Selection, Design, and Construction of a Multilevel Groundwater Monitoring System

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Background/Objectives. This paper describes the design and construction of the multilevel well systems to provide high resolution monitoring of water levels and water quality at fractured bedrock sites. Multilevel systems include nested wells, system which use packers (e.g., Solinst Model 401 Multilevel System and Westbay MP38 system), and systems which line the borehole wall (e.g., Water FLUTe). A multilevel well system allows installation of multiple monitoring zones in one borehole. A conventional monitoring well requires a separate borehole and well for each monitoring zone. Use of one borehole reduces the amount of drilling required, the amount of waste generated, and the time required to complete the well.

Approach/Activities. The selection of a multilevel well system is based on site hydrogeology, extent and nature of groundwater contamination, and data required to meet project objectives. Adequate site and borehole characterization is a critical part of successful multilevel well design. In an unconsolidated formation this can include lithologic sampling, vertical groundwater quality profiling, and borehole geophysical logging. In bedrock, rock coring is recommended, but not required, to provide a smooth borehole wall and to provide rock core for inspection and analysis. In bedrock borehole geophysical logging is required to produce an adequate multi-level well design. The typical suite of logs run in bedrock includes caliper, natural gamma, formation electrical resistivity, optical and acoustic televiewer, fluid temperature and fluid conductivity. These logs are run first and the results are used to select targets in the borehole for heat pulse flow meter logging. The heat pulse flow meter log is run under both ambient and pumped conditions. All the logs are combined in a software tool and viewed together to complete analysis and well design. The capabilities of each multilevel system will be compared according to various criteria, including work area required, maximum depth of installation, maximum number of ports, optimal borehole size, construction procedure, subcontractor support required, potential installation problems, water level monitoring procedure, groundwater sampling procedure, potential post-installation problems, additional capabilities, and decommissioning.

Results/Lessons Learned. Case studies of the installation of each of the systems will be presented. At a site in Pennsylvania nested wells were installed in fractured rock because only two or three zones needed to be monitored. At a site on Long Island, New York, the Solinst Model 401 Multilevel system was installed to monitor the Upper Glacial Aquifer. The Solinst system was chosen in part because it offered a bladder pump for sample collection. The systems were installed in multi-screen 4-inch diameter stainless steel well. At a site near Auburn, New York, Westbay MP 38 systems were installed in a multilayer carbonate aquifer system. The Westbay uses a wire-line tool to sample water and measure pressure at each port and is moved from well to well. At a site in Puerto Rico, Water FLUTe systems were installed in 6-inch diameter boreholes drilled in volcanic rock to assess the lateral and vertical extent of groundwater contamination. The FLUTe system is made of fabric, filled with water, and completely lines and seals the borehole except were sampling ports are installed to allow water level monitoring and groundwater sampling. All three of these systems can provide good water level and water quality data. The Westbay system is the easiest to construct and no pumps or transducers are left permanently downhole. The Waterloo system is the most complex to construct, but offers a variety of pumps for use downhole at sampling ports. The FLUTe system offers the ability to seal the entire borehole wall which is an advantage where matrix diffusion is a concern.