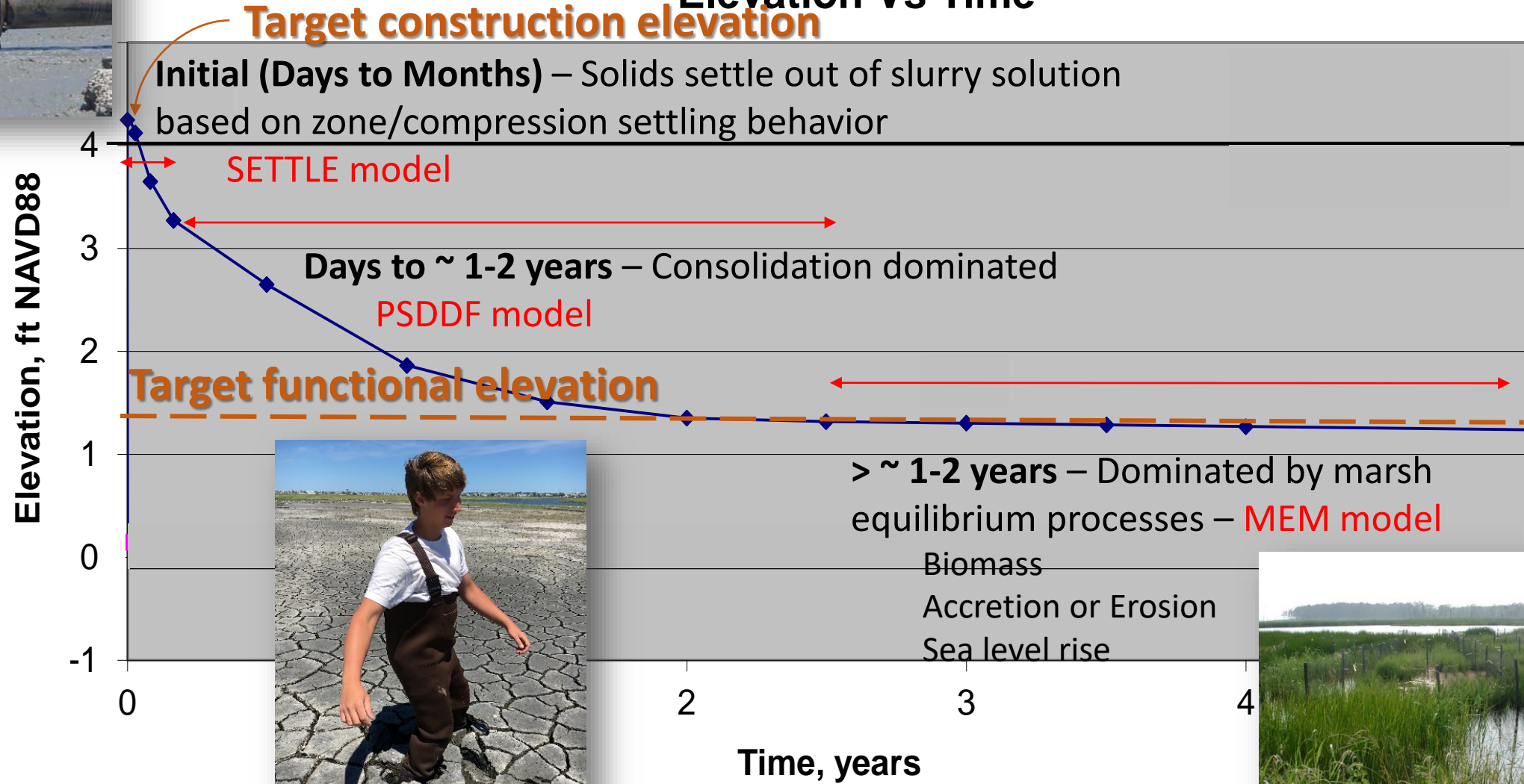
- Sponsor: USACE Dredging Operations and Environmental Research (DOER) program (<https://doer.el.ercd.dren.mil/>)
- Team: Susan Bailey, Zachary Tyler, Tim Welp, Paul Schroeder
- Objectives
 - Develop understanding of impacts of wetland processes on consolidation
 - Vegetation
 - Fluctuating water tables
 - Improve tools (PSDDF) to model DM elevation over time following TLP
- Approach
 - Laboratory experimentation
 - Field verification



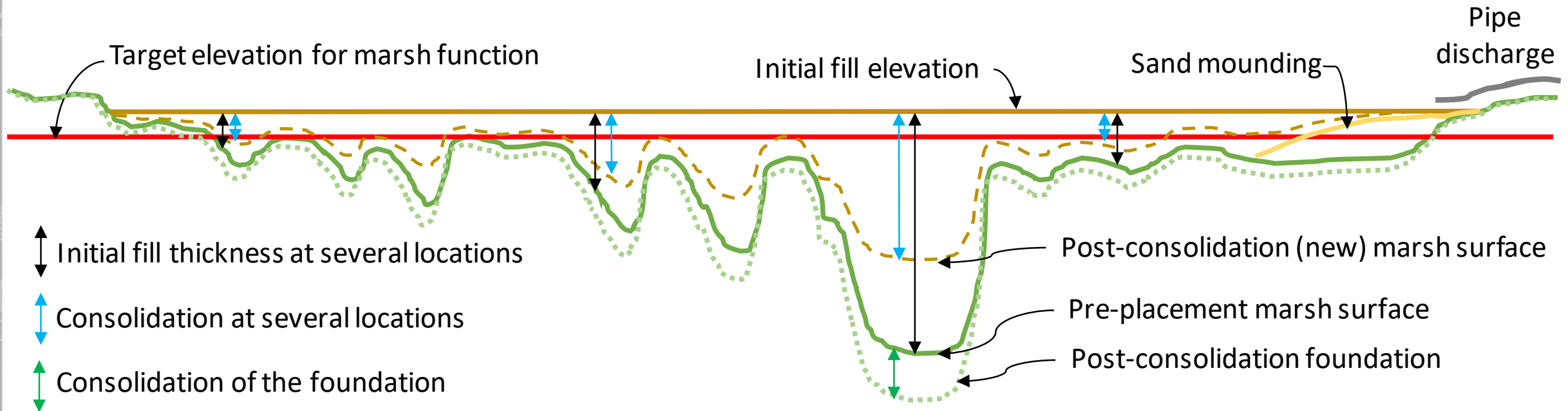
Dominant Processes that Control Marsh Elevation over Time



Elevation Vs Time



Conceptual marsh topography changes as a result of DM placement and consolidation



1. Existing (pre-placement) marsh surface (solid green line)
2. Place DM slurry to initial fill elevation (solid tan line)
3. Over time, the DM consolidates (dotted tan line)
4. Original marsh surface also consolidates (dotted green line) due to weight of placed DM

Initial Settling

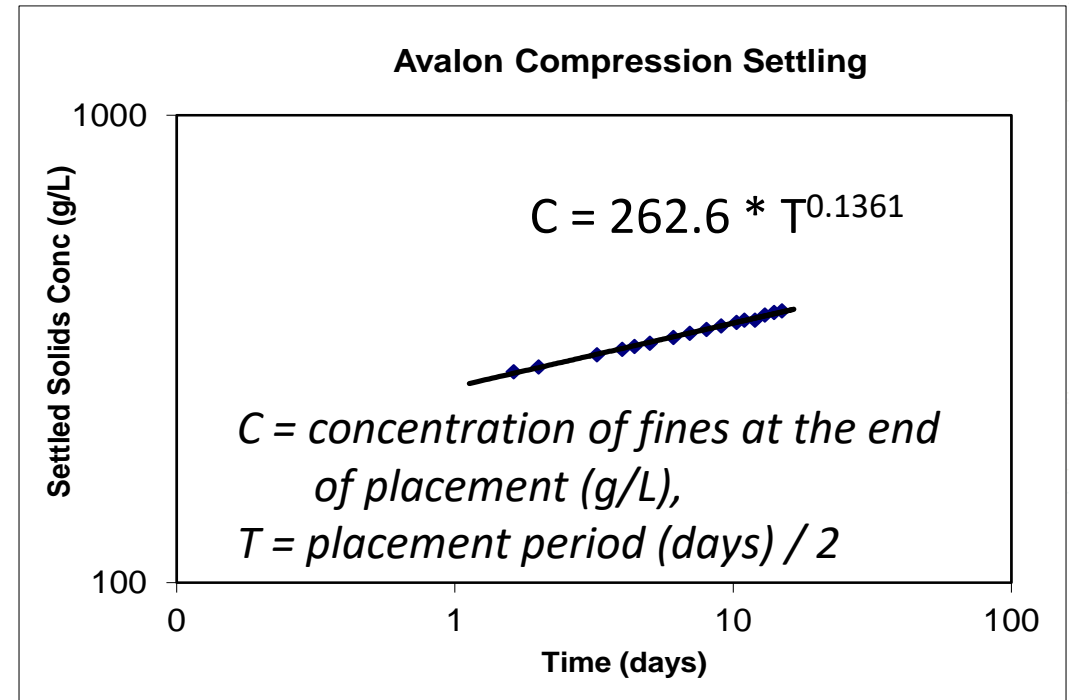
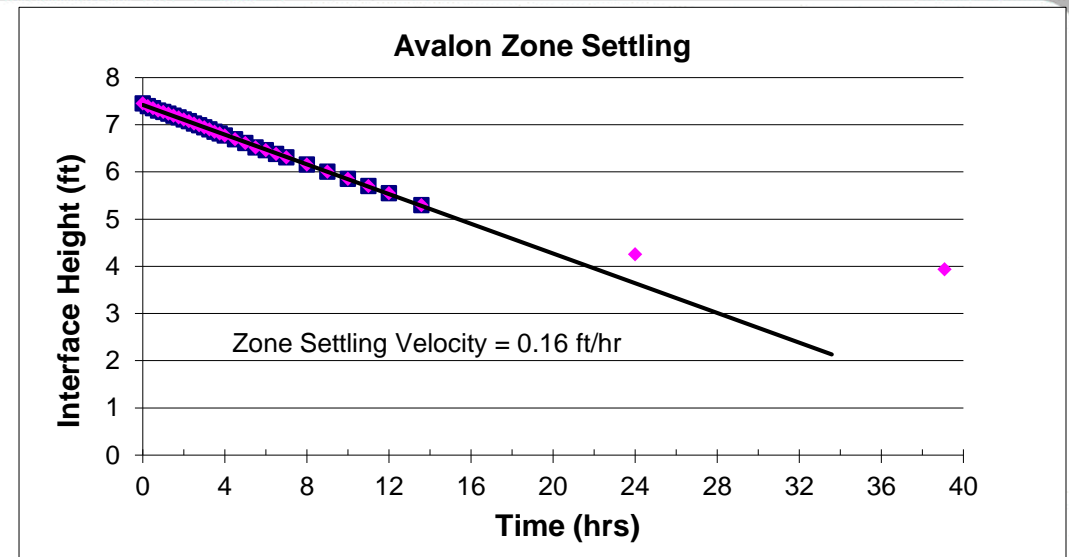
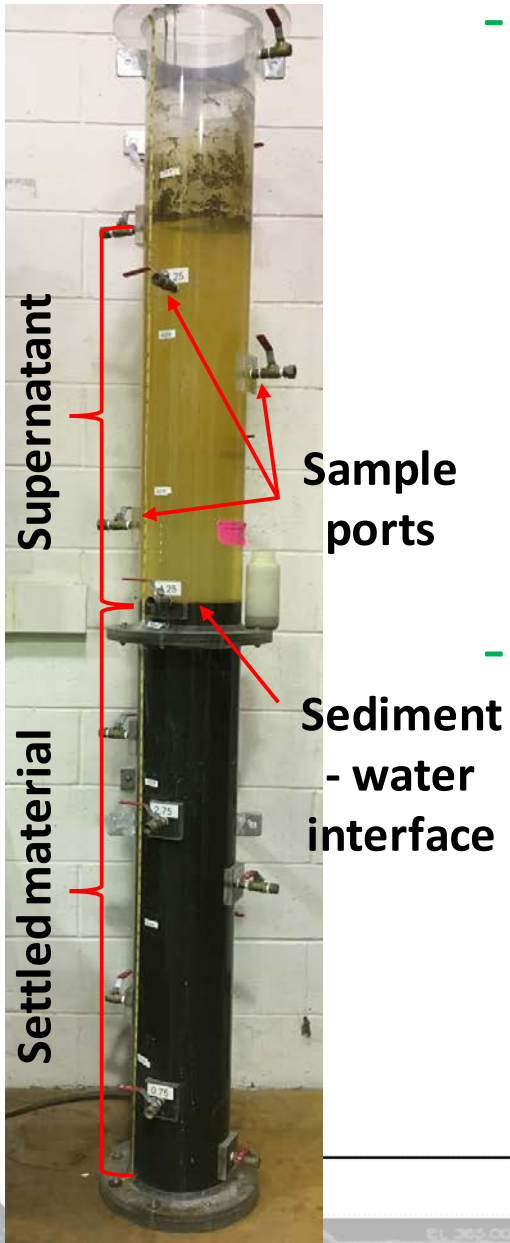
- Column settling test

- 6 ft tall, 8-in diameter
- Record sediment-water interface over 15 days
- Sample supernatant for water quality data (TSS/flocculant settling)

- SETTLE model

- Predict bulking ($V_{\text{final}} / V_{\text{in situ}}$)
- End of placement condition
 - Void ratio
 - Thickness

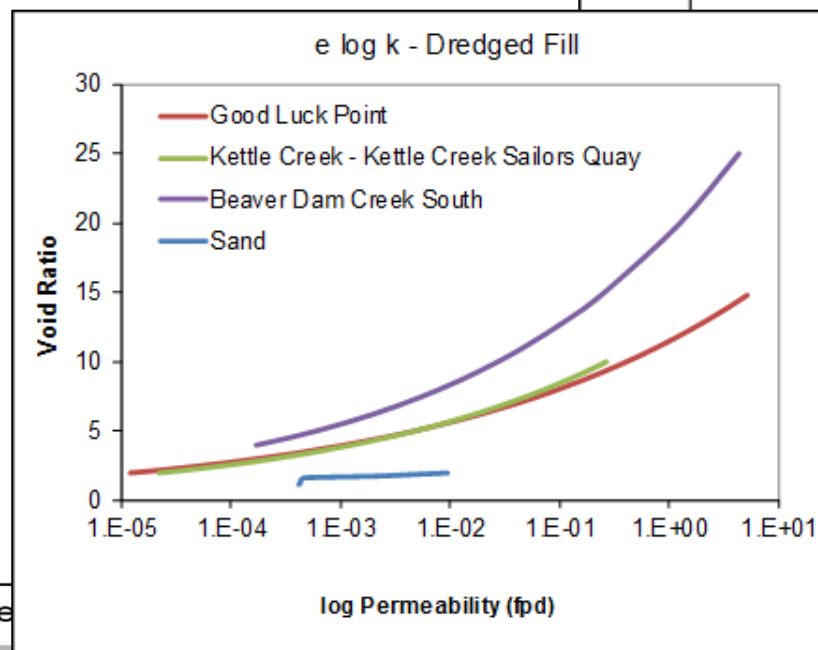
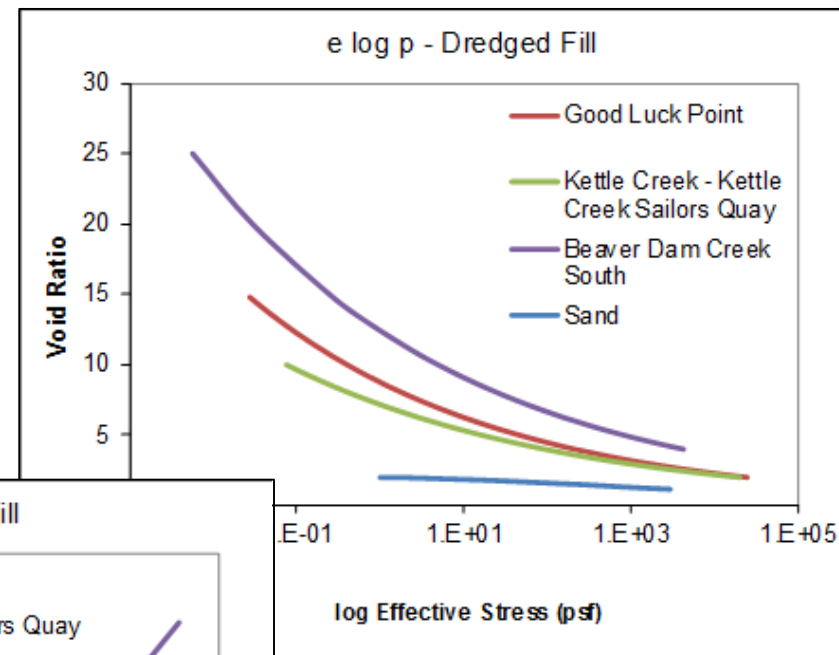
Input to PSDDF model



Consolidation Modeling - PSDDF

- **P** Primary consolidation, **S** Secondary compression and **D**esiccation of **D**redged **F**ill
 - Models longer term consolidation
- Uses data from laboratory consolidation tests
 - Self weight (DM only)
 - Standard oedometer (DM & Foundation)
- Other primary input
 - Void ratio & thickness at end of placement (SETTLE)
 - Climate data
 - Water table elevation
 - Soil parameters

Used to develop $e \log p$ and $e \log k$ curves



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Model info at:
<https://el.erdc.dren.mil/products.cfm?Topic=model&Type=drgmat>

ter

PSDDF Model designed for DISPOSAL...not TLP

Confined Disposal Facility

- Containment for DM slurry
- Designed for recurring placement
- Assumed no significant vegetation
- Thick deposits, large tolerances
- Water table – assumed constant
- PSDDF validated



Thin Layer Placement/Marsh

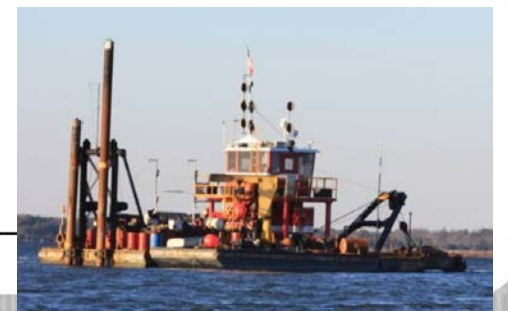
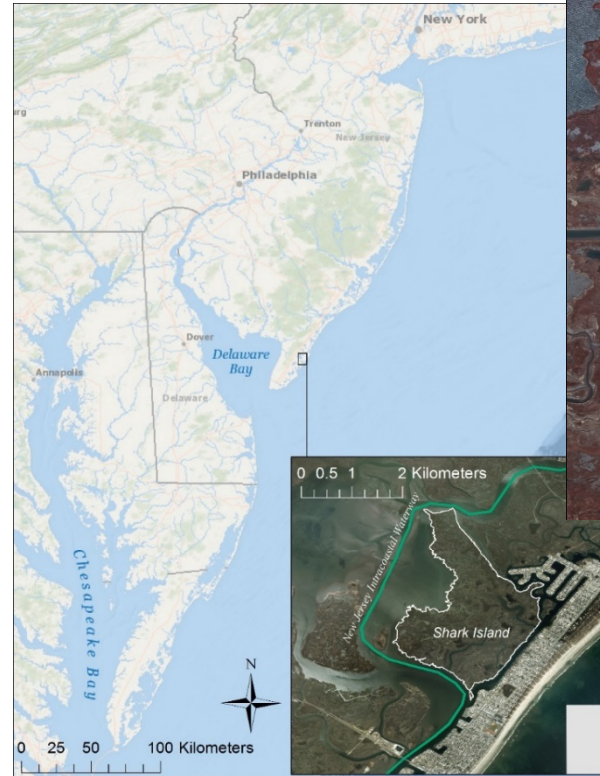
- Maybe containment
- Designed for one-time placement
- Vegetation reestablishment
- Thin deposits, tighter tolerance
- May be tidally influenced
- PSDDF not validated



Model Deficiencies?? Need to evaluate model optimization to account for wetland processes.

Field Study Avalon, NJ

- USACE Philadelphia District pumped sediment from the navigation channel to ~35 acres marsh between Nov 2015 – Feb 2016
- Thicknesses ranged from a few cm to ~0.5 m in pools



Field Study Avalon, NJ

- Surveys

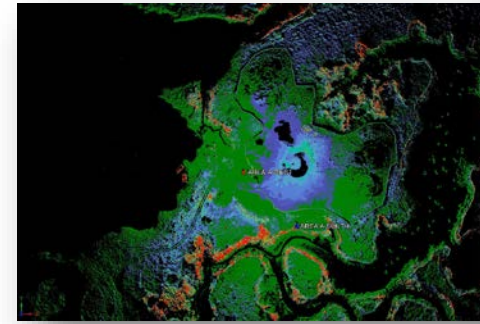
- March 2016; June 2016; June 2017

- Core samples in Area E: June 2016, June 2017

- DM thickness
- DM composition (grain size, organic content)
- Void ratio vs. depth

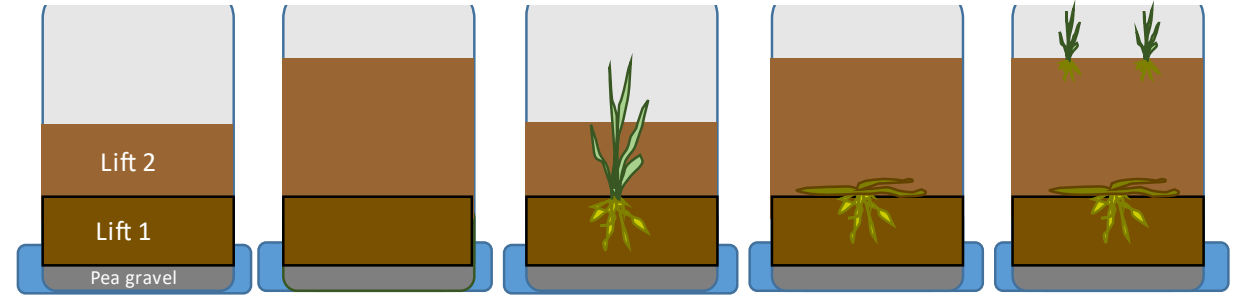
- Piezometers

- Nested piezometers in 4 locations
- Data loggers deployed Jun - Sep 2016, 2017



Laboratory Evaluation – Vegetation Impacts

- Conducted in 30 gal drums
- Sediment from Pascagoula, MS
- Simulated DM placement on vegetation



(2 Reps)

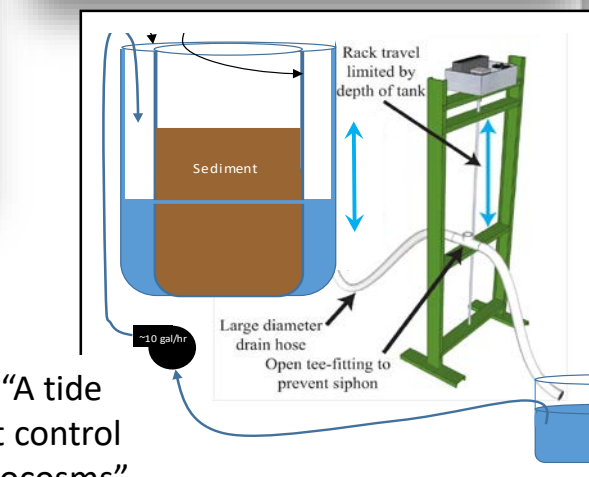
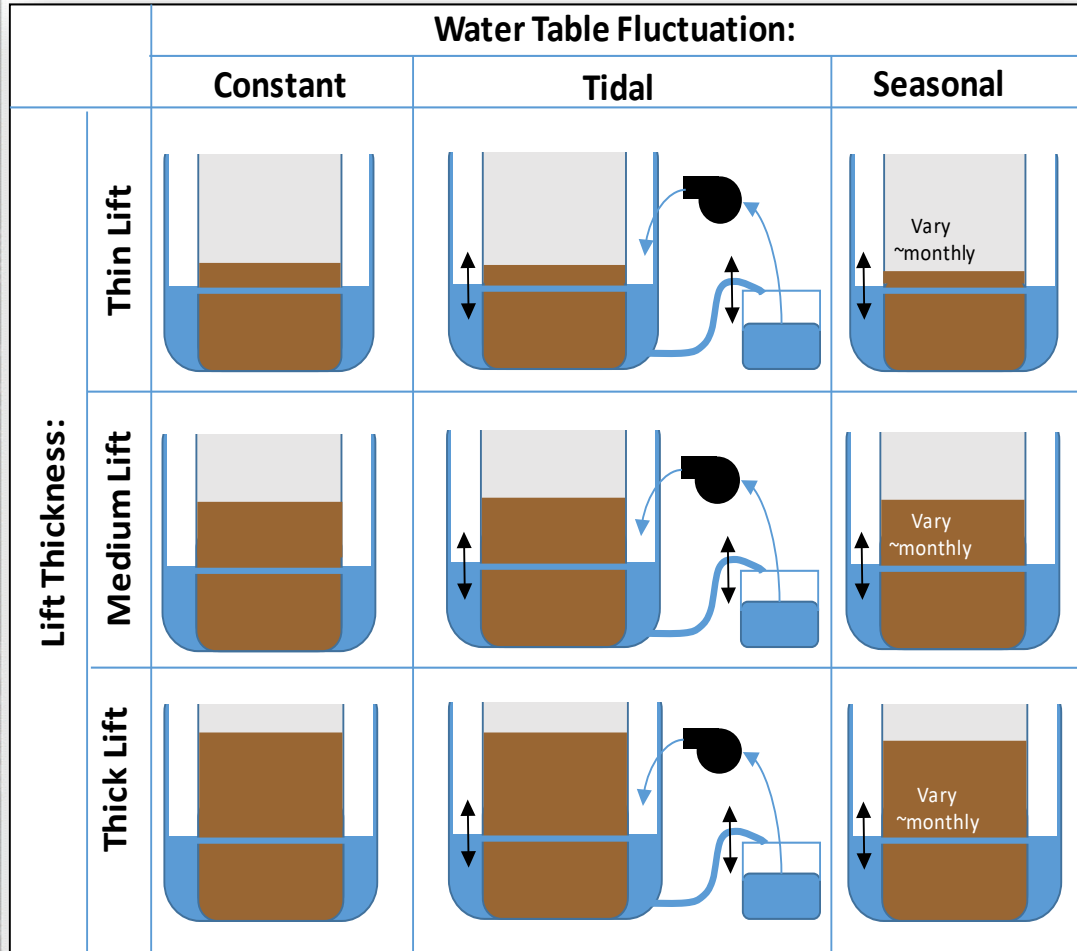
Lift 1	Lift 2
Aug 2017	June 2018
12" lift	4 drums 6" 6 drums 16"
6 veg / 4 not	2 replanted



Laboratory Evaluation – Impacts of Water Level

- Conducted in 30 gal drums
- Sediment from Pascagoula, MS

Set	#	Trial 1	Trial 2
Constant	6	12/17	5/1/18
Seasonal	5	12/17	5/1/18
Tidal	6	12/17	2/27/18



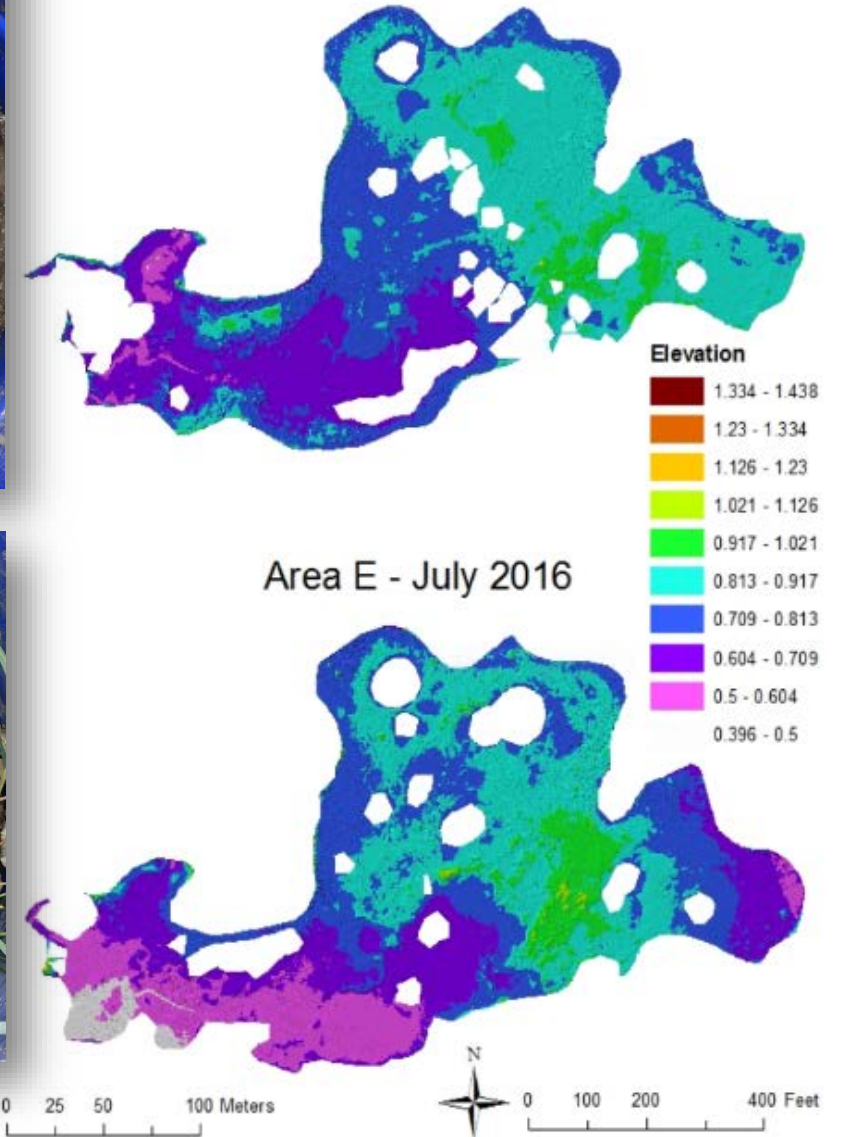
Miller and Long (2015). "A tide prediction and tide height control system for laboratory mesocosms"

Results

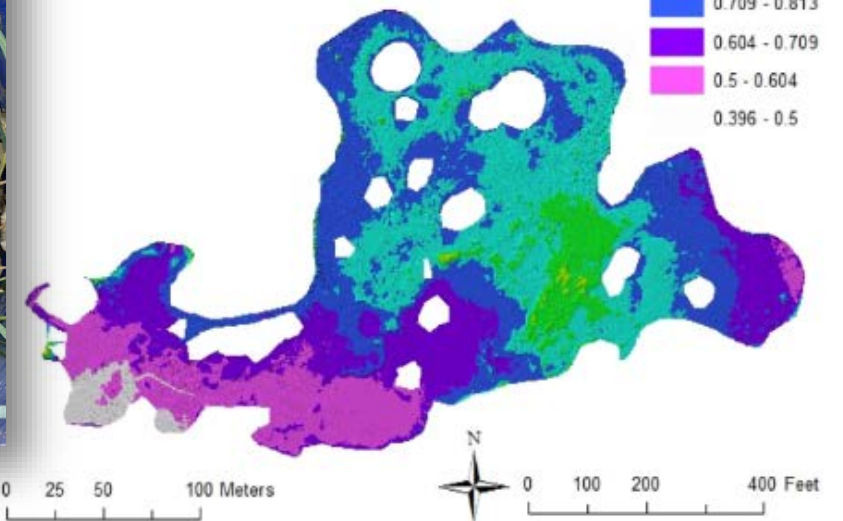
- Data analysis FY19
- Based on preliminary results
 - consolidation endpoint not likely to be impacted by these processes
 - rate of consolidation is impacted
- Run models and compare results
- Reports FY19/FY20
<https://doer.el.erdc.dren.mil/>
- Additional field validation



Avalon New Jersey - Area E - March 2016



Area E - July 2016



Summary

- Modeling consolidation is important design component to reach target elevation
- Need to understand how the marsh surface will behave over time
- Existing tools to predict elevation change over time
- Working to improve modeling to account for wetland processes
- Will have results from lab and field studies FY19
- Could use additional field validation

