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## Pacific Northwest National Laboratory

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# K Basins Groundwater Monitoring Task, Spent Nuclear Fuels Project: Report for April, May, and June 2006

R. E. Peterson

August 2006



Prepared for 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 April, May , and June 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. 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.

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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 Groundwater Performance Assessment Project. Subsequent new results and facility information may warrant changes to these initial interpretations.

## 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 April 2006.
- Additional monthly sampling continued at several wells near KE Basin to more closely monitor conditions while sludge removal activities are underway. (Note: An interruption to monthly sampling occurred while geophysical logging was conducted in these wells; monthly sampling will resume by August.)
- The next regularly scheduled quarterly sampling event occurred during July 2006, and analytical results are expected by late August/early September.

### 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 shortly thereafter, and current concentrations are below the drinking water standard. 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. Other radiological indicators for basin water do not show similar trends.

### 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.
- 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 source 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**

For a well location map, refer to the Groundwater Performance Assessment Project annual report (Peterson et al. 2006, Section 2.3; <http://groundwater.pnl.gov/reports/gwrep05>), or call or email Bob Peterson (373-9020; [robert.peterson@pnl.gov](mailto:robert.peterson@pnl.gov)). Note that detailed maps of facilities and aerial photographs are limited to official use only.

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.

### **2.1 Groundwater Conditions Near the KE Fuel Storage Basin**

Analytical results for the second 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 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

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 the reactors. The absence of a long-term gradually decreasing trend suggests some re-supply of tritium to this 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 condensate crib and underlying soil are the source for the tritium. The tritium observed at well 199-K-29 may reflect lateral dispersion of the plume whose primary source is the former crib.

## **2.2 Groundwater Conditions Near the KW Fuel Storage Basin**

Analytical results for the second 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 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 show a trend toward higher values, but the concentrations remain within the long-term historical range of variability for the well. At new well 199-K-132, located between the KW Reactor and the Columbia River, results are consistent with expectations and with previous trends at decommissioned well 199-K-33, which was replaced by well 199-K-132.

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 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.

Because of high tritium concentrations in the KW Basin (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 reactor buildings. Interpretations to date indicate 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 that area.
- At the KW Reactor, several new wells will be installed in the coming months as part of a pump-and-treat remedial action system to address the chromium plume beneath that reactor.
- At the southeast corner of KW Reactor, nitrate concentrations at well 199-K-108A continue to climb well above the drinking water standard, having risen from ~20,000 µg/L in 1994 to a current level of ~80,000 µg/L.

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**Table 1.** Tritium in Groundwater Near the KE Fuel Storage Basin (Apr/May/June 2006)

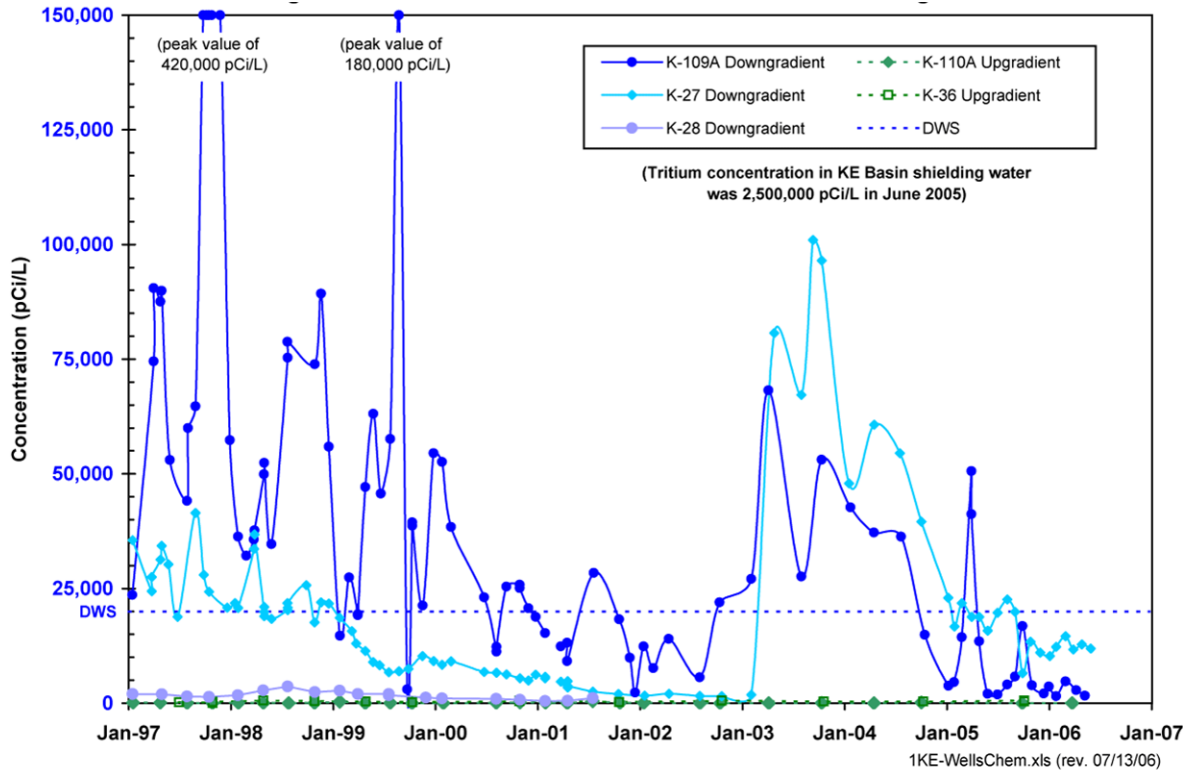
(Updated July 18, 2006; new results, changes, and interpretations are printed in blue)

Well, (Sample Frequency), and Position	Recent Results (pCi/L)	Current Concentration Trend	Prior Results (pCi/L)	Historical Concentration Trend Since 1997
<b>Wells Downgradient of KE Fuel Storage Basin</b> (Tritium concentration in KE Basin shielding water is ~2,250,000 pCi/L—June 2006)				
<input checked="" type="checkbox"/> <b>199-K-109A</b> (Q/M) <i>Adjacent to KE Basin and basin drain field.</i>	2,860 (4/14/06) 1,630 (5/15/06)	Concentrations have dropped back to well below the DWS, following start of pulse in early 2003 (cause of pulse not identified). Tc-99 not detected.	3,600 3,630 (1/06/06) 1,520 (2/01/06) 4,750 (3/07/06)	General decline from high of ~90,000 in mid-1997 to early-2003. Periodic peaks up to 420,000 caused by utility line leaks remobilizing contamination from past disposal to drain field.
<input checked="" type="checkbox"/> <b>199-K-27</b> (Q/M) <i>Adjacent to KE Basin.</i>	11,700 (4/04/06) 12,800 (5/04/06) 11,900 (6/05/06)	Concentrations now below the DWS, following pulse that started in early 2003 (cause of pulse not identified). Tc-99 not detected.	10,300 (1/10/06) 12,300 (2/01/06) 14,600 (3/07/06)	General decline from high of ~66,000 to low of ~2,000, until spring 2003 when new pulse started. Tc-99 was detected.
<b>199-K-32A</b> (Q) <i>Between KE Reactor and the Columbia River.</i>	8,890 (3/30/06)	Continued gradual decrease following peak of ~ 80,000 in late 2001, which represents passage of plume created by 1993 leak.	11,700 (1/10/06)	Historically within range of ~4,000 to ~14,000 until mid-1999 when passage of plume created by 1993 leakage from KE Basin occurs.
<b>Wells East of KE Fuel Storage Basin</b>				
<b>199-K-29</b> (Q/M) <i>Downgradient of KE Condensate Crib; near KE Basin.</i>	23,100 (4/04/06) 19,400 (5/01/06) 14,500 (6/01/06)	Gradual decline to just below the DWS in most recent samples. Source of tritium assumed to be former condensate crib, not basin.	30,200 (1/06/06) 28,000 (2/01/06) 24,100 (3/07/06)	Generally constant within range ~16,000 ± ~8,000 until summer 2001, when concentrations rose, reaching a high of 98,300 pCi/L in January 2002.
<b>199-K-30</b> (Q) <i>Downgradient of KE Condensate Crib; alongside KE Basin.</i>	251,000 (3/30/06)	Variable; back to more typical long-term levels.	509,000 (1/06/06)	Variable; cyclic within range of ~150,000 to ~2,360,000 since mid-1998. All-time low of ~60,000 in 2003.
<b>199-K-111A</b> (Q/M) <i>Adjacent to 100-K Burial Ground.</i>	14,400 (4/03/06) 13,800 (5/01/06)	Continued gradual decrease from ~100,000 peak in late 2001/early 2002.	15,900 (1/09/06) 14,600 (3/07/06)	Tritium undetected until late 1998; increase started in late 2000 and peaked in 2002. Presumed 100-K burial ground source.
<b>Wells Upgradient of the KE Fuel Storage Basin</b>				
<b>199-K-110A</b> (SA) <i>Adjacent to KE Reactor.</i>	ND (3/30/06)	Typically not detected.	ND (10/03/05)	Generally not detected (i.e., less than several hundred pCi/L).
<b>199-K-36</b> (A) <i>Background for KE Reactor.</i>	392 574 (10/10/05)	Essentially constant at levels near the method detection limit.	344 (10/14/04)	Changed to current level in 1997; rapid drop from ~2,400 to ~600.
<input checked="" type="checkbox"/> 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; ND = not detected; DWS = drinking water standard. <u>Regulatory Standards for Tritium in Groundwater:</u> The DWS is 20,000 pCi/L and the DOE derived concentration guide is 2,000,000 pCi/L. The offsite laboratory (STL-RL) detection limit is ~300 pCi/L.				

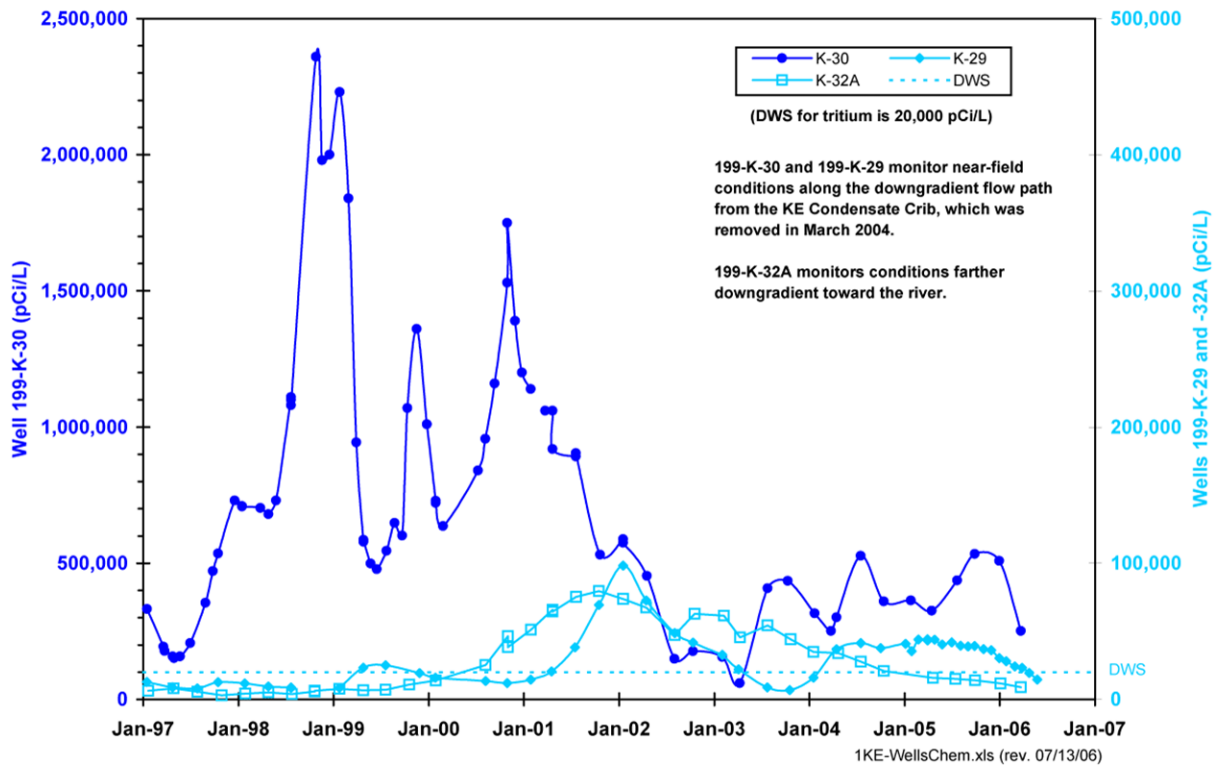
**Table 2.** Tritium in Groundwater Near the KW Fuel Storage Basin (Apr/May/June 2006)

(Updated July 18, 2006; new results, changes, and interpretations are printed in blue)

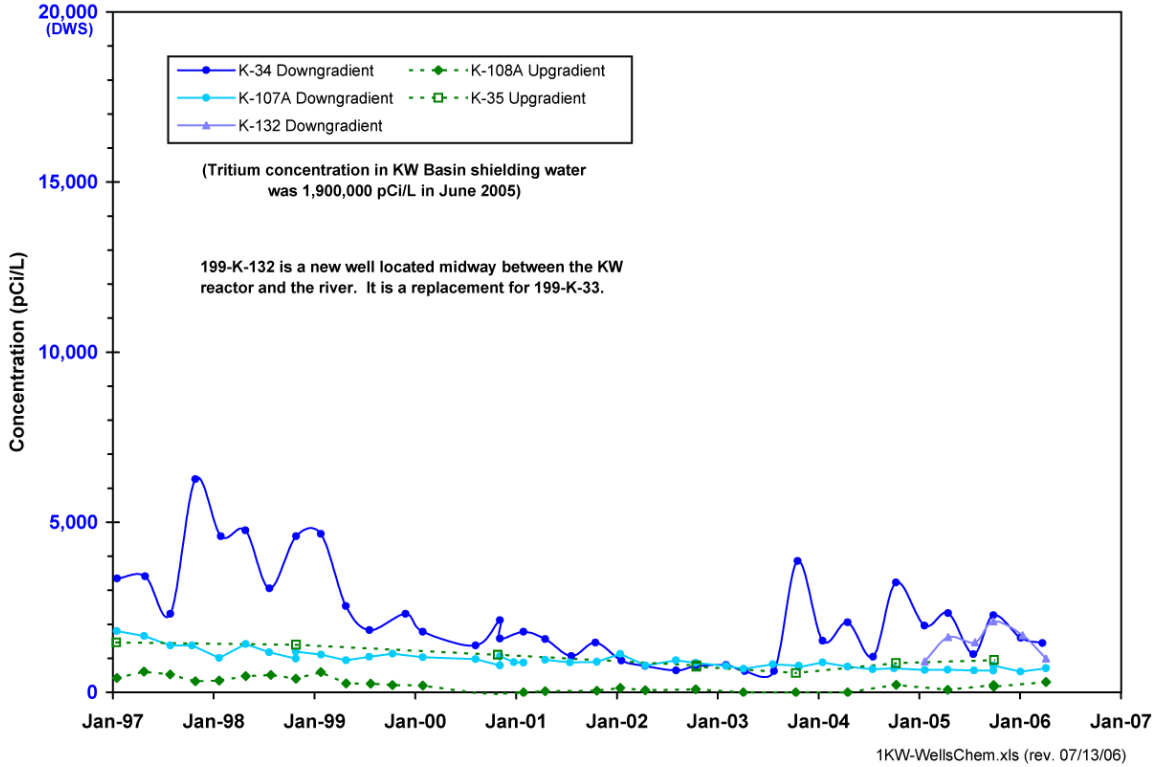
Well, (Sample Frequency), and Position	Recent Results (pCi/L)	Current Concentration Trend	Prior Results (pCi/L)	Historical Concentration Trend Since 1997
<b>Wells Downgradient of KW Fuel Storage Basin</b> (Tritium concentration in KW Basin shielding water is ~1,800,000 pCi/L—June 2006)				
<input checked="" type="checkbox"/> <b>199-K-34</b> (Q) Adjacent to KW Basin.	1,450 (3/30/06)	Recent change in trend started October 2003; other indicators did not change.	1,600 (1/10/06)	Long-term gradual decrease; variable in range of ~600 to ~6,000 pCi/L.
<input checked="" type="checkbox"/> <b>199-K-107A</b> (Q) Adjacent to KW Basin and basin drain field.	707 711 (4/12/06)	Continued long-term decline; low variability.	608 (1/09/06)	Long-term decline, historical range of ~2,300 down to <1,000.
<b>199-K-132</b> (Q) Between KW Reactor and the Columbia River.	989 4/12/06)	Consistent with trends in decommissioned well 199-K-33.	1,680 (1/17/06)	Overall decline from plume that passed K-33 during 1995~1998, with peak values of ~45,000.
<b>199-K-31</b> (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, NO <sub>3</sub> , Tc-99).
<b>Wells East of KW Fuel Storage Basin</b>				
<b>199-K-106A</b> (Q) Downgradient of KW Condensate Crib; alongside KW Basin.	669,000 (4/14/06)	Continued high and variable concentrations. Chloride, nitrate, and Tc-99 are also elevated.	429,000 (1/06/06)	Variable within range of ~2,500 to ~25,000, following 1996 plume passage that had peak of 676,000. Recent pulse started in July 2001.
<b>Wells upgradient of the KW Fuel Storage Basin</b>				
<b>199-K-108A</b> (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 (10/04/05)	Gradual decline from ~650 in 1996, until dilution by clean water started in 1999; not detected since.
<b>199-K-35</b> (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).
<input checked="" type="checkbox"/> 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; ND = not detected. <u>Regulatory Standards for Tritium in Groundwater:</u> 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.				



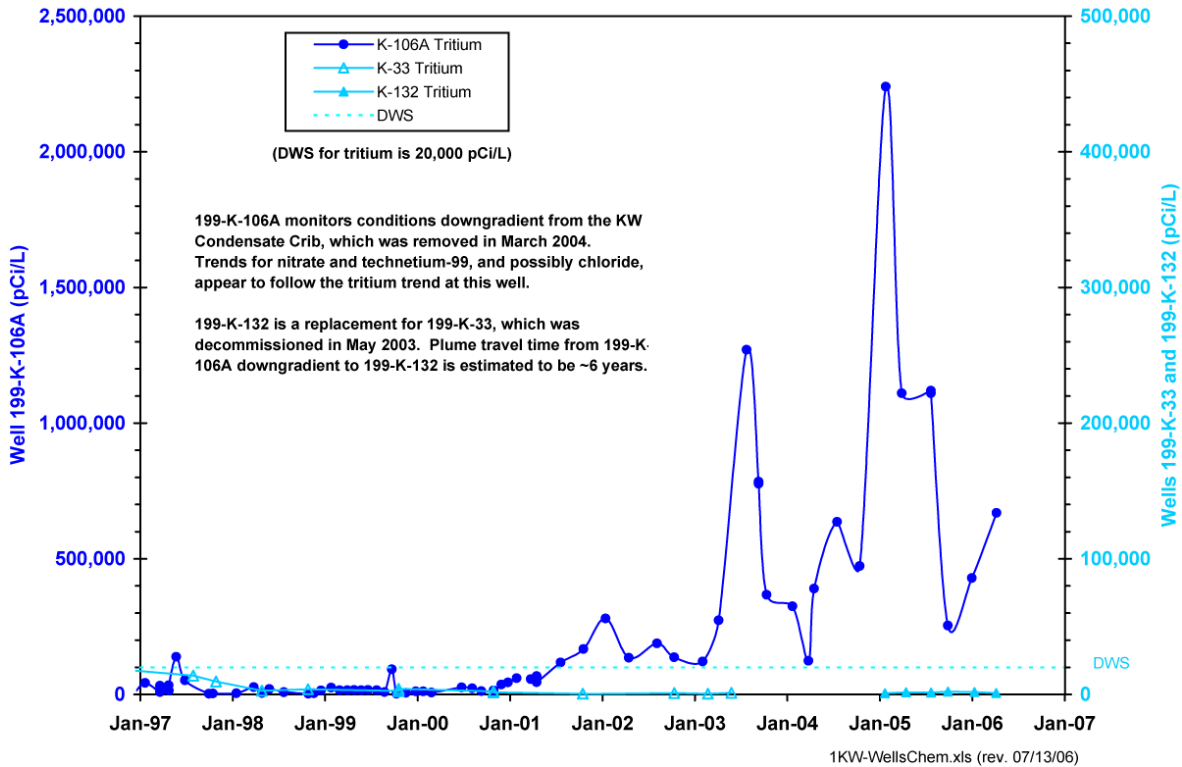
**Figure 1.** Tritium in Groundwater Near the KE Fuel Storage Basin



**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

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