Application of Multiple Technologies to Achieve Risk-Based Remediation of Petroleum Hydrocarbons in a Challenging International Environment

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Background/Objectives. A bulk petroleum terminal in Southeast Asia was demolished and is in the process of remediation, to facilitate site redevelopment. The terminal was in operation for over 80 years, and petroleum impacts are present due to past practices. The country's regulatory framework is in development, so that rather than a strict regulatory-based cleanup standard, a risk-based approach was applied to develop cleanup criteria. The site is located along a river where groundwater is relatively shallow, and light non-aqueous phase liquid (LNAPL) is present in a portion of the site.

Approach/Activities. A human health and ecological risk assessment was performed to assess potential future risks. The petroleum at the site had little benzene, toluene, ethylbenzene, and xylene (BTEX) or polyaromatic hydrocarbons (PAHs); as a result, the risk assessment concluded that the site did not pose an unacceptable risk, unless there was mobile/free LNAPL present that a future site or construction worker could contact. Therefore, cleanup criteria were developed to limit the potential for mobile LNAPL to be present in the subsurface. The presence of LNAPL in an excavation is used as a first line of evidence that removal is required. A cleanup level of 10,000 mg/kg total petroleum hydrocarbons (TPH) (C6 to C36) was ultimately selected as a numeric soil criteria based on published literature and guidance from several other countries and U.S. states; this level was judged to be appropriately mitigative for potential mobile LNAPL. Soil aesthetics (odors/ staining) were additional cleanup considerations based on anticipated future use.

Results/Lessons Learned. The primary remedial technology is excavation with biopile treatment. Excavations are being performed to 2 meters below ground surface, which is at least 0.5 meters into the water table. A bioremediation approach was selected to treat affected soil, given that very low cleanup levels are not required, rates of degradation are relatively rapid at the prevailing ambient temperatures (often greater than 30^{o} C), and it is a sustainable, economical approach. Biopiles were selected over landfarming, since biopiles will be covered and treatment can continue even during the seasonal high rainfall periods and offer better vapor/odor control given proximity to residential areas.

A secondary remediation approach was required for areas adjacent to the river, due to concerns for the potential structural stability of the river wall with standard excavation close to the wall. Sheet piling was initially considered; however, in situ solidification/stabilization was assessed to be the better approach, as it delivered the desired structural integrity, mitigated the concerns with LNAPL (by fixing the LNAPL in place), and also reduced the volume of soil needing to be excavated for biopile treatment.

The presentation will focus on the technical and implementation issues encountered during the remediation and the methods to use to manage them.