

Appendix D

Quality Assurance and Quality Control

Contents

Quality Assurance and Quality Control	D.1
D.1 Sample Collection and Analysis	D.1
D.2 Data Completeness	D.2
D.3 Field Quality Control Samples	D.2
D.3.1 Long-Term Monitoring	D.2
D.3.2 Interim Action Monitoring	D.4
D.4 Holding Times	D.5
D.5 Laboratory Performance	D.5
D.5.1 Nationally Based Performance Evaluation Studies	D.6
D.5.1.1 Water Pollution and Water Supply Studies	D.6
D.5.1.2 DOE Quality Assessment and Mixed Analyte Performance Evaluation Programs	D.6
D.5.1.3 InterLaB RadCheM Proficiency Testing Program Studies	D.7
D.5.2 Double-Blind Standard Evaluation	D.7
D.5.3 Laboratory Internal QA/QC Programs	D.8
D.5.3.1 Issue Resolution	D.10
D.5.3.2 Laboratory Audits/Assessments	D.10
D.6 Limit of Detection, Limit of Quantitation, and Method Detection Limit	D.11
D.7 Conclusions	D.12
D.8 References	D.13

Tables

D.1 Long-Term Monitoring Full Trip Blanks Exceeding Quality Control Limits	D.15
D.2 Long-Term Monitoring Field Transfer Blanks Exceeding Quality Control Limits	D.15
D.3 Long-Term Monitoring Equipment Blanks Exceeding Quality Control Limits	D.16
D.4 Long-Term Monitoring Field Duplicates Exceeding Quality Control Limits	D.17
D.5 Long-Term Monitoring Split Sample Results for Total Organic Carbon	D.18
D.6 Interim Action Monitoring Field Blank Detections	D.18
D.7 Interim Action Monitoring Field Duplicates Exceeding Quality Control Limits	D.19
D.8 Interim Action Monitoring Interlaboratory Splits Exceeding Quality Control Limits	D.19
D.9 Groundwater Performance Assessment Project Maximum Recommended Holding Times	D.20
D.10 Summary of Severn Trent-St. Louis Water Pollution Performance Evaluation Studies	D.21
D.11 Summary of Lionville Laboratory Water Pollution Performance Evaluation Studies	D.21
D.12 Summary of Severn Trent Interlaboratory Performance, Fiscal Year 2003	D.22
D.13 Summary of Eberline Services Interlaboratory Performance, Fiscal Year 2003	D.22

D.14	Summary of Severn Trent Laboratories Double-Blind Spike Determinations	D.23
D.15	Summary of Lionville Laboratory, Inc. and Eberline Services Double-Blind Spike Determinations	D.24
D.16	Percentage of Out-of-Limit Quality Control Results by Category, Severn Trent Laboratories	D.24
D.17	Method Blank Results, Severn Trent Laboratories	D.25
D.18	Laboratory Control Samples, Severn Trent Laboratories	D.26
D.19	Matrix Spikes and Matrix Spike Duplicates, Severn Trent Laboratories	D.27
D.20	Matrix Duplicates, Severn Trent Laboratories	D.29
D.21	Summary of Issue Resolution Forms Received from Severn Trent Laboratories for Fiscal Year 2003	D.30
D.22	Results of Laboratory Assessments	D.31
D.23	Summary of Analytical Laboratory Detection/Quantitation Limits Determined from Field Blank Data, Severn Trent Laboratories	D.32
D.24	Summary of Detection and Quantitation Limits, Severn Trent Laboratory	D.34

Appendix D

Quality Assurance and Quality Control

C. J. Thompson

This appendix presents fiscal year 2003 quality assurance/quality control (QA/QC) information for long-term and interim action groundwater monitoring at the Hanford Site. The phrase “long-term monitoring” refers to monitoring performed to meet the requirements of the *Resource Conservation and Recovery Act* (RCRA) and the *Atomic Energy Act of 1954* (AEA). Long-term monitoring also includes monitoring performed at *Comprehensive Environmental Response, Compensation, and Liability Act* (CERCLA) sites with no groundwater remediation. Pacific Northwest National Laboratory (PNNL) manages long-term monitoring via the Groundwater Performance Assessment Project (groundwater project). Interim action monitoring encompasses monitoring at sites with active groundwater remediation under CERCLA. Fluor Hanford, Inc. provided oversight for interim action groundwater monitoring during fiscal year 2003. For both categories of groundwater monitoring, PNNL managed sample scheduling, sample collection, analytical work, and entry of associated information into the Hanford Environmental Information System (HEIS) database.

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 may also be evaluated for overall quality. These parameters are evaluated through laboratory QC checks (e.g., matrix spikes, laboratory blanks), replicate sampling and analysis, analysis of blind standards and blanks, and interlaboratory comparisons. Acceptance criteria have been established for each of these parameters. When a parameter is outside the criteria, corrective actions are taken to prevent a future occurrence.

The QA/QC practices for RCRA samples are based on guidance from the U.S. Environmental Protection Agency (EPA) (EPA 1986a [SW-846] and 1986b [OSWER-9950.1]). 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 (PNNL-SA-40114). Guidance for interim action monitoring QA/QC practices is provided in project-specific documents (e.g., BHI-00038; DOE/RL-90-08; DOE/RL-91-03; DOE/RL-91-46; DOE/RL-92-76; DOE/RL-96-07; DOE/RL-96-90; DOE/RL-97-36). A glossary of QA/QC terms is provided in PNNL-13080. Additional information about the QA/QC program and fiscal year 2003 data (e.g., results of individual QC samples and/or associated groundwater samples) is available on request.

D.1 Sample Collection and Analysis

C. J. Thompson and D. L. Stewart

Fluor Hanford, Inc. nuclear chemical operators, under the supervision of Duratek Federal Services, Inc., conducted groundwater sampling for fiscal year 2003. Their tasks included bottle preparation, sample set coordination, field measurements, sample collection, sample shipping, well pumping, and coordination of purgewater containment and disposal. Duratek’s statement of work^(a) defines quality requirements for sampling activities. Groundwater project staff review all sampling procedures before the procedures are implemented.

Groundwater project staff periodically reviewed sample collection activities performed by nuclear chemical operators from Fluor Hanford, Inc. The purpose of the surveillances was to ensure that samples were collected and submitted to the laboratories in accordance with high-quality standards. Nine surveillances were conducted in the following areas: bottle preparation; sample collection (two events); water-purification system maintenance; measurement of groundwater

(a) SOW-409744-A-B3. 2001. Statement of Work between Pacific Northwest National Laboratory and Duratek Federal Services, Inc., Richland, Washington.

levels; decontamination of sampling equipment; calibration of field instruments; training and associated documentation; and sample packing, shipping, and storage. A few minor procedural deviations were identified. Corrective actions for eight of these surveillances have been received and accepted.

During fiscal year 2003, Severn Trent Laboratories, Incorporated, St. Louis, Missouri (STL St. Louis), performed most of the routine analyses of Hanford groundwater samples for hazardous and non-hazardous chemicals. Lionville Laboratory, Incorporated, Lionville, Pennsylvania (Lionville Laboratory), served as a secondary laboratory for chemical analyses of split samples and blind standards.

Severn Trent Laboratories, Incorporated, Richland, Washington (STL Richland), performed the majority of radiological analyses on Hanford 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 provided in PNNL-13080.

D.2 Data Completeness

C. J. Thompson

Data judged to be complete are data that are not suspect, rejected, associated with a missed holding time, out-of-limit field duplicate or field blank, or qualified to indicate laboratory blank contamination. For fiscal year 2003, 87% of the groundwater project data were considered complete. Potentially invalid data were flagged in the database. The percentages of data flagged were 1.9% for field QC problems, 0.2% for exceeded holding times, 0.0% for rejected results, 0.4% for suspect values, and 10.8% for laboratory blank contamination. These values are similar to the percentages observed in fiscal year 2002.

Specific evaluation of completeness for interim action groundwater monitoring was not performed for this report. Completeness issues are primarily assessed as part of site-specific validation activities. No validation activities were performed on interim action groundwater monitoring data in fiscal year 2003.

D.3 Field Quality Control Samples

C. J. Thompson and R. L. Weiss

Field QC samples include field duplicates, split samples, and three types of field blanks. The three types of field blanks are full trip, field transfer, and equipment blanks. Field duplicates are used to assess sampling and measurement precision. Split samples are used to confirm out-of-trend results and for interlaboratory comparisons. Field blanks provide an overall measure of contamination introduced during the sampling and analysis process.

D.3.1 Long-Term Monitoring (Groundwater Performance Assessment Project)

The groundwater project's criteria for evaluating the analytical results of field QC samples are as follows:

- field duplicates – Results of field duplicates must have precision within 20%, as measured by the relative percent difference. Only those field duplicates with at least one result greater than five times the method detection limit or minimum detectable activity are evaluated.
- split samples – Results must have a relative percent difference <20%. Only those results that are greater than five times the method detection limit or minimum detectable activity at both laboratories are evaluated.
- field blanks – For most chemical constituents, 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. Results for metals are

flagged if they exceed two times the instrument detection limit. For radiological data, blank results are flagged if they are greater than two times the total propagated analytical uncertainty.

If a field blank does not meet the established criteria, it is assumed that there are potential problems with the data for all associated samples. 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 all of the following in common with an equipment blank:

- collection date
- collection method/sampling equipment
- analysis method

Data associated with out-of-limit field blanks are flagged with a Q in the database to indicate a potential contamination problem. A Q is also applied to both duplicate results when their precision exceeds the QC limits.

The percentages of acceptable field blank ($4,821/5,006 = 96\%$) and duplicate ($2,780/2,824 = 98\%$) results evaluated in fiscal year 2003 were high, indicating little problem with contamination and good precision overall. None of the split samples collected during the year met the evaluation criteria, but the results from these samples helped identify and troubleshoot a problem with total organic carbon analyses.

Tables D.1 through D.4 summarize the field blank and field duplicate results that exceeded QC limits. To assist with their evaluation, the tables are divided into the following categories, where applicable: general chemical parameters, ammonia and anions, metals, volatile organic compounds, semivolatile organic compounds, and radiological parameters. Constituents not listed in the tables had 100% acceptable field blanks and/or field duplicates.

With the exception of semivolatile organic compounds, all classes of constituents had results that were flagged as potentially contaminated because of out-of-limit field blank results. Sixty-one percent of the out-of-limit blank results were less than quantifiable limits. A few constituents such as chloride, nitrate, sodium, sulfate, and uranium had several quantifiable field blank results, but the concentrations were much lower than the levels of these constituents in almost all groundwater samples.

Relative to fiscal year 2002, the number of field blank results for total organic carbon that exceeded the QC limits decreased significantly. One out of 81 results was greater than two times the detection limit. Last year, 41% of the field blanks exceeded the QC limits. Unfortunately, the improved performance on field blanks did not correlate to improved method accuracy for regular groundwater samples. The primary laboratory had problems with high-biased results for total organic carbon during most of the year.

Thirty-five field blank results for metals exceeded the QC limits. In general, the field blank concentrations were similar to those from last year. Most of the unacceptable results were within a factor of 5 of the instrument detection limits. All of the metals with out-of-limit field blank results had one or more comparable method-blank results, suggesting that the elevated field blank values were caused by false detections or laboratory contamination.

Concentrations of five volatile organic compounds exceeded the QC limits in one or more field blanks. Methylene chloride was the predominant volatile contaminant, accounting for 95% of the out-of-limit results. Levels of acetone and 2-butanone were also out of limits in two field blanks. Laboratory contamination is the suspected source of these common contaminants, because similar concentrations also were measured in several method blanks. Trace levels of carbon disulfide and carbon tetrachloride also were measured in field blanks. These compounds had low frequencies of detection (i.e., <2%) in field blanks, and the overall impact on the data is minor.

Gross beta, tritium, and uranium were the only radiological constituents with out-of-limit field blank results. Although the field blank concentrations of gross beta and tritium were low, they were greater than levels of these constituents in some of the associated groundwater samples. In contrast, the field blank concentrations for uranium were significantly lower than the levels in the associated samples. All three constituents were measured in one or more laboratory method blanks at concentrations similar to the field blank values.

Comparison of full-trip and equipment blank results suggests that the use of non-dedicated sampling equipment at some wells did not have a significant impact on data quality. Overall, fewer constituents were detected in equipment blanks, and the concentrations of most constituents were lower in equipment blanks. However, only a limited comparison can be made because only 7 equipment blanks were collected compared to 79 full trip blanks. The percentages of out-of-limit results were generally higher in equipment blanks for those constituents detected in both types of blanks.

Duplicate results were flagged for all constituent classes (Table D.4). Overall, the relative number of flagged duplicate results was very low (<2%), but the percentages of unacceptable results were high for several constituents based on the number of duplicates that met the evaluation criteria. The metals and radiological parameters categories accounted for approximately two-thirds of the out-of-limit results. Most of the associated samples were unfiltered; thus, suspended solids in heterogeneous sample fractions may have caused some of the discrepancies in the results. 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 blind standards and laboratory duplicates (discussed in Sections D.5.2 and D.5.3). 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. Especially poor agreement was observed between a pair of results for the following: alkalinity (124,000 and 226,000 µg/L), gross alpha (14.0 and 26.9 pCi/L), and uranium (0.842 and 5.69 µg/L). Swapped samples or procedural deviations at the laboratory may have caused the unmatched results.

During the second quarter of the fiscal year, groundwater project staff observed that several results for total organic carbon were significantly higher than previous measurements. For example, at several sites the concentrations increased from a historical average of ~200 to 400 µg/L to values over 1,500 µg/L. The suspect values were flagged in the database, and several steps were taken to investigate the problem. Results from field and laboratory blanks were reviewed, and all of the results were either non-detected or just slightly above the detection limit. Additionally, the data were examined for possible trends in analysis dates, pump types, sampling personnel, and well locations. No obvious connections between these variables and the elevated values were determined. Twenty-five split samples were collected from seven wells during the last two quarters of the year to help investigate the problem. STL St. Louis and Lionville Laboratory analyzed the samples. Although none of the results met the QC evaluation criteria, the data for most of the samples show distinctly higher concentrations were determined by the St. Louis laboratory (Table D.5). Lionville Laboratory's results are generally consistent with historical data for the associated wells, suggesting that STL St. Louis' results were biased high. The problem was discussed with the St. Louis laboratory, and laboratory staff discovered that an under-pressurized gas line was affecting the sparging of samples during the analysis. Since the sparging process removes carbonate and bicarbonate (i.e., inorganic carbon) from the sample, inadequate sparging would produce high-biased results. Field and method blanks would not be affected, however, because the blanks are prepared from deionized water. The laboratory corrected the gas pressure in August, and more recent data suggest the overall problem has been resolved.

D.3.2 Interim Action Monitoring

Trained staff collected samples in accordance with approved procedures. In general, field QC samples consisted of field duplicates, splits, equipment blanks, and trip blanks. Field QC data are evaluated as necessary to make decisions that may modify or terminate a remedial action. In fiscal year 2003, no evaluations were necessary for decision-making purposes.

Field QC data were examined to monitor laboratory operations and to identify potential problem areas where improvements were necessary. Evaluation criteria were essentially the same as those used for the groundwater project with the following exceptions:

- Field blanks were evaluated based on the number of detections (rather than the groundwater project's approach of using two times the detection limit as an acceptance criterion). Sample-specific detection limits were not captured for interim action monitoring samples, making an identical evaluation impossible.
- The 20% relative percent difference criterion for field duplicate and split sample results was relaxed for sample analytical results near (i.e., typically within five times) nominal method detection limits. This accounts for expected increased analytical error when values are close to detection limits.

For field blank samples, >89% of all results were returned as non-detected. Over 80% of the detected organic constituents were common laboratory contaminants, and in most cases, detected compounds also were measured at similar levels in the analytical batch blank. Evaluation of other field blank sample results showed no evidence of unexpected or excessive contamination of blanks in the field or by the laboratory. The constituents and levels of contamination found should have no impact on decision making for interim action monitoring. This is comparable, but slightly better than last year's results (88% non-detect) and still improved over previous years (80% to 85%). Blank detects are summarized in Table D.6.

Field duplicate and split results showed <10% exceeding the criteria used for evaluation. The percentage of out-of-limit splits was ~2 times higher than the relative number of out-of-limit duplicates. The criteria used to evaluate splits are likely more restrictive than necessary because they are based on similar criteria for laboratory replicate evaluation (i.e., analysis of multiple aliquots from the same sample container by the same laboratory in the same analytical batch).

As noted in previous years, metals analysis by the inductively coupled plasma method accounts for the largest group of results exceeding the criteria. Field duplicate evaluations are summarized in Table D.7, and interlaboratory split evaluations are summarized in Table D.8.

Previous evaluations noted an apparent non-random variability in interlaboratory splits for analysis of some metals at low levels. At levels below ~50 µg/L, results reported by STL St. Louis were noted greater than Lionville Laboratory for vanadium; the other comparisons showed no identifiable trends in results.

Overall evaluation indicates no significant issues between procedures and analyses performed by the laboratories providing services to the interim action monitoring program. The general performance for fiscal year 2003 is similar to the previous year.

D.4 Holding Times

D. S. Sklarew

Holding time is the elapsed time period between sample collection and analysis. Samples should be analyzed within recommended holding times to minimize the possibility of changes in constituent concentrations caused by volatilization, decomposition, or other chemical alterations. Samples are also 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 D.9. 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 fiscal year 2003, recommended holding times were exceeded for 86 out of 6,213 (1.4%) of the groundwater project's non-radiological sample analysis requests. A sample analysis request is defined as a sample that is submitted for analysis by a particular analytical method. In general, the missed holding times should not have a significant impact on the data. Results for samples with missed holding times are flagged with an H in the database. Holding times were exceeded for 86 out of 6,113 (1.4%) of STL St. Louis' sample analysis requests. Of these, the constituents with the most missed holding times were anions by ion chromatography (66 samples), alkalinity (9 samples), and cyanide (6 samples). Shipping delays and laboratory QC failures caused most of the missed holding times. STL Richland did not exceed holding times for the 49 coliform samples. Lionville Laboratory did not exceed holding times for the 50 analysis requests that were processed for the groundwater project. The missed holding times were discussed with STL St. Louis to help laboratory staff identify areas where improvements are needed.

Specific evaluation of adherence to analytical holding times for interim action monitoring was not performed for this report. Analytical holding times are monitored as part of ongoing sample and data management activities throughout the year. However, interim action monitoring data are not flagged for missed holding times. No remediation decisions were affected by missed holding times in fiscal year 2003.

D.5 Laboratory Performance

C. J. Thompson, D. S. Sklarew, and D. L. Stewart

Laboratory performance is measured by several indicators, including nationally based 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 STL St. Louis and STL Richland. Brief summaries of performance measures for Lionville Laboratory and Eberline Services also are presented throughout this section. The majority of the laboratory's results were within the acceptance limits, indicating good performance overall.

D.5.1 Nationally Based Performance Evaluation Studies

During fiscal year 2003, Environmental Resources Associates and DOE conducted nationally based studies to evaluate laboratory performance for chemical and radiological constituents. STL St. Louis and Lionville Laboratory participated in the EPA sanctioned Water Pollution and Water Supply Performance Evaluation studies conducted by Environmental Resources Associates. STL Richland and Eberline Services took part in DOE's Quality Assessment Program. STL Richland participated in the Environmental Resources Associates' InterLaB RadChem Proficiency Testing Program. All four 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.

D.5.1.1 Water Pollution and Water Supply Studies

The purpose of water pollution and water supply studies is to evaluate the performance of laboratories in analyzing selected organic and inorganic compounds. Every month, 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.

For the five water pollution studies in which STL St. Louis participated this year (ERA WP-97, 99, 100, 101, and 102), the percentage of acceptable results submitted to the groundwater project ranged from 80% to 100% (Table D.10); three of these studies had a limited number of analytes. Of the 27 different constituents with unacceptable results, total Kjeldahl nitrogen was out of limits in all three studies in which it was analyzed; conductivity was out of limits in both studies in which it was analyzed; and a number of base/neutral compounds were out of limits in one out of two studies. The laboratory provided information about possible causes for many of the unacceptable results and suggested corrective actions where appropriate. The constituents that were out of limits last year are mainly within limits this year. Overall, the unacceptable results should not have a significant impact on Hanford groundwater samples.

Lionville Laboratory participated in water pollution studies WP-92 and 96 this year; one of the studies had a limited number of analytes. For the results submitted to the groundwater project, the percentage of Lionville's acceptable results ranged from 99% to 100% (Table D.11). Only two constituents were out of limits in one study. The laboratory provided information about possible causes for the unacceptable results and suggested corrective actions where appropriate. Overall, the unacceptable results should not have a significant impact on Hanford groundwater samples.

D.5.1.2 DOE Quality Assessment and Mixed Analyte Performance Evaluation Programs

DOE's Quality Assessment Program evaluates how laboratories perform when they analyze radionuclides in water, air filter, soil, and vegetation samples. This discussion considers only water samples. The program is coordinated by the Environmental Measurements Laboratory in New York. The Environmental Measurements Laboratory provides blind standards that contain specific amounts of one or more radionuclides to participating laboratories. Constituents analyzed can include americium-241, cesium-134, cesium-137, cobalt-60, gross alpha, gross beta, plutonium-238, plutonium-239, strontium-90, tritium, uranium-234, uranium-238, and total uranium. After sample analysis, each participating laboratory forwards the results to the Environmental Measurements Laboratory for comparison with known values and with results from other laboratories. The Environmental Measurements Laboratory evaluates the accuracy of the results based on the historical analytical capabilities for the individual analyte/matrix pairs. Using a cumulative normalized distribution, acceptable performance yields results between the 15th and 85th percentiles. Acceptable with warning results are between the 5th and 15th percentile and between the 85th and 95th percentile. Not acceptable results include the outer 10% (<5th percentile or >95th percentile) of historical data (EML-618, 621).

For the two studies conducted this year, QAP57 and QAP 58 (EML-618 and 621, respectively), the percentage of STL Richland's acceptable results ranged from 85% to 100% (Table D.12). The unacceptable results were for gross alpha and gross beta. Four constituents (18%) had results that were evaluated as acceptable with warning (Table D.12).

The percentage of Eberline Services' results that was acceptable ranged from 92% to 100% (Table D.13). The unacceptable result was for gross alpha. Three constituents had results that were evaluated as acceptable with warning (Table D.13).

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, and is similar in operation to DOE's Quality Assessment Program discussed above. 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.

Preliminary results for STL Richland for fiscal year 2003 (MAPEP-02-W10) were all acceptable (Table D.12). Results are not yet available for STL St. Louis, Eberline Services, or Lionville Laboratory.

D.5.1.3 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. The program provides blind standards that contain specific amounts of one or more radionuclides in a water matrix to participating laboratories. Environmental Resources Associates standards were prepared for the following radionuclides/parameters: barium-133, cesium-134, cesium-137, cobalt-60, gross alpha, gross beta, iodine-131, radium-226, radium-228, strontium-89, strontium-90, tritium, uranium, and zinc-65. 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).

In the two studies in which STL Richland participated this year (RAD 51 and 52), 29 constituents were analyzed. All were acceptable (Table D.12).

Eberline Services does not participate in the Environmental Resources Associates program.

D.5.2 Double-Blind Standard Evaluation

The groundwater project forwarded blind QC standards to STL Richland and St. Louis, Lionville Laboratory, and Eberline Services during fiscal year 2003. 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 prepared in a groundwater matrix from a background well. Some special metals standards from the fourth quarter were prepared in organic free, 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. Generally, if a result was out of limits, the data 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 if appropriate.

Tables D.14 and D.15 list the number and types of blind standards used in fiscal year 2003 along with the control limits for each constituent. Overall, 88% of the blind spike determinations were acceptable. This is lower than the percentage from the previous year (95%), although several additional constituents were evaluated this year. Thirty-three out of 295 results were out of limits for STL Richland and St. Louis. Total organic carbon, total organic halides, cyanide, cadmium, silver, elemental strontium, chloroform, trichloroethene, gross alpha, plutonium-239, and tritium were the constituents with out-of-limit results. Collectively, Lionville Laboratory and Eberline Services had 7 out of 31 unacceptable results. The affected constituents were total organic carbon, cyanide, and gross beta.

Most of STL St. Louis' results for total organic carbon were biased high, and three were outside the acceptance limits. Typical recoveries ranged from 107% to 121%. A similar tendency was observed in last year's blind standard results. The standards with the out-of-limit recoveries were spiked at the lowest level (1,010 µg/L, which is approximately equal to the laboratory's practical quantitation limit). The results from the third quarter were initially biased high by a factor of 2. As discussed earlier, the laboratory had some problems with the analysis during this timeframe, which

likely caused the results to be elevated. STL St. Louis re-analyzed the samples after the sparge-gas problem had been corrected, and the re-analysis results were acceptable. All of the fourth-quarter results were also within the acceptance limits.

Fourteen of 27 results for total organic halides from STL St. Louis were out of limits. Half of the unacceptable results were for standards spiked with 2,4,6-trichlorophenol. Three of the standards are believed to have been spiked incorrectly, based on a confirmatory analysis by gas chromatography-mass spectroscopy. The other phenolic standards with the out-of-limit results were spiked at a concentration close to the method detection limit. All of the unacceptable results for the standards spiked with volatile organic compounds had low recoveries (50% to 70%). PNNL staff performed in-house analyses on splits of the volatile standards and confirmed that the standards were spiked at the proper concentrations. Consequently, the reason for the low bias appears to be volatilization or weak retention of the volatile analytes on the charcoal cartridges used in the analysis. The laboratory investigated the out-of-limit results but was unable to determine the source of error. Low-biased total organic halide results are of concern because of the potential for not detecting halogenated organics at RCRA sites. However, even with a 50% negative bias, detection should occur at concentrations well below the limit of quantitation (discussed in Section D.6).

STL St. Louis' results for cyanide were highly variable for the standards submitted during the third and fourth quarters. Recoveries ranged from 40% to 102%. The laboratory re-analyzed those samples with out-of-limit results, and in some cases, the re-analysis results were acceptable. Reasons for the low recoveries are unknown, but loss of cyanide during sample distillation is suspected.

During August, some special blind standards containing metals were submitted to STL St. Louis to evaluate the laboratory's inductively coupled plasma mass spectroscopy (ICP-MS) capability. Two concentration levels were included in the study. High-level standards were spiked at concentrations ranging from 100 to 2,000 µg/L (10 to 100 times greater than the ICP-atomic emission spectroscopy [AES] detection limits). Low-level standards were spiked at 1/10 the concentrations of the high-level standards. The standards were analyzed by both ICP-MS and traditional ICP-AES for confirmatory purposes. Since many of the low-level standards' results were reported as non-detected by both methods, only the high-level results are included in this evaluation. A study to investigate the practical detection limits for the ICP-MS method is planned for next fiscal year. All of the ICP-AES results were acceptable, indicating that the standards had been prepared correctly. Cadmium, silver, and strontium had low recoveries by ICP-MS. Matrix interferences appeared to be responsible for the low-biased results, because the low-level spike results for these elements were acceptable, and matrix spikes associated with the high-level standards had low recoveries. These results have been discussed with STL St. Louis, and the laboratory is planning to investigate this problem further.

In general, STL Richland performed well on the analysis of radiological blind standards. Six results were outside the QC limits. Of these, three (tritium) are believed to be associated with incorrectly spiked standards. The out-of-limit results for gross alpha were from the second quarter; recoveries ranged from 71% to 73%. A procedural error at the laboratory may have caused the results to be biased low.

Lionville Laboratory had one out-of-limit result for total organic carbon and three unacceptable results for cyanide. The total organic carbon result was biased high (129% recovery), but the standard was spiked at a level near the laboratory's practical quantitation limit (1,000 µg/L). Reasons for the out-of-limit cyanide results are unknown. STL St. Louis had acceptable recoveries on splits of these standards, indicating that the standards were spiked correctly. The impact of the out-of-limit results is minimal because Lionville Laboratory did not analyze many routine groundwater samples for total organic carbon or cyanide during fiscal year 2003.

Eberline Services analyzed 12 blind standards for gross beta; all three of the results from the first quarter were approximately twice as high as the expected concentrations. The laboratory re-analyzed the samples with the out-of-limit results, but the re-analysis results were consistent with the original values. Since Eberline Services served as a backup laboratory (<10 samples analyzed for gross beta), the impact of the out-of-limit results is minor.

Fluor Hanford, Inc. sent no blind standards as part of interim action monitoring to the commercial laboratories in fiscal year 2003. The great similarity of matrices between the long-term and interim action monitoring samples and common use of the same laboratories make additional analysis of blind standards redundant.

D.5.3 Laboratory Internal QA/QC Programs

STL Richland, STL 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 (see PNNL-13080 for definitions of these terms). This information provides a means of assessing 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. An assessment of the laboratory QC data for fiscal year 2003 is summarized in this section. STL data are discussed in detail first. Table D.16 provides a summary of the STL QC data 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 D.17 through D.20. Constituents not listed in these tables did not exceed STL's QC limits. A brief summary of Lionville Laboratory and Eberline Services data is presented at the end of the section.

Most of this year's laboratory QC results were within acceptance limits, suggesting that the analyses were in control and reliable data were generated. Nevertheless, a number of parameters had unacceptable results.

Evaluation of results for method blanks was based on the frequency of detection above the blank QC limits. In general, these limits are two times the method detection limit for chemical constituents and two times the total propagated error for radiochemistry parameters. 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 D.17 summarizes method blank results from STL Richland and St. Louis. The ammonia and anions category had the greatest percentages of method blank results exceeding the QC limits. The following parameters had >10% of method blank results outside the QC limits: specific conductance, chloride, sulfate, iron, tin, methylene chloride, carbon-14, and uranium. The out-of-limit method blank results for specific conductance are not a significant problem because the values are much lower than the levels measured in Hanford Site groundwater. Similarly, the highest method blank results for chloride (0.2 mg/L), sulfate (0.36 mg/L), magnesium (350 µg/L), sodium (379 µg/L), and elemental strontium (0.086 µg/L) are lower than the respective levels measured in Hanford groundwater. The percentage of out-of-limit method blanks for nitrogen in ammonia, aluminum, beryllium, cadmium, calcium, copper, magnesium, and sodium decreased significantly compared to last year, while the percentage for vanadium and carbon-14 increased.

Table D.18 summarizes results for the laboratory control samples from STL Richland and St. Louis. Only volatile organic compounds and semivolatile organic compounds had >1% of their measurements outside the QC limits. Specific compounds with >10% of out-of-limit laboratory control samples included 1,1,2,2-tetrachloroethane, TPH gasoline, 2,4-dinitrophenol, 4,6-dinitro-2-methylphenol, 4-nitrophenol, Aroclor-1016, chrysene, delta-BHC, and uranium-238. In all of these cases except the phenols, the number of QC samples analyzed was limited (<20).

Table D.19 summarizes results for the matrix spikes and matrix spike duplicates from STL Richland and St. Louis. The general chemical parameters and ammonia and anions categories had the greatest percentage of matrix spikes/spike duplicates exceeding the QC limits. This represents an increase compared to last year's results for these two categories. Fewer than 5% of the matrix spikes or matrix spike duplicates for metals, volatile organic compounds, semivolatile organic compounds and radiochemistry parameters were out of limits. Table D.19 indicates which constituents had >10% of matrix spikes/spike duplicates out of limits.

Matrix duplicates were evaluated by comparing the relative percent difference to the QC limit for results that were five times greater than the method detection limit or the minimum detectable activity. Table D.20 lists the constituents that exceeded the relative percent difference limits. The semivolatile organic compounds category had the greatest percentage of matrix duplicates exceeding the QC limits. This represents an increase compared to last year's results for this category. All other categories had fewer than 3% of their measurements outside the QC limits. Constituents with >10% of matrix duplicates out of limits are listed in Table D.20.

Surrogate data included eight compounds each for volatile organics and for semivolatile organics. For volatile organic compounds, 3.6% of the surrogate results were outside of QC limits; the corresponding percentage for semivolatile organic surrogates was 4.5%.

QC data for Eberline Services and Lionville Laboratory were limited for fiscal year 2003 because these laboratories did not analyze many samples for the groundwater project. Lionville Laboratory analyzed method blanks, laboratory control samples, matrix spikes, and matrix duplicates for total organic carbon and cyanide. All of the QC data were within limits. Eberline Services QC data were limited to gross beta and strontium-90. All of the QC data were within limits.

D.5.3.1 Issue Resolution

Issue resolution forms are documents that are used to record and resolve problems encountered with sample receipt, sample analysis, missed hold times, and data reporting (e.g., broken bottles or QC problems). The laboratories generate the forms and forward 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 with the issues. The documentation is intended to identify occurrences, deficiencies, and/or issues that may potentially have an adverse effect on data integrity.

Table D.21 indicates the specific issues identified during fiscal year 2003 and the number of times these occurred. The number of issues identified by the laboratories was small compared to the total number of analytical requests submitted (~12,500, consisting of ~17,400 bottles). The frequencies of the individual issues increased in most categories prior to receipt at the laboratory but decreased in others after receipt at the laboratory. Most of the increases are related to the increase in the number of analytical requests submitted during fiscal year 2003. This increase of analytical requests is due to the addition of the interim action monitoring program samples being submitted to these laboratories. Previously, the samples were submitted to the secondary laboratory and were managed by Bechtel Hanford, Inc. The number of hold time issues was primarily related to delays caused by the need for radiological screens prior to shipment. A small percentage of the hold time issues were related to shipping delays.

D.5.3.2 Laboratory Audits/Assessments

Laboratory activities are regularly assessed by surveillance and auditing processes to ensure that quality problems are prevented and/or detected. Regular assessment supports continuous process improvement. Five assessments of the commercial analytical laboratories were performed. Four of these audits were conducted by the DOE-sponsored Environmental Management Consolidated Assessment Program (EMCAP), and one audit was conducted by a joint team of Bechtel Hanford, Inc. and PNNL representatives.

The goal of the EMCAP 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 EMCAP were to assess the ability of the laboratories to produce data of acceptable and documented quality through analytical operations that follow approved and technically sound methods and to handle DOE samples and associated waste in a manner that protects human health and the environment.

The four EMCAP audits were performed at the following laboratories: STL St. Louis, May 20-22, 2003; Eberline Services, June 3-5, 2003; Lionville Laboratory, June 24-26, 2003; and STL Richland, August 12-14, 2003. The assessment scope of the EMCAP audits included the following specific functional areas: (1) QA management systems and general laboratory practices, (2) data quality for organic analyses, (3) data quality for inorganic and wet chemistry analyses, (4) data quality for radiochemistry analysis, (5) hazardous and radioactive materials management, and (6) verification of corrective-action implementation from previous audit findings.

The purpose of the joint Bechtel Hanford, Inc. and PNNL assessment, conducted on March 18 to 20, 2003, was to evaluate the continued support of analytical services to Hanford Site contractors as specified in the statement of work between Fluor Hanford, Inc. and STL.^(b) The audit was based on the analytical and QA requirements for both groundwater and multi-media samples as specified in the statement of work. The primary areas of focus were personnel training, procedure compliance, sample receipt and tracking, instrument operation and calibration, equipment maintenance, instrumentation records and logbooks, implementation of STL's QA Management Plan in accordance with Hanford Analytical Services Quality Assurance Document (HASQARD, Volumes 1 and 4, DOE/RL-96-68), and the implementation of corrective actions for deficiencies identified in previous audits.

A total for 16 findings and 31 observations were noted for the 4 EMCAP audits, and 7 findings and 6 observations were identified in the joint Bechtel Hanford, Inc. and PNNL audit. Results of each of these audits are summarized in Table D.22. Corrective actions have been accepted for all the audits, and verification of the corrective actions will be performed in future audits. All laboratories have been qualified to continue to provide analytical services for samples generated at DOE sites.

(b) RFSH-SOW-93-0003, Rev. 6. 1999. *Environmental and Waste Characterization of Analytical Services*. Statement of Work between Fluor Daniel Hanford, Inc. and Severn Trent Laboratories, Richland, Washington.

In addition to many of the past audit findings being closed, several proficiencies for all of the laboratories were noted in each audit this year, indicating that the laboratories are improving their processes and continuing to provide quality analytical services. Continued assessments of the laboratories are planned for the upcoming year to further evaluate performance and to ensure those corrective actions for the past findings and observations have been implemented.

D.6 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, OSWER 9355.0-14). 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, in fact, absent. A false-negative error is an instance when an analyte is declared absent but is, in fact, 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 D.23 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 D.23 are most useful for assessing 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, OSWER 9355.0-14). 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.

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 D.23.

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 formulas are summarized below:

$$\begin{aligned}\text{MDL} &= 3.14 \times s \\ \text{LOD} &= 3 \times (\sqrt{2} \times s) \\ &= 4.24 \times s \\ \text{LOQ} &= 10 \times (\sqrt{2} \times s) \\ &= 14.14 \times s\end{aligned}$$

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 non-radiological constituents of concern (besides total organic carbon and total organic halides) are listed in Table D.24. The values in the table apply to STL St. Louis only.

Specific evaluation of detection-limit issues for the interim action groundwater monitoring program was not performed for this report. Detection-limit issues are primarily assessed as part of site-specific validation activities. No validation activities were performed on interim action groundwater monitoring data in fiscal year 2003.

D.7 Conclusions

Overall, assessments of fiscal year 2003 QA/QC information indicate that groundwater monitoring data are reliable and defensible. Sampling was conducted in accordance with reviewed procedures. Few contamination or other sampling-related problems were encountered that affected data integrity. Likewise, laboratory performance was excellent in most respects, based on the large percentages of acceptable field and laboratory QC results. Satisfactory laboratory audits and generally acceptable results in nationally based performance evaluation studies also demonstrated good laboratory performance. However, the following areas of concern were identified and should be considered when interpreting groundwater monitoring results:

- A few QC samples were probably swapped in the field or at the laboratory based on a small number of unusually high field blank results and duplicate results with poor precision. The same problem likely occurred for a small number of groundwater samples. Mismatched results for key constituents should be identified during data review.
- Several indicator parameters, anions, metals, volatile organic compounds, and radiological parameters were detected at low levels in field and/or laboratory method blanks. The most significant contaminants were alkalinity, copper, iron, methylene chloride, total organic halides, and zinc.
- Maximum recommended holding times were exceeded for ~1.4% of groundwater project samples that were analyzed by non-radiological methods. Anions were primarily affected, though the data impacts are considered minor.
- A laboratory problem caused several results for total organic carbon to be biased high. Samples collected during the last three quarters of the fiscal year may have been affected. The problem has been corrected, and most of the anomalous results have been flagged in the database.
- STL St. Louis had several out-of-limit blind-standard results for total organic halides. Most of the results had a low bias, suggesting that groundwater results for total organic halides may also be biased low. Both STL St. Louis and Lionville Laboratory had performance problems with cyanide and total organic carbon. Unacceptable blind-standard results were also reported by STL Richland for gross alpha, plutonium-239, tritium, and uranium. Finally, Eberline Services had out-of-limit results for gross beta.

D.8 References

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Table D.1. Long-Term Monitoring Full Trip Blanks Exceeding Quality Control Limits

Constituent	Number Out of Limits	Number of Analyses	Percent Out of Limits	Range of QC Limits ^(a)	Range of Out-of-Limit Results
General Chemical Parameters					
Alkalinity	4	47	8.51	2,376 - 8,086 µg/L	22,000 - 94,000 µg/L
Chemical oxygen demand	1	3	33.33	7,128 - 9,600 µg/L	8,000 µg/L
Total organic carbon	1	79	1.27	286 - 1,000 µg/L	670 µg/L
Total organic halides	1	59	1.69	4.40 - 7.96 µg/L	6.5 µg/L
Ammonia and Anions					
Chloride	11	57	19.30	58.2 - 89.8 µg/L	59 - 410 µg/L
Fluoride	6	57	10.53	61.6 - 80.6 µg/L	62 - 94 µg/L
Nitrogen in nitrate	4	57	7.02	8.8 - 22.3 µg/L	16 - 25 µg/L
Sulfate	9	57	15.79	74.8 - 108.1 µg/L	150 - 340 µg/L
Metals					
Antimony	2	47	4.26	45.6 - 89.6 µg/L	44.8 - 46.5 µg/L
Beryllium	2	47	4.26	0.52 - 1.46 µg/L	0.65 - 1.1 µg/L
Cobalt	4	47	8.51	4.4 - 10 µg/L	4.6 - 6.5 µg/L
Copper	2	47	4.26	1.72 - 6.4 µg/L	3.5 - 42.3 µg/L
Iron	1	47	2.13	5.6 - 98.8 µg/L	47.6 µg/L
Manganese	2	47	4.26	1.18 - 3.8 µg/L	0.81 - 2.3 µg/L
Nickel	1	47	2.13	20 - 31.6 µg/L	10.5 µg/L
Sodium	1	47	2.13	163.6 - 320 µg/L	556 µg/L
Vanadium	11	47	23.40	2.8 - 20.8 µg/L	4.8 - 9.1 µg/L
Zinc	5	47	10.64	2.6 - 7 µg/L	2.8 - 19.7 µg/L
Volatile Organic Compounds					
Methylene chloride	5	17	29.41	0.6 - 1.5 µg/L	1.6 - 6.1 µg/L
Radiological Parameters					
Gross beta	2	33	6.06	2.2 - 3.4 pCi/L ^(b)	3.3 - 5.33 pCi/L
Tritium	4	44	9.09	6.4 - 320 pCi/L ^(b)	17.1 - 276 pCi/L
Uranium	17	26	65.38	0.0007 - 0.046 µg/L ^(b)	0.0101 - 0.101 µg/L

(a) Because method detection limits 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.

(b) The limit for radiological analyses is determined by the sample-specific total propagated uncertainty.
QC = Quality control.

Table D.2. Long-Term Monitoring Field Transfer Blanks Exceeding Quality Control Limits

Constituent	Number Out of Limits	Number of Analyses	Percent Out of Limits	Range of QC Limits ^(a) (µg/L)	Range of Out-of-Limit Results (µg/L)
2-butanone	1	101	1.0	0.58	15
Acetone	1	101	1.0	3.3	11
Carbon disulfide	1	101	1.0	0.86	1.2
Carbon tetrachloride	1	101	1.0	0.3	0.4
Methylene chloride	74	101	73.3	1.5	1.6 - 13

(a) Because method detection limits 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.

QC = Quality control.

Table D.3. Long-Term Monitoring Equipment Blanks Exceeding Quality Control Limits

<u>Constituent</u>	<u>Number Out of Limits</u>	<u>Number of Analyses</u>	<u>Percent Out of Limits</u>	<u>Range of QC Limits^(a) (µg/L)</u>	<u>Range of Out-of- Limit Results (µg/L)</u>
General Chemical Parameters					
Total organic halides	4	5	80.0	4.40 - 7.96	10.1 - 12.4
Ammonia and Anions					
Chloride	2	3	66.7	58.2	68 - 85
Nitrogen in nitrate	1	3	33.3	8.8	41
Metals					
Aluminum	1	3	33.3	22.4 - 60.8	48
Copper	2	3	66.7	5.2 - 6.2	5.9 - 9.8
Manganese	1	3	33.3	1.18 - 3	1.9
Zinc	2	3	66.7	2.6 - 3.6	8.6 - 10

(a) Because method detection limits 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.
QC = Quality control.

Table D.4. Long-Term Monitoring Field Duplicates Exceeding Quality Control Limits

Constituent	Total Number of Duplicates	Number of Duplicates Evaluated ^(a)	Number Out of Limits	Percent Out of Limits	Range of Relative Percent Differences ^(b)
General Chemical Parameters					
Alkalinity	49	49	1	2.0	58.3
Oil and grease	2	1	1	100.0	55.4
Specific conductance	4	1	1	100.0	26.5
Ammonia and Anions					
Bromide	3	1	1	100.0	136.8
Chloride	57	57	1	1.8	20.6
Cyanide	7	1	1	100.0	57.4
Nitrogen in ammonia	7	1	1	100.0	179.1
Nitrogen in nitrite	57	1	1	100.0	20.9
Metals					
Cadmium	73	1	1	100.0	133.3
Copper	59	1	1	100.0	152.0
Iron	59	12	5	41.7	24.8 - 43.9
Manganese	59	17	2	11.8	23.7 - 28.0
Potassium	59	21	2	9.5	20.1 - 32.0
Vanadium	59	18	1	5.6	20.0
Zinc	59	17	1	5.9	95.4
Volatile Organic Compounds					
1,1,1-trichloroethane	22	5	1	20.0	34.5
1,4-dichlorobenzene	22	1	1	100.0	136.0
2-butanone	21	1	1	100.0	135.2
Acetone	21	1	1	100.0	125.6
Methylene chloride	22	2	2	100.0	98.2 - 168.0
Semivolatile Organic Compounds					
Tributyl phosphate	1	1	1	100.0	28.6
Radiological Parameters					
Carbon-14	1	1	1	100.0	22.0
Gross alpha	33	5	2	40.0	23.6 - 63.1
Gross beta	37	18	4	27.8	21.5 - 35
Iodine-129	17	3	1	33.3	185.1
Technetium-99	32	18	4	22.2	20.1 - 25.1
Uranium	30	30	3	10.0	23.9 - 148.4
Uranium-238	1	1	1	100.0	23.4

(a) Duplicates with both results <5 times the method detection limit or minimum detectable activity were excluded from the evaluation.

(b) 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 D.5. Long-Term Monitoring Split Sample Results for Total Organic Carbon

Well	Sampling Date	Number of Split Sample Pairs	STL St. Louis Average Concentration ($\mu\text{g/L}$) ^(a)	Lionville Laboratory Average Concentration ($\mu\text{g/L}$) ^(a)
299-E33-33	06/25/03	4	1,725	675 ^(b)
299-E33-33	07/31/03	4	1,275	515 ^(b)
299-E33-34	07/31/03	4	1,600	648
299-E33-36	06/25/03	4	2,375	550 ^(b)
299-E33-36	07/31/03	4	1,250	528 ^(b)
699-22-35	08/13/03	1	8,700	500 ^(b)
699-23-34A	08/14/03	1	390 ^(b)	500 ^(b)
699-24-34B	08/14/03	2	390 ^(b)	500 ^(b)
699-24-35	08/13/03	1	5,100	690

(a) In cases where total organic carbon was not detected, the method detection limit was used to calculate the average.

(b) One or more results were non-detected.

Table D.6. Interim Action Monitoring Field Blank Detections

Constituent	Number of Detects	Number of Analyses ^(a)	Percent Out of Limits	RDL ^(b) ($\mu\text{g/L}$)	Range of Detected Results ($\mu\text{g/L}$)
Anions					
Chloride	1	12	8.3	500	91
Fluoride	1	12	8.3	500	120
Nitrate	3	12	25.0	250	29.7 - 66.4
Sulfate	1	12	8.3	500	230
Metals					
Aluminum	1	16	6.3	200	40.6
Beryllium	1	16	6.3	5	0.88
Copper	7	16	43.8	25	0.99 - 25.0
Iron	2	16	12.5	100	23.0 - 55.4
Potassium	1	16	6.3	5,000	3,900
Zinc	4	16	25.0	20	2.6 - 15.4
Volatile Organic Compounds					
1,2-dichloroethane	1	5	20.0	5	0.28
Carbon tetrachloride	1	5	20.0	5	0.66
Methylene chloride	3	5	60.0	5	2.9 - 5.3
Radiological Parameters					
Uranium	1	1	100.0	1	0.36
Tritium	1	9	11.1	200 ^(c)	291 ^(c)

(a) Results that were <5 times the method detection limit and where method blank contamination was also present were excluded from the evaluation.

(b) Contractually defined required detection limit.

(c) Units for tritium are pCi/L.

Table D.7. Interim Action Monitoring Field Duplicates Exceeding Quality Control Limits

Constituent	Total Number of Duplicates	Number of Duplicates Evaluated ^(a)	Number Out of Limits	Percent Out of Limits	Range of Relative Percent Differences
Ammonia and Anions					
Fluoride	11	7	2	28.6	27 - 70
Nitrate	11	11	1	9.0	50
Metals					
Aluminum	18	1	1	100.0	26
Vanadium	18	16	2	12.5	39 - 45
Zinc	18	4	1	25.0	93
Radiological Parameters					
Uranium	5	4	2	50.0	37 - 54
Technetium-99	2	1	1	100.0	25
Strontium-90	5	3	1	33.3	40

(a) Duplicates with both results <5 times the method detection limit or minimum detectable activity were excluded from the evaluation.

Table D.8. Interim Action Monitoring Interlaboratory Splits Exceeding Quality Control Limits

Constituent	Total Number of Splits	Number of Splits Evaluated ^(a)	Number Out of Limits	Percent Out of Limits	Range of Relative Percent Differences
Metals					
Aluminum	12	3	2	66.6	49 - 105
Chromium	12	10	2	20.0	47 - 82
Iron	12	7	5	71.4	22 - 73
Manganese	12	2	1	50.0	24
Potassium	12	8	1	12.5	25
Vanadium	12	9	7	77.8	23 - 100
Zinc	12	9	3	33.3	21 - 149
Radiological Parameters					
Carbon-14	1	1	1	100.0	29
Gross beta	7	4	2	50.0	43 - 50
General Organics					
Diesel range organics	1	1	1	100.0	141
Oil and grease	1	1	1	100.0	156
Fixed Laboratory-Field Analyses					
Hexavalent chromium	53	42	4	9.5	22 - 139
Sulfate	12	12	1	8.3	27

(a) Split sample pairs with both results <5 times the method detection limit or minimum detectable activity were excluded from the evaluation.

Table D.9. Groundwater Performance Assessment Project Maximum Recommended Holding Times

Method	Constituent	Holding Time
8010/8020/8260 (SW-846)	Volatile organics	14 days
8270 (SW-846)	Semivolatile organics	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
8040 (SW-846)	Phenols	7 days before extraction; 40 days after extraction
6010 (SW-846)	Inductively coupled plasma metals	6 months
7060 (SW-846)	Arsenic	6 months
7131 (SW-846)	Cadmium	6 months
7191 (SW-846)	Chromium	6 months
7421 (SW-846)	Lead	6 months
7470 (SW-846)	Mercury	28 days
7740 (SW-846)	Selenium	6 months
7841 (SW-846)	Thallium	6 months
9012 (SW-846)	Cyanide	14 days
9020 (SW-846)	Total organic halides	28 days
9060 (SW-846)	Total organic carbon	28 days
9131 (SW-846)	Coliform	1 day
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

Table D.10. Summary of Severn Trent-St. Louis Water Pollution (WP) Performance Evaluation Studies

<u>Accreditation Laboratory</u>	<u>WP-97</u> April 2003 Acceptable <u>Results/Total</u>	<u>WP-99</u> June 2003 Acceptable <u>Results/Total</u>	<u>WP-100</u> July 2003 Acceptable <u>Results/Total</u>	<u>WP-101</u> August 2003 Acceptable <u>Results/Total</u>	<u>WP-102</u> September 2003 Acceptable <u>Results/Total</u>
Environmental Resource Associates	214/220 ^(a)	7/7	5/6 ^(b)	4/5 ^(b)	190/212 ^(c)

(a) Unacceptable results were for conductivity, pH, orthophosphate as P, total phosphorus as P, 1,2-dichloroethane, and grease and oil.

(b) Unacceptable result was for total Kjeldahl nitrogen.

(c) Unacceptable results were for total Kjeldahl nitrogen, conductivity, acenaphthene, acenaphthylene, benzo(a)anthracene, benzo(b)fluoranthene, bis(2-chloroethoxy)methane, bis(2-chloroethyl)ether, 4-chlorophenyl-phenylether, 2,4-dinitrotoluene, 2,6-dinitrotoluene, bis(2-ethylhexyl)phthalate, fluoranthene, fluorene, hexachlorobenzene, hexachlorobutadiene, hexachlorocyclopentadiene, isophorone, N-nitrosodimethylamine, N-nitroso-di-n-propylamine, phenanthrene, and 1,2,4-trichlorobenzene.

Table D.11. Summary of Lionville Laboratory Water Pollution (WP) Performance Evaluation Studies

<u>Accreditation Laboratory</u>	<u>WP-92</u> November 2002 Acceptable <u>Results/Total</u>	<u>WP-96</u> March 2003 Acceptable <u>Results/Total</u>
Environmental Resource Associates	1/1 ^(a)	221/223 ^(b)

(a) Makeup for WP-90.

(b) Unacceptable results were for sodium and dicamba.

Table D.12. Summary of Severn Trent Interlaboratory Performance, Fiscal Year 2003

Radionuclides	Number of Results Reported for Each	Number Within Acceptable Control Limits
DOE Quality Assessment Program (QAP57, 58) Environmental Measurements Laboratory		
Americium-241, cesium-134, cesium-137, cobalt-60, plutonium-238, plutonium-239, strontium-90, tritium, uranium-234, uranium-238, total uranium	2	2 ^(a,b)
Gross alpha, gross beta	2	1 ^(a)
DOE Mixed Analyte Performance Evaluation Program (MAPEP-02-W10) Radiological and Environmental Sciences Laboratory		
Americium-241, cesium-134, cesium-137, cobalt-57, cobalt-60, iron-55, manganese-54, nickel-63, plutonium-238, plutonium-239/240, strontium-90, technetium-99, uranium-234/233, uranium-238, zinc-65	1	1 ^(c)
ERA InterLaB RadChem Proficiency Testing Program (RAD 51, 52) Environmental Resource Associates		
Gross alpha, gross beta, radium-226, radium-228, uranium	3	3 ^(d,e)
Cesium-134, cesium-137, cobalt-60, strontium-89, strontium-90	2	2 ^(d)
Barium-133, iodine-131, tritium, zinc-65	1	1 ^(d)

(a) Control limits from EML-618 and EML-621.

(b) One result each for cesium-134, plutonium-238, plutonium-239, and strontium-90 was acceptable but outside warning limits.

(c) Preliminary results from STL Richland.

(d) Control limits from National Standards for Water Proficiency Testing Studies Criteria Document.

(e) These constituents were analyzed twice in one study.

Table D.13. Summary of Eberline Services Interlaboratory Performance, Fiscal Year 2003

Radionuclides	Number of Results Reported for Each	Number Within Acceptable Control Limits
DOE Quality Assessment Program (QAP57, 58) Environmental Measurements Laboratory		
Americium-241, cesium-134, cesium-137, cobalt-60, gross beta, plutonium-238, plutonium-239, strontium-90, tritium, uranium-234, uranium-238, uranium	2	2 ^(a,b)
Gross alpha	2	1 ^(a,b)

(a) Control limits from EML-618 and EML-621.

(b) One result each for gross alpha, plutonium-238, and plutonium-239 was acceptable but outside warning limits.

Table D.14. Summary of Severn Trent Laboratories Double-Blind Spike Determinations

Constituent	Laboratory	Sample Frequency	Number of Results Reported ^(a)	Number of Results Outside QC Limits ^(b)	Control Limits ^(c) (%)
General Chemical Parameters					
Specific conductance	St. Louis	Quarterly	12	0	±25
Total organic carbon (potassium hydrogen phthalate spike)	St. Louis	Quarterly	16	2	±25
Total organic halides (2,4,6-trichlorophenol spike)	St. Louis	Quarterly	14	7	±25
Total organic halides (carbon tetrachloride, chloroform, and trichloroethene spike)	St. Louis	Quarterly	13	7	±25
Anions					
Cyanide	St. Louis	Quarterly	13	2	±25
Fluoride	St. Louis	Quarterly	12	0	±25
Nitrogen in nitrate	St. Louis	Quarterly	12	0	±25
Metals					
Aluminum	St. Louis	Annually	4	0	±25
Arsenic	St. Louis	Annually	2	0	±25
Barium	St. Louis	Annually	4	0	±25
Beryllium	St. Louis	Annually	4	0	±25
Boron	St. Louis	Annually	2	0	±25
Cadmium	St. Louis	Annually	4	2	±25
Calcium	St. Louis	Annually	4	0	±25
Chromium	St. Louis	Semiannually	7	0	±20
Cobalt	St. Louis	Annually	4	0	±25
Copper	St. Louis	Annually	4	0	±25
Iron	St. Louis	Annually	4	0	±25
Lead	St. Louis	Annually	2	0	±25
Magnesium	St. Louis	Annually	2	0	±25
Manganese	St. Louis	Annually	4	0	±25
Nickel	St. Louis	Annually	4	0	±25
Potassium	St. Louis	Annually	2	0	±25
Selenium	St. Louis	Annually	2	0	±25
Silicon	St. Louis	Annually	2	0	±25
Silver	St. Louis	Annually	4	2	±25
Sodium	St. Louis	Annually	4	0	±25
Strontium	St. Louis	Annually	4	2	±25
Thallium	St. Louis	Annually	2	0	±25
Titanium	St. Louis	Annually	2	0	±25
Vanadium	St. Louis	Annually	4	0	±25
Zinc	St. Louis	Annually	4	0	±25
Volatile Organic Compounds					
Carbon tetrachloride	St. Louis	Quarterly	12	0	±25
Chloroform	St. Louis	Quarterly	12	1	±25
Trichloroethene	St. Louis	Quarterly	12	2	±25
Radiological Parameters					
Gross alpha (plutonium-239 spike)	Richland	Quarterly	12	2	±25
Gross beta (strontium-90 spike)	Richland	Quarterly	12	0	±25
Cesium-137	Richland	Annually	3	0	±30

Table D.14. (contd)

Constituent	Laboratory	Sample Frequency	Number of Results Reported ^(a)	Number of Results Outside QC Limits ^(b)	Control Limits ^(c) (%)
Radiological Parameters (contd)					
Cobalt-60	Richland	Annually	3	0	±30
Iodine-129	Richland	Semiannually	6	0	±30
Plutonium-239	Richland	Quarterly	12	1	±30
Strontium-90	Richland	Semiannually	6	0	±30
Technetium-99	Richland	Quarterly	12	0	±30
Tritium	Richland	Semiannually	6	3	±30
Uranium-238	Richland	Quarterly	12	0	±30

(a) Blind standards were generally submitted in duplicate, triplicate, or quadruplicate.

(b) Quality control limits are given in the Groundwater Performance Assessment Project's Quality Assurance plan.

(c) Each result must be within the specified percentage of the known value to be acceptable.

QC = Quality control.

Table D.15. Summary of Lionville Laboratory, Inc. and Eberline Services Double-Blind Spike Determinations

Constituent	Laboratory	Sample Frequency	Number of Results Reported ^(a)	Number of Results Outside QC Limits ^(b)	Control Limits ^(c) (%)
General Chemical Parameters					
Total organic carbon (potassium hydrogen phthalate spike)	Lionville	Quarterly	14	1	±25
Ammonia and Anions					
Cyanide	Lionville	Annually	3	3	±25
Radiological Parameters					
Gross beta (strontium-90 spike)	Eberline	Quarterly	12	3	±25

(a) Blind standards were submitted in triplicate or quadruplicate.

(b) Quality control limits are given in the Groundwater Performance Assessment Project's Quality Assurance plan.

(c) Each result must be within the specified percentage of the known value to be acceptable.

QC = Quality control.

Table D.16. Percentage of Out-of-Limit Quality Control Results by Category, Severn Trent Laboratories (Richland and St. Louis)

Quality Control Parameter	General Chemistry Parameters	Ammonia and Anions	Metals	Volatile Organic Compounds	Semivolatile Organic Compounds	Radiological Parameters	Total
Method blanks	1.5	8.1	3.5	1.0	0.001	1.8	2.3
Laboratory control samples	0.3	0	0	1.6	2.5	0.4	0.9
Matrix spikes	9.0	8.9	0.4	2.2	4.8	2.7	2.4
Matrix duplicates	1.3	0.2	0	2.7	9.6	1.7	2.4
Surrogates	--	--	--	3.6	4.5	--	3.8

Table D.17. Method Blank Results, Severn Trent Laboratories (Richland and St. Louis)

Constituent	Percent Out of Limit ^(a)	Number of Analyses	Concentration Range of Out-of-Limit Results
General Chemical Parameters			
Total general chemical parameters	1.5	328	--
Conductivity	45.5	11	0.43 - 0.58 µS/cm
Ammonia and Anions			
Total ammonia and anions	8.1	1,030	--
Bromide	4.5	22	0.087 mg/L
Chloride	17.9	190	0.059 - 0.2 mg/L
Fluoride	5.8	190	0.064 - 0.13 mg/L
Nitrogen in nitrate	3.7	190	0.01 - 0.014 mg/L
Sulfate	15.8	190	0.18 - 0.36 mg/L
Metals			
Total metals	3.5	2,099	--
Aluminum	8.7	103	23.8 - 131 µg/L
Beryllium	8.4	107	0.0013 - 1.5 µg/L
Chromium	1.8	110	2.6 - 3.1 µg/L
Copper	3.9	102	1.8 - 4.6 µg/L
Iron	11.7	103	8.4 - 112 µg/L
Lead	7.4	27	0.93 - 2.4 µg/L
Magnesium	1.9	103	163 - 350 µg/L
Manganese	5.8	104	1.4 - 2.5 µg/L
Potassium	1.0	103	2,710 µg/L
Silver	0.9	106	7.6 µg/L
Sodium	4.8	104	204 - 379 µg/L
Strontium	1.0	103	0.086 µg/L
Tin	50.0	2	7.8 µg/L
Vanadium	9.6	104	2.9 - 16.8 µg/L
Zinc	6.9	102	4 - 17.3 µg/L
Volatile Organic Compounds			
Total volatile organic compounds	1.0	3,008	--
2-butanone	1.7	115	5.4 - 6.1 µg/L
4-methyl-2-pentanone	1.7	115	0.77 - 2.3 µg/L
Acetone ^(b)	7.8	115	3.6 - 7.0 µg/L
Methylene chloride ^(b)	14.5	117	1.6 - 4.5 µg/L
Semivolatile Organic Compounds			
Total semivolatile organic compounds	0.001	1,707	--
2,3,4,6-tetrachlorophenol	2.6	39	8.4 µg/L
Radiological Parameters			
Total radiological parameters	1.8	1,138	--
Carbon-14	14.3	7	36.6 pCi/L
Gross alpha	1.4	69	12.9 pCi/L
Gross beta	1.4	71	3.98 pCi/L
Strontium-90	3.8	53	1.17 - 1.25 pCi/L
Tritium	2.4	164	17.4 - 29.2 pCi/L
Uranium	15.5	71	0.0238 - 0.217 pCi/L

(a) Quality control limits are twice the method detection limit.

(b) Quality control limits are five times the method detection limit.

Table D.18. Laboratory Control Samples, Severn Trent Laboratories (Richland and St. Louis)

<u>Constituent</u>	<u>Percent Out of Limit</u>	<u>Number of Analyses</u>
General Chemical Parameters		
Total general chemical parameters	0.3	330
Total organic carbon	1.1	89
Ammonia and Anions		
Total ammonia and anions	0.0	1,030
Metals		
Total metals	0.0	1,992
Volatile Organic Compounds		
Total volatile organic compounds	1.6	2,217
1,1,1-trichloroethane	0.9	115
1,1,2,2-tetrachloroethane	33.3	3
1,1,2-trichloroethane	0.9	115
1,1-dichloroethane	0.9	115
1,2-dichloroethane	1.7	116
2-butanone	3.5	115
4-methyl-2-pentanone	2.6	115
Acetone	7.0	115
Carbon disulfide	0.9	115
Carbon tetrachloride	0.8	126
Chloroform	0.9	117
Methylene chloride	1.7	115
Toluene	5.1	118
TPH gasoline	12.5	16
Vinyl chloride	0.9	116
Semivolatile Organic Compounds		
Total semivolatile organic compounds	2.5	1,162
2,4,5-trichlorophenol	2.5	40
2,4,6-trichlorophenol	2.5	40
2,4-dichlorophenol	2.4	41
2,4-dimethylphenol	2.5	40
2,4-dinitrophenol	10.0	40
2,6-dichlorophenol	3.2	31
2-chlorophenol	2.5	40
2-methylphenol	2.4	41
2-nitrophenol	2.4	41
2-sec-Butyl-4,6-dinitrophenol	2.9	35
3-+4-methylphenol	3.2	31
4,6-dinitro-2-methylphenol	10.0	40
4-chloro-3-methylphenol	2.5	40
4-nitrophenol	10.0	40
Aroclor-1016	25.0	4
Chrysene	11.1	9
delta-BHC	50.0	2
Oil and grease	9.1	11
Pentachlorophenol	2.4	41
Phenol	2.4	41
Radiological Parameters		
Total radiological parameters	0.4	847
Technetium-99	1.1	87
Uranium-238	18.2	11

Table D.19. Matrix Spikes and Matrix Spike Duplicates, Severn Trent Laboratories (Richland and St. Louis)

<u>Constituent</u>	<u>Percent Out of Limit</u>	<u>Number of Analyses</u>
General Chemical Parameters		
Total general chemical parameters	9.0	166
Total organic carbon	11.1	99
Total organic halides	6.1	66
Ammonia and Anions		
Total ammonia and anions	8.9	382
Chloride	3.2	63
Cyanide	25.9	27
Fluoride	14.3	63
Nitrogen in nitrate	19.0	63
Nitrogen in nitrite	3.2	63
Phosphate	16.7	6
Sulfate	1.5	67
Metals		
Total metals	0.4	3,618
Antimony	1.1	178
Cadmium	1.6	190
Chromium	1.1	186
Iron	0.6	178
Nickel	0.6	178
Silver	1.1	178
Strontium	1.1	178
Tin	33.3	6
Zinc	0.6	178
Volatile Organic Compounds		
Total volatile organic compounds	2.2	2,176
1,1,1-trichloroethane	0.9	110
1,2-dichloroethane	2.7	112
4-methyl-2-pentanone	3.6	110
Benzene	0.9	114
Carbon tetrachloride	20.5	112
Chloroform	4.5	112
Chloromethane	33.3	6
Ethylbenzene	0.9	110
Methylene chloride	5.5	110
TPH gasoline	7.7	26
Semivolatile Organic Compounds		
Total semivolatile organic compounds	4.8	1,672
2-(2,4-dichlorophenoxy)propionic acid	50.0	4
2,2-dichloropropionic acid	25.0	4
2,4,5-T	50.0	4
2,4,5-TP (silvex)	50.0	4
2,4,5-trichlorophenol	8.8	57
2,4,6-trichlorophenol	5.3	57
2,4-D	50.0	4
2,4-dichlorophenol	3.4	59
2,4-dimethylphenol	5.3	57
2,4-dinitrophenol	12.3	57
2,6-dichlorophenol	2.3	44
2-chlorophenol	1.8	57
2-methylphenol	3.4	59
2-nitrophenol	6.8	59
2-sec-Butyl-4,6-dinitrophenol	10.4	48
4-(2,4-dichlorophenoxy)butyric acid	50.0	4
4,6-dinitro-2-methylphenol	14.0	57
4-chloro-3-methylphenol	1.8	57
4-methylphenol	25.0	8
4-nitrophenol	8.8	57

Table D.19. (contd)

<u>Constituent</u>	<u>Percent Out of Limit</u>	<u>Number of Analyses</u>
Semivolatile Organic Compounds (contd)		
Aroclor-1016	25.0	8
Chrysene	15.4	13
Dibenz[a,h]anthracene	7.7	13
Hexachlorocyclopentadiene	15.4	13
Hexachloroethane	15.4	13
Pentachlorophenol	13.6	59
Phenol	1.7	59
TPH diesel	12.5	24
Radiological Parameters		
Total radiological parameters	2.7	148
Technetium-99	4.9	81

Table D.20. Matrix Duplicates, Severn Trent Laboratories (Richland and St. Louis)

<u>Constituent</u>	<u>Percent Out of Limit</u>	<u>Number of Analyses</u>
General Chemical Parameters		
Total general chemical parameters	1.3	452
Total organic carbon	2.3	176
Total organic halides	2.9	68
Ammonia and Anions		
Total ammonia and anions	0.2	1,405
Nitrogen in ammonia	2.6	39
Nitrogen in nitrate	0.4	252
Sulfate	0.4	256
Metals		
Total metals	0.0	1,809
Volatile Organic Compounds		
Total volatile organic compounds	2.7	1,201
1,1,1-trichloroethane	1.6	61
1,1-dichloroethene	3.2	31
2-butanone	6.6	61
4-methyl-2-pentanone	3.3	61
Acetone	14.8	61
Bromomethane	66.7	3
Carbon disulfide	4.9	61
Carbon tetrachloride	1.6	63
Methylene chloride	3.3	61
Tetrachloroethene	1.6	62
TPH gasoline	7.1	14
Trichloroethene	1.6	62
Vinyl chloride	8.1	62
Semivolatile Organic Compounds		
Total semivolatile organic compounds	9.6	1,148
2-(2,4-dichlorophenoxy)propionic acid	25.0	4
2,2-dichloropropionic acid	50.0	4
2,3,4,6-tetrachlorophenol	12.1	33
2,4,5-T	25.0	4
2,4,5-TP (silvex)	25.0	4
2,4,5-trichlorophenol	12.2	41
2,4,6-trichlorophenol	12.2	41
2,4-D	25.0	4
2,4-dichlorophenol	14.3	42
2,4-dimethylphenol	4.9	41
2,4-dinitrophenol	17.1	41
2,6-dichlorophenol	6.1	33
2-chlorophenol	9.8	41
2-methylphenol	14.3	42
2-nitrophenol	14.3	42
2-sec-Butyl-4,6-dinitrophenol	8.1	37
3-+4-methylphenol	12.1	33
4-(2,4-dichlorophenoxy)butyric acid	25.0	4
4,6-dinitro-2-methylphenol	4.9	41
4-chloro-3-methylphenol	9.8	41
4-chloroaniline	12.5	8
4-methylphenol	16.7	6
4-nitrophenol	26.8	41
Aroclor-1016	25.0	4
Aroclor-1260	25.0	4

Table D.20. (contd)

<u>Constituent</u>	<u>Percent Out of Limit</u>	<u>Number of Analyses</u>
Semivolatile Organic Compounds (contd)		
Benzo(ghi)perylene	12.5	8
Dibenz[a,h]anthracene	37.5	8
Dicamba	25.0	4
Indeno(1,2,3-cd)pyrene	12.5	8
Oil and grease	9.5	21
Pentachlorophenol	16.7	42
Phenol	28.6	42
TPH diesel	7.1	14
Radiological Parameters		
Total radiological parameters	1.7	1,038
Americium-241	60.0	5
Carbon-14	14.3	7
Cobalt-60	2.0	50
Gross beta	2.9	69
Iodine-129	5.1	59
Technetium-99	4.9	82
Tritium	1.2	83
Uranium	4.5	66

Table D.21. Summary of Issue Resolution Forms Received from Severn Trent Laboratories (Richland and St. Louis) for Fiscal Year 2003

<u>Issue Category</u>	<u>Number of Occurrences</u>	
	<u>Prior to Receipt at the Laboratory</u>	<u>After Receipt at the Laboratory</u>
Hold time missed	241	43
Broken bottles	5	
Missing samples	3	
Temperature deviation	3	
pH variance	60	
Bottle size/type (insufficient volume)	6	
Chain of custody forms incomplete	21	
Laboratory QC out of limits		99
Analytical preparation deviations		17
Method failures/discontinued analyses		38

QC = Quality control.

Table D.22. Results of Laboratory Assessments

<u>Laboratory</u>	<u>Audit Team</u>	<u>Findings</u>	<u>Observations</u>	<u>Summary of Results</u>
STL-St. Louis, MO	EMCAP	10	8	Findings related to insufficient documentation for training, internal chain of custody not maintained for fractions, lack of procedures or incomplete procedures, lack of control charts for method QC, and lack of initial verification of standards. Observations related to inconsistent general laboratory practices.
Eberline Services-Richmond, CA	EMCAP	0	4	Observations related to QA Management systems and general laboratory practices (i.e., training documentation, expired standards, incomplete documentation).
Lionville Laboratory, Inc.-Lionville, PA	EMCAP	3	11	Findings related to use of expired standards, unclear documentation of sample disposition, and receiving and inspecting of samples outside the fume hood. Observations were related to incomplete procedures, lack of procedures, and inconsistent general practices within the laboratory.
STL-Richland, WA	EMCAP	3	8	Findings related to lateness in the annual review of Radiation Radiation Protection Program, incomplete site-specific information in the Waste Management Plan, and mis-match in the STL acceptance criteria for standard verification to the requirements of the Basic Order Agreement. Observations related to incomplete procedures, missing reviews of logbooks, and inconsistent general practices within the laboratory.
STL-St. Louis, MO	PNNL/BHI Joint Team	7	6	Findings related to inadequate compliance to STL procedures, inadequate training of personnel, inadequate standard certification, insufficient SOPs and document control, inadequate implementation of the HASQARD requirements in the STL QA Program. Observations related mostly to inconsistent general laboratory practices.

BHI = Bechtel Hanford, Inc.
 EMCAP = Environmental Management Consolidated Audit Program.
 HASQARD = Hanford Analytical Services Quality Requirements Document.
 PNNL = Pacific Northwest National Laboratory.
 QA = Quality assurance.
 QC = Quality control.
 SOP = Standard operating procedure.
 STL = Severn Trent, Inc.

Table D.23. Summary of Analytical Laboratory Detection/Quantitation Limits Determined from Field Blanks Data, Severn Trent Laboratories (Richland and St. Louis)

Period ^(a)	Number of Samples	Mean	Standard Deviation	Limit of Detection	Limit of Quantitation
Constituent: Total Organic Carbon (µg/L)					
12/14/01 - 11/15/02	50 ^(b)	150.38	122.49	370 ^(c)	1,220 ^(c)
03/12/02 - 03/07/03	59	90.37	128.94	390	1,290
05/17/02 - 06/24/03	64	64.06	128.06	380	1,280
10/04/02 - 09/29/03	73	66.10	135.88	410	1,360
Summary	73	66.10	135.88	410	1,360
Constituent: Total Organic Halides (µg/L)					
12/14/01 - 11/15/02	48	0.61	1.12	3.3 ^(c)	11.2 ^(c)
03/12/02 - 03/04/03	52	0.57	1.36	4.1	13.6
06/06/02 - 06/25/03	55	0.56	1.36	4.1	13.6
10/04/02 - 09/29/03	59	0.62	1.49	4.5	14.9
Summary	59	0.62	1.49	4.5	14.9
Constituent: Cesium-137 (pCi/L)					
10/18/02 - 12/13/02	4	-0.79	1.36	4.08 ^(c)	13.61 ^(c)
01/07/03 - 03/24/03	8	0.15	1.19	3.58	11.95
05/14/03 - 09/29/03	3	-0.95	0.44	1.32	4.40
Summary	15	-0.32	1.15	3.46	11.53
Constituent: Cobalt-60 (pCi/L)					
10/18/02 - 12/13/02	4	0.30	1.43	4.30 ^(c)	14.33 ^(c)
01/07/03 - 03/24/03	8	-0.18	1.11	3.33	11.11
05/14/03 - 09/29/03	3	0.71	0.47	1.40	4.68
Summary	15	0.13	1.13	3.38	11.27
Constituent: Europium-152 (pCi/L)					
02/05/03 - 09/29/03	8	0.91	2.02	6.05 ^(c)	20.18 ^(c)
Constituent: Europium-154 (pCi/L)					
10/18/02 - 12/13/02	4	1.47	4.57	13.71 ^(c)	45.71 ^(c)
01/07/03 - 03/24/03	8	-0.32	3.16	9.48	31.61
05/14/03 - 09/29/03	3	1.45	4.05	12.15	40.51
Summary	15	0.51	3.71	11.14	37.13
Constituent: Europium-155 (pCi/L)					
10/18/02 - 12/13/02	4	1.73	1.50	4.50 ^(c)	15.00 ^(c)
01/07/03 - 03/24/03	8	-0.38	1.64	4.91	16.37
05/14/03 - 09/29/03	3	-0.61	1.21	3.64	12.14
Summary	15	0.13	1.54	4.62	15.40
Constituent: Gross Alpha (pCi/L)					
10/02/02 - 12/18/02	16	0.04	0.20	0.60 ^(c)	1.99 ^(c)
01/06/03 - 03/24/03	10	0.13	0.25	0.76	2.54
04/03/03 - 06/23/03	8	0.06	0.09	0.27	0.89
07/08/03 - 09/08/03	4	-0.00	0.05	0.16	0.53
Summary	38	0.06	0.19	0.57	1.91
Constituent: Gross Beta (pCi/L)					
10/02/02 - 12/13/02	16	0.48	0.62	1.85 ^(c)	6.18 ^(c)
01/06/03 - 03/24/03	11 ^(b)	0.80	0.66	1.99	6.63
04/03/03 - 06/23/03	8	1.01	1.12	3.35	11.18
07/08/03 - 09/08/03	4	1.17	1.51	4.53	15.09
Summary	39	0.75	0.86	2.57	8.57

Table D.23. (contd)

<u>Period</u>	<u>Number of Samples</u>	<u>Mean</u>	<u>Standard Deviation</u>	<u>Limit of Detection</u>	<u>Limit of Quantitation</u>
Constituent: Iodine-129 (pCi/L)					
10/02/02 - 12/18/02	8	-0.02	0.07	0.22 ^(c)	0.72 ^(c)
01/09/03 - 02/13/03	5	-0.04	0.06	0.19	0.63
04/03/03 - 06/23/03	3 ^(b)	0.00	0.24	0.73	2.43
07/08/03 - 09/08/03	4	-0.07	0.04	0.12	0.40
Summary	20	-0.03	0.10	0.31	1.05
Constituent: Strontium-90 (pCi/L)					
10/02/02 - 12/18/02	5	0.07	0.07	0.22 ^(c)	0.75 ^(c)
01/06/03 - 03/04/03	7	0.14	0.07	0.21	0.70
07/08/03 - 09/29/03	2	0.27	0.23	0.70	2.33
Summary	14	0.14	0.1	0.30	0.98
Constituent: Technetium-99 (pCi/L)					
10/02/02 - 12/18/02	9	-0.00	5.60	16.8 ^(c)	56.0 ^(c)
01/06/03 - 03/12/03	9	1.33	5.82	17.5	58.2
04/03/03 - 06/17/03	8	4.75	4.25	12.8	42.5
07/10/03 - 09/15/03	7	7.96	6.36	19.1	63.6
Summary	33	3.20	5.54	16.6	55.4
Constituent: Tritium (pCi/L)					
10/04/02 - 12/18/02	17	121.9	96.9	291 ^(c)	969 ^(b)
01/06/03 - 03/24/03	12	39.7	86.5	259	865
04/03/03 - 06/23/03	11	100.0	86.2	258	862
07/08/03 - 09/15/03	9	73.7	70.6	212	706
Summary	49	88.0	87.8	263	878
Constituent: Tritium – Low-Level Method (pCi/L)					
01/06/03 - 02/12/03	3	24.0	14.8	44 ^(c)	148 ^(c)
Constituent: Uranium (µg/L)					
10/04/02 - 12/27/02	7 ^(b)	0.015	0.007	0.037 ^(d)	0.087 ^(d)
01/06/03 - 03/24/03	6	0.022	0.016	0.072	0.186
04/03/03 - 06/23/03	7 ^(b)	0.042	0.039	0.157	0.428
07/10/03 - 09/18/03	7	-0.005	0.068	0.200	0.679
Summary	27	0.019	0.041	0.141	0.428

(a) Time period covered for total organic carbon and total organic halides is a moving average of four quarters.

(b) Excluded outliers.

(c) 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.

(d) 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 D.24. Summary of Detection and Quantitation Limits, Severn Trent Laboratory (St. Louis)

Method	Constituent	Initial MDL ^(a) (µg/L)	Initial LOD (µg/L)	Initial LOQ (µg/L)	Ending Values, Effective Date	Ending MDL ^(a) (µg/L)	Ending LOD (µg/L)	Ending LOQ (µg/L)
General Chemical Parameters								
EPA-600/4-81-004, 120.1	Conductivity ^(b)	0.147	0.198	0.662	05/13/03	0.486	0.656	2.189
EPA-600/4-81-004, 160.1	Total dissolved solids	4,392	5,931	19,778	05/13/03	3.497	4.722	15.75
EPA-600/4-81-004, 310.1	Alkalinity	4,043	5,459	18,206	05/13/03	1,188	1,604	5,350
EPA-600/4-81-004, 410.4	Chemical oxygen demand	4,800	6,482	21,615	05/13/03	3,564	4,813	16,049
EPA-600/4-81-004, 413.1	Oil and grease	915	1,236	4,120				
Ammonia and Anions								
EPA-600/4-81-004, 300.0	Bromide	18.3	24.7	82.4	05/13/03	41.76	56.39	188.1
EPA-600/4-81-004, 300.0	Chloride	29.1	39.3	131.0	05/13/03	44.89	60.62	202.1
EPA-600/4-81-004, 300.0	Fluoride ^(c)	31	41.9	139.6	05/13/03	40.29	54.40	181.4
EPA-600/4-81-004, 300.0	Nitrogen in nitrate	4.4	5.9	19.8	05/13/03	11.17	15.08	50.30
EPA-600/4-81-004, 300.0	Nitrogen in nitrite	10.9	14.7	49.1	05/13/03	7.37	10.0	33.2
EPA-600/4-81-004, 300.0	Phosphate	79	107	356	05/13/03	258.2	348.7	1,163
EPA-600/4-81-004, 300.0	Sulfate	37.4	50.5	168	05/13/03	54.05	72.98	243.4
EPA-600/4-81-004, 350.1	Nitrogen in ammonia	11.935	16.116	53.746	05/13/03	21.598	29.164	97.260
SW-846, 9012	Cyanide	4.654	6.284	20.96	03/03/03	4.847	6.545	21.83
Metals								
SW-846, 6010	Aluminum ^(d)	20.3	27.4	91.4				
SW-846, 6010	Antimony ^(d)	16	21.6	72.1				
SW-846, 6010	Barium ^(d)	6.5	8.8	29.3				
SW-846, 6010	Beryllium ^(d)	0.17	0.2	0.8				
SW-846, 6010	Cadmium ^(d)	2	2.7	9				
SW-846, 6010	Calcium ^(d)	148	199.8	666.5				
SW-846, 6010	Chromium ^(d)	2	2.7	9				
SW-846, 6010	Cobalt ^(d)	4	5.4	18				
SW-846, 6010	Copper ^(d)	7.7	10.4	34.7				
SW-846, 6010	Iron ^(d)	14.5	19.6	65.3				
SW-846, 6010	Lead ^(d)	9	12.2	40.5				
SW-846, 6010	Magnesium ^(d)	138	186.3	621.4				
SW-846, 6010	Manganese ^(d)	0.79	1.1	3.6				
SW-846, 6010	Nickel ^(d)	12	16.2	54				
SW-846, 6010	Potassium ^(d)	1,330	1,796	5,989				
SW-846, 6010	Silver ^(d)	6	8.1	27				
SW-846, 6010	Sodium ^(d)	140	189	630.4				
SW-846, 6010	Strontium (elemental) ^(d)	1.5	2	6.8				
SW-846, 6010	Tin ^(d)	19.8	26.7	89.2				
SW-846, 6010	Vanadium ^(d)	2.3	3.1	10.4				
SW-846, 6010	Zinc ^(d)	1.3	1.8	5.9				

Table D.24. (contd)

Method	Constituent	Initial MDL ^(a) (µg/L)	Initial LOD (µg/L)	Initial LOQ (µg/L)	Ending Values, Effective Date	Ending MDL ^(a) (µg/L)	Ending LOD (µg/L)	Ending LOQ (µg/L)	
SW-846, 7060	Arsenic	1.38	1.90	6.20	01/28/03	1.053	1.422	4.742	
SW-846, 7131	Cadmium	0.2	0.3	0.9	01/28/03	0.078	0.11	0.35	
SW-846, 7191	Chromium	0.3	0.4	1.4	01/28/03	0.364	0.492	1.639	
SW-846, 7421	Lead	1.01	1.40	4.50	01/28/03	0.622	0.840	2.801	
SW-846, 7470	Mercury	0.012	0.016	0.054	01/15/03	0.01	0.01	0.5	
SW-846, 7740	Selenium	1.22	1.6	5.5	01/28/03	1.652	2.231	7.439	
SW-846, 7841	Thallium	1.77	2.40	8.00	01/28/03	1.298	1.753	5.845	
Volatile Organic Compounds									
SW-846, 8010	1,1,1-trichloroethane	0.09	0.12	1.41					
SW-846, 8010	1,1,2-trichloroethane	0.2	0.27	0.90					
SW-846, 8010	1,1-dichloroethane	0.23	0.311	1.04					
SW-846, 8010	1,2-dichloroethane	0.18	0.243	0.811					
SW-846, 8010	1,4-dichlorobenzene	None							
SW-846, 8010	Carbon tetrachloride	0.16	0.22	0.72					
SW-846, 8010	Chloroform	0.12	0.16	0.54					
SW-846, 8010	cis-1,2-dichloroethylene	0.14	0.19	0.63					
SW-846, 8010	Methylene chloride	0.12	0.16	0.54					
SW-846, 8010	Tetrachloroethylene	0.17	0.23	0.77					
SW-846, 8010	trans-1,2-dichloroethylene	0.14	0.19	0.63					
SW-846, 8010	Trichloroethylene	0.21	0.28	0.95					
SW-846, 8010	Vinyl chloride	0.21	0.28	0.95					
SW-846, 8020	1,4-dichlorobenzene	0.04	0.054	0.18					
SW-846, 8020	Benzene	0.04	0.054	0.18					
SW-846, 8020	Ethylbenzene	0.05	0.068	0.23					
SW-846, 8020	Toluene	0.05	0.068	0.23					
SW-846, 8020	Xylenes (total)	0.05	0.068	0.23					
SW-846, 8260	1,1,1,2-tetrachloroethane	0.04	0.05	0.18					
SW-846, 8260	1,1,1-trichloroethane	0.17	0.23	0.77					
SW-846, 8260	1,1,2,2-tetrachloroethane	0.17	0.23	0.77					
SW-846, 8260	1,1,2-trichloroethane	0.05	0.07	0.23					
SW-846, 8260	1,1-dichloroethane	0.2	0.27	0.9					
SW-846, 8260	1,1-dichloroethylene	0.16	0.22	0.72					
SW-846, 8260	1,2,3-trichloropropane	0.15	0.2	0.68					
SW-846, 8260	1,2-dibromomethane	0.06	0.08	0.27					
SW-846, 8260	1,2-dichloroethane	0.08	0.11	0.36					
SW-846, 8260	1,2-dichloroethylene (total)	0.17	0.23	0.77					
SW-846, 8260	1,2-dichloropropane	0.24	0.32	1.08					

Table D.24. (contd)

Method	Constituent	Initial MDL ^(a) (µg/L)	Initial LOD (µg/L)	Initial LOQ (µg/L)	Ending Values, Effective Date	Ending MDL ^(a) (µg/L)	Ending LOD (µg/L)	Ending LOQ (µg/L)
SW-846, 8260	1,4-dichlorobenzene	0.11	0.15	0.5				
SW-846, 8260	1,4-dioxane	11.1	15.0	50.0				
SW-846, 8260	1-butanol	4.57	6.17	20.6				
SW-846, 8260	2-butanone	0.29	0.39	1.31				
SW-846, 8260	2-hexanone	0.14	0.19	0.63				
SW-846, 8260	4-methyl-2-pentanone	0.35	0.47	1.58				
SW-846, 8260	Acetone	0.66	0.89	2.97				
SW-846, 8260	Acetonitrile	2.7	3.65	12.2				
SW-846, 8260	Acrolein	2.13	2.88	9.59				
SW-846, 8260	Benzene	0.07	0.09	0.32				
SW-846, 8260	Bromodichloromethane	0.18	0.24	0.81				
SW-846, 8260	Bromoform	0.2	0.27	0.9				
SW-846, 8260	Bromomethane	0.61	0.82	2.75				
SW-846, 8260	Carbon disulfide	0.43	0.58	1.94				
SW-846, 8260	Carbon tetrachloride	0.15	0.20	0.68				
SW-846, 8260	Chlorobenzene	0.08	0.11	0.36				
SW-846, 8260	Chloroethane	0.32	0.43	1.44				
SW-846, 8260	Chloroform	0.07	0.09	0.32				
SW-846, 8260	Chloromethane	0.2	0.27	0.90				
SW-846, 8260	cis-1,2-dichloroethylene	0.06	0.08	0.27				
SW-846, 8260	cis-1,3-dichloropropene	0.24	0.32	1.08				
SW-846, 8260	Dichlorodifluoromethane	0.32	0.43	1.44				
SW-846, 8260	Ethyl cyanide							
SW-846, 8260	Ethylbenzene	0.14	0.19	0.63				
SW-846, 8260	Methylene chloride	0.3	0.41	1.35				
SW-846, 8260	Styrene	0.07	0.09	0.32				
SW-846, 8260	Tetrachloroethylene	0.17	0.23	0.77				
SW-846, 8260	Tetrahydrofuran	1.74	2.35	7.84				
SW-846, 8260	Toluene	0.12	0.16	0.54				
SW-846, 8260	trans-1,2-dichloroethylene	0.17	0.23	0.77				
SW-846, 8260	trans-1,3-dichloropropene	0.05	0.07	0.23				
SW-846, 8260	Trichloroethene	0.16	0.22	0.72				
SW-846, 8260	Vinyl acetate	0.2	0.27	0.9				
SW-846, 8260	Vinyl chloride	0.25	0.34	1.13				
SW-846, 8260	Xylenes (total)	0.28	0.38	1.26				
SW-846, 8260	1,4-dichlorobenzene	2.55	3.44	11.48	03/01/03	0.41	0.55	1.85
WTPH_Gasoline	TPH, gasoline fraction	0.05	0.07	0.23				

Table D.24. (contd)

Method	Constituent	Initial MDL ^(a) (µg/L)	Initial LOD (µg/L)	Initial LOQ (µg/L)	Ending Values, Effective Date	Ending MDL ^(a) (µg/L)	Ending LOD (µg/L)	Ending LOQ (µg/L)
Semivolatile Organic Compounds								
SW-846, 8015	TPH, diesel function	5	6.75	22.52	02/01/03	0.06	0.081	0.27
SW-846, 8040	2,3,4,6-tetrachlorophenol	3.73	5.04	16.8				
SW-846, 8040	2,4,5-trichlorophenol	2.91	3.93	13.1				
SW-846, 8040	2,4,6-trichlorophenol	2.65	3.58	11.9				
SW-846, 8040	2,4-dichlorophenol	2.9	3.92	13.1				
SW-846, 8040	2,4-dimethylphenol	3.75	5.06	16.9				
SW-846, 8040	2,4-dinitrophenol	3.45	4.66	15.5				
SW-846, 8040	2,6-dichlorophenol	2.66	3.59	12.0				
SW-846, 8040	2-chlorophenol	2.65	3.58	11.9				
SW-846, 8040	2-methylphenol (cresol, o-)	2.79	3.77	12.6				
SW-846, 8040	2-nitrophenol	2.65	3.58	11.9				
SW-846, 8040	2-sec-Butyl-4,6-dinitrophenol (DNBP)	1.43	1.93	6.44				
SW-846, 8040	3,4-methyl phenol	3.54	4.78	15.9				
SW-846, 8040	4,6-dinitro-2-methyl phenol	4.02	5.43	18.1				
SW-846, 8040	4-chloro-3-methylphenol	2.78	3.75	12.5				
SW-846, 8040	4-nitrophenol	2.81	3.79	12.7				
SW-846, 8040	Pentachlorophenol	2.5	3.38	11.3				
SW-846, 8040	Phenol	3	4.05	13.5				
SW-846, 8082	Aroclor-1016	0.22	0.3	0.99				
SW-846, 8082	Aroclor-1221	0.22	0.3	0.99				
SW-846, 8082	Aroclor-1232	0.49	0.66	2.21				
SW-846, 8082	Aroclor-1242	0.2	0.27	0.9				
SW-846, 8082	Aroclor-1248	0.14	0.19	0.63				
SW-846, 8082	Aroclor-1254	0.38	0.51	1.71				
SW-846, 8082	Aroclor-1260	0.19	0.26	0.86				
SW-846, 8270	1,2,4,5-tetrachlorobenzene	1.98	2.67	8.92	03/01/03	0.53	0.72	2.39
SW-846, 8270	1,2,4-trichlorobenzene	2.55	3.44	11.48	03/01/03	0.45	0.61	2.03
SW-846, 8270	1,2-dichlorobenzene	2.58	3.48	11.62	03/01/03	0.28	0.38	1.26
SW-846, 8270	1,3-dichlorobenzene	2.5	3.38	11.26	03/01/03	0.29	0.39	1.31
SW-846, 8270	2,2'-oxybis(1-chloropropane)	2.75	3.71	12.38	03/01/03	0.27	0.36	1.22
SW-846, 8270	2,4,5-trichlorophenol	1.98	2.67	8.92	03/01/03	0.64	0.86	2.88
SW-846, 8270	2,4,6-trichlorophenol	1.73	2.34	7.79	03/01/03	0.44	0.59	1.98
SW-846, 8270	2,4-dichlorophenol	1.7	2.30	7.66	03/01/03	0.27	0.36	1.22
SW-846, 8270	2,4-dimethylphenol	2.73	3.69	12.29	03/01/03	5.31	7.17	23.91
SW-846, 8270	2,4-dinitrophenol	1.26	1.70	5.67	03/01/03	1.74	2.35	7.84
SW-846, 8270	2,4-dinitrotoluene	2.15	2.90	9.68	03/01/03	0.62	0.84	2.79
SW-846, 8270	2,6-dinitrotoluene	1.85	2.50	8.33	03/01/03	0.68	0.92	3.06

Table D.24. (contd)

Method	Constituent	Initial MDL ^(a) (µg/L)	Initial LOD (µg/L)	Initial LOQ (µg/L)	Ending Values, Effective Date	Ending MDL ^(a) (µg/L)	Ending LOD (µg/L)	Ending LOQ (µg/L)
SW-846, 8270	2-chloronaphthalene	2.56	3.46	11.53	03/01/03	0.28	0.38	1.26
SW-846, 8270	2-chlorophenol	1.45	1.96	6.53	03/01/03	0.25	0.34	1.13
SW-846, 8270	2-methylnaphthalene	2.36	3.19	10.63	03/01/03	0.37	0.50	1.67
SW-846, 8270	2-methylphenol (cresol, o-)	1.24	1.67	5.58	03/01/03	0.24	0.32	1.08
SW-846, 8270	2-nitroaniline	2.45	3.31	11.03	03/01/03	0.65	0.88	2.93
SW-846, 8270	2-nitrophenol	2	2.70	9.01	03/01/03	0.64	0.86	2.88
SW-846, 8270	3,3'-dichlorobenzidine	1.3	1.76	5.85	03/01/03	1.33	1.80	5.99
SW-846, 8270	3-nitroaniline	1.42	1.92	6.39	03/01/03	0.56	0.76	2.52
SW-846, 8270	4,6-dinitro-2 methyl phenol	1.38	1.86	6.21	03/01/03	0.53	0.72	2.39
SW-846, 8270	4-bromophenylphenyl ether	3.06	4.13	13.78	03/01/03	0.42	0.57	1.89
SW-846, 8270	4-chloro-3-methylphenol	1.49	2.01	6.71	03/01/03	0.37	0.50	1.67
SW-846, 8270	4-chloroaniline	1.63	2.20	7.34	03/01/03	1.09	1.47	4.91
SW-846, 8270	4-chlorophenylphenyl ether	2.69	3.63	12.11	03/01/03	0.44	0.59	1.98
SW-846, 8270	4-methylphenol (cresol, p-)	1.51	2.04	6.80	03/01/03	7.14	9.64	32.2
SW-846, 8270	4-nitroaniline	1.44	1.94	6.48	03/01/03	1.01	1.36	4.55
SW-846, 8270	4-nitrophenol	0.63	0.85	2.84	03/01/03	0.81	1.09	3.65
SW-846, 8270	Acenaphthene	2.47	3.34	11.1	03/01/03	0.35	0.47	1.58
SW-846, 8270	Acenaphthylene	2.35	3.17	10.6	03/01/03	0.34	0.46	1.53
SW-846, 8270	Aniline	1.86	2.51	8.38	03/01/03	0.29	0.39	1.31
SW-846, 8270	Anthracene	2.44	3.29	10.99	03/01/03	0.39	0.53	1.76
SW-846, 8270	Benzo(a)anthracene	2.08	2.81	9.37	03/01/03	0.47	0.63	2.12
SW-846, 8270	Benzo(a)pyrene	1.8	2.43	8.11	03/01/03	1.1	1.49	4.95
SW-846, 8270	Benzo(b)fluoranthene	1.82	2.46	8.20	03/01/03	0.83	1.12	3.74
SW-846, 8270	Benzo(ghi)perylene	1.27	1.71	5.72	03/01/03	1.21	1.63	5.45
SW-846, 8270	Benzo(k)fluoranthene	2.05	2.77	9.23	03/01/03	1.47	1.98	6.62
SW-846, 8270	Benzyl alcohol	1.79	2.42	8.06	03/01/03	0.33	0.45	1.49
SW-846, 8270	Bis(2-chloroethoxy)methane	2.05	2.77	9.23	03/01/03	0.37	0.50	1.67
SW-846, 8270	Bis(2-chloroethyl) ether	2.69	3.63	12.11	03/01/03	0.43	0.58	1.94
SW-846, 8270	Bis(2-ethylhexyl) phthalate	3.19	4.31	14.37	03/01/03	2.67	3.61	12.02
SW-846, 8270	Butylbenzylphthalate	2.88	3.89	12.97	03/01/03	0.55	0.74	2.48
SW-846, 8270	Chrysene	1.89	2.55	8.51	03/01/03	0.6	0.81	2.70
SW-846, 8270	Di-n-butylphthalate	2.21	2.98	9.95	03/01/03	0.47	0.63	2.12
SW-846, 8270	Di-n-octylphthalate	2.22	3.00	10.0	03/01/03	5.12	6.91	23.06
SW-846, 8270	Dibenz[a,h]anthracene	2.02	2.73	9.10	03/01/03	1.35	1.82	6.08
SW-846, 8270	Dibenzofuran	2.48	3.35	11.2	03/01/03	0.36	0.49	1.62
SW-846, 8270	Diethylphthalate	2.41	3.25	10.9	03/01/03	0.24	0.32	1.08
SW-846, 8270	Dimethyl phthalate	2.09	2.82	9.41	03/01/03	0.68	0.92	3.06

Table D.24. (contd)

Method	Constituent	Initial MDL ^(a) (µg/L)	Initial LOD (µg/L)	Initial LOQ (µg/L)	Ending Values, Effective Date	Ending MDL ^(a) (µg/L)	Ending LOD (µg/L)	Ending LOQ (µg/L)
SW-846, 8270	Fluoranthene	1.78	2.40	8.02	03/01/03	0.44	0.59	1.98
SW-846, 8270	Fluorene	2.55	3.44	11.5	03/01/03	0.38	0.51	1.71
SW-846, 8270	Hexachlorobenzene	3.57	4.82	16.1	03/01/03	0.47	0.63	2.12
SW-846, 8270	Hexachlorobutadiene	2.01	2.71	9.05	03/01/03	0.41	0.55	1.85
SW-846, 8270	Hexachlorocyclopentadiene	2.11	2.85	9.50	03/01/03	2.4	3.24	10.81
SW-846, 8270	Hexachloroethane	2.33	3.15	10.49	03/01/03	0.24	0.32	1.08
SW-846, 8270	Indeno(1,2,3-cd)pyrene	1.47	1.98	6.62	03/01/03	1.24	1.67	5.58
SW-846, 8270	Isophorone	0.94	1.27	4.23	03/01/03	0.23	0.31	1.04
SW-846, 8270	N-nitroso-di-n-propylamine	2.49	3.36	11.21	03/01/03	0.89	1.20	4.01
SW-846, 8270	N-nitrosodimethylamine	1.57	2.12	7.07	03/01/03	0.46	0.62	2.07
SW-846, 8270	N-nitrosodiphenylamine	1.64	2.21	7.39	03/01/03	0.45	0.61	2.03
SW-846, 8270	Naphthalene	2.64	3.56	11.9	03/01/03	0.3	0.41	1.35
SW-846, 8270	Pentachlorophenol	1.29	1.74	5.81	03/01/03	0.58	0.78	2.61
SW-846, 8270	Phenanthrene	2.5	3.38	11.3	03/01/03	0.4	0.54	1.80
SW-846, 8270	Phenol	0.91	1.23	4.10	03/01/03	0.26	0.35	1.17
SW-846, 8270	Pyrene	2.19	2.96	9.86	03/01/03	0.46	0.62	2.07

(a) 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.

(b) µMhos/cm.

(c) Between March 13, 2003, and May 12, 2003, a third MDL (value not shown in table) was in effect for this compound.

(d) Two instruments (standard and trace level) were used for samples analyzed by method 6010. MDL values for the standard instrument were included in this table. MDL values for the trace instrument were typically 2 to 10 times lower, but in several cases, the MDL values for the trace instrument were the same as or higher than those reported for the standard instrument.

LOD = Limit of detection.

LOQ = Limit of quantitation.

MDL = Method detection limit.