Autopsy of a Small UST site in Bedrock: Implications for Remedial Effectiveness

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The former Defense Reutilization and Marketing Office (DRMO) at Devens made use of a 5000-gallon UST (UST-13) for collecting waste oils, comprised mainly of spent fuels and chlorinated solvents. The tank was removed in 1992 in conjunction with a limited amount of contaminated soil, as the tank grave was partially excavated into bedrock. From 1994 to 1997, an RI, FS and ROD were completed for the site. In 1998 the selected remedy implemented monitored natural attenuation (MNA) with long-term monitoring to evaluate ground water cleanup as a follow-up to the source actions.

A number of factors conspired to complicate the ongoing evaluation of MNA and source action effectiveness. Construction of a large warehouse structure occurred in 2000 to 2001. An extensive cut-and-fill program, including significant bedrock blasting, was carried out in order to prepare the site for construction. Most significantly, the construction process interrupted the LTMP by destroying a number of key monitoring wells. New monitoring wells were immediately installed post-construction in 2001, and LTM efforts were resumed, but the presence of the new building precluded replacement of many wells to the original locations. Moreover, post-construction ground water flow patterns were observed to change, and it was expected that additional work would be needed to verify the adequacy of the monitoring network, and to make adjustments to the well network or the remedy, as necessary.

The presence of shallow bedrock beneath large portions of the site, as well as the fact that the shallow water table is locally within the bedrock further complicate analysis of ground water clean-up. The former tank grave is located at or near a local ground water divide and the grave of the former leaking waste oil tank (UST-13) penetrated into the upper bedrock. The release of contaminants has affected bedrock, and it appears likely that some residual source material exists in the bedrock beneath the former tank grave. These matters support the ongoing need for additional evaluation of bedrock.

Persistent lingering contamination in the source area supported additional efforts to address the bedrock contamination more comprehensively. In 2007, EPA performed an analysis of bedrock data collected during the 2000 blasting event. As fresh bedrock exposures were created, EPA conducted geologic mapping and measured the three-dimensional orientations of the rock fabric and associated fractures identified in the sheared granite gneiss and meta-sedimentary bedrock. A total of 156 joint orientation measurements were collected (66 stations) and 49 foliation measurements were recorded (49 stations). The data was used to create an updated conceptual site model (CSM), particularly with respect to elements of the bedrock fracture network relevant to ground

water flow at the site-scale. Stereo-plots and 2-D mapping of these bedrock structural elements were integrated with updated maps of the bedrock surface morphology. Additionally, lateral hydraulic gradients, vertical hydraulic gradients, and long-term water level trends were reevaluated for the bedrock and overburden ground water systems, culminating in a series of detailed hydrogeologic cross sections parallel and normal to ground water gradients in the area centered on former UST-13. The prevalence and consistency of the bedrock foliation strongly suggest that this basic characteristic of the bedrock needs to be factored into any remedial or monitoring scheme. Although joint orientations were much more variable, the most prevalent joint orientations are generally also parallel to the foliation (i.e., foliation-parallel joints). These foliation-parallel joints may play a significant role in contaminant migration, particularly in the immediate vicinity of UST-13. The analysis suggests that the potential for down-dip migration of contaminants, including residual NAPL, to the west/southwest and lateral migration of dissolved COCs along strike, to the south, are possible, yet neither pathway is currently monitored.

In order to address these findings, several new monitoring wells in the UST-13 source area and in down-gradient directions were recommended, but in 2009, the project team re-focused available resources to actively address persistent residual fuel hydrocarbons and chlorobenzene compounds (chlorobenzene, 1,2-dichlorobenze, 1,3-dichlorobenze, 1,4-dichlorobenze). An in-situ chemical oxidation (ISCO) injection effort, aimed at the hotspot area near well 32M-01-18XBR, was conducted in February of 2009. Approximately 1800 gallons of water/sodium persulfate solution with a sodium hydroxide catalyst was injected through 4 new injection wells drilled into or on top of the bedrock in the former UST-13 area. The 4 post-injection monitoring events conducted to date point to significant decreases of many key contaminants of concern in well 32M-01-18XBR, but hydraulic information collected during the injection events suggests considerable uncertainty still exists with respect to the interconnectivity of the fracture system, and by extension, the appropriateness of the current monitoring and injection wells.

Moving forward, evaluation of time-series contaminant trends will need to carefully consider the role of seasonal water level changes in relation to oscillating contaminant values. If contaminants persist, additional remedial action may be needed. In such a case, optimization of remedial systems and associated monitoring will likely need to more carefully consider the characteristics of the bedrock fracture system.