PNNL-16270

Pacific Northwest National Laboratory
Operated by Battelle for the U.S. Department of Energy

K Basins Groundwater Monitoring Task, K Basins Closure Project: Report for July, August, and September 2006

R. E. Peterson

December 2006

Prepared for the U.S. Department of Energy
under Contract DE-AC05-76RL01830

PACIFIC NORTHWEST NATIONAL LABORATORY
operated by
BATTELLE
for the
UNITED STATES DEPARTMENT OF ENERGY
under Contract DE-AC05-76RL01830

Printed in the United States of America

Available to DOE and DOE contractors from the
Office of Scientific and Technical Information,
P.O. Box 62, Oak Ridge, TN 37831-0062;
ph: (865) 576-8401
fax: (865) 576-5728
email: reports@adonis.osti.gov

Available to the public from the National Technical Information Service,
U.S. Department of Commerce, 5285 Port Royal Rd., Springfield, VA 22161
ph: (800) 553-6847
fax: (703) 605-6900
email: orders@ntis.fedworld.gov
online ordering: http://www.ntis.gov/ordering.htm

This document was printed on recycled paper.

PNNL-16270

K Basins Groundwater Monitoring Task, K Basins Closure Project: Report for July, August, and September 2006

R. E. Peterson

December 2006

Prepared for
the U.S. Department of Energy
under Contract DE-AC05-76RL01830

Pacific Northwest National Laboratory
Richland, Washington 99352

Summary

This report provides information on groundwater monitoring at the K Basins during July, August, and September 2006. Conditions remain very similar to those reported in the previous quarterly report, with no evidence in monitoring results to suggest groundwater impact from current loss of basin water to the ground. The K Basins monitoring network will be modified in the coming quarters as a consequence of remedial action at KE Basin, i.e., removal of sludge and basin demolition.

Contents

Figures

Tables

1.0 Introduction

The information contained in this periodic report represents an initial interpretation of monitoring results by a hydrologist from Pacific Northwest National Laboratory's Groundwater Performance Assessment Team. Subsequent new results and/or facility information may warrant changes to these initial interpretations. There has been little change in groundwater conditions near the K Basins since the second quarter report (Peterson 2006). Some of the information below is repeated from that earlier report, such that each quarterly report provides a stand alone description of conditions.

1.1 Synopsis of Current Conditions and Key Issues

1.1.1 Sampling and Analysis Activities

- The quarterly groundwater sampling event occurred as scheduled during July 2006.

- Additional monthly sampling continued at three wells near KE Basin to more closely monitor conditions while sludge removal activities are underway.

- The next regularly scheduled quarterly sampling event occurred during October 2006, and analytical results are expected by mid-December.

1.1.2 Monitoring for Basin Water Loss

- Groundwater monitoring results do not reveal evidence to indicate current water loss to the ground from either fuel storage basin. If water loss to the ground is occurring, it is a relatively small volume, when compared to the previous well-documented leakage from KE Basin in 1993.

- No new information has been uncovered to explain the increases in tritium that began at two wells near KE Basin in 2003. The trend reversed itself during 2004 and current concentrations are typical of pre-2003 trends. Although an association with potential loss of basin water to the ground is possible, there is no conclusive evidence for this and alternative explanations are plausible.

1.1.3 Groundwater Contamination from Past Leakage and Other Sources

- The core of the tritium plume created by the 1993 leakage from the KE Basin has migrated downgradient more than half the distance to the river. The leading edge of that plume is likely to be near the shoreline currently, and at concentrations below the drinking water standard.

- Sources other than past leakage at the KE Basin (i.e., 1976–1979; 1993) contribute tritium to the currently mapped plume. The most prominent waste site sources near the reactor buildings are the gas wing condensate cribs, which were removed in 2004. Some contamination is likely to remain in the vadose zone beneath those waste site excavations.

- Tritium and other radionuclides may also remain in the vadose zone beneath the drain fields/injection wells associated with each fuel storage basin. These past-practices waste sites have not yet been remediated. They are located within the anticipated excavation zone associated with future demolition of the fuel storage basins. Unusually high water-table conditions and/or infiltration of moisture from the surface are suspected of periodically remobilizing radiological contamination beneath these waste sites.

2.0 Technical Details and Discussion

The following sections describe groundwater conditions near the KE and KW fuel storage basins, which are located within the respective reactor buildings. These basins are monitored under a groundwater monitoring plan for an operating facility (Peterson 2002). The rivershore downgradient from the basins is monitored using aquifer tubes (Peterson et al. 2005). Because of high tritium concentrations in basin water and tritium's mobility in the environment, that constituent is monitored as a key indicator for detecting basin water loss to the ground. However, tritium in groundwater near the 100-K reactors may come from a variety of past-practices waste sites, as well as potential loss from the basins, so additional groundwater constituents are monitored to help identify the various sources.

For a well location map, refer to the Groundwater Performance Assessment Project annual report (Peterson et al. 2006, Section 2.3; http://www.pnl.gov/publications), or call or email Bob Peterson (373-9020; robert.peterson@pnl.gov). Note that detailed maps of facilities and aerial photographs are limited to official use only.

2.1 Groundwater Conditions Near the KE Fuel Storage Basin

Analytical results for the third calendar quarter of 2006 for wells that monitor the flow path beneath the KE Basin are listed in Table 1 and updated tritium concentration trends are shown in Figure 1. Tritium concentrations at wells 199-K-27 and 199-K-109A, which are adjacent to and downgradient of the KE Basin, have declined to levels either near or below the drinking water standard (20,000 pCi/L), following an abrupt rise that started in early 2003. The cause for the unexpected change in tritium concentrations at these wells remains unexplained. Other shielding water indicators (e.g., technetium-99; gross alpha and gross beta) at these two wells do not show similar trends. Monthly sampling continued during most of the quarter at wells 199-K-27, 199-K-29, and 199-K-109A to monitor this unexplained departure from expected conditions and to provide enhanced monitoring while sludge removal activities are underway.

The plume created by leakage from the KE Basin in 1993 passed well 199-K-27 with a peak concentration of ~600,000 pCi/L (the tritium concentration in KE shielding water was ~3,000,000 pCi/L at that time). This plume subsequently began to pass downgradient well 199-K-32A in 2001, leading to an estimated migration rate of 0.12 m/d (Peterson 2002, pp. 5.11 to 5.13). The peak concentration observed at well 199-K-32A was ~80,000 pCi/L. Assuming a similar migration rate and a reduction in concentration that is proportionate to the reduction between wells 199-K-27 and 199-K-32A, this plume may be currently near the river shoreline and at concentrations that are below the drinking water standard. Tritium is normally measured in water samples from aquifer tube sites AT-K-2 and AT-19, with the next event planned for fall 2007, in an effort to monitor this plume.

Tritium concentrations are elevated above the drinking water standard at wells within the groundwater flow path that passes just to the east of the KE Reactor building. The presumed waste site source for this tritium (and co-contaminant carbon-14) is the former KE condensate crib (116-KE-1), which was excavated in March 2004. Tritium trends in the three wells that monitor the flow path downgradient of the crib are shown in Figure 2. Tritium concentrations at well 199-K-30 remained high relative to other locations near KE Reactor. The absence of a long-term gradually decreasing trend at this well suggests some re-supply of tritium to the plume. In early 2001, an increasing trend started at well 199-K-29, which is located ~50 meters north of the northeast corner of the KE Basin. This well is near to, but not in, the presumed groundwater flow path beneath the KE Basin. That trend peaked in early 2002; currently, groundwater at the well shows a decreasing tritium concentration trend and values below the drinking water standard. The absence of technetium-99 and presence of carbon-14 at the well support the assumption that the former KE condensate crib and underlying soil are the source for the tritium.

2.2 Groundwater Conditions Near the KW Fuel Storage Basin

Analytical results for the third calendar quarter of 2006 for wells that monitor the flow path beneath the KW Basin are listed in Table 2 and updated tritium concentration trends are shown in Figure 3. For wells adjacent to and immediately downgradient of the KW Basin, recent tritium concentrations remain well below the drinking water standard, with no evidence for water loss from the basin causing an impact on groundwater. Starting in mid-2003, results for samples from well 199-K-34 showed a trend toward slightly higher values, but have since declined to very low concentrations; the trend fluctuations remain within the long-term historical range of variability for the well. At well 199-K-132, located between the KW Reactor and the Columbia River, results are consistent with upgradient well 199-K-34, and also with previous trends at decommissioned well 199-K-33.

To the east of the KW Reactor building, tritium concentrations remain relatively high and variable at well 199-K-106A (Figure 4). The recent trend began with a gradual increase during 2001, followed by two distinct spikes each exceeding 1,000,000 pCi/L. Concentrations for the current quarter are lower than those peak values, but remain significantly elevated compared to historical levels for this location. The well is located ~50 meters northeast of the KW Reactor building and monitors conditions downgradient of the former KW condensate crib (116-KW-1), which was excavated in early 2004. The suspected tritium source is the vadose zone beneath the former crib, which likely contains tritium and carbon-14.

Nitrate (and specific conductance) also increased sharply at well 199-K-106A, in sync with the most recent tritium increase. However, nitrate has not been previously linked to the condensate crib. The increase in nitrate suggests that a sanitary sewer system may be involved. Chloride and technetium-99 also show recent increases at this well, but the trends for those constituents are not exactly in sync with the tritium trend. Soil samples from the condensate crib excavation were tested for technetium-99, but none was detected. There is currently no clear explanation for the origin of the technetium-99 at this well; concentrations are well below the drinking water standard of 900 pCi/L.

A pulse of high tritium concentrations occurred previously at well 199-K-106A in 1995 and 1996, with a peak value of ~700,000 pCi/L. Based on a flow direction and rate inferred from the water table gradient, it was expected that the pulse would reveal itself at downgradient well 199-K-33 in ~2001, but that has not occurred (the well went out of service in May 2003). Also, there is no evidence of the pulse at well 199-K-132, which was installed as a replacement for well 199-K-33 (see Figure 4). The exact migration pattern for plumes in this area remains unclear.

Because of high tritium concentrations in the KW Basin (e.g., 1,800,000 pCi/L in June 2006), loss of KW Basin water to the ground is routinely evaluated as a possible cause when interpreting changes in the characteristics of tritium plumes near the KW Reactor building. However, interpretations to date suggest that unusual circumstances would have to exist if the basin were the source for the tritium observed at well 199-K-106A, and the possibility of that is considered remote (see previous quarterly reports for further discussion).

2.3 Other Central 100-K Area News

Following completion of sludge removal activities at KE Basin, an excavation will be started on the north side of the building to provide access for demolition of the basin. Excavation activities will require the decommissioning of wells 199-K-27 and 199-K-109A, along with removal of the upper 20+ feet of their casings and that of previously decommissioned well 199-K-28. The excavation as currently planned should not encounter the injection well casing associated with the KE drain field (116-KE-3), but will come close to it.

- Two new monitoring wells are planned for the area between the KE Reactor and the former KE water retention basins. These wells will provide long-term monitoring coverage for the area between the KE Reactor and the Columbia River.

- At the KW Reactor, several new wells have been installed as part of a pump-and-treat remedial action system to address the chromium plume beneath that reactor. Results for hexavalent chromium in water samples collected during drilling suggest higher concentrations than indicated by previous monitoring in the area.

- At the southeast corner of KW Reactor, nitrate concentrations at well 199-K-108A continue to climb well above the 45 mg/L drinking water standard, having risen from ~20 mg/L in 1994 to a current level of ~95.5 mg/L.

3.0 References

Peterson RE. 2002. *Groundwater Monitoring and Assessment Plan for the 100-K Area Fuel Storage Basins*. PNNL-14033, Pacific Northwest National Laboratory, Richland, Washington.

Peterson RE. 2006. *K Basins Groundwater Monitoring Task, Spent Nuclear Fuels Project: Report for April, May, and June 2006*. PNNL-16001, Pacific Northwest National Laboratory, Richland, Washington.

Peterson RE, FA Spane, KB Olsen, and MD Williams. 2002. *Evaluation of Potential Sources for Tritium Detected in Groundwater at Well 199-K-111A, 100-K Area*. PNNL-14031, Pacific Northwest National Laboratory, Richland, Washington.

Peterson RE, MJ Hartman, RF Raidl, and JV Borghese. 2005. *100/300 Areas Aquifer Tube Task: Annual Sampling Event for Fiscal Year 2006, Hanford Site, Washington*. PNNL-15444, Pacific Northwest National Laboratory, Richland, Washington.

Peterson RE, RF Raidl, and SW Petersen. 2006. "100-KR-4 Operable Unit." Chapter 2.3 in *Hanford Site Groundwater Monitoring for Fiscal Year 2005*. PNNL-15670, MJ Hartman, LF Morasch, and WD Webber (eds.), Pacific Northwest National Laboratory, Richland, Washington.

Table 1. Tritium in Groundwater Near the KE Fuel Storage Basin (Jul/Aug/Sep 2006)

(Updated November 6, 2006; new results, changes, and interpretations are printed in blue)

Well, (Sample Frequency), and Position	Recent Results (pCi/L)	Current Concentration Trend	Prior Results (pCi/L)	Historical Concentration Trend Since 1997
Wells Downgradient of KE Fuel Storage Basin (Tritium concentration in KE Basin shielding water is ~2,250,000 pCi/L—June 2006)				
☑ **199-K-109A** (Q/M) *Adjacent to KE Basin and basin drain field.*	Missed (7/17/06) 2,440 (8/07/06) 3,340 (9/12/06)	Concentrations remain well below the DWS, following start of pulse in early 2003 (cause of pulse not identified). Tc-99 not detected.	2,860 (4/14/06) 1,630 (5/15/06) Missed (6/05/06)	General decline from high of ~90,000 in mid-1997 to early 2003. Periodic peaks up to 420,000 possibly caused by infiltration through contaminated soil.
☑ **199-K-27** (Q/M) *Adjacent to KE Basin.*	Missed (7/17/06) 26,900 (8/10/06) 21,500 (9/13/06)	Concentrations currently near the DWS, following pulse that started in early 2003 (cause of pulse not identified). Tc-99 not detected.	11,700 (4/04/06) 12,800 (5/04/06) 11,900 (6/05/06)	General decline from high of ~40,000 to low of several hundred, until early 2003 when new pulse started.
199-K-32A (Q) *Between KE Reactor and Columbia River.*	5,340 (7/18/06)	Continued gradual decrease following peak of ~80,000 in late 2001.	8,890 (3/30/06)	Historically 4,000~80,000; detected plume created by 1993 leakage from KE Basin.
Wells East of KE Fuel Storage Basin				
199-K-29 (Q/M) *Downgradient of KE Condensate Crib; near KE Basin.*	11,300 (7/17/06) 13,200 (8/14/06) 12,700 (9/13/06)	Gradual decline to below the DWS in recent samples. Source of tritium assumed to be former KE condensate crib, not KE basin.	23,100 (4/04/06) 19,400 (5/01/06) 14,500 (6/01/06)	Generally constant within range of 8,000~24,000 until summer 2001, when concentrations rose, reaching a high of 98,300 pCi/L in January 2002.
199-K-30 (Q) *Downgradient of KE Condensate Crib.*	239,000 (7/18/06)	Variable; back to more typical long-term levels.	251,000 (3/30/06)	Variable; cyclic within range of ~150,000 to ~2,360,000 since mid-1998.
199-K-111A (Q/M) *Adjacent to 100-K Burial Ground.*	10,800 (7/13/06) 8,200 (8/14/06) 6,450 (9/12/06)	Continued gradual decrease from ~100,000 peak in late 2001/early 2002.	14,400 (4/03/06) 13,800 (5/01/06) 11,000 (6/05/06)	Tritium undetected until late 1998; increase starts in late 2000 and peaks in 2002. Presumed source is 100-K burial ground.
Wells Upgradient of the KE Fuel Storage Basin				
199-K-110A (SA) *Near KE Reactor.*	ND (3/30/06)	Typically not detected.	ND (10/03/05)	Generally not detected (less than several hundred pCi/L).
199-K-36 (A) *Inland from Reactor*	392 & 574 (10/10/05)	Essentially constant near the method detection limit.	344 (10/14/04)	Change to current level in ~1997.

☑ Indicates key well for detecting shielding water impact on groundwater. Technetium-99 (Tc-99) is an additional indicator for shielding water.

Abbreviations: (M) = monthly; (Q) = quarterly; (SA) = semiannually; (A) = annually; and (BE) = biennially

Regulatory Standards for Tritium in Groundwater: The drinking water standard (DWS) is 20,000 pCi/L and the DOE derived concentration guide is 2,000,000 pCi/L. The offsite lab (STL-RL) detection limit is ~300 pCi/L.

Table 2. Tritium in Groundwater Near the KW Fuel Storage Basin (Jul/Aug/Sep 2006)

(Updated November 6, 2006; new results, changes, and interpretations are printed in blue)

Well, (Sample Frequency), and Position	Recent Results (pCi/L)	Current Concentration Trend	Prior Results (pCi/L)	Historical Concentration Trend Since 1997
Wells Downgradient of KW Fuel Storage Basin (Tritium concentration in KW Basin shielding water is ~1,800,000 pCi/L—June 2006)				
☑ **199-K-34** (Q) *Adjacent to KW Basin.*	727 (7/26/06)	Continued gradual decline to concentrations well below the DWS.	1,450 (3/30/06)	Long-term gradual decrease from ~6,000 to ~1,000. Recent unexplained change in trend started late 2003.
☑ **199-K-107A** (Q) *Adjacent to KW Basin and basin drain field.*	653 (7/13/06)	Continued long-term decline to well below the DWS; low variability.	707 711 (4/12/06)	Long-term gradual decline from ~2,000 down to <1,000.
199-K-132 (Q) *Between KW Reactor and the Columbia River.*	1,050 1,080 (7/13/06)	Consistent with 199-K-34, which is upgradient.	989 4/12/06)	Overall decline from plume that passed 199-K-33 during 1995~1998, with peak values of ~45,000.
199-K-31 (A) *Near river.*	1,350 (10/04/05)	Fairly constant, low variability.	1,070 (10/15/04)	Long-term gradual decline; in path of plume from 200 East (tritium, NO3, Tc-99).
Wells East of KW Fuel Storage Basin				
199-K-106A (Q) *Downgradient of KW Condensate Crib; alongside KW Basin.*	648,000 (7/13/06)	Continued high and variable concentrations. Chloride, nitrate, and Tc-99 are also elevated.	669,000 (4/14/06)	Variable within range of ~2,500 to ~25,000 (following 1996 plume passage that had peak of 676,000), until recent pulse started in July 2001.
Wells upgradient of the KW Fuel Storage Basin				
199-K-108A (A) *Adjacent to KW Reactor.*	ND (4/12/06)	Dilution of groundwater by clean water at this well appears to have stopped. Some contaminants are showing a return (increase) back to pre-dilution concentrations.	ND (4/20/05)	Gradual decline from ~650 in 1996, until dilution by clean water started in 1999; not detected since.
199-K-35 (BE) *Background for KW Reactor.*	949 (10/05/05)	Continued gradual decline to background levels.	861 (10/14/04)	Long-term decline from ~2,600 to <1,000 (regional background for 100-K Area).

☑ Indicates key well for detecting shielding water loss to the ground. Technetium-99 (Tc-99) is an additional indicator for shielding water.
Abbreviations: (M) = monthly; (Q) = quarterly; (SA) = semiannually; (A) = annually; (BE) = biennially
Regulatory Standards for Tritium in Groundwater: The drinking water standard (DWS) is 20,000 pCi/L and the DOE derived concentration guide is 2,000,000 pCi/L. The offsite lab (STL-RL) detection limit is 300 pCi/L.

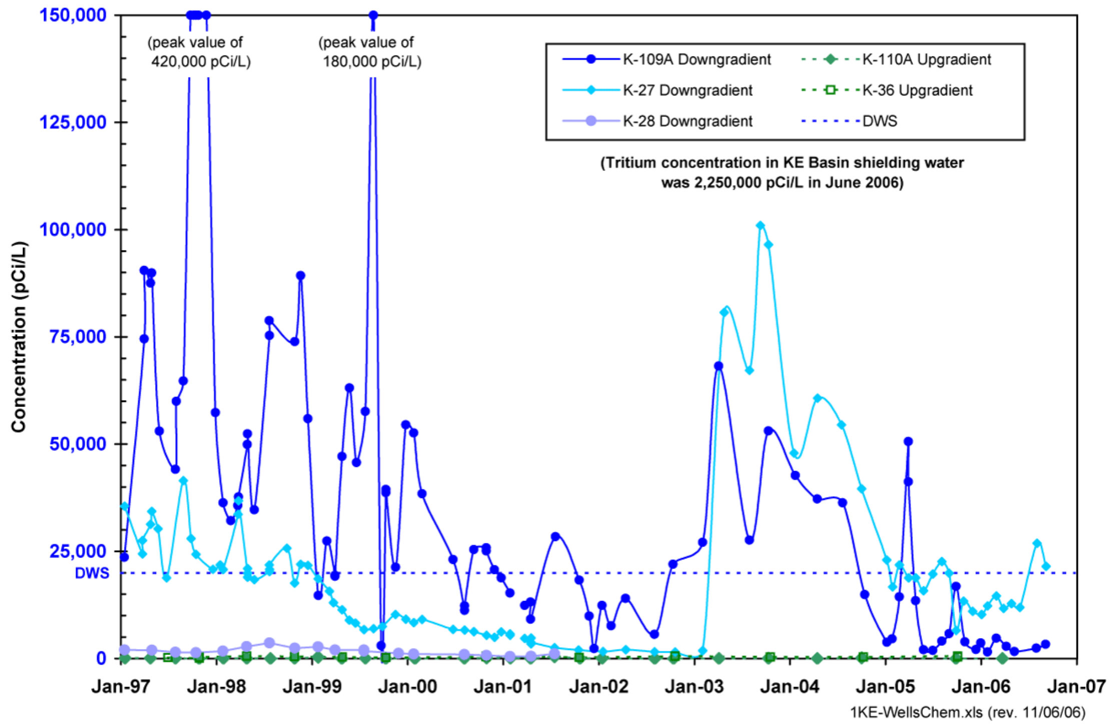

Figure 1. Tritium in Groundwater Near the KE Fuel Storage Basin

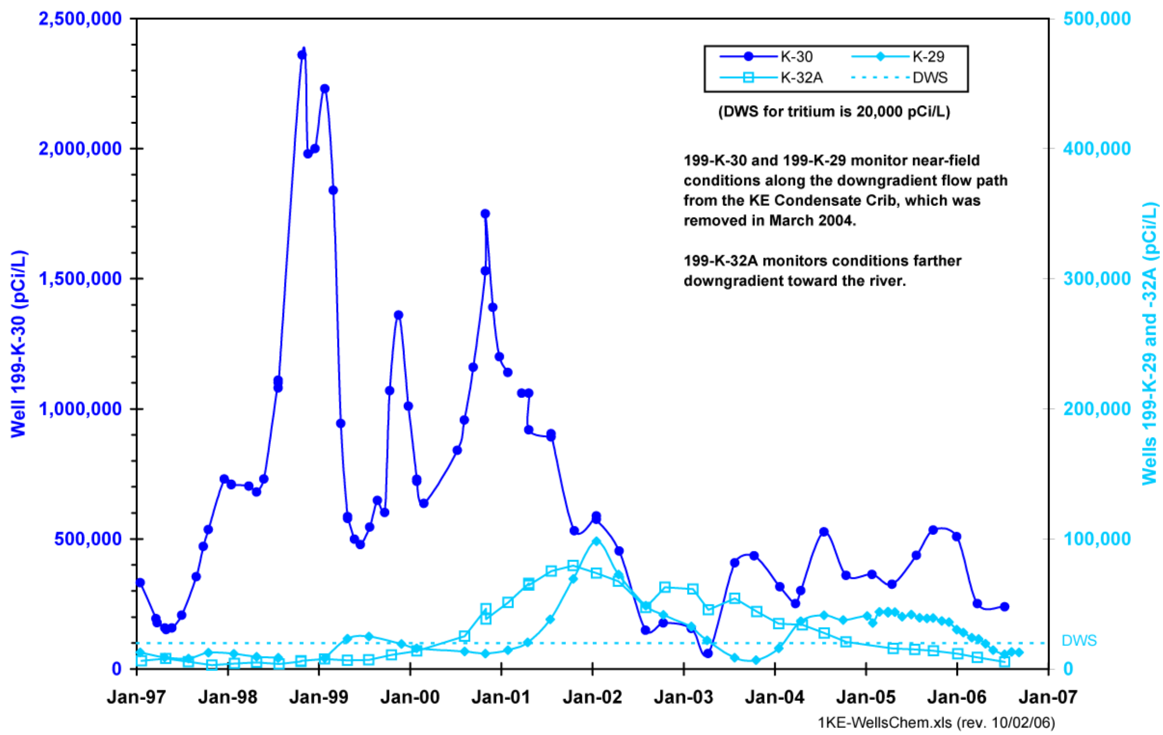

Figure 2. Tritium in Groundwater Along East Side of KE Reactor Building

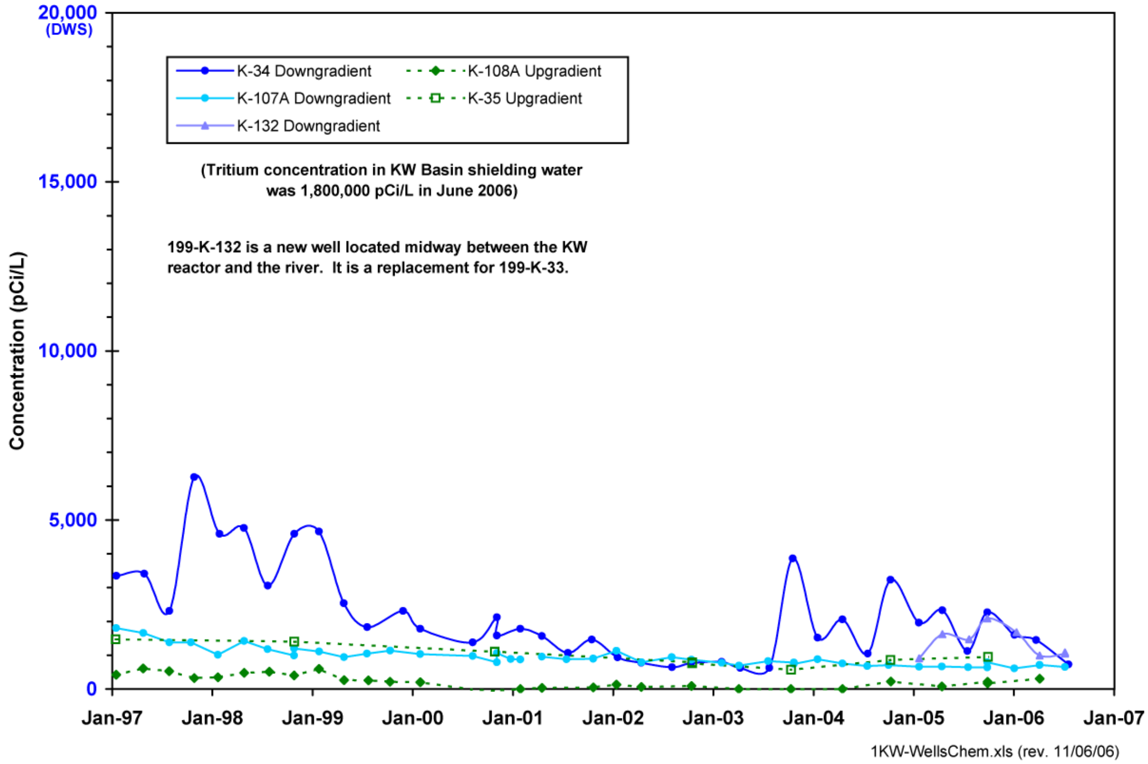

Figure 3. Tritium in Groundwater Near the KW Fuel Storage Basin

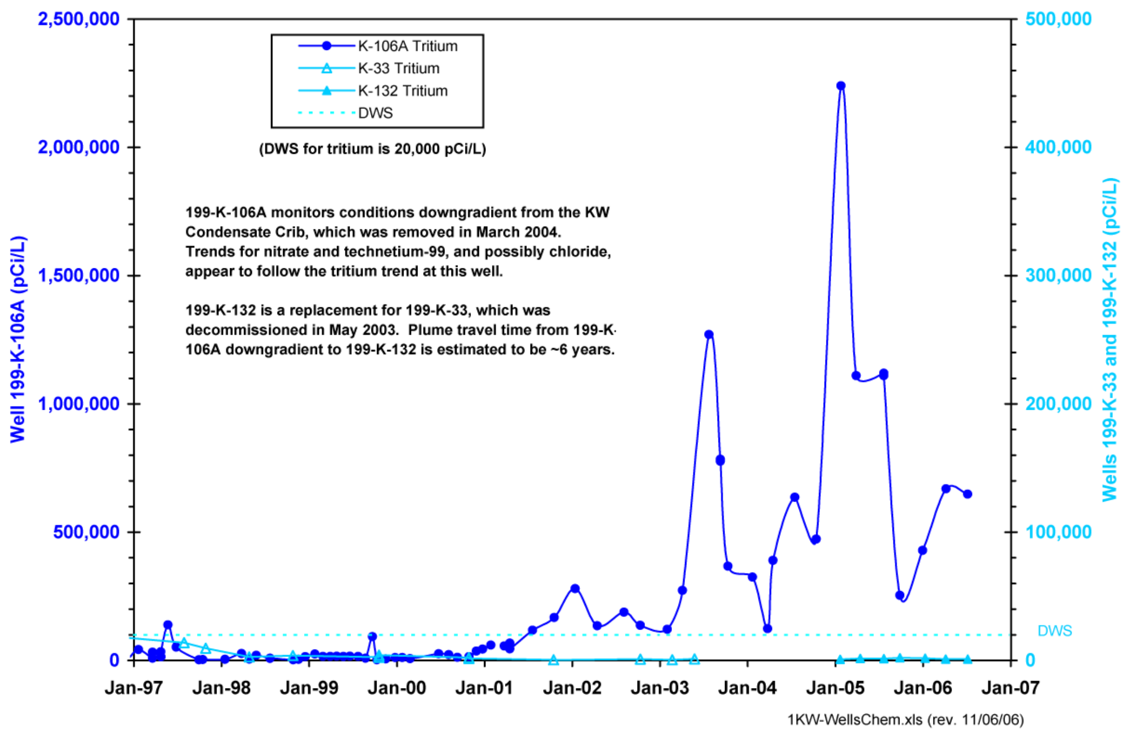

Figure 4. Tritium in Groundwater Along East Side of the KW Reactor Building

Distribution*

No. of Copies		
	ONSITE	
7	**DOE Richland Operations Office**	
	LD Earley	A5-19
	JP Hanson	A5-13
	RD Hildebrand	A6-38
	PM Pak	A5-16
	KM Thompson	A6-38
	AC Tortoso	A6-38
	J Zeisloft	A3-04
3	**Fluor Hanford, Inc. (K Basins Closure Project)**	
	GS Hunacek	X3-79
	RM Jochen	X3-74
	DJ Watson (Dave)	X3-79
2	**Fluor Hanford, Inc. (Groundwater Project)**	
	LC Swanson	E6-35
	RL Jackson	E6-35

No. of Copies		
	Washington Closure Hanford, LLC	
	RA Carlson	X0-17
8	**Pacific Northwest National Laboratory**	
	MD Freshley	K9-33
	JS Fruchter	K6-96
	MJ Hartman	K6-96
	SP Luttrell	K6-96
	RE Peterson	K6-75
	RM Smith	K6-96
	Project File, Groundwater Performance Assessment Project	
	Hanford Technical Library	P8-55

*Note: This report will be distributed in .pdf format via email, unless otherwise requested by recipients. If other copies are needed, please contact RE Peterson (509-373-9020), Pacific Northwest National Laboratory, Richland, Washington.