

**Hartman, Mary J****0059938**

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**From:** Furman, Marvin J  
**Sent:** Thursday, May 08, 2003 9:39 AM  
**To:** Goswami, Dibakar; Caggiano, Joseph  
**Cc:** Morse, John G; Luttrell, Stuart P; Hartman, Mary J  
**Subject:** RCRA QUARTERLY GROUNDWATER MONITORING REPORT

Please find attached for your information the RCRA Groundwater Monitoring Report for the period October through December 2002. This report is by exception; that is, information and discussion addresses only those facilities where issues and anomalies were identified during the reporting period. Groundwater monitoring data for this reporting period for the facilities not addressed in this report are available for your inspection. A comprehensive treatment of the groundwater monitoring data for all of the facilities is presented in the annual report. Also included is the quality control information for the reported data.

**QUARTERLY RESOURCE CONSERVATION AND RECOVERY ACT  
GROUNDWATER MONITORING DATA FOR THE PERIOD  
OCTOBER THROUGH DECEMBER 2002.**

Seventeen *Resource Conservation and Recovery Act of 1976* (RCRA) sites<sup>1</sup> were sampled during the reporting quarter, as listed in Table 1. Sampled sites include seven monitored under groundwater indicator evaluation ("detection") programs [40 CFR 265.93(b)], eight monitored under groundwater quality assessment programs [40 CFR 265.93(d)], and two monitored under final-status groundwater corrective action programs [WAC 173-303-645(11)].

### **Comparison to Concentration Limits**

Contamination indicator parameter data (pH, specific conductance, total organic halides, and total organic carbon) from downgradient wells were compared to background values at sites monitored under interim-status, indicator evaluation requirements, as described in 40 CFR 265.93. The 216-A-29 Ditch, the 216-B-63 Trench, LLWMA 1, LLWMA 2, and WMA A-Ax had an exceedance in a downgradient well during the quarter, but none of these appears to indicate dangerous waste contamination from the RCRA sites, as explained below.

**216-A-29 Ditch:** Average concentration of specific conductance in downgradient wells 299-E25-35 (341 uS/cm) and 299-E25-48 (408.5 uS/cm) continued to exceed the critical mean value of 265 uS/cm in October. Also, specific conductance (based on one measurement) in another downgradient well, 299-E26-13, was at the critical mean level of 265 uS/cm. The exceedances in wells 299-E25-35 and 299-E25-48 were reported earlier. The rise in specific conductance has been attributed to non-hazardous constituents, sulfate, calcium, and sodium (Thompson, 2000). No further action is necessary.

**216-B-63 Trench:** Average pH in downgradient well 299-E33-37 (8.49) exceeded the upper critical mean limit of 8.44 (recently revised for fiscal year 2003 comparisons) in October. The October pH value did not represent an increase, but the revised critical range is narrower than the previous critical range. Specific conductance (average of 330 uS/cm) remained below the critical mean of 519 uS/cm but has shown an increasing trend since 1998. Verification sampling for pH was conducted in early April, 2003. Two sets of quadruplicate pH measurements were below the critical mean value (the set of field quadruplicate measurements averaged 8.30). Detection monitoring will continue.

**LLWMA 1:** Specific conductance in downgradient well 299-E33-34 (average of replicates = 1,051 uS/cm) continued to exceed the critical mean of 683 uS/cm in December. An exceedance in 299-E33-34 was reported earlier, along with assessment results (Furman, 1999). Specific conductance peaked at 1,284 uS/cm on 12/6/01 and is now decreasing. Nitrate, sulfate, calcium, and sodium are all elevated in this well and follow a pattern similar to specific conductance. Because no waste has been placed in the northern portion of the waste management area and there is a known nitrate plume from an upgradient source (cribs located to the east), verification sampling is not necessary.

**LLWMA 2:** In October 2002, replicate average results of specific conductance, TOC, and TOX in upgradient well 299-E34-7 (2,452 uS/cm, 5,380 ug/L, and 24.0 ug/L respectively) continued to exceed the

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<sup>1</sup> A site is a Treatment, Storage, and/or Disposal (TSD) unit or a waste management area associated with a TSD unit.

critical mean values of these parameters (1,082 uS/cm, 2,110 ug/L, and 11.72 ug/L). The rise in specific conductance is attributable mainly to chloride (356 mg/L), calcium (339 mg/L), nitrate (145 mg/L), and sulfate (655 mg/L). Contributor(s) to the elevated TOC and TOX are under continuing investigations. This well was sampled for an extensive list of Appendix IX waste and other constituents this quarter. The only Appendix IX organic compound detected was a low level of endrin aldehyde (0.08 ug/L). This compound is an impurity or breakdown product of the pesticide, endrin. Oil and grease were not detected although they were detected previously. Because the indicator parameter exceedances occurred in an upgradient well, assessment monitoring is not required.

**SST WMA A-AX:** The average of pH measurements from downgradient well 299-E25-46 (6.81) was below the lower limit of the critical range [6.82, 9.54] in December. The samples were collected at the end of an extended purge, and pH dropped during the purge period. Verification sampling for pH was conducted in early April, with two sets of four measurements. The average value for each of the two sets was 7.0, which is within the critical mean range. Detection monitoring will continue. The chromium concentration in this well increased sharply from 281 ug/L (6/5/02) to 6,250 ug/L (12/11/02). Similar patterns also were observed for manganese and nickel, but not iron. The groundwater project will continue to monitor trends in these constituents.

**SST WMA C:** The current direction of groundwater flow beneath this waste management area is toward the southwest, as stated in a recent interim change notice (Narbutovskih, 2002). Well 299-E27-7 is now the only upgradient well, and specific conductance is rising steadily in this well. The elevated specific conductance in well 299-E27-7 is due to increasing sulfate, calcium, nitrate, and sodium. A critical mean for specific conductance cannot be calculated using data from this well until four quarters of stable data are available. Consequently, no upgradient/downgradient comparisons will be made until four quarters of stable data are obtained from well 299-E27-7 or from a new upgradient well to be drilled later this year.

### **Wells Not Sampled as Scheduled**

Seven wells that were scheduled to be sampled for RCRA during the reporting period were not sampled as scheduled. Most of these wells were sampled the next quarter; one well is dry. Table 2 lists the wells that were not sampled as scheduled, and the reason why.

### **Status of Assessment Programs**

This section describes the seven RCRA sites currently monitored under groundwater quality assessment. Discussions of waste constituents not regulated under RCRA (e.g., radionuclides) are included where the information may provide further insight regarding the source and migration of dangerous waste constituents in groundwater.

Table 1. Status of RCRA Sites October-December 2002.

Site	Routine sampling?	DG Statistical exceedance?	Comments
<b>Indicator Evaluation Sites [40 CFR 265.93(b)] (sampled semiannually)</b>			
1301-N Liquid Waste Disposal Facility	No	Not sampled	Received results from delayed sampling at UG well N-57 (11/02) and DG well N-105A (10/02). No new exceedances.
1325-N Liquid Waste Disposal Facility	No	Not sampled	
1324-N Surface Impoundment and 1324-NA Percolation Pond	No	Not sampled	
216-B-3 Pond	No	Not sampled	Trial period for alternative statistical method.
216-A-29 Ditch	Yes	Yes <sup>a</sup>	
216-B-63 Trench	Yes	Yes	See text.
216-S-10 Pond and Ditch	Yes	No	Current network 1 UG and 1 DG well <sup>(b)</sup>
LERF	Yes	Not applicable	No statistical evaluation per Ecology direction.
LLBG WMA 1	Yes	Yes <sup>a</sup>	
LLBG WMA 2	Yes	Yes <sup>a</sup>	Wells monitoring the north part of the LLWMA are dry.
LLBG WMA 3	No	Not sampled	9 of 20 wells in original network are dry <sup>(b)</sup>
LLBG WMA 4	No	Not sampled	Current network 2 DG wells <sup>(b)</sup>
SST WMA A-AX	Yes	Yes	See text.
SST WMA C	Yes	See comment	Sampled quarterly. No statistical evaluation until 4 quarters stable data from UG well.
NRDWL	No	Not sampled	
<b>Groundwater Quality Assessment Sites [40 CFR 265.93(d)] (sampled quarterly)</b>			
Seven sites <sup>c</sup>	Yes	Not required	See updates in text.
<b>Final Status Sites [WAC 173-303-645(11)]</b>			
300 Area Process Trenches	Yes	Yes <sup>d</sup>	Trial period for alternative statistical method.
183-H Solar Evaporation Basins	Yes	Yes <sup>d</sup>	Sampled annually in November.
CM = Critical mean value(s)		NRDWL = Nonradioactive Dangerous Waste Landfill	
DG = Downgradient		SST = Single-Shell Tanks	
LERF = Liquid Effluent Retention Facility		UG = upgradient	
LLBG = Low-Level Burial Grounds		WMA = Waste Management Area	

<sup>a</sup> No indication of dangerous waste contamination from facility; see text for explanation.

<sup>b</sup> Well installation needs are addressed each year as part of the M-24 milestone process.

<sup>c</sup> U-12 Crib, PUREX Crib, SST WMAs B-BX-BY, S-SX, T, TX-TY, and U.

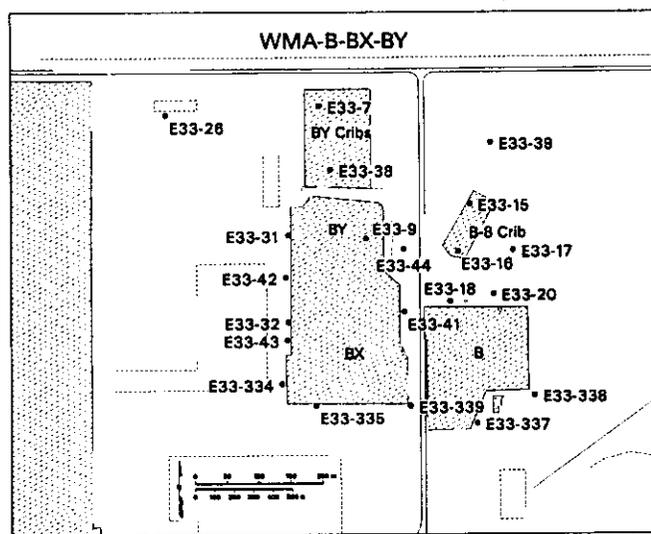
<sup>d</sup> Site has entered corrective action monitoring because of previous exceedances.

Table 2. Wells Not Sampled as Scheduled During July-September 2002.

Well	RCRA Site	Date Scheduled	Date Sampled	Reason delayed or not sampled
299-E34-3	LLWMA 2	10/7/2002	--	Dry well.
299-W15-763	WMA TX-TY	11/18/2002	1/8/2003	Electrical problems.
299-W15-765	WMA TX-TY	11/18/2002	1/8/2003	Electrical problems.
299-W22-44	WMA S-SX	12/2003	1/16/2003	Scheduling conflict with tank farms support delayed sampling until January 2003.
299-W23-19	WMA S-SX	12/2003	1/16/2003	Scheduling conflict with tank farms support delayed sampling until January 2003.
399-1-11	300 APT	12/2002	1/2/2003	Samplers behind schedule; minor delay.
699-36-70A	216-U-12 Crib	12/2003	1/8/2003	Samplers behind schedule; minor delay.

**Single-Shell Tanks Waste Management Area B-BX-BY:** There was no apparent change in the direction or rate of groundwater flow during the reporting period. Based on in situ measurements, the groundwater is nearly stagnant in the north part of the waste management area, flowing slowly to the southwest. In the southern half, it flows towards the south-southeast to southeast with a faster flow rate.

In general, nitrate concentrations appear to be increasing beneath most of the WMA. For example, in the northern part of the 241-BY Tank Farm in well 299-E33-9, levels have increased from 100 mg/L in August 2002 to 130 mg/L in December 2002. A sharp increase was seen under the BY cribs in well 299-E33-7, as nitrate levels rose from 602 mg/L to 735 mg/L. The recent value is close to the maximum value seen in the 1990s, which was 748 mg/L (August 2001, well 299-E33-7). At the B-8 Crib, nitrate also increased from 589 mg/L (August) to 624 mg/L (November). The lowest nitrate concentration, found in the southeast corner of the WMA, increased slightly from 8.8 mg/L in August 2002 to 9.7 mg/L in December 2002. Nitrate levels continued to rise slowly in the southwest corner of the site, with values approaching the drinking water standard of 45 mg/L in well 299-E33-43 (37 mg/L in November 2002).



Elevated cyanide is found in the groundwater under the BY cribs, west to well 299-E33-26 and south to the northern part of the 241-BY Tank Farm. Cyanide levels decreased slightly during the reporting period, ranging from 235 ug/L under the BY cribs to 22 ug/L under the tank farm. The drinking water standard is 200 ug/L.

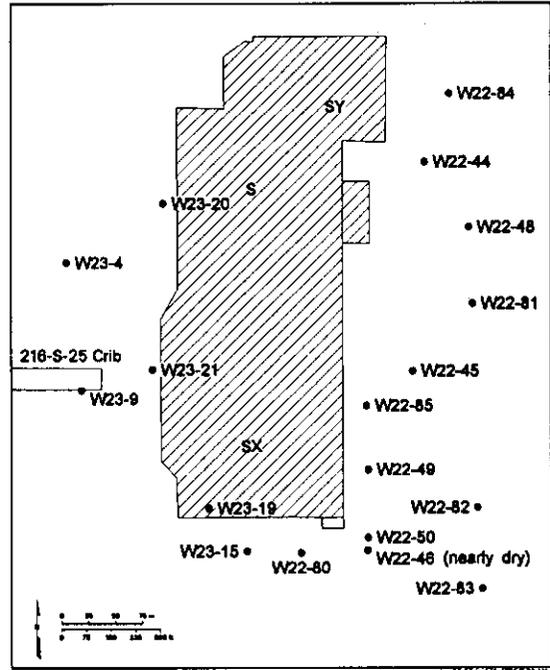
The nitrite concentration increased in well 299-E33-44 in the central part of the waste management area, from 122 ug/L in August 2002 to 394 ug/L for November 2002. Nitrite is not usually found in the

groundwater, probably because it oxidizes to nitrate before it can be detected. However if reducing conditions exist, as might be caused by microbial action, nitrite in the groundwater might be expected. Measurements for dissolved oxygen and reduction-oxidation potential have been added to the sampling schedule for this well to provide more insight to the causes of the localized nitrite concentrations.

**Single-Shell Tanks Waste Management Area S-SX:**

Groundwater beneath this site is contaminated with hexavalent chromium attributed to two general source areas within the waste management area. All analytical results from groundwater samples collected in December 2002 were on trend. The water table continued to decline, but the gradient and flow direction are stable with the interpreted flow direction to the east.

The northern contaminant plume, with an apparent source in S Tank Farm and passing through well 299-W22-48, remained stable during the quarter. Chromium and nitrate concentrations in well 299-W22-48 remained constant for the quarter. The bulk of the contaminant plume is limited to between well 299-W22-44 on the north and 299-W22-81 on the south. The plume may be expanding laterally, based on increasing chromium concentrations in well 299-W22-81 for the past two quarterly sampling periods.



The contaminant plume migrating from the SX Tank Farm in the southern portion of the waste management area continues to spread slowly downgradient. This plume is comprised of chromium and the non-dangerous constituent nitrate, just as the S Tank Farm plume to the north. Confirmation that the chromium appears to have reached well 299-W22-83, the farthest monitoring well downgradient in the network, in the last quarter as reported previously, is indicated by the trend (see Figure 1), and the chromium concentration at this location has continued to rise in a typical breakthrough response. The northern margin of the plume continued to be defined by wells 299-W22-49 and 299-W22-82, where nitrate concentrations were at levels much lower than in wells to the south.

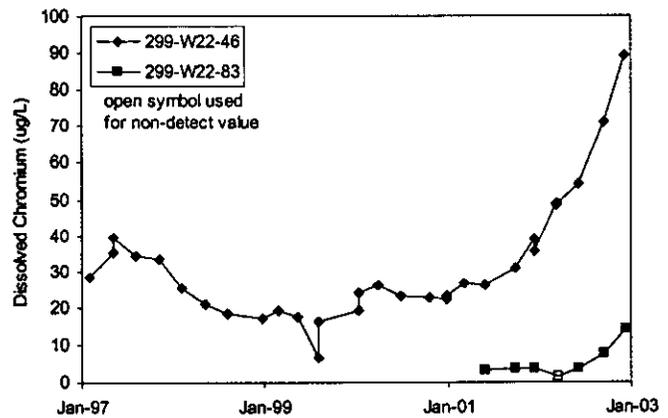
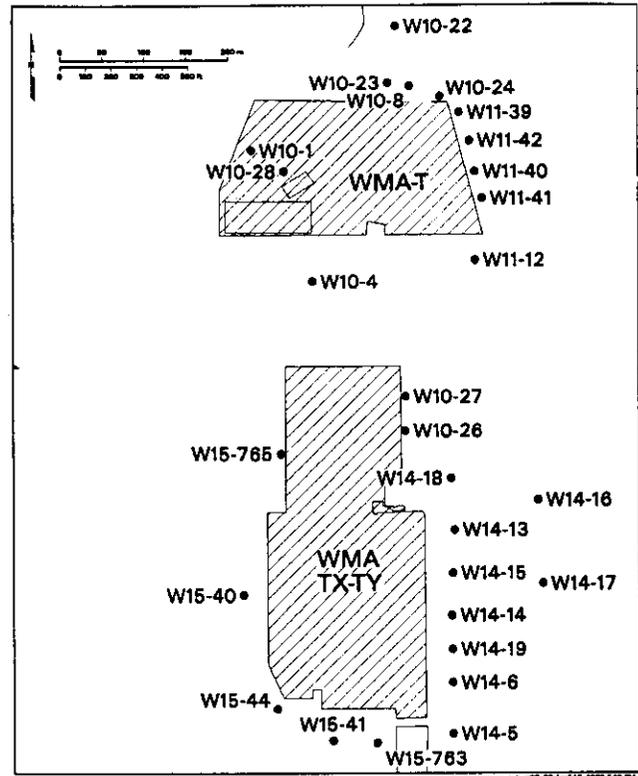


Figure 1. Chromium Concentrations in Wells 299-W22-46, Near Tank Farm, and 299-W22-83, Farther from Tank Farm.

Sampling of wells 299-W22-44 and 299-W23-19 was delayed until January 2003, a several week delay from the routine schedule, because tank farm support could not be scheduled during the reporting quarter. These wells can be sampled only with support from tank farm personnel. Results from the January sampling will be presented in the next report.

**Single-Shell Tanks Waste Management Areas T and TX-TY:** Water levels near these waste management areas continued to decline during the reporting period. At WMA T, the water level dropped between 0.29 and 0.37 meter in wells in the monitoring network since the first quarter of fiscal year 2002. At WMA TX-TY, the water level dropped between 0.1 and 0.38 meter during the same time period.

While the water table has continued to drop, the gradients remain unchanged; therefore, the rate and direction of groundwater flow did not change appreciably during the reporting quarter. Groundwater flow at WMA T is between about 5 degree north and 8 degrees south of east at a rate of about 0.025 meters per day. Groundwater flow at WMA TX-TY varies from the north to the south part of the WMA. In the north, groundwater flow is approximately 20 degrees south of east at a rate of about 0.01 to 0.025 meter per day. In the south, where groundwater flow has been altered by the 200-ZP-1 pump-and-treat operations, groundwater flow is to the south or south southwest at about 0.3 meter per day.



New data from aquifer tests became available during November 2002 (Spane et al. 2002). The data are from aquifer tests performed on wells drilled in fiscal year 2001. The aquifer tests include slug tests at four wells at WMA T and five wells at WMA TX-TY. Also, tracer dilution tests, tracer pumpback tests, and constant-rate pumping tests were done at two wells in WMA T and one well in WMA TX-TY. Finally, in-well vertical flow assessments were done at two wells at WMA-T.

Table 3 lists selected data from the aquifer tests and calculated Darcy flow velocities using the test data. In addition to the data listed in Table 1, vertical flow tests at WMA T noted in-well, downward, vertical flow at an average rate of 0.001 m/min in well 299-W11-39 and at an average rate of 0.017 m/min in well 299-W11-40.

## WMA T

Chromium, carbon tetrachloride, and TCE continued to be the only dangerous waste constituent found in the groundwater beneath WMA T. The source of the carbon tetrachloride and TCE is liquid disposals associated with processes at the Plutonium Finishing Plant and not WMA T. Carbon tetrachloride and TCE are monitored as part of the 200-ZP-1 Operable Unit.

Chromium concentrations continued to exceed the drinking water standard (100 µg/L) in three wells (Figure 2). The highest chromium concentration was in well 299-W10-4, located upgradient of the WMA. The concentration of chromium in this well was 307 µg/L and increased substantially from 242 µg/L during the previous quarter. Well 299-W10-4 is located near the 216-T-36 crib and the crib is the most likely source for the chromium.

Table 3. Aquifer Test Data from New Wells in WMA T and WMA TX-TY.

Waste Management Area and Well	Hydraulic Conductivity (m/d) <sup>1</sup>	Hydraulic Gradient (m/m) <sup>1</sup>	Darcy Flow Velocity (m/d) <sup>2</sup>	Groundwater Flow Direction <sup>1</sup>
WMA T				
299-W11-39	1.31 – 1.69	0.00115	0.007 – 0.010	East 8 degrees south
299-W11-40	3.56 – 4.58	0.00132	0.024 – 0.030	
299-W11-41	7.57 – 7.78		0.038 – 0.039	East 6 degrees south
299-W11-42	28.1		0.14	
WMA TX-TY				
299-W10-27	0.05 – 0.07		0.0002 – 0.0003	East 31 degrees south
299-W14-15	3.77 – 4.50	0.00140	0.026 – 0.032	
299-W14-16	3.90 – 5.08		0.020 – 0.025	
299-W14-17	3.71 – 4.89		0.018 – 0.024	
299-W15-763	0.71 – 0.93		0.004 – 0.005	

1. Data from Spane et al (2002). Hydraulic conductivities are from slug test data; hydraulic gradient and flow direction are from trend surface analyses.
2. Calculated using the hydraulic gradient given by Spane et al. (2002) or by assuming a gradient of 0.001 if no value was given by Spane et al. (2002). Effective porosity is assumed to be 0.2, the mean of values given in Hartman et al. (2002)

Chromium concentrations above the drinking water standard continued to be found in two downgradient wells: 299-W11-41 and 299-W11-42. The chromium concentration was 143 µg/L in well 299-W11-41 and 126 µg/L in well 299-W11-42. The concentration of chromium increased in well 299-W11-41 during the quarter (chromium was 129 µg/L in August 2002) and remained essentially unchanged in well 299-W11-42 (chromium was 121 during the previous quarter). Both wells are located downgradient of well 299-W10-4 and the 216-T-36 crib. The chromium found downgradient of WMA T is most likely from the same source as that found in well 299-W10-4. Figure 3 shows a plume map of chromium in the area of WMA T.

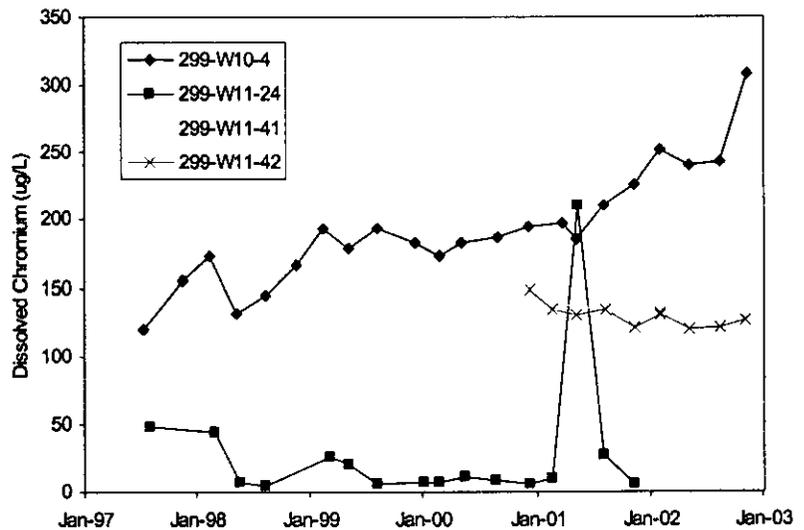


Figure 2. Chromium in filtered samples from selected wells at WMA T (299-W11-42 replaced 299-W11-24).

Nitrate is not a regulated, dangerous waste constituent. However, nitrate concentrations increased in most wells and remained above the drinking water standard in all wells in the WMA T network during the reporting period. The highest reported concentrations of nitrate were in upgradient wells 299-W10-28, where nitrate increased from 1,460 mg/L in August 2002 to 1,990 mg/L in November 2002, and in well 299-W10-4, where nitrate increased from 1,740 mg/L (August 2002) to 2,090 mg/L.

Nitrate concentrations in all monitoring wells except 299-W11-39 on the downgradient (east) side of WMA T are between 145 mg/L (well 299-W11-12) and 770 mg/L (well 299-W11-42).

Fluoride is not a regulated, dangerous waste constituent. During the reporting period, three wells exceeded the Washington State drinking water standard for fluoride (4.0 mg/L). Two of these wells are at the northeast corner of the WMA (wells 299-W10-23 and 299-W10-24), where concentrations ranged between 4.1 and 4.3 mg/L and one well is on the downgradient, east side of the WMA (well 299-W11-42), where the concentration was 4.0 mg/L. Fluoride levels greater than 2.0 mg/L were detected in four other wells. These are 299-W10-4, located upgradient of the WMA, 299-W10-8, in the northeast corner of the WMA, and wells 299-W11-40 and 299-W11-41, east (downgradient) of the WMA.

**WMA TX-TY**

Chromium is the only dangerous-waste constituent that has been detected in groundwater beneath WMA TX-TY and may be from a source within the WMA. Chromium exceeded the drinking water standard of 100 µg/L in one well at WMA TX-TY; well 299-W14-13 (Figure 4). The chromium concentration in that well was 427 µg/L during the reporting quarter, a substantial increase from the previous quarter concentration of 361 µg/L. The chromium

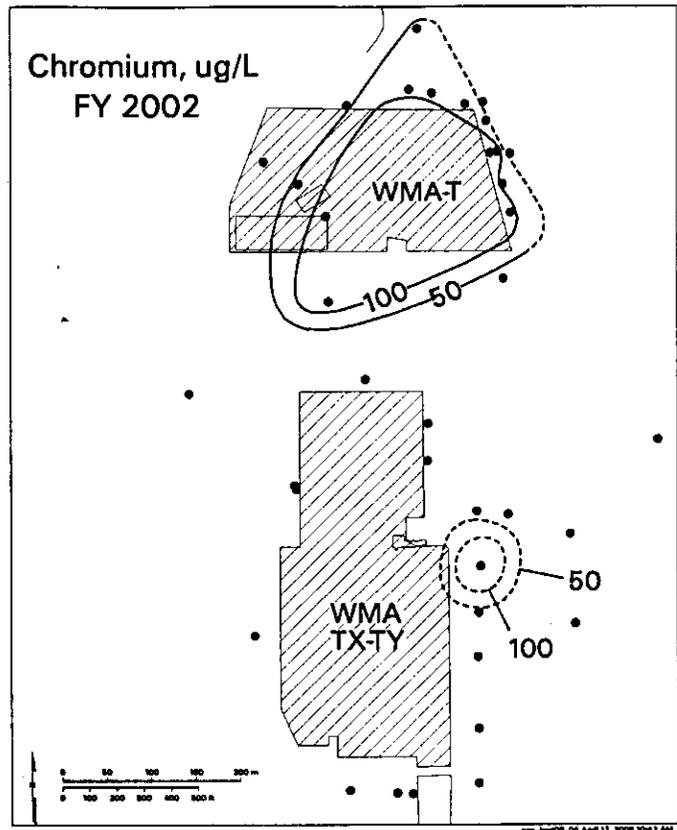


Figure 3. Chromium Plume at Waste Management Areas T and TX-TY, October-December 2002.

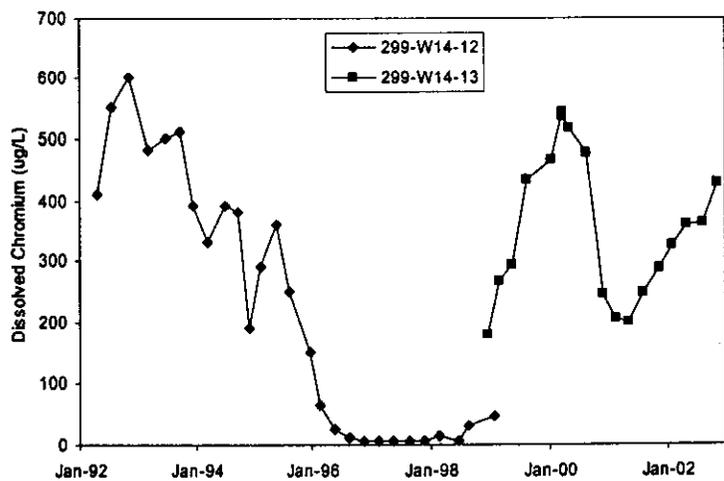


Figure 4. Chromium in Filtered Samples from Well 299-W14-12 and Its Replacement, 299-W14-13.

concentration has been above the drinking water standard since the well was first sampled in December 1998 and the concentration has been increasing since May 2001. The vertical distribution of chromium in the screened interval of the aquifer at well 299-W14-13 is described below.

Nitrate is not a regulated dangerous waste constituent. However, nitrate continued to exceed the drinking water standard (45 mg/L) in all wells in the WMA TX-TY monitoring network except 299-W15-763 during the reporting quarter. Well 299-W15-763 is located south of the WMA and has had anomalously low (compared to other wells at WMA TX-TY) nitrate concentrations since the well was drilled in 2001. The highest nitrate concentration was found in well 299-W14-13 in the central part of the east side of the WMA. The nitrate concentration in this well was 487 mg/L in November 2002, up substantially from 324 mg/L in August 2002. The regional nitrate plume at WMA TX-TY is attributed to past disposal practices at facilities associated with the Plutonium Finishing Plant and T Plant. The relatively high nitrate at well 299-W14-13 may be due to one, or a combination of, nearby liquid disposal facilities and WMA TX-TY. The vertical distribution of nitrate in well 299-W14-13 is discussed below.

Manganese concentrations exceed the groundwater standard of 50 µg/L in wells 299-W10-27 (249 µg/L) and 299-W14-18 (101 µg/L). Manganese has been steadily decreasing in both wells since they were drilled in 2001. The high manganese is thought to be an artifact of drilling. Manganese also exceeded the groundwater standard in all samples obtained during drilling of new wells 299-W14-19 and 299-W15-44. Other analytical results from samples from the new wells are discussed below.

#### **Vertical Sampling in Well 299-W14-13.**

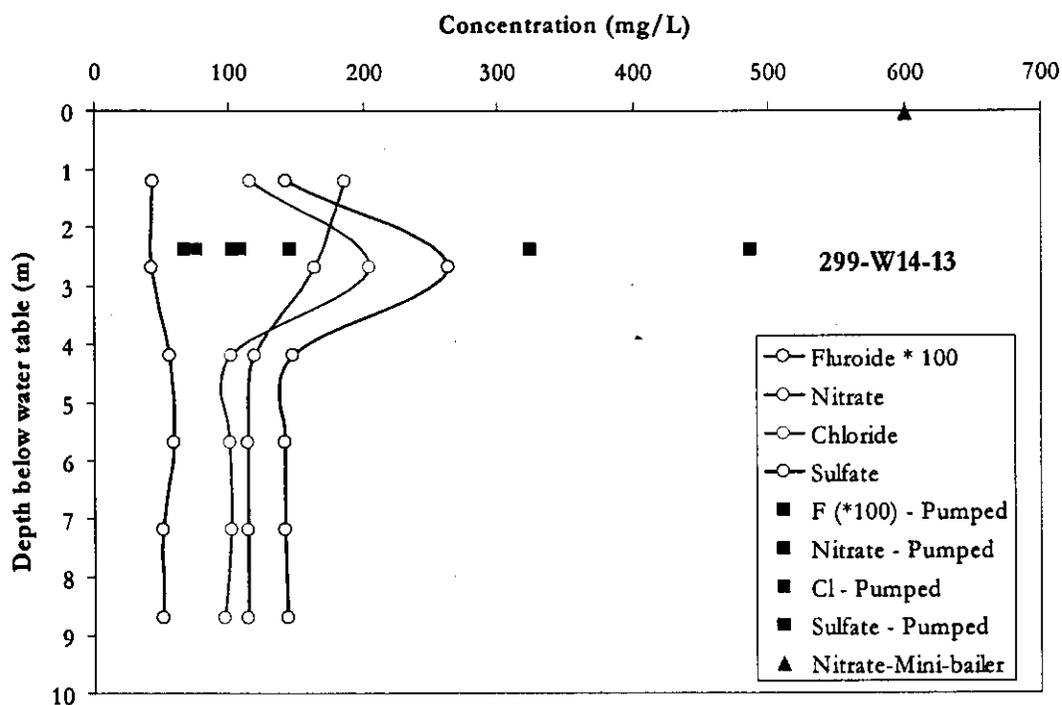
Well 299-W14-13 has the highest concentrations of chromium and several other constituents at WMA TX-TY. Previous investigations suggest that some constituents may be stratified with depth in the aquifer. A multi-level, dialysis sampling device was used in the well to investigate the possible stratification. Groundwater samples were collected at approximately 1.5-meter intervals throughout the screened interval of the well. The dialysis sampler was left in the well for one month for equilibration with the groundwater. The samples were analyzed for ICP metals and anions in late 2002.

The shallowest sample taken with the dialysis device was at about 1 meter below the water table. A follow-up sample was taken at about 4 centimeters below the water table during February 2003 for laboratory and field analysis of chromium and field analysis of nitrate<sup>2</sup>.

Figure 5 shows anion concentrations versus depth in the screened interval of well 299-W14-13. The anion concentrations in the well were fairly consistent throughout most of the screened interval with the exception of a "high" at about 2.5 meters below the water table. The pumped concentrations of chloride, fluoride, and sulfate are similar to the dialysis concentrations (except at the 2.5 meter depth). The concentrations of chloride and sulfate are several times greater than natural background (background for chloride is ~5 to 10 mg/L and background for sulfate is ~30 to 40 mg/L). Sulfate is the dominant anion throughout most of the screened interval.

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<sup>2</sup> The 4 cm sample was collected with a mini-bailer device constructed by securing a piece of 5/8 inch tygon tubing around an electrical tape. The tubing was sealed at the top and bottom with the exception of a small slit cut in the top of the tubing to allow water to enter. The device was lowered through the port in the pump landing plate used for water level measurements. The device was lowered until the electrical tape encountered groundwater and then lowered until the slit was 4 cm below the water table. The results of the test show that this device can be used to obtain shallow, depth discrete samples without the time and expense to remove and replace the sampling pump.



**Figure 5.** Anion concentrations versus depth below the water table in the screened interval of well 299-W14-13. Concentrations connected by solid lines are from samples collected by the multi-level dialysis device. Solid squares are concentrations from routine, quarterly pumped samples (August and November 2002). The depth of the solid squares is at the depth of the pump intake. The solid triangle is the nitrate concentration from the mini-bailer sample.

Nitrate showed a concentration distribution in the upper part of the aquifer different from the distributions of the other anions (and different than most major cations). The dialysis data show that the nitrate concentration increased upward from ~ 4 to ~ 1 meter below the water table. The mini-bailed sample, from 4 centimeters below the water table, showed a marked increase in nitrate concentration compared to the dialysis samples. Thus, there was a large nitrate concentration gradient in the screened interval of well 299-W14-13, with the highest concentrations coming from the uppermost part of the aquifer. The routine, quarterly pumped samples seem to represent a mixture of the shallow, high nitrate-bearing water with the deeper water with lower nitrate concentrations.

The dialysis data for chromium (Figure 6) show a fairly constant chromium concentration throughout the screened interval. The chromium concentrations in pumped samples, however, were lower than the concentrations measured in the dialysis samples. This suggests that the pumped samples incorporate some lower chromium-bearing water. The source of the lower chromium water is not known.

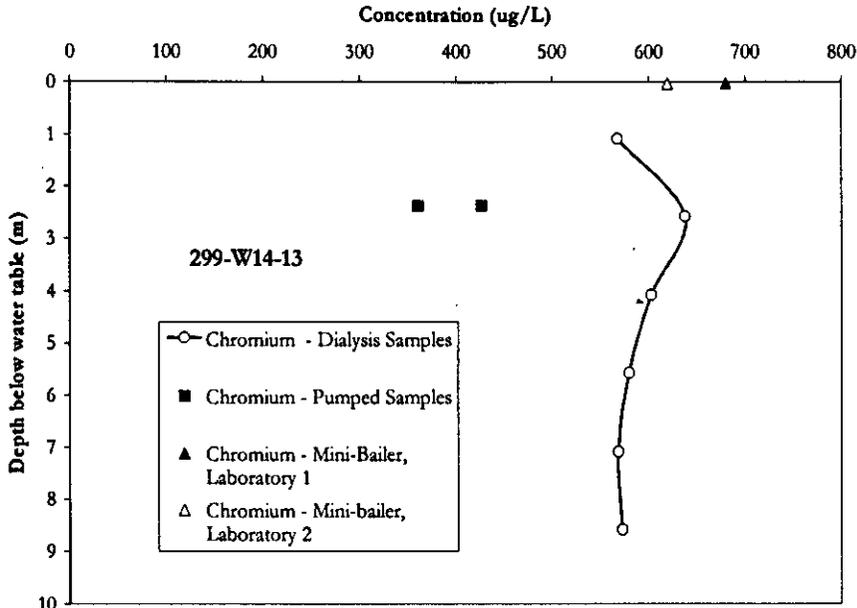


Figure 6. Chromium concentrations versus depth below the water table in the screened interval of well 299-W14-13. Concentrations connected by solid lines are from samples collected by the multi-level dialysis device. Solid squares are concentrations from routine, quarterly pumped samples (August and November 2002). The depth of the solid squares is at the depth of the pump intake. Triangles are the chromium concentration measured in the mini-bailer sample.

It was previously thought that chromium concentrations were higher at depth in the aquifer at well 299-W14-13, than near the water table (Horton 2002). This was based on comparing chromium concentrations in well 299-W14-12 (now dry) with chromium concentrations in deeper, replacement well 299-W14-13. The two wells are about 2 meters apart, horizontally. The concentration of chromium in the last sample from well 299-W14-12 was about 45  $\mu\text{g/L}$  and was thought to represent the concentration of chromium at the top of the aquifer. The first sample from replacement well 299-W14-13 contained 180  $\mu\text{g/L}$  chromium, which was considered to represent the chromium concentration throughout the screened interval which extends to ~10 meters below the water table.

The more recent multi-level dialysis sampler data do not support the previous conclusion. The dialysis and mini-bailer data suggest that chromium is in greater concentration at the water table than deeper in the aquifer.

Two other factors must be considered when interpreting contaminant distribution in the aquifer at well 299-W14-13. First, there is downward vertical flow within the well bore of about 0.01 m/min (Spaine et al. 2001). Second, trend plots show that the concentrations of most contaminants, major metals, and anions all track each other through time (Horton, 2002). This seems to require simultaneous dilution imposed on all constituents during purging and sampling regardless of any existing vertical stratification.

Taken as a whole, the data from well 299-W14-13 are very difficult to interpret. The complexities in the data seem to require some combination of 1) multiple sources of water in the well, 2) contaminant sources at different distances from the well, 3) vertical variations in hydrogeologic properties of the aquifer in the

screened interval, and 4) water sources that vary through time (overall periods of dilution). The interpretation of recently acquired data from well 299-W14-13 will continue.

### New Wells at WMA TX-TY

Two new wells were drilled at WMA TX-TY in October 2002 in fulfillment of Tri-Party Agreement milestone M-24-00N: wells 299-W14-19 and 299-W15-44. Well 299-W14-19 is located east of the central part of the 241-TX tank farm and is a downgradient well, filling a gap in the monitoring network between wells 299-W14-14 and 299-W14-6. Well 299-W15-44 is located at the southwest corner of the 241-TX tank farm, in an area where groundwater flow has been artificially altered toward the southwest by the 200-ZP-1 pump-and-treat operation.

Seven air-lifted slurries of sediment and groundwater were collected during drilling of each of the new boreholes. Samples were collected at about 20-foot intervals beginning near the water table and continuing to about 120 feet below the water table. The slurries were allowed to settle overnight and the groundwater was decanted into sample jars for analyses of metals, anions, technetium-99 and tritium.

In addition to laboratory analyses, aliquots of the slurry samples were collected for analyses of nitrate and specific conductance by field methods. Some groundwater samples also were collected by decanting groundwater from the archived grab samples of sediment. Finally, a few samples were collected for nitrate analyses by extracting soluble nitrate from archived sediment. The extractions were made by adding a known amount of deionized water to a known amount of sediment, shaking the mixture, and decanting the solution. The concentrations of nitrate in the extracts were corrected for dilution and for the moisture content of the sediment.

Analytical results for chromium, the only identified regulated dangerous waste constituent associated with WMA TX-TY, were below detection limits in all samples from both wells. Analytical results for several non-regulated metals and for some of the anions showed concentration variations with depth in the aquifer. Figure 7 shows an example using the results of the field analyses for nitrate from well 299-W14-19. The laboratory results also are included in the figure. The water table is at a depth of approximately 225 ft below ground surface. The laboratory and field analyses were in relatively good agreement except for the sample from 305 ft below the surface (80 feet below the water table). The nitrate data in Figure 7 show a maximum nitrate concentration at about 265 ft depth and a minimum between about 280 to 285 ft depth. The minimum

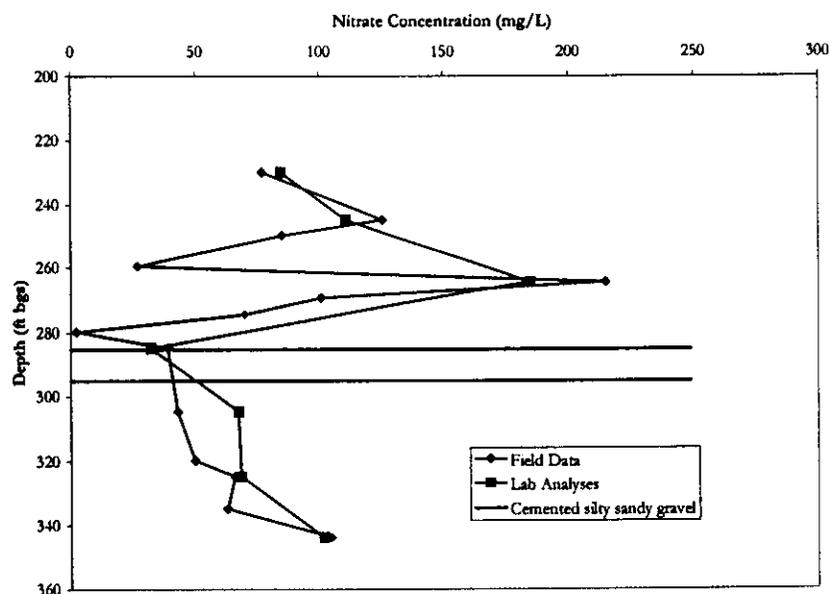


Figure 7. Nitrate concentrations versus depth in new well 299-W14-19.

corresponds to the top of a cemented, silty sandy gravel unit that the geologist noted as “very hard drilling with visible cement on gravel”. Below the cemented zone, nitrate concentrations increased to the bottom of the borehole. Several other nonregulated constituents showed concentration differences across this lithologic zone.

The analytical results from drilling well 299-W15-44 are similar to those in well 299-W14-19. Several non-regulated metals and some anions show variations in concentration with depth in the aquifer at well 299-W15-44. The geologist noted “heaving sand” in the well between about 285 ft and 292 ft below the surface in a thick sequence of sandy gravel with some cementation. Concentration changes in the aquifer at this depth in the well may be related to the change in lithology.

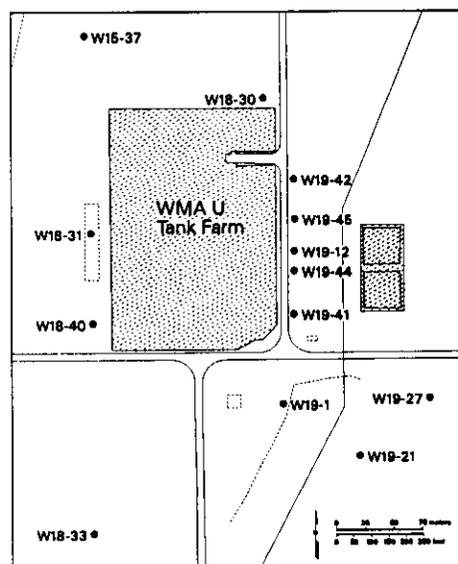
Both new wells in the area of WMA TX-TY showed substantial changes in groundwater composition across a zone at about 300 feet below ground surface. Although the zone has been described differently in each of the wells, it is likely that a lithologic layer at about that depth is having some influence on the distribution of groundwater contaminants in the area.

A report entitled *RCRA Groundwater Quality Assessment Report for Single-Shell Tank Waste Management Area TX-TY (January 1998 through December 2001)* was issued during the first quarter of fiscal year 2003 (Horton, 2002).

**Single-Shell Tanks Waste Management Area U:** This waste management area, which has been in assessment monitoring since 1999, has affected groundwater quality with elevated concentrations of chromium and the non-dangerous constituent nitrate. The impact has been limited to the southern half of the downgradient (east) side of the WMA.

The water table elevation continued to decline but the gradient is stable and the interpreted flow direction remains to the east.

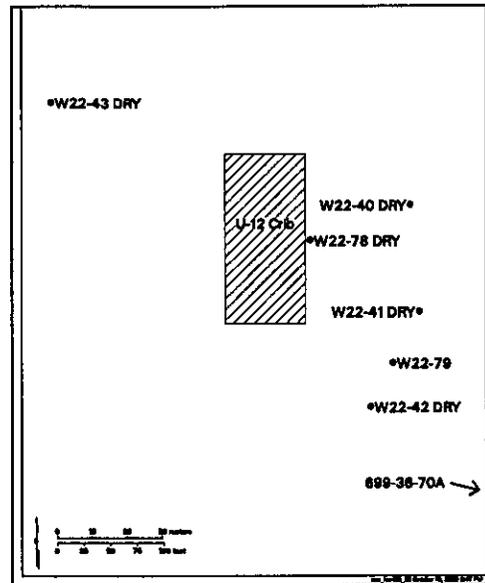
All analytical results from groundwater samples collected in November 2002 were on trend. Chromium concentrations exceeded background levels during the quarter only in downgradient wells 299-W19-41 and 299-W19-12. The highest chromium concentrations, in well 299-W19-41, continued to decrease to the current low of 13.0  $\mu\text{g/L}$  during the reporting quarter.



Nitrate concentrations have increased over the past several years, but until this quarter, remained below the drinking water standard. The nitrate concentration in well 299-W19-41 increased to a mean of 49 mg/L in November. While nitrate concentrations also increased in upgradient wells at the same time, their concentrations are only about 30% of levels found in the downgradient wells.

**216-U-12 Crib:** The current groundwater assessment monitoring network for the 216-U-12 Crib consists of only two downgradient wells (299-W22-79 and 699-36-70A), because other wells have gone dry. The wells were sampled in December 2002 (299-W22-79) and January 2003 (699-36-70A; delayed from the previous quarter). Concentrations of nitrate (with a source at the 216-U-12 Crib) and the indicator parameter specific conductance continued to decrease in both wells.

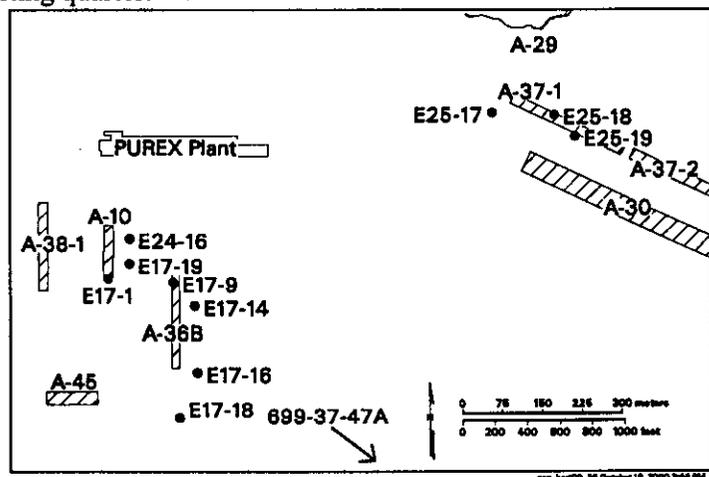
Specific conductance was measured at ~345  $\mu\text{S}/\text{cm}$  in downgradient well 299-W22-79, and at 528  $\mu\text{S}/\text{cm}$  in well 699-36-70A. The nitrate concentration in well 299-W22-79 was 63.8 mg/L and in 699-36-70A was 83.7 mg/L, both above the 45 mg/L drinking water standard. There currently is no upgradient well in this network.



The groundwater flow direction beneath the crib has remained relatively unchanged, toward the east-southeast, for years. Without an upgradient well and additional downgradient wells it is difficult to assess flow direction. The network is inadequate to fully evaluate the rate and extent of contaminant migration. Additional monitoring wells are addressed annually as part of the M-24 Milestone process.

**PUREX Crib (216-A-10, 216-A-36B, and 216-A-37-1):** All eleven of the near-field network wells were sampled during October 2002. Manganese and nitrate concentrations exceeded drinking water standards in one or more network wells during the reporting quarter.

Beneath the PUREX Crib, the differences in water table elevations from well to well are very small. During the reporting period the greatest water level difference (0.21 meter) was between wells at the 216-A-10 and 216-A-37-1 cribs. Therefore, the water table gradient is too low to determine groundwater flow rate or flow direction reliably. However, groundwater flow directions determined from the movement of groundwater contamination plumes indicate that the regional flow is toward the southeast.



The drinking water standard for manganese (50  $\mu\text{g}/\text{L}$ ) was exceeded at well 299-E17-19 (near the 216-A-10 Crib) for a sample collected in October 2002. The result was 57.5  $\mu\text{g}/\text{L}$ . The trend for manganese has been increasing in this well since 1997.

The drinking water standard for nitrate (45 mg/L) was exceeded at four wells, two at the 216-A-10 Crib and two at the 216-A-36B Crib. The well with the highest concentration was well 299-E17-9 at the 216-A-36B Crib (170 mg/L in October 2002). The overall trend at this well is slightly increasing since 1995, but the latest reported result was lower than the previous result of 233 mg/L for a sample collected in October 2001.

The latest sample collected from well 299-E17-9 is perhaps the last that will be collected from the well because the water level has dropped to a level that is making sampling very difficult. Well 299-E17-16 will replace well 299-E17-9 in the PUREX Cribs near-field well network. Well 299-E17-9 typically had the highest levels of analyzed waste constituents in PUREX Cribs well network. The replacement well (299-E17-16) is expected to have much lower measured concentrations of the analyzed waste constituents because of its location.

### Quality Control

Highlights of the Groundwater Monitoring Project's quality control program for October-December 2002 are listed in Table 4. We are transmitting a separate attachment with more specific QC information. The quality control program indicated that the data were acceptable for use in the statistical comparisons discussed above.

Table 4. Quality Control Highlights, October-December 2002.

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- Forty-six results were flagged with an H due to missed holding times. All of the flagged results were anions, and the data impacts should be minor.
  - Most of the field duplicate results demonstrated good precision, although the relative percent differences for nine pairs of results failed to meet the acceptance criteria. Acetone, alkalinity, ammonia, carbon-14, gross beta, iron, potassium, 1,1,1-trichloroethane, and zinc were the constituents with out-of-limit results.
  - Approximately 4% of the field-blank results exceeded the QC limits. Most of the out-of-limit results were for alkalinity, chloride, fluoride, iron, methylene chloride, sulfate, uranium and vanadium. In general, the field blank results should have little impact on the interpretation of 4<sup>th</sup> quarter groundwater data.
  - Severn Trent, Lionville Laboratory, and Eberline Services performed well on the analysis of blind standards. Severn Trent had out-of-limit results for total organic halides (3), trichloroethene (2), and tritium (3), while Eberline Services had high-biased results for gross beta (3). Incorrectly spiked standards probably account for the unacceptable gross beta and tritium results.
  - Performance-evaluation study results were available from one InterLaB RadCheM study, one Water Pollution study, and one Department of Energy Quality Assessment Program this quarter. The majority of the labs' results were within the acceptance limits, indicating good performance overall.
  - Most of the laboratory QC results for this quarter were within acceptance limits, suggesting that the analyses were in control and reliable data were generated. Parameters with more than one result that was *significantly* out of limits include method blanks for sulfate, aluminum, copper, iron, and vanadium; matrix spikes for total organic carbon, cyanide, carbon tetrachloride, chloroform, and methylene chloride; matrix duplicates for 2,2-dichloropropionic acid; and two surrogates.
-

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**Hanford Groundwater Monitoring Project**  
**Quality Control Report**  
**October 1 to December 31, 2002**

**Highlights**

- Forty-six results were flagged with an H due to missed holding times. All of the flagged results were anions, and the data impacts should be minor.
- Most of the field duplicate results demonstrated good precision, although the relative percent differences for nine pairs of results failed to meet the acceptance criteria. Acetone, alkalinity, ammonia, carbon-14, gross beta, iron, potassium, 1,1,1-trichloroethane, and zinc were the constituents with out-of-limit results.
- Approximately 4% of the field-blank results exceeded the QC limits. Most of the out-of-limit results were for alkalinity, chloride, fluoride, iron, methylene chloride, sulfate, uranium and vanadium. In general, the field blank results should have little impact on the interpretation of 4<sup>th</sup> quarter groundwater data.
- Severn Trent, Lionville Laboratory, and Eberline Services performed well on the analysis of blind standards. Severn Trent had out-of-limit results for total organic halides (3), trichloroethene (2), and tritium (3), while Eberline Services had high-biased results for gross beta (3). Incorrectly spiked standards probably account for the unacceptable gross beta and tritium results.
- Performance-evaluation study results were available from one InterLaB RadChem study, one Water Pollution study, and one Department of Energy Quality Assessment Program this quarter. The majority of the labs' results were within the acceptance limits, indicating good performance overall.
- Most of the laboratory QC results for this quarter were within acceptance limits, suggesting that the analyses were in control and reliable data were generated. Parameters with more than one result that was *significantly* out of limits include method blanks for sulfate, aluminum, copper, iron, and vanadium; matrix spikes for total organic carbon, cyanide, carbon tetrachloride, chloroform, and methylene chloride; matrix duplicates for 2,2-dichloropropionic acid; and two surrogates.

This quality control (QC) report presents information on laboratory performance and field QC sample results for the 4<sup>th</sup> quarter of CY 2002. Routine chemical and radiochemical analyses were performed by Severn Trent Laboratories, Inc. (St. Louis, MO and Richland, WA) for Hanford Groundwater Monitoring Project (HGWMP) samples. Supplemental analyses of split samples and blind standards were performed by Lionville Laboratory (Lionville, PA) and Eberline Services (Richmond, CA). Severn Trent, Lionville Laboratory, and Eberline Services operate under contract with Fluor Hanford, Inc. Groundwater sampling was conducted by Fluor Hanford, Inc. nuclear chemical operators (NCOs) under the direction of Duratek Federal Services Incorporated, Northwest Operations. The tasks conducted by the samplers and Duratek included bottle preparation, sample set coordination, field measurements, sample collection, sample transport and shipping, well pumping, and coordination of purgewater containment and disposal.

Tables 1 and 2 summarize the data completeness for the HGWMP. The determination of completeness is made by dividing the number of results judged to be valid by the total number of results evaluated and multiplying by 100. Data judged to be valid are results that have not been flagged as suspect, rejected, having a missed holding time, or associated with out-of-limit method blanks or field QC samples. Eighty-five percent of the 4<sup>th</sup> quarter's 13,644 results were considered valid. This percentage is slightly lower than the value from the previous quarter (87%). Roughly 93% of the 4<sup>th</sup> quarter flags resulted from detection of anions, metals, and volatile organic compounds in field and method blanks. The majority of these results were at levels near the method detection limits; thus, the overall impact of sample contamination or false-detection on data quality is believed to be minor.

Compared to the previous quarter, the number of results that were flagged with an H increased significantly (i.e., 46 versus 4). Eighty-seven percent of the 4<sup>th</sup> quarter flags were associated with nitrate and nitrite. Most of the late analyses were caused by shipping delays. A laboratory QC failure (i.e., out-of-limit matrix spike) resulted in missed holding times for 6 cyanide samples.

**Table 1. Completeness Summarized by Project**

Project	Total Results	Suspect Results	Rejected Results	Field QC Flags	Missed Holding Times	Method Blank Qualifiers	Results Flagged
100-K Area	201	-	-	17	-	32	40
216-A-29 Ditch	478	-	-	10	10	64	74
216-B-63 Ditch	331	-	-	7	-	43	50
216-S-10 Pond	68	-	-	-	-	15	15
216-U-12 Crib	60	-	-	-	-	20	20
316-5 Trenches	124	-	-	2	-	12	14
400 Area	89	-	-	2	-	13	15
LERF	212	-	-	4	-	24	26
LLWMA-1	580	-	-	-	-	97	97
LLWMA-2	651	-	-	37	2	66	100
LLWMA-3	161	-	-	2	-	21	22
LLWMA-4	80	1	-	2	-	11	13
Not RCRA/SURV	2936	8	-	43	8	341	381
PUREX Cribs	312	-	-	14	2	34	47
Solid Waste Landfill	152	-	-	6	-	22	23
SST WMA-A-AX	493	3	-	4	-	76	78
SST WMA-B-BX-BY	945	2	-	17	-	125	140
SST WMA-C	311	2	-	-	5	53	60
SST WMA-S-SX	33	-	-	-	-	9	9
SST WMA-T	223	-	-	2	-	27	29
SST WMA-TX-TY	192	-	-	-	2	31	33
SST WMA-U	146	-	-	-	-	26	26
Surveillance Central	2764	1	-	82	5	361	406
Surveillance Horn	494	1	-	10	-	73	84
Surveillance North	969	-	-	24	-	110	132
Surveillance South	659	1	-	28	12	51	79

**Table 2. Completeness Summarized by Method**

HEIS Method Name	Total Results	Suspect Results	Rejected Results	Field QC Flags	Missed Holding Times	Method Blank Qualifiers	Results Flagged
<b>General Chemical Parameters</b>							
120.1_CONDUCT	20	-	-	-	-	9	9
160.1_TDS	6	-	-	-	-	-	0
214A_TURBIDITY	330	-	-	-	-	-	0
310.1_ALKALINITY	260	-	-	32	-	-	32
360.1_OXYGEN_FLD	27	-	-	-	-	-	0
410.4_COD	12	-	-	-	-	-	0
413.1_OILGREASE	1	-	-	-	-	-	0
9020_TOX	277	5	-	-	-	7	12
9040_PH	433	-	-	-	-	-	0
9050_CONDUCT	434	1	-	-	-	-	1
9060_TOC	336	-	-	9	-	219	219
9223_COLIFORM	12	1	-	-	-	-	1
COLOR_TK_FLD	1	-	-	-	-	-	0
REDOX_PROBE_FLD	27	-	-	-	-	-	0
TEMP_FLD	420	-	-	-	-	-	0
WTPH_DIESEL	1	-	-	-	-	-	0
WTPH_GASOLINE	1	-	-	-	-	-	0
<b>Ammonia and Anions</b>							
300.0_ANIONS_IC	1251	-	-	96	40	254	339
350.1_AMMONIA	29	-	-	2	-	-	2
9012_CYANIDE	36	-	-	-	6	-	6
<b>Metals</b>							
6010_METALS_ICP	4541	2	-	87	-	1135	1176
7060_AS_GFAA	28	-	-	-	-	21	21
7131_CD_GFAA	6	-	-	-	-	4	4
7191_CR_GFAA	6	-	-	2	-	-	2
7421_PB_GFAA	46	-	-	-	-	3	3
7470_HG_CVAA	46	-	-	-	-	-	0
CR6_HACH M	35	1	-	-	-	-	1
<b>Volatile Organic Compounds</b>							
8010_VOA_GC	144	-	-	2	-	4	6
8020_VOA_GC	71	-	-	-	-	-	0
8260_VOA_GCMS	2217	2	-	47	-	68	103
<b>Semivolatile Organic Compounds</b>							
8040_PHENOLIC_GC	1020	-	-	-	-	-	0
8081_PEST_GC	19	-	-	-	-	-	0
8082_PCB_GC	105	-	-	-	-	-	0
8151_HERBICIDE_GC	9	-	-	-	-	-	0
8270_SVOA_GCMS	119	-	-	-	-	-	0
<b>Radiological Parameters</b>							
906.0_H3_LSC	182	3	-	8	-	-	11
9310_ALPHABETA_GPC	292	-	-	2	-	7	9
BETA_GPC	3	3	-	-	-	-	3
C14_CHEM_LSC	8	-	-	-	-	2	2
GAMMA_GS	396	1	-	-	-	-	1
I129_SEP_LEPS_GS	74	-	-	-	-	-	0
PUIISO_PLATE_AEA	8	-	-	-	-	-	0
SRISO_SEP_PRECIP_GPC	71	-	-	-	-	-	0

HFIS Method Name	Total Results	Suspect Results	Rejected Results	Field QC Flags	Missed Holding Times	Method Blank Qualifiers	Results Flagged
TC99_ETVDSK_LSC	156	-	-	-	-	-	0
TC99_SEP_LSC	1	-	-	-	-	-	0
TRITIUM ELECT_LSC	4	-	-	-	-	-	0
UIISO_PLATE_AEA	9	-	-	-	-	-	0
UTOT_KPA	134	-	-	26	-	24	50

### Field QC Data

Field QC samples include field duplicates, split samples, and field blanks. Quadruplicate samples collected at many wells for total organic carbon and total organic halides analyses also provide useful QC data. Field blanks collected during the 4<sup>th</sup> quarter of 2002 included full trip blanks, field transfer blanks, and equipment blanks. In general, the desired collection frequency for field duplicates and full trip blanks is one sample per 20 well trips. The target collection frequency for field transfer blanks is one blank on each day in which routine well samples are collected for analysis of volatile organic compounds. Equipment blanks are normally collected once per 10 well trips for portable Grundfos pumps or as needed for special projects. Split samples are also collected on an as-needed basis. Table 3 lists the number of QC samples and their frequencies of collection for the 4<sup>th</sup> quarter. Results from each type of QC sample are summarized below.

**Table 3. Quality Control Samples for 4<sup>th</sup> Quarter 2002**

QC Samples	Number of well trips	Number of QC samples <sup>(a)</sup>	Frequency
Field Duplicates	261	20	8%
Split Samples	0 <sup>(b)</sup>	0	—
TOC Quadruplicates	93 <sup>(c)</sup>	77	83%
TOX Quadruplicates	69 <sup>(c)</sup>	67	97%
Full Trip Blanks	261	18	7%
Field Transfer Blanks	VOC samples collected on 21 days	21 (on 21 days)	100% <sup>(d)</sup>
Equipment Blanks	4 <sup>(e)</sup>	1	25%

<sup>a</sup> values listed do not include field duplicates and blanks collected for interim-action groundwater monitoring or nonroutine sampling events (i.e., special projects)

<sup>b</sup> number of well trips scheduled for split samples

<sup>c</sup> number of well trips in which TOC and/or TOX samples were collected

<sup>d</sup> number of field transfer blanks divided by the number of unique collection dates (i.e., 21/21)

<sup>e</sup> number of routine sampling events in which non-dedicated sampling equipment was used

**Field duplicates.** Field duplicates provide a measure of the overall sampling and analysis precision. Evaluation of field-duplicate data is based on the relative percent difference (RPD) statistic, which is calculated for each matching pair of results. Field duplicates with at least one result greater than 5 times the method detection limit (MDL) or minimum detectable activity (MDA) must have RPDs less than 20% to be considered acceptable. Duplicates with RPDs outside this range are flagged with a Q in the database.

Twenty field duplicates were collected and analyzed during the 4<sup>th</sup> quarter of 2002 to produce 859 pairs of results. Overall, the results demonstrate good sampling and analysis precision. Nine pairs of qualifying duplicate results had relative percent differences greater than 20% (Table 4). In general, the results in the table are consistent with historical data at the associated wells. However, the larger values for alkalinity and ammonia appear to be out of trend. The laboratory records associated with these results were reviewed, but no errors were identified. Swapped samples in the field or at the laboratory may account for the poor precision. Laboratory contamination is the suspected source of acetone in the samples from well 299-E26-11. Likewise, the carbon-14 results for well 199-K-11 may have been affected by laboratory contamination since carbon-14 was detected in the associated method blank. Suspended solids in the unfiltered samples may have contributed to some of the remaining discrepancies in the table.

**Table 4. Field Duplicate Results that Exceeded Quality Control Limits**

Constituent	Well	Method	Filtered	Result 1	Result 2	RPD
General Chemical Parameters						
Alkalinity	199-H4-7	EPA 310.1	No	124000 µg/L	226000 µg/L	58%
Ammonia and Anions						
Nitrogen in ammonia	699-24-34B	EPA 350.1	No	216 µg/L	11.9 µg/L U	179%
Metals						
Iron	699-2-6A	EPA 6010	No	315 µg/L	421 µg/L	29%
Potassium	299-E34-9	EPA 6010	Yes	8600 µg/L	7030 µg/L	20%
Zinc	699-2-7	EPA 6010	No	19.2 µg/L B	6.8 µg/L B	95%
Volatile Organic Compounds						
1,1,1-Trichloroethane	699-24-34B	EPA 8010	No	1.7 µg/L	1.2 µg/L	34%
Acetone	299-E26-11	EPA 8260	No	3.5 µg/L JB	0.8 µg/L JB	126%
Radiological Parameters						
Carbon-14	199-K-11	Lab specific	No	76.2 pCi/L B	61.1 pCi/L B	22%
Gross beta	299-E32-2	EPA 9310	No	19 pCi/L	24.1 pCi/L	24%

**TOC and TOX Quadruplicates.** Samples for total organic carbon and total organic halides analyses are normally collected in quadruplicate in accordance with RCRA requirements. While these samples are not intended as QC samples, quadruplicates may provide useful information about the overall sampling and analysis precision for organic indicator parameters. For the purposes of this discussion, total organic carbon and total organic halides quadruplicate data were evaluated based on the relative standard deviation (RSD) for each set of quadruplicate results. Each quadruplicate set having an RSD greater than 20% and at least one result greater than 5 times the method detection limit was considered to have poor precision.

For the 4<sup>th</sup> quarter, 7 out of 77 total organic carbon quadruplicates and 2 out of 67 total organic halide quadruplicates failed to meet the evaluation criteria (Table 5). Several of the quadruplicates appeared to contain an outlier (shaded values in the table). Removing the outliers drops the RSDs below the QC limits in each case. The variability in the total organic carbon results appears to be related to low sample concentrations. All of the total organic carbon quadruplicates in the table include at least two results that are within a factor of 5 of the method detection limit. The reasons for the poor precision in the total organic halide quadruplicates are

unknown. Laboratory records for these results were reviewed, but no errors were found. Failure to account for sample dilution may have caused the low result for well 299-W15-16.

**Table 5. TOC and TOX Quadruplicates with Low Precision<sup>(a)</sup>**

Well	MDL (µg/L)	Result 1 (µg/L)	Result 2 (µg/L)	Result 3 (µg/L)	Result 4 (µg/L)	RSD
TOC						
299-E33-334	143	750 B	860 B	540 B	590 B	21%
299-E33-35	143	740 BCN	150 BCN	330 BCN	720 BCN	60%
299-E33-28	143	710 BCN	280 BC	720 BC	960 BC	42%
299-E28-26	143	570 B	680 BC	920 BC	160 BC	54%
299-E28-28	143	670 BC	570 BC	740 BC	150 BC	50%
299-E32-10	143	200 BCN	230 BCN	680 BCN	780 BCN	64%
299-E33-30	143	490 B	490 B	730 B	540 B	20%
TOX						
299-W15-16	3.98	1250 D	1050 D	1030 D	104	60%
299-E33-35	3.98	4 U	4 U	21.7	5	100%

<sup>a</sup> Suspected outliers are shaded.

**Field Blanks.** Full trip blanks, field transfer blanks, and equipment blanks are used to check for contamination resulting from field activities and/or bottle preparation. Definitions of full trip blanks, field transfer blanks, and equipment blanks are provided in the Appendix (p. 20). In general, the QC limit for blank results is 2 times the method detection limit (MDL) or instrument detection limit for chemistry methods and 2 times the total propagated error for radiochemistry methods. For common laboratory contaminants such as acetone, methylene chloride, 2-butanone, toluene, and phthalate esters, the QC limit is 5 times the MDL. Blank results that exceed these limits may indicate a contamination or false-detection problem for regular groundwater samples. Results from groundwater samples that are associated with an out-of-limit field blank are flagged with a Q in the database.

A total of 1,290 results were produced from the 4<sup>th</sup> quarter field blank samples. Approximately 4% of the results (i.e., 49 results) exceeded the QC limits for field blanks. Relative to last quarter, the percentage of out-of-limit results was the same. Table 6 lists the 4<sup>th</sup> quarter field blank results that were greater than the QC limits. Results that exceeded the QC limits by a factor of 5 or more are shaded in gray. Most of the flagged results were for alkalinity, chloride, fluoride, iron, methylene chloride, sulfate, uranium, and vanadium; however, results were also flagged for carbon disulfide, copper, manganese, nitrate, and tritium. The potential impacts on the data are minor in most cases. For example, although chloride, fluoride, nitrate, sulfate, and uranium had field blank results that were greater than the QC limits, the blank concentrations were significantly lower than the levels of these constituents in most 4<sup>th</sup> quarter groundwater samples.

With a few exceptions (i.e., alkalinity, carbon disulfide, total organic carbon, and tritium), most of the constituents that had out-of-limit field blank results also had out-of-limit method blank results. Moreover, several analytes (chloride, fluoride, copper, iron, vanadium, and uranium) had higher method blank concentrations, suggesting that many of the field blank

detections were caused by laboratory contamination or false detection. Low-level detection of these constituents in Hanford groundwater samples should be viewed as suspect.

**Table 6. Field Blank Results that Exceeded QC Limits**

Constituent Name	Blank Type <sup>(a)</sup>	Result	QC Limit	Result/QC Limit
General Chemical Parameters				
Alkalinity	FTB	22000 µg/L	8086 µg/L	2.7
Alkalinity	FTB	28000 µg/L	8086 µg/L	3.5
Alkalinity	FTB	32000 µg/L	8086 µg/L	4.0
Alkalinity	FTB	94000 µg/L	8086 µg/L	11.6
Total organic carbon	FTB	670 µg/L	286 µg/L	2.3
Anions				
Chloride	FTB	59 µg/L	58.2 µg/L	1.0
Chloride	FTB	59 µg/L	58.2 µg/L	1.0
Chloride	FTB	66 µg/L	58.2 µg/L	1.1
Chloride	FTB	66 µg/L	58.2 µg/L	1.1
Chloride	FTB	80 µg/L	58.2 µg/L	1.4
Fluoride	FTB	78 µg/L	62 µg/L	1.3
Fluoride	FTB	78 µg/L	62 µg/L	1.3
Fluoride	FTB	94 µg/L	62 µg/L	1.5
Nitrogen in Nitrate	FTB	22 µg/L	8.8 µg/L	2.5
Sulfate	FTB	150 µg/L	74.8 µg/L	2.0
Sulfate	FTB	310 µg/L	74.8 µg/L	4.1
Sulfate	FTB	340 µg/L	74.8 µg/L	4.6
Metals				
Copper	FTB	2.4 µg/L	1.72 µg/L	1.4
Iron	FTB	6.2 µg/L	5.6 µg/L	1.1
Iron	FTB	7.6 µg/L	5.6 µg/L	1.4
Iron	FTB	9.3 µg/L	5.6 µg/L	1.7
Manganese	FTB	1.3 µg/L	1.18 µg/L	1.1
Vanadium	FTB	2.9 µg/L	2.8 µg/L	1.0
Vanadium	FTB	4.9 µg/L	2.8 µg/L	1.8
Vanadium	FTB	7.3 µg/L	2.8 µg/L	2.6
Volatile Organic Compounds				
Carbon disulfide	FXR	1.2 µg/L	0.86 µg/L	1.4
Methylene chloride	FXR	2 µg/L	1.5 µg/L	1.3
Methylene chloride	FXR	2 µg/L	1.5 µg/L	1.3
Methylene chloride	FXR	2 µg/L	1.5 µg/L	1.3
Methylene chloride	FTB	2.2 µg/L	1.5 µg/L	1.5
Methylene chloride	FXR	2.3 µg/L	1.5 µg/L	1.5
Methylene chloride	FXR	2.6 µg/L	1.5 µg/L	1.7
Methylene chloride	FXR	2.8 µg/L	1.5 µg/L	1.9
Methylene chloride	FTB	2.8 µg/L	1.5 µg/L	1.9
Methylene chloride	FXR	2.9 µg/L	1.5 µg/L	1.9
Methylene chloride	FXR	3 µg/L	1.5 µg/L	2.0
Methylene chloride	FXR	3.1 µg/L	1.5 µg/L	2.1
Methylene chloride	FXR	3.1 µg/L	1.5 µg/L	2.1
Methylene chloride	FXR	3.2 µg/L	1.5 µg/L	2.1
Methylene chloride	FXR	3.7 µg/L	1.5 µg/L	2.5
Methylene chloride	FXR	4.4 µg/L	1.5 µg/L	2.9

Constituent Name	Blank Type <sup>(a)</sup>	Result	QC Limit	Result/QC Limit
Methylene chloride	FXR	5.3 µg/L	1.5 µg/L	3.5
Methylene chloride	FXR	6 µg/L	1.5 µg/L	4.0
Radiological Parameters				
Tritium	FTB	276 pCi/L	260 pCi/L	1.1
Uranium	FTB	0.011 µg/L	0.0054 µg/L	2.0
Uranium	FTB	0.0148 µg/L	0.0072 µg/L	2.1
Uranium	FTB	0.0243 µg/L	0.0118 µg/L	2.1
Uranium	FTB	0.0149 µg/L	0.0072 µg/L	2.1
Uranium	FTB	0.0261 µg/L	0.0124 µg/L	2.1

<sup>a</sup> FTB = Full trip blank, FXR = Field transfer blank

### Laboratory QC Data

**Blind Standards.** Double-blind standards containing known amounts of selected anions, metals, organic compounds, and radionuclides were prepared and submitted to Severn Trent in November. Duplicates of the total organic carbon and gross beta standards were submitted concurrently to Lionville Laboratory and Eberline Services. In all cases, the standards were prepared using groundwater from background wells. Standards for indicator analyses were spiked using the following constituents: potassium hydrogen phthalate was used to prepare total organic carbon standards, 2,4,5-trichlorophenol was used to prepare TOX-phenol standards, and TOX-VOA standards were prepared using a mixture of carbon tetrachloride, chloroform, and trichloroethene. Gross alpha and gross beta standards were spiked with plutonium-239 and strontium-90, respectively. The standards' spiked concentrations and analytical results are listed in Table 7.

The acceptance limits for blind standard recoveries are generally 75 – 125% except for specific radionuclides, which have a ± 30% acceptance range. Most of the results were acceptable, indicating good performance overall. Severn Trent St. Louis had out-of-limit results for total organic halides, trichloroethene, and tritium, and Eberline Services had unacceptable results for gross beta. The total organic halide results were highly variable with recoveries ranging from 61-101%. Reasons for the poor precision are unknown. Two out of three of the trichloroethene results were out of limits. The laboratory reanalyzed the samples, but the reanalysis results were lower than the first set of results, possibly due to extended storage of the samples. A PNNL analysis of duplicates of the volatile organic blind standards produced acceptable results. Consequently, we believe the standards containing volatile organics were spiked at the correct concentrations. The out-of-limit results for gross beta (Eberline Services) and tritium (STL Richland) were confirmed by reanalyses. Therefore, we suspect that those blind standards may have been inadvertently spiked at higher concentrations. Sampling and Analysis staff will closely monitor the laboratories' performance on gross beta and tritium analyses during the next quarter to determine whether further investigation into the cause of the high-biased results is warranted.

**Table 7. Blind Standard Results**

Constituent	Spike Amount	Lab <sup>1</sup>	Result 1	Recovery	Result 2	Recovery	Result 3	Recovery	Mean	RSD
<b>General Chemical Parameters</b>										
Conductivity	445µS/cm	SL	481	108%	451	101%	426	96%	453	6%
TOC	2490µg/L	SL	3000	120%	2800	112%	2800	112%	2850	4%
TOC	2490µg/L	LL	2800	112%	2800	112%	2900	116%	2850	2%
TOX (phenol)	100µg/L	SL	85.2	85%	101	101%	70.7	71%	79.4	22%
TOX (VOA)	104µg/L	SL	86.4	83%	72.4	70%	102	98%	86.9	17%
<b>Anions</b>										
Cyanide	101µg/L	SL	94.3	93%	84.3	83%	89.1	88%	89.2	6%
Fluoride	1000µg/L	SL	1200	120%	1200	120%	1200	120%	1200	0%
Nitrate as N	45180µg/L	SL	45600	101%	47300	105%	46500	103%	46467	2%
<b>Volatile Organic Compounds</b>										
Carbon tetrachloride	7µg/L	SL	5.8	83%	5.3	76%	6.3	90%	5.8	9%
Chloroform	104µg/L	SL	90	87%	100	96%	93	89%	94.3	5%
Trichloroethene	7µg/L	SL	5.1	73%	4.7	67%	5.5	79%	5.1	8%
<b>Radiological Parameters</b>										
Gross alpha	20.03pCi/L	RL	21.8	109%	21.8	109%	16.6	83%	20.1	15%
Gross beta	40.1pCi/L	RL	39	97%	40.9	102%	37.8	94%	39.2	4%
Gross beta	40.02pCi/L	ES	71.3	178%	70.7	177%	71.5	179%	71.2	1%
Iodine-129	29.9pCi/L	RL	29.9	100%	30.6	102%	29.7	99%	30.1	2%
Plutonium-239	20.03pCi/L	RL	36.7	183%	23.9	119%	23.3	116%	28.0	27%
Technetium-99	474.5pCi/L	RL	500	105%	497	105%	491	103%	496	1%
Tritium	20119pCi/L	RL	49400	246%	50500	251%	48200	240%	49367	2%
Uranium-238	62.7µg/L	RL	66.9	107%	62.9	100%	69.1	110%	66.3	5%

<sup>a</sup> Lab codes: SL = Severn Trent St. Louis, RL = Severn Trent Richland, LL = Lionville Laboratory, ES = Eberline Services

<sup>b</sup> TOC standards were submitted to Severn Trent St. Louis in quadruplicate. The 4<sup>th</sup> result was 2800 µg/L, and the recovery was 112%.

<sup>c</sup> Lionville Laboratory's 4<sup>th</sup> TOC result was 2900 µg/L, and the recovery was 116%.

<sup>d</sup> TOX phenol standards were submitted to Severn Trent St. Louis in quadruplicate. The 4<sup>th</sup> result was 60.8 µg/L, and the recovery was 61%.

<sup>e</sup> The gross beta spike amount is based on equal contributions from Sr-90 and Y-90 and has been corrected by adding the average gross beta activity of the source-water well (699-49-100C) to the original spiked amount. The average gross beta activity of well 699-49-100C was calculated from quarterly measurements made since the 4<sup>th</sup> quarter of last year.

**ERA Water Supply/Water Pollution Programs.** Severn Trent, St. Louis (STL St. Louis) and Lionville Laboratory participate in the EPA sanctioned Water Supply/Water Pollution (WS/WP) Performance Evaluation studies conducted by New York State (Environmental Laboratory Approval Program [ELAP]) and Environmental Resources Associates (ERA), respectively. Every month, standard water samples are distributed as blind standards to participating laboratories. These samples contain specific organic and inorganic analytes at concentrations unknown to the participating laboratories. After analysis, the laboratories submit their results to the study administrator. Regression equations are used to determine acceptance and warning limits for the study participants. The results of these studies, expressed in this report as a percentage of the results that the PE provider found acceptable, independently verify the level of laboratory performance.

An investigative report from one Water Pollution (WP-90) study was received from STL St. Louis. The percentage of acceptable results was 90.0%. Of the 24 unacceptable results, four

(total phenol, calcium hardness, heptachlor, and orthophosphate as phosphorous) were caused by calculation or reporting errors; six (individual phenols) were due to a sample preparation error; one (cyanide) was most likely caused by a poorly-sealed distillation apparatus; and thirteen (alkalinity, chloride, potassium, sodium, magnesium, cobalt, manganese, heptachlor epoxide, alpha-BHC, 4,4'-DDT, settleable solids, oil and grease, and sulfide) had unknown causes. Remedial samples were analyzed for most of the constituents that had unacceptable results, and the majority of the remedial results were acceptable. Remedial analyses were not performed for settleable solids, oil and grease, or sulfide.

**Mixed Analyte Performance Evaluation Program.** The Mixed Analyte Performance Evaluation Program (MAPEP) is conducted by the Department of Energy. In this program, samples containing metals, volatile and semivolatile organic compounds, and radionuclides are sent to participating laboratories in January and July. No new MAPEP results were available this quarter.

**InterLaB RadChem Proficiency Testing Program Studies.** The InterLaB RadChem Proficiency Testing Program is conducted by Environmental Resource Associates (ERA). Control limits are based on the National Standards for Water Proficiency Testing Studies Criteria Document, December 1998.

The results from one RadChem PE study were received from STL Richland this quarter (RAD-51). All results were acceptable, viz., cesium-134, cesium-137, cobalt-60, gross alpha, gross beta, iodine-131, radium-226, radium-228, strontium-89, strontium-90, tritium, and uranium. Eberline Services does not participate in the RadChem PE studies.

**Department of Energy Quality Assessment Program.** This program is conducted by the Environmental Measurements Laboratory (EML) and is designed to evaluate the performance of participating laboratories through the analysis of air filter, soil, vegetation, and water samples containing radionuclides. Only the water results are considered in this report. Control limits established by the EML are based on historic data distributions from data collected by the EML from 1982 to 1992. Acceptable results should fall within the 15<sup>th</sup> and 85<sup>th</sup> percentile of the cumulative normalized distribution. Results are within warning limits if they fall between the 5<sup>th</sup> and 15<sup>th</sup> percentile or the 85<sup>th</sup> and 95<sup>th</sup> percentile. Results less than the 5<sup>th</sup> percentile or greater than the 95<sup>th</sup> percentile are "not acceptable" (DOE 1995).

Results for QAP 57 were reported this quarter. Two results from STL Richland were not acceptable, viz., gross alpha and gross beta. All results from Eberline Services were acceptable, but gross alpha was within the warning limits. The constituents that had unacceptable results in this report had acceptable results in the previous QAP report.

**Laboratory QC Data from Severn Trent Laboratories.** Laboratory QC data provide a means of assessing laboratory performance and the suitability of a method for a particular sample matrix. These data are not currently used for in-house validation of individual sample results unless the laboratory is experiencing unusual performance problems with an analytical method.

Laboratory QC data include the results from method blanks, laboratory control samples, matrix spikes, matrix spike duplicates, surrogates, and matrix or laboratory duplicates.

Different criteria are used to evaluate the various laboratory QC parameters. Results for method blanks are evaluated based on the frequency of detection above the blank QC limits. In general, these limits are two times the method detection limit (MDL) for chemical constituents and two times the total propagated error (MDA) for radiochemistry components. For common laboratory contaminants such as acetone, methylene chloride, 2-butanone, toluene, and phthalate esters, the QC limit is five times the MDL. Results for laboratory control samples, matrix spikes, and surrogates are evaluated by comparing the recovery percentages with minimum and maximum control limits. For matrix duplicates, only those samples with values five times greater than the MDL or MDA are considered. Quantifiable matrix duplicates are evaluated by comparing the relative percent difference (RPD) with an acceptable RPD maximum for each constituent.

As an aid in identifying the most problematic analytes, a distinction has been made between QC data that were slightly out of limits and QC data that were "significantly out-of-limits". For method blanks, "significantly out-of-limits" was defined to mean results were greater than twice the QC limit. For laboratory control samples, matrix spikes, and duplicates, "significantly out-of-limits" means the results were outside the range of the QC limits plus or minus 10 percentage points (e.g., if the QC limits are 80-120%, significantly out-of-limits would mean less than 70% or greater than 130%).

Most of the 4<sup>th</sup> quarter laboratory QC results were within acceptance limits, suggesting that the analyses were in control and reliable data were generated. Table 7 provides a summary of the QC data by listing the percentage of QC results that were out of limits for each analyte category and QC parameter. Table 8 lists the individual constituents that had out-of-limit method blanks, including the concentration range for method blanks above the detection limit. Table 9 summarizes the out-of-limit results for the other QC parameters. The number of significantly out-of-limit results is also indicated in Tables 8 and 9. Finally, Table 10 lists the constituents, analysis dates, and wells having data associated with the significantly out-of-limit QC results. It should be noted that these tables incorporate all QC data that were reported for the quarter, including QC results for both original and reanalysis data. However, when samples are reanalyzed, only one set of results (i.e., either the original results or the reanalysis results) are retained in HEIS. Thus, it is possible that some of the QC data described in this report may no longer be associated with current results in HEIS.

Some of the more significant findings from the laboratory QC data include the following:

- The relative number of out-of-limit results was similar to the percentage for last quarter.
- Two or more method blank results exceeded the QC limits for conductivity, chloride, fluoride, nitrogen in nitrate, sulfate, aluminum, copper, iron, manganese, vanadium, zinc, acetone, and uranium.
- For several of the constituents with method blanks that were significantly out of limits (i.e., fluoride, aluminum, copper, iron, silver, vanadium, 2-butanone, methylene chloride, gross alpha, and uranium), a number of Hanford groundwater sample results were less than five

times the blank values. Table 10 indicates which wells have data associated with blank results that were significantly out of limits.

- Relative to last quarter, fewer volatile organic compounds had laboratory control sample results that were out of limits. The following constituents had laboratory control sample results that were significantly out of limits: acetone, vinyl chloride, chrysene, and oil and grease. Table 10 indicates which wells have data associated with laboratory control sample results that were significantly out of limits.
- Compared to last quarter, more constituents in the general chemistry parameters and ammonia and anions classes had matrix spike results that were out of limits. In contrast, fewer semivolatile organic compounds had matrix-spike problems. Total organic carbon, total organic halides, cyanide, nitrogen in nitrate, carbon tetrachloride, chloroform, methylene chloride, and chrysene had matrix spike results that were significantly out of limits. Of these, total organic carbon, total organic halides, nitrogen in nitrate, and methylene chloride had matrix spike results that were out of limits last quarter.
- Matrix spike duplicates were significantly out of limits for total organic carbon, 2-butanone, acetone, 2-(2,4-dichlorophenoxy)propionic acid, 2,2-dichloropropionic acid, 2,4,5-TP, 2,4-D, 2,4-dinitrophenol, 2-secbutyl-4,6-dinitrophenol, 4-(2,4-dichlorophenoxy)butyric acid, 4,6-dinitro-2-methyl phenol, 4-nitrophenol, dicamba, indeno(1,2,3-cd)pyrene, oil and grease, carbon-14, cobalt-60, gross beta, iodine-129, and technetium-99. Of these, 2-butanone, acetone, iodine-129, and technetium-99 had matrix spike duplicate results that were also out of limits last quarter.
- Four surrogates had results that were significantly out of limits this quarter; dibromofluoromethane had five results and 2,4,6-tribromophenol had nine results in this category.

Project scientists requiring additional information about the laboratory QC data are encouraged to contact Debbie Sklarew or Chris Thompson.

**Laboratory QC Data from Eberline Services and Lionville Laboratory.** Fourth quarter QC data from Eberline are limited to gross beta. All of the QC data were within limits. Fourth quarter QC data from Lionville Laboratory are limited to total organic carbon. All of the QC data were within limits.

**Table 7. Percentage of Out-of-Limit QC Results by Category**

	General Chemistry Parameters	Ammonia and Anions	Metals	VOC	SVOC	Radiological Parameters	Total
Method Blanks	4.0	10.3	4.9	0.7	0	1.8	2.9
Lab Control Samples	1.0	0	0	1.5	1.0	0	0.6
Matrix Spikes	15.5	10.2	0.1	3.2	2.6	0	2.5
Matrix Duplicates	0.6	0	0	2.0	5.1	2.8	1.7
Surrogates	—	—	—	1.3	8.2	—	3.4

**Table 8. Method Blanks with Out-of Limit Results**

Constituent	Number Out of Limits <sup>(a)</sup>	Number of Analyses	Concentration Range of Detections
General Chemistry Parameters			
Conductivity	4	6	0.43 – 0.58 µS/cm
Ammonia and Anions			
Chloride	15(1)	50	0.066 – 0.15 mg/L
Fluoride	5(1)	50	0.077 – 0.13 mg/L
Nitrogen in nitrate	2	50	0.01 – 0.014 mg/L
Sulfate	6(6)	50	0.18 – 0.31 mg/L
Metals			
Aluminum	6(4)	30	52.6 – 125 µg/L
Beryllium	1	30	0.99 µg/L
Copper	4(2)	30	1.8 – 4.6 µg/L
Iron	8(6)	30	8.4 – 112 µg/L
Manganese	2	30	1.4 µg/L
Potassium	1	30	2710 µg/L
Silver	1(1)	30	7.6 µg/L
Vanadium	4(2)	30	2.9 – 7.4 µg/L
Zinc	2	30	4 – 5.7 µg/L
Volatile Organic Compounds			
2-Butanone	1(1)	26	5.4 µg/L
Acetone	3	26	3.0 – 6.1 µg/L
Methylene chloride	1(1)	27	3.1 µg/L
Radiological Parameters			
Carbon-14	1	3	36.6 pCi/L
Gross alpha	1(1)	18	12.9 pCi/L
Uranium	3(1)	17	0.0238 – 0.0424 µg/L

<sup>a</sup> Numbers in parentheses are the number of results that were significantly out of limits as defined in the text.

**Table 9. Laboratory Spikes and Duplicates with Out-of-Limit Results**

Constituent	Number Out of Limits <sup>(a)</sup>	Number of Analyses
<b>Laboratory Control Samples</b>		
<i>General Chemistry Parameters</i>		
Total organic carbon	1	37
<i>Volatile Organic Compounds</i>		
2-Butanone	2	26
4-Methyl-2-pentanone	2	26
Acetone	3(1)	26
Vinyl chloride	1(1)	27
<i>Semi-volatile Organic Compounds</i>		
Chrysene	1(1)	2
delta-BHC	1	1
Oil and grease	1(1)	2
<b>Matrix Spikes and Matrix Spike Duplicates</b>		
<i>General Chemistry Parameters</i>		
Total organic carbon	8(2)	36
Total organic halides	1(1)	22
<i>Ammonia and Anions</i>		
Cyanide	3(2)	6
Fluoride	2	16
Nitrogen in nitrate	2(1)	16
Nitrogen in nitrite	2	16
Sulfate	1	17
<i>Metals</i>		
Cadmium	1	42
<i>Volatile Organic Compounds</i>		
1,2-Dichloroethane	2	28
4-Methyl-2-pentanone	4	26
Carbon tetrachloride	2(2)	28
Chloroform	2(2)	28
Chloromethane	2	4
Methylene chloride	6(2)	26
<i>Semivolatile Organic Compounds</i>		
2,2-Dichloropropionic acid	1	2
2,4,5-Trichlorophenol	1	20
2-Methylphenol	2	20
2-secButyl-4,6-dinitrophenol	2	18
4-Methylphenol	2	4
Chrysene	2(1)	4
Hexachlorocyclopentadiene	2	4
Hexachloroethane	2	4
Pentachlorophenol	1	20
<b>Duplicates</b>		
<i>General Chemistry Parameters</i>		
Total organic carbon	1(1)	68
<i>Volatile Organic Compounds</i>		
2-Butanone	1(1)	14
Acetone	2(1)	14
Bromomethane	1	2
Methylene chloride	1	14

Constituent	Number Out of Limits <sup>(a)</sup>	Number of Analyses
Vinyl chloride	1	15
<i>Semivolatile Organic Compounds</i>		
2-(2,4-Dichlorophenoxy)propionic acid	1(1)	2
2,2-Dichloropropionic acid	2(2)	2
2,3,4,6-Tetrachlorophenol	1	10
2,4,5-T	1	2
2,4,5-TP	1(1)	2
2,4-D	1(1)	2
2,4-Dinitrophenol	1(1)	12
2-secButyl-4,6-dinitrophenol	1(1)	12
4-(2,4-Dichlorophenoxy)butyric acid	1(1)	2
4,6-Dinitro-2-methyl phenol	1(1)	12
4-Nitrophenol	1(1)	12
Benzo(ghi)perylene	1	2
Dibenz[a,h]anthracene	1	2
Dicamba	1(1)	2
Indeno(1,2,3-cd)pyrene	1(1)	2
Oil and grease	1(1)	4
Pentachlorophenol	1	12
<i>Radiological Parameters</i>		
Carbon-14	1(1)	3
Cobalt-60	1(1)	12
Gross beta	1(1)	17
Iodine-129	2(1)	16
Technetium-99	1(1)	20
Uranium	1	14
Surrogates		
<i>Volatile Organic Compounds</i>		
1-Chloro-2-fluorobenzene	3	13
Dibromofluoromethane	5(5)	157
<i>Semivolatile Organic Compounds</i>		
2,4,5,6-Tetrachloro-m-xylene	1	5
2,4,6-Tribromophenol	11(9)	105
2,4-Dichlorophenylacetic acid	1(1)	7
2-Fluorophenol	8	102
Decachlorobiphenyl	2(1)	24

<sup>a</sup> Numbers in parentheses are the number of results that were significantly out of limits as defined in the text.

**Table 10. Wells Associated with Laboratory QC Parameters with Significantly Out-of-Limit Results**

Constituent	Analysis Date	Wells with Associated Data
Method Blanks		
Chloride	12/11/02	299-E24-19, 299-E25-40, 299-E33-26, 299-E33-30, 299-E33-34
Fluoride	12/17/02	299-W22-82, 299-W22-83, 299-W22-84, 299-W26-7, 299-W26-13, 299-W27-2
Sulfate	10/7/02	299-E24-16, 299-E25-26, 299-E25-32P, 299-E25-34, 299-E25-48, 299-E26-12, 299-E26-13, 299-E27-11
	11/22/02	699-24-33, 699-25-34C
	11/27/02	699-97-43
	12/11/02	299-E24-19, 299-E25-40, 299-E33-26, 299-E33-30, 299-E33-34
	12/17/02	299-W22-82, 299-W22-83, 299-W22-84, 299-W26-7, 299-W26-13, 299-W27-2
	1/2/03	299-W15-42, 399-1-2, 399-3-6, 399-3-12, 399-4-1, 399-4-12
	1/7/03	399-1-16A
Aluminum	10/28/02	299-E25-35, 299-E27-8, 299-E27-9, 299-E27-16, 299-E27-19, 299-E33-28, 299-E33-29, 299-E34-2, 299-E34-5, 299-E34-9, 299-E34-12, 299-W23-19
	11/26/02	199-H3-2C, 199-H4-9, 199-H4-15A, 199-H4-47, 299-W10-1, 299-W10-8, 299-W10-22, 299-W10-23, 299-W10-24, 299-W11-7, 299-W11-12, 299-W11-39, 299-W11-40, 299-W11-41, 299-W11-42
	12/2/02	299-W10-28, 299-W14-5, 299-W14-6, 299-W14-13, 299-W14-15, 299-W14-18, 299-W15-40
	1/14/03	299-W15-763, 299-W15-765, 699-36-70A
Copper	10/8/02	299-E17-14, 299-W7-4, 299-W15-16, 699-24-34B, 699-89-35
	11/20/02	199-D8-68, 299-E34-8, 299-W7-12
Iron	11/22/02	299-E17-9
	11/26/02	199-H3-2C, 199-H4-9, 199-H4-15A, 199-H4-47, 299-W10-1, 299-W10-8, 299-W10-22, 299-W10-23, 299-W10-24, 299-W11-7, 299-W11-12, 299-W11-39, 299-W11-40, 299-W11-41, 299-W11-42
	12/10/02	699-24-33, 699-25-34C
	12/19/02	299-E26-4, 299-E26-10, 299-E26-11, 299-E27-7, 299-E27-13, 299-E27-14, 299-E27-15, 299-E33-9
	12/24/02	299-W22-82, 299-W22-83, 299-W22-84, 299-W26-7, 299-W26-13, 299-W27-2
	1/6/03	299-W15-42, 399-1-16A
	1/13/03	699-10-E12, 699-S3-E12, 699-S6-E4A
	1/14/03	299-W15-763, 299-W15-765, 699-36-70A
Silver	12/16/02	299-E24-19, 299-E25-40, 299-E25-41, 299-E25-46, 299-E27-12, 299-E33-26, 299-E33-30, 299-E33-34
Vanadium	12/24/02	299-E24-20, 299-E25-2, 299-E33-38, 299-W19-44, 299-W22-45, 299-W22-46, 299-W22-48, 299-W22-49, 299-W22-50, 299-W22-80, 299-W22-81, 299-W22-85, 299-W23-15, 299-W23-20, 299-W23-21
	1/6/03	299-W15-42, 399-1-16A

Constituent	Analysis Date	Wells with Associated Data
2-Butanone	11/1/02	699-25-34B
Methylene chloride	10/14/02	299-E34-7
Gross alpha	12/18/02	299-E33-31, 299-E33-41, 299-E33-42, 299-E33-44
Uranium	1/20/03	399-1-1, 399-1-7, 399-1-8, 399-1-10A, 399-1-10B, 399-1-17A, 399-1-17B, 399-1-21A, 399-1-21B
Laboratory Control Samples		
Acetone	10/21/02	199-F5-42, 199-F5-43A, 199-F5-45
Vinyl chloride	10/22/02	199-F5-4, 199-F5-6, 199-F5-43B, 199-F5-44
Chrysene	10/15/02	299-E34-7
Oil and grease	10/15/02	299-E34-7
Matrix Spikes or Matrix Spike Duplicates		
Total organic carbon	10/11/02	299-E25-35, 299-E34-2
	10/14/02	299-E34-2
	12/19/02	299-W26-7
	12/23/02	299-W26-7, 299-W26-13
Total organic halides	10/9/02	299-W7-4
	10/10/02	299-W7-4
Cyanide	10/15/02	299-E33-28, 299-E33-29
	11/19/02	299-E33-41, 299-E33-42, 299-E33-43, 299-E33-44, 299-E33-337
Nitrogen in Nitrate	10/17/02	199-K-29, 199-K-106A
Carbon tetrachloride	11/24/02	699-22-35, 699-23-34A, 699-23-34B, 699-24-33, 699-24-34A, 699-24-34B, 699-24-34C, 699-24-35, 699-25-34C, 699-26-35A
Methylene chloride	1/8/03	399-4-9, 399-5-4B, 399-6-2, 399-8-5A, 699-S6-E4A
Chrysene	10/15/02	299-E34-7
Duplicates		
Total organic carbon	11/15/02	699-49-100C
2-Butanone	1/3/03	299-W15-42, 399-1-2, 399-1-16A, 399-1-16B, 399-2-1, 399-2-2, 399-3-6, 399-3-12, 399-4-1, 399-4-12
Acetone	1/8/03	399-4-9, 399-5-4B, 399-6-2, 399-8-5A, 699-S6-E4A
2,2-Dichloropropionic acid	10/16/02	299-E34-7
	10/31/02	299-E34-7
2,4,5-TP (silvex)	10/16/02	299-E34-7
2,4-D	10/16/02	299-E34-7
2,4-Dinitrophenol	10/15/02	299-E34-7
2-(2,4-Dichlorophenoxy)propionic acid	10/16/02	299-E34-7
2-secButyl-4,6-dinitrophenol(DNBP)	10/16/02	299-E34-7
4,6-Dinitro-2methyl phenol	10/15/02	299-E34-7
4-(2,4-Dichlorophenoxy)butyric acid	10/16/02	299-E34-7

Constituent	Analysis Date	Wells with Associated Data
4-Nitrophenol	10/15/02	299-E34-7
Dicamba	10/16/02	299-E34-7
Indeno(1,2,3-cd)pyrene	10/15/02	299-E34-7
Oil and grease	10/15/02	299-E34-7
Carbon-14	1/9/03	199-K-11
	1/10/03	199-K-11
Cobalt-60	12/23/02	299-E33-7
Gross beta	12/26/02	299-E33-15, 299-E33-17, 299-E33-18, 299-E33-33, 299-E33-36, 299-W10-8, 299-W11-12, 299-W11-39, 299-W11-40, 299-W11-41, 299-W11-42, 699-49-100C
Iodine-129	1/10/03	299-E33-29, 299-E33-334
	1/11/03	299-E33-28, 299-E33-29
Technetium-99	11/20/02	699-70-68
Surrogates		
Dibromofluoromethane	10/3/02	299-W7-4, 299-W15-16, 399-1-17A, 699-24-34B, 699-S31-1
	11/7/02	299-W10-20, 299-W10-22
	1/3/03	299-W15-42, 399-1-2, 399-1-16A, 399-1-16B, 399-2-1, 399-2-2, 399-3-6, 399-3-12, 399-4-1, 399-4-12
2,4,6-Tribromophenol	10/15/02	299-E34-7
	10/17/02	299-E25-28, 299-E33-37, 299-E34-7
	10/21/02	299-E27-8, 299-E27-9, 299-E27-10, 299-E27-16, 299-E27-17, 299-E27-18, 299-E27-19, 299-E34-5, 299-E34-9, 299-E34-10, 299-E34-12
	12/26/02	299-E25-2
	12/27/02	299-E24-20, 299-W26-7, 299-W26-13
2,4-Dichlorophenylacetic acid	10/31/02	299-E34-7
Decachlorobiphenyl	10/18/02	299-E27-8, 299-E27-9, 299-E27-10, 299-E27-11, 299-E27-17, 299-E34-5, 299-E34-7, 299-E34-9, 299-E34-10, 299-E34-12

## **Appendix: Field Blank Definitions**

**Full Trip Blank (FTB)** – A field blank sample that is used to check for sample contamination resulting from sample bottles, preservatives, and sample storage and handling. FTBs are initially prepared in the laboratory by filling a preserved bottle set with Type II reagent water. After the bottles have been sealed, they are transported to the field in the same storage container that will be used for groundwater samples collected that day. FTBs are not removed from the storage container until they have been delivered to the laboratory.

**Field Transfer Blank (FXR)** – A field blank sample that is used to check for in-the-field sample contamination by volatile organic compounds. FXRs are prepared near a well sampling site by filling preserved VOA sample bottles with Type II reagent water that has been transported to the field. FXRs are normally prepared at the same time VOA samples are being collected from the well. After collection, the FXR bottles are sealed and placed in the same sample storage container as the rest of the samples. FXRs are not removed from the storage container until they have been delivered to the lab.

**EB Blank (EB)** – A field blank sample that is used to check for sample contamination caused by unclean sampling equipment or the sampling equipment itself. Generally, equipment blanks are only collected at wells that are sampled using non-dedicated pumps. EBs are prepared by passing Type II reagent water through the pump or manifold after the equipment has been decontaminated (sometimes just prior to sampling a well) and collecting the rinsate in preserved bottles. EBs are placed in the same container as other field samples and are not removed from the container until they have been delivered to the lab.

