Targeted Remediation in Fractured Bedrock on a Remote Superfund Site using Electrical Hydrogeology

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Background: Vertical borings and monitoring wells are the traditional choice for characterizing environmentally impacted sites. These methods are useful to help characterize horizontal distribution of contaminants and geologic layers. However, the industry has found that vertical tools are largely inadequate to locate and evaluate discrete vertical features and flow paths, which can significantly contribute to contaminant migration and distribution in the subsurface Electrical hydrogeology utilizes a specialty scanning technology, designed specifically for the environmental industry, to generate continuous 2D subsurface electrical images across a project site and detect discrete vertical geologic features and migration pathways. This process has been used over the last two decades at sites in varying alluvial and bedrock geology for ultra-high resolution site characterization (Ultra-HRSC) and more robust remedial design characterization (RDC), resulting in more meaningful conceptual site models (CSMs). These data have also been collected temporally as 4D datasets, to evaluate ongoing contaminant migration and/or effectiveness of remediation.

Solution Approach: At a DNAPL site in fractured volcanic rock, electrical hydrogeology was successfully utilized to track preferential contaminant flowpaths related to geologic structures underlying the site. Identifying the deformation zone, faults, and fractures allowed these high flow zones where most of the contaminant migration was occurring to be targeted for remediation in a more effective manner. A process for successful management of these big data projects included 2D/3D data integration and visualization of multiple lines of evidence (including historical site data and follow up ground truthing confirmation drilling data), to allow robust virtual and/or in person collaboration by project team/stakeholders.

Project Outcomes: 3D electrical imaging data integrated with targeted one-dimensional (1D) point confirmation drilling and monitoring well data provided insight into the complex contaminant distribution, subsurface microbial activity, and varying effects from previous remediation attempts, at this Superfund Site located in the US Virgin Islands. This RDC approach yielded a conceptual site model built on thousands of field data points and successfully located fractures, faults, and a deformation zone where most of the groundwater flow and contaminant migration is occurring. This site knowledge allowed the remediation team to place extraction wells in confirmed high flow pathways with the intent of remediating the chlorinated solvent plume more effectively and at lower cost.

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Kyle W. Spears, M.Sc. is a Technical Sales Manager/ Hydrogeologist at Aestus. During his tenure at Aestus, Kyle previously led field teams to perform electrical hydrogeology characterization and identify preferential groundwater flowpaths, NAPL contaminant distribution, and geohazards in alluvial and bedrock sites across the USA. In his current role, Kyle works to build meaningful relationships with existing and new clients and help them solve problems relative to complex subsurface issues at their project sites.

Kyle previously worked for the Oklahoma Water Resources Board as a Groundwater Resources Geologist. He performed groundwater well hydraulic testing and co-authored technical publications on several of the state's aquifers. As part of completing his Master's degree at Oklahoma State University he conducted research using electrical hydrogeology to characterize alluvial aquifers and evaluated new methods used to collect deeper data and delineate paleochannel morphology.