State Water Resources Control Board
Summary of key findings
September 20, 2023

USGS Groundwater Study in and Near the Lost Hills and South Belridge Oil Fields Analyzes Data from Groundwater and Oil Wells to Determine if Mature Oil Fields Potentially Contain Multiple Fluid Migration Pathways Toward Protected Groundwater

A U.S. Geological Survey (USGS) study in and near the Lost Hills and South Belridge Oil Fields analyzes newly collected and historical data from groundwater and oil wells to determine if extensively developed oil fields potentially contain multiple fluid migration pathways toward protected groundwater. Protected groundwater is defined as water with <10,000 mg/L total dissolved solids and outside an exempt aquifer. The study "Fluid migration pathways to groundwater in mature oil fields: Exploring the roles of water injection/production and oil-well integrity in California, USA" was published in *Science of the Total Environment*. The USGS is conducting this research under an agreement with the State Water Resources Control Board (State Water Board), in accordance with Senate Bill 4 (Pavley, statutes of 2013), which required the State Water Board to develop and implement a regional groundwater monitoring program.

Distinguishing anthropogenic from natural geochemical patterns is extremely difficult in mature oil field settings. In many of the oil fields in California, natural sources of oil and gas are present within the same aquifer used for water supply. In addition, surface water and excess water pumped out of oil-bearing zones are re-injected back into producing deposits, creating complex mixtures. The findings of this study indicate that injection and production of oil field water and groundwater withdrawals altered hydraulic gradients and caused the migration of chemical constituents from deeper to shallower zones. These migrations occurred in areas where old oil wells with gaps in annular cement and casing damage are likely to act as migration pathways. Groundwater samples collected in the study areas from shallow aquifers indicate potential mixing with constituents associated with or influenced by injection in deeper formations where more injection has occurred than production. The USGS suggests further insight to the potential sources of fluid mixing could be provided by long-term time-series monitoring data for groundwater elevations and chemistry, comprehensive characterization of end-member waters to assess mixing, installation of depth-specific monitoring wells in key locations, and improvements to compiling oil well construction and integrity records.

Data associated with this report are also available online (https://doi.org/10.5066/P9MHSTGS)

Visit the State Water Board Oil and Gas Regional Groundwater Monitoring Program and USGS California Oil, Gas, and Groundwater websites for more information.