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contaminant Groundwater Interception - RMA

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Contaminant Groundwater Interception - RMA

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Abstract

Resolution of groundwater contamination is the major environmental concern at most contamination sites. At some sites immediate control is required to prevent further damage. This paper describes a pioneer groundwater interception and treatment system developed and evaluated at a major Army installation.

Acknowledgment

The tests described and the resulting data presented herein, unless otherwise noted, were obtained from research conducted for the Program Manager, Rocky Mountain Arsenal, by the U.S. Army Engineer Waterways Experiment Station. Permission was granted by the Chief of Engineers to publish this information.

Background

Rocky Mountain Arsenal (RMA) covers approximately 27 square miles northeast of Denver, CO, Figure 1. Since opening in 1942, RMA has produced chemical, biological and incendiary munitions and demilitarized obsolete chemical munitions. Additionally private corporations have produced pesticides at RMA. Effluents from these operations were discharged into several basins at RMA

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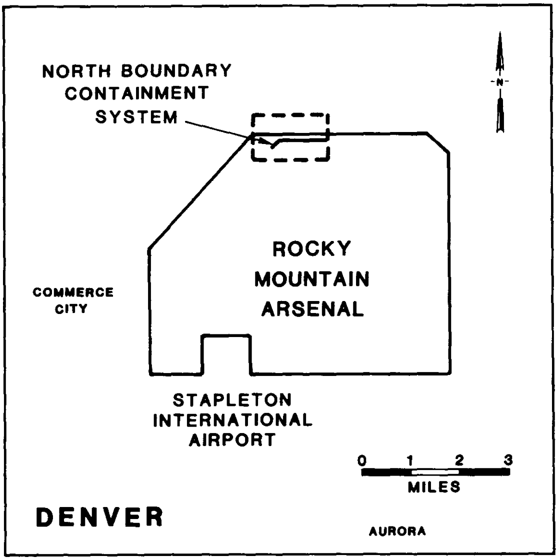

Figure 1. Location of RMA and North Boundary Containment System

resulting in contamination of groundwater beneath the basins (Thompson et al. 1985).

Alluvial groundwater generally moves north to northwest across the arsenal. With the discovery of contamination moving with the groundwater a pioneer system was developed by RMA and the Waterways Experiment Station to intercept, treat and recharge groundwater (Miller 1976). The North Boundary System (NBS) Figure 1 and Figure 2 was initiated in 1977 and has been in operation since that time. Periodically performance assessments were made to evaluate the performance of the NBS (PMSO, 1987) (PMSO, 1980).

This paper discusses the effect of the NBS on groundwater from 1977-1987. Since this study was completed additional modifications have been made to the system to increase its recharge effectiveness. During the period of this study the NBS consisted of four major components shown in Figure 2. These components include a line of dewatering wells to intercept the north-flowing groundwater, a slurry trench to act as a groundwater barrier in the alluvial aquifer, and a second line of wells which recharge groundwater treated in the fourth component—the treatment system. One objective of the

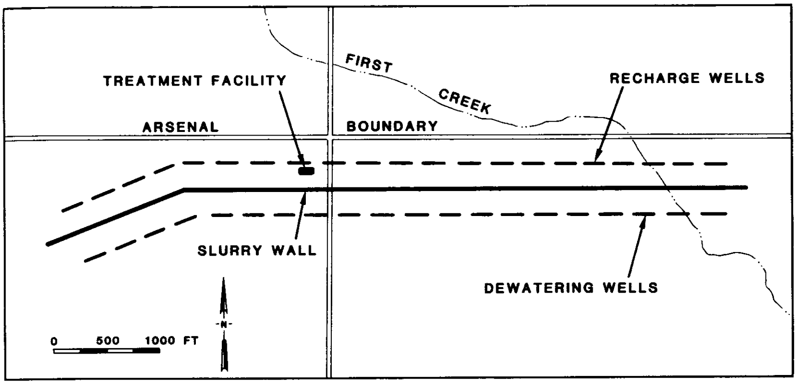

Figure 2. Components of North Boundary Containment System, Rocky Mountain Arsenal

periodic studies was to determine the effect of the NBS on alluvial groundwater flow and determine the average flow rate of groundwater toward the system; i.e. what should the system flow rate be to maintain the general areal groundwater flow regime?

Hydrogeology

The near-surface geology in the vicinity of the North Boundary System consists of about 25 ft of predominantly alluvial soils overlying the irregular erosional surface of the Denver formation. Figure 3, a geologic profile parallel to and approximately 250 ft south of the System barrier, illustrates the principle features of the upper geologic materials. Fine grained soils overlie relatively permeable basal sands and gravels in the alluvium. The Denver formation consists of older clayshales, sands and sandstone with permeabilities lower than those of the alluvium. The system barrier wall extends through the alluvium and is keyed in the Denver formation. Part of the system barrier is constructed across a broad alluvial valley incised into the Denver formation erosional surface.

Groundwater flows readily through the coarse alluvium and is the primary conduit for groundwater contaminants migrating toward the north boundary of RMA. Approximately 250 monitoring wells have been installed upgradient (south) and downgradient (north) of the system barrier in the alluvium. Quarterly readings of the water levels in the wells permitted construction of groundwater elevation contour maps for evaluation of the flow to and from the north boundary system. Figure 4, the contour map of water levels for March, 1986, depicts the alluvial

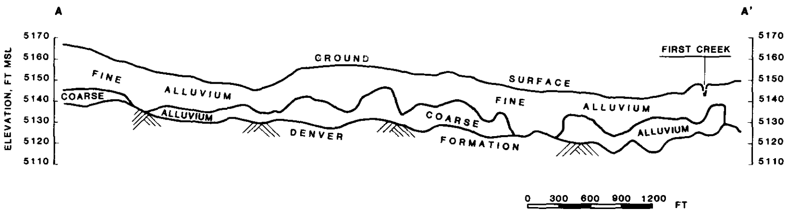

Figure 3. Simplified geologic profile parallel to slurry wall of North Boundary Containment System. Profile is approximately 250 ft south (upgradient) of slurry wall.

flow system near the north boundary. Groundwater flow (arrows) is channeled to the north boundary in the broad alluvial valley between areas of non-saturated alluvium to the west and east near Denver formation highs.

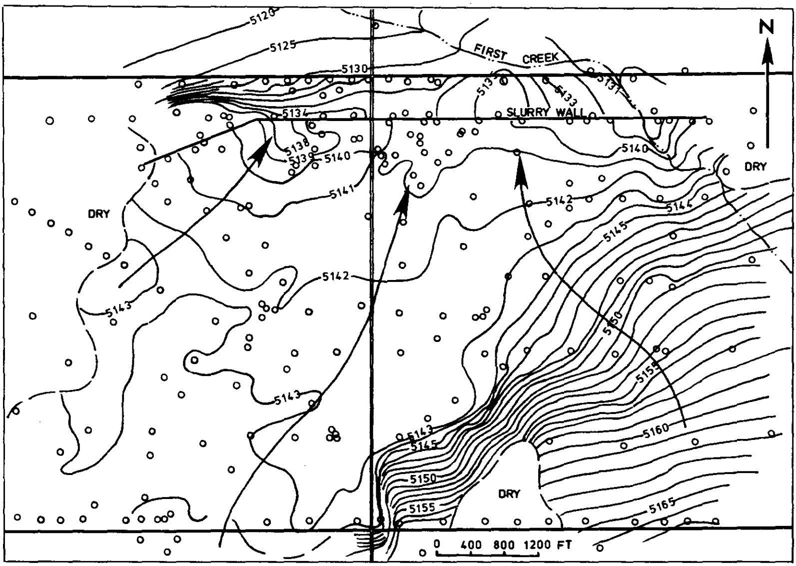

Figure 4. Groundwater contours for alluvial aquifer for 2nd Quarter FY 86, North Boundary. Arrows show groundwater flow direction. Circles are wells.

Twelve quarters of groundwater levels and system flow data were compiled for the evaluation presented in this paper.

Groundwater Flow and Influences

Various groundwater contour maps (e.g. Figure 4) and water level profiles were constructed from the large data base developed over the study period. Groundwater levels during certain parts of the study period were closely scrutinized and compared with precipitation, system flow rates, and major storm events; Fiscal Years (FY) 1985 and 1986 were such a period. Groundwater contours for this period indicated a seasonal cyclic movement of water levels. In the second quarter of each FY (Jan-Mar) contours would move toward the barrier (i.e. higher groundwater levels) relative to groundwater contours in the first (Oct-Dec) and fourth (Jul-Sep) quarters of the FY. Precipitation rates from nearby Stapelton Airport gave highest levels of precipitation in Apr-Sep and lowest levels in Oct-Mar. This pattern is opposite to that expected if precipitation had a strong influence on groundwater levels. The second major influence on groundwater levels to be analyzed was system flow rates, Figure 5. Flow rates were generally 200-300+ gpm for

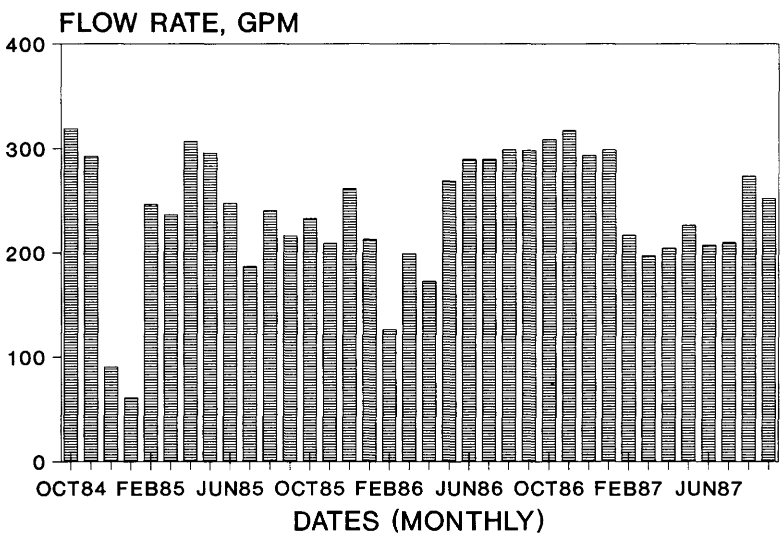

Figure 5. Total monthly flow through North Boundary treatment plant adsorbers, Oct 1984 through Sept 1987

FY 85 and 86 except for two periods; Dec-Jan 1984-85 and Jan-Apr 1986. These periods coincide with the higher upgradient water tables during the second quarter of FY 85 and 86.

In addition to these seasonal fluctuations a longer term trend of lower groundwater over the study period was noted. Again this did not appear to relate to precipitation rates.

Conclusions

Based on the type of monitoring data presented herein and on evaluation of treatment system effectiveness the NBS was intercepting essentially all of the groundwater flow moving toward the North Boundary. The lowering of groundwater during FY 85 and FY 86 implied that dewatering rates for these FYs exceeded groundwater flow rate toward the NBS. The cyclic nature of groundwater elevation upgradient of the system was primarily a function of system operation. The best estimate of the groundwater flow rate toward the system was 230 gpm.

Appendix I - References

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