Laboratory Treatability Study for In Situ Stabilization/Solidification (ISS) of Hydrocarbon-Contaminated Sediments in Kendall Bay, Sydney, New South Wales (NSW), Australia

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Background/Objectives. Hydrocarbon contamination (polycyclic aromatic hydrocarbons [PAHs], total recoverable hydrocarbons [TRH], benzene, toluene, ethylbenzene and xylenes [BTEX]) within the sediments of Sydney Harbour has resulted from operation of a former gasworks. The gasworks itself was remediated and developed for high density residential land use two decades ago. NSW Environmental Protection Agency (EPA) have now issued a clean-up notice for remediation of the sediments within the adjacent bay. This presents a challenge to develop a remediation methodology for the contaminated sediments that minimizes impact to the adjacent residents and the environment, particularly with regards to odor generation and traffic movements. For this reason, ISS has been selected as the preferred remediation technology. In situ treatment will significantly reduce the number of truck movements required to transport contaminated material off-site compared to traditional dredging approaches and odor will be managed by maintaining water cover above the sediments.

Approach/Activities. A comprehensive laboratory treatability study was undertaken to optimize the mix of reagents and grout additives that would allow the project performance criteria (unconfined compressive strength [UCS], contaminant leachability and hydraulic conductivity) and remediation productivity to be met. Some of the project-specific performance criteria, specifically the 1 MPa to 2.5 MPa (~150 to 360 psi) UCS development, presented significant challenges because of the high moisture content of the sediments. Reagents tested included binders (Portland cement, ground granular blast furnace slag [GGBFS]) and treatment enhancers (RemBind, powdered activated carbon, organoclay). Grout modifiers tested included bentonite, an accelerant, anti-washout agents and a superplasticizer. The laboratory study comprised material characterization, treatability studies, treatability optimization and treatability validation stages. Baseline leachability of untreated sediments was assessed using the Australian Standard Leaching Procedure (ASLP) and US EPA Leaching Environmental Assessment Framework (LEAF) Method 1316. Reductions in cumulative release of contaminants from the ISS samples were assessed using US EPA LEAF Method 1315.

Results/Lessons Learned. The laboratory study successfully identified the additive ratios of Portland cement and GGBFS required to meet the project performance criteria, and identified that no other treatment enhancers were required. Grout modifiers are likely to be required to overcome the placement challenges associated with underwater ISS. A superplasticizer may be required to ensure grout viscosity is maintained between the batch plant and mixing head at field-scale. An accelerant and/or anti-washout agent will be required to minimize both seawater ingress and the washout of cement, and field pilot studies will be used to determine the most effective product(s) and their final application rates. The field studies will also assess the effect of seawater ingress at the ISS interface and its impact on the ability to achieve the project performance criteria.

Laboratory results will be further assessed with the aim of refining the validation criteria to be implemented during full-scale remediation. Results to date show there is a strong correlation between accelerated and standard UCS analysis. The results also indicate that UCS may be utilized as the sole validation criteria to demonstrate that acceptable reductions in contaminant leachability and sediment hydraulic conductivity have been achieved. Additional data will be collected during the field pilot study to further demonstrate these relationships and justify the final validation criteria to the site auditor and NSW EPA.