Quantitative High-Resolution Site Characterization (qHRSC) and Lessons Learned

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Background/Objectives. Limitations in funding or regulatory requirements often lead to soil and groundwater data gaps and an incomplete conceptual site model (CSM). An accurate CSM leads to better remedy selection, surgical application of the chosen remedy or remedies, shorter remedial timeframes, and lower overall remedial costs. One of the most common data gaps is limited speciated saturated soil analytical data and discrete assessment in underlying units. An integral approach to characterization and remediation is to obtain spatially and vertically dense soil analytical data and vertical profiling of groundwater; vertical groundwater profiling can effectively be twinned with high density soil sampling to determine contaminant mass distribution, gradients, and variability in aquifer properties due to geologic heterogeneity. These limitations also apply to transition zone and bedrock units but can be resolved with recent advances in procedures and methodologies.

Approach/Activities. Most overburden injection via direct-push technology (DPT) is not adequate to capture the total contaminant mass present nor is the equipment effective for installation within the geologic medium. Improvements to overburden injection methodologies will highlight the use of flexible overburden remediation units (low pressure/low flow to high pressure/high flow) combined with unique downhole tooling and field installation protocols to allow expert installation of all commercially available injectates.

Additionally, subsurface conditions exist within the transition between overburden and competent bedrock lithologies that may prevent the use of traditional equipment or techniques to reach and isolate the targeted depth interval for assessment and treatment. These obstructions can be naturally occurring (hardpan/caliche, chert layers, dense fine-grained sediments, gravel, partially weathered rock, etc.) or anthropogenic (cut and fill, buried rubble like concrete, etc.). Development of the GeoTAP™ technique has provided both access for characterization and access to these intervals. It has been used successfully on 50+ project sites across the country accessing depths as great as 180 feet below ground surface. This method characterizes these zones such that drilling is conducted like a bedrock application and injection is like overburden reactant/reagent installations.

Finally, a key to bedrock remediation is not to just treat the highly transmissive zones. A combination of custom packers for discrete sampling and injection (18 inches between inflation elements) and a unique bedrock injection unit (flow rates ranging from 50 to 250 gallons per minute and pressures up to 2,700 psi.) allows focused treatment using high energy access to the smaller aperture fracture networks which typically contain more contaminant mass than more transmissive features. Being able to isolate and treat these zones is a key component to success at difficult fractured rock sites.

Results/Lessons Learned. A comparative evolution of recent improvements to techniques and approaches to characterization and injection in overburden, transition zone/saprolite, and consolidated lithologies will be discussed. Site-specific case studies will illustrate the development of both quantified high-density data (CSMs) and focused in situ remediation techniques. Lessons learned and relevant data will depict the benefits of high-density indiscriminate soil and groundwater sampling for quantitative lab analysis, then subsequent

aggressive techniques to install the required in situ treatment in targeted locations and loadings.