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Phase II Operations Report for Groundwater Extraction at Well 4411, Oak Ridge National Laboratory, Oak Ridge, Tennessee
(DOE/OR/01-1882&D1)

May 30, 2000

This Phase II Operations Report discusses results of a recent groundwater pumping test conducted at Well 4411 located in the main plant area at Oak Ridge National Laboratory (ORNL). The pumping test was conducted to determine the optimum extraction rate for the Well 4411 system and, with this optimum extraction rate, to determine if extracted groundwater can be discharged directly to the ORNL Process Waste Treatment Plant (PWTP) without pre-treatment. The overall objective of the Well 4411 project is to extract groundwater at Well 4411 to provide additional containment of the Corehole 8 groundwater plume located in the ORNL main plant area. Further discussion of these activities is documented in the *Action Memorandum Addendum for the Waste Area Grouping 1 Corehole 8 Removal Action at the Oak Ridge National Laboratory, Oak Ridge, Tennessee* (DOE/OR/01-1831&D2).

PUMPING TEST

The Well 4411 pumping test was initiated on October 26, 1999, and concluded on January 24, 2000, when the variable speed pump control unit capacitor at Well 4411 failed and pumping operations were discontinued. At startup, pump discharge rates from Well 4411 to the ORNL PWTP were set at approximately 0.5 gallons per minute (gpm). Pump rates were increased in 0.5-gpm increments until a maximum pump rate of 5.0 gpm was reached on November 8, 1999.

On December 1, 1999, pump rates were decreased to approximately 3.0 gpm. The decision to decrease pump rates from 5.0 to 3.0 gpm was based on reviews of analytical data that showed decreases in contaminant levels being extracted at the higher 5.0-gpm pump rate. The decrease in contaminant levels was determined to be associated with removal of groundwater from the secondary porosity within the area of influence of the well, causing less contaminated groundwater from outside the zone of influence to be drawn in and extracted. Groundwater extraction continued at the 3.0-gpm rate from December 1, 2000, until January 24, 2000.

During the pumping test, the additional discharges to the ORNL PWTP were tracked as part of daily operations monitoring. Water grab samples were collected from the ORNL PWTP influent and changes to average contaminant loads received at the ORNL PWTP were documented. Additionally, grab samples were collected from the facility secondary waste stream filter cake to verify waste stream compliance with the facility Waste Acceptance Criteria (WAC). Field water level measurements also were collected during the pumping test from Well 4411 and other wells in the vicinity, including Wells 4005 (Corehole 8), 4410, 0539, and 0590. Water level measurements helped to determine the influence that extraction from the Well 4411 location had on the surrounding aquifer. Results of the pumping test are discussed below.

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PUMPING TEST RESULTS

Affect of PWTP Filter Cake Activity Levels

As previously stated, several grab samples were collected from the ORNL PWTP secondary waste stream filter cake during the Well 4411 pumping test. At extraction rates of 3.0 gpm or less, radionuclide levels in all associated filter cake samples remained below the current facility WAC for disposal at Envirocare of Utah, Inc. Levels of strontium-90 (Sr-90) were determined to be the closest to exceeding the 9.3E2-becquerel/gram (Bq/g) WAC limit. At 3.0 gpm, Sr-90 rates were detected just below the 9.3E2-Bq/g WAC limit. At an extraction rate of 2.0 gpm, Sr-90 rates decreased to approximately 7.0E2 Bq/g. As long as future extraction rates are kept at the optimal rate between 2.0 and 3.0 gpm, the ORNL PWTP WAC for secondary waste stream filter cake will not be exceeded and no pre-treatment system will be required at Well 4411 for extracted groundwater.

Affect of Pumping on the Plume

Water level measurements collected during the pumping test indicated the following results (Fig. 1). The maximum drawdown of 20 ft from pre-pumping water levels was observed in Well 4411 at the 5.0-gpm pumping rate. Head measurements collected at Well 4005 (Corehole 8), located approximately 200 ft along the geologic strike to the west of Well 4411, indicated that the deepest intervals in Well 4005 responded almost immediately to pump rate and water level changes in Well 4411. The maximum water level drawdowns in Well 4005 were approximately 18 ft in the bedrock zone from which Well 4411 was pumping and approximately only 3 ft near the bedrock surface. The subdued drawdown behavior in the shallow bedrock zone is consistent with the site conceptual model that the Corehole 8 plume is contained within a dipping limestone bed that is hydraulically isolated from overlying strata.

During the pumping test, water levels were observed to decline at Well 0539 (located approximately 1000 ft west of Well 4411) to levels approximately 1 ft deeper than have ever been observed previously in that well. Although drought conditions existed during the pumping test, the record low-water elevations in Well 0539 are attributed to the pumping test at Well 4411 because, during similar drought periods, Well 0539 had not shown such low-water elevations. Toward the end of the pumping test, review of data regarding the groundwater collection volume that was captured in the Corehole 8 Plume Collection and Transfer System indicated a decrease of approximately 1.0 gpm (i.e., from approximately 5.0 gpm to 4.0 gpm). This is approximately a 20% decrease in plume water flow volume at a distance of approximately 1000 ft west of the well pumping test at Well 4411.

Water levels in Wells 0590 and 4410, located approximately 300 ft and 500 ft, respectively, to the east of and along the geologic strike from Well 4411, were not affected during the Well 4411 pumping test. These observations support previous interpretations that the Corehole 8 plume apparently discharges predominantly to the west toward First Creek. The lack of hydraulic response in Well 4410, which intersects the geologic stratum that should contain the plume, probably indicates that the limestone containing the plume is thinner and less fractured or weathered to the east.

Daily measurements of influent gross alpha/gross beta concentrations were made at the ORNL PWTP as part of normal process monitoring. The influent concentration data were used to calculate the amount of alpha and beta activity that is attributed to the pumping test at Well 4411. During an approximately 87-day period when the pumping test occurred, approximately 0.075 mCi of alpha activity and approximately 1.8 mCi of beta activity were removed from the Corehole 8 plume and directed to the ORNL PWTP for treatment. Extrapolation of the data from the 87-day pumping period to an annual activity removal estimate results in an expected annual removal of about 0.3 mCi of alpha and about

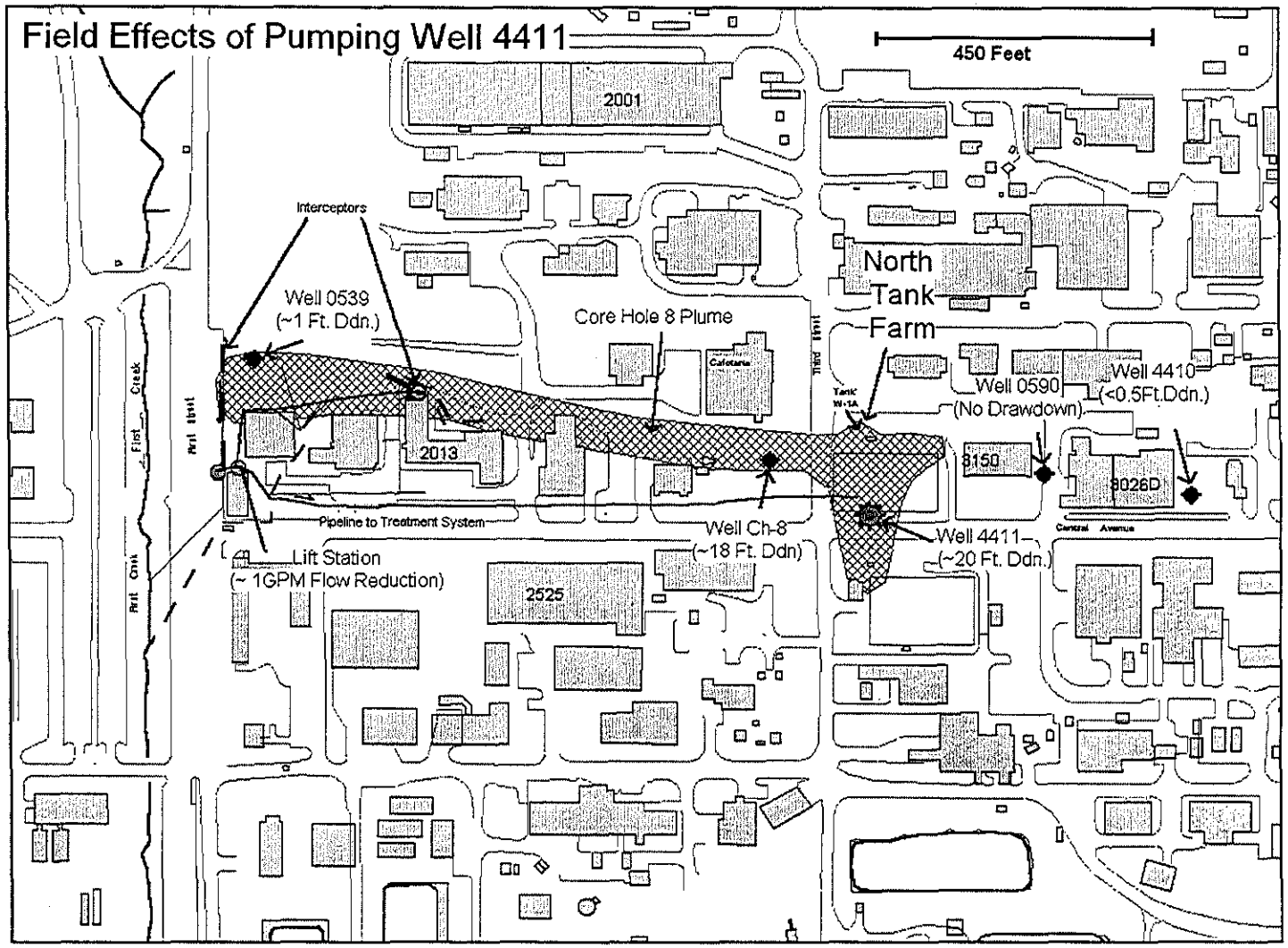

Fig. 1. Field effects of pumping Well 4411.

7.5 mCi of beta activity from groundwater extraction at Well 4411. The daily concentration and flux maximum were observed approximately 16 days after pumping was initiated and within a few days of pumping at the 5.0-gpm maximum achieved discharge rate. Because contaminant mass removal from the plume is dependent on diffusion of contaminants from stagnation areas in bedrock pores into active flow paths in fractures, it is apparent that groundwater extraction at the 5.0-gpm rate is excessive for optimal mass removal. In future groundwater extraction activities at Well 4411, pumping rates should be maintained in the 2.0- to 3.0-gpm range and flux estimates to the ORNL PWTP should continue to be monitored to optimize contaminant mass removal for treatment.

FUTURE ACTIONS AT WELL 4411

To provide additional containment of the Corehole 8 groundwater plume located in the ORNL main plant area, long-term groundwater extraction activities are scheduled to begin at Well 4411 in June 2000. Groundwater extraction activities at Well 4411 currently are scheduled to precede the Tank W-1A Removal Action (Corehole 8 plume source). This has been determined due to the success of lowering the shallow groundwater table near the source area during the pumping test. Sequencing groundwater extraction at Well 4411 prior to the Tank W-1A Removal Action could help reduce the amount of excavation dewatering required during tank removal activities.

Prior to the initiation of system startup, several upgrades and repairs are scheduled to be completed. In January 2000, during the pumping test, a capacitor in the variable speed pump control unit malfunctioned. While repairing the variable speed pump control unit, electricians determined that the pump motor also would require repair because of what appeared to be a short in the system. The main line and re-circulation line flow meters also will be upgraded to provide more accurate flow measurements, which will be utilized to calculate discharge rates to the ORNL PWTP. Concrete jersey barriers will be placed around the Well 4411 system discharge lines in the North Tank Farm to provide additional physical protection of the discharge pipe along Central Avenue and Third Street. As part of long-term operation, monthly groundwater grab samples will be collected from the Well 4411 system sample port. Samples will be analyzed for gross alpha/gross beta to provide general information on month-to-month system operation and contaminant-level tracking. Effectiveness of groundwater extraction activities at Well 4411 will be reported annually in the Remediation Effectiveness Report for the Oak Ridge Reservation.