MICHIGAN DEPARTMENT OF ENVIRONMENTAL QUALITY

INTEROFFICE COMMUNICATION

February 25, 2005

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SUBJECT: Evaluation of Unit E Interim Response Work Plan

Pall Life Sciences (PLS) has submitted a work plan in which they propose to implement an interim response in the vicinity of the Maple Village Shopping Center to remediate the 1,4-Dioxane in the Unit E Aquifer. The work plan was prepared by Fishbeck, Thompson, Carr & Huber, Inc. (FTC&H). Included in this work plan were the analytical modeling of a proposed extraction well and injection well system that will be the primary interim response measure and a proposal for monitoring the interim response. The purpose of this correspondence is to provide comments regarding the adequacy of the modeling and the proposed monitoring network.

Analytical Modeling of Interim Response

PLS has proposed to use a single extraction well pumping at 200 gallons per minute (gpm) and two injection wells, each with an injection rate of 100 gpm as a partial remedy of the 1,4-Dioxane plume found at depth in sands referred to as the "Unit E Aquifer." An analytical model was used to evaluate the effectiveness of the design of this extraction and injection well system. FTC&H used AquiferWin32 (version 3.1) in developing this model. With AquiferWin32 it is possible to use an analytical well hydraulics model (e.g., Theis confined aquifer solution) to compute groundwater-level (hydraulic head) declines, or increases in head, and superimpose these declines and increases on the regional hydraulic head gradient to get a "disturbed" potentiometric surface. This surface is then used in a particle tracking analysis to show the simulated hydraulic influence of the proposed well system.

Model Assumptions

Very little information was provided in the few paragraphs contained in the work plan that describe the modeling. As a result, it is necessary for us to make certain assumptions regarding the application of the analytical model to this problem. The assumptions with this model are as follows:

1. A Theis (assumed) well-hydraulics model having the following assumptions is applicable:
    - Confined aquifer.
    - No recharge to aquifer.
    - Well fully penetrates the aquifer.
    - The aquifer is laterally extensive and has uniform thickness throughout its extent (85 feet).
    - The aquifer is homogeneous and isotropic (horizontally and vertically) with a hydraulic conductivity equal to 307 feet/day.
2. The hydraulic head gradient is uniform (0.00226 feet/feet).
3. There is no vertical head gradient within the aquifer.
4. Particles movement within the aquifer is in the horizontal direction only and uniform throughout the vertical extent of the aquifer.

5. Particle movement is determined by horizontal head gradients and is not impacted by horizontal heterogeneities within the aquifer.

Model Results

The model was used to simulate the impact of pumping a central extraction well at a rate of 200 gpm and injection of treated groundwater in two lateral injection wells (100 gpm each) on the groundwater-flow field in the vicinity of Maple Road. Particle tracks depicting the simulated direction of groundwater flow were shown in Figure 1 of the work plan. These particle tracks show that the simulated area of capture appears to encompass, in map view, the area of highest delineated 1,4-Dioxane contamination. The particle tracking analysis also shows that many particles that migrate from areas of apparently lower 1,4-Dioxane concentrations are not captured and migrate downgradient of Maple Road. Presumably these particles represent groundwater having 1,4-Dioxane concentrations less than 2,800 ug/L. The simulated particle-tracking results also show that there appears to be a small amount of deflection of the contaminant plume to the north and south as a result of the injection of treated groundwater at IW-3 and IW-4 (TW-16).

Model Evaluation

The model used for design of the interim response wells is very simple and there has been no demonstration that it can be used to replicate hydraulic responses in the field. It should have been obvious from the performance of the TW-16 aquifer test that the subsurface geology and the degree of interconnection between sand zones are very complex and not well understood. It was because of the data from this test that there is so much uncertainty in the estimated transmissivity and storativity of the aquifer. The degree of interconnection and the migration of the contaminant plume in the vicinity of Maple Road are still not well understood. That being said, it may be possible to estimate an extraction rate that may be conservatively modeled using a Theis (or any other) well hydraulics model and a relatively high hydraulic conductivity. However, it will not be possible to obtain reasonable particle tracking simulations using this model without first demonstrating that the simulated flow paths are reasonably accurate by comparing simulated flow paths with those estimated from field data. To do this, it would be necessary to account for aquifer heterogeneity and inhomogeneity, including hydrogeologic boundaries, while performing the particle-tracking analysis. This means that it would be necessary to determine the reasons for the relatively sharp 1,4-Dioxane concentration and hydraulic-head gradient immediately east of Maple Road. It has to be determined whether these gradients are the result in changes in subsurface geology, or sampling and data distribution. The mechanisms responsible for these gradients may have a significant impact on the interim response well system and will have a definite impact on the migration of uncaptured contaminated groundwater and the placement of performance monitoring wells.

In other words, the particle tracking analysis performed using the analytical model in the work plan is not based on a calibrated model that accounts for aquifer heterogeneity and inhomogeneity and, as a result, cannot be used as a predictor of contaminant plume migration pathways or in the design of the performance monitoring network.

Recommendations

Extraction Well Pumping Rate

The analytical model analysis showed that a pumping rate of 200 gpm may be adequate to capture the horizontal extent of the highest delineated 1,4-Dioxane contamination. However, it has yet to be determined whether the aquifer is capable of producing water at this rate, what the actual lateral extent of drawdown will be, or what the actual vertical extent of influence will be at this location. It is recommended that the pumping rate be re-evaluated after the testing of wells TW-18 and IW-3.

This would also apply to the determination of injection rations for the two injection wells. It may be that the aquifer or well at one, or both locations may not be able to accept the treated groundwater at the proposed rate (100 gpm).

Work Associated With Drilling, Installation, and Testing of TW-18 and IW-3

There is no mention of the anticipated drilling depths for either TW-18 or IW-3. An examination of the data from wells MW-85 and MW-88 would indicate that the minimum drilling depths at TW-18 and IW-3 would be 200 feet and 150 feet, respectively. This is much greater than the 90 feet stated in the work plan. Vertical profiling of groundwater quality should exceed these depths to insure that maximum concentrations have been delineated, at least for TW-18.

Also, in the work plan there is not mention of the collection of sediment samples for performing grain-size distribution analysis for proper sizing of the gravel pack and screen slot opening. On the basis of work done at surrounding locations, it should be possible to anticipate the expected screen interval for these wells. It is recommended that sediment samples be collected from appropriate depths for grain-size distribution analysis.

There is no mention of performing geophysical logging of the open boreholes. It is recommended that geophysical logging (gamma ray or others) be completed in the open borehole prior to the installation of well casing and well screen. This is a necessary step to insure proper well screen placement when designing and installing wells TW-18 and IW-3.

Other than selecting a pump, there is no mention of other purposes for which the test data might be used, nor is there a list of nearby monitoring wells in which to measure drawdown and recovery. The test data would be used to refine the estimate of transmissivity and storativity, and to evaluate the impact of possible hydrogeologic boundaries on drawdown and flow paths in the vicinity of Maple Road. The assumption being that the area having the greatest relative connection to the zone in which TW-18 will be screened, and presumably through which the center of mass of the plume migrates, will show the greatest impact during the test. It is recommended that wells MW-85, MW-79, MW-84s&d, and MW-87s&d be used to monitor the test of TW-18, and that wells MW-88 and MW-79 be used to monitor the test of IW-3.

Performance Monitoring Network

PLS has proposed to monitor the performance of the interim response using existing monitoring wells that were installed for the purpose of delineating the extent of 1,4-Dioxane contamination within the Unit E Aquifer. The locations of these wells were shown on Figure 4 in the work plan. The wells located nearest (downgradient) to the interim response wells are MW-79, MW-84s&d, MW-89, MW-81, MW-83s&d and MW-90. We feel that the design of a good performance monitoring network is critical since our evaluation of the performance of the interim response will be based on field chemical data and not on the simplistic particle tracking analysis that was presented. It's also our opinion that, because the migration pathway east of Maple Road is not well known, it is not possible to state that the proposed monitoring network is adequate to monitor the effectiveness of the proposed interim response. These wells may not be located in the correct locations for this purpose; and, additional monitoring well clusters may be required. Rather than make specific recommendations regarding the final configuration of the performance monitoring network, we would recommend revisiting this issue after the drilling, vertical sampling, and testing of TW-18 and IW-3. It is likely that additional monitoring well clusters will need to be installed north and south of MW-84s&d.

Please contact me if you have any questions regardiing this review.