

# Appendix C

## Quality Assurance and Quality Control

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## Appendix C – Quality Assurance and Quality Control

### **H. L. Anastos**

This appendix presents fiscal year (FY) 2008 quality assurance/quality control (QA/QC) information for groundwater monitoring at the Hanford Site. Groundwater monitoring activities were managed by the Soil and Groundwater Remediation Project (groundwater project) during FY 2008. This includes monitoring performed to meet the requirements of the *Resource Conservation and Recovery Act of 1976* (RCRA), the *Atomic Energy Act of 1954* (AEA), and *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA). The QA/QC practices used by the groundwater project assess and enhance the reliability and validity of field and laboratory measurements conducted to support these programs. Accuracy, precision, and detection are the primary parameters used to assess data quality (Mitchell et al., 1985). Representativeness, completeness, and comparability also can be evaluated for overall quality; however, representativeness and comparability are considered qualitative and do not have specific evaluation criteria. These six parameters are evaluated through laboratory QC checks (e.g., matrix spikes, laboratory blanks), replicate sampling and analysis, analysis of blind standards and field blanks, and interlaboratory comparisons. Acceptance criteria have been established for each of these QC checks. When QC is outside the criteria, groundwater analytical support staff review the data and ensure appropriate data qualifying flags are entered in the Hanford Environmental Information System (HEIS) database. When a recurring problem is identified, corrective actions are taken.

This appendix is intended to evaluate the overall QA/QC program for the groundwater project. Quality control data are reviewed against the QA/QC requirements in the groundwater project QA plan (GRP-QA-001, HNF-20635). Through the comprehensive review provided in this appendix, the groundwater project identifies and resolves issues with data quality and initiates process improvements. This process enhances the reliability and validity of groundwater monitoring data. The annual QA/QC appendix summarizes data quality for the groundwater-monitoring project and can be a tool for data users in determining usability of specific data sets for decision-making purposes.

The QA/QC practices for RCRA samples are based on guidance from the U.S. Environmental Protection Agency (EPA) (EPA, 1986; SW-846). U.S. Department of Energy (DOE) Orders and internal requirements provide the guidance for the collection and analysis of samples for other long-term monitoring. The QA/QC practices for the groundwater project are described in the project-specific QA plan (GRP-QA-001, HNF-20635). A glossary of QA/QC terms is provided in Section C.9.0. Additional information about the QA/QC program and FY 2008 data (e.g., results of individual QC samples and/or associated groundwater samples) are available on request. The FY 2007 data referenced in this report can be found in DOE/RL-2008-01.

### **C.1.0 Sample Collection and Analysis**

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#### **H. L. Anastos**

Sampling crews collected groundwater samples for FY 2008. Their tasks included bottle preparation, sample set coordination, measurement of field parameters, sample collection, sample shipping, well pumping, and coordination of purge water containment and disposal.

During FY 2008, the groundwater project completed transition of the chemical and radiological analyses from TestAmerica (TA) Laboratories (St. Louis and Richland) to the Waste Sampling and Characterization Facility (WSCF). WSCF is an onsite laboratory. Excluding field measurements, WSCF performed approximately 80% of the analytical services for groundwater monitoring in FY 2008. Section C.6.5 provides additional information about the transition.

WSCF and TA St. Louis performed most of the routine analyses of Hanford Site groundwater samples for hazardous and nonhazardous chemicals. Lionville Laboratory, Incorporated, Lionville, Pennsylvania (Lionville Laboratory), served as a secondary laboratory for chemical analyses. WSCF and TA Richland performed the majority of radiological analyses on Hanford Site groundwater samples. Eberline Services, Richmond, California, also analyzed samples for radiological constituents.

Standard methods from EPA and American Society for Testing and Materials (ASTM) were used for the analysis of chemical constituents. Methods employed for radiological constituents were developed by the analyzing laboratories and are recognized as acceptable within the radiochemical industry. Descriptions of the analytical methods used are available upon request.

## **C.2.0 Data Review and Validation**

### ***H. Hampt***

Groundwater staff review and validate groundwater data according to an established process. Validation produces an electronic data set, with suspect or erroneous data corrected or identified (flagged). The validation process includes the following activities:

- Review of sampling documents and analytical data verification
- QC evaluation
- Project scientists' evaluation
- Resolution of data issues identified during the evaluation.

### **C.2.1 Review of Sampling Documents and Data Verification**

Sampling documents include the groundwater sampling record, chain-of-custody forms, field logbook pages, and other paperwork associated with sampling and shipping. Groundwater staff review these forms to determine if the documents are filled out completely, signed appropriately, and legible, as well as to determine if problems arose during sampling that may have affected the data. Staff also verify that analytical data from the laboratories are complete and reported correctly. Moreover, staff review laboratory documents to check the condition of the samples upon receipt at the laboratory and determine if problems arose during analysis that may have affected the data. Identified issues are documented, investigated, and resolved (Sections C.2.4 and C.6.3.1).

### **C.2.2 Quality Control Evaluation**

A quarterly evaluation of field and laboratory QC data is conducted as part of the validation process. Groundwater analytical support staff assess the laboratories' internal QC practices and submit field QC samples and blind standards to the laboratories on a regular basis. QC results are then summarized for project scientists, DOE, and other data users in the quarterly RCRA groundwater monitoring reports, as well as in this annual report.

### **C.2.3 Project Scientists' Evaluation**

Data management staff generate routine data reports for project scientists' review. Among these are biweekly data reports, which are generated twice each month and include analytical data loaded into the HEIS database since the previous reporting period. The tables are organized by groundwater interest area, RCRA site, or special project (e.g., confined aquifer data). As soon as practical after receiving a report, the project scientists review the data, typically by viewing trend plots, to determine the following:

- If there are significant changes in contaminant concentrations or distribution
- If there are data points that appear erroneous.

Project scientists also review quarterly compilations of the data. The quarterly review provides a method for groundwater staff to check whether there were problems with sampling, all requested analyses were received,

and that the data seem to represent actual groundwater quality. Unlike the biweekly reports, the quarterly reports usually include a full data set (i.e., all the data from the wells sampled during the previous quarter have been received and loaded into HEIS). This review also includes water-level data, preliminary maps of selected analytical data, and a partial listing of sampling comments. When specific questions arise regarding field measurements, analytical results, dates of analysis or sampling, or sample or well numbers, the project scientist requests a formal data review. Section C.2.4 described the process for data reviews.

#### **C.2.4 Resolution of Data Issues**

Requests for data reviews are the formal mechanism used by the groundwater project to resolve specific issues with data. When potential anomalies are encountered during a review of analytical data or water-level measurements, the project scientist reviewing the data will initiate a request for data review. Depending on the type of data issue identified, groundwater analytical support staff resolve the request for data review through some or all of the following actions:

- Request a laboratory recheck, recount, or re-analysis
- Review laboratory hard copy data
- Review sampling documents for data-entry errors or other problems.

The affected data can be flagged, with one of the data flags described in Table C-1.

A review of the sampling documents and/or hard copy data from the laboratory can sometimes provide an explanation for unusual results (e.g., data entry errors or samples swapped in the field). However, when a laboratory re-analysis or recount is requested, the laboratory re-analyzes or recounts the original sample and reports the new results. If there is a discrepancy between the original and new results, groundwater staff determine which results appear to be more representative and assign an appropriate review code to the results loaded into HEIS. Laboratory rechecks involve an internal laboratory review of the data. When discrepancies are discovered by the laboratory, the data are re-reported. The original data are removed from HEIS, the corrected data are loaded into HEIS, and the data are flagged appropriately.

Requests for data reviews are most commonly resolved by assigning Y, G, or R flags to the data in HEIS. If a review determines that the result is valid, the result is flagged with a G. If there is clear, documented evidence that a result is erroneous, the result is flagged with an R. If a review did not determine the validity of the result, the result is considered suspect and flagged Y. Data flagged with a Y or R are typically excluded from statistical evaluations, maps, and other interpretations, but are not deleted from HEIS. Occasionally, a request for data review is submitted on data that are not managed by the groundwater project. In those cases, the data owner is notified, but no further action is taken by the groundwater project.

Table C-2 lists the number of analytical and water-level results that were flagged during FY 2008 as a result of the request for data review process. As of November 14, 2008, requests for data reviews have been filed on 1,677 of ~128,000 analytical results (1.3%). Requests for data reviews of water-level measurements have been filed on 175 of 3,736 measurements (4.7%). The resolution of 350 analytical requests for review and 104 water-level measurements is pending, and additional requests may yet be filed on FY 2008 data. In FY 2008, WSCF performed approximately 70% of the analytical measurements for groundwater monitoring and WSCF data received 85% of the requests for data review. The bulk of those requests for data review (68%) were filed on metals results. Sections C.4.1 and C.6.4 provide more information about metals data from WSCF. Requests for data review also were filed on WSCF results from wet chemistry methods (17%), organic methods (8%), and radiological methods (6%). Requests for data review from the field and other laboratories were scattered among a varied group of methods and issues. No trends were identified.

## **C.3.0 Data Completeness**

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### **H. L. Anastos**

Data judged to be complete are data that are not suspect, rejected, associated with a missed holding time, out-of-limit field duplicate, or qualified to indicate laboratory blank contamination. Table C-3 provides a summary of data completeness. During FY 2008, 94% of the groundwater data were considered complete. The percentages of potentially invalid data were 2.1% for field QC problems, 0.7% for exceeded holding times, 0.1% for rejected results, 0.4% for suspect values, and 3.0% for laboratory blank contamination. These values are similar to the percentages observed in FY 2007.

## **C.4.0 Field Quality Control Samples**

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### **H. L. Anastos**

Field QC samples include field duplicates, split samples, and three types of field blanks: full trip, field transfer, and equipment blanks. Section C.9.0 provides definitions for these QC samples. Field QC samples are used to assess precision, repeatability, and potential contamination related to both sampling and laboratory activities. Tables C-4 through C-8 summarize the field QC results that exceeded QC limits. Constituents not listed in the tables had 100% acceptable field QC. The tables are divided into the following categories, where applicable: General chemistry parameters, ammonia and anions, metals, volatile organic compounds, semivolatile organic compounds, and radiological parameters. Table C-9 provides additional information on the method categories.

### **C.4.1 Field Blanks**

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Field blanks are used to assess potential for contamination because of sampling and laboratory activities. Results above two times the method detection limit are identified as suspected contamination. However, for common laboratory contaminants such as acetone, methylene chloride, 2-butanone, toluene, and phthalate esters, the limit is five times the method detection limit. For radiological data, blank results are identified as potentially contaminated if they are greater than two times the total minimum detectable activity.

Results associated with field blanks that do not meet these criteria are flagged with a Q in the HEIS database to indicate potential contamination issues. Q flags indicate results with potential contamination and/or precision issues. If a field blank does not meet the established criteria, data for all associated samples are flagged. For full trip and field transfer blanks, an associated sample is one that was collected on the same day and analyzed by the same method as a full trip or field transfer blank. For equipment blanks, an associated sample is one that has the same collection date, collection method/sampling equipment, and analysis method as the equipment blank.

The percentage of acceptable field blank results ( $12,197/12,676 = 96\%$ ) evaluated in FY 2008 was high, indicating little problem with contamination and good precision overall. Semivolatile organic compounds had 100% acceptable field blanks and therefore are not listed in Tables C-4 through C-6. All of the constituents in the tables had results that were flagged as potentially contaminated because of out-of-limit field blank results. All affected data (4%) are flagged Q in the HEIS database. Data users must evaluate the usability of data associated with quality issues based on the data quality objective requirements established for the specific monitoring campaign.

Compared to FY 2007, out-of-limit blank results for metals increased in FY 2008 while all other categories decreased. The relative percent of elevated field blank results for metals increased from 1.1% to 2.7%. This problem was investigated by groundwater analytical support staff and is primarily attributed to laboratory problems, not field contamination. This is demonstrated by the associated method blank results, as described in Section C.6.3 and Table C-10. While field blank concentrations of calcium, potassium, magnesium, and

sodium were frequently above QC limits, the levels detected were orders of magnitude lower than the average concentration of these constituents in Hanford Site groundwater. For several other metals (including antimony, cadmium, cobalt, copper, iron, manganese, nickel, silver, vanadium, and zinc), the levels detected in the blank are similar or higher than those found in groundwater, resulting in likely false-positive detections.

WSCF has experienced several issues during the year that have resulted in false-positive detections at low metal concentrations for the EPA SW-846 Method 6010C “Inductively Coupled Plasma – Atomic Emission Spectrometry.” In particular, the laboratory altered their calibration method, which resulted in high variability and false-positive detections at the low end of the calibration curve. False-positive results were identified for antimony, cobalt, copper, chromium, iron, nickel, silver, vanadium, and zinc. Reverting to the previous calibration strategy resolved that particular issue. Groundwater analytical support staff have worked with the laboratory to investigate and resolve several occurrences of false-positive detections; however, the overall issue with low-level variability and likely false-positive results persists. Another investigation is underway at the laboratory to identify additional causes and corrective actions.

One hundred and eighteen field blank results for volatile organic compounds (1.7%) exceeded the QC limits, which is less than the FY 2007 number (128; 2.1%). In August, 9 failures for acetone were identified and investigated. It was determined that instrument contamination at WSCF was responsible for the high results. Laboratory method blanks during this time show similar or higher levels of acetone. All samples analyzed for acetone at WSCF during this time have been flagged F (under review). Groundwater staff are determining the appropriate actions and data flags to resolve this issue.

Despite the acetone failures listed above, methylene chloride continues to be the predominant volatile organic contaminant, accounting for 69% of the volatile organic compound out-of-limit results. Similar concentrations were measured in method blanks, therefore laboratory contamination is suspected. In addition, 52 field blanks had concentrations of methylene chloride greater than the drinking water standard of 5 ug/L. This limits the usability of low-level detections for methylene chloride in groundwater monitoring samples. Affected samples are flagged Q (quality failures) and/or Y (data are suspect) in the HEIS database. Groundwater analytical support staff continue to work with the laboratories to decrease both the frequency and magnitude of methylene chloride contamination.

Nineteen field blank results for carbon tetrachloride exceeded the QC limits. This is higher than FY 2007 (9); however, 8 of these results are associated with samples analyzed at WSCF in August. It is possible that these samples were affected by the same instrument contamination problem as the acetone results. Five of the 19 results were greater than the drinking water standard of 5 ug/L. Trace levels of several other volatile organic compounds also were measured in field blanks (Tables C-4 through C-6). The frequencies of detection for these compounds were low (less than 3%) and the impact on the data is minor.

One anion field blank sample (B1RTC6) had four of the highest out-of-limit results. This was investigated and is suspected to be an isolated sampling problem. All other anion field blank results are much lower than typical groundwater concentrations. One oil and grease blank result was especially high (12,200 µg/L); however, investigation for cause was inconclusive. Samples associated with this blank show much lower levels of oil and grease and are flagged Q in the HEIS database.

A small number of radiological constituents were detected at levels that exceeded blank QC limits (Tables C-4 and C-6). However, the frequency and magnitude of detections for these compounds was low (less than 6%) and no trends were identified.

## **C.4.2 Field Duplicates**

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Field duplicates are used to assess sampling and measurement precision. Results of field duplicates must have precision within  $\pm 20\%$ , as measured by the relative percent difference. Only field duplicates with at least one result greater than five times the method detection limit or minimum detectable activity are evaluated. Results associated with field duplicates that do not meet these criteria are flagged with a Q in the HEIS database, to indicate potential precision issues.

The percentages of acceptable duplicate ( $1,493/1,596 = 94\%$ ) results evaluated in FY 2008 were high, indicating little problem with contamination and good precision overall. Duplicate results were flagged for all constituent classes except general chemistry parameters and semivolatile organic compounds (Table C-7). Although the relative number of flagged duplicate results increased from 2% in FY 2007 to 3% in FY 2008, the percentage remains low. The increase in out-of-limit duplicates was primarily because of metal results from WSCF. The number of out-of-limit metal duplicates increased from two metals with one failure each last year to 15 metals and a total of 62 failures FY 2008. Most (94%) of these metal failures are associated with WSCF data and nearly half (47%) occurred in the first quarter of the fiscal year. Groundwater analytical support staff identified a data quality issue associated with WSCF's SW-846 Method 6010C data during that time (Section C.6.4; SGW-37533, Section B1.0). Groundwater analytical support staff continue to work with WSCF to improve the quality of their metals analysis. Omitting the samples from the first quarter of the fiscal year, 82% of the remaining duplicates that exceeded QC limits are unfiltered samples. Suspended solids in heterogeneous sample fractions may have caused some of the discrepancies in the results. Likewise, all of the associated samples in the radiological parameters category were unfiltered, which may explain some of the out-of-limit results. Four of the 13 volatile organic parameter duplicates exceeding QC limits are associated with analysis at WSCF during August. It is likely these samples were affected by the instrument contamination problems (Section C.4.1).

The majority of the out-of-limit duplicate results appear to be anomalous instances of poor precision based on other QC indicators, such as the results from the laboratory duplicates. In several cases, the laboratory was asked to re-analyze or investigate duplicate results with a very high relative percent difference, but the checks did not reveal the source of the problem. Some of these investigations are underway during the writing of this report.

### **C.4.3 Field Splits**

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Split samples are used to confirm out-of-trend results and for interlaboratory comparisons. Results must have a relative percent difference less than or equal to 20%. Only those results that are greater than five times the method detection limit or minimum detectable activity at both laboratories are evaluated.

In FY 2008, 161 split samples were analyzed for 68 different analytes generating nearly 1,600 field split pairs of data. The split sample data were used to evaluate the performance of the laboratories during the transition of analyses to WSCF, as well as to troubleshoot total organic carbon and total organic halide analytical problems at WSCF. With the exception of metals and fluoride, there was reasonable agreement between laboratories when both data pairs were greater than five times the reporting limit (or minimum detectable activity for radionuclides). The results for field splits that exceeded QC limits are summarized in Table C-8. The relative percent of pairs outside the acceptance limits of 20% relative percent difference increased from 21% in FY 2007 to 25% in FY 2008. The increase is predominantly a result of an increase in the number of metals splits exceeding QC limits. Section C.6.4 provides additional detail on issues associated with metal analysis in FY 2008.

Over 80% of the splits outside of QC limits are associated with metals analysis. Several corrective actions have been performed to attempt to resolve this issue; however, it is still being actively investigated. In addition, there is poor precision between laboratories for fluoride analysis. Recent corrective actions at TA St Louis, including use of an improved separation column, have been evaluated and appear to have corrected some of the past issues. Anions of primary interest (chloride, nitrate, and sulfate) show improved precision over FY 2007 as evidenced by the decreased range of out of limit results; however, this method will continue to be closely monitored to determine if additional corrective actions for anions are needed.

## **C.5.0 Holding Times**

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### ***H. Hampt and H. L. Anastos***

Holding time is the elapsed time period between sample collection and analysis. Samples are required to be analyzed within recommended holding times to minimize the possibility of changes in constituent concentrations caused by volatilization, decomposition, or other chemical processes. Samples also are refrigerated to slow potential chemical reactions within the sample matrix. Maximum recommended holding times for constituents frequently analyzed for the groundwater project are listed in Table C-11. Radiological constituents do not have recommended maximum holding times because these constituents are not typically lost under ambient temperatures when appropriate preservatives are used. Results of radionuclide analysis are corrected for decay from sampling date to analysis date.

During FY 2008, recommended holding times were met for 99% nonradiological results (Table C-3). Holding times were exceeded for 903 nonradiological results. Results for samples with missed holding times are flagged with an H in the HEIS database.

Seventy-five percent of the missed holding times were associated with anions by EPA Method 300.0 (686 results). Nitrate, nitrite, and phosphate have 48-hour holding times. When anion samples are shipped off site, it is not uncommon for the holding time to be missed due to shipping delays; however, a number of samples that went to the onsite laboratory missed holding times as well (238 results). Late delivery caused approximately one-third of the missed holding times for anion samples at WSCF. Other anion samples missed holding times at WSCF largely because of laboratory capacity and scheduling issues.

## **C.6.0 Laboratory Performance**

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### ***H. L. Anastos, C. J. Thompson, G. A. Fies, H. Hampt, and L. C. Sumner***

Laboratory performance is measured by several indicators, including national performance evaluation studies, double-blind standard analyses, laboratory audits, and internal laboratory QA/QC programs. This section provides a detailed discussion of the performance indicators for WSCF, TA St. Louis, and TA Richland. Brief summaries of performance measures for Lionville Laboratory and Eberline Services are also presented throughout this section. The percentage of results within the acceptance limits for all laboratories was 98%, indicating good performance overall.

### **C.6.1 National Performance Evaluation Studies**

During FY 2008, Environmental Resources Associates and DOE conducted national studies to evaluate laboratory performance for chemical and radiological constituents. TA St. Louis and WSCF participated in the EPA sanctioned Water Pollution Performance Evaluation studies conducted by Environmental Resources Associates. WSCF, TA St. Louis, TA Richland, and Eberline participated in the Environmental Resources Associates' InterLaB RadChem Proficiency Testing Program. All five laboratories took part in DOE's Mixed Analyte Performance Evaluation Program. Results of those studies related to groundwater monitoring at the Hanford Site are described in this section.

#### **C.6.1.1 Water Pollution Studies**

The purpose of water pollution studies is to evaluate the performance of laboratories in analyzing selected organic and inorganic compounds in water matrices. An accredited agency, such as Environmental Resource Associates, distributes standard water samples to participating laboratories. These samples contain specific organic and inorganic analytes at concentrations unknown to the participating laboratories. After analysis, the laboratories submit results to the accredited agency, which uses regression equations 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 accredited agency found acceptable, independently verify the level of laboratory performance. In the event of an unacceptable result, the laboratories may order an ERA QuiK™Response sample to verify successful corrective action. QuiK™Response samples are similar to water pollution/water supply samples, and results are reported in a comparable fashion.

For the three water pollution studies (ERA WP-156, WP-161, and WP-162) in which TA St. Louis participated during FY 2008, the percentage of results within acceptance limits submitted to the groundwater project ranged from 89% to 99% (Table C-12). Seventeen different constituents had unacceptable results, none of which were repeated across studies. Nine of the constituents that were out of limits last year were also reported out of limits in at least one study FY 2008. The following five constituents were unacceptable in FY 2006, FY 2007 and FY 2008: Ammonia as nitrogen, orthophosphate as phosphorus, total petroleum hydrocarbon (gravimetric), total organic halides, and benzene in gasoline range organics. Of these constituents, only total organic halides were routinely performed by TA for groundwater monitoring. The two most recent performance studies for this method were WP-156 and WP-162. TA successfully quantified total organic halides in WP-156; however, the results for WP-162 were biased slightly high (129% recovery). This correlates with the most recent TA blind standard results for total organic halides (phenol) which also show high bias (Section C.6.2). Groundwater analytical support staff are working with the laboratory to improve future performance.

For the two water pollution studies (ERA WP-156 and 162) and one QuiK™Response study (022808A) in which WSCF participated during FY 2008, the percentage of results for all three was 100% (Table C-13). As shown in Tables C-12 and C-13, the number of constituents reported by WSCF in the water pollution studies was considerably fewer than those reported by TA St. Louis, so the percentages from the two laboratories are not directly comparable.

### **C.6.1.2 InterLaB RadChem Proficiency Testing Program Studies**

The purpose of the InterLaB RadChem Proficiency Testing Program (conducted by Environmental Resources Associates) is to evaluate the performance of laboratories in analyzing selected radionuclides. This program provides blind standards that contain specific amounts of one or more radionuclides in a water matrix to participating laboratories. After sample analysis, the results were forwarded to Environmental Resources Associates for comparison with known values and with results from other laboratories. Environmental Resources Associates bases its control limits on the EPA's National Standards for Water Proficiency Testing Studies Criteria Document (NERL-Ci-0045).

During FY 2008, TA St. Louis participated in study RAD-71, and analyzed a total of sixteen constituents. Unacceptable results were reported for cobalt-60 and gross alpha (Table C-12).

During FY 2008, TA Richland participated in study RAD-72, and analyzed a total of 14 constituents. All results were acceptable (Table C-12).

During FY 2008, WSCF participated in study RAD-72 and QuiK™Response study 022808A. WSCF performed poorly on RAD-72, adequately quantifying only three out of the seven constituents reported. Later investigation by the laboratory QC staff identified that the samples were not prepared and analyzed in accordance with the suppliers instructions. These preparation instructions are specific to the performance evaluation samples; therefore, this error did not affect any groundwater samples. QuiK™Response performance samples for radium-226 and uranium were requested by the laboratory immediately following notification of the RAD-72 results, and acceptable results were achieved on the QuiK™Response samples.

Eberline Services participated in two studies (RAD-72 and RAD-74), and analyzed a total of twenty-eight constituents. Two of the results, strontium-89 and radium-228, were unacceptable (Table C-14).

### **C.6.1.3 DOE Mixed Analyte Performance Evaluation Programs**

DOE's Mixed Analyte Performance Evaluation Program examines laboratory performance in the analysis of soil and water samples containing metals, volatile and semivolatile organic compounds, and radionuclides. This report considers only water samples. The program is conducted at the Radiological and Environmental

Sciences Laboratory in Idaho Falls, Idaho. DOE evaluates the accuracy of the Mixed Analyte Performance Evaluation Program results for radiological and inorganic samples by determining if they fall within a 30% bias of the reference value.

One study was available for FY 2008 (MAPEP-07-OrW18&GrW18&MaW18). Two results for TA St. Louis were unacceptable, hexachlorobenzene and tritium (reported as hydrogen-3). (Table C-12); however, both compounds were within the acceptance limits for FY 2007. All results were acceptable for TA Richland (Table C-12), Lionville Laboratory, and Eberline Services (Table C-14). WSCF performed poorly on the radiological analytes, adequately quantifying only six out of the fourteen constituents reported. Later investigation by the laboratory QC staff identified that the laboratory did not prepare the samples according to the suppliers instructions. Because this preparation is specific to the performance evaluation samples, this error did not affect any groundwater samples. Additional performance samples were requested by the laboratory immediately following notification of the MAPEP-07-MaW18 results and acceptable results on the follow-on samples were achieved.

### **C.6.2 Double-Blind Standard Evaluation**

Double-blind standards provide a measure of both inter- and intra-laboratory precision and accuracy. These studies also help groundwater staff troubleshoot analytical problems identified through data reviews and QC evaluations. The double-blind standards also may be used to confirm the adequacy of corrective actions to resolve analytical problems. During FY 2008, the groundwater project forwarded double-blind QC standards to TA Richland and St. Louis, WSCF, Lionville Laboratory, and Eberline Services. Blind-spiked standards were generally prepared in triplicate and submitted to the laboratories to check the accuracy and precision of analyses. For most constituents, the standards were matrix-matched double-blind standards, which are prepared in a groundwater matrix from a background well. Standards for specific conductance were commercially prepared in deionized water. In all cases, the standards were submitted to the laboratories in double-blind fashion (i.e., the standards were disguised as regular groundwater samples). After analysis, the laboratory's results were compared with the spiked concentrations, and a set of control limits were used to determine if the data were acceptable. Out-of-limit results were reviewed for errors. In situations where several results for the same method were unacceptable, the results were discussed with the laboratory, potential problems were investigated, and corrective actions were taken when appropriate.

Tables C-15 through C-17 summarize the number and types of double-blind standards used in FY 2008, along with the control limits and number of unacceptable results for each constituent. WSCF and TA were provided the same number of test samples, allowing for direct comparison between their results. Lionville received the same number of total organic carbon and chloride samples, but fewer fluoride, nitrate, and nitrite samples. Overall, 90% of the blind spike determinations were acceptable. This was slightly higher than the percentage from FY 2007 (88%). The WSCF laboratory improved their performance on blind samples, with 91% of their blind results within control limits compared to 79% in FY 2007. TA (Richland and St. Louis) reported acceptable results for 93% of the blind constituents. The Lionville Laboratory had relatively poor performance based on their percentage of acceptable results (69%). Nine of the 16 unacceptable results were associated total organic carbon analyses. The Lionville Laboratory did not perform total organic carbon analysis in support of groundwater monitoring in FY 2008. Further corrective actions are needed prior to Lionville performing this work scope. Total organic carbon blind sample results for both WSCF and TA were all within acceptance limits and these laboratories will continue to provide the primary analytical service for this work scope. Lionville Laboratory's blind sample performance for analyses other than total organic carbon was 80%, still much lower than the other laboratories. All of the remaining unacceptable results for Lionville were associated with anion analysis. Groundwater analytical support staff are working with laboratory staff to help improve future performance. All of the results from Eberline Services were within the acceptance limits.

Performance of blind standards for total organic halides continues to be an area of needed improvement, because of multiple failures at both laboratories. Blind standards for total organic halides are prepared using

two different spiking solutions (2,4,5-trichlorophenol and a mixture of carbon tetrachloride, chloroform, and trichloroethene). WSCF improved performance on total organic halides with 3 unacceptable results compared to 12 in FY 2007; however, WSCF did not achieve acceptable results on 3 out of the 7 volatile spiked organic halide standards (43%). This is a much higher failure rate than TA (14%). Corrective actions have been implemented for the WSCF total organic halide method, which are anticipated to resolve the issues causing high variability and outlier results. While TA performance for total organic halides was consistent with FY 2007, five blind standards were not adequately quantified. This method will be closely monitored in FY 2009.

TA St. Louis and WSCF performed well on the analysis of anions in blind standards. All of the cyanide results from both laboratories were within the acceptance limits and ion chromatography results were improved during the year. However, Lionville Laboratory had four unacceptable results for nitrogen in nitrite and three for chloride in the first two quarters of the year. Subsequent blind analyses were acceptable. Lionville Laboratory is currently working to improve their anion performance through the following actions: procurement of a new instrument, replacement of standards, and optimizing sample dilutions. These improvements will be monitored to ensure satisfactory performance through future double-blind samples.

During FY 2008, metals analysis at WSCF was noted as needing additional monitoring (DOE/RL-2008-01, Section C.6.5). Blind standards for metals were submitted in the first and third quarters of FY 2008. Both WSCF and TA successfully completed the first set of blind standards with 100% acceptable results. However, follow-up testing for metals in the third quarter identified some potential issues. In particular, WSCF achieved a 92% success rate, while TA achieved 96%. In conjunction with other QC indicators (blank, duplicate, and split samples), the results indicate WSCF performance on metals analysis warrants corrective action. The laboratory has been notified and they are investigating the issues to identify appropriate corrective actions.

Performance for TA St. Louis and WSCF on the analysis of volatile organic compounds improved slightly in FY 2008. The laboratories' percentages of unacceptable results were very similar to last year at 17 and 43%, respectively; however, TA St. Louis' results showed better accuracy. All of the out-of-limit results at WSCF were biased low, in particular, 75% of WSCF results for trichloroethene were biased low. All of the chloroform results for both laboratories were acceptable. Since the water solubility of chloroform is much higher than that of carbon tetrachloride and trichloroethene, the low recoveries may be caused by volatilization of the less-soluble compounds prior to analysis. Despite laboratory corrective actions, results for volatile organics have only slightly improved; therefore, a more detailed evaluation of the volatile organic methods is planned during FY 2009.

Laboratory performance on radiological blind standards improved in FY 2008. WSCF had the greatest improvement, correctly quantifying 94% of the radiological parameters, compared to 86% in FY 2007. TA Richland successfully quantified all of the tritium blinds, demonstrating that the issues associated with last year's failures have been resolved. However, two out of six of TA Richland's results for iodine-129 are outside of the acceptance limits. The recoveries for these failures were between 60 and 70%. Further blind samples are planned in FY 2009 to investigate this.

Overall, the evaluation of the double-blind standards indicates that the current laboratories meet the precision and accuracy requirements of the groundwater-monitoring project. Specific analytical areas at each laboratory continue to be identified for process improvements.

### **C.6.3 Laboratory Internal QA/QC Programs**

WSCF, TA Richland, TA St. Louis, Eberline Services, and Lionville Laboratory maintain internal QA/QC programs that generate data on analytical performance by analyzing method blanks, laboratory control samples, matrix spikes and matrix spike duplicates, matrix duplicates, and surrogates (Section C.9.0 for definitions of these terms). This information provides a means to assess laboratory performance and the suitability of a method for a particular sample matrix. Laboratory QC 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. A brief assessment of the laboratory QC data for FY 2008 is summarized in this section. Tables C-18 and C-19

provide a summary of the TA and WSCF QC data, respectively, by listing the percentage of QC results that were out of limits for each analyte category and QC parameter. Additional details are presented in Tables C-10 and C-20 through C-24. Constituents not listed in these tables did not exceed WSCF's or TA's QC limits. An overview of Lionville Laboratory and Eberline Services data is presented at the end of the section.

Approximately 97% of the FY 2008 laboratory QC results were within the acceptance limits, indicating that the analyses were in control and reliable data were generated. Method blanks, laboratory control samples, matrix spikes and matrix spike duplicates, matrix duplicates, and surrogates QC results were evaluated against the acceptance limits. Unacceptable results are summarized below.

Evaluation of results for method blanks was based on the frequency of detection above the blank QC limits. Except as noted below, these limits are two times the method detection limit for chemical constituents and two times the minimum detectable activity for radiochemistry parameters. Because minimum detectable activities are not electronically reported for radiochemistry analytes from WSCF, two times the practical quantitation limit was used as the QC limit for WSCF. For common laboratory contaminants such as 2-butanone, acetone, methylene chloride, phthalate esters, and toluene, the QC limit is five times the method detection limit.

Table C-10 summarizes method blank results from WSCF. Approximately 98% of the results were acceptable. Of the six analyte categories, metals had the greatest percentages of method blank results exceeding the QC limits (5% overall). The unacceptable results for calcium, magnesium, potassium, and sodium are not significant when the blank concentrations are compared to the levels of these constituents in most Hanford Site groundwater samples. Nonetheless, the failed blanks are indicative of process improvements needed for metals analysis at WSCF (Section C.4.1). Results associated with out-of-limit metal blank results are flagged with a C by the laboratory. Several volatile organic compounds had method blank results that exceeded the QC limits. Of these, acetone and methylene chloride had the highest percentages of out-of-limit results. Both compounds are common laboratory contaminants, and low-level detections of them in Hanford Site groundwater samples should be considered suspect. Results associated with out-of-limit volatile organic compound blank results are flagged with a B by the laboratory. Table C-25 summarizes method blank results from TA. The ammonia/anions and metals categories had the greatest percentages of method blank results outside the QC limits. Blank concentrations of some of the more prevalent constituents (calcium, chloride, and sodium) were relatively insignificant compared to typical levels of these constituents in Hanford Site groundwater. As noted above, results associated with out-of-limit inorganic blank results are flagged with a C by the laboratory. Several volatile organic compounds had results that exceeded the QC limits. All of these compounds were found at trace levels, and their percentages of unacceptable blank results were low (less than 10%). Nonetheless, the apparent presence of any analytes in method blanks dictates caution when interpreting low-level results for the same constituents in Hanford Site groundwater. Results associated with out-of-limit volatile organic compound blank results are flagged with a B by the laboratory. Overall, the method blank results for WSCF and TA indicate acceptable laboratory performance. The results are similar to those from FY 2007.

Table C-21 summarizes results for the laboratory control samples from WSCF. WSCF had a low number of failures; 99.8% of the results were within the control limits. Most of the unacceptable results were associated with low recoveries (51 to 75%), which indicates that some of the associated results may be biased low. Mercury, potassium, and plutonium-239 had slightly high recoveries ranging from 117 to 132%. Table C-20 summarizes results for the laboratory control samples from TA Richland and St. Louis. Several volatile and semivolatile organic compounds had one or two unacceptable results, while bromomethane had 5 results outside the QC limits. The out-of-limit laboratory control sample results for bromomethane were biased high and sample results were not detected; therefore, there is no impact to groundwater data. The majority of these compounds are not commonly found in Hanford Site groundwater samples. However, as noted above, some bias is likely in the associated groundwater sample results for these compounds.

Table C-23 summarizes results for the matrix spikes and matrix spike duplicates from WSCF. Approximately 96% of the results were acceptable. The metals and radiological categories had the greatest percentage of matrix spikes/spike duplicates exceeding the QC limits (6.9 and 9.9%, respectively). Calcium, magnesium, sodium,

and technetium-99 account for most of these results. All of the matrix spikes for the three metals and 9 out of 16 of the spikes for technetium-99 had very low spike amounts compared to the original sample concentrations. Consequently, the matrix spikes were inadequate for assessing method performance on the associated samples. This is a limitation that arises from the common laboratory practice of always spiking a fixed amount of analyte without prior knowledge of the unspiked sample's concentration. Table C-22 summarizes results for the matrix spikes and matrix spike duplicates from TA Richland and St. Louis. The ammonia and anions category had the greatest percentage of matrix spikes/spike duplicates exceeding the QC limits. Most of these results were for chloride, where the spike level was relatively low compared to the sample concentrations. Many of the organic compounds that had unacceptable matrix spike/spike duplicate results are not commonly detected in Hanford Site groundwater.

For matrix duplicates, only those samples with values five times greater than the method detection limit or the minimum detectable activity (or practical quantitation limit for WSCF) are considered. Quantifiable matrix duplicates are evaluated by comparing the relative percent difference with an acceptable relative percent difference maximum ( $\pm 20\%$ ) for each constituent. Tables C-24 and C-26 list the constituents from WSCF and the TA laboratories that exceeded the relative percent difference limits. Overall, the percentage of duplicates having poor precision was low (less than 1% for all three laboratories), demonstrating good analytical reproducibility. WSCF had 7 out of 63 matrix duplicates for technetium-99 that had relative percent differences between 20 and 46%. For the TA laboratories, no constituents had more than one matrix duplicate that failed to meet the acceptance criteria.

Surrogate data from WSCF that were out of limits included four compounds for semivolatile organics and o-terphenyl for total petroleum hydrocarbons diesel. More than 99% of WSCF's surrogate results were acceptable. TA St. Louis had out-of-limit surrogate results for 5 methods: phenols, pesticides, volatile organics, semivolatile organics, and total petroleum hydrocarbons gasoline. Approximately 98% of TA St. Louis' surrogate results were within the acceptance limits.

QC data for Eberline Services and Lionville Laboratory were limited for FY 2008 because these laboratories did not analyze many samples for routine groundwater monitoring. Lionville Laboratory analyzed a limited number of method blanks, laboratory control samples, matrix spikes, and matrix duplicates for anions by ion chromatography and mercury by cold vapor atomic absorption. Problems have been noted with Lionville Laboratory's laboratory control standards for anions, in particular, high bias with phosphate (SGW-38743, Section B.36). Corrective actions are underway at the laboratory. Eberline Services QC data were limited to carbon-14, radionuclides by gamma spectroscopy, gross alpha, gross beta, and protactinium-231. All of the QC data were acceptable except for 4 out of 8 laboratory control samples for protactinium-231. The recoveries for these samples ranged from 122 to 130%, indicating the associated sample results could be biased slightly high.

### **C.6.3.1 Issue Resolution**

Issue resolution forms are documents used to record and resolve problems encountered with sample receipt, sample analysis, missed holding times, and data reporting (e.g., broken bottles or QC problems). The laboratories generate these forms and submit them to the groundwater project as soon as possible after a potential problem is identified. The forms provide a means for the project to give direction to the laboratory on resolution of the issues. The documentation is intended to identify occurrences, deficiencies, and/or issues that may potentially have an adverse effect on data integrity. During FY 2008, 117 issue resolution forms addressing analytical requests for groundwater monitoring samples were submitted by the WSCF, TA St. Louis, and TA Richland laboratories. Issue resolution forms were not received from the secondary or limited use laboratories.

Table C-27 indicates the specific issues identified FY 2008 and the number of analytical requests that were impacted. Issues are categorized according to whether they occurred prior to or after receipt at the laboratory. Approximately 2% of analytical requests were documented as having a problem on an issue resolution form. Roughly half of the issues occurred prior to receipt at the laboratories. The majority of these issues were missed

hold times, samples received outside of temperature specifications, chain of custody issues, and incorrect preservation of samples. These issues are tracked, and when adverse trends are identified, corrective actions are initiated. In FY 2008, the number of issues associated with incorrect preservation of samples was increasing, and a quality assurance nonconformance report (NCR-08-SGRP-011) was issued to address this problem.

The number of issue resolution forms varies from year to year based on laboratory reporting. During FY 2008, WSCF did not submit issue resolution forms for laboratory QC failures or late analyses. This may have made the total number of analyses impacted after receipt at WSCF artificially low. Approximately 80% of the issue resolution forms submitted by WSCF for analyses impacted after receipt at the laboratory were associated with missed holding times.

### **C.6.3.2 Laboratory Audits and Assessments**

Laboratory and field activities were regularly assessed by surveillance and auditing processes to ensure that quality problems were prevented and/or detected. Evaluation of laboratory and analytical activities is performed by various oversight organizations with each using slightly differing criteria and terminology. Audits are performed on the commercial laboratories by the DOE Consolidated Audit Program. These audits are based on the DOE Quality Systems for Analytical Services requirements. Assessments are performed for onsite laboratories, such as WSCF. Assessments are performed by integrated contractor assessment teams to the requirements of the Hanford Analytical Quality Assurance Requirements Document. Surveillances are performed by Fluor Hanford Environmental Quality Assurance staff. They can cover any areas of interest including laboratory, field, or data management processes and are considered less formal than audits or assessments.

During FY 2008, a total of five formal reviews were conducted on laboratories that routinely analyzed Hanford Site groundwater samples. Four audits were conducted on commercial laboratories by the DOE Consolidated Audit Program. One assessment was conducted on WSCF by an integrated contractor assessment team. In addition to the formal reviews, two analytical surveillances were conducted at WSCF and three field surveillances were performed on sampling and field analytical data acquisition activities. The surveillances were conducted by Environmental QA personnel. Corrective actions were initiated for all findings associated with surveillances, and process improvements were evaluated.

***DOE Consolidated Audit Program Audits.*** The goal of the DOE Consolidated Audit Program is to design and implement a program to consolidate site audits of commercial and DOE environmental laboratories providing services to DOE Environmental Management. The specific audit objectives of the DOE Consolidated Audit Program were to assess the ability of the laboratories to produce data of acceptable and documented quality through analytical operations that follow approved methods, and the handling of DOE samples and associated waste in a manner that protects human health and the environment. All laboratories were evaluated against the requirements of DOECAP, 2007.

The DOE Consolidated Audit Program audits were performed at the following laboratories: TA, Earth City, Missouri, April 22 through 24, 2008, (080424-TAS); Eberline Services, Richmond, California, March 11 through 13, 2008, (080313-ESR); Lionville Laboratory, Inc., Lionville, Pennsylvania, June 3 through 5, 2008, (080605-LLI); and TA, Richland, Washington, June 24 through 26, 2008, (080626-TAR).

The assessment scope of the DOE Consolidated Audit Program included the following specific functional areas:

- QA management systems and general laboratory practices
- Data quality for organic analyses
- Data quality for inorganic and wet chemistry analyses
- Data quality for radiochemistry analysis
- Hazardous and radioactive materials management
- Verification of corrective-action implementation from previous audit findings.

A total of 18 findings and 31 observations were noted for the four DOE audits. Results of these audits are summarized in Table C-28. All corrective actions have been accepted and verification of the corrective actions will be performed in future audits. All laboratories have been recommended by DOECAP to continue to provide analytical services for samples generated at DOE sites.

***Integrated Contractor Assessment Team Assessments.*** An integrated contractor assessment team assessment is performed by Hanford Site contractor personnel on Hanford Site analytical laboratories and is used to verify the implementation of the requirements stated in DOE/RL-96-68, Volumes 1 and 4. An integrated contractor assessment team assessment of WSCF was performed on July 21 through 24, 2008, (FH-QA-IA-08-02). The overall results of the assessment indicated that programs and processes reviewed were in place and implemented in accordance with the laboratory QA program plan and DOE/RL-96-68. The laboratory was qualified by the integrated contractor assessment team to continue to provide analytical services for samples generated at the Hanford Site.

A total of three findings and four observations were noted during the assessment. Results are summarized in Table C-28. Corrective actions have been accepted for all findings and observations, and verification of the corrective actions will be performed in a future assessment.

***Analytical Surveillances at WSCF Laboratory.*** Two surveillances were performed by Environmental QA personnel to evaluate corrective actions taken at WSCF to resolve total organic carbon and total organic halide issues. The total organic carbon analysis was reviewed on April 28, 2008, (QA-EQA-SURV-08-089). This activity was found to be satisfactory and resulted in no findings and two opportunities for improvement. The total organic halides analysis was assessed on August 13, 2008, (QA-EQA-SURV-08-140). This activity was found to be satisfactory and resulted in no findings and two opportunities for improvement.

***Field Sampling and Data Acquisition Surveillances.*** Three field surveillances were performed by Environmental QA personnel during FY 2008. A surveillance on groundwater level measurement was performed on December 17 and 18, 2007 (QA-EQA-GRP-SURV-08-036). This activity was found to be unsatisfactory and resulted in one finding; the reference point for well 199-N-122 was incorrectly identified for water level measurement and caused the groundwater elevation to be erroneously high by approximately 0.122 m (0.4 ft). The corrective actions taken as a result of this finding included review of the measurement points for other wells of similar construction and training for water level measurement personnel. Other wells of similar design may have been impacted by erroneous groundwater level measurement up to 0.122 m (0.4 ft). The measurement of flush mount wells has now been standardized and the error has been eliminated. Another surveillance was conducted on the sampling and analysis activities for hexavalent chromium at the 100-HR-3 Pump-and-Treat System from May 27 to June 9, 2008, (QA-EQA-GRP-SURV-08-104). This activity resulted in two findings that were corrected during the surveillance; work was being performed without a current sampling authorization form and the analysis procedure was not retrievable at the work location. The corrective actions were taken included issuance of the sampling authorization form and obtaining the procedure at the work location. It was determined these findings did not have an impact on data quality. A surveillance was conducted on the operational monitoring of groundwater sampling at well 199-N-71 on December 18, 2007 and September 24 and 30, 2008, (QA-EQA-GRP-SURV-08-166). This activity resulted in one finding that was corrected during the surveillance; the preservatives used in sample preservation were not traceable to the vendor certificate of analysis. The corrective action for this was accomplished with a procedure revision. This corrective action was administrative in nature and it was determined that this finding did not have an impact on sample quality. Corrective actions were initiated for all findings associated with surveillances, and process improvements were evaluated for opportunities for improvement.

#### **C.6.4 Analytical Troubleshooting**

During evaluations of requests for data review submittals, trends may be observed that warrant further investigation by the groundwater analytical support staff. Over the past two years, the number of requests for

data review submitted has increased (~600 to ~1,700). Approximately 85% of the requests for data review were associated with WSCF, which performed about 70% of the work in FY 2008. Requests for data review are evaluated, and when trends are observed, the issue is investigated and corrective actions are performed when appropriate. These investigations include evaluation of the field, analytical, and reporting activities to identify cause. During FY 2008, several analytical issues for the laboratories were investigated by groundwater analytical support staff. The issues discussed below account for approximately 80% of the total requests for data review processed in FY 2008 to date. The remaining 20% of the total requests appear to be minor or isolated issues.

**Metals** – Approximately 68% of the requests for data review associated with WSCF were for metals. The majority of the metals requests (96%) were associated with the EPA SW-846 (Test Methods for Evaluating Solid Waste: Physical/Chemical Methods) Method 6010C (“*Inductively Coupled Plasma – Atomic Emission Spectrometry*”). The issue identified last year related to elevated, out-of-trend results tied to specific analytical batches performed at the laboratory on specific days has not recurred. However, out-of-trend results for low concentrations of metals have been an on-going problem. In the first and second quarters of the fiscal year, it was identified that WSCF had altered their calibration strategy for inductively coupled plasma metals, which resulted in false-positive results at the low end of the calibration range. This was resolved by reinstating the previous calibration strategy, after which the data improved in the third quarter. However, review of fourth quarter data shows a significant increase in the number of detections for metals in field and method blanks. This is an indication of continuing analytical problems. Re-analysis of a select number of samples by the EPA Method 200.8 (“*Determination of Trace Elements in Waters and Wastes by Inductively Coupled Plasma - Mass Spectrometry*”) also confirms the WSCF 6010 method is producing low-level, false-positive results. The laboratory is investigating the issue to determine cause(s) and appropriate corrective actions.

**Total Organic Carbon** – Approximately 6% of the requests for data review associated with WSCF (5% of the total) were for total organic carbon. In February through March 2008, WSCF reported results from an instrument with a plugged purge tube. This problem causes the instrument to detect both inorganic and organic carbon, biasing the data high. Eighteen wells were resampled due to this problem and the results for original 63 samples associated with these wells were rejected. More information about this problem can be found in SGW-38473, Section B1.0.

**Total Organic Halides** – Approximately 3% of the requests for data review associated with WSCF (3% of the total) were for total organic halides. The majority of this data was flagged as suspect due to high variability in quadruplicates (poor precision) and poor agreement with historical data for the wells. In addition, WSCF performed poorly on the first quarter blinds for total organic halides. Due to these issues, total organic halide analysis was diverted to TA St. Louis pending corrective actions at WSCF. WSCF completed a thorough investigation and implemented corrective actions. As of November 2008, the groundwater project is in process of transitioning this work scope back to WSCF. The method will be closely monitored to ensure corrective actions were effective. More information about this problem can be found in SGW-38473, Section B1.0.

**Hexavalent Chromium** – Following the data compilation for this report, 42 additional requests for data review associated with WSCF for hexavalent chromium were submitted. The majority of this data were flagged as suspect due to laboratory failure to perform turbidity blanks. Turbidity blanks are done to correct for any discoloration or suspended solids in the sample that might otherwise interfere with the analysis resulting in a high bias. The issue was identified when several samples were found with hexavalent chromium higher than total, filtered chromium. Investigation of these results by the laboratory identified the failure to perform turbidity blanks and reanalysis of a few samples confirmed that sample turbidity was most likely the cause of the discrepancy. Corrective actions are underway at the laboratory.

**Iodine-129** – Approximately 46 results for low-level iodine-129 analysis yielded results with a non-detect greater than the drinking water standard of 1 pCi/L. Historically, it has been difficult to obtain minimum detectable activities below 1 pCi/L. In FY 2008, all of the minimum detectable activities were reported less than 1 pCi/L; however, non-detects were still reported at higher levels. The laboratory uses three gamma energy

lines to detect iodine-129. They require both the primary and at least one of the secondary lines to be identified by the software in order to confirm the presence of I-129. This is a conservative approach that minimizes the potential for false-positive results (i.e., stating that I-129 is present when in fact it is not). The secondary energy lines are less sensitive than the primary line; therefore, it is possible to detect I-129 on the primary line but have both secondary lines not detected. When this happens, the laboratory reports the activity of the primary line as the non-detect value. In some cases, the value detected on the primary line is higher than the minimum detectable activity. The minimum detectable activity is based on the most sensitive line (the primary line) – not the secondary lines, which have much higher minimum detectable activity limits. Groundwater Analytical Support Staff continue to work with the laboratories to lower the reporting limits for iodine-129.

### **C.6.5 Laboratory Transition Overview**

WSCF superseded TA Richland and St. Louis as the primary analytical laboratory supporting groundwater monitoring during FY 2007. To minimize impacts to the monitoring program, a gradual transition of the sample load to WSCF was initiated last year and completed in the first quarter of FY 2008. Figure C-1 summarizes the percent of analyses performed by each of the laboratories for each quarter of the past three fiscal years.

In general, the number of analyses performed by WSCF remained stable throughout the year. As a result of WSCF's technical problem with total organic halides (Section C.6.4) and capacity issues in the late summer/fall, some analyses were temporarily diverted to TA. WSCF's performance relative to the commercial laboratories was monitored using split samples and QC blind standards in addition to comparing WSCF results with historical trends at numerous sites. Summaries of the split-sample and blind-standard results are provided in Sections C.4.3 and C.6.2, respectively. It is expected that WSCF will continue to provide primary analytical support to the groundwater-monitoring project with the commercial laboratories functioning as secondary providers for high volume or in response to technical problems.

## **C.7.0 Limit of Detection, Limit of Quantitation, and Method Detection Limit**

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Detection and quantitation limits are essential to evaluate data quality and usefulness because they provide the limits of a method's measurement. The detection limit is the lower limit at which a measurement can be differentiated from background. The quantitation limit is the lower limit where a measurement becomes quantifiably meaningful. The limit of detection, limit of quantitation, and method detection limit are useful for evaluating groundwater data.

The limit of detection is defined as the lowest concentration level statistically different from a blank (Currie, 1988). The concentration at which an analyte can be detected depends on the variability of the blank response. For the purpose of this discussion, the blank is taken to be a method blank.

In general, the limit of detection is calculated as the mean concentration in the blank plus three standard deviations of that concentration (EPA/540/P-87/001). The blank-corrected limit of detection is simply three times the blank standard deviation. At three standard deviations from the blank mean, the false-positive and the false-negative error rates are each ~7% (Miller and Miller, 1988). A false-positive error is an instance when an analyte is declared present, but is absent. A false-negative error is an instance when an analyte is declared absent, but is present.

The limit of detection for a radionuclide is typically computed from the counting error associated with each reported result (e.g., EPA/520/1-80/012) and represents instrumental or background conditions at the time of analysis. In contrast, the limit of detection and limit of quantitation for the radionuclides shown in Table C-29 are based on variabilities that result from both counting errors and uncertainties introduced by sample handling. In the latter case, distilled water, submitted as a sample, is processed as if it were an actual sample. Thus, any random cross contamination of the blank during sample processing will be included in the overall error, and the values shown in Table C-29 are most useful to assess long-term variability in the overall process.

The limit of quantitation is defined as the level above which quantitative results may be obtained with a specified degree of confidence (Keith, 1991). The limit of quantitation is calculated as the blank mean plus 10 standard deviations of the blank (EPA/540/P-87/001). The blank-corrected limit of quantitation is simply 10 times the blank standard deviation. The limit of quantitation is most useful for defining the lower limit of the useful range of concentration measurement technology. When the analyte signal is 10 times larger than the standard deviation of the blank measurements, there is a 95% probability that the true concentration of the analyte is within  $\pm 25\%$  of the measured concentration.

The method detection limit is defined as the minimum concentration of a substance that can be measured and reported with a 99% confidence that the analyte concentration is greater than zero. The method detection limit is determined from analysis of a sample in a given matrix containing the analyte (Currie, 1988). The method detection limit is 3.14 times the standard deviation of the results of seven replicates of a low-level standard. Note that the method detection limit, as defined above, is based on the variability of the response of low-level standards rather than on the variability of the blank response. This is the reporting limit most commonly provided from the analytical laboratories with groundwater data (i.e., the reporting limit in HEIS).

For this report, total organic carbon, total organic halides, and radionuclide field blank data are available for limit of detection and limit of quantitation determinations. The field blanks are QC samples that are introduced into a process to monitor the performance of the system. The use of field blanks to calculate the limit of detection and the limit of quantitation is preferred over the use of laboratory blanks because field blanks include error contributions from sample preparation and handling, in addition to analytical uncertainties. Methods to calculate the limit of detection and the limit of quantitation are described in detail in Appendix A of DOE/RL-91-03. The results of the limit of detection and limit of quantitation determinations are listed in Table C-30 for WSCF, Table C-31 for TA, and Table C-29 for radiological constituents.

Because of the lack of blank data for other constituents of concern, it was necessary to calculate approximate limit of detection and limit of quantitation values by using variability information obtained from low-level standards. The data from the low-level standards are obtained from laboratory method detection limit studies. If low-level standards are used, the variability of the difference between the sample and blank response is increased by a factor of 2 (Currie, 1988, p. 84). The minimum detection level (MDL), (LOD), and (LOQ) calculated as follows:

$$\text{MDL} = 3.14 * s$$

$$\text{LOD} = 3(\sqrt{2} * s) = 4.24 * s$$

$$\text{LOQ} = 10(\sqrt{2} * s) = 14.4 * s$$

Where  $s$  = standard deviation from the seven replicates of the low-level standard.

The results of limit of detection, limit of quantitation, and method detection limit calculations for most nonradiological constituents of concern (besides total organic carbon and total organic halides) are listed in Tables C-30 and C-31. The values in Table C-30 apply to WSCF and the values in Table C-31 apply to TA St. Louis. The radiological constituents, total organic carbon, and total organic halides are in Table C-29.

## **C.8.0 Conclusions**

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### **H. L. Anastos**

Overall, assessments of FY 2008 QA/QC information indicate that groundwater-monitoring data are reliable and defensible. Few contamination or other sampling-related problems were encountered that affected data integrity. Likewise, laboratory performance was good in most respects, based on the large percentages of acceptable field and laboratory QC results. Laboratory audits and generally acceptable results in nationally based performance evaluation studies also demonstrated acceptable laboratory performance for the groundwater project. However, the following areas of concern were identified and should be considered when interpreting groundwater-monitoring results.

Several indicator parameters, anions, metals, volatile organic compounds, and radiological parameters were detected at low-levels in field and/or laboratory method blanks. This indicates possible contamination in the field or laboratory and data associated with this QC is flagged in the HEIS database. Data users must consider data flags when making decisions regarding data usability.

Maximum recommended holding times were exceeded for less than 1% of groundwater monitoring samples that were analyzed by nonradiological methods. This is improved from 3.7% FY 2007. Affected data are flagged with an H in the HEIS database. Data users should consider H flags when making decisions regarding data usability.

Several analytical areas have been identified for continued evaluation and follow-up in FY 2009. These include anions, metals, total organic carbon, total organic halides, and volatile organic compounds.

## C.9.0 Glossary

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**Accuracy** – closeness of agreement between an observed value and a true value. Accuracy is assessed by means of reference samples and percent recoveries. Laboratory matrix spikes; laboratory control samples; EPA water pollution, water supply and interlaboratory comparison programs; and blind standards are all used to assess accuracy.

**Blind standard** – sample that contains a concentration of analyte known to the supplier but unknown to the analyzing laboratory. The analyzing laboratory is informed that the sample is a QC sample and not a field sample. Blind, double-blind, and matrix-matched double-blind standards are used to evaluate analytical accuracy and precision as a measure of laboratory performance.

**Comparability** – degree to which one set of data can be compared to another. For example, the results from samples analyzed by more than one laboratory may or not be comparable. Ideally, comparability should be evaluated using identical samples to ensure that valid comparisons can be made.

**Completeness** – amount of acceptable data divided by the total number of data points. The Hanford Site groundwater project determines completeness by calculating the number of unflagged data resulting from the validation process, dividing the total number of data evaluated, and multiplying by 100. The calculated percentages used in reporting completeness are conservative because all data flagged with B, H, Q, R, and Y (flags) are used in calculating the percentage complete; however, flagged data may still be valid.

**Data management staff** – groundwater project staff responsible for tracking samples and data from sample planning through data receipt. This title includes staff responsible for management of the databases and electronic tools used to support data management activities.

**Double-blind standards** – sample that contains a concentration of analyte known to the supplier but unknown to the analyzing laboratory. The analyzing laboratory is not informed that the sample is a QC sample. All attempts are made to make sure this sample appears like a field sample. Double-blind standards may or may not include matrix-matching. Blind, double-blind, and matrix-matched double-blind standards are used to evaluate analytical accuracy and precision as a measure of laboratory performance.

**Equipment blank** – sample that contains reagent water and any required preservative(s). An equipment blank is filled by pumping or washing reagent water through a non-dedicated pump or manifold. The equipment blank is analyzed for all constituents scheduled for the sampling event. Equipment blanks are used to monitor contamination due to improperly cleaned equipment.

**Field duplicate sample** – replicate sample to determine the precision of sampling and analytical measurement process by comparing results with an identical sample collected at the same time and location. Matching field duplicates are stored in separate containers and are analyzed independently by the same laboratory.

**Field trip blank (field transfer blank)** – sample that contains reagent water and any required preservative(s). At the time of sample collection, the field trip blank is filled at the sampling site by pouring reagent water from a cleaned container into sample vials. After collection, the field trip blank is treated in the same manner as the

other samples collected during the sampling event. Field trip blanks are collected only on days when other samples are collected for volatile organic analysis and are analyzed only for volatile organic constituents. Field trip blanks are used to check for volatile contamination associated with sampling activities.

**Flags (as qualifiers)** – codes that alert data users to limitations on reported data values. Data flags may be assigned by the laboratory or by groundwater monitoring staff. A complete list of review flags can be found in Table C-1. The common flags that are used include, but are not limited to, the following:

- B – data associated with contamination in the laboratory method blank (organics)
  - result detected was less than the contract-required detection limit but greater than the minimum detection level (inorganics)
  - data associated with contamination in the blank greater than 2 times the minimum detectable activity (radiochemistry)
- C – data associated with contamination in the laboratory method blank (inorganics)
- F – suspect data currently under review
- H – holding time exceeded
- G – reviewed data found to be valid
- P – potential problem with the sample or well that may have affected the data
- Q – result associated with suspect field QC data
- R – reviewed data found to be unusable
- Y – reviewed data found to be suspect.

**Full trip blank** – sample that contains reagent water and any required preservative(s). A full trip blank is used to check for contamination in sample bottles and sample preparation. The full trip blank is analyzed for all constituents of interest and is collected in all types of sample bottles used during that sampling period. The full trip blank is filled during bottle preparation using the same sample-preparation procedures as for regular well samples. The full trip blank is not opened in the field.

**Groundwater analytical support staff** – groundwater project staff responsible for reviewing and assessing the quality of data and analytical services. This group performs quarterly and annual reviews of QC data and ensures appropriate data flags are applied. They monitor the qualification and performance of the laboratories supporting the groundwater project.

**Groundwater project** – the Hanford Site groundwater monitoring program.

**Groundwater staff** – employees of the Hanford Site groundwater monitoring project. This includes project scientists, analytical support staff, data management staff, field staff, etc.

**Laboratory control sample** – sample of reagent water spiked with known amounts of the target analyte(s). The sample is extracted (if appropriate) and analyzed to monitor the performance of the analytical method.

**Matrix duplicate** – replicate analysis of a regular (i.e., groundwater) sample. Matrix duplicates and matrix spike duplicates are used to evaluate the precision of an analysis. Precision of  $\pm 20\%$  is expected for matrix duplicates.

**Matrix-matched double-blind standard** – sample prepared to contain a concentration of analyte known to the supplier but unknown to the analyzing laboratory. The sample matrix is selected to closely match that of field samples. Matrix-matched double-blind standards are disguised to appear as regular well samples to help ensure that any analyses performed are representative of those for routine well samples. Most of the blind standards submitted for the groundwater project are matrix-matched double-blind standards.

**Matrix spikes/matrix spike duplicates** – sample(s) prepared by adding known quantities of one or more target analytes to a sample prior to extraction and analysis. Comparison of the original (i.e., unspiked) sample and matrix spike results provides information about the suitability of an analysis for the sample matrix. For

example, unusually high or low recoveries of the spiked compounds may indicate that components in the sample matrix interfere with the analysis. Matrix spike duplicates are replicate matrix spike samples that are used to assess the precision of an analysis. Precision of  $\pm 20\%$  is expected for matrix spike duplicates.

**Method blank** – sample of reagent water prepared in the laboratory, extracted (if appropriate), and analyzed as if it were a regular sample. Method blanks are used to monitor the possible introduction of contaminants during sample preparation and analysis at the laboratory.

**Precision** – agreement among individual measurements of the same property, usually under prescribed similar conditions. For a set of duplicate measurements, precision is calculated by the relative percent difference of the duplicate results. For the Hanford Site groundwater project, results from laboratory duplicates, matrix spike duplicates, blind standards, split samples, and field duplicates are used to evaluate precision.

**Project scientist** – groundwater project scientist responsible for the technical evaluation of data for a specific well or set of wells.

**Reagent water** – distilled or deionized water free of contaminants that may interfere with the analytical test.

Relative percent difference (RPD) – calculated as follows:

$$RPD = \frac{|D_1 - D_2| \times 100}{(D_1 + D_2) / 2}$$

Where D1 = original sample value

D2 = duplicate sample value.

**Representativeness** – expression of the degree to which samples represent the actual composition of the groundwater in the aquifer. Representativeness is addressed qualitatively by the specification of well construction, sampling locations, sampling intervals, and sampling and analysis techniques addressed in monitoring plans.

**Split samples** – replicate samples sequentially collected from the same location in the same sampling event and analyzed by different laboratories. Split samples are used to evaluate laboratory precision and comparability.

**Surrogates** – organic compounds similar to analytes of interest in chemical composition, extraction, and analytical properties, but which are not normally found in environmental samples. Surrogates are spiked into method blanks, samples, and matrix spikes and are then extracted and analyzed to monitor the effectiveness of sample preparation and analysis on individual samples.

## C.10.0 References

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**Table C-1. Data Review Codes.**

Flag	Definition
F	Result is being reviewed as part of the RDR process. This flag is assigned when an RDR is initiated.
G	Result is valid according to further review.
H	Holding time exceeded before the sample was analyzed.
P	Potential problem. Collection/analysis circumstances make value questionable.
Q	Associated quality control sample is out of limits.
R	Result is not valid according to further review.
Y	Result is suspect. Review had insufficient evidence to show result valid or invalid.
Z	Miscellaneous circumstance exists. See project file.
RDR = request for data review.	

**Table C-2. Requests for Data Review, Fiscal Year 2008 Data.**

Flag G	Flag Y	Flag R	Flag P	Notify Owner	Other Action	Pending	Number of Results with an Assigned RDR
<b>Analytical Results</b>							
581	578	112	1	0	56	350	1677
<b>Water-Level Measurements</b>							
0	35	5	31	0	0	104	175
G = result is valid according to further review. P = potential problem. Collection/analysis circumstances make value questionable. R = result is not valid according to further review. RDR = request for data review. Y = result is suspect. Review had insufficient evidence to show result valid or invalid.							

**Table C-3. Data Completeness Summary.**

	Suspect Data	Rejected Data	Field QC	Holding Time	Method Blank	Total
Number of Results Flagged	565	112	2738	903	3902	7517
Percent Flagged Data	0.4%	0.1%	2.1%	0.7%	3.0%	5.9%
Percent Acceptable Data			97.9%	99.3%	97.0%	94.1%
NOTE: Total number of reported results was 128,373.						

**Table C-4. Full Trip Blanks Exceeding Quality Control Limits.**

Constituent	Number Out of Limits	Number of Analyses	Percent Out of Limits	Range of QC Limits <sup>a</sup>	Range of Out-of-Limit Results
<b>General Chemistry Parameters</b>					
Oil and Grease	1	1	100.0	1,000 µg/L	12,200 µg/L
<b>Ammonia and Anions</b>					
Nitrogen in Nitrate	1	90	1.1	44.2 - 638 µg/L	48.7 µg/L
<b>Metals</b>					
Cobalt	10	158	6.3	8 µg/L	18.4 - 27.2 µg/L
Copper	9	158	5.7	8 - 12 µg/L	8.3 - 17.1 µg/L
Hexavalent Chromium	1	38	2.6	4 µg/L	7.8 µg/L
Iron	14	158	8.9	18 - 50µg/L	19.7 - 70.3 µg/L
Magnesium	55	158	34.8	12 - 220 µg/L	12.6 - 263 µg/L
Manganese	10	158	6.3	1.92 - 8 µg/L	9 - 16.4 µg/L
Mercury	1	22	4.5	0.1 - 0.186 µg/L	0.5 µg/L
Nickel	10	158	6.3	8 - 26.6 µg/L	16.5 - 24.3 µg/L
Potassium	11	158	7.0	90 - 3300 µg/L	170 - 599 µg/L
Silver	12	157	7.6	10 - 12 µg/L	14.6 - 29.1 µg/L
Sodium	24	158	15.2	54 - 268 µg/L	54.1 - 796 µg/L
Vanadium	10	158	6.3	8.2 - 24 µg/L	14.6 - 26.5 µg/L
Zinc	18	158	11.4	8 - 18 µg/L	9 - 30.6 µg/L
<b>Volatile Organic Compounds</b>					
Acetone	4	40	10	2.8 - 5 µg/L	31 - 230 µg/L
Carbon tetrachloride	2	40	5	0.084 - 2 µg/L	2.5 - 2.8 µg/L
Methylene chloride	10	40	25.0	0.455 - 25 µg/L	0.72 - 100 µg/L
<b>Radiological Parameters<sup>b</sup></b>					
Americium-241	1	5	20.0	0.03 - 0.72 pCi/L	0.054 pCi/L
Gross beta	2	55	3.6	2.6 - 28 pCi/L	3.8 - 4.1 pCi/L
Potassium-40	1	28	3.6	55.6 - 300 pCi/L	63.2 pCi/L
Total beta radiostrontium	1	6	16.7	1.8 - 2.6 pCi/L	3.8 pCi/L
Tritium	1	66	1.5	400 - 622 pCi/L	870 pCi/L
<p><sup>a</sup> Because method detection limits are specific to the laboratory and may change throughout the year, the limits are presented as a range. However, each result was evaluated according to the method detection limit in effect at the time the sample was analyzed.</p> <p><sup>b</sup> The limit for radiological analyses is determined by the sample-specific total propagated uncertainty.</p> <p>QC = quality control.</p>					

**Table C-5. Field Transfer Blanks Exceeding Quality Control Limits.**

Constituent	Number Out of Limits	Number of Analyses	Percent Out of Limits	Range of QC Limits*	Range of Out-of-Limit Results
2-Pentanone, 4-Methyl	1	165	0.6	0.42 - 2 µg/L	4.4 µg/L
Acetone	7	165	4.2	2.8 - 5 µg/L	5.9 - 180 µg/L
Carbon tetrachloride	9	165	5.5	0.084 - 2 µg/L	0.24 - 11 µg/L
Chloroform	4	165	2.4	0.16 - 2 µg/L	0.67 - 30 µg/L
Methylene chloride	69	165	41.8	0.455 - 5 µg/L	0.53 - 48 µg/L
Trichloroethene	1	165	0.6	0.2 - 2 µg/L	8 µg/L
<p>* Because method detection limits are specific to the laboratory and may change throughout the year, the limits are presented as a range. However, each result was evaluated according to the method detection limit in effect at the time the sample was analyzed.</p> <p>QC = quality control.</p>					

**Table C-6. Equipment Blanks Exceeding Quality Control Limits.**

Constituent	Number Out of Limits	Number of Analyses	Percent Out of Limits	Range of QC Limits*	Range of Out-of-Limit Results
<b>General Chemistry Parameters</b>					
Oil and grease	1	1	100.0	1,000 µg/L	1,500 µg/L
<b>Ammonia and Anions</b>					
Chloride	6	40	15.0	60 – 440 µg/L	191 – 16,900 µg/L
Fluoride	1	40	2.5	12 – 92 µg/L	411 µg/L
Nitrogen in Nitrate	4	38	10.5	44.2 – 638 µg/L	58 – 126,000 µg/L
Sulfate	1	40	2.5	140 – 520 µg/L	35,300 µg/L
<b>Metals</b>					
Barium	1	49	2.0	1.7 – 8 µg/L	374 µg/L
Calcium	21	49	42.9	37.2 – 146 µg/L	37.8 – 400 µg/L
Chromium	5	49	10.2	6.2 – 26 µg/L	8.9 – 28 µg/L
Cobalt	2	49	4.1	8 µg/L	26.2 - 29.7 µg/L
Copper	5	49	10.2	8 – 12 µg/L	8.2 - 25.9 µg/L
Hexavalent Chromium	1	15	6.7	4 µg/L	4.3 µg/L
Iron	8	49	16.3	18 – 50 µg/L	19.5 – 191 µg/L
Magnesium	15	49	30.6	12 – 220 µg/L	12.3 – 390 µg/L
Manganese	2	49	4.1	1.92 – 8 µg/L	12.2 – 13.4 µg/L
Nickel	4	49	8.2	8 - 26.6 µg/L	10.9 – 24.6 µg/L
Potassium	2	49	4.1	90 – 3,300 µg/L	343 – 690 µg/L
Silver	6	49	12.2	10 – 12 µg/L	13.3 - 24.8 µg/L
Sodium	4	49	8.2	54 – 268 µg/L	58.2 – 1,070 µg/L
Strontium	1	49	2.0	1.08 – 8 µg/L	12.4 µg/L
Vanadium	4	49	8.2	8.2 – 24 µg/L	14.5 - 17.5 µg/L
Zinc	6	49	12.2	8 – 18 µg/L	9.1 – 134 µg/L
<b>Volatile Organic Compounds</b>					
Carbon tetrachloride	8	26	30.8	0.084 – 2 µg/L	0.16 – 21 µg/L
Chloroform	1	26	3.8	0.16 – 2 µg/L	6.4 µg/L
Methylene chloride	2	26	7.7	0.455 – 5 µg/L	1.6 – 5.9 µg/L
<b>Radiological Parameters</b>					
Gross beta	1	8	12.5	2.8 – 5.6 pCi/L	6.3 pCi/L
Tritium	1	30	3.3	400 – 500 pCi/L	450 pCi/L
<p>* Because method detection limits are laboratory specific and may change throughout the year, the limits are presented as a range. However, each result was evaluated according to the method detection limit in effect at the time the sample was analyzed.</p> <p>QC = quality control.</p>					

**Table C-7. Field Duplicates Exceeding Quality Control Limits.**

Constituent	Total Number of Duplicates	Number of Duplicates Evaluated <sup>a</sup>	Number Out of Limits	Percent Out of Limits	Range of Out-of-Limit Relative Percent Differences <sup>b</sup>
<b>Ammonia and Anions</b>					
Cyanide	21	10	1	10.0	20.9
Fluoride	115	75	9	12.0	22.8 - 111.1
Nitrogen in Nitrate	108	105	1	1.0	29.6
Nitrogen in Nitrite	108	8	5	62.5	25.3 - 157.4
<b>Metals</b>					
Calcium	182	182	1	0.5	51.7
Chromium	182	50	8	16.0	25.1 - 138.0
Copper	182	1	1	100.0	179.3
Hexavalent Chromium	66	45	2	4.4	55.0 - 169.7
Iron	182	71	30	42.3	20.3 - 150.4
Magnesium	182	182	1	0.5	62.7
Manganese	182	25	1	4.0	20.4
Nickel	182	18	4	22.2	27.6 - 107.8
Potassium	182	170	1	0.6	32.8
Silver	182	10	3	30.0	20.9 - 54.8
Sodium	182	182	1	0.5	42.4
Strontium	182	182	1	0.5	53.9
Uranium	53	53	2	3.8	22.4 - 46.3
Vanadium	182	18	4	22.2	20.8 - 28.8
Zinc	182	25	2	8.0	96.8 - 166.5
<b>Volatile Organic Compounds</b>					
Acetone	56	3	3	100.0	30.1 - 188.2
Carbon disulfide	56	1	1	100.0	66.7
Chloroform	56	13	1	7.7	20.7
Chloromethane	2	2	1	50.0	161.7
Methylene chloride	56	7	6	85.7	27.8 - 175.0
Trichloroethene	56	7	1	14.3	159.2
<b>Radiological Parameters</b>					
Gross alpha	45	11	2	18.2	22.4 - 38.3
Gross beta	59	42	6	14.3	20.7 - 40.0
Technetium-99	57	41	1	2.4	23.0
Total beta radiostrontium	9	4	1	25.0	239.2
Tritium	78	53	2	3.8	22.2 - 25.8
<sup>a</sup> Duplicates with both results less than five times the method detection limit or minimum detectable activity were excluded from the evaluation. <sup>b</sup> In cases where a non-detected result was compared with a measured value, the method detection limit or minimum detectable activity was used for the non-detected concentration.					

Table C-8. Field Splits Exceeding Quality Control Limits.

Constituent	Total Number of Splits	Number of Splits Evaluated <sup>a</sup>	Number Out of Limits	Percent Out of Limits	Range of Out-of-Limit Relative Percent Differences <sup>b</sup>
<b>General Chemistry Parameters</b>					
Total organic carbon	33	4	4	100.0	32.8 - 181.2
Total organic halides	24	4	1	25.0	144.6
<b>Ammonia and Anions</b>					
Chloride	39	39	1	2.6	91.2
Fluoride	39	26	15	57.7	21.4 - 122.4
Nitrogen in Nitrate	26	24	3	12.5	21.7 - 98.8
Nitrogen in Nitrite	31	1	1	100.0	39.1
Sulfate	41	40	2	5.0	21.3 - 87.1
<b>Metals</b>					
Barium	61	55	1	1.8	21.8
Calcium	60	60	5	8.3	22.7 - 29.0
Chromium	62	35	16	45.7	22.4 - 124.8
Cobalt	63	9	9	100.0	75.9 - 174.7
Copper	63	1	1	100.0	180.3
Hexavalent Chromium	65	46	14	30.4	20.5 - 175.4
Iron	61	22	19	86.4	20.3 - 182.4
Magnesium	63	63	1	1.6	26.2
Manganese	62	14	9	64.3	33.3 - 128.0
Nickel	61	8	4	50.0	88.5 - 131.3
Potassium	59	59	32	54.2	24.0 - 100.7
Silver	58	2	2	100.0	174.7 - 177.6
Sodium	59	59	2	3.4	20.5 - 26.0
Strontium	59	59	7	11.9	21.0 - 40.6
Vanadium	59	9	8	88.9	53.7 - 112.4
Zinc	58	21	14	66.7	20.3 - 125.3
<b>Radiological Parameters</b>					
Carbon-14	3	3	3	100.0	47.1 - 50.9
Gross beta	19	8	3	37.5	51.3 - 77.2
Uranium	3	3	1	33.3	23.6
<sup>a</sup> Splits with both results less than five times the method detection limit or minimum detectable activity were excluded from the evaluation. <sup>b</sup> In cases where a non-detected result was compared with a measured value, the method detection limit or minimum detectable activity was used for the non-detected concentration.					

**Table C-9. Analytical Method Categories.**

Category	HEIS Method Name	Description
General Chemistry Parameters	120.1_CONDUCT	Specific Conductivity, Conductance Bridge
	120.1_CONDUCT_FLD	Specific Conductivity, Field Measurement
	170.1_TEMP_FLD	Temperature, Field Measurement
	180.1_TURBIDITY_FLD	Nephelometric Turbidity, Field Measurement
	2320_ALKALINITY	Alkalinity
	310.1_ALKALINITY	Alkalinity, Titrametric
	360.1_OXYGEN	Dissolved Oxygen
	360.1_OXYGEN_FLD	Dissolved Oxygen (DO)
	410.4_COD	Chemical Oxygen Demand (COD), Automated; Manual
	413.1_OILGREASE	Oil and Grease, Total Recoverable, Gravimetric, Separatory Funnel Extraction
	420.2_PHENOLIC	Phenolics, Automated Colorimetric
	9020_TOX	Total Organic Halides (TOX)
	9060_TOC	Total Organic Carbon
	9223_COLIFORM	Coliform by Enzyme Substrate Test
	CONDUCT_FLD	Field conductivity by instrument manufacturer instructions
	D1498_ORP	Oxidation-Reduction Potential for Water
	PH_ELECT_FLD	PH Analysis by Electrode, Field Measurement
	REDOX_PROBE_FLD	Oxidation-Reduction Potential by platinum electrode
	TEMP_FLD	Temperature, Field Measurement
	TURBIDITY_FLD	Nephelometric Turbidity, Field Measurement
WTPH_DIESEL	Total Petroleum Hydrocarbons, SE/GC-FID, Washington State Dept. of Ecology	
WTPH_GASOLINE	Total Petroleum Hydrocarbons, P&T/GC-FID, Washington State Dept. of Ecology	
Ammonia and Anions	300.0_ANIONS_IC	Anions by ion chromatography
	300.7_CATIONS_IC	Cations by ion chromatography
	335.2_CYANIDE	Total Cyanide, Titrametric, Spectrophotometric
	9012_CYANIDE	Cyanide, Automated Colorimetric
	9030_SULFIDE	Sulfide by Titration
Metals	200.8_METALS_ICPMS	Metals by ICPMS
	6010_METALS_ICP	Metals by ICP
	6010_METALS_ICP_TR	Metals by ICP, trace
	6020_METALS_ICPMS	Metals by ICPMS
	7196_CR6	Chromium(Hex) - Cr+6, Colorimetric
	7470_HG_CVAA	Mercury (Hg) by CVAA
Volatile Organic Compounds	8015_VOA_GC	Non-Halogenated Volatiles by GC
	8260_VOA_GCMS	Volatile Organics by GC/MS Capillary Column
Semivolatile Organic Compounds	8040_PHENOLIC_GC	Phenols by GC
	8081_PEST_GC	Organochlorine pesticides by GC
	8082_PCB_GC	PCBs BY GC
	8270_SVOA_GCMS	Semivolatiles by GCMS

Table C-9. (cont.)

Category	HEIS Method Name	Description
Radiological Parameters	900.0_ALPHABETA_GPC	Gross Alpha/Beta by GPC
	906.0_H3_LSC	Tritium in Drinking Water, Liquid Scintillation
	906.0ML_H3_LSC	Tritium in Drinking Water, Mid-Level, Liquid Scintillation
	9310_ALPHABETA_GPC	Gross Alpha and Gross beta by GPC
	ALPHA_GPC	Gross Alpha, GPC
	AMCMISO_EIE_PLT_AEA	Americium/Curium Isotopic, separated by sequential Eichrom ion exchange resin, plated, Alpha Spectrometry
	AMCMISO_IE_PREC_AEA	Americium/Curium Isotopic, separated by ion exchange, precipitated, Alpha Spectrometry
	BETA_GPC	Gross Beta GPC
	C14_CHEM_LSC	C-14, Chemical Oxidation/LSC
	C14_LSC	C-14 analysis by unknown method
	GAMMA_GS	Gamma Spectroscopy, Germanium High Energy Detectors
	GAMMALL_GS	Gamma spectroscopy, low-level, germanium high-energy detector
	I129_SEP_LEPS_GS	Iodine-129, separation, precipitation, LEPS
	I129LL_SEP_LEPS_GS	Iodine-129, low-level, separation, precipitation, LEPS detection
	NI63_LSC	Nickel-63 by Liquid Scintillation
	NP237_IE_PRECIP_AEA	Isotopic Neptunium-237 Isotopic, Ion Exchange Separation, Precipitated on Disk, Alpha Spectrometry
	NP237_LLE_PLATE_AEA	Neptunium Isotopic, Liquid-Liquid Extraction, Electroplated, Alpha Spectrometry
	PA231_IE_PLATE_AEA	Protactinium 231, separated by ion exchange, plated, Alpha Spectrometry
	PUISO_IE_PRECIP_AEA	Isotopic Plutonium, Ion Exchange Separation, Precipitated on Disk, Alpha Spectrometry
	PUISO_PLATE_AEA	Isotopic Plutonium, Unknown Separation, Electroplated, Alpha Spectrometry
	RADISOTOPES_ICPMS	Radioisotopes by ICP/MS
	SE79_SEP_IE_LSC	Selenium-79, separated, ion exchange resin, Liquid Scintillation
	SRISO_SEP_PRECIP_GPC	Strontium beta isotopic, chemical separation, precipitated, GPC
	SRTOT_SEP_PRECIP_GPC	Total Beta Strontium, chemical separation, precipitation, GPC
	TC99_3MDSK_LSC	Technetium-99, 3M Disk separation, LSC
	TC99_ETVDSK_LSC	Technetium-99, Eichrome Teva Disk separation, LSC
	TC99_SEP_LSC	Technetium-99, ppt. and ion exchange resin separation, LSC
	THISO_IE_PRECIP_AEA	Isotopic Thorium, ion exchanges separation with and from Pb-210, precipitated, Alpha Spectrometry
	TRITIUM_EIE_LSC	Tritium in water, purification by Eichrome ion exchange, LSC
	TRITIUM_ELECT_LSC	Tritium in liquid samples by Electrolytic Enrichment, LSC
	UIISO_PLATE_AEA	Uranium isotopic, separation unknown, electroplated, Alpha Spectrometry
	UTOT_KPA	Total Uranium, unknown separation, Laser Phosphorimetry

Table C-10. Method Blank Results, WSCF.

Constituent	Percent Out of Limit <sup>a</sup>	Number of Analyses	Concentration Range of Out-of-Limit Results
<b>General Chemistry Parameters</b>			
Total General Chemistry Parameters	0.0	221	—
<b>Ammonia and Anions</b>			
Total Ammonia and Anions	0.0	3,693	—
Nitrogen in Nitrate	0.1	708	0.0727 µg/L
<b>Metals</b>			
Total Metals	5.2	3,608	—
Aluminum	9.1	11	14 µg/L
Calcium	1.7	178	87.9 – 127 µg/L
Chromium	8.3	181	8.4 – 31.1 µg/L
Cobalt	7.7	181	8.1 – 29.5 µg/L
Copper	6.0	182	8.2 – 18 µg/L
Iron	5.0	180	18.8 – 48.9 µg/L
Magnesium	28.5	179	12.4 – 46.9 µg/L
Manganese	5.5	182	9.1 – 16.6 µg/L
Nickel	7.2	181	10.5 – 24.5 µg/L
Potassium	8.9	179	90.7 – 721 µg/L
Silver	6.6	182	16.3 – 32.5 µg/L
Sodium	0.6	179	59.4 µg/L
Vanadium	8.2	183	14.5 – 31.1 µg/L
Zinc	9.9	181	8.3 – 34.9 µg/L
<b>Volatile Organic Compounds</b>			
Total Volatile Organic Compounds	1.2	2,543	—
1,1,1-Trichloroethane	1.0	97	2.9 µg/L
1,1,2-Trichloroethane	1.0	96	4.2 µg/L
Acetone <sup>b</sup>	14.4	97	10 – 3,400 µg/L
Benzene	2.1	97	2.2 – 4.9 µg/L
Carbon tetrachloride	1.0	97	6.1 µg/L
Chlorobenzene	1.0	97	5.1 µg/L
Chloroform	1.0	97	6.2 µg/L
cis-1,2-Dichloroethylene	1.0	97	2.4 µg/L
Ethylbenzene	1.0	97	4 µg/L
Methylene chloride <sup>b</sup>	5.2	97	7.6 – 620 µg/L
Tetrachloroethene	1.0	97	4.2 µg/L
Xylenes (total)	1.0	97	4.4 µg/L
<b>Semivolatile Organic Compounds</b>			
Total Semivolatile Organic Compounds	0.0	430	—
<b>Radiological Parameters</b>			
Total Radiochemistry Parameters	0.1	734	—
Gross beta	1.3	75	11 pCi/L
<sup>a</sup> Quality control limits are twice the method detection limit. <sup>b</sup> Quality control limits are five times the method detection limit.			

**Table C-11. Hanford Groundwater Monitoring Project Maximum Recommended Holding Times.**

Method	Constituent	Holding Time
120.1 (EPA-600/4-81-004)	Conductivity	28 days
160.1 (EPA-600/4-81-004)	Total dissolved solids	7 days
300.0 (EPA-600/4-81-004)	Bromide	28 days
300.0 (EPA-600/4-81-004)	Chloride	28 days
300.0 (EPA-600/4-81-004)	Fluoride	28 days
300.0 (EPA-600/4-81-004)	Nitrate	48 hours
300.0 (EPA-600/4-81-004)	Nitrite	48 hours
300.0 (EPA-600/4-81-004)	Phosphate	48 hours
300.0 (EPA-600/4-81-004)	Sulfate	28 days
310.1 (EPA-600/4-81-004)	Alkalinity	14 days
350.1 (EPA-600/4-81-004)	Ammonia	28 days
410.4 (EPA-600/4-81-004)	Chemical oxygen demand	28 days
6010 (SW-846)	Inductively coupled plasma metals	6 months
6020 (SW-846)	Inductively coupled plasma-mass spectrometry metals	6 months
7060 (SW-846)	Arsenic	6 months
7196 (SW-846)	Hexavalent chromium	24 hours
7421 (SW-846)	Lead	6 months
7470 (SW-846)	Mercury	28 days
8015M (SW-846)	Total petroleum hydrocarbons	14 days
8040 (SW-846)	Phenols	7 days before extraction; 40 days after extraction
8081 (SW-846)	Pesticides	7 days before extraction; 40 days after extraction
8082 (SW-846)	Polychlorinated biphenyls	7 days before extraction; 40 days after extraction
8260 (SW-846)	Volatile organics	14 days
8270 (SW-846)	Semivolatile organics	7 days before extraction; 40 days after extraction
9012 (SW-846)	Cyanide	14 days
9020 (SW-846)	Total organic halides	28 days
9030 (SW-846)	Sulfides	7 days
9060 (SW-846)	Total organic carbon	28 days
9223 (APHA/AWWA/WEF)	Coliform	24 hours

**Table C-12. Summary of TestAmerica Performance Evaluation Studies.**

<b>Accreditation Laboratory, Environmental Resource Associates</b>			
	WP-156 March 2008	WP-161 August 2008	WP-162 September 2008
TA St. Louis	519/524 <sup>a</sup>	480/489 <sup>b</sup>	66/74 <sup>c</sup>
<b>DOE Mixed Analyte Performance Evaluation Program Radiological and Environmental Sciences Laboratory</b>			
	MAPEP-07-OrW18 February 2008	MAPEP-07-GrW18 February 2008	MAPEP-07-MaW18 February 2008
TA St. Louis	68/69 <sup>d</sup>	—	34/35 <sup>e</sup>
TA Richland	—	2/2	15/15
<b>ERA InterLaB RadChem Proficiency Testing Program Environmental Resource Associates</b>			
	RAD-71 December 2007	RAD-72 March 2008	
TA St. Louis	14/16 <sup>f</sup>	—	
TA Richland	—	14/14	
<sup>a</sup> Unacceptable results were for nitrate as N, nitrite as N, acidity as CaCO <sub>3</sub> , cyanide (total), and TPH (Gravimetric). <sup>b</sup> Unacceptable results were for Aroclor 1016, Aroclor 1242, dacthal diacid (DCPA), ammonia as N, ortho-phosphate as P, cobalt (2), alkalinity as CaCO <sub>3</sub> (2). <sup>c</sup> Unacceptable results were for total organic halides (3), benzene in gasoline range organics (2), benzene, ethylbenzene, toluene. <sup>d</sup> Unacceptable results were for hexachlorobenzene. <sup>e</sup> Unacceptable results were for tritium (reported as Hydrogen-3). <sup>f</sup> Unacceptable results were for cobalt-60 and gross alpha.			

**Table C-13. Summary of WSCF Performance Evaluation Studies.**

<b>Accreditation Laboratory, Environmental Resource Associates</b>			
	WP-156 March 2008	WP-162 September 2008	QuiK™ Response 022808A March 2008
WSCF	86/86	86/86	2/2
<b>DOE Mixed Analyte Performance Evaluation Program Radiological and Environmental Sciences Laboratory</b>			
	MAPEP-07-OrW18 February 2008	MAPEP-07-GrW18 February 2008	MAPEP-07-MaW18 February 2008
WSCF	57/57	2/2	23/31 <sup>a</sup>
<b>ERA InterLaB RadChem Proficiency Testing Program Environmental Resource Associates</b>			
	RAD-72 March 2008		
WSCF	3/7 <sup>b</sup>		
<sup>a</sup> Unacceptable results were for americium-241, cobalt-57, cobalt-60, manganese-54, plutonium-238, uranium-234/233, uranium-238, zinc-65. <sup>b</sup> Unacceptable results were for radium-226 (2), natural uranium (2). WP = water pollution.			

**Table C-14. Summary of Eberline and Lionville Performance Evaluation Studies.**

<b>DOE Mixed Analyte Performance Evaluation Program Radiological and Environmental Sciences Laboratory</b>			
	MAPEP-07-OrW18 February 2008	MAPEP-07-GrW18 February 2008	MAPEP-07-MaW18 February 2008
Eberline	—	2/2	—
Lionville	57/57	—	15/15
<b>ERA InterLaB RadChem Proficiency Testing Program Environmental Resource Associates</b>			
	RAD-72 March 2008	RAD-74 September 2008	
Eberline	14/14	12/14*	
* Unacceptable results were for strontium-89 and radium-228.			

**Table C-15. Summary of TestAmerica Laboratories Double-Blind Spike Determinations.**

Constituent	Laboratory	Sample Frequency	Number of Results Reported <sup>a</sup>	Number of Results Outside QC Limits	Acceptable Results	Control Limits <sup>b</sup> (%)
<b>General Chemical Parameters</b>						
Specific conductance	St. Louis	Quarterly	12	0	100%	±25
Total organic carbon (potassium hydrogen phthalate spike)	St. Louis	Quarterly	16	0	100%	±25
Total organic halides (2,4,5-trichlorophenol spike)	St. Louis	Semiannually	7	4	43%	±25
Total organic halides (carbon tetrachloride, chloroform, and trichloroethene spike)	St. Louis	Semiannually	7	1	86%	±25
<b>Ammonia and Anions</b>						
Chloride	St. Louis	Quarterly	12	0	100%	±25
Cyanide	St. Louis	Semiannually	6	0	100%	±25
Fluoride	St. Louis	Quarterly	12	1	92%	±25
Nitrate as Nitrogen	St. Louis	Quarterly	9	2	78%	±25
Nitrite as Nitrogen	St. Louis	Quarterly	12	0	100%	±25
<b>Metals</b>						
Arsenic	St. Louis	Annually	3	0	100%	±20
Barium	St. Louis	Annually	3	1	67%	±20
Cadmium	St. Louis	Semiannually	6	1	83%	±20
Chromium (total)	St. Louis	Quarterly	12	1	92%	±20
Cobalt	St. Louis	Semiannually	6	0	100%	±20
Copper	St. Louis	Semiannually	6	0	100%	±20
Hexavalent chromium	Richland	Quarterly	9	0	100%	±20
Iron	St. Louis	Semiannually	6	0	100%	±20
Magnesium	St. Louis	Annually	3	0	100%	±20
Manganese	St. Louis	Annually	3	0	100%	±20
Nickel	St. Louis	Annually	3	0	100%	±20
Potassium	St. Louis	Annually	3	0	100%	±20
Silver	St. Louis	Annually	3	0	100%	±20
Sodium	St. Louis	Annually	3	0	100%	±20
Vanadium	St. Louis	Annually	3	0	100%	±20
Zinc	St. Louis	Annually	3	0	100%	±20
<b>Volatile Organic Compounds</b>						
Carbon tetrachloride	St. Louis	Quarterly	12	3	75%	±25
Chloroform	St. Louis	Semiannually	6	1	83%	±25
Trichloroethene	St. Louis	Quarterly	12	1	92%	±25

Table C-15. (cont.)

Constituent	Laboratory	Sample Frequency	Number of Results Reported <sup>a</sup>	Number of Results Outside QC Limits	Acceptable Results	Control Limits <sup>b</sup> (%)
<b>Radiological Parameters</b>						
Gross alpha (plutonium-239 spike)	Richland	Quarterly	12	1	92%	±30
Gross beta (strontium-90 spike)	Richland	Quarterly	15	0	100%	±30
Cesium-137	Richland	Semiannually	6	0	100%	±30
Cobalt-60	Richland	Semiannually	6	0	100%	±30
Iodine-129	Richland	Semiannually	6	2	67%	±30
Neptunium-237	Richland	Annually	3	0	100%	±30
Plutonium-239	Richland	Quarterly	12	0	100%	±30
Strontium-90	Richland	Annually	3	0	100%	±30
Technetium-99	Richland	Quarterly	12	0	100%	±30
Tritium	Richland	Semiannually	6	0	100%	±30
Uranium-238	Richland	Quarterly	12	1	92%	±30
<sup>a</sup> Blind standards were generally submitted in triplicate or quadruplicate. <sup>b</sup> Each result must be within the specified percentage of the known value to be acceptable.						

**Table C-16. Summary of WSCF Double-Blind Spike Determinations.**

Constituent	Sample Frequency	Number of Results Reported <sup>a</sup>	Number of Results Outside QC Limits	Acceptable Results	Control Limits <sup>b</sup> (%)
<b>General Chemical Parameters</b>					
Specific conductance	Quarterly	12	0	100%	±25
Total organic carbon (potassium hydrogen phthalate spike)	Quarterly	16	0	100%	±25
Total organic halides (2,4,5-trichlorophenol spike)	Semiannually	7	0	100%	±25
Total organic halides (carbon tetrachloride, chloroform, and trichloroethene spike)	Semiannually	7	3	57%	±25
<b>Ammonia and Anions</b>					
Chloride	Quarterly	12	0	100%	±25
Cyanide	Semiannually	6	0	100%	±25
Fluoride	Quarterly	12	0	100%	±25
Nitrate as Nitrogen	Quarterly	9	0	100%	±25
Nitrite as Nitrogen	Quarterly	12	0	100%	±25
<b>Metals</b>					
Arsenic	Annually	3	1	67%	±20
Barium	Annually	3	1	67%	±20
Cadmium	Semiannually	6	1	83%	±20
Chromium (total)	Quarterly	12	1	92%	±20
Cobalt	Semiannually	6	1	83%	±20
Copper	Semiannually	6	1	83%	±20
Hexavalent chromium	Quarterly	9	0	100%	±20
Iron	Semiannually	6	0	100%	±20
Magnesium	Annually	3	0	100%	±20
Manganese	Annually	3	0	100%	±20
Nickel	Annually	3	0	100%	±20
Potassium	Annually	3	0	100%	±20
Silver	Annually	3	0	100%	±20
Sodium	Annually	3	0	100%	±20
Vanadium	Annually	3	0	100%	±20
Zinc	Annually	3	0	100%	±20
<b>Volatile Organic Compounds</b>					
Carbon tetrachloride	Quarterly	12	3	75%	±25
Chloroform	Semiannually	6	1	83%	±25

Table C-16. (cont.)

Constituent	Sample Frequency	Number of Results Reported <sup>a</sup>	Number of Results Outside QC Limits	Acceptable Results	Control Limits <sup>b</sup> (%)
Trichloroethene	Quarterly	12	9	25%	±25
<b>Radiological Parameters</b>					
Gross alpha (plutonium-239 spike)	Quarterly	12	1	92%	±30
Gross beta (strontium-90 spike)	Quarterly	15	2	87%	±30
Cesium-137	Semiannually	6	0	100%	±30
Cobalt-60	Semiannually	6	0	100%	±30
Neptunium-237	Annually	3	0	100%	±30
Plutonium-239	Quarterly	12	0	100%	±30
Strontium-90	Annually	3	0	100%	±30
Technetium-99	Quarterly	18	2	89%	±30
Tritium	Annually	3	0	100%	±30
Uranium-238	Quarterly	12	0	100%	±30
<sup>a</sup> Blind standards were generally submitted in triplicate or quadruplicate. <sup>b</sup> Each result must be within the specified percentage of the known value to be acceptable.					

**Table C-17. Summary of Lionville Laboratory, Inc. and Eberline Services Double-Blind Spike Determinations.**

Constituent	Laboratory	Sample Frequency	Number of Results Reported <sup>a</sup>	Number of Results Outside QC Limits	Acceptable Results	Control Limits <sup>b</sup> (%)
<b>General Chemical Parameters</b>						
Total organic carbon (potassium hydrogen phthalate spike)	Lionville	Quarterly	16	9	44%	±25
<b>Ammonia and Anions</b>						
Chloride	Lionville	Quarterly	12	3	75%	±25
Fluoride	Lionville	Quarterly	9	0	100%	±25
Nitrate as Nitrogen	Lionville	Quarterly	6	0	100%	±25
Nitrite as Nitrogen	Lionville	Quarterly	9	4	56%	±25
<b>Radiological Parameters</b>						
Gross beta (strontium-90 spike)	Eberline	Quarterly	12	0	100%	±30
<sup>a</sup> Blind standards were generally submitted in triplicate or quadruplicate. <sup>b</sup> Each result must be within the specified percentage of the known value to be acceptable.						

**Table C-18. Percentage of Out-of-Limit Quality Control Results by Category, TestAmerica Laboratories (Richland and St. Louis).**

QC Parameter	General Chemistry Parameters	Ammonia and Anions	Metals	VOC	SVOC	Radiological Parameters	Total
Method Blanks	0.0	2.9	1.9	0.6	0.0	0.1	0.6
Lab Control Samples	0.0	1.4	0.1	1.7	2.2	0.4	0.9
Matrix Spikes	1.5	13.5	3.0	5.1	7.5	6.4	5.3
Matrix Duplicates	0.0	0.7	1.3	0.0	0.0	0.1	0.2
Surrogates	—	—	—	1.4	1.8	—	1.6
QC = quality control. Total = total number of QC out-of-limits divided by the total number of QC multiplied by 100. SVOC = semivolatile organic compounds. VOC = volatile organic compounds.							

**Table C-19. Percentage of Out-of-Limit Quality Control Results by Category, WSCF.**

QC Parameter	General Chemistry Parameters	Ammonia and Anions	Metals	VOC	SVOC	Radiological Parameters	Total
Method Blanks	0.0	0.0	5.2	1.2	0.0	0.1	2.0
Lab Control Samples	0.6	0.0	0.1	0.4	0.0	1.6	0.1
Matrix Spikes	2.6	2.0	6.9	1.1	0.7	9.9	4.5
Matrix Duplicates	0.0	0.4	1.1	0.0	0.0	1.4	0.6
Surrogates	—	—	—	0.0	1.8	—	0.3
QC = quality control. Total = total number of QC out-of-limits divided by the total number of QC multiplied by 100. SVOC = semivolatile organic compounds. VOC = volatile organic compounds.							

**Table C-20. Laboratory Control Samples, TestAmerica Laboratories (Richland and St. Louis).**

Constituent	Percent Out of Limit	Number of Analyses
<b>General Chemistry Parameters</b>		
Total General Chemistry Parameters	0.0	120
<b>Ammonia and Anions</b>		
Total Ammonia and Anions	1.4	145
Cyanide	12.5	16
<b>Metals</b>		
Total Metals	0.1	948
Zinc	2.2	45
<b>Volatile Organic Compounds</b>		
Total Volatile Organic Compounds	1.7	1,459
1,4-Dioxane	5.4	37
1-Butanol	2.6	39
Acetone	2.6	39
Acrolein	6.3	16
Allyl chloride	6.7	15
Bromomethane	35.7	14
Carbon tetrachloride	5.0	40
Chloroethane	6.7	15
Chloroform	2.6	39
cis-1,3-Dichloropropene	6.3	16
Dichlorodifluoromethane	6.3	16
Ethyl acetate	20.0	5
Iodomethane	6.3	16
Methacrylonitrile	6.3	16
Methylene chloride	5.1	39
Trichloroethene	5	40
Vinyl chloride	2.6	39
<b>Semivolatile Organic Compounds</b>		
Total Semivolatile Organic Compounds	2.2	721
Aroclor-1016	25.0	4
2,4-Dinitrophenol	50.0	4
Anthracene	33.3	3
Benzo(a)anthracene	33.3	3
Benzo(a)pyrene	33.3	3
Benzo(b)fluoranthene	33.3	3
Benzo(k)fluoranthene	33.3	3
Bis(2-ethylhexyl) phthalate	11.1	9
Butylbenzylphthalate	33.3	3
Chrysene	33.3	3
Di-n-octylphthalate	33.3	3
Fluoranthene	33.3	3

Table C-20. (cont.)

Constituent	Percent Out of Limit	Number of Analyses
Hexachlorobenzene	33.3	3
Phenanthrene	33.3	3
Pyrene	33.3	3
<b>Radiological Parameters</b>		
Total Radiochemistry Parameters	0.4	803
Tritium	4.8	42
Uranium-235	25.0	4

Table C-21. Laboratory Control Samples, WSCF.

Constituent	Percent Out of Limit	Number of Analyses
<b>General Chemistry Parameters</b>		
Total General Chemistry Parameters	0.6	328
TPH - gasoline range	12.5	16
<b>Ammonia and Anions</b>		
Total Ammonia and Anions	0.0	1,994
<b>Metals</b>		
Total Metals	0.1	3,611
Mercury	13.3	15
Potassium	0.6	179
Strontium	0.6	179
<b>Volatile Organic Compounds</b>		
Total Volatile Organic Compounds	0.4	503
1,1-Dichloroethene	1.0	96
Trichloroethene	1.0	96
<b>Semivolatile Organic Compounds</b>		
Total Semivolatile Organic Compounds	0.0	223
<b>Radiological Parameters</b>		
Total Radiochemistry Parameters	1.6	444
Neptunium-237	18.2	11
Plutonium-239/240	6.7	15
Total beta radiostrontium	4.2	24
Tritium	2.8	107
TPH = total petroleum hydrocarbons.		

**Table C-22. Matrix Spikes and Matrix Spike Duplicates,  
TestAmerica Laboratories (Richland and St. Louis).**

Constituent	Percent Out of Limit	Number of Analyses
<b>General Chemistry Parameters</b>		
Total General Chemistry Parameters	1.5	137
Specific Conductance	20.0	5
Total organic carbon	2.1	48
<b>Ammonia and Anions</b>		
Total Ammonia and Anions	13.5	141
Chloride	8.7	23
Fluoride	4.3	23
<b>Metals</b>		
Total Metals	3.0	1,987
Antimony	2.3	86
Beryllium	2.3	86
Cadmium	1.2	86
Calcium	7.0	86
Sodium	3.5	86
Strontium	3.5	86
Cadmium	16.7	6
Silicon	50.0	6
Silver	33.3	6
Vanadium	50.0	6
Zinc	16.7	6
Hexavalent Chromium	9.2	153
<b>Volatile Organic Compounds</b>		
Total Volatile Organic Compounds	5.1	3,384
1,2-Dichloroethene (Total)	5.3	38
1,3,5-Trimethylbenzene	50.0	4
1,4-Dioxane	15.5	84
1-Butanol	23.3	90
2-Butanone	13.3	90
2-Chloroethyl vinyl ether	100.0	2
Carbon disulfide	4.5	88
Carbon tetrachloride	2.4	82
Chloroethane	11.1	36
Chloromethane	5.3	38
Chloroprene	10.5	38
Dichlorodifluoromethane	10.5	38
Ethyl acetate	33.3	12
Ethyl cyanide	6.7	90
Iodomethane	28.9	38
Isobutyl alcohol	10.5	38
Methacrylonitrile	10.5	38
Methylene chloride	7.8	90
Styrene	5.3	38
Tetrahydrofuran	2.2	90
trans-1,2-Dichloroethylene	2.2	90
Trichloroethene	2.2	90

Table C-22. (cont.)

Constituent	Percent Out of Limit	Number of Analyses
Trichloromonofluoromethane	2.6	38
Vinyl acetate	21.1	38
Vinyl chloride	4.4	90
<b>Semivolatile Organic Compounds</b>		
Total Semivolatile Organic Compounds	7.5	1,474
2,3,4,6-Tetrachlorophenol	12.5	48
2,4,5-Trichlorophenol	12.5	48
2,4,6-Trichlorophenol	12.5	48
2,4-Dichlorophenol	12.5	48
2,4-Dimethylphenol	8.3	48
2,4-Dinitrophenol	12.5	48
2,6-Dichlorophenol	12.5	48
2-Chlorophenol	8.3	48
<b>Radiological Parameters</b>		
Total Radiochemistry Parameters	6.4	78
Uranium	25.0	16

**Table C-23. Matrix Spikes and Matrix Spike Duplicates, WSCF.**

Constituent	Percent Out of Limit	Number of Analyses
<b>General Chemistry Parameters</b>		
Total General Chemistry Parameters	2.6	608
Total organic halides	2.5	200
Total organic carbon	2.5	314
TPH - gasoline range	9.4	32
<b>Ammonia and Anions</b>		
Total Ammonia and Anions	2	3,940
Chloride	3.4	740
Fluoride	0.4	744
Nitrogen in Nitrate	2.1	750
Nitrogen in Nitrite	1.3	742
Phosphorus in phosphate	3.5	86
Sulfate	1.6	742
Cyanide	11.5	96
<b>Metals</b>		
Total Metals	6.9	6,894
Arsenic	0.8	126
Uranium	4.1	148
Calcium	79.1	244
Chromium	0.3	354
Cobalt	0.3	354
Copper	0.3	356
Iron	1.1	350
Magnesium	46.7	244
Potassium	1.4	350
Silver	2.2	356
Sodium	53.3	246
Strontium	0.6	350
Hexavalent Chromium	1.8	330
<b>Volatile Organic Compounds</b>		
Total Volatile Organic Compounds	1.1	978
1,1-Dichloroethene	1.6	186
Benzene	1.1	186
Chlorobenzene	1.1	186
Toluene	1.1	186
Trichloroethene	1.1	186
<b>Semivolatile Organic Compounds</b>		
Total Semivolatile Organic Compounds	0.7	446
Pentachlorophenol	4.8	42

**Table C-23. (cont.)**

Constituent	Percent Out of Limit	Number of Analyses
<b>Radiological Parameters</b>		
Total Radiochemistry Parameters	9.9	202
Technetium-99	27.0	63
Tritium	2.8	106
TPH = total petroleum hydrocarbons.		

**Table C-24. Matrix Duplicates, TestAmerica Laboratories (Richland and St. Louis).**

Constituent	Percent Out of Limit	Number of Analyses
<b>General Chemistry Parameters</b>		
Total General Chemistry Parameters	0.0	109
<b>Ammonia and Anions</b>		
Total Ammonia and Anions	0.7	141
Fluoride	4.3	23
<b>Metals</b>		
Total Metals	1.3	78
Hexavalent Chromium	1.3	78
<b>Volatile Organic Compounds</b>		
Total Volatile Organic Compounds	0.0	0
<b>Semivolatile Organic Compounds</b>		
Total Semivolatile Organic Compounds	0.0	0
<b>Radiological Parameters</b>		
Total Radiochemistry Parameters	0.1	1,354
Gross alpha	1.5	68
Uranium-234	3.6	28

**Table C-25. Method Blank Results, TestAmerica Laboratories (Richland and St. Louis).**

Constituent	Percent Out of Limit <sup>a</sup>	Number of Analyses	Concentration Range of Out-of-Limit Results
<b>General Chemistry Parameters</b>			
Total General Chemistry Parameters	0.0	120	—
<b>Ammonia and Anions</b>			
Total Ammonia and Anions	2.9	137	—
Chloride	18.2	22	0.042 – 0.086 mg/L
<b>Metals</b>			
Total Metals	1.9	950	—
Antimony	4.5	44	2.2 – 15.7 µg/L
Barium	2.4	42	1.8 µg/L
Beryllium	2.4	42	1.8 µg/L
Cadmium	2.4	42	1.6 µg/L
Calcium	11.9	42	42.8 – 308 µg/L
Copper	2.4	42	43.9 µg/L
Iron	4.5	44	65.7 – 93.1 µg/L
Manganese	2.4	42	2.2 µg/L
Nickel	2.4	42	49.9 µg/L
Sodium	2.4	42	271 µg/L
Strontium	2.4	42	3 µg/L
Hexavalent Chromium	1.3	77	0.025 mg/L
<b>Volatile Organic Compounds</b>			
Total Volatile Organic Compounds	0.6	1,528	—
1,4-Dioxane	2.7	37	86 µg/L
Acetone <sup>b</sup>	2.6	39	3.1 µg/L
Bromomethane	7.1	14	0.45 µg/L
Carbon disulfide	2.6	38	0.44 µg/L
Chloroform	5.1	39	0.24 – 0.3 µg/L
Chloromethane	5.9	17	0.13 µg/L
Methylene chloride <sup>b</sup>	2.6	39	0.48 µg/L
Styrene	6.3	16	0.43 µg/L
<b>Semivolatile Organic Compounds</b>			
Total Semivolatile Organic Compounds	0.0	979	—
<b>Radiological Parameters</b>			
Total Radiochemistry Parameters	0.1	1,392	—
Technetium-99	2.9	34	12.3 pCi/L
<sup>a</sup> Quality control limits are twice the method detection limit. <sup>b</sup> Quality control limits are five times the method detection limit.			

**Table C-26. Matrix Duplicates, WSCF.**

Constituent	Percent Out of Limit	Number of Analyses
<b>General Chemistry Parameters</b>		
Total General Chemistry Parameters	0.0	90
<b>Ammonia and Anions</b>		
Total Ammonia and Anions	0.4	1,922
Fluoride	1.1	372
Nitrogen in Nitrite	0.5	371
Phosphorus in phosphate	2.3	43
<b>Metals</b>		
Total Metals	1.1	176
Hexavalent Chromium	1.1	176
<b>Volatile Organic Compounds</b>		
Total Volatile Organic Compounds	0.0	23
<b>Semivolatile Organic Compounds</b>		
Total Semivolatile Organic Compounds	0.0	0
<b>Radiological Parameters</b>		
Total Radiochemistry Parameters	1.4	724
Gross alpha	1.6	63
Gross beta	9.6	73
Tritium	1.9	106

**Table C-27. Summary of Issue Resolution Forms, FY 2008.**

Issue Category	Number of Analyses Impacted		
	Prior to Receipt at the Laboratory	After Receipt at the TA Laboratory*	After Receipt at the WSCF Laboratory
Hold Time Missed	50	4	109
Broken Bottles	9	—	—
Late analysis	—	50	—
Temperature Deviation	54	1	22
Bottle Size/Type (insufficient volume or headspace)	12	9	—
Chain-of-Custody Form Issues	39	—	2
Laboratory QC Out of Limits/Incomplete		39	—
Incorrect Preservation of the Sample	58	—	—
Analytical Preparation Deviations	—	2	4
Method Failures/Discontinued Analyses	—	—	—
Total	222	105	137
*Includes data from TA St. Louis and TA Richland. QC = quality control. SDG = sample delivery group.			

**Table C-28. Laboratory Audits and Assessment Results.**

Laboratory	Findings	Observations	Summary of Findings
<b>Audit Results</b>			
TestAmerica, Inc., Richland, WA	1	2	Balance check weights not bracketing expected sample weight range.
Eberline Services, Richmond, CA	11	11	No formal documentation for detectors Counting gas changes for GPC not documented Gamma spec. efficiencies not calibrated for varying densities and no software density corrections Gamma spec. checks performed weekly instead of daily MCA and amplifier checks for gamma spec. not documented Background counts for NaI gamma spec. performed weekly instead of by batch Glassware not acid cleaned for low-level uranium analysis by KPA MS not analyzed for all samples for KPA analysis No acceptance criteria for KPA sample analysis No SOP for Ni-63 methodology No policy or direction on waste brokering and TSDF for waste disposal
Lionville Laboratory, Inc., Lionville, PA	3	4	Multiple active SOPs had "draft" status No SOP calibration protocols for reference standard weight sets IECs were not performed semi-annually
TestAmerica, Inc., St. Louis	3	14	Acceptable PT results not achieved for Sb in soil SOPs not accurate for current lab activities Routine bioassays not performed as defined in procedure.
<b>Assessment Results</b>			
Waste Sampling and Characterization Facility, Hanford Site	3	4	Tritium LCS concentration outside range specified by procedure No I-125 standard prep. Verification HASQARD standard/reagent labeling requirements not met.

**Table C-29. Summary of Analytical Laboratory Detection/Quantitation Limits Determined from Field Blanks Data, Severn Trent Laboratories (Richland and St. Louis) and WSCF.**

Period <sup>a</sup>	Number of Samples	Mean	Standard Deviation	Limit of Detection	Limit of Quantitation
<b>Constituent: Total Organic Carbon (µg/L)</b>					
1/18/06 - 11/7/06	58 <sup>b</sup>	265.0	207.0	620 <sup>c</sup>	2,070 <sup>c</sup>
5/15/06 - 2/20/07	49	250.1	234.3	700	2,340
7/21/06 - 6/28/07	63	119.5	145.3	436	1,450
10/3/06 - 9/12/07	65	113.4	143.3	430	1,430
Summary	65	113.4	143.3	430	1,430
<b>Constituent: Total Organic Halides (µg/L)</b>					
1/18/06 - 12/18/06	55 <sup>b</sup>	1.53	2.26	6.8 <sup>c</sup>	22.6 <sup>c</sup>
5/15/06 - 2/13/07	48 <sup>b</sup>	0.91	1.30	3.9	13.0
7/21/06 - 6/23/07	59	1.85	2.25	6.8	22.5
10/3/06 - 9/12/07	60 <sup>b</sup>	2.23	2.29	6.9	22.9
Summary	60 <sup>b</sup>	2.23	2.29	6.9	22.9
<b>Constituent: Cesium-137 (pCi/L)</b>					
11/17/06 - 11/28/06	3	0.27	1.02	3.06 <sup>c</sup>	10.18 <sup>c</sup>
1/10/07 - 2/23/07	2	0.7	0.09	0.28	0.94
4/5/07 - 6/23/07	9	0.37	1.08	3.23	10.77
9/7/07 - 9/30/07	4	-0.09	0.41	1.22	4.05
Summary	18	0.28	0.92	2.76	9.2
<b>Constituent: Cobalt-60 (pCi/L)</b>					
11/17/06 - 11/28/06	3	0.91	1.38	4.13 <sup>c</sup>	13.77 <sup>c</sup>
1/10/07 - 2/23/07	2	-0.43	0.37	1.10	3.66
4/5/07 - 6/23/07	9	0.05	0.78	2.34	7.8
9/7/07 - 9/30/07	4	0.46	0.34	1.03	3.44
Summary	18	0.23	0.81	2.43	8.08
<b>Constituent: Europium-152 (pCi/L)</b>					
11/17/06 - 11/28/06	3	-3.67	1.99	5.96 <sup>c</sup>	19.86 <sup>c</sup>
1/10/07 - 2/23/07	2	-0.94	1.12	3.36	11.21
4/5/07 - 6/23/07	9	-0.13	1.68	5.03	16.77
9/7/07 - 9/30/07	4	-0.63	1.88	5.64	18.81
Summary	18	-0.92	1.74	5.21	17.37
<b>Constituent: Europium-154 (pCi/L)</b>					
11/17/06 - 11/28/06	3	-1.29	4.20	12.61 <sup>c</sup>	42.04 <sup>c</sup>
1/10/07 - 2/23/07	2	-0.73	0.99	2.96	9.86
4/5/07 - 6/23/07	9	1.29	4.20	12.60	42.01
9/7/07 - 9/30/07	4	-1.75	1.21	3.62	12.06
Summary	18	-0.04	3.60	10.81	36.04
<b>Constituent: Europium-155 (pCi/L)</b>					
11/17/06 - 11/28/06	3	-1.41	3.40	10.21 <sup>c</sup>	34.03 <sup>c</sup>
1/10/07 - 2/23/07	2	-0.63	0.06	0.17	0.57
4/5/07 - 6/23/07	9	0.24	1.99	5.98	19.92
9/7/07 - 9/30/07	4	-0.07	1.08	3.24	10.80

Table C-29. (cont.)

Period <sup>a</sup>	Number of Samples	Mean	Standard Deviation	Limit of Detection	Limit of Quantitation
Summary	18	-0.20	2.04	6.13	20.43
<b>Constituent: Gross Alpha (pCi/L)</b>					
10/26/06 - 12/22/06	9	0.01	0.33	0.98 <sup>c</sup>	3.26 <sup>c</sup>
1/5/07 - 2/23/07	7	0.41	0.39	1.16	3.87
4/19/07 - 6/28/07	13	0.11	0.21	0.64	2.13
9/6/07 - 9/30/07	7	0.19	0.22	0.67	2.25
Summary	36	0.16	0.28	0.85	2.85
<b>Constituent: Gross Beta (pCi/L)</b>					
10/26/06 - 12/22/06	9 <sup>b</sup>	0.74	0.67	2.02 <sup>c</sup>	6.74 <sup>c</sup>
1/5/07 - 2/23/07	8	1.14	1.10	3.29	10.96
4/16/07 - 6/28/07	14 <sup>b</sup>	0.85	0.94	2.81	9.37
7/10/07 - 9/30/07	8	0.78	0.82	2.46	8.19
Summary	39 <sup>b</sup>	0.87	0.90	2.69	8.97
<b>Constituent: Iodine-129 (pCi/L)</b>					
10/3/06 - 11/17/06	4	-0.02	0.09	0.26 <sup>c</sup>	0.87 <sup>c</sup>
1/5/07 - 2/23/07	4	-0.02	0.06	0.18	0.61
4/16/07 - 6/22/07	7	0.04	0.11	0.33	1.11
9/12/07 - 9/30/07	2	-0.10	0.14	0.41	1.38
Summary	17	-0.01	0.10	0.30	0.99
<b>Constituent: Strontium-90 (pCi/L)</b>					
10/12/06 - 12/11/06	5	-0.10	0.14	0.42 <sup>c</sup>	1.41 <sup>c</sup>
1/9/07 - 1/10/07	2	0.24	0.05	0.15	0.49
4/5/07 - 8/24/07	8 <sup>b</sup>	0.10	0.17	0.51	1.69
Summary	15	0.05	0.16	0.48	1.60
<b>Constituent: Technetium-99 (pCi/L)</b>					
10/3/06 - 11/21/06	9	-0.27	3.31	9.94 <sup>c</sup>	33.1 <sup>c</sup>
1/5/07 - 3/29/07	10	0.03	1.58	4.73	15.8
4/16/07 - 6/28/07	12	0.81	2.41	7.24	24.1
8/7/07 - 9/16/07	5	-3.19	2.42	7.25	24.2
Summary	36	-0.23	2.49	7.46	24.9
<b>Constituent: Technetium-99, Low-Level Method (pCi/L)</b>					
11/10/06 - 9/28/07	4	9.54	9.39	28.2 <sup>c</sup>	93.9 <sup>c</sup>
<b>Constituent: Tritium (pCi/L)</b>					
10/3/06 - 12/22/06	10	115.3	88.7	266 <sup>c</sup>	887 <sup>c</sup>
1/10/07 - 2/23/07	11	63.9	109.7	329	1,097
4/9/07 - 6/22/07	13 <sup>b</sup>	40.3	94.2	283	942
8/7/07 - 9/12/07	7	43.9	50.4	151	504
Summary	41	65.5	90.8	272	908

Table C-29. (cont.)

Period <sup>a</sup>	Number of Samples	Mean	Standard Deviation	Limit of Detection	Limit of Quantitation
<b>Constituent: Tritium, Low-Level Method (pCi/L)</b>					
12/27/06 - 1/12/07	3	99.5	7.1	21.3 <sup>c</sup>	70.9 <sup>c</sup>
4/25-07 - 6/15/07	2	52.6	16.6	49.9	166.2
9/17/07 - 9/30/07	3	62.7	6.3	18.8	62.6
Summary	8	74.0	9.5	28.6	95.4
<b>Constituent: Uranium (µg/L)</b>					
10/3/06 - 12/27/06	11	0.001	0.008	0.026 <sup>d</sup>	0.084 <sup>d</sup>
1/5/07 - 3/29/07	6	-0.004	0.008	0.019	0.073
4/16/07 - 6/23/07	7	-0.007	0.015	0.038	0.142
8/24/07 - 9/17/07	2	-0.002	0.003	0.006	0.026
Summary	26	-0.002	0.010	0.028	0.100
<sup>a</sup> Time period covered for total organic carbon and total organic halides is a moving average of four quarters. <sup>b</sup> Excluded outliers. <sup>c</sup> Limit of detection (blank corrected) equals 3 times the blank standard deviation; limit of quantitation (blank corrected) equals 10 times the blank standard deviation. Numbers are rounded. <sup>d</sup> Limit of detection equals the mean blank concentration plus 3 standard deviations; limit of quantitation equals the mean blank concentration plus 10 standard deviations. Numbers are rounded.					

Table C-30. Summary of Detection and Quantitation Limits, WSCF.

Method	Constituent	Initial MDL <sup>a</sup> (µg/L)	Initial LOD (µg/L)	Initial LOQ (µg/L)	Ending Values, Effective Date	Ending MDL <sup>a</sup> (µg/L)	Ending LOD (µg/L)	Ending LOQ (µg/L)
<b>General Chemical Parameters</b>								
EPA-600/R-93/100, 120.1	Conductivity <sup>b</sup>	0.49	0.66	2.21				
EPA-600/R-93/100, 310.1	Alkalinity	1000	1350	4503				
<b>Ammonia and Anions</b>								
EPA-600/R-93/100, 300.0	Chloride	30	41	135	7/22/2008	47	63	212
EPA-600/R-93/100, 300.0	Fluoride	6	8	27	7/22/2008	23	31	104
EPA-600/R-93/100, 300.0	Nitrate	22.1	30	100	7/22/2008	53.1	72	239
EPA-600/R-93/100, 300.0	Nitrite	32.8	44	148	7/22/2008	42.7	58	192
EPA-600/R-93/100, 300.0	Phosphate	123	166	554				
EPA-600/R-93/100, 300.0	Sulfate	70	95	315	7/22/2008	130	176	585
EPA-600/R-93/100, 300.7	Ammonium	12	16.2	54.0				
EPA-600/R-93/100, 335.2	Cyanide	4	5.4	18.0				
<b>Metals</b>								
SW-846, 6010	Aluminum	30	40.5	135.1	7/18/2008	52	70	234
SW-846, 6010	Antimony	32	43	144	7/1/2008	56	76	252
SW-846, 6010	Barium	4	5.4	18.0				
SW-846, 6010	Beryllium	4	5.40	18.01				
SW-846, 6010	Cadmium	4	5	18				
SW-846, 6010	Calcium	34	46	153	7/1/2008	73	99	329
SW-846, 6010	Chromium	4	5	18	7/1/2008	13	17.6	58.5
SW-846, 6010	Cobalt	4	5	18				
SW-846, 6010	Copper	4	5.4	18.0	7/1/2008	6	8.1	27.0
SW-846, 6010	Iron	9	12.2	40.5	7/1/2008	25	34	113
SW-846, 6010	Magnesium	6	8	27	7/1/2008	50	68	225
SW-846, 6010	Manganese	4	5.4	18.0				
SW-846, 6010	Nickel	4	5	18				
SW-846, 6010	Potassium	45	61	203	7/1/2008	170	230	766
SW-846, 6010	Silver	5	7	23				
SW-846, 6010	Sodium	27	36	122	7/1/2008	51	69	230
SW-846, 6010	Strontium (elemental)	4	5.4	18.0				
SW-846, 6010	Vanadium	7	9.5	31.5	7/1/2008	12	16.2	54.0
SW-846, 6010	Zinc	4	5.4	18.0	7/1/2008	9	12.2	40.5
EPA-600/R-94/111, 200.8	Aluminum	5	6.8	22.5				
EPA-600/R-94/111, 200.8	Antimony	0.3	0.4	1.4				
EPA-600/R-94/111, 200.8	Arsenic	0.4	0.5	1.8				
EPA-600/R-94/111, 200.8	Barium	0.2	0.3	0.9				
EPA-600/R-94/111, 200.8	Cadmium	0.1	0.1	0.5				
EPA-600/R-94/111, 200.8	Chromium	0.5	0.7	2.3				
EPA-600/R-94/111, 200.8	Cobalt	0.05	0.1	0.2				
EPA-600/R-94/111, 200.8	Copper	0.1	0.1	0.5				
EPA-600/R-94/111, 200.8	Lead	0.1	0.1	0.5				
EPA-600/R-94/111, 200.8	Manganese	0.1	0.1	0.5				
EPA-600/R-94/111, 200.8	Mercury	0.05	0.1	0.2				
EPA-600/R-94/111, 200.8	Nickel	0.2	0.3	0.9				
EPA-600/R-94/111, 200.8	Strontium (elemental)	0.1	0.1	0.5				
EPA-600/R-94/111, 200.8	Thallium	0.1	0.1	0.5				
EPA-600/R-94/111, 200.8	Uranium	0.05	0.1	0.2				
EPA-600/R-94/111, 200.8	Vanadium	0.2	0.3	0.9				

Table C-30. (cont.)

Method	Constituent	Initial MDL <sup>a</sup> (µg/L)	Initial LOD (µg/L)	Initial LOQ (µg/L)	Ending Values, Effective Date	Ending MDL <sup>a</sup> (µg/L)	Ending LOD (µg/L)	Ending LOQ (µg/L)
<b>Volatile Organic Compounds</b>								
SW-846, 8260	1,1,1-Trichloroethane	1	1.35	4.50				
SW-846, 8260	1,1,2-Trichloroethane	1	1.35	4.50				
SW-846, 8260	1,1-Dichloroethane	1	1.35	4.50				
SW-846, 8260	1,1-Dichloroethene	1	1.35	4.50				
SW-846, 8260	1,2-Dichloroethane	1	1.35	4.50				
SW-846, 8260	1,4-Dichlorobenzene	1	1.35	4.50				
SW-846, 8260	1-Butanol	100	135	450				
SW-846, 8260	2-Butanone	1	1.35	4.50				
SW-846, 8260	2-Pentanone, 4-Methyl	1	1.35	4.50				
SW-846, 8260	Acetone	1	1.35	4.50				
SW-846, 8260	Benzene	1	1.35	4.50				
SW-846, 8260	Carbon disulfide	1	1.35	4.50				
SW-846, 8260	Carbon tetrachloride	1	1.35	4.50				
SW-846, 8260	Chlorobenzene	1	1.35	4.50				
SW-846, 8260	Chloroform	1	1.35	4.50				
SW-846, 8260	cis-1,2-Dichloroethylene	1	1.35	4.50				
SW-846, 8260	Ethyl cyanide	2	2.70	9.01				
SW-846, 8260	Ethylbenzene	1	1.35	4.50				
SW-846, 8260	Methylene chloride	1	1.35	4.50				
SW-846, 8260	Tetrachloroethene	1	1.35	4.50				
SW-846, 8260	Tetrahydrofuran	2	2.70	9.01				
SW-846, 8260	Toluene	1	1.35	4.50				
SW-846, 8260	trans-1,2-Dichloroethylene	1	1.35	4.50				
SW-846, 8260	Trichloroethene	1	1.35	4.50				
SW-846, 8260	Vinyl chloride	1	1.35	4.50				
SW-846, 8260	Xylenes (total)	1	1.35	4.50				
SW-846, 8015	TPH, gasoline fraction	50	67.52	225.16				
<b>Semivolatile Organic Compounds</b>								
SW-846, 8015	TPH, diesel fraction <sup>c</sup>	71	96	320				
SW-846, 8015	TPH, kerosene fraction <sup>c</sup>	71	96	320				
SW-846, 8270	1,2,4-Trichlorobenzene <sup>c</sup>	2.1	3	9				
SW-846, 8270	1,4-Dichlorobenzene <sup>c</sup>	1.3	1.76	5.85				
SW-846, 8270	2,3,4,6-Tetrachlorophenol <sup>c</sup>	0.49	0.7	2.2				
SW-846, 8270	2,4,5-Trichlorophenol <sup>c</sup>	0.64	0.9	2.9				
SW-846, 8270	2,4,6-Trichlorophenol <sup>c</sup>	0.49	0.7	2.2				
SW-846, 8270	2,4-Dichlorophenol <sup>c</sup>	0.48	0.6	2.2				
SW-846, 8270	2,4-Dimethylphenol <sup>c</sup>	0.93	1.3	4.2				
SW-846, 8270	2,4-Dinitrophenol <sup>c</sup>	2	2.7	9.0				
SW-846, 8270	2,4-Dinitrotoluene <sup>c</sup>	0.48	0.6	2.2				
SW-846, 8270	2,6-Dichlorophenol <sup>c</sup>	0.59	0.8	2.7				
SW-846, 8270	2-Chlorophenol <sup>c</sup>	0.48	0.6	2.2				
SW-846, 8270	2-Methylphenol (cresol, o-) <sup>c</sup>	0.48	0.6	2.2				
SW-846, 8270	2-Nitrophenol	0.48	0.6	2.2				
SW-846, 8270	2-Picoline <sup>c</sup>	4.8	6.5	21.6				
SW-846, 8270	3+4-Methylphenol (cresol, m+p) <sup>c</sup>	0.48	0.6	2.2				
SW-846, 8270	4,6-Dinitro-2-methylphenol <sup>c</sup>	0.98	1.3	4.4				

Table C-30 (cont.)

Method	Constituent	Initial MDL <sup>a</sup> (µg/L)	Initial LOD (µg/L)	Initial LOQ (µg/L)	Ending Values, Effective Date	Ending MDL <sup>a</sup> (µg/L)	Ending LOD (µg/L)	Ending LOQ (µg/L)
SW-846, 8270	4-Chloro-3-methylphenol <sup>c</sup>	0.48	0.6	2.2				
SW-846, 8270	4-Nitrophenol <sup>c</sup>	0.95	1.3	4.3				
SW-846, 8270	Acenaphthene	2.5	3.4	11.3				
SW-846, 8270	Benzothiazole <sup>c</sup>	0.57	0.8	2.6				
SW-846, 8270	Bis(2-ethylhexyl) phthalate <sup>c</sup>	0.76	1.0	3.4				
SW-846, 8270	Naphthalene <sup>c</sup>	2	3	9				
SW-846, 8270	Dinoseb(2-secButyl-4, 6-dinitrophenol) <sup>c</sup>	0.98	1	4				
SW-846, 8270	Pentachlorophenol <sup>c</sup>	1.4	1.9	6.3				
SW-846, 8270	Phenol <sup>c</sup>	0.48	0.65	2.16				
SW-846, 8270	Pyrene <sup>c</sup>	0.48	0.65	2.16				
SW-846, 8270	Total cresols <sup>c</sup>	0.95	1.28	4.28				
SW-846, 8270	Tributyl phosphate <sup>c</sup>	0.48	0.65	2.16				
SW-846, 8270	Tris-2-chloroethyl phosphate <sup>c</sup>	0.62	0.8	2.8				
SW-846, 8270	n-Nitrosodi-n-dipropylamine <sup>c</sup>	0.57	0.8	2.6				
SW-846, 8270	n-Nitrosodimethylamine <sup>c</sup>	0.75	1.0	3.4				

<sup>a</sup> MDLs for many constituents changed during the fiscal year. For these constituents, the initial MDL, LOD, and LOQ were in effect until the date the values were updated (ending values, effective date). In cases where the MDL did not change, no ending values are listed.

<sup>b</sup> µMhos/cm.

<sup>c</sup> Additional MDLs were used during the year for these compounds.

LOD= limit of detection.  
LOQ = limit of quantitation.  
MDL = method detection limit.

**Table C-31. Summary of Detection and Quantitation Limits, TestAmerica Laboratory (St. Louis).**

Method	Constituent	Initial MDL <sup>a</sup> (µg/L)	Initial LOD (µg/L)	Initial LOQ (µg/L)	Ending Values, Effective Date	Ending MDL <sup>a</sup> (µg/L)	Ending LOD (µg/L)	Ending LOQ (µg/L)
<b>General Chemical Parameters</b>								
EPA-600/4-81-004, 120.1	Conductivity <sup>b</sup>	0.23	0.3	1.0	06/02/08	0.097	0.1	0.4
EPA-600/4-81-004, 310.1	Alkalinity	100	135	450				
EPA-600/4-81-004, 413.1	Oil and grease	500	675	2,252				
<b>Ammonia and Anions</b>								
EPA-600/R-93/100, 300.0 <sup>c</sup>	Chloride	20	27	90				
EPA-600/R-93/100, 300.0 <sup>c</sup>	Fluoride	25	34	113	02/12/08	10	14	45
EPA-600/R-93/100, 300.0 <sup>c</sup>	Nitrate	40	54	180	12/01/07	38	51	171
EPA-600/R-93/100, 300.0 <sup>c</sup>	Nitrite	16	22	72	05/17/08	7	9	32
EPA-600/R-93/100, 300.0 <sup>c</sup>	Sulfate	50	68	225				
SW-846, 9012	Cyanide	2.8	3.8	12.6				
SW-846, 9030 <sup>c</sup>	Sulfide	180	243	811				
<b>Metals</b>								
SW-846, 6010	Aluminum	54.3	73	245	09/19/08	79.9	107.9	360
SW-846, 6010	Antimony	44.8	60.5	202	05/01/08	4	5.4	18
SW-846, 6010	Barium	5	7	23	05/01/08	0.85	1.1	4
SW-846, 6010	Beryllium	1.1	1.49	5.0	05/01/08	0.5	0.7	2.3
SW-846, 6010	Cadmium	3.5	4.7	16	05/01/08	0.45	0.6	2
SW-846, 6010	Calcium	100	135	450	05/01/08	18.6	25	84
SW-846, 6010	Chromium	2.5	3.4	11	05/01/08	3.1	4.2	14
SW-846, 6010	Cobalt	2	3	9	05/01/08	4	5	18
SW-846, 6010	Copper	2	2.7	9	05/01/08	4.6	6	21
SW-846, 6010	Iron	18.6	25	84	05/01/08	16	22	72
SW-846, 6010	Lithium	9.6	13	43				
SW-846, 6010	Magnesium	128	173	576	05/01/08	110	149	495
SW-846, 6010	Manganese	1	1	5	05/01/08	0.96	1	4
SW-846, 6010	Nickel	4.6	6	21	05/01/08	13.3	18.0	59.9
SW-846, 6010	Potassium	1,630	2201	7340	05/01/08	1,650	2228	7430
SW-846, 6010	Silver	1.7	2.3	8	05/01/08	6	8.1	27.0
SW-846, 6010	Sodium	78.5	106	354	05/01/08	134	181	603
SW-846, 6010	Strontium (elemental)	0.56	0.76	2.5	05/01/08	0.54	0.7	2.4
SW-846, 6010	Vanadium	6.1	8.2	27	05/01/08	4.1	5.5	18.5
SW-846, 6010	Zinc	9.6	13	43	05/01/08	5.2	7.0	23.4
SW-846, 6020	Aluminum	9.9	13	45				
SW-846, 6020	Antimony	0.22	0.3	1.0	06/09/08	0.68	0.9	3.1
SW-846, 6020	Arsenic	1.6	2	7	05/06/08	1.9	2.6	8.6
SW-846, 6020	Barium	0.52	0.70	2.34				
SW-846, 6020	Beryllim	0.13	0.18	0.59				
SW-846, 6020	Boron	18	24.3	81				
SW-846, 6020	Cadmium	0.042	0.057	0.19				
SW-846, 6020	Calcium	29	39	131				
SW-846, 6020	Chromium	2	2.7	9	06/09/08	3	4.1	13.5
SW-846, 6020	Cobalt	0.24	0.32	1.08				
SW-846, 6020	Copper	0.47	0.63	2.12	06/09/08	0.81	1.1	3.6
SW-846, 6020	Iron	7.6	10	34	06/09/08	16	21.6	72.1

Table C-31. (cont.)

Method	Constituent	Initial MDL <sup>a</sup> (µg/L)	Initial LOD (µg/L)	Initial LOQ (µg/L)	Ending Values, Effective Date	Ending MDL <sup>a</sup> (µg/L)	Ending LOD (µg/L)	Ending LOQ (µg/L)
SW-846, 6020	Lead	0.49	0.66	2.21				
SW-846, 6020	Magnesium	3.1	4.2	14				
SW-846, 6020	Manganese	0.6	0.81	2.70				
SW-846, 6020	Molybdenum	0.45	0.6	2.0				
SW-846, 6020	Nickel	0.49	0.66	2.21				
SW-846, 6020	Potassium	11.6	16	52				
SW-846, 6020	Selenium	0.48	1	2				
SW-846, 6020	Silicon	38.4	52	173				
SW-846, 6020	Silver	0.2	0.3	0.9				
SW-846, 6020	Sodium	6.9	9	31	06/09/08	10	13.5	45.0
SW-846, 6020	Strontium (elemental)	0.24	0.32	1.08				
SW-846, 6020	Thallium	0.6	0.81	2.70	06/09/08	0.14	0.2	0.6
SW-846, 6020	Tin	0.46	0.6	2.1	06/09/08	0.68	0.9	3.1
SW-846, 6020	Titanium	0.3	0.41	1.35	06/09/08	1	1.4	4.5
SW-846, 6020	Vanadium	2.1	2.8	9.5				
SW-846, 6020	Zinc	3	4	14	06/09/08	4	5.4	18.0
SW-846, 7470	Mercury	0.093	0.13	0.42	05/21/08	0.061	0.1	0.3
<b>Volatile Organic Compounds</b>								
SW-846, 8260	1,1,1,2-Tetrachloroethane	0.1	0.14	0.45				
SW-846, 8260	1,1,1-Trichloroethane	0.1	0.14	0.45				
SW-846, 8260	1,1,2,2-Tetrachloroethane	0.14	0.19	0.63	04/11/08	0.27	0.36	1.22
SW-846, 8260	1,1,2-Trichloroethane	0.19	0.26	0.86				
SW-846, 8260	1,1-Dichloroethane	0.046	0.06	0.21	03/24/08	0.07	0.09	0.32
SW-846, 8260	1,1-Dichloroethene	0.045	0.06	0.20	03/24/08	0.085	0.11	0.38
SW-846, 8260	1,2,3-Trichloropropane	0.24	0.32	1.08	04/11/08	0.22	0.30	0.99
SW-846, 8260	1,2-Dibromo-3-chloropropane	0.55	0.74	2.48	04/11/08	0.48	0.65	2.16
SW-846, 8260	1,2-Dibromoethane	0.13	0.18	0.59	04/11/08	0.15	0.20	0.68
SW-846, 8260	1,2-Dichloroethane	0.11	0.15	0.50	03/24/08	0.18	0.24	0.81
SW-846, 8260	1,2-Dichloroethene (total)	0.1	0.14	0.45	04/11/08	0.14	0.2	0.6
SW-846, 8260	1,2-Dichloropropane	0.077	0.10	0.35				
SW-846, 8260	1,4-Dichlorobenzene	0.1	0.1	0.5				
SW-846, 8260	1,4-Dioxane	12	16	54	03/24/08	7	9.5	31.5
SW-846, 8260	1-Butanol	14	18.9	63.0				
SW-846, 8260	2-Butanone	1.8	2.43	8.11	03/24/08	0.96	1.3	4.3
SW-846, 8260	2-Hexanone	1	1.35	4.50	04/11/08	0.08	0	0
SW-846, 8260	4-Methyl-2-pentanone	0.21	0.3	0.9	03/24/08	0.72	0.97	3.24
SW-846, 8260	Acetone	0.8	1.1	3.6	03/24/08	0.56	0.76	2.52
SW-846, 8260	Acetonitrile	1.5	2.0	6.8	04/11/08	4.2	5.7	18.9
SW-846, 8260	Acrolein	0.44	0.6	2.0	04/11/08	0.52	0.70	2.34
SW-846, 8260	Allyl chloride	0.047	0.06	0.21	04/11/08	0.2	0.27	0.90
SW-846, 8260	Benzene	0.1	0.14	0.45	03/24/08	0.032	0.0	0.1
SW-846, 8260	Bromodichloromethane	0.064	0.09	0.29	04/11/08	0.088	0.119	0.40
SW-846, 8260	Bromoform	0.12	0.16	0.54	04/11/08	0.27	0.36	1.22
SW-846, 8260	Bromomethane	0.085	0.11	0.38	04/11/08	0.5	0.68	2.25
SW-846, 8260	Carbon disulfide	0.1	0.14	0.45	03/24/08	0.029	0.0	0.1

Table C-31. (cont.)

Method	Constituent	Initial MDL <sup>a</sup> (µg/L)	Initial LOD (µg/L)	Initial LOQ (µg/L)	Ending Values, Effective Date	Ending MDL <sup>a</sup> (µg/L)	Ending LOD (µg/L)	Ending LOQ (µg/L)
SW-846, 8260	Carbon tetrachloride	0.1	0.14	0.45	03/24/08	0.042	0.1	0.2
SW-846, 8260	Chlorobenzene	0.1	0.1	0.5	04/11/08	0.48	0.6	2.2
SW-846, 8260	Chloroethane	0.1	0.14	0.45	04/11/08	0.085	0.1	0.4
SW-846, 8260	Chloroform	0.1	0.14	0.45	03/24/08	0.08	0.1	0.4
SW-846, 8260	Chloromethane	0.1	0.1	0.5	04/11/08	0.036	0.0	0.2
SW-846, 8260	Chloroprene	0.1	0.1	0.5	04/11/08	0.085	0.1	0.4
SW-846, 8260	Dibromochloromethane	0.11	0.15	0.50	04/11/08	0.17	0.23	0.77
SW-846, 8260	Dibromomethane	0.12	0.16	0.54	04/11/08	0.14	0.19	0.63
SW-846, 8260	Dichlorodifluoromethane	0.045	0.06	0.20	04/11/08	0.074	0.10	0.33
SW-846, 8260	Ethyl acetate	0.23	0.31	1.04	03/24/08	0.44	0.6	2.0
SW-846, 8260	Ethyl cyanide	1.7	2.3	7.7	03/24/08	4.7	6.3	21.2
SW-846, 8260	Ethyl methacrylate	0.66	0.89	2.97	04/11/08	0.39	0.53	1.76
SW-846, 8260	Ethylbenzene	0.064	0.09	0.29	03/24/08	0.061	0.082	0.27
SW-846, 8260	Hexane	0.1	0.14	0.45	04/24/08	0.16	0.216	0.72
SW-846, 8260	Iodomethane	0.13	0.18	0.59	04/11/08	0.33	0.446	1.49
SW-846, 8260	Isobutyl alcohol	29	39.16	130.59	04/11/08	6.1	8.24	27.47
SW-846, 8260	Methacrylonitrile	0.3	0.4	1.4	04/11/08	1.8	2.4	8.1
SW-846, 8260	Methyl methacrylate	0.84	1.1	3.8	04/11/08	0.62	0.84	2.79
SW-846, 8260	Methylene chloride	0.1	0.1	0.5	03/24/08	0.091	0.1	0.4
SW-846, 8260	Styrene	0.1	0.14	0.45	04/11/08	0.079	0.1	0.4
SW-846, 8260	Tetrachloroethene	0.17	0.23	0.77	03/24/08	0.14	0.19	0.63
SW-846, 8260	Tetrahydrofuran	1.2	1.6	5.4	03/24/08	3.2	4.3	14.4
SW-846, 8260	Toluene	0.1	0.1	0.5	03/24/08	0.029	0.0	0.1
SW-846, 8260	trans-1,2-Dichloroethylene	0.1	0.14	0.45	03/24/08	0.089	0.1	0.4
SW-846, 8260	trans-1,3-Dichloropropene	0.085	0.11	0.38	04/11/08	0.08	0.11	0.36
SW-846, 8260	trans-1,4-Dichloro-2-butene	0.43	0.58	1.94	04/11/08	0.75	1.01	3.38
SW-846, 8260	Trichloroethene	0.1	0.1	0.5	03/24/08	0.11	0.1	0.5
SW-846, 8260	Trichloromonofluoromethane	0.1	0.1	0.5				
SW-846, 8260	Vinyl acetate	0.72	0.97	3.24	04/11/08	0.22	0.30	0.99
SW-846, 8260	Vinyl chloride	0.044	0.06	0.20	03/24/08	0.13	0.18	0.59
SW-846, 8260	Xylenes (total)	0.3	0.41	1.35	03/24/08	1.6	2.2	7.2
SW-846, 8015	TPH, gasoline fraction	9.5	12.8	42.8	05/29/08	10	13.5	45.0
<b>Semivolatile Organic Compounds</b>								
SW-846, 8015	TPH, diesel fraction	33	45	149				
SW-846, 8040	2,3,4,6-Tetrachlorophenol	2	3	9				
SW-846, 8040	2,4,5-Trichlorophenol	2.2	3.0	9.9				
SW-846, 8040	2,4,6-Trichlorophenol	2.2	3.0	9.9				
SW-846, 8040	2,4-Dichlorophenol	2.1	2.8	9.5				
SW-846, 8040	2,4-Dimethylphenol	2.1	2.8	9.5				
SW-846, 8040	2,4-Dinitrophenol	2.4	3.2	10.8				
SW-846, 8040	2,6-Dichlorophenol	2.1	2.8	9.5				
SW-846, 8040	2-Chlorophenol	2.2	3.0	9.9				
SW-846, 8040	2-Methylphenol (cresol, o-)	2.2	3.0	9.9				
SW-846, 8040	2-Nitrophenol	2.3	3.1	10.4				

Table C-31. (cont.)

Method	Constituent	Initial MDL <sup>a</sup> (µg/L)	Initial LOD (µg/L)	Initial LOQ (µg/L)	Ending Values, Effective Date	Ending MDL <sup>a</sup> (µg/L)	Ending LOD (µg/L)	Ending LOQ (µg/L)
SW-846, 8040	2-secButyl-4,6-dinitrophenol (DNBP)	2.4	3.2	10.8				
SW-846, 8040	3- + 4-Methylphenol	2.2	3.0	9.9				
SW-846, 8040	4,6-Dinitro-2-methyl phenol	2.2	3.0	9.9				
SW-846, 8040	4-Chloro-3-methylphenol	2.4	3.2	10.8				
SW-846, 8040	4-Nitrophenol	2.2	3.0	9.9				
SW-846, 8040	Pentachlorophenol	2.4	3.2	10.8				
SW-846, 8040	Phenol	2.3	3.1	10.4				
SW-846, 8081	4,4'-DDD	0.0075	0.010	0.034	07/21/08	0.0038	0.0051	0.0171
SW-846, 8081	4,4'-DDE	0.013	0.018	0.059	07/21/08	0.0027	0.0036	0.0122
SW-846, 8081	4,4'-DDT	0.013	0.018	0.059	07/21/08	0.0056	0.008	0.025
SW-846, 8081	Aldrin	0.0044	0.0059	0.020	07/21/08	0.004	0.0054	0.0180
SW-846, 8081	alpha-BHC	0.0031	0.004	0.014	07/21/08	0.0025	0.0034	0.0113
SW-846, 8081	beta-BHC	0.015	0.020	0.068	07/21/08	0.013	0.0176	0.0585
SW-846, 8081	Chlordane	0.099	0.134	0.446	07/21/08	0.18	0.243	0.811
SW-846, 8081	delta-BHC	0.0046	0.006	0.021	07/21/08	0.006	0.0081	0.0270
SW-846, 8081	Dieldrin	0.0057	0.008	0.026	07/21/08	0.0023	0.0031	0.0104
SW-846, 8081	Endosulfan I	0.0078	0.0105	0.035	07/21/08	0.0025	0.0034	0.0113
SW-846, 8081	Endosulfan II	0.0053	0.007	0.024	07/21/08	0.01	0.0135	0.0450
SW-846, 8081	Endosulfan sulfate	0.0063	0.009	0.028	07/21/08	0.017	0.023	0.077
SW-846, 8081	Endrin	0.0068	0.009	0.031	07/21/08	0.0028	0.0038	0.0126
SW-846, 8081	Endrin aldehyde	0.009	0.0122	0.041	07/21/08	0.0032	0.0043	0.0144
SW-846, 8081	gamma-BHC (lindane)	0.0032	0.0043	0.014	07/21/08	0.0025	0.0034	0.0113
SW-846, 8081	Heptachlor	0.034	0.0459	0.153	07/21/08	0.0025	0.0034	0.0113
SW-846, 8081	Heptachlor epoxide	0.0062	0.0084	0.028	07/21/08	0.0032	0.0043	0.0144
SW-846, 8081	Methoxychlor	0.01	0.014	0.045	07/21/08	0.005	0.0068	0.0225
SW-846, 8081	Toxaphene	0.59	0.80	2.66	07/21/08	0.33	0.45	1.49
SW-846, 8082	Aroclor-1016	0.44	0.59	1.98				
SW-846, 8082	Aroclor-1221	0.44	0.59	1.98				
SW-846, 8082	Aroclor-1232	0.44	0.59	1.98				
SW-846, 8082	Aroclor-1242	0.44	0.59	1.98				
SW-846, 8082	Aroclor-1248	0.44	0.59	1.98				
SW-846, 8082	Aroclor-1254	0.3	0.41	1.35				
SW-846, 8082	Aroclor-1260	0.3	0.41	1.35				
SW-846, 8270	1,2,4,5-Tetrachlorobenzene	1	1	5				
SW-846, 8270	1,2,4-Trichlorobenzene	1	1	5				
SW-846, 8270	1,2-Dichlorobenzene	1	1	5				
SW-846, 8270	1,3-Dichlorobenzene	1	1	5				
SW-846, 8270	1,4-Dichlorobenzene	1	1	5				
SW-846, 8270	1,4-Dioxane	2	3	9				
SW-846, 8270	1,4-Naphthoquinone	0.95	1.3	4.3				
SW-846, 8270	1-Naphthylamine	1	1	5				
SW-846, 8270	2,3,4,6-Tetrachlorophenol	1	1	5				
SW-846, 8270	2,4,5-Trichlorophenol	2	3	9				
SW-846, 8270	2,4,6-Trichlorophenol	2	3	9				

Table C-31. (cont.)

Method	Constituent	Initial MDL <sup>a</sup> (µg/L)	Initial LOD (µg/L)	Initial LOQ (µg/L)	Ending Values, Effective Date	Ending MDL <sup>a</sup> (µg/L)	Ending LOD (µg/L)	Ending LOQ (µg/L)
SW-846, 8270	2,4-Dichlorophenol	1	1	5				
SW-846, 8270	2,4-Dimethylphenol	1	1	5				
SW-846, 8270	2,4-Dinitrophenol	10	14	45				
SW-846, 8270	2,4-Dinitrotoluene	1.1	1.5	5.0				
SW-846, 8270	2,6-Dichlorophenol	1	1	5				
SW-846, 8270	2,6-Dinitrotoluene	1.1	1.5	5.0				
SW-846, 8270	2-Acetylaminofluorene	1	1	5				
SW-846, 8270	2-Chloronaphthalene	1	1	5				
SW-846, 8270	2-Chlorophenol	1	1	5				
SW-846, 8270	2-Methylnaphthalene	1	1	5				
SW-846, 8270	2-Methylphenol (cresol, o-)	2	3	9				
SW-846, 8270	2-Naphthylamine	1	1	5				
SW-846, 8270	2-Nitroaniline	2	3	9				
SW-846, 8270	2-Nitrophenol	1	1	5				
SW-846, 8270	2-Picoline	5.5	7.4	24.8	07/23/08	1	1.35	4.50
SW-846, 8270	2-secButyl-4,6-dinitrophenol(DNBP)	2	3	9				
SW-846, 8270	3,3'-Dichlorobenzidine	1	1	5				
SW-846, 8270	3,3'-Dimehtylbenzidine	10	14	45				
SW-846, 8270	3- + 4-Methylphenol	1.2	1.6	5.4	07/23/08	1	1.35	4.50
SW-846, 8270	3-Methylcholanthrene	1	1	5				
SW-846, 8270	3-Nitroaniline	1.1	1.5	5.0				
SW-846, 8270	4,6-Dinitro-2-methyl phenol	5	7	23				
SW-846, 8270	4-Aminobiphenyl	1	1	5				
SW-846, 8270	4-Bromophenylphenyl ether	1	1	5				
SW-846, 8270	4-Chloro-3-methylphenol	1	1	5				
SW-846, 8270	4-Chloroaniline	1	1	5				
SW-846, 8270	4-Chlorophenylphenyl ether	1	1	5				
SW-846, 8270	4-Methylphenol (cresol, p-)	1	1	5	04/16/08	10	13.50	45.03
SW-846, 8270	4-Nitroaniline	1.3	1.8	5.9				
SW-846, 8270	4-Nitrophenol	5	7	23				
SW-846, 8270	4-Nitroquinoline-1-oxide	5	7	23				
SW-846, 8270	5-Nitro-o-toluidine	1	1	5				
SW-846, 8270	7,12-Dimethylbenz[a]anthracene	1	1	5				
SW-846, 8270	Acenaphthene	1	1	5				
SW-846, 8270	Acenaphthylene	1	1	5				
SW-846, 8270	Acetophenone	1	1	5				
SW-846, 8270	alpha,alpha-Dimethylphenethylamine	20	27	90				
SW-846, 8270	Aniline	1	1	5				
SW-846, 8270	Anthracene	1.1	1.5	5.0				
SW-846, 8270	Aramite	20	27	90				
SW-846, 8270	Azobenzene	1	1	5				
SW-846, 8270	Benzo(a)anthracene	1	1	5				
SW-846, 8270	Benzo(a)pyrene	1	1	5				

Table C-31. (cont.)

Method	Constituent	Initial MDL <sup>a</sup> (µg/L)	Initial LOD (µg/L)	Initial LOQ (µg/L)	Ending Values, Effective Date	Ending MDL <sup>a</sup> (µg/L)	Ending LOD (µg/L)	Ending LOQ (µg/L)
SW-846, 8270	Benzo(b)fluoranthene	1	1	5				
SW-846, 8270	Benzo(ghi)perylene	1	1	5				
SW-846, 8270	Benzo(k)fluoranthene	1	1	5				
SW-846, 8270	Benzothiazole	1	1	5				
SW-846, 8270	Benzyl alcohol	1	1	5				
SW-846, 8270	Bis(2-Chloroethoxy)methane	1	1	5				
SW-846, 8270	Bis(2-chloroethyl) ether	1	1	5				
SW-846, 8270	Bis(2-ethylhexyl) phthalate	1	1	5				
SW-846, 8270	Butylbenzylphthalate	1	1	5				
SW-846, 8270	Chlorobenzilate	1	1	5				
SW-846, 8270	Chrysene	1	1	5				
SW-846, 8270	Diallate	2	3	9				
SW-846, 8270	Di-n-butylphthalate	1	1	5				
SW-846, 8270	Di-n-octylphthalate	5	7	23				
SW-846, 8270	Dibenz[a,h]anthracene	1	1	5				
SW-846, 8270	Dibenzofuran	1	1	5				
SW-846, 8270	Diethylphthalate	1	1	5				
SW-846, 8270	Dimethoate	1.1	1.5	5.0				
SW-846, 8270	Dimethyl phthalate	1	1	5				
SW-846, 8270	Disulfoton	1	1	5				
SW-846, 8270	Ethyl methanesulfonate	1	1	5				
SW-846, 8270	Famphur	50	68	225				
SW-846, 8270	Fluoranthene	1	1	5				
SW-846, 8270	Fluorene	1	1	5				
SW-846, 8270	Hexachlorobenzene	1	1	5				
SW-846, 8270	Hexachlorobutadiene	1	1	5				
SW-846, 8270	Hexachlorocyclopentadiene	2.5	3.4	11.3				
SW-846, 8270	Hexachloroethane	1	1	5				
SW-846, 8270	Hexachlorophene	10	14	45				
SW-846, 8270	Hexachloropropene	2.5	3.4	11.3				
SW-846, 8270	Indeno(1,2,3-cd)pyrene	1	1	5				
SW-846, 8270	Isodrin	1	1	5				
SW-846, 8270	Isophorone	1	1	5				
SW-846, 8270	Isosafrole	5.7	7.7	25.7				
SW-846, 8270	Kepone	20	27	90				
SW-846, 8270	m-Dinitrobenzene	1	1	5				
SW-846, 8270	Methapyriene	14	19	63				
SW-846, 8270	Methyl methanesulfonate	5	7	23				
SW-846, 8270	Methyl parathion	1	1	5				
SW-846, 8270	Naphthalene	1	1	5				
SW-846, 8270	Nitrobenzene	1	1	5				
SW-846, 8270	Nitrosopyrrolidine	1	1	5				
SW-846, 8270	N-Nitrosodiethylamine	1	1	5				
SW-846, 8270	N-Nitrosodimethylamine	2	3	9				
SW-846, 8270	N-Nitroso-di-n-butylamine	1	1	5				

Table C-31. (cont.)

Method	Constituent	Initial MDL <sup>a</sup> (µg/L)	Initial LOD (µg/L)	Initial LOQ (µg/L)	Ending Values, Effective Date	Ending MDL <sup>a</sup> (µg/L)	Ending LOD (µg/L)	Ending LOQ (µg/L)
SW-846, 8270	N-Nitroso-di-n-propylamine	1	1	5				
SW-846, 8270	N-Nitrosodiphenylamine	1	1	5				
SW-846, 8270	N-Nitrosomethylethylamine	1	1	5				
SW-846, 8270	N-Nitrosomorpholine	0.96	1.3	4.3				
SW-846, 8270	N-Nitrosopiperidine	1	1	5				
SW-846, 8270	O,O,O-Triethyl phosphorothioate	1	1	5				
SW-846, 8270	O,O-DiethylO-2-pyrazinyl phosphorothioa	0.99	1.3	4.5				
SW-846, 8270	o-Toluidine	1	1.4	4.5				
SW-846, 8270	Parathion	1	1.4	4.5				
SW-846, 8270	p-Dimethylaminoazobenzene	1	1.4	4.5				
SW-846, 8270	Pentachlorobenzene	2.7	3.6	12.2				
SW-846, 8270	Pentachloroethane	1	1	5				
SW-846, 8270	Pentachloronitrobenzene (PCNB)	1.1	1.5	5.0				
SW-846, 8270	Pentachlorophenol	2	3	9				
SW-846, 8270	Phanacetin	0.94	1.3	4.2				
SW-846, 8270	Phenanthrene	1	1	5				
SW-846, 8270	Phenol	4	5	18				
SW-846, 8270	Phorate	2.9	3.9	13.1				
SW-846, 8270	p-Phenylenediamine	1	1	5				
SW-846, 8270	Pronamide	1	1	5				
SW-846, 8270	Pyrene	1	1	5				
SW-846, 8270	Pyridine	5	7	23				
SW-846, 8270	Safrol	1	1	5				
SW-846, 8270	sym-Trinitrobenzene	5	7	23				
SW-846, 8270	Tetraethyl dithiopyrophosphate	1	1	5				
SW-846, 8270	Tributyl phosphate	1.1	1.5	5.0	07/23/08	1.5	2.03	6.75
SW-846, 8270	tris-2-Chloroethyl phosphate	1.2	1.6	5.4				

<sup>a</sup> MDLs for many constituents changed during the fiscal year. For these constituents, the initial MDL, LOD, and LOQ were in effect until the date the values were updated (ending values, effective date). In cases where the MDL did not change, no ending values are listed.

<sup>b</sup> µMhos/cm.

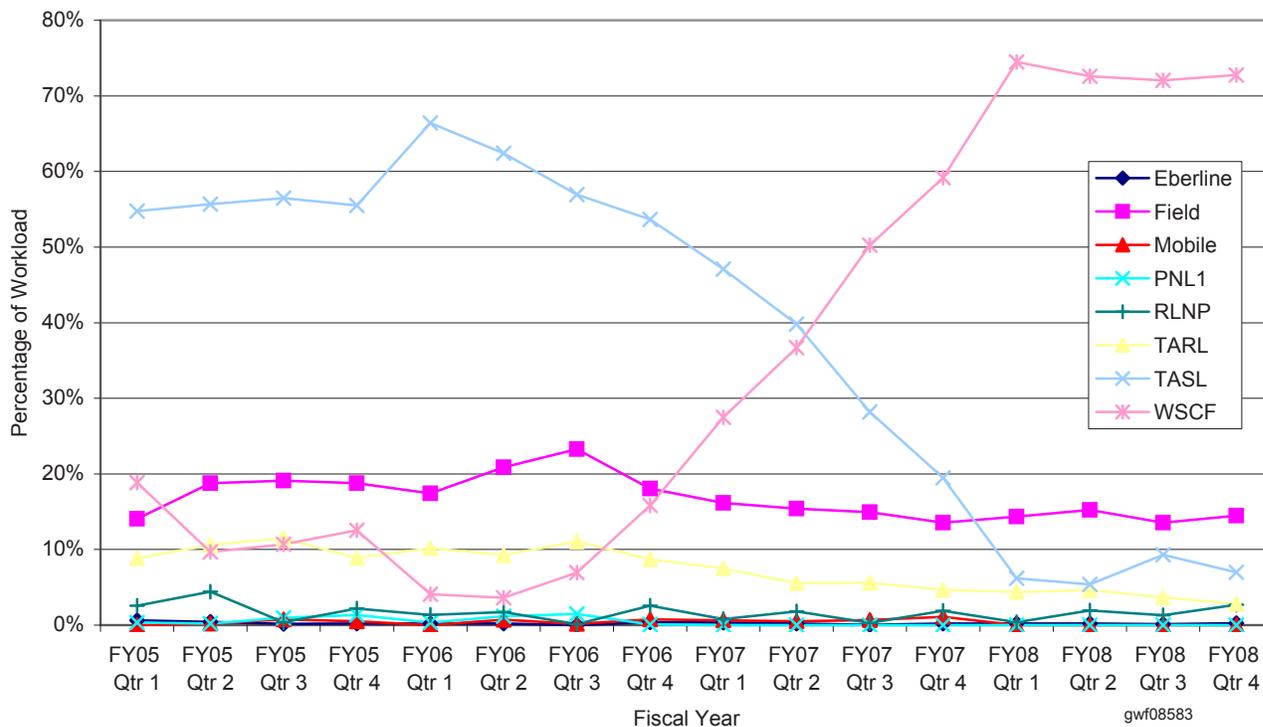
<sup>c</sup> Units for this method are mg/L.

LOD = limit of detection.

LOQ = limit of quantitation.

MDL = method detection limit.

Figure C-1. Distribution of Analytical Workload by Laboratory.



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