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A comparison between ground water monitoring alternatives (direct-push installed monitoring wells and drilled monitoring wells) is being conducted on the leading edge of a methyl tertiary butyl ether (MTBE) plume located in a shallow semi-perched aquifer (saturated thickness extending 9 to 22 feet (2.7 to 6.7 meters) below ground surface). The purpose of this effort is te determine whether direct-push wells compare favorably with conventional hollow stem auger (HAS) drilled wells. To make this determination, ground water samples were extracted from numerous adjacent direct-push and HAS installed wells over several sampling events. Analysis of variance (ANOVA) statistical techniques were applied to the resulting chemical data to differentiate between the variability attributed to well type, temporal, and spatial factors.

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Advanced Fuel Hydrocarbon Remediation National Technology Test Site, Port Hueneme

Performance Comparison: Direct-Push Wells Versus Drilled Wells

INTRODUCTION

A comparison between ground water monitoring alternatives (direct-push installed monitoring wells and drilled monitoring wells) is being conducted on the leading edge of a methyl tertiary butyl ether (MTBE) plume located in a shallow semi-perched aquifer (saturated thickness extending 9 to 22 feet (2.7 to 6.7 meters) below ground surface). The purpose of this effort is to determine whether direct push wells compare favorably with conventional hollow stem auger (HSA) drilled wells. To make this determination, groundwater samples were extracted from numerous adjacent direct-push and HSA installed wells over several sampling events. Analysis of variance (ANOVA) statistical techniques were applied to the resulting chemical data to differentiate between the variability attributed to well type, temporal, and spatial factors.

BACKGROUND

Direct-push monitoring wells are typically considered "temporary" monitoring points, since detailed comparisons with conventional drilled HSA monitoring wells have not previously been conducted. The main regulatory concerns regarding the use of direct-push wells for long-term ground water monitoring include the following:

- Filter pack materials (to prevent sediment entry) are either not used or are not based on grain size distribution of the formation in contact with the well screen section.
- Direct-push well installation specifications do not exist. Therefore, current minimum annular sealing requirements are based soley on drilled well specifications.
- Annular sealing may not be complete for pre-packaged well screen devices and tremmied filter pack applications under certain geologic conditions.

Sample representativeness can be affected by vertical migration of contaminants (cross contamination) caused by incomplete annular sealing of the well. Tremmie filter pack installation methods used for HSA wells can produce voids and preferential migration pathways, and lead to cross contamination. The American Society of Testing and Materials (ASTM) Standard Practice for Design and Installation of Groundwater Monitoring Wells in Aquifers (ASTM D 5092) specifies filter pack design based on grain size distribution of the screened interval of the aquifer formation.

The State of California Department of Water Resources (1981) requires the following:

"An oversized hole, at least 4 inches (100 millimeters) greater than the diameter of the conductor casing, shall be drilled to the depth specified ... and the annular space ... filled with sealing material."

The purpose of the 2-inch (5.08-cm) increase in annular sealing radius is to ensure that formation particles are inhibited from entering the well. However, since the design theory of sand pack gradation is based on mechanical retention of the formation particles, a pack thickness of only two or three grain diameters is required to retain and control the formation materials (Driscoll, 1986). Since it is impractical to tremmie a sand pack in a drilled well annulus only a fraction of an inch thick and expect the material to completely surround the well screen, the 2-inch (5.08-cm) requirement has been used as a minimum criteria. Current designs for pre-packaged direct-push well screens allow for the use of "thin" filter packs (Figure 1). Therefore, the 2-inch (5.08-cm) requirement applied to drilled wells may not be necessary for direct-push, pre-packed wells.

APPROACH

On 11 August 1999, an advisory committee comprised of experts from industry, government regulatory entities, and academia was assembled to determine how best to compare the performance of direct-push and drilled monitoring wells. Of particular interest was the comparison of chemical data (e.g., concentration of contaminant of concern and monitored natural attenuation indicator parameters), field measured parameters (e.g., temperature, pH, dissolved oxygen, etc.), and hydrogeologic data (potentiometric surface measurement) for the different types of wells. Detailed discussions related to direct-push well construction, experimental design, well configuration plans, statistical analysis, and sampling approaches were considered.

Field efforts included piezocone measurements, collection of core samples and water samples from selected depths, installation of customized monitoring well test cells (Figures 2 and 3), and sampling of the wells in triplicate using a low flow sampling procedure developed by EPA Region 1 through four rounds. Laboratory efforts included chemical analysis of water samples (for MTBE) and various inorganic materials and parameters), determination of permeability for selected core samples (for screen placement selections), and determination of grain size distribution (for well design as required by ASTM D 5092). To evaluate performance of wells adhering to the ASTM D 5092 specifications, grain size distribution curves were generated to determine filter pack grain size and corresponding slot size recommendations.

The recent development of pre-packaged well screen materials and annular protection devices for direct-push wells meeting the ASTM D 5092 specifications offers an alternative to the highly uncertain HSA tremmie filter pack installation method. Pre-packed well screens were evaluated during this comparison. Two additional well designs were also employed to account for the most common well installation designs used by HSA drillers and direct-push device operators. A total of 32 wells were installed in two cells from 8 to 14 February 2000.

An extensive statistical effort was conducted to compare the performance of the different well designs for the specific hydrogeologic regime. Analysis of variance (ANOVA) was selected as the best technique for analyzing data consisting of categorical factor predictors and a continuously varying response variable.

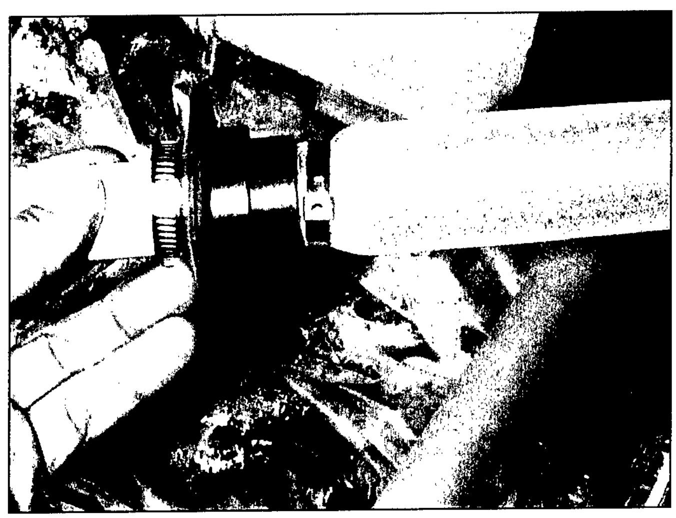

Figure 1. Preparation of a 3/4-inch prepack direct-push well. The stainless steel enmeshed sand pack sleeve covers the slotted portion of the PVC riser pipe. The flanged area protects the screen from backfill materials.

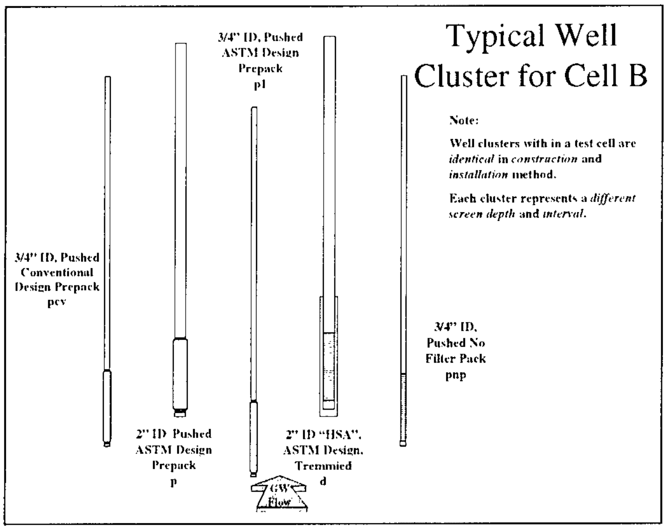

Figure 2. Cell B well cluster configuration.

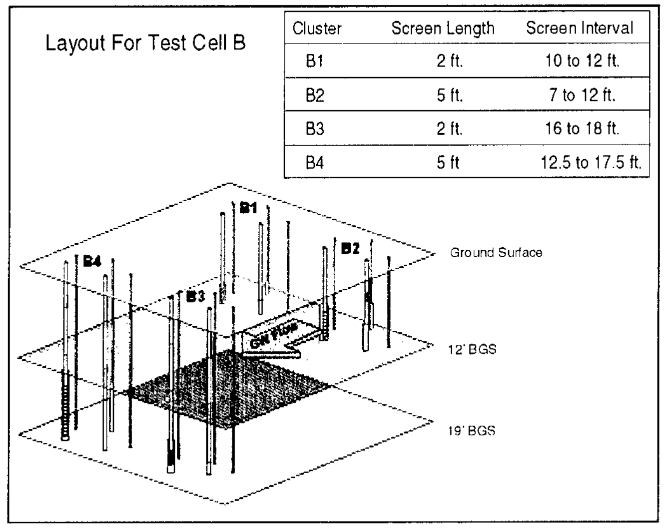

Figure 3. Cell B layout.

RESULTS

Using ANOVA standard statistical techniques, it was determined that no significant performance differences were observed between the direct-push wells and HSA drilled wells. Within experimental error, the performance was comparable for the particular hydrogeologic setting. Details of the analytical and statistical approach can be found in Kram et al., 2001. Although a comprehensive hydraulic evaluation was not conducted, the different well designs performed similarly with respect to water level measurement. Efforts to gain regulatory acceptance are currently in progress.

BENEFITS

Direct-push sample access devices can help Remediation Project Managers save significant amounts of money and time for well installation, sampling, and monitoring efforts. For instance, more direct-push wells can be installed per day, material costs are lower, and no hazardous soil cutting waste is generated.

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