INTEGRATED FIELD RESEARCH CHALLENGE SITE
Hanford 300 Area

U.S. Department of Energy Office of Science
Environmental Remediation Sciences Program

An Initial Non-Reactive Tracer Experiment at the Hanford 300 Area IFRC Site

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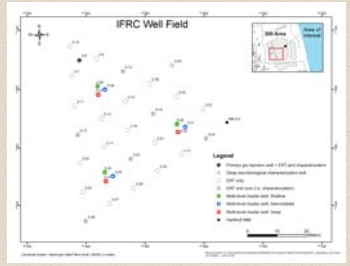
Abstract

The U.S. Department of Energy - Environmental Remediation Sciences Division is supporting an Integrated Field Research Challenge (IFRC) Site at Hanford's 300 Area. This site, immediately adjacent to the Columbia River, is the location of a groundwater uranium plume that resulted from past discharges of liquid effluent to unlined disposal ponds and trenches. As an initial step in the hydrologic characterization of this field research site, a non-reactive tracer experiment was conducted in November, 2008. The objectives of this tracer experiment were to assess transport processes and formational heterogeneities present in the saturated zone, to refine the site conceptual model and associated numerical models, and to test operational procedures. A solution containing a conservative tracer (~56 mg/L Br-) was injected into a single injection well and tracer arrival was monitored in surrounding wells. A tracer solution volume of ~160,000 gal was injected at a rate of 180 gpm, for a total injection phase duration of ~900 minutes (15 hrs). The test was run for a sufficient duration to fully describe the arrival response at the three closest monitoring wells, at which time the injection was stopped and the tracer plume was allowed to drift under natural gradient conditions. The location of the injected tracer plume within the well field was tracked by sampling selected monitoring wells over time and monitoring with downhole probes. Bromide concentrations were measured using Ion Selective Electrodes (ISE), both in a bench-top flow-through cell for analyzing aqueous samples and in situ using downhole ISE probes. Archive samples were also collected and submitted to PNNL laboratories for verification of Br- concentration by ion chromato-graphy. The objectives of this initial non-reactive tracer experiment were met, providing for an improved understanding of the formational heterogeneities and flow system characteristics at the IFRC site. This research is part of the ERSP 300 Area IFRC at Pacific Northwest National Laboratory.

Introduction

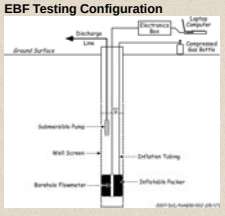
Hanford's IFRC Site was established in summer 2008 in the 300 Area just North of Richland, Washington, USA. Thirty-five wells were installed at the site (Figure 2) using a resonant sonic drilling method. Thirty-four wells were installed to a depth of ~18 m, and one to a depth of ~45 m.



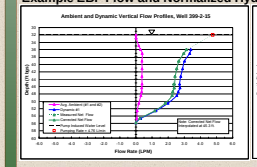
Initial Hydrologic Characterization Activities (pre-tracer experiment):

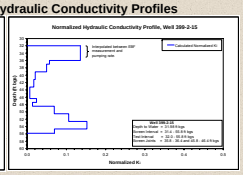
- Electromagnetic Borehole Flowmeter (EBF) Testing
  - EBF profiling of all IFRC monitoring wells.
  - Measure of vertical distribution of horizontal hydraulic conductivity.
- Aquifer Testing
  - Constant-rate injection tests in 14 wells.
  - Measure of spatial distribution of depth averaged hydraulic conductivity.

EBF Testing Configuration

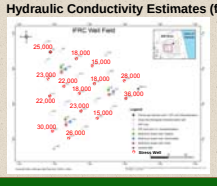


Example EBF Flow and Normalized Hydraulic Conductivity Profiles





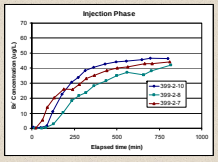
Hydraulic Conductivity Estimates (ft/day)



- Depth averaged hydraulic conductivity estimates are based on early-time pressure buildup response at closest observation wells ($r \leq 50$ ft).
- Resulting values provide data for converting relative K values from EBF profiles to absolute K.
- Hydraulic testing results used in a geostatistical analysis to develop 3D K distributions.

Initial Non-Reactive Tracer Experiment

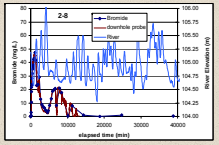
Tracer Arrival at 3 Closest Monitoring Wells

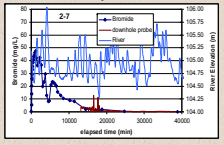


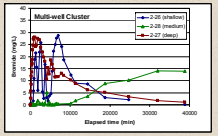
Tracer Test Operations:

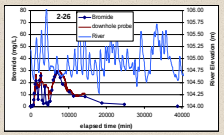
- Average Br concentration = 56 mg/L
- Injection volume = ~160,000 gal
- Injection rate = 180 gpm
- Injection duration = ~900 min (15 hrs)

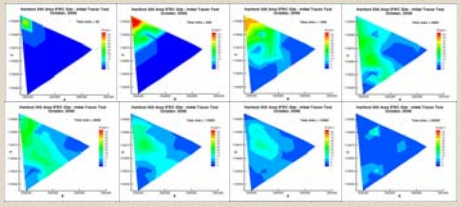
Selected Results From Initial Non-Reactive Tracer Experiment





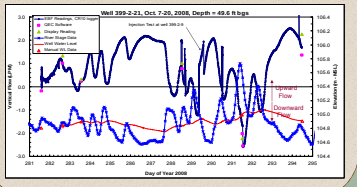






Potential Impacts of Ambient Vertical Flows in Fully Screened Wells on Tracer Monitoring Results

- Vertical flows related to river hydrodynamics are observed.



Initial Tracer Test Observations

- Arrival response at three closest monitoring wells was comparable.
- Tracer arrival at northern most multi-well cluster consistent with EBF profile results indicating a general (although non-uniform) depth varying K distribution – lower permeability materials over middle portion of aquifer.
- Upper zone appears to more hydraulically connected to river, resulting in significant vertical flows in fully screened monitoring wells.

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