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Subject:
GM-38 Area Model Simulation Results Comparison.

ENVIRONMENTAL

Date:
5 May 2003

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Dear Dave:

The purpose of this letter is to document the work performed and results of groundwater modeling conducted in support of the GM-38 Area Remedial System Design, and to respond to comments by H2M Group (H2M) on the modeling conducted. Specifically, this letter describes details of model construction, as they relate to the representation of groundwater quality in the model, and the data sources relied upon to develop that groundwater quality representation. In addition, this letter compares model simulation results for the currently proposed GM-38 Area Remedial System versus a scenario where no active remediation of the GM-38 Area occurs. The comparison provides a clear perspective as to the expected groundwater system benefits as a result of remedial system implementation.

The GM-38 Area is an area of elevated volatile organic compound (VOC) concentrations in groundwater in the vicinity of Monitoring Well Cluster GM-38. Monitoring Well Cluster GM-38 is located southeast of the Northrop Grumman facility in Bethpage, New York, between Bethpage Water District (BWD) Plant 4 (i.e., Supply Wells 6915 and 6916) and BWD Plant 5 (i.e., Supply Well 8004), as shown on Figure 1 (Plate 1).

Based on comments obtained from some members of the Technical Advisory Committee (TAC) (H2M Group letter to Carlo SanGiovanni dated January 2, 2003 and H2M Group letter to Steven Scharf dated December 2, 2002), it appears as though some misconceptions exist related to the goals of the GM-38 Area Remedial System and the distribution of contaminant mass in the model. This letter restates and more clearly describes both the GM-38 Area remedial goals and the representation of contaminant mass in the model.

GM-38 Area Remedial System Goal

The goals of the GM-38 Area Remedial System (the System) are to provide capture, contaminant mass removal, and treatment of VOCs in groundwater from the area of

elevated concentrations in the vicinity of Well Cluster GM-38. The currently proposed System was designed to address contaminant mass removal from both the area within the 1,000 µg/L TVOC contour and the area within the 500 µg/L TVOC contour, although a slightly longer period of operation is required to remove TVOCs at and above 500 µg/L. As currently proposed, the System meets the remedial goals and satisfies the requirements of the New York State Department of Environmental Conservation (NYSDEC) Record of Decision (ROD).

The updated Northrop Grumman groundwater model (documented in the ARCADIS October 30, 2002 letter report) was used in this evaluation.

Sources of Groundwater Quality Data

Water quality data from groundwater monitoring wells, supply wells, and vertical profile borings were used to develop the contaminant mass distribution used in the model.

Groundwater monitoring well data is representative of water quality in a much smaller portion of the aquifer than supply wells, because monitoring well screens are typically between 10 and 20 feet long and monitoring wells do not impart a significant pumping stress on the aquifer that might tend to dilute concentrations coming from impacted aquifer segments. As such, groundwater quality data collected from monitoring wells is appropriately representative of a small vertical section of the aquifer. Groundwater monitoring well data was used in developing the contaminant contour maps that were used to define the distribution of contaminant mass in the model.

Vertical profile borings utilize a 2-ft long screen that is sampled at specific depth intervals within a vertical column of the aquifer. In most instances, the sampling takes place at 10 or 20-ft intervals. The results of this sampling provides the most detailed vertical distribution of groundwater quality in the groundwater system, at a given location. Results obtained from many vertical profile borings were used in conjunction with the monitoring well data to develop the contaminant distribution contour maps described above.

In general, supply wells have long screens and collect water from a large vertical section of the aquifer. As such, water quality results from supply wells tend to report concentrations that are lower than the peak concentration of contaminants within discrete segments of the aquifer. This is because water from the aquifer's cleaner zones mixes with water from impacted portions of the aquifer as the water is extracted by the well. For this reason, supply well water quality data was generally used in a qualitative manner to validate contaminant contouring.

Representation of Contaminant Mass in the Model

The general methods used to represent contaminant mass in groundwater modeling are summarized immediately below. The specific approach used to represent mass in the Northrop Grumman model is described in the below section entitled "Data Grouping and Mass Distribution". Frequently, multiple (vertical) water quality data points will exist for a single model layer. When the distribution of contaminant mass is simulated in the a model, the assignment of mass for a given layer must be representative of the real-world data collected throughout the entire vertical section of the aquifer represented by that layer. Spatially, in the horizontal direction, assigned concentrations within a single model layer may vary, however, a single appropriate value must be used to represent the vertical distribution of concentrations within a single model layer and single model cell. Simply put, within a single model layer, every model cell can have a different value that is representative of contaminant mass, however, if multiple data points are available within a single model cell, a determination must be made to how best represent the mass within the single cell. Assignment of a concentration value to the model based on a single sample, without accounting for the range in concentration associated with samples collected above and below that sample (that were collected within the bounds of the same model layer and cell) could bias the model to over- or underestimate mass in the aquifer.

Data Grouping and Mass Distribution

The Northrop Grumman groundwater model has been constructed with 11 layers, each approximately 100 ft thick. For the Northrop Grumman model, water quality data was evaluated by grouping the groundwater quality data that corresponded to the various model layers based upon the elevation from which the samples were collected. Monitoring well data collected between December 1999 and December 2001 were averaged; vertical profile boring data representative of a specific model layer were also averaged, to develop an average VOC concentration representative of the elevation range assigned to a given model layer. The averaged monitoring well and vertical profile boring data were then used to develop contour maps of specific model layers, as well as the model layers in between. As such, the concentration assigned to an individual model cell (when several vertical samples have been collected from the aquifer within the top and bottom elevations of the corresponding model cell), may have a lower concentration than the highest concentration detected in any of the individual groundwater samples representative of a particular model layer.

For example, five samples are collected at 20 foot intervals over a 100 foot vertical thickness of aquifer material. The 100 foot thick aquifer segment exactly corresponds to a 100-foot thick layer within the groundwater model. All five samples show VOCs at 10 ppb. The concentration value assigned to the model cell within the model layer that corresponds to this 100 foot thick aquifer horizon would be 10 ppb. However, if one of the samples showed a concentration of 20 ppb, the assigned concentration for the model cell would be 12 ppb (a straight average of concentrations when sampled intervals are evenly spaced throughout the vertical section). If the sample locations are not evenly distributed in the vertical section, then a weighted average is calculated with more weight assigned to those concentrations that represent thicker aquifer horizons. In this manner, the mass of contaminants within the entire 100 foot thick aquifer horizon is appropriately represented in the model and contaminant mass is conserved. Given all available data, and the goals and objectives of the modeling effort, this approach to mass representation and level of vertical discretization is appropriate.

No Active Remediation versus GM-38 Area Remedial System

To better illustrate how the contaminant mass was represented in the model, and how the proposed GM-38 Remedial System achieves the remedial project goals, ARCADIS has prepared a series of figures that depict the initial plume (contaminant mass) distribution and the model-predicted movement of the GM-38 Area TVOC plume. Two types of figures have been prepared; one type shows the current location of the plume, as well as the model-predicted plume location at 5, 10 and 30 years simulated time, for Model Layers 5, 6 and 7 for the No Active Remediation (or baseline) scenario. The other type shows the plume at the same times, and in the same model layers, but with the proposed 2-well GM-38 Remediation System operating during the first 10 years of the simulation (i.e., the remediation system only operates for 10 years, after which time [years 10 to 30] the model continues to run with the remedial system off).

Model Layers 5, 6, and 7 are shown because they correspond to the most significantly impacted portion of the aquifer. Although other portions of the aquifer are also impacted in the vicinity of Well Cluster GM-38, the concentrations associated with these impacts are lower than the 50 µg/L threshold used for this presentation.

No Active Remediation Scenario

Figures 1 through 3, 7 through 9, 13 through 15, and 19 through 21 (Plates 1 through 4, respectively) show how the unremediated (i.e., no active remediation) TVOC

plume, located at the GM-38 Area, moves through the aquifer with time. It is significant to note that even without the operation of the GM-38 remedial system, concentrations of TVOCs in the aquifer decline substantially over 30 years. After 30 years, TVOC concentrations in Model Layers 5 and 6 declined from peak concentrations in excess of 1,000 µg/L to less than 500 µg/L.

It is apparent from these figures that the ongoing operation of BWD Supply Wells 6915, 6916, and 8004 is limiting the movement of the TVOC plume. Changes in the shape of the plume, and its general tendency to remain in the GM-38 Area rather than migrate to the southeast in the direction of regional groundwater flow suggest that the plumes movement is influenced by the operation of the BWD supply wells.

GM-38 Area Remedial System Scenario

Figures 4 through 6, 10 through 12, 16 through 18, and 22 through 24 (Plates 1 through 4, respectively) show how the operation of the proposed (2 well) GM-38 remedial system affects peak concentrations and movement of the TVOC plume over time. To produce these figures, a 30-year solute transport simulation was conducted. Model output from the first ten years of the simulation was used to generate Figures 4 through 6, 10 through 12, and 16 through 18. During this ten year period, the remedial system is simulated as operating and the figures show the plume at the present time, 5 years from now, and 10 years from now. After 10 years, the GM-38 remedial and injection wells were turned off, and the movement of the plume was tracked for the remaining 20 years. Figures 16 through 18 indicate that after 10 years, the concentrations of TVOCs in groundwater in the GM-38 area have fallen below 100 µg/L in Model Layers 5 and 7, and are below 50 µg/L in Model Layer 6. Figures 22 through 24 show that after 30 years, TVOC concentrations in the vicinity of the GM-38 Area are less than 50 µg/L, therefore, no contour lines are visible in these figures.

Conclusions

When comparing the movement of the TVOC plume under the No Active Remediation (Figures 1 through 3, 7 through 9, 13 through 15, and 19 through 21) and the GM-38 Area Remediation scenarios (Figures 4 through 6, 10 through 12, 16 through 18, and 22 through 24), it is clear that the operation of the proposed GM-38 Remedial System provides a significant benefit with respect to the rate of aquifer cleanup. Further, operation of the proposed GM-38 Remedial System for a period of ten years would be sufficient time to accomplish the stated goals. In fact, the goals would be far exceeded.

Operation of the proposed GM-38 Remedial System removes the potential for contaminant mass (greater than 500 ppb) currently located in the GM-38 Area from migrating downgradient and potentially impacting downgradient receptors. In fact, model simulation results indicate that contaminant mass (greater than 50 ppb) currently located in the GM-38 Area will not migrate downgradient and potentially impact downgradient receptors. This result would far exceed the original goals of GM-38 system.

Please don't hesitate to call with any questions or comments.

Sincerely,

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Copies:
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