PROJECT PROFILE

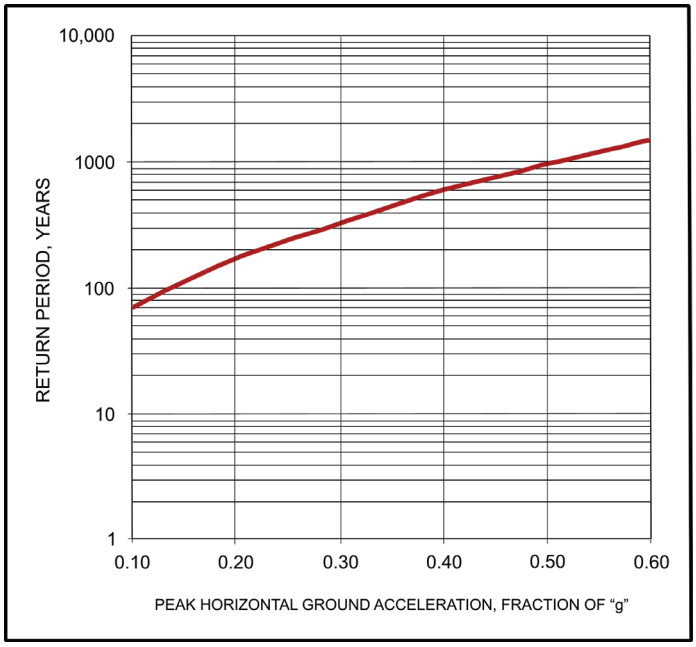
SEISMIC STABILITY ANALYSIS OF UNDERWATER SLOPE IN DREDGED CHANNEL

To maintain navigable channel depths, the Cooper River near Charleston, South Carolina is dredged to depths of about 40 feet. The soils comprising the dredged slope consist of loose sand and stiff clay layers to a depth of about 40 to 60 feet, underlain by the Cooper Marl. D'Appolonia was retained to evaluate the stability of the dredged slope at the Charleston Naval Weapons Station under seismic conditions.

The first step in evaluating the stability of the dredged slopes was to adopt a design ground motion. This was accomplished through a simplified probabilistic analysis. Major earthquakes have occurred in the historical past near Charleston. The large 1886 Charleston Earthquake was not a unique, isolated event, but the manifestation of an active, local seismic source. This conclusion is based on the discovery and dating of prehistoric liquefaction phenomena by the University of South Carolina and the U.S.G.S.

As the site is located in the meizoseismal area of the 1886 Charleston Earthquake, the recurrence assessment needed to consider only a local Charleston source. The recurrence curve of peak horizontal ground acceleration (PGA) shown was derived in consideration of the historical seismicity and paleoliquefaction phenomena. As an 1886-type event has an apparent return period of only about 1,500 years, the worst-case scenario for PGA was assumed for the design input as 0.6g.

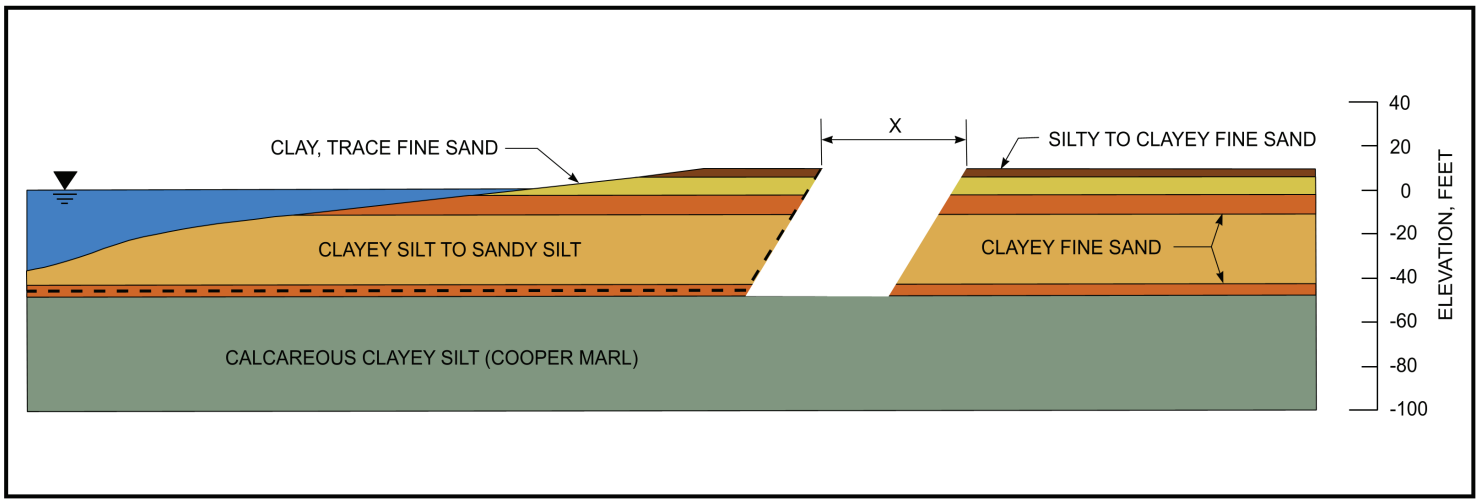
The dynamic stability of the underwater slope was determined using limiting equilibrium analytical methods representing a range of static and dynamic loading conditions. Circular and wedge-shaped failure surfaces were examined. A loose sand layer on the top of the Cooper Marl was separately evaluated because of its potential to lose strength through an increase in pore pressure under repeated loading (liquefaction).



Plot of peak horizontal ground acceleration versus return period for the Charleston Naval Weapons Station site.

The dredged slope at the Charleston Naval Weapons Station was determined to be unstable under earthquake loadings determined from the seismicity study. The sand layer immediately above the Cooper Marl proved to control the slope failure such that a sliding wedge model was most appropriate, as shown below. The earthquake loadings required for slope failure ranged from 0.06 to 0.28g (return periods of 30 to 275 years) depending on the assumed pore pressure dissipation in the sand layer. In any case, failure would occur at a PGA significantly less than the design basis earthquake.

The "X" distance in the cross section shown below corresponds to the permanent displacement under the postulated seismic event, which was calculated to be five feet. This potential permanent displacement was subsequently accounted for in the design of the mooring structures at the Naval Weapons Station. While D'Appolonia's study focused on this specific site, the results would be applicable to other dredged slopes in the vicinity of Charleston.



Schematic cross section of subsurface conditions at the project site.