Mixing, Transporting, Placing, and Field Verification of a Chemical Containment Subaqueous Cap: A Case Study

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Background/Objectives. Following the dredging of 30,000 CY of coal tar-impacted sediment from a harbor in the northeast, a subaqueous cap was installed in a section of the harbor to prevent upwelling porewater from re-contaminating the nearshore sediments adjacent to a former MGP facility. The composite multi-layered cap was designed to provide chemical containment, with provisions to limit erosional scour by prop-wash and wave action. Two types of cap were installed to accommodate different harbor conditions: a three-layer granular cap consisting of a containment layer overlain by a filtration layer and an armor stone layer; and a dual-compartment Marine Armor Mattress (MAM) cap with a containment layer underlying an armor stone layer. The chemical containment layers consisted of a mixture of pre-defined quantities of fine sand and Organoclay®, a CETCO product. The challenge: how to achieve and maintain grain-size-scale homogeneity of a mix containing materials of widely disparate specific gravities; ineffective mixing, with too much or too little Organoclay® in localized areas, may result in preferential pathways and diminish the effectiveness and longevity of the cap, thus conventional excavator/dozer mixing was excluded. Instead, specific techniques were developed to uniformly mix the materials and maintain homogeneity during loading / unloading and transport, and to field-verify the presence of Organoclay® in each batch of cap material.

Approach/Activities. The chemical containment material needed to be homogenously mixed, transported to the site, and placed in the harbor. The layers consisted of either 50% fine sand and 50% Organoclay® (by weight) for the granular cap, or 75% fine sand and 25% Organoclay® for the MAM cap. A field mixing pilot study was conducted to establish and verify mixing procedures. The pilot study was performed at a concrete plant and included use of a vibrating hopper, concrete mixing trucks, weight scales, and storage areas. Mixing was performed in batches, and grab samples were collected from each batch, divided, and real-time field tested for homogeneity. The chemical containment layer was successfully mixed and tested, thus yielding an approved procedure for implementation at the site. Real-time field testing was verified by an innovative heavy liquid separation laboratory analysis prior to installation.

Results/Lessons Learned. Field tests demonstrated that readily available high shear equipment provided effective mixing, but the Organoclay® behaved as a lightweight sand that easily separated from the denser fine sand during mixing/transport. However, manipulation of the intergranular capillary tensions was found to be successful at preventing vibration induced segregation and maintaining mix homogeneity. A real-time field “ignition” test method was also developed to semi-quantitatively verify Organoclay® presence, and thus the absence of unmixed zones in the composite material. The veracity of this field method was confirmed using fully quantitative laboratory testing of additional samples. The mixing and field testing procedures were implemented throughout the project to provide a homogenous material that met the design specifications for the cap.