Use of a Clay Based Barrier Technology for *In Situ* Management of Impacted Sediments

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Abstract: Sediments impacted by organic compounds, heavy metals, and other potentially toxic contaminants can be effectively managed in various ways. They can be removed by dredging and treated *ex situ* prior to disposal. The sediments can also be managed in place, or *in situ. In situ* management approaches can include natural recovery, encapsulation, or treatment by biological or chemical means. Choosing the most appropriate and environmentally protective approach is often a complicated process and may, for some projects, best involve an integration of several different technologies, e.g. dredging plus subsequent encapsulation. Installation of *in situ* sediment caps, or barriers, can be an attractive management approach, implemented alone or in concert with other management technologies. Appropriately designed sediment barriers can: physically isolate contaminated sediments from benthic macroinvertebrate communities; stabilize the contaminated sediment mass; significantly reduce the movement of dissolved contaminants into the overlying water column; and provide a replacement substrate for flora and fauna. AquaBlok™, a clay based capping technology displaying performance attributes equivalent or superior to granular-based capping materials, can offer such an effective and versatile environmental barrier.

In situ sediment capping – which generally involves placing clean sediments or similar earthen materials across the surface of contaminated sediments – can be a viable and cost-effective approach for managing impacted sediments and the ecological risks they can pose (NRC, 1997). The equivalent of relatively rapid natural recovery, placement of such environmental barriers can offer a more-or-less immediate and significant reduction in risk by isolating sediment-borne contaminants from exposure to ecological receptors. Appropriately designed *in situ* caps can not only physically isolate contaminated sediments from benthic communities, but can also stabilize the contaminated sediment mass (minimizing its re-distribution and dispersion during high-flow conditions) as well as significantly reduce the movement of dissolved contaminants into the overlying water column. Depending on the lifestyle of local benthic organisms as well as site ecology, capping materials can also provide a "replacement" substrate for faunal and floral colonization.

To date, granular materials have typically been used as capping materials in most remedial *in situ* capping projects. While sand- and gravel-based caps can effectively meet project needs in a number of cases, it is also recognized that many such materials are relatively non-reactive, relatively permeable, and can be eroded under high-flow conditions. Finer-grained sediments are often recognized as more reactive, less permeable, and more cohesive (erosion-resistant) capping materials, however, logistical

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aspects have, in the past, precluded the use of finer-grained materials like silts and clays for *in situ* remedial sediment capping.

AquaBlok™ is a patented, composite-aggregate technology resembling small stones and comprised of a dense aggregate core, clay or clay sized materials, and polymers. For typical product formulations, AquaBlok™'s clay component consists largely of bentonite clay. Other clay minerals (like attapulgite or organoclays) or clay-sized materials (like gypsum, iron oxides, or activated carbon) can also be incorporated to accommodate particular site-, contaminant-, or project-specific needs. Additionally, sediment caps can comprise AquaBlok™ exclusively or can incorporate other materials like geotextiles, sands, or surficial armor layers.

AquaBlok™ particles expand when hydrated, with the degree of expansion determined largely by the product formulation, application rate, and salinity of the hydrating water. When a mass of discrete and relatively hard AquaBlok particles is hydrated, the mass transforms into a continuous and relatively soft body of material. Once developed, the hydrated AquaBlok barrier displays: (1) a relatively cohesive and homogeneous physical character; (2) low permeability (typical bentonite-based formulations display saturated hydraulic conductivities on the order of 4×10^{-9} cm/s in low-salinity waters); and (3) relatively high chemical reactivity, in that the high surface area clay component can effectively sorb or attenuate various types of dissolved contaminants.

The clay based AquaBlok barrier technology can either be deployed alone or in concert with *ex situ* techniques like removal and with other *in situ* methods like biological treatment. Collateral environmental impacts may occur to the overlying water column as a result of attempting to inject chemicals into sediment to accomplish *in situ* treatment; combining capping with *in situ* treatment may limit such environmental impacts, as well as increase the efficiency of *in situ* treatment processes (Jersak and Hull 2000).

The concept of sediment capping is also easily integrated with sediment-removal activities. Considering the spectrum of sediment contamination that can occur at many impacted sites, management of more highly contaminated “hot spots” may involve dredging and removal whereas capping may be used to adequately address less highly, but still significantly impacted areas. Dredged areas may also be subsequently capped for isolation of residual contaminants.

The AquaBlok™ technology has been deployed on field-pilot or demonstration scales, including at an impacted wetland Superfund site in Alaska as well as within a PCB-impacted riverine system in Toledo, Ohio. Other full-scale remedial applications of this clay based barrier technology in a variety of impacted aquatic environments are currently being considered.

Results of a one-acre field pilot study conducted by the USDA at an army base in Eagle River Flats, Alaska (ERF) in 1994/95 indicated that, in addition to supporting the growth of wetland vegetation, this clay based capping technology significantly reduced waterfowl mortality by minimizing waterfowl dabbling within white phosphorous-impacted sediments. Because of its pilot study performance, AquaBlok ™ was incorporated into the 1998 Record of Decision for OUC as one of two planned remedies for addressing impacted sediments at ERF (please see www.epa.gov/superfund/sites/rodsites/1001455.htm). A summary of the ERF pilot study is also provided by Pochop et al. (2000).

The Ottawa River Demonstration Capping project, conducted in Northwestern Ohio during 1999/00, generally involved installation and field-scale testing of several different AquaBlok ™ based sediment-cap designs across a 2.5-acre portion of the Ottawa River containing PCB-contaminated sediments. Primary project goals included assessing the relative, long-term effectiveness of AquaBlok based sediment caps in physically stabilizing and isolating impacted sediments as well as demonstrating different techniques for cap construction. Results of this demonstration capping project, summarized in part by Hull and Stephens (2000), indicated that good spatial coverage of capping materials across targeting areas was achieved and maintained as well as adequate and relatively consistent, hydrated cap thicknesses. Together, these observations indicated the viability of the different techniques demonstrated to accomplish cap construction (including a conveyor, a helicopter, and a crane plus clamshell). Results of monthly monitoring of near-bank, encapsulated areas as well as end-of-project coring and surveying also indicated AquaBlok stabilized and isolated impacted sediments at the site.

References

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