Application of a Horizontal Well for Optimized Light Nonaqueous Phase Liquid Recovery

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Background/Objectives. LNAPL at the project site has traditionally been recovered using submersible pumps in vertical extraction wells. A pilot test was conducted to evaluate LNAPL recovery from a horizontal well and compare LNAPL and total fluid recovery rates, operation and maintenance requirements, and cost to operations at vertical wells. The study location was chosen based on accessibility, flat topography, occurrence of shallow light non-aqueous phase liquid (LNAPL), coarse subsurface lithology amenable to recovery, and close proximity to existing infrastructure (air supply and conveyance piping). Additionally, in order to allow comparison of LNAPL recovery and cost, the horizontal well was installed near existing vertical wells with proven LNAPL recoverability.

Approach/Activities. A 248-foot surface-to-surface horizontal well was installed utilizing a Vermeer D36x50 Series II directional drill rig and a DigiTrax F5 walkover locating system. The well was constructed of 4-inch diameter high density polyethylene casing with 100 feet of slotted horizontal casing at 13 feet below ground surface, and blank casing angling to ground surface on either end of the screened section (70 feet and 78 feet, respectively). The well length and depth were selected based on historical groundwater elevation data and ROST laser induced fluorescence surveys that identified the vertical extent of LNAPL in the area. Total fluids were recovered using a double-diaphragm pump with drop tube and bubbler level control. The fluid recovery intake was positioned at the midpoint of the well screen (120 feet into the well) and the bubbler level control was positioned 5 feet beyond the start of the well screen (75 feet into the well). The pump was set for a desired drawdown of 13 feet bgs with the control initiating fluid removal at 2.8 inches above the intake screen. The LNAPL recovery pilot test was conducted over a 30-day period. Data collected during the pilot test included totalizer readings to estimate flow rates and volume removed, fluid level measurements from the horizontal well and nearby vertical wells, monitoring the cycling frequency of the extraction pump, product cut tests of extracted total fluids to estimate LNAPL recovery, and chemical testing of extracted fluids.

Results/Lessons Learned. Pumping from the horizontal well successfully drew down local groundwater and recovered LNAPL from the area. Fluid level changes in response to the horizontal well pumping were observed up to 18 feet from the well casing, suggesting a significantly larger area of influence for the horizontal well as compared to nearby vertical wells which have typical radius of influences around 5 feet. Total fluid recovery rates decreased over the span of the pilot test from 4.6 gallons per minute (gpm) at startup to 0.8 gpm at the end of the test, equating to a total fluids recovery rate 30% greater than nearby vertical extraction wells. LNAPL recovery volumes from the horizontal well were around an order of magnitude greater than the volumes removed at nearby vertical recovery systems, ranging from 25 to 125 gallons per day (gpd) at the beginning of the test down to 10 to 30 gpd during the second half of the test. Typical LNAPL recovery volumes in nearby vertical wells generally range from 0 to 4 gpd. A comparison of horizontal versus vertical well installation costs demonstrates horizontal wells are approximately six times more expensive, while O&M efforts remain similar. This suggests that while it is possible to successfully and reliably extract fluid from a horizontal well feature, the area of influence should be evaluated to confirm whether a horizontal well or vertical well network would be more cost effective.