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April 14, 2006

Ms. Amy McLaughlin
Remedial Project Manager
U.S. Environmental Protection Agency, Region IV
4WD-SRTMB
61 Forsyth Street
Atlanta, Georgia 30303-3104

Subject: Approaches to Evaluating Vertical Hydraulic Connection of Backfill Material Used in Construction of UF Aquifer Wells at the Cabot Carbon /Koppers Site in Gainesville, FL

Dear Ms. McLaughlin:

On behalf of Beazer East, Inc. (Beazer), enclosed with this letter is an assessment of potential approaches to evaluating vertical hydraulic connection of the fine-sand backfill material used in the construction of the UF Aquifer wells. Attachment A includes a brief discussion of the alternative well design and conceptual model. Table 1, included with Attachment A, presents various technical approaches to attempt to address the issue of vertical flow through the backfill material along with their respective advantages and disadvantages.

As indicated in Attachment A, there is no single approach to directly measure vertical hydraulic connection through the backfill material; however, there are two approaches that may provide a quasi-estimate of vertical groundwater flow through the find sand and its' potential affect on data obtained from the UF wells.

Please feel free to contact me at (303) 665-4390 if you have any questions or comments concerning this technical assessment of potential methods.

Sincerely,

James R. Erickson

James R. Erickson
Program Manager

Attachment

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Attachment A
Technical Approaches to Evaluate Hydraulic Connection of UF Aquifer Well Backfill Materials – Approach, Advantages and Disadvantages

The U.S. Environmental Protection Agency (EPA) has requested that Beazer perform an evaluation of potential technical approaches to assess the hydraulic interconnection of groundwater through fine-sand backfill material separating the screen intervals for the Upper Floridan (UF) Aquifer wells. This evaluation is intended to address recent concerns raised by the Gainesville Regional Utilities (GRU) Team as to the potential for significant groundwater flow through the backfill material used to separate multiple-screen intervals in the UF Aquifer wells. It should be noted that all Stakeholders were provided the opportunity to review and comment on the proposed alternative well design prior to the construction of the UF wells and that no concerns were raised by the Stakeholders at that time. It is only after transmittal of transect well preliminary sampling results that the GRU Team chose to raise concern for potential cross flow.

It is the Beazer Team's position that the well design and backfill materials used in the construction are appropriate and technically defensible, given the conceptual model of a vertically hydraulic connected Upper Transmissive Zone (UTZ) and the low vertical hydraulic-head gradients across this zone. Further, the alternative well design provides a more effective isolation of discrete zones within the UTZ than the original well design proposed for the UF Aquifer Program that consisted of an open borehole with individual zones isolated by a 3-foot long inflatable packer. The potential for vertical flow around the relatively short packer seal via vertical fractures and secondary dissolution features in the porous limestone is much greater than an approximately 10-foot long fine-sand backfill seal.

The conceptual model for the specification of the backfill material used in the UF wells is that the vertical permeability of the backfill material should be approximately equal to or less than the average vertical permeability of the UTZ beneath the Koppers site (the Site). The average vertical permeability of the UTZ is primarily dominated by secondary dissolution features, but the matrix permeability of the partially consolidated and porous limestone rock matrix is also expected to have a significant impact on the average vertical permeability of the UTZ.

Geologic core collected during the drilling of wells in the UF Aquifer demonstrated that an open borehole completion was not feasible for the installation of a Westbay system. The core provided direct visual confirmation that the upper 80 to 100 feet of the Ocala Limestone bedrock was primarily highly indurated (unconsolidated) throughout the majority of the UTZ beneath the Site. As such, a multiple-screen well design was proposed for completion of the wells. The multiple-screen well design consisted of 10-foot long well screens separated by 10-foot long blank casing. Core samples collected from two boreholes were analyzed for grain size to establish the screen-slot size and filter pack appropriate for the Ocala Limestone beneath the Site. The results of this analysis demonstrated that a 30-slot screen opening would be the maximum size opening appropriate for a production well completed in the natural unconsolidated and porous deposits in the Ocala Limestone. To minimize the amount of potential fines entering the well, a more conservative 20-slot screen size was chosen for the UTZ. In addition, because the grain-size of the natural formation was large enough to accommodate a 30-slot screen opening, it was reasonable to assume that a 30/65 fine-sand mixture is a much smaller grain size than the natural formation and would therefore be less permeable than the natural formation material. Also, this is the lowest permeability material that could be feasibly placed down the well from land surface.

Technical Approach

Direct measurement of the in-situ hydraulic connection through the fine-sand backfill material is not possible. There is no single approach that can address this issue directly. Table 1 provides a summary of potential approaches to address the issue of hydraulic-head gradients and vertical hydraulic conductivities of the UTZ and backfill material. Although none of these methods will provide undisputable evidence of the presence or lack of significant hydraulic connection through the backfill material, select methods may provide a level of assurance that significant vertical hydraulic-head gradients are not present in the UTZ and that the fine-sand backfill material is not significantly affecting data collected from these wells.

The following is a list of potential methods that could be examined to determine their viability of addressing the issue of vertical hydraulic connection through the fine-sand backfill material and the issue of vertical hydraulic gradients across the UTZ. The approaches are grouped based on: 1) Laboratory measurements, 2) In-situ tests, and 3) Installation of new wells.

Laboratory Permeability Measurements

1) Fine-sand backfill K_v versus model UTZ K_v;
2) Fine-sand backfill K_v versus UTZ Core K_v; and
3) Grain-size analysis of fine sand and UTZ core for K_h estimate.

In-Situ Tests and Measurements

4) Field measurements of K_h UTZ compared to laboratory fine-sand backfill K_v (Orders of magnitude differences comparison) ;
5) Field measurements of K_v;
6) Tracer tests; and
7) Flow meter non-pumping.

Install Monitoring Wells and Measure Hydraulic Heads

8) Install new wells with short screens (10-ft) at top of UTZ and base of UTZ;
9) Install new well at base of UTZ adjacent to existing FW well in UTZ; and
10) Construct temp well and measure vertical hydraulic heads in FW-24C.

As indicated above, none of the technical approaches listed will provide a direct measure of vertical groundwater flux through backfill material. Table 1 presents potential approaches and the advantages/disadvantages of each approach.

Table 1. Potential approaches, advantages and disadvantages to evaluating vertical hydraulic connection through backfill material used in the construction of UF Aquifer wells.

Approach	Test Methods	Advantages	Disadvantages
#1 Lab K_v for fine sand versus numerical model estimated K_v	• Laboratory falling-head permeameter test on 3 samples of fine sand. • Calibrated model K_v.	• Lab K_v good value for sand (addresses potential flow in fine sand issue). • Model K_v represents REV for UTZ that includes secondary K_v permeability features.	• Model K_v value not an in-situ measured value. • Lab K_v value based on small volume (but sand fairly homogeneous). • Model K_v for UTZ only an estimate.
#2 Lab K_v for fine sand versus lab K_v for UTZ	• Laboratory falling-head permeameter test on 3 samples of fine sand and 3 samples of UTZ core.	• Lab K_v good value for sand (addresses potential flow in fine sand issue).	• Lab K_v value UTZ does not represent dominant secondary K_v permeability features. • GRU's concern about UTZ core representativeness.
#3 Estimate K from Grain-Size Analysis	• Laboratory grain-size analysis on 3 samples of fine sand and 3 samples of unconsolidated UTZ core.	• Easy to measure in lab • Should give relative estimate for K_v sand, and K_h limestone of the unconsolidated fraction (addresses potential flow in fine sand relative to flow in porous formation). • Performed this analysis for alternative design to size screen slots. • Screen manufacture recommended 30 slot (about 12/20 filter pack) for UTZ; backfill sand (30/65) is much smaller grain-size.	• Does not address flow in fine sand. • Estimate of K_h and not K_v. • How accurate are K values estimated from grain size? • GRU's concern about UTZ core representativeness. • Only appropriate for unconsolidated fraction of limestone core and would not be representative of partially consolidated sections of core.

Table 1. Continued

#4 Lab fine sand K_v vs field K_h for UTZ	• Laboratory falling-head permeameter test on 3 samples of fine sand. • Pumping test performed in 1 well to estimate K_h in the UTZ.	• Good K_v value for sand (addresses potential flow in fine sand issue). • In-situ K_h representative of larger aquifer volume. • K_h will control hydraulic heads and impacts of low flux.	• Not a direct comparison to UTZ K_v vs Sand K_v.
#5 Lab fine sand K_v vs. field K_v for UTZ	• Laboratory falling-head permeameter test on 3 samples of fine sand. • Single-well pumping test in an isolated zone while measuring hydraulic heads above and below pumping zone.	• Good K_v value for sand (addresses potential flow in fine sand issue). • Estimate of in-situ K_v.	• No good methods to measure K_v in situ. • Data analysis methods limited and questionable. • Method based on a porous media and not for secondary K_v permeability features. • Requires a new well.
#6 Tracer Test	• Inject tracer into a Westbay purge port and monitor for tracer in zone below.	• Direct measure of interconnectivity of UTZ in combination with fine sand.	• Inability to isolate/attribute tracer migration to fine-sand backfill versus UTZ matrix. • How to distinguish flow in porous formation vs fine sand? • Relation of tracer concentration to impacts on flow and head questionable.

Table 1. Continued

#7 Flow Meter	• Perform a static flow meter survey in 1 to 3 of the UF Wells, after the Westbay systems have been removed; requires an extremely sensitive low- flow downhole meter.	• Easy to run once Westbay system removed from well (allowing potential cross contamination).	• Does not address potential flow in fine sand (measures flow between screen intervals in an open borehole that does not exist when Westbay system in place). • Measure of flow between screen intervals, but not fine sand outside of well casing. • No information on head differences between zones.
#8 Two new wells screened top and bottom of UTZ	• Install a new well, with a 10-foot screen about 20 feet into the top of the Ocala Limestone and a second similar well at the base of the UTZ.	• Direct measure of head gradient across UTZ. • Can be compared to hydraulic-head gradient in discrete intervals at Westbay installations.	• Does not directly address potential flow in fine sand. • Additional compromise of HG clays as a result of additional well penetrations. • Costs to install 2 new wells.
#9 One new well screened bottom UTZ next to FW-4 or FW-2	• Install 1 new well screened in the base of the Ocala Limestone UTZ adjacent to existing FW-well that is only screened in top of UTZ.	• Direct measure of head gradient across UTZ. • Only 1 new well required. • Can be compared to hydraulic-head gradient in discrete intervals at Westbay installations.	• Does not address potential flow in fine sand. • Additional compromise of HG clays. • Screen intervals of existing UF wells about 20 feet in length. • Costs to install 1 new well.

Table 1. Continued

#10 Install temporary well to measure heads FW-24C	• Place drill rig on standby once Ocala is encountered and measure heads in upper 10 feet of Ocala Limestone; drill to base of UTZ and construct temporary well to measure heads at base of UTZ, prior to completing permanent well in semi-confining unit.	• Easy to measure head in top of UTZ (but not bottom). • No additional wells required. • Grouting UTZ will not impact this well, since UTZ will be grouted as part of final design. • Costs less than new well.	• Does not address potential flow in fine sand. • Rig standby and temp well construction costs. • Difficulty in measuring hydraulic head at bottom of UTZ because of the need to construct a temporary well that seals the UTZ above the screen.

Recommendation

Given the limitations of the majority of the proposed methods above, it is the Beazer Team's position that the best technical approaches to addressing the potential hydraulic connection through the fine sand is a combination of methods #1 and #10. Method #1 will provide some indication of vertical hydraulic conductivity of the fine sand in relation to regional calibrated hydraulic-conductivity values of the aquifer system, and method #10 will provide a direct measure of vertical hydraulic gradient to compare to Westbay measurements. With these parameter values, a quasi-estimate of vertical groundwater flux can be determined and compared to horizontal flux in the UTZ. The results of this calculation will provide an approximation of potential impacts, if any, of vertical groundwater flux through the backfill material.