# Promoting marsh resiliency with dredged sediment in New Jersey: research and modeling applications

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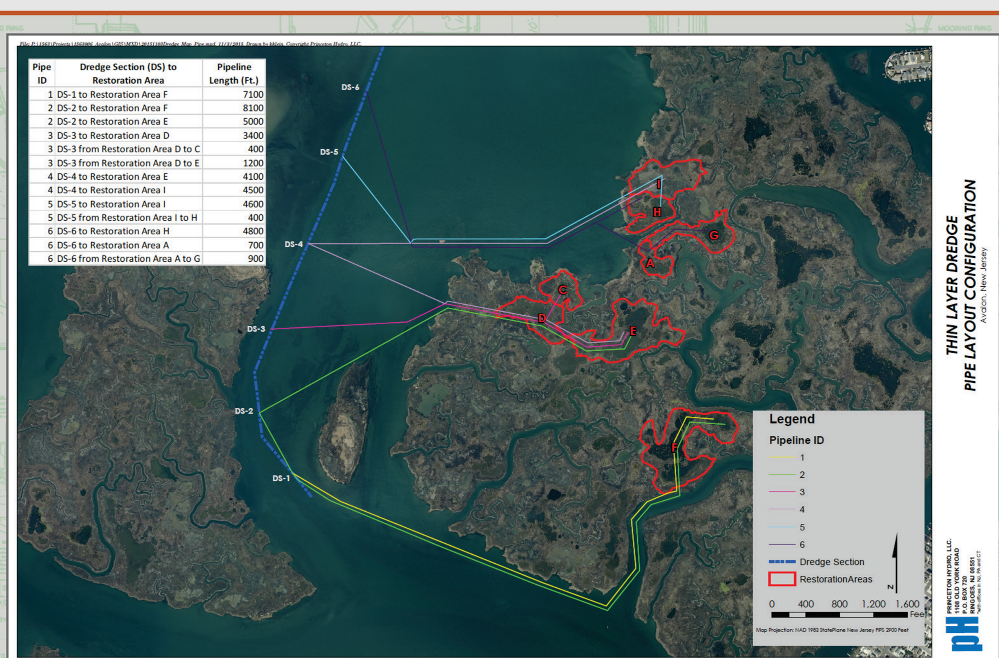
## Project background

As part of a multi-partner demonstration project in response to Superstorm Sandy, the USACE Philadelphia District (NAP) dredged 45,000 CY of sediment from the New Jersey Intracoastal Waterway from November 2015 through February 2016 and placed it on 14 ha of a nearby marsh owned by the New Jersey Department of Environmental Protection (NJDEP). Placement depths ranged from a few centimeters to nearly 1 m in marsh pools to achieve the biological target elevation determined by the project partners.



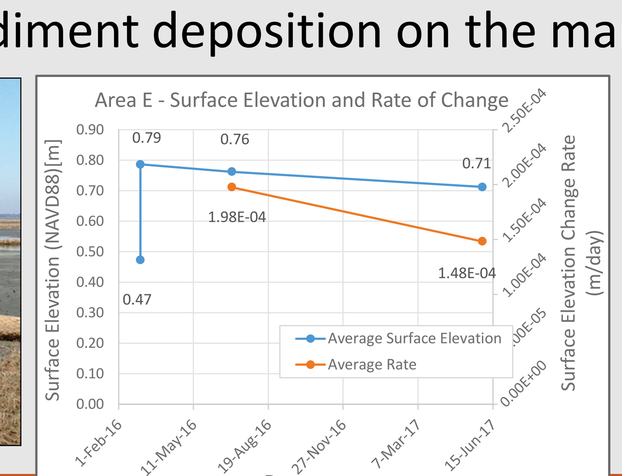

The USACE Philadelphia District, ERDC, and numerous partners teamed to bring the Avalon thin layer placement (TLP) project to fruition. Within ERDC, researchers leveraged funds through DOER and EMRRP to develop tools and advance TLP knowledge and techniques.

## Learning together

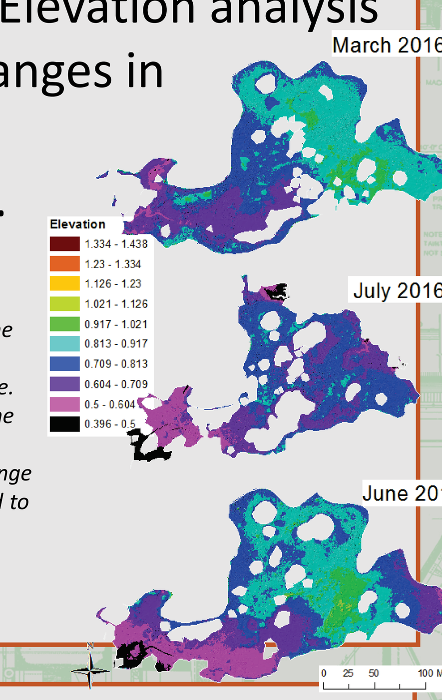
After construction, the partner organizations continued to work together to learn as much as possible from the demonstration TLP project. NJDEP, The Nature Conservancy, GreenVest, Princeton Hydro, and The Wetlands Institute collected data related to vegetation growth and infaunal, fish, and bird use. ERDC and NAP leveraged funds to monitor the elevation change and sediment consolidation after placement, surface and shallow groundwater levels, and soil physical and biogeochemical properties in the former marsh surface and the dredged material layer. These data feed two model development efforts focused on updating existing tools to simulate wetland TLP: PSDDF and MEM.

## Monitoring elevation change after placement

To quantify elevation change of the marsh surface, time-series terrestrial lidar scanning was employed in conjunction with pre-construction survey information. Elevation analysis also provides information pertaining to changes in inundation time and marsh function, i.e. sediment deposition on the marsh surface.




*Terrestrial Lidar and elevation data sets are being used to analyze the elevation change (consolidation) over time. Preliminary results at one location (Area E) shows moderate elevation change which may be attributed to consolidation, dredge material surficial equilibration.*

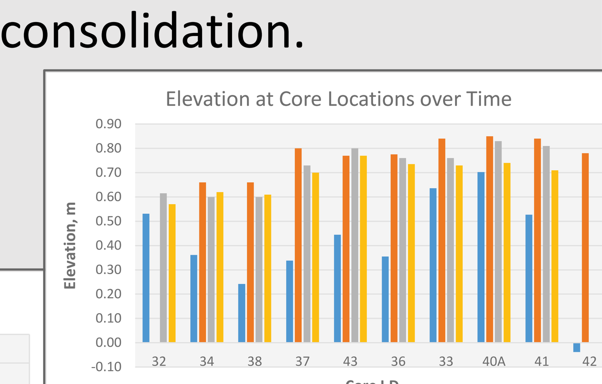


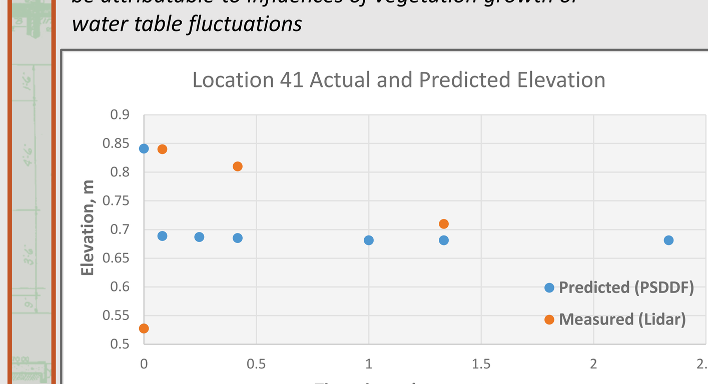

## Modeling settling and consolidation with PSDDF

Since settling and consolidation occur rapidly in the months after placement, engineers must define the construction target elevation required to achieve the biological target elevation defined by the design team.

A model developed for confined placement of dredged material (PSDDF model) is being evaluated for its suitability to predict consolidation for thin layer placement in a marsh setting. Dredged material thickness was measured in core samples taken at Avalon at different time periods, as well as corresponding geotechnical analysis of grain size and water content with depth. Consolidation was also estimated based on elevation differences between lidar surveys. Consolidation at various locations will be modeled using PSDDF and compared to the measured data. Laboratory testing is being performed to evaluate the impacts of vegetation and water table fluctuations on consolidation.

*The PSDDF model is being used to predict the elevation change (consolidation) over time. Preliminary results at one location shows significant differences which might be attributable to influences of vegetation growth or water table fluctuations*



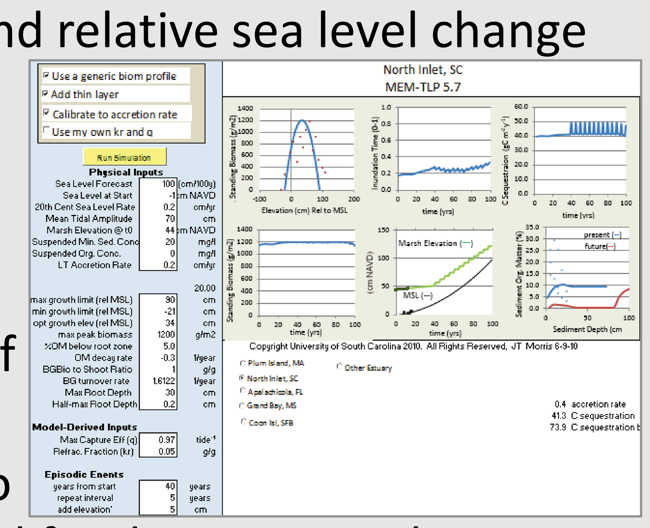

*Surveys (RTK and/or lidar) were taken over time to evaluate the elevation change at various locations across the site.*

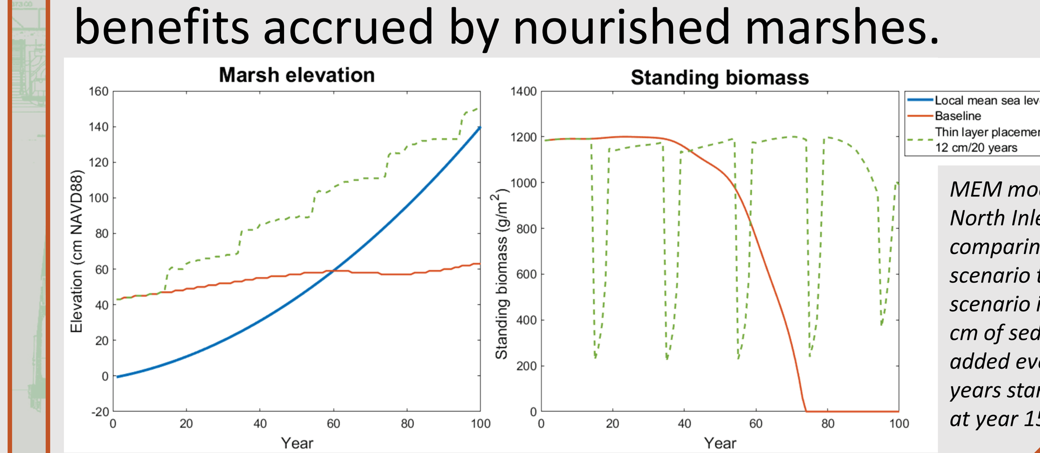
## Water level and soil properties: early indicators of marsh function

For two growing seasons following placement, ERDC monitored surface and shallow groundwater levels and soil properties. Water level monitoring compared soil saturation in the root zone between areas that received dredged material and control areas. Soil physical and biogeochemical properties monitoring compared differences between native marsh substrate and deposited sediment, and response of the active microbial pool to placement. Soil physical properties monitored include: moisture content, bulk density, and particle size distribution. Soil biogeochemical properties include: organic matter content, nutrient concentrations, and microbial biomass. Initial results suggest sediment placement in open water pannes increased bulk density to within the range capable of supporting vegetation while reducing inundation times in formerly vegetated and panne areas. Buried marsh soils remained microbially active and displayed the capacity for nitrogen cycling.

## Simulating thin layer placement effects on marsh function with MEM

The data from Avalon and other sites are being used to add additional functionality to the Marsh Equilibrium Model (MEM) to simulate the effects of thin layer placement and relative sea level change on marsh elevation. The resulting model updates, under development by ERDC and Dr. James Morris of the University of South Carolina, allow MEM to be used as a design tool for determining the TLP biological target elevation as well as the frequency of TLP events to maintain elevation. Simulation of future marsh biomass and carbon sequestration also provide a tool for planners to calculate future benefits accrued by nourished marshes.




*MEM model output for North Inlet, SC marsh comparing a baseline scenario to a TLP scenario in which 12-cm of sediment is added every 20 years starting at year 15.*

## Turning lessons learned into guidance

The data, models, and lessons-learned from this effort will be combined with knowledge from other projects and organizations to develop engineering TLP guidance. The guidance document, scheduled to be completed by the end of 2018, will be a snapshot of the current state of TLP engineering practice for both wetland and shallow open water settings. Several knowledge and technology gaps were identified through the course of this effort and are targets for future R&D tasks.

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