

# **Managing Unexpected Outcomes from Remediation in Fractured Bedrock Geological Settings – How a Revision in the Conceptual Site Model Helped Resolve Unforeseen Conditions**

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## **ABSTRACT**

To meet groundwater compliance goals established by federal and state regulatory agencies, active groundwater remediation, in addition to source control and monitored natural attenuation, is often needed. Groundwater extraction is a common hydraulic control measure to achieve plume containment and mass removal. However, in places with complicated geological settings such as fractured bedrock, the hydraulic stress introduced by pumping groundwater can lead to unexpected mobilization of constituents and unfavorable outcomes.

Undesired increases in concentration in unexpected areas could be attributed to previously unknown transport pathways and/or alternative sources. Multiple tools are available to identify the exact cause(s) and inform the potential solutions. In this case study, an unforeseen increase in constituent concentrations was detected in a bedrock monitoring well that had previously been in compliance with regulatory standards after a groundwater extraction system began operating near the source area.

A re-evaluation of the conceptual site model was undertaken using a multiple lines of evidence approach including fracture tracing, trend and regression analyses, geochemistry evaluation, and analytical/numerical modeling. An alternative source was identified, leading to an update in the site conceptual model and a mitigation plan with minimal alteration of the extraction system to achieve the compliance goals.

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