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Pacific Northwest National Laboratory
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K Basins Groundwater Monitoring Task, K Basins Closure Project: Report for October, November, and December 2006

R. E. Peterson

March 2007

Prepared for Fluor Hanford, Inc. and the
U.S. Department of Energy
under Contract DE-AC05-76RL01830

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Pacific Northwest National Laboratory
Richland, Washington 99352

Summary

This report provides information on groundwater monitoring at the K Basins during October, November, and December 2006. Conditions remained 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 months as a consequence of new wells having been installed near KW Basin as part of a pump-and-treat system for chromium contamination, and new wells installed between the KE Basin and the river to augment long-term monitoring in that area.

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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 third quarter report (PNNL-16270, 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 October 2006.

- Additional monthly sampling continued at three wells near KE Basin to more closely monitor conditions while sludge removal activities are underway, although some monthly sampling was not conducted because of well access issues.

- The next regularly scheduled quarterly sampling event occurred during January 2007, and analytical results are expected by mid-March.

1.1.2 Monitoring for Basin Water Loss

- Groundwater monitoring results do not exhibit 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.

- The increases in tritium that began at two wells near KE Basin in 2003 remain unexplained. 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.

1.1.3 Groundwater Contamination from Past Leakage and Other Sources

- 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, with concentrations lower than the drinking water standard. The two aquifer tube sites downgradient of this plume had no detectable tritium in February 2006. The tubes were sampled again in January 2007 and results will be discussed in the next quarterly report.

- 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-practice waste sites have not yet been remediated. Unusually high water-table conditions and/or infiltration of moisture from the surface are suspected of periodically remobilizing radiological contamination remaining 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-practice waste sites, as well as from potential basin loss, so additional groundwater constituents are monitored to help identify the various sources.

Well locations in the 100-K Area are shown in Figure 1. Additional maps for the 100-K Area are included in the Groundwater Performance Assessment Project annual report (Peterson and Raidl 2007), 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 Basin

Analytical results for the fourth 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 2. 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. Other shielding water indicators (e.g., technetium-99; gross alpha and gross beta) at these two wells do not show similar trends, so a definitive explanation for the tritium trend remains elusive. Some planned monthly samples were not collected from wells 199-K-109A, 199-K-27, and 199-K-111A this quarter because of well access issues and schedule delays.. Table 1 lists the dates each well was sampled. The purpose of monthly sampling is to track trends following the 2003 peak and to monitor groundwater while sludge removal activities are underway.

The plume created by leakage from the KE Basin construction joint 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 arrived at downgradient well 199-K-32A in 2001, as revealed by concentration trends shown in Figure 3. These trends have been used to estimate the migration rate for the plume at 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 at concentrations that are below the drinking water standard. The arrival of this plume should be revealed by monitoring tritium in water samples from aquifer tube sites AT-K-2 and AT-19 during the annual fall sampling event. (Note: Tubes at these sites were sampled in January 2007; results will be presented in next quarterly report).

Tritium concentrations are also 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 (see Figure 1 for location map). Tritium trends in the three wells that monitor the flow path downgradient of the crib are shown in Figure 4. 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, declined to well below the drinking water standard in 2003, rose again in 2004, and currently, remains constant at a level 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 Basin

Analytical results for the fourth 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 5. For wells adjacent to and immediately downgradient of the KW Basin, recent tritium concentrations remained well below the drinking water standard, with no evidence for water loss from the basin causing an impact on groundwater. (Note: Tritium concentrations in KW Basin shielding water were 1,800,000 pCi/L in June 2006). Starting in mid-2003, results for samples from well 199-K-34 showed a trend toward slightly higher values, but still within the range of historical variability. The variability appears to be episodic, and the most recent result from the well is back toward the high side of the range. At well 199-K-132, located between the KW Reactor and the Columbia River, results are consistent with upgradient well 199-K-34.

To the east of the KW Reactor building, tritium concentrations remained relatively high and variable at well 199-K-106A (Figure 6). The rising trend at the well began with a gradual increase during 2001, followed by two distinct spikes each exceeding 1,000,000 pCi/L. The results for the reporting quarter were lower than those peak values, and lower than typical concentrations since 2003. 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. The processes responsible for the elevated tritium (and other waste indicators, e.g., nitrate, technetium-99) in groundwater at this well are not fully understood, although a connection to the KW Basin is unlikely.

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 did not occur (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 6). Details for the migration pattern of plumes in this area remain unclear.

Because of high tritium concentrations in the KW Basin, 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

New wells were installed in fall 2006 near the KW Reactor as part of a pump-and-treat system for chromium contamination in groundwater. The wells are 199-K-137, 199-K-138, 199-K-139, and 199-K-140 (see Figure 1 for locations). Three of the new wells located downgradient from KW Reactor, along with existing well 199-K-132, will be used as groundwater extraction wells. Several wells inland of the KW Reactor will be used to inject treated effluent. The system began operating in January 2007.

Two new long-term monitoring wells were installed in December 2006 between the KE Reactor and the Columbia River (199-K-141 and 199-K-142). The purpose for these wells is to provide long-term monitoring, and coverage in the event that existing wells near the KE Basin must be removed to make way for basin demolition activities. Monitoring data from these new wells should be available for the next quarterly report.

At the southeast corner of KW Reactor, nitrate concentrations at well 199-K-108A remained well above the 45 mg/L drinking water standard, having risen from ~20 mg/L in 1994 to a current level ranging between 76 and 80 mg/L. Dilution of groundwater at this well by an unknown clean water source appeared to stop in 2004.

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 July, August, and September 2006*. PNNL-16270, 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 and RF Raidl. 2007. "100-KR-4 Operable Unit." In Chapter 2.3 of *Hanford Site Groundwater Monitoring for Fiscal Year 2006*. PNNL-16346, MJ Hartman, LF Morasch, and WD Webber (eds.), Pacific Northwest National Laboratory, Richland, Washington.

Table 1. Tritium in Groundwater Near the KE Basin (Oct/Nov/Dec 2006)

(Updated February 26, 2007; new results, changes, and interpretations are printed in blue)

Well, (Sample Frequency), and Position	**Current Quarter, pCi/L (sample date)**	**Current Concentration Trend**	**Prior Results, pCi/L (sample date)**	**Historical Concentration Trend Since 1997**
Wells Downgradient of KE 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.*	4,200 4,100 3,600 (12/20/06)	Concentrations remain well below the DWS, following pulse starting in 2003. Tc-99 not detected.	2,440 (8/07/06) 3,340 (9/12/06)	General decline from high of ~90,000 in mid-1997 (with periodic peaks up to 420,000) until early 2003, when new pulse began.
☑ **199-K-27** (Q/M) *Adjacent to KE Basin.*	11,500 11,000 (12/01/06)	Concentrations currently below the DWS, following pulse starting in 2003. Tc-99 not detected.	26,900 (8/10/06) 21,500 (9/13/06)	General decline from high of ~40,000 in 1997 to low of several hundred, until early 2003 when new pulse started.
199-K-32A (Q) *Between KE Reactor and Columbia River.*	5,800 (10/19/06)	Continued long-term gradual decrease.	5,340 (7/18/06)	Historically 4,000~80,000; plume created by 1993 KE Basin leak passed in 2001.
Wells East of KE Basin				
199-K-29 (Q/M) *Downgradient of KE Condensate Crib; near KE Basin.*	13,400 (10/26/06) 13,700 (12/01/06) 14,000 (12/22/06)	Constant and below the DWS in recent samples. Source of tritium assumed to be former KE condensate crib, not KE basin.	11,300 (7/17/06) 13,200 (8/14/06) 12,700 (9/13/06)	Generally constant within range of 8,000~24,000 until summer 2001, when concentrations rose, reaching a high of 98,300 in 2002.
199-K-30 (Q) *Downgradient of KE Condensate Crib.*	190,000 (10/19/06)	Variable; gradual decrease during past year.	239,000 (7/18/06)	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.*	6,900 7,570 (10/16/06) 8,300 (12/20/06)	Relatively constant during past year at level below the DWS.	10,800 (7/13/06) 8,200 (8/14/06) 6,450 (9/12/06)	Tritium undetected until late 1998. Increase started 2000 and peaked at ~100,000 in 2002. Presumed source is 100-K burial ground.
Wells Upgradient of the KE Basin				
199-K-110A (SA) *Near KE Reactor.*	ND (10/31/06)	Typically not detected.	ND (3/30/06)	Generally not detected (less than several hundred pCi/L).
199-K-36 (A) *Inland from Reactor*	ND (10/19/06)	Essentially constant near the method detection limit.	392 & 574 (10/10/05)	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 Basin (Oct/Nov/Dec 2006)

(Updated February 26, 2007; new results, changes, and interpretations are printed in blue)

Well, (Sample Frequency), and Position	Current Quarter,pCi/L (sample date)	Current Concentration Trend	Prior Results, pCi/L (sample date)	Historical Concentration Trend Since 1997
Wells Downgradient of KW Basin ***(Tritium concentration in KW Basin shielding water is ~1,800,000 pCi/L—June 2006)***				
☑ **199-K-34** (Q) *Adjacent to KW Basin.*	3,500 (10/31/06)	Change from gradual decline to rising (however, still well below the DWS).	727 (7/26/06)	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.*	500 (10/12/06)	Continued long-term decline to well below the DWS; low variability.	653 (7/13/06)	Long-term gradual decline from ~2,000 down to <1,000.
199-K-139 (Q) *Downgradient of KW Reactor.*	730 630 (10/31/06)	New well installed as part of pump-and-treat system for chromium.		
199-K-132 (Q) *Between KW Reactor and the Columbia River.*	2,000 1,500 (10/12/06)	Variable; concentration range similar to 199-K-34.	1,050 1,080 (7/13/06)	Overall decline from plume that passed 199-K-33 during 1995~1998, with peak values of ~45,000.
199-K-31 (A) *Near river.*	860 (10/19/06)	Fairly constant, low variability.	1,350 (10/04/05)	Long-term gradual decline; in path of plume from 200 East (tritium, NO3, Tc-99).
Wells East of KW Basin				
199-K-106A (Q) *Downgradient of KW Condensate Crib; alongside KW Basin.*	160,000 150,000 (12/20/06)	Returning to lower concentrations, following high values in 2005. Chloride, nitrate, and Tc-99 are also elevated.	648,000 (7/13/06)	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 Basin				
199-K-108A (A) *Adjacent to KW Reactor.*	250 (10/12/06)	Barely detectable. Other contaminants show a return (increase) back to pre-dilution concentrations.	ND (4/12/06)	Gradual decline from ~650 in 1996, until dilution by clean water started in 1999, with tritium undetected. Dilution stopped in 2004.
199-K-35 (BE) *Background for KW Reactor.*	420 (10/19/06)	Continued gradual decline to background levels.	949 (10/05/05)	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.

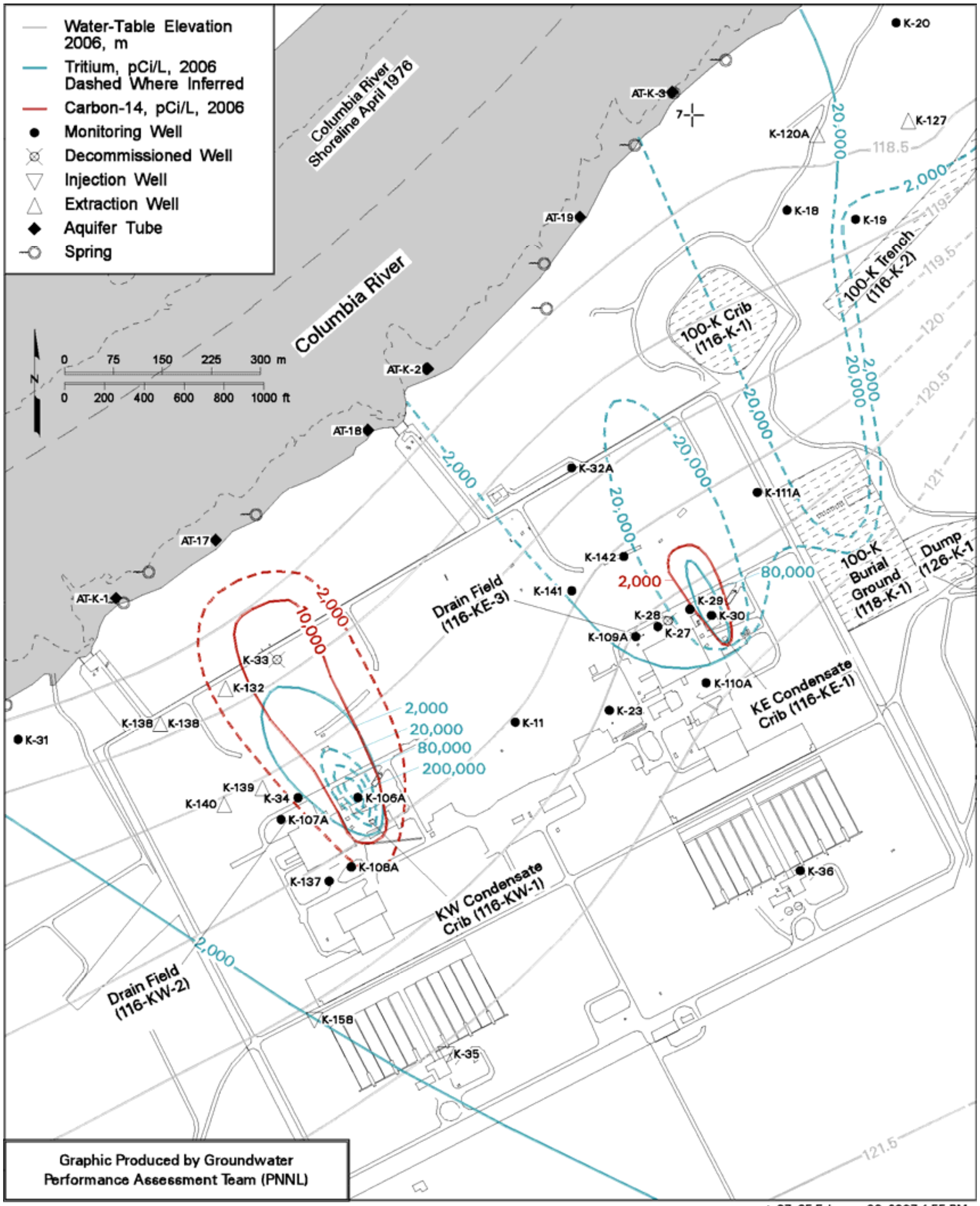

Figure 1. Location Map for Wells in the Vicinity of the K Basins, and 2006 Tritium and Carbon-14 Plumes (after PNNL-16346).

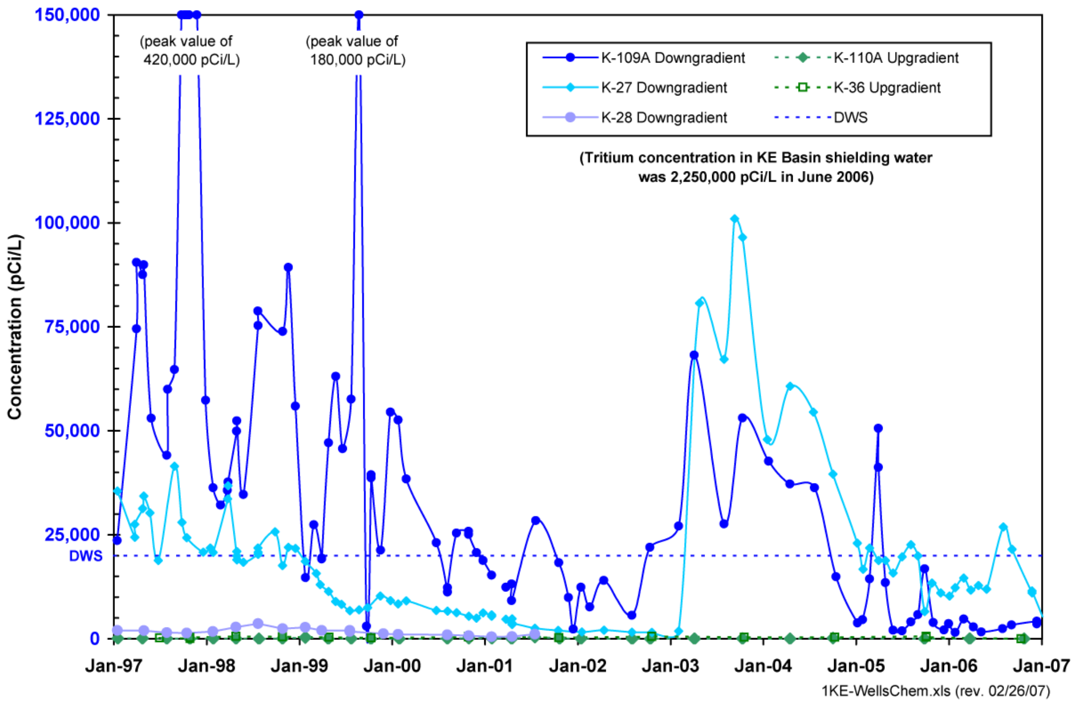

Figure 2. Tritium in Groundwater Near the KE Basin

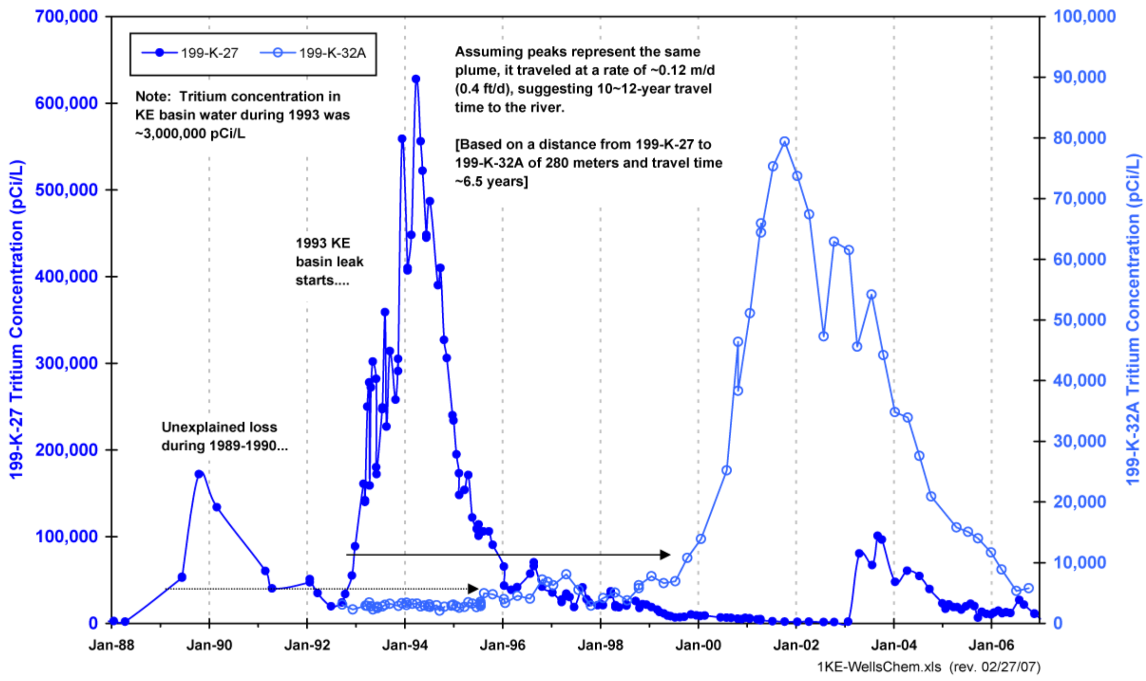

Figure 3. Travel Time from KE Basin Toward Columbia River

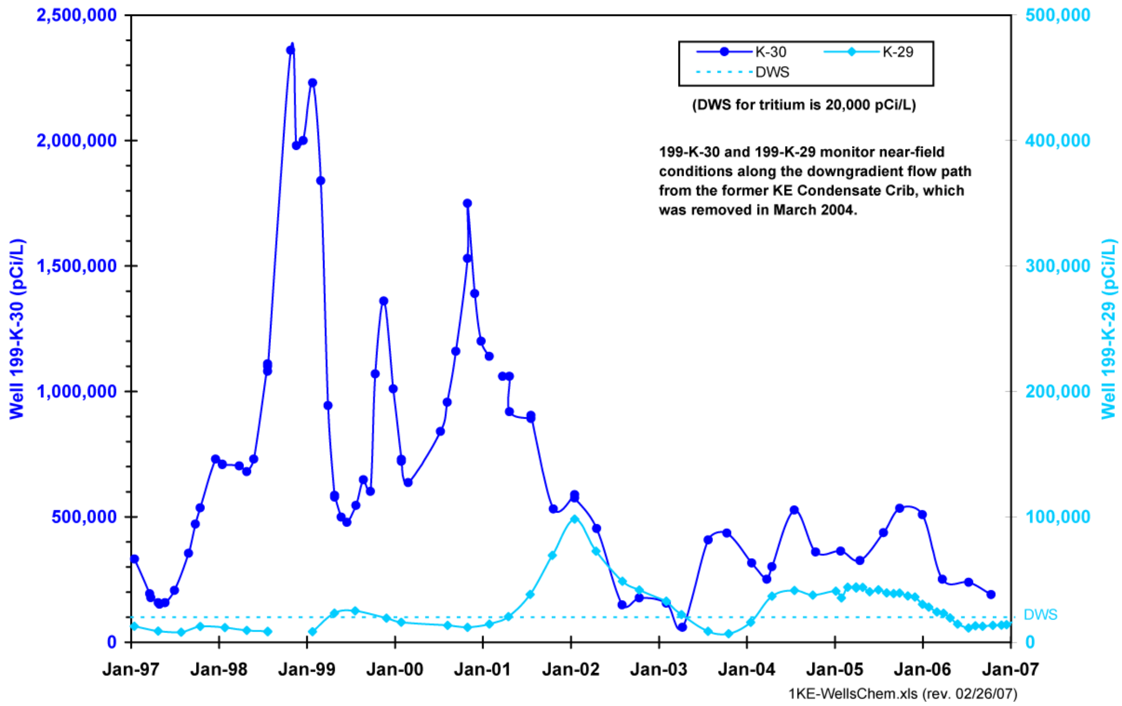

Figure 4. Tritium in Groundwater Along East Side of KE Reactor Building

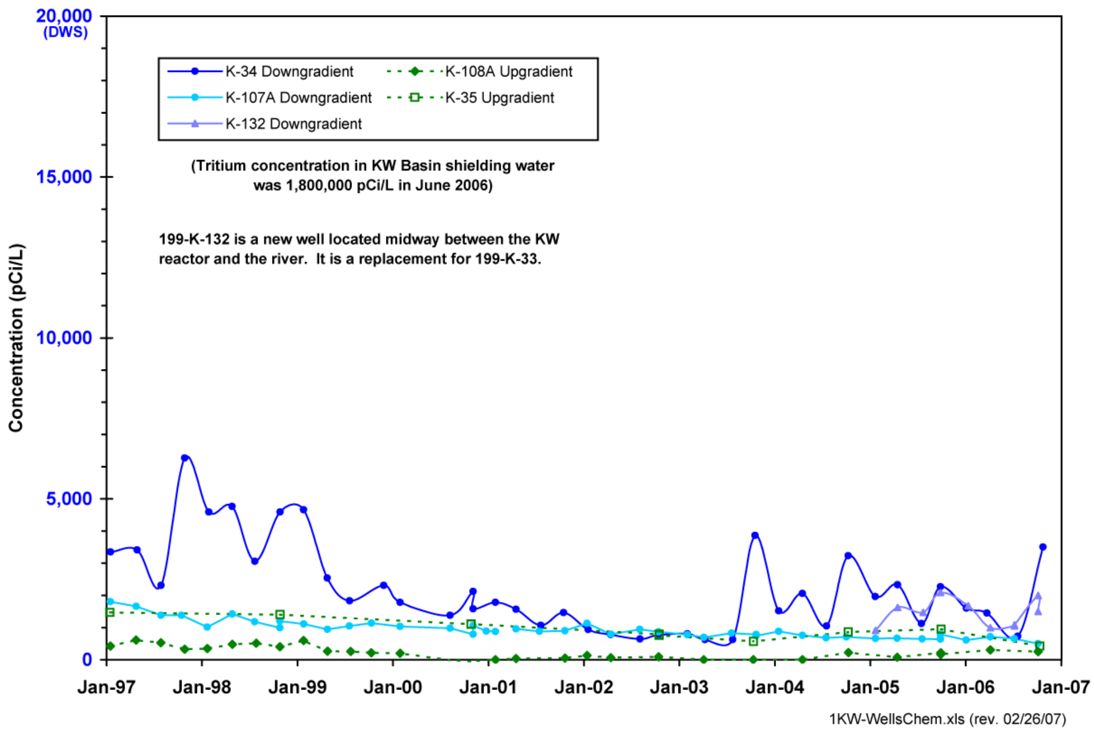

Figure 5. Tritium in Groundwater Near the KW Basin

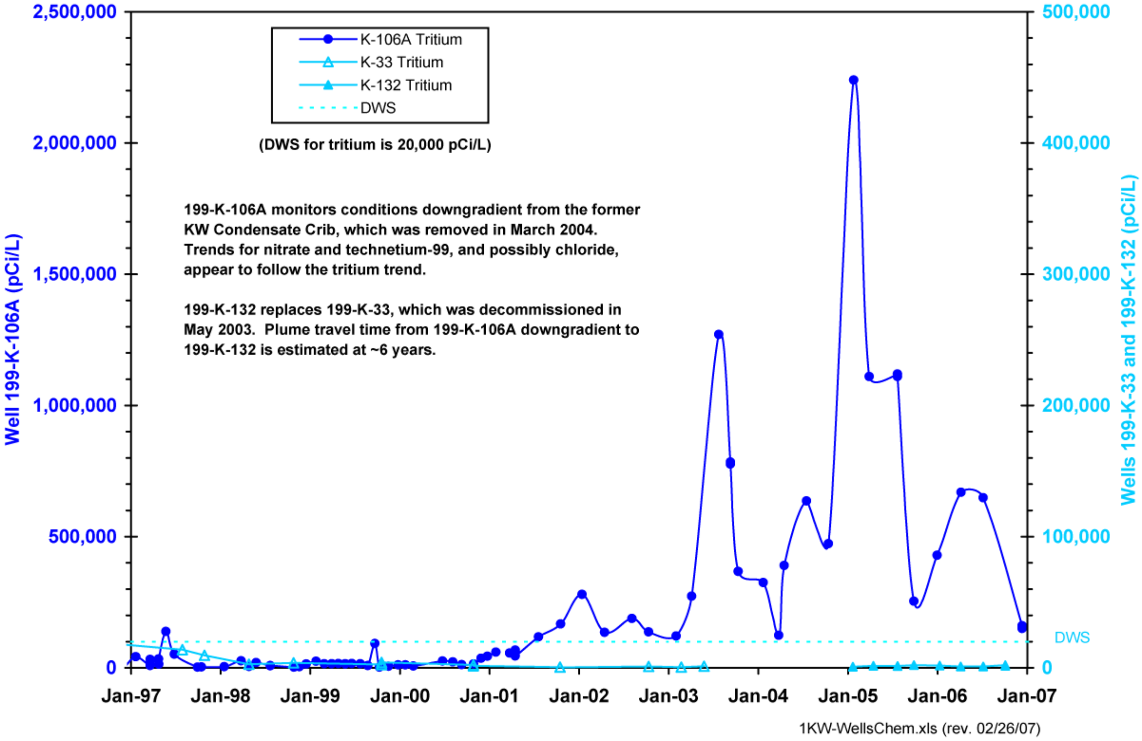

Figure 6. Tritium in Groundwater Along East Side of the KW Reactor Building

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