

Delineation of Oil Field Brine in Groundwater Using Time Domain Electromagnetic Induction Surveys and Discrete-Depth Sampling

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A series of percolation ponds are used for the disposal of produced water from operations at the Lost Hills oil field, located on the west side of the central San Joaquin Valley. The produced water has a total dissolved solids (TDS) concentration of about 23,000 milligrams per liter (mg/l) and a correspondingly high electrical conductivity (EC). Regional groundwater beneath the area of the ponds occurs at a depth of about 100 ft below ground surface (bgs). Groundwater quality near the ponds is poor (estimated TDS is from 3000 to >5000 mg/l).

In order to evaluate possible groundwater impact due to the infiltration of produced water from the ponds, a geophysical survey was conducted in the vicinity of the ponds using the time domain electromagnetic induction (TDEM) technique. The TDEM technique relies on the contrast of EC between the background (unaffected) groundwater and groundwater that may be affected. Thirty-two TDEM soundings were collected on adjacent agricultural land in the vicinity of the percolation ponds. The results of the TDEM survey indicated that an electrical conductivity anomaly, possibly related to a plume of produced water, extended approximately 1700 ft downgradient of the percolation ponds and to depths of about 400 ft bgs.

To confirm the TDEM results, four borings were drilled, geophysically logged, and sampled within and at the apparent edges of the produced water plume. Discrete-depth groundwater samples were collected using the case-and-bail method at various depths in each boring and analyzed for general minerals. These data confirmed the presence of produced water in a shallow perched zone and a stratified regional aquifer system to depths of about 400 ft bgs. The combination of TDEM surveys and discrete-depth groundwater sampling provides an effective tool to delineate the vertical and lateral extent of oil field brines in groundwater at a fraction of the cost of delineation using the more traditional monitoring wells.