

APPENDIX C

**MAY 21, 1999 NORCAL GEOPHYSICAL CONSULTANTS
SURVEY OF BUILDINGS 103**

May 21, 1999

Mr. Dave Zuber
Brown and Caldwell
9616 Micron Avenue, Suite 600
Sacramento, CA 95827-2627

Dear Mr. Zuber:

This report presents the findings of the geophysical investigation performed by NORCAL Geophysical Consultants, Inc. at Building 103 at the Benicia Arsenal Environmental Restoration project in Benicia, California. This investigation was conducted under the guidelines presented in Brown and Caldwell's scope of work, Task Order 1, Exhibit A, dated December 31, 1998, and the Revisions to Task Order 1, Exhibit A, dated February 22, 1999. The geophysical survey at Building 103 concludes the Phase 1 work, as described in the Revisions to Task Order 1, Exhibit A. The field survey was performed on May 6, 1999 by NORCAL Geophysicist Donald J. Kirker. Logistical support was provided by Brown and Caldwell personnel Paul E. Lopez. All geophysical work performed at the Benicia Arsenal was governed by the Brown and Caldwell Quality Assurance Program Plan (QAPP) dated February 1999.

SITE DESCRIPTION AND PURPOSE

The geophysical survey was conducted in two areas adjacent to Building 103, as specified by Brown and Caldwell, and is shown on Plate 1. The first area measures approximately 20 by 30 feet and is located adjacent to the west side of the building. The second measures approximately 30 by 40 feet and is located south of the building. Both survey areas are covered with concrete, asphalt, and/or gravel. Two former fuel distribution pump islands are located north and northwest of Building 103, respectively. Pipe stubs, representing possible fuel lines, are located in the center of each pump island. Two UST associated vent lines are evident at the southwest corner of the building. A square shaped concrete footing is located in the center of the southern most survey area. This footing is similar in size and shape to the UST associated vaults located adjacent to Building 154, as described in our report dated April 2, 1999. Both survey areas are generally free of above ground cultural objects.

Information, provided by Brown and Caldwell, indicates that underground storage tanks (UST's) may be located at this site. This is evidenced by the pump islands and vent lines located near the building. However, records are incomplete regarding their exact locations. Therefore, the purpose of the geophysical investigation is to obtain subsurface information that will aid in determining the location and extent of possible UST's within each survey area.

METHODOLOGY

For this investigation, we used the electromagnetic line locating (EMLL) and ground penetrating radar (GPR) methods. The EMLL method was used to locate possible UST associated piping, as well as to scan the site for near surface metal that may indicate the presence of a UST. The GPR



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method was used to aid in further characterizing the source of any detected EMLL anomalies, as well as to investigate areas in close proximity to the building and metal fences.

Typically, the vertical magnetic gradient (VMG) and electromagnetic terrain conductivity (TC) methods are used in conjunction with these techniques to detect buried metal objects. However, interference caused by the nearby structures and metal fences precluded the use of the VMG and TC methods at this site. Descriptions of the GPR and EMLL methods were provided in our report dated April 2, 1999.

EQUIPMENT FUNCTIONAL CHECKS

At the beginning and end of the field day, we performed equipment functional checks, as recommended by the instrument manufacturers to ensure proper equipment function. These functional checks included testing the power supply, as well as instrument response. The equipment was operated over a selected test site located northwest of Building 103 to verify appropriate gain settings and instrument repeatability. Particular attention was paid to the GPR calibration, with the same gain, filter, and time-depth scales chosen each time to check for repeatable results. This calibration check was documented by printing the calibration plot on the chart recorder. Proper functioning of the equipment was verified by determining that the trends observed in the data were repeatable. The results of these tests indicated that our equipment was functioning properly and accurately throughout the duration of the survey.

DATA ACQUISITION AND ANALYSIS

Data Acquisition

We used the EMLL technique to scan both survey areas along south-north and west-east trending traverses spaced 5 feet apart. The GPR techniques was then systematically used over the detected EMLL anomalies, as well as in close proximity to the building and chain link fence. GPR data were obtained along both south-north and west-east trending traverses that ranged in length from 10 to 40 feet. The limits of the survey area and the location of the GPR traverses are shown on Plate 1.

GPR and EMLL Analysis

We examined the GPR records for hyperbolic reflection patterns characteristic of UST's and underground utilities. We also reviewed the records for changes in reflection character that could indicate the presence of fill material associated with an excavation.



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The EMLL instrumentation indicates the presence of buried metal by emitting an audible tone. There are no recorded data to analyze. The locations of buried objects detected with the EMLL method were marked on the ground surface with white marking paint.

RESULTS

The results of the EMLL and GPR surveys are presented on Plate 1. This plate shows the limits of the survey area, the structures or above ground cultural features that may be in close proximity to the site, the GPR traverses, and the locations of any detectable subsurface features and UST associated utilities. Since a utility search was not the primary objective of this survey, there may be additional utilities that are not shown.

The EMLL and GPR surveys detected evidence in three areas that may represent possible UST's. The first and most definite was detected with both the EMLL and GPR techniques. It measures approximately 10 by 26 feet and extends east from the concrete footings (suspected UST vault). These dimensions are consistent with a 15,000 gallon UST. A product line detected with the EMLL extends from the northern most pump island to the concrete footings at the west end of the suspected UST. Furthermore, underground vent lines were detected (using EMLL) from the UST (concrete footings) to the visible vent lines at the southwest corner of the building.

The second possible UST is located adjacent to the former truck scale. It was detected with the EMLL. It measures approximately 6 by 12 feet and is consistent with a 2,500 gallon UST. It should be noted, however, that the GPR did not define evidence of a UST at this location. Therefore, if this EMLL anomaly does represent a UST, it is buried deeper than the detection capabilities of the GPR.

The third area is located in the vicinity of the pipe stub near the small pump island. This area was defined by the GPR and measures approximately 5 by 5 feet. We refer to this zone as a GPR anomaly on Plate 1. The GPR data defined reflection patterns typical of disturbed soils. Since a product line trends to this general area, we believe that these reflections may represent backfill material associated with a UST that is buried deeper than the detection capabilities of the GPR. However, this could not be confirmed by the EMLL technique because of interference caused by the close proximity of the chain link fence.

STANDARD CARE AND WARRANTY

The scope of NORCAL's services for this project consisted of using geophysical methods to characterize the shallow subsurface. The accuracy of our findings is subject to specific site conditions and limitations inherent to the techniques used. We performed our services in a manner consistent with the level of skill ordinarily exercised by members of the profession currently



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employing similar methods. No warranty, with respect to the performance of services or products delivered under this agreement, expressed or implied, is made by NORCAL.

We appreciate having the opportunity to provide you with this information.

Respectfully,

NORCAL Geophysical Consultants, Inc.

Donald J. Kirker

Donald J. Kirker
Geophysicist, GP-997

DJK/jh

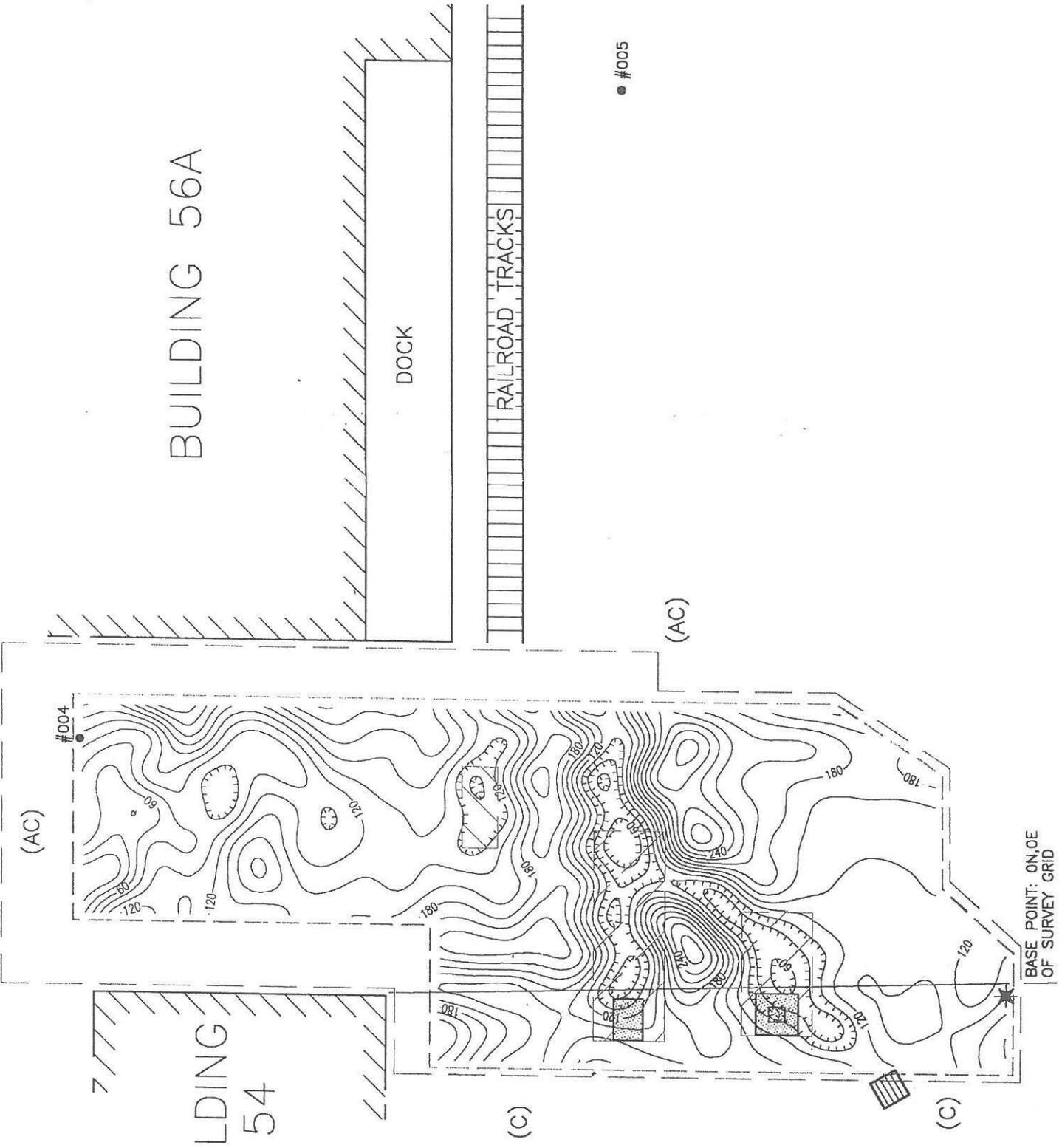
Enclosure: Plate 1

BUILDING 56A

DOCK

RAILROAD TRACKS

BUILDING 154



LEGEND	
---	LIMITS OF ELECTRICAL CONDUCTIVITY SURVEY
---	LIMITS OF SURVEY
▨	TERRAIN CONDUCTIVITY POSSIBLE USE
▧	EMLL ANOMALY
—○—	ELECTROMAGNETIC (CONTOUR INTERPOLATION)
▣	CONCRETE/METAL
▤	STORM DRAIN
● #004	PROPOSED BORING
(AC)	ASPHALT
(C)	CONCRETE (UNFINISHED)

ELECTRICAL CONDUCTIVITY SURVEY

APPENDIX D

DATA QUALITY ASSESSMENT

DATA QUALITY ASSESSMENT

Samples associated with the investigation of underground storage tank sites at Buildings 53, 73, 103 and 154 at the former Arsenal were sent to EMAX in four work orders (WOs): 99F051, 99F058, 99F065 and 99F079.

Samples from WO 99F079 received full validation for all elements identified in the third column of Table 4-1 of the QAPP (FA/BC, 1999) against the requirements of that QAPP and the revisions summarized in the September 1999 Amendment (a copy of the full validation report is included in Appendix E). The three remaining WO's were verified for the subset of elements identified in column 2 of the same table. This assessment summarizes the findings from all verification and validation activities. These requirements were developed in alignment with the United States Environmental Protection Agency (USEPA) Contract Laboratory Program National Functional Guidelines for Organic Data Review (EPA540/R-94/012) and Inorganic Data Review (EPA540/R094/013), but were modified to reflect the use of SW-846 rather than CLP Methods and to meet the specific requirements of the USACE. A summary of data qualified as a result of this assessment is presented in Appendix F.

The assessment is organized by method and matrix. At the end of each section, there is a table that summarizes completeness with respect to several different criteria. The calculations used for each type of completeness are listed below.

$$\text{Contract Completeness} = \frac{\# \text{ results not associated with contract compliance failure}}{\# \text{ results reported}} \times 100$$

$$\text{Analytical Completeness} = \frac{\# \text{ unqualified results}}{\# \text{ results reported}} \times 100$$

$$\text{Technical Completeness} = \frac{\# \text{ usable results}^\dagger}{\# \text{ results reported}} \times 100$$

$$\text{Field Sampling Completeness} = \frac{\# \text{ samples collected}}{\# \text{ samples planned}} \times 100$$

[†] Estimated results considered as usable for project decision-making

For inorganic and metals analyses, each analyte has been evaluated individually for completeness. For multi-analyte organic methods, completeness has been calculated for each sample using the aggregate results for all analytes. All completeness evaluations are made in accordance with guidance given in the QAPP (FA/BC, 1999).

5.1 Total Dissolved Solids By Method E160.1

One water sample was collected for total dissolved solids (TDS) by Method E160.1. The sample was collected in a one-liter amber bottle and transported cold to EMAX where it was analyzed in one laboratory batch. For a tabulated count of the samples and the associated batch QC samples, see Appendix D (*QC Samples by Method, Matrix, and Batch*).

Preservation and Holding Times. The sample was collected in the proper container, preserved correctly at 2.0 – 3.5 °C, and analyzed within the method prescribed holding time of seven (7) days from date of collection.

Laboratory Method Blanks and Field QC Blanks. Laboratory method blanks were analyzed at the required frequency of one method blank per laboratory batch. The water sample was analyzed in one laboratory batch with one method blank. TDS was not detected in the method blank above the method detection limit (MDL).

LCS/LCSD Recoveries and Precision. The sample was analyzed along with one laboratory control sample (LCS) in one analytical batch. A laboratory control sample duplicate (LCSD) was not required. The recovery was within the laboratory control limits of 85-115 percent for accuracy. An LCDS was not prepared with this batch. To measure analytical batch precision, a laboratory duplicate sample was analyzed.

Laboratory Replicate Precision. A laboratory duplicate sample was prepared and analyzed with the analytical batch to measure analytical precision. The relative percent difference (RPD) value between the laboratory duplicate pair (1.0 percent) was within the 20 percent RPD maximum limit.

Field Duplicate Precision. There were no water field duplicate samples collected for TDS by Method E160.1. Compliance with the criteria for field duplicate precision defined in the Table E-2 of the QAPP could not be evaluated. The frequency requirement for field duplicate collection of 10 percent was not met. The field duplicate was inadvertently omitted, due to the small number of samples collected. Failing to collect field duplicates impacts the qualitative assessment of completeness, which is reflective of the percentage for field sampling completeness.

TDS Calibration and Quantitation. The laboratory did not report any calibration or quantitation problems, and none were observed during full validation of work order 99F079.

Overall Assessment and Completeness. Overall, the data met the requirements of the method and the QAPP and are usable for project decision-making.

**Table D-1
Completeness for TDS in Water samples**

Analyte	Samples Planned	Samples Taken	Analytes per Sample	Samples Taken	Number of Results				Completeness			
					Non-Contract Compliant	Rejected	Estimated due to QC	Estimated due to >MDL but <PQL	Contract Compliance	Technical	Analytical*	Sampling
TDS	2	1	1	1	0	0	0	0	100.0%	100.0%	100.0%	50.0%

* Note: Estimations due to results <PQL do not affect the calculated completeness

5.2 Total Metals by Method SW6010B

5.2.1 Total Metals in Soil Samples. Ten environmental soil samples and a field duplicate were collected for metals analysis by inductively coupled plasma (ICP) Method SW6010B. Nine of the soil samples were analyzed for lead (Pb) only. The other soil sample was analyzed for cadmium (Cd), chromium (Cr), lead (Pb), nickel (Ni) and zinc (Zn). The samples were collected in 6-inch stainless steel sleeves and transported cold to the laboratory, where they were

digested in one laboratory batch by EMAX using Method SW3050B and analyzed by Method SW6010B. For a tabulated count of the samples and the associated batch QC samples see Appendix D.

Preservation and Holding Times. Samples were collected in the proper containers and preserved correctly by being maintained at a temperature of <8°C until digested by Method SW3050B. Soil samples were digested and analyzed within the prescribed holding time of 180 days from the date of collection.

Laboratory Method Blanks and Field QC Blanks. Laboratory method blanks were analyzed at the required frequency of one method blank per laboratory batch. Total metals were not detected above the MDL in the method blank. There were no equipment blanks associated with any of the soil samples analyzed for metals by Method SW6010B.

MS/MSD Recoveries and Precision. Matrix spike/matrix spike duplicate (MS/MSD) pairs were prepared and analyzed for metals at the frequency of one pair per lab batch. Sample B103TR003-S06 was designated as the soil sample for MS/MSD analysis. It was analyzed for lead only. The recoveries were within the project control limits for accuracy of 75-125 percent recovery. MS/MSD precision was within the maximum limit of 35 percent RPD for metals in soil by Method SW6010B. The percentage of samples spiked, one per batch, met the minimum frequency requirement of one MS per lab batch. No MS/MSD accuracy or precision data are available for Cd, Cr, Ni, or Zn. An MS/MSD sample was not planned for Cd, Cr, Ni, or Zn due to the limited number of samples (1) for each metal. Failing to collect an MS/MSD impacts the qualitative assessment of completeness which is reflective of the percentage for sampling completeness.

LCS/LCSD Recoveries and Precision. An LCS/LCSD pair was prepared and analyzed at the appropriate frequency of one pair per lab batch for metals, since not all analytes were evaluated with the matrix spike pair. All recoveries were within the project control limits for accuracy of 80-120 percent recovery. LCS/LCSD precision was within the maximum RPD limit of 35 percent for Cd, Cr, Ni, Pb and Zn in soil by Method SW6010B.

Field Duplicate Precision. Sample B154TR007-S06 was a field duplicate of sample B154TR007-S03. These samples were analyzed for lead only. The results were within the precision control limit of 50 percent RPD for metals in soil by Method SW6010B. The requirement for collection of 10 percent field duplicates was met for Pb but not for Cd, Cr, Ni and Zn. A field duplicate was not collected due to the small number of primary samples. Failing to collect a field duplicate impacts the qualitative assessment of completeness, which is reflective of the percentage for sampling completeness.

Laboratory Replicate Precision. Laboratory replicates were not analyzed. MS/MSD precision was used to evaluate precision in the matrix.

Surrogate Recoveries. Surrogates are not required for this method.

Instrument Calibration and Internal Standards. The laboratory did not report any calibration problems and none were observed during full validation of work order 99F079. Internal standards are not applicable to this method.

Analyte Identification and Analyte Quantitation. The soil practical quantitation limit (PQL) values reported by the laboratory were at or below the soil PQL values listed in Table A-1 of the QAPP.

A sample serial dilution was performed on soil sample B103TR003-S06 for the standard ICP analysis. The serial dilution results for Cr, Ni and Zn were not within the acceptance criteria. A post-digestion spike was prepared and the results for Cr and Zn were within 25 percent of the expected values. The result for Ni was not within 25 percent of the expected value. Therefore, the result for Ni on soil sample B073TR001-S03 was flagged J as estimated.

Overall Assessment and Completeness. Overall, the data are considered usable for project decision-making. A summary of completeness for total metals in soil is presented in Table D-2.

**Table D-2
Completeness for Metals in Soil Samples**

Analyte	Samples Planned	Samples Taken	Analytes per Sample	Total	Number of Results				Completeness			
					Non-Contract Compliant	Rejected	Estimated due to QC	Estimated due to >MDL but <PQL	Contract Compliance	Technical	Analytical*	Sampling
Cadmium	3	1	1	1	0	0	0	1	100.0%	100.0%	100.0%	33.3%
Chromium	3	1	1	1	0	0	0	0	100.0%	100.0%	100.0%	33.3%
Lead	10	10	1	10	0	0	0	0	100.0%	100.0%	100.0%	100.0%
Nickel	3	1	1	1	1	0	1	0	0.0%	100.0%	0.0%	33.3%
Zinc	3	1	1	1	0	0	0	0	100.0%	100.0%	100.0%	33.3%

* Note: Estimations due to results <PQL do not affect the calculated completeness

D.2.2 Dissolved Metals in Water Samples. Five water samples were collected for dissolved metals analysis by ICP Method SW6010B. Three of the water samples were analyzed for lead Pb only. One water sample (a sample of the on-site source water) was analyzed for Cd, Cr, Pb, Ni and Zn. The final water sample (a material rinsate blank prepared by pouring pure deionized water through one of the filters used for field-filtering the actual samples) was analyzed by ICP Method SW6010B for the 20 metals listed in Table A-1 of the QAPP. The water samples were digested and analyzed in one laboratory batch. For a tabulated count of the samples and the batch QC samples, see Appendix D.

Preservation and Holding Times. The samples were field filtered, collected in 500-milliliter (ml) polyethylene bottles, preserved with nitric acid, and transported cold to the laboratory where they were analyzed by Method SW6010B. Sample pH readings were within the acceptance limit (pH less than 2) for dissolved metals. The samples were analyzed within the prescribed holding time of 180 days from the date of collection.

Laboratory Method Blanks and Field QC Blanks. Laboratory method blanks were analyzed at the required frequency of one method blank per laboratory batch. Beryllium (Be) and tin (Sn) were detected above the MDL in the water method blank. The result for Be in the associated water sample was less than five times the concentration found in the method blank. Tin was not detected in the associated water sample.

The table below lists the Be and Sn results detected in the method blank and associated sample.

**Table D-3
Samples With Associated Method Blank Contamination**

Blank Type/Location ID	Concentration of Metals, mg/L		Flag
	Be	Sn	
Method blank	0.0002	0.034	----
B073TR001-W02	0.0003	<0.025	UJ for Be

The Be result for water sample B073TR001-W02 was flagged UJ because the sample concentration was less than five times the method blank concentration. No corrective action was required by the laboratory, since the concentration of the blank was less than half the PQL. The raised detection limit of 0.0003 mg/L had no impact since it was below both the primary water Maximum Contaminant Level (MCL) of 0.004 mg/L and the tap water Preliminary Remediation Goal (PRG) of 0.073 mg/L.

There were two filter-rinsate blanks ("clean" water that has been poured through the same type of filter that was used to filter real samples, used as a check on possible contamination introduced from the filter material), B154TR003-W02 and B073TR001-W03, associated with the samples. B154TR003-W02 was analyzed for Pb only, while B073TR001-W03 was analyzed for Cd, Cr, Pb, Ni and Zn. Zinc was detected above the PQL in material rinsate blank B073TR001-W03. The result for zinc in one of the associated water samples was less than five times the concentration found in the material rinsate blank; the result for that sample, B073TR001-W01, was flagged as not-detected (UJ). The raised detection limit of 0.02 mg/L had no impact since it was below both the secondary water MCL of 5.0 mg/L and the tap water PRG of 11.0 mg/L. No primary water MCL has been established for Zn. The following table lists the zinc results detected in the material rinsate blank and associated samples.

**Table D-4
Samples With Associated Method Blank Contamination**

Blank Type/Location ID	Concentration of Metals (mg/L)	Flag
	Zn	
Material rinsate blank	0.03	----
B073TR001-W01	0.02	UJ
B073TR001-W02	0.17	NONE

MS/MSD Recoveries and Precision. Sample B073TR001-W01, which required analysis only for Cd, Cr, Ni, Pb and Zn, was designated for MS/MSD analysis in the single preparation batch. Recoveries were within the project control limits for accuracy of 75-125 percent recovery. MS/MSD precision was within the Method SW6010B maximum RPD limit of 20 percent for dissolved metals in water. The percentage of samples spiked, one per batch, met the minimum frequency requirement of one MS per lab batch.

LCS/LCSD Recoveries and Precision. An LCS/LCSD pair was prepared and analyzed at the appropriate frequency of one pair per lab batch for metals, since not all analytes were evaluated with the matrix spike pair. Recoveries for all analytes found in Table A-1 of the Benicia Arsenal QAPP were within the project control limits for accuracy of 80-120 percent recovery. LCS/LCSD

precision was within the Method SW6010B maximum RPD limit of 20 percent for dissolved metals in water.

Field Duplicate Precision. There were no field duplicate water samples collected for dissolved metals analysis by Method SW6010B. Compliance with the criteria for field duplicate precision defined in the Table E-2 of the QAPP could not be evaluated. The frequency requirement for field duplicate collection of 10 percent was not met. The field duplicate was inadvertently omitted, due to the small number of samples collected. Failing to collect field duplicates impacts the qualitative assessment of completeness, which is reflective of the percentage for field sampling completeness.

Laboratory Replicate Precision. Laboratory replicates were not analyzed. MS/MSD precision was used to evaluate precision in the matrix.

Surrogate Recoveries. Surrogates are not required for this method.

Instrument Calibration and Internal Standards. The laboratory did not report any calibration problems and none were observed during full validation of work order 99F079. Internal standards are not applicable to this method.

Analyte Identification and Analyte Quantitation. The water PQL values reported by the laboratory were at or below the water PQL values listed in Table A-1 of the QAPP.

Sample serial dilutions were performed on water samples B073TR001-W01 (ICP-Trace) and B073TR001-W02 (standard ICP). Calcium and Zn were not within the acceptance criteria for serial dilutions. The post-digestion spike results for all the analytes were within 25 percent of the expected value. No data were qualified.

Overall Assessment and Completeness. Overall, the data met the requirements of the method and of the QAPP and are usable for project decision-making. A summary of completeness for metals analyses in water is presented in Table D-5.

D.3 Mercury By Method SW7470

D.3.1 Dissolved Mercury in Water By Method SW7470. One water sample was collected for dissolved mercury (Hg) analysis by Method SW7470A. The sample was transported cold to EMAX where it was digested and analyzed by Method SW7470A in one laboratory batch.

Preservation and Holding Times. The samples were field filtered, collected in 500-ml polyethylene bottles, preserved with nitric acid, and transported cold to the laboratory where they were analyzed by Method SW7470A. The sample pH reading was within the acceptance limit (pH less than 2) for dissolved mercury. The water sample was analyzed within the prescribed holding time of 28 days from the date of collection.

Laboratory Method Blanks and Field QC Blanks. Laboratory method blanks were analyzed at the required frequency of one method blank per laboratory batch. The water sample was analyzed in one laboratory batch with one method blank. Mercury was not detected in the method blank above the MDL. No equipment blanks were collected in association with the one water sample.

**Table D-5
Completeness for Metals in Water Samples**

Analyte	Samples Planned	Samples Taken	Analytes per Sample	Total	Number of Results				Completeness			
					Non-Contract Compliant	Rejected	Estimated due to QC	Estimated due to >MDL but <PQL	Contract Compliance	Technical	Analytical*	Sampling
Aluminum	1	1	1	1	0	0	0	0	100.0%	100.0%	100.0%	100.0%
Arsenic	1	1	1	1	0	0	0	0	100.0%	100.0%	100.0%	100.0%
Barium	1	1	1	1	0	0	0	0	100.0%	100.0%	100.0%	100.0%
Beryllium	1	1	1	1	0	0	1	0	100.0%	100.0%	0.0%	100.0%
Cadmium	3	2	1	2	0	0	0	0	100.0%	100.0%	100.0%	66.7%
Calcium	1	1	1	1	0	0	0	0	100.0%	100.0%	100.0%	100.0%
Chromium	3	2	1	2	0	0	0	0	100.0%	100.0%	100.0%	66.7%
Copper	1	1	1	1	0	0	0	1	100.0%	100.0%	100.0%	100.0%
Iron	1	1	1	1	0	0	0	1	100.0%	100.0%	100.0%	100.0%
Lead	7	6	1	6	0	0	0	3	100.0%	100.0%	100.0%	85.7%
Magnesium	1	1	1	1	0	0	0	0	100.0%	100.0%	100.0%	100.0%
Manganese	1	1	1	1	0	0	0	1	100.0%	100.0%	100.0%	100.0%
Molybdenum	1	1	1	1	0	0	0	0	100.0%	100.0%	100.0%	100.0%
Nickel	3	2	1	2	0	0	0	0	100.0%	100.0%	100.0%	66.7%
Potassium	1	1	1	1	0	0	0	0	100.0%	100.0%	100.0%	100.0%
Selenium	1	1	1	1	0	0	0	0	100.0%	100.0%	100.0%	100.0%
Silver	1	1	1	1	0	0	0	0	100.0%	100.0%	100.0%	100.0%
Sodium	1	1	1	1	0	0	0	0	100.0%	100.0%	100.0%	100.0%
Tin	1	1	1	1	0	0	0	0	100.0%	100.0%	100.0%	100.0%
Thallium	1	1	1	1	0	0	0	0	100.0%	100.0%	100.0%	100.0%
Zinc	3	2	1	2	0	0	1	0	100.0%	100.0%	50.0%	66.7%

* Note: Estimations due to results <PQL do not affect the calculated completeness

MS/MSD Recoveries and Precision. Batch HGF024W did not include an MS/MSD pair, as MS/MSD analyses were not requested for the soil sample. MS/MSD was not planned due to the limited numbers of samples (1) collected. Failing to collect an MS/MSD impacts the qualitative assessment of completeness which is reflected in the percentage for sampling completeness. MS/MSD recoveries and precision could not be calculated, and the frequency requirement for an MS/MSD pair per batch was not met. To measure analytical batch accuracy and precision, an LCS/LCSD pair was analyzed.

LCS/LCSD Recoveries and Precision. An LCS/LCSD pair for mercury was prepared and analyzed at the appropriate frequency of one pair per lab batch when an MS/MSD pair is not present. All recoveries were within the project control limits for accuracy of 80-120 percent recovery. LCS/LCSD precision was within the RPD maximum limit of 20 percent for mercury in soil by Method SW7470A.

Field Duplicate Precision. There were no water field duplicate samples collected for mercury by Method SW7470A. Therefore, compliance with the criteria for field duplicate precision defined in the Table E-2 of the QAPP could not be evaluated, and the frequency requirement for field duplicate collection of 10 percent was not met. A field duplicate was not collected due to

the limited numbers of primary (1) samples. Failing to collect an MS/MSD impacts the qualitative assessment of completeness which is reflected in the percentage for sampling completeness.

Laboratory Replicate Precision. Laboratory replicates were not analyzed by the laboratory.

Mercury Quantitation. The laboratory did not report any calibration or quantitation problems and none were observed during verification of the sample. Full validation was not performed for the analysis of mercury by SW7470A.

Overall Assessment and Completeness. Overall, the data met the requirements of the method and the QAPP and are usable for project decision-making. A summary of completeness for dissolved mercury in water is presented in Table D-6.

**Table D-6
Completeness for Dissolved Mercury in Water Samples**

Analyte	Samples Planned	Samples Taken	Analytes per Sample	Total	Number of Results				Completeness			
					Non-Contract Compliant	Rejected	Estimated due to QC	Estimated due to >MDL but <PQL	Contract Compliance	Technical	Analytical*	Sampling
Mercury	3	1	1	1	0	0	0	0	100.0%	100.0%	100.0%	33.3%

* Note: Estimations due to results <PQL do not affect the calculated completeness

D.4 Volatile Petroleum Hydrocarbons as Gasoline-range Organics by Method SW8015B

D.4.1 Gasoline-Range Organics in Soil Samples. Nine environmental soil samples and a field duplicate were collected for volatile petroleum hydrocarbons quantitated as gasoline-range organics (GROs) from 2-methylpentane (approximately C6) to 1,2,4-trimethylbenzene (approximately C10). The samples were collected and preserved by Method SW5035 in Encore samplers and transported cold to the laboratory, where they were transferred to methanol for mid-level analysis by GC Method SW8015B/SW5030. The soil samples were analyzed by EMAX Laboratories in three laboratory batches. For a tabulated count of the samples and the associated batch QC samples see Appendix D.

Preservation and Holding Times. The samples were collected in the proper Encore containers and preserved correctly by being maintained at a temperature of <6°C until transferred to methanol within 48 hours of collection. They were analyzed within the prescribed holding time of 14 days from the date of collection.

Laboratory Method Blanks and Field QC Blanks. Laboratory method blanks were analyzed at the required frequency of one method blank per laboratory batch. Gasoline-range organics were not detected above the MDL in any of the method blanks. There were no equipment

blanks or trip blanks associated with any of the samples analyzed for GROs in soil by Method SW8015B.

MS/MSD Recoveries and Precision. Sample B103TR003-S05 was designated for MS/MSD analysis and included in batch VMF1239. The recoveries were within the project control limits for accuracy of 65-135 percent recovery. MS/MSD precision was within the RPD maximum limit of 40 percent for GROs in soil by Method SW8015B. Batches VMF0839 and VMF 1139 did not include an MS/MSD pair.

LCS/LCSD Recoveries and Precision. LCS/LCSD pairs for GROs were prepared and analyzed at the appropriate frequency of one pair per lab batch when an MS/MSD pair is not present and a minimum of one LCS in each batch that contains matrix spikes. All recoveries were within the project control limits for accuracy of 65-135 percent recovery. LCS/LCSD precision was within the RPD maximum limit of 40 percent for GROs in soil by Method SW8015B.

Field Duplicate Precision. Sample B154TR007-S05 was a field duplicate of sample B154TR007-S02. Both samples were re-analyzed at a dilution due to high levels of GROs. The dilution runs were not within the precision control limits of 50 percent RPD for GROs in soil by Method SW8015B; however, no data were flagged as defined in Table E-2 of the QAPP. The requirement for collection of field duplicates at a rate of 10 percent was met.

Qualified Data Due to Field Duplicate Precision

Method	B154TR007-S02	B154TR007-S05	% RPD	Flag
SW8015B GRO	1150 mg/kg	2140 mg/kg	60	NONE

Laboratory Replicate Precision. Laboratory replicates are not required for this method.

Surrogate Recoveries. Surrogate compounds, 1-bromo-4-fluorobenzene (BFB) and 1,1,1-trifluorotoluene (TFT), were added to environmental and lab QC samples and used to measure method performance on a sample-specific basis. One sample was qualified because one of the two surrogate recoveries was not within project control limits of 65-135 percent. The GRO result for this soil sample was flagged J as estimated due to high surrogate recovery. The laboratory did not perform any corrective action because the surrogate that was high was being interfered with by the hydrocarbon pattern and reanalysis would have produced a similar result (the sample contained 82 mg/kg of GRO). The surrogate that fell outside the hydrocarbon pattern had good recovery, showing that the extraction was performed properly. The data is usable for site assessment.

Qualified Data Due to Surrogate Recovery

Location	Depth	BFB Recovery	TFT Recovery	Flag
B154TR002	3.8	233%	105%	J

Instrument Calibration and Internal Standards. The laboratory did not report any calibration problems. During full validation of work order 99F079, it was noted that the low calibration standard was equivalent to a soil concentration of 2.5 mg/kg, since all soil samples were prepared by a mid level extraction. The impact of this is discussed in the next section. Internal standards are not applicable to this method.

Analyte Identification and Analyte Quantitation. The PQL of 1.0 mg/kg for soil samples used by the laboratory was not supported by the analysis of a low standard at or below that concentration. The lowest standard would support a PQL concentration of 2.5 mg/kg or higher; therefore, results below 2.5 mg/kg (as adjusted for moisture and dilutions) were treated as estimated trace concentrations. This affected samples B103TR003-S05 and B154TR006-S02, which were measured at a concentration above the laboratory reported PQL of 1.0 mg/kg, but below the low standard equivalent concentration of 2.5 mg/kg. The result for sample B103TR003-S05 (1.33 mg/kg) and sample B154TR006-S02 (1.21 mg/kg) were flagged J as estimated. All other sample results were either not detected (ND) or greater than 2.5 mg/kg. The laboratory did not report any analyte identification problems, nor were any identified during full validation of work order 99FO79. The chromatograms showed evidence of gasoline-range organic compounds. The chromatograms also showed evidence of heavier hydrocarbons outside the GRO range, which were not quantitated as part of this method.

Overall Assessment and Completeness. Overall, the data are considered usable for project decision-making. A summary of completeness for GRO in soil analyses is presented in Table D-7.

**Table D-7
Completeness for GROs in Soil Samples**

Analyte	Samples Planned	Samples Taken	Analytes per Sample	Number of Results					Completeness			
				Total	Non-Contract Compliant	Rejected	Estimated due to QC	Estimated due to >MDL but <PQL	Contract Compliance	Technical	Analytical*	Sampling
GRO	9	9	1	9	1	0	1	2	88.9%	100.0%	88.9%	100.0%

* Note: Estimations due to results <PQL do not affect the calculated completeness

D.4.2 Gasoline-Range Organics in Water Samples. Five water samples were collected for volatile petroleum hydrocarbons quantitated as GROs from 2-methylpentane (approximately C6) to 1,2,4-trimethylbenzene (approximately C10) by GC Method SW8015B. The water samples were analyzed by EMAX in two laboratory batches.

Preservation and Holding Times. Samples were collected in the proper containers and preserved correctly at <6°C. Sample pH readings were within the acceptance limit (pH less than 2) for GROs. Preserved water samples were analyzed within the prescribed holding time of 14 days from the date of collection.

Laboratory Method Blanks and Field QC Blanks. Laboratory method blanks were analyzed at the required frequency of one method blank per laboratory batch. All water samples were initially analyzed in one laboratory batch with one method blank. One water sample with a high GRO concentration was re-analyzed at a dilution in a second analytical batch with another method blank. Gasoline-range organics were not detected above the MDL in any of the method blanks. There were no equipment blanks or trip blanks associated with any of the samples analyzed for GROs in water by Method SW8015B.

MS/MSD Recoveries and Precision. Sample B073TR001-W01 was designated for MS/MSD analysis and included in batch VAF1539. Recoveries were within the project control limits for accuracy of 65-135 percent recovery. MS/MSD precision was within the maximum limit of 25 percent RPD for GROs in water by Method SW8015B. The second batch, VAF1639, included only the dilution run for the parent sample of the MS. The MS/MSD pair were not re-analyzed in the second batch.

LCS/LCSD Recoveries and Precision. LCS/LCSD pairs were prepared and analyzed at the appropriate frequency of one pair per lab batch when an MS/MSD pair is not present and a minimum of an LCS in batches that contain matrix spikes. All recoveries were within the project control limits for accuracy of 65-135 percent recovery. LCS/LCSD precision was within the RPD maximum limit of 25 percent for GROs in water by Method SW8015B.

Field Duplicate Precision. There were no field duplicate water samples collected for GROs analysis by Method SW8015B. Therefore, compliance with the criteria for field duplicate precision defined in the Table E-2 of the QAPP could not be evaluated and the frequency requirement for field duplicate collection of 10 percent was not met. The field duplicate was inadvertently omitted due to the small number of samples collected. Failing to collect field duplicate impacts the qualitative assessment of completeness, which is reflective of the percentage for field sampling completeness.

Laboratory Replicate Precision. Laboratory replicates are not required for this method.

Surrogate Recoveries. Surrogate compounds, 1-bromo-4-fluorobenzene (BFB) and 1,1,1-trifluorotoluene (TFT), were added to environmental and lab QC samples and used to measure method performance on a sample-specific basis. All surrogate recoveries were within project control limits of 65-135 percent, with the exception of sample B073TR001-W01, which was re-analyzed at a 1:5 dilution, with acceptable surrogate recoveries. The results of this dilution were reported with no qualification.

Instrument Calibration and Internal Standards. The laboratory did not report any calibration problems and none were observed during full validation of work order 99F079. Internal standards are not applicable to this method.

Analyte Identification and Analyte Quantitation. The laboratory did not report any analyte identification problems. The chromatograms showed evidence of gasoline-range organic compounds. The chromatograms also showed evidence of heavier hydrocarbons outside the GRO range, which were not quantitated as part of this method.

Overall Assessment and Completeness. Overall, the data met the requirements of the method and the QAPP, and are considered usable for project decision-making. A summary of completeness for GRO in water analysis is presented in Table D-8.

**Table D-8
Completeness for GROs in Water Samples**

Analyte	Samples Planned	Samples Taken	Analytes per Sample	Total	Number of Results					Completeness			
					Non-Contract Compliant	Rejected	Estimated due to QC	Estimated due to >MDL but <PQL	Contract Compliance	Technical	Analytical*	Sampling	
GRO	6	5	1	5	0	0	2	1	100.0%	100.0%	60.0%	83.3%	

* Note: Estimations due to results <PQL do not affect the calculated completeness

D.5 Extractable Petroleum Hydrocarbons as Diesel-range and Residual-range Organics by Method SW8015B

D.5.1 Diesel-range and Residual-range Organics in Soil Samples. Ten environmental soil samples plus a field duplicate were collected for extractable petroleum hydrocarbons quantitated as diesel and residual-range organics (DROs and RROs). DROs were quantitated between the hydrocarbon range of decane (C-10) to tetracosane (C-24) using diesel fuel #2 as the calibration standard. RROs were quantitated between the hydrocarbon range of eicosane (C-20) to tetratriacontane (C-34) using SAE-30 motor oil as the calibration standard. The samples were collected in 6-inch metal sleeves and transported cold to EMAX where they were extracted with methylene chloride in one batch using Soxhlet Method SW3540C. The extracts were silica gel cleaned by Method SW3630B and analyzed by GC Method SW8015B. For a tabulated count of the samples and the associated batch QC samples, see Appendix D.

Preservation and Holding Times. Samples were collected in the proper containers and preserved correctly by being maintained at a temperature of <6°C until extracted by Method SW3540C. Soil samples were extracted within the prescribed holding time of 14 days from the date of collection and analyzed within 40 days of extraction.

Laboratory Method Blanks and Field QC Blanks. Laboratory method blanks were analyzed at the required frequency of one method blank per laboratory batch. DROs and RROs were not detected above the MDL in the method blank. There were no equipment blanks associated with any of the samples analyzed for DROs and RROs in soil by Method SW8015B.

MS/MSD Recoveries and Precision. Sample B103TR003-S06 was designated for MS/MSD analysis with the single preparation batch. The recoveries were within the project control limits for accuracy of 65-135 percent recovery. MS/MSD precision was within the RPD maximum limit of 40 percent for DROs in soil by Method SW8015B.

LCS/LCSD Recoveries and Precision. Since an MS/MSD pair was analyzed, only the LCS was prepared and analyzed. The recovery for DROs in the LCS was within the project control limits for accuracy of 65-135 percent recovery for DROs in soil by Method SW8015B.

Field Duplicate Precision. Sample B154TR007-S06 was a field duplicate of sample B154TR007-S03. Sample B154TR007-S03 was non-detect for both DROs and RROs. Sample B154TR007-S06 had a detected value for DROs (25 mg/kg) was above five times the MDL of 2.4 mg/kg. No data were qualified, in accordance with Table E-2 of the QAPP. The requirement for collecting 10 percent field duplicates was met.

Qualified Data Due to Field Duplicate Precision

Method	B154TR007-S03	B154TR007-S06	% RPD	Flag
SW8015B DROs	<2.4 mg/kg	25 mg/kg	165	None
SW8015B RROs	<21 mg/kg	<21 mg/kg	0	None

Laboratory Replicate Precision. Laboratory replicates are not required for this method.

Surrogate Recoveries. Surrogate compounds, bromobenzene (BBZ) and n-hexacosane (C-26), were added to environmental and lab QC samples and used to measure method performance on a sample-specific basis. Six results in three samples were qualified due to surrogate recoveries not being within project control limits of 65-135 percent. The samples were not re-extracted and reanalyzed, as required. The DRO and RRO results for these three soil samples were flagged J as estimated due to low and high surrogate recoveries.

Qualified Data Due to Surrogate Recovery

Location	Depth	BBZ Recovery	C-26 Recovery	Flag
B154TR003	4.0	146%	118%	J
B154TR006	3.5	149%	108%	J
B103TR003	6.0	233%	87%	J

Instrument Calibration and Internal Standards. The lowest calibration standard was equivalent to 10 mg/kg for DROs and 100 mg/kg for RROs. Due to insufficient concentration of the extracts by the laboratory, these standards were above the QAPP required reporting limit of 5 mg/kg for DROs and 50 mg/kg for RROs. All PQLs for DROs and RROs are twice as high as the required PQLs listed in Table A-7 of the QAPP. All the samples are consider to be analyzed at a 2X dilution. The laboratory did not report any other calibration problems and none were observed during full validation of work order 99F079. Internal standards are not applicable to this method.

Analyte Identification and Analyte Quantitation. Soil samples B053TR001-S03 and B053TR001-S06 had hydrocarbons reported in both of the DRO and RRO ranges. The chromatogram for these two samples showed evidence of RRO compounds that overlapped with the DRO range. There was no evidence of a diesel or lighter hydrocarbon pattern. The DRO result for these two samples were flagged N as a presumptive identification with a reason code of U. The U reason code indicates that the DRO result is actually part of the RRO pattern and is fully quantitated in the RRO fraction. Some chromatograms showed evidence of a light extractable hydrocarbon that elutes during the first half of the diesel-range that was quantitated as DROs. Sample B154TR002-S03 was the only sample that exhibited a diesel fuel pattern. All other detected DRO results represented the fuel pattern in the lighter range of C-10 to C-18 by itself or in combination with overlap from motor oil in the RRO range. All detected and reported RRO results were quantitated using 30-weight motor oil as the standard.

Overall Assessment and Completeness. Overall, the data are usable for project decision-making. A summary of DRO/RRO is soil analyses is presented in Table D-9.

**Table D-9
Completeness for DROs & RROs in Soil Samples**

Analyte	Samples Planned	Samples Taken	Analytes per Sample	Number of Results					Completeness			
				Total	Non-Contract Compliant	Rejected	Estimated due to QC	Estimated due to >MDL but <PQL	Contract Compliance	Technical	Analytical*	Sampling
All	10	10	2	20	6	0	6	0	70.0%	100.0%	70.0%	100.0%

* Note: Estimations due to results <PQL do not affect the calculated completeness

D.5.2 Diesel and Residual-range Organics in Water Samples. Five water samples were collected for extractable petroleum hydrocarbons quantitated as DROs and RROs. DROs were quantitated between the hydrocarbon range of (C-10) to (C-24) using diesel fuel #2 as the calibration standard. RROs were quantitated between the hydrocarbon range of (C-20) to (C-34) using SAE-30 motor oil as the calibration standard. The samples were collected in one-liter amber bottles and transported cold to EMAX they were extracted with methylene chloride in one batch using continuous liquid/liquid extraction Method SW3520C. The extracts were silica gel cleaned by Method SW3630B and analyzed by GC Method SW8015B.

Preservation and Holding Times. Samples were collected in the proper containers and preserved correctly by being maintained at a temperature of <6°C. Water samples were extracted within the prescribed holding time of 7 days from date of collection and analyzed within 40 days of extraction.

Laboratory Method Blanks and Field QC Blanks. Laboratory method blanks were analyzed at the required frequency of one method blank per laboratory batch. All water samples were analyzed in one laboratory batch with one method blank. DROs and RROs were not detected above the MDL in the method blank. There were no equipment blanks associated with any of the samples analyzed for DROs and RROs in water by Method SW8015B.

MS/MSD Recoveries and Precision. Sample B073TR001-W01 was designated for MS/MSD analysis with the single preparation batch. Recoveries were within the project control limits for accuracy of 65-135 percent recovery. MS/MSD precision was within the RPD maximum limit of 25 percent for DROs in water by Method SW8015B.

LCS/LCSD Recoveries and Precision. An LCS/LCSD pair were prepared and analyzed with the lab batch for DROs even though it contained a matrix spike pair. All recoveries were within the project control limits for accuracy of 65-135 percent recovery. LCS/LCSD precision was within the RPD maximum limit of 25 percent for DROs in water by Method SW8015B.

Field Duplicate Precision. There were no water field duplicate samples collected for DROs and RROs by Method SW8015B. Therefore, compliance with the criteria for field duplicate precision defined in the Table E-2 of the QAPP could not be evaluated, and the frequency requirement for field duplicate collection of 10 percent was not met. The field duplicate was inadvertently omitted due to the small number of samples collected. Failing to collect field

duplicate impacts the qualitative assessment of completeness, which is reflective of the percentage for field sampling completeness.

Laboratory Replicate Precision. Laboratory replicates are not required for this method.

Surrogate Recoveries. Surrogate compounds, bromobenzene (BBZ) and n-hexacosane (C-26), were added to environmental and lab QC samples and used to measure method performance on a sample-specific basis. All surrogate recoveries were within project control limits of 65-135 percent for all samples, with the exception of sample B154TR003-W01. This sample was not re-extracted and re-analyzed as required because the poor recovery was not identified by the laboratory until after the holding time had expired. Also, the high levels of petroleum hydrocarbons present in the sample (3300 ug/L DRO and 4100 ug/L RRO may have interfered with the integration of the C-26 surrogate. The DRO and RRO results for this water sample were flagged J as estimated due to low surrogate recoveries. The data are still usable for site evaluation and risk assessment.

Qualified Data Due to Surrogate Recovery

Location	Depth	BBZ Recovery	C-26 Recovery	Flag
B154TR003	6.0	104%	61%	J

Instrument Calibration and Internal Standards. The lowest calibration standard for DROs was 100 mg/L (and reported 200 mg/L) and for RROs it was 1000 mg/L. Due to the lack of sufficient concentration of the extracts by the laboratory, these standards were above the QAPP-required reporting limit of 100 mg/L for DROs and 500 mg/kg for RROs. All PQLs for DROs and RROs are twice as high as the required PQLs listed in Table A-7 of the QAPP. All the samples are considered to be analyzed at a 2X dilution. The laboratory did not report any other calibration problems, and none were observed during full validation of work order 99F079. Internal standards are not applicable to this method.

Analyte Identification and Analyte Quantitation. The laboratory did not report any analyte identification problems. The chromatograms showed evidence of light diesel-range organic compounds. Detected DRO samples had a fuel pattern in the lighter range of C-10 to C-18. The chromatograms also showed evidence of heavier hydrocarbons in the RRO range; all detected and reported RRO results were quantitated using 30-weight motor oil as the standard.

Overall Assessment and Completeness. Overall, the data are usable for project decision-making. A summary of DRO and RRO analysis in water is presented in Table D-10.

**Table D-10
Completeness for DROs & RROs in Water Samples**

Analyte	Samples Planned	Samples Taken	Analytes per Sample	Total	Number of Results				Completeness			
					Non-Contract Compliant	Rejected	Estimated due to QC	Estimated due to >MDL but <PQL	Contract Compliance	Technical	Analytical*	Sampling
All	6	5	2	10	2	0	2	2	80.0%	100.0%	80.0%	83.3%

* Note: Estimations due to results <PQL do not affect the calculated completeness

D.6 Volatile Organics and Oxygenates by Method SW8260B

D.6.1 Volatile Organics and Oxygenates in Soil Samples. Nine environmental soil samples and a field duplicate were collected for VOCs and oxygenates analysis by Method SW8260B. The samples were collected in Encore samplers and transported cold to EMAX where one set of samples were preserved with sodium bisulfate for low level analysis, and a second set was transferred to methanol for mid-level analysis, both following the guidelines for extraction of volatile organics in soil for a closed-system purge-and-trap found in Method SW5035. For the analysis of the mid-level extracts, Method SW5035 references Method SW5030. For this reason, the mid level results were reported with a preparation method of SW5030. The soil samples were analyzed in three laboratory batches. Two of the batches, VOF1703 and VOF2703, used the mid level methanol extracts, while batch VOF2003 used the preserved low level samples.

Preservation and Holding Times. Samples were collected in the proper Encore containers and preserved correctly by being maintained at a temperature of <6°C until preserved with sodium bisulfate or transferred to methanol within 48 hours of collection. Soil samples were analyzed within the prescribed holding time of 14 days from the date of collection.

Laboratory Method Blanks and Field QC Blanks. Laboratory method blanks were analyzed at the required frequency of one method blank per laboratory batch. VOCs were not detected above the MDL in any of the method blanks. Five trip blanks, one per cooler shipped, were associated with the samples analyzed for VOCs in soil by Method SW8260B. The water trip blanks had no detected VOCs above the MDL. There were no equipment blanks associated with the soil samples.

MS/MSD Recoveries and Precision. Sample B103TR003-S04 was designated for MS/MSD analysis and was included in batch VOF2003. Only the MSD results were reported; the MS sample was lost due to a purging problem. The recoveries in the reported MSD were within the project control limits for accuracy found in Table C-14 of the QAPP. MS/MSD precision could not be calculated VOCs in soil by Method SW8260B. Analytical precision was measured using the LCS/LCSD results. Batches VOF1703 and VOF2703 did not include an MS/MSD pair.

LCS/LCSD Recoveries and Precision. LCS/LCSD pairs for VOCs and oxygenates were prepared and analyzed at the appropriate frequency of one pair per lab batch when an MS/MSD pair is not present and a minimum of one LCS in each batch that contains matrix spikes. All recoveries, with the exception of t-butanol in batch VOF2703, were within the project control limits for accuracy of 65-135 percent recovery. The LCS recovery for t-butanol in batch VOF2703 was below the control limit for accuracy; three associated t-butanol results were qualified. LCS/LCSD precision was within the RPD maximum limit of 40 percent for VOCs in soil by Method SW8260B.

Qualified Data Due to LCS/LCSD Accuracy (t-butanol)

Location	Depth	Batch	Result	Flag
VOF2603L (LCS)	N/A	VOF2703	29%	N/A
B154TR007	5.0	VOF2703	ND	UJ
B154TR007FD	4.8	VOF2703	ND	UJ
B103TR003	6.0	VOF2703	ND	UJ

Field Duplicate Precision. Sample B154TR007-S04 was a field duplicate of sample B154TR007-S01. Both samples were run at high dilutions due to the high levels of target analytes found in the GRO analysis. Sample B154TR007-S01 had two detects above the PQL and twelve trace value results (it was run at a 500X dilution), while the field duplicate B154TR007-S04 was all non-detect (it was run at a 1000X dilution). The precision for these two samples could not be calculated due to the difference in the dilutions. The requirement for collection of field duplicates at a rate of 10 percent was met and no significant impact to overall data quality is anticipated.

Laboratory Replicate Precision. Laboratory replicates are not required for this method.

Surrogate Recoveries. Surrogate compounds, 1-bromo-4-fluorobenzene (BFB), toluene-d8 (BZME) and 1,2-dichloroethane-d4 (1,2-DCA), were added to environmental and lab QC samples and used to measure method performance on a sample-specific basis. Three samples (B154TR006, B154TR007, and B073TR001) had one surrogate recovery above project control limits of 70-130%. Only the detected VOCs in these samples were qualified as estimated due to a possible high bias (J). One sample (B053TR001) had a surrogate recovery below the project control limit. This sample had all the non-detect VOCs results qualified as non-detected (UJ) and all the detect results qualified as estimated (J) because of possible low bias. Three of the four samples were associated with locations where high concentrations of petroleum hydrocarbons were found. These hydrocarbons may be the cause of the sporadic surrogate recovery problems. For these samples, two out of the three surrogates were recovered within control limits showing that the preparation process was probably in control. In the fourth sample, the matrix interferences were so great as to cause all 4 internal standard recoveries to be outside acceptance limits in each of 2 separate sample preparations (see next section). Three other samples were run at high dilutions where the surrogates were diluted out. For these three soil samples, no qualification was required. All site data are considered usable for site evaluation and risk assessment. The results of sample B073TR001 are suspect due to legitimate matrix interferences.

Qualified Data Due to Surrogate Recovery

Location	Depth	BFB recovery	BZME recovery	12DCA recovery	Flag
B053TR001	2.0	67%	87%	113%	UJJ
B154TR003	4.0	Diluted out	Diluted out	Diluted out	None
B154TR006	3.5	81%	97%	182%	J-Detects
B154TR007	5.0	140%	105%	100%	J-Detects
B154TR007FD	4.8	Diluted out	Diluted out	Diluted out	None
B103TR003	6.0	Diluted out	Diluted out	Diluted out	None
B073TR001	4.0	137%	97%	193%	J-Detects

Instrument Calibration and Internal Standards. The laboratory did not report any calibration problems based on the criteria for laboratory self-evaluation and corrective action listed in Appendix B of the QAPP. Issues not addressed in the laboratory narrative were identified during full validation of work order 99F079 using the criteria set forth in Appendix E of the QAPP. The data validation guidance included additional criteria beyond those specified in the section the laboratory was required to follow. This resulted in the re-evaluation of all data packages. The following problems, which resulted in flagged yet contract compliant data, were noted.

For the medium-level and low-level soils, a separate initial calibration curve was generated for the oxygenate analytes and the non-oxygenate analytes. The percent relative standard deviation (%RSD) was less than 30 percent for a majority of analytes, and therefore, the average relative response factor (RRF) was used for sample quantitation. For analytes with a %RSD > 30, a first order curve was generated and the correlation coefficient was evaluated. The acrolein correlation coefficient (0.985) was less than 0.990 for the medium-level soil calibration curve. For both calibration curves, the acrolein minimum RRF was less than 0.01. The minimum relative response factor (RRF) was met for all analytes. All medium-level acrolein results were rejected (UR) due to poor correlation of initial calibration data and all low-level acrolein results were estimated (UJ) due to a low RRF. (Acrolein results would also have been estimated for low RRF if they had not already been rejected.) For a summary of qualified results, refer to page 7 of Appendix F to this report.

The laboratory identified the initial calibration verification (ICV) standard as the second source standard. A second-source ICV was performed for both the medium-level and low-level soil calibrations. Acrolein, 2-hexanone, and 2-butanone did not meet all second-source ICV requirements. The minimum RRF for acrolein was <0.01 on both second-source ICVs. Since all acrolein medium-level results were previously rejected (UR) due to poor correlation of initial calibration data and all acrolein low-level results were previously estimated (UJ) due to a low RRF, no additional qualification was necessary. ICV recovery for 2-hexanone was biased high on both medium and low-level second-source ICVs; and for 2-butanone, on only the low-level second-source ICV. All 2-hexanone results and the low-level 2-butanone results were estimated (UJ) in accordance with the guidance in the QAPP, but high bias on a non-detect result has no impact on data usability. All other percent differences calculated between the two sources were within 25 percent.

Continuing calibration verification (CCV) standards were analyzed prior to each analytical sequence. For the medium-level soils batch VOF1703, the following analytes did not meet the CCV percent difference (%D) acceptance criteria: acrylonitrile, bromomethane, vinyl acetate and vinyl chloride. The results for these analytes were estimated (UJ) in the three associated medium-level soil sample analyses. Also, acrolein did not meet the minimum RRF requirement; however, all results were previously estimated (UJ) due to a low RRF in the initial calibration. For the medium-level soils batch VOF2703, the following analytes did not meet the CCV %D acceptance criteria: acrolein and vinyl acetate. The acrolein %D was >20% but <40% and therefore, all acrolein results were estimated (UJ). The %D for vinyl acetate was >40% and therefore, all vinyl acetate results were rejected (UR). For a summary of qualified results, refer to Appendix F of this QCSR (acrylonitrile pg. 7, bromomethane pg. 8, vinyl acetate and vinyl chloride pg. 15).

For the low-level soils batch VOF2003, acrolein did not meet the minimum RRF requirement and several analytes did not meet the CCV %D acceptance criteria. Since all acrolein low-level results were previously estimated (UJ) due to a low RRF in the initial calibration, no additional acrolein qualification was necessary. The following analytes did not meet the CCV %D acceptance criteria: bromomethane, 2,2-dichloropropane, ethyl methacrylate, hexachlorobutadiene, iodomethane, and naphthalene. All %D values were >20% but <40% and therefore, the results for these analytes were estimated (UJ). For a summary of qualified results, refer to Appendix F of this QCSR (bromomethane pg. 8, 2,2-dichloropropane pg. 5, ethyl methacrylate and hexachlorobutadiene pg. 10, iodomethane pg. 11, and naphthalene pg. 12). All other CCV analytes were within acceptance criteria. For sample B073TR001-S01, all four internal standard recoveries were below acceptance limits. The sample was re-analyzed by the laboratory and again all four internal standard area counts were below acceptance limits,

confirming the presence of matrix effects. All detected results for this sample were flagged as estimate (J) and all non-detects were flagged UJ, and the quantitation should be considered suspect. All other internal standard recoveries were within the acceptance criteria.

The estimation of results due to initial and continuing calibration problems only affected analytes which were not-detected. These were all analytes for which there is no known historic use at the Arsenal. All calibration anomalies resulted in the estimation rather than the rejection of data for all analytes with the exception of acrolein and vinyl acetate. All estimated data is still considered usable for site assessment. Because acrolein and acrylonitrile are not typically capable of obtaining good response factors without a heated purge and are not known chemicals of concern at the Arsenal, it is recommended that they be removed from the target analyte list for future investigations. For vinyl acetate, one of the two rejected results was from a field duplicate pair. The usable data from the field duplicate can be used to replace the rejected normal sample data. This only leaves a data gap for one point from B103TR003. Since vinyl acetate was not a required target analyte for the investigation of the UST sites, the data gap has no impact on the ability to fully evaluate the site with existing data. (A full rather than a shortened SW8260 list was analyzed so as to collect additional data concerning possible migration into the area of solvents from the nearby 50 Series Complex without collecting additional samples.)

Analyte Identification and Analyte Quantitation. An MDL study was performed and some of the laboratory reported PQL values did not meet the required PQL values listed in Table A-15 of the QAPP. Acrolein and trans-1,4-dichloro-2-butene results were reported with a soil PQL of 50 ug/kg. Table A-15 of the QAPP lists the soil PQL at 5.0 ug/kg for these analytes. Acrylonitrile and naphthalene were reported at 10 ug/kg instead of the QAPP required PQL of 5 ug/kg. The PQL for vinyl chloride was raised from 1.0 ug/kg to 5.0 ug/kg in soil samples. Table A-15 of the QAPP is currently being updated to include laboratory variances to the PQLs. In addition, raised PQLs are still below residual PRGs and are not likely to impact data usability.

Analyte identification was performed using a relative retention time as established in Method SW8260B. Acetonitrile, which is specified in Table A-15 of the QAPP, was not reported by the laboratory.

Overall Assessment and Completeness. Overall, the data are considered usable for project decision making. A summary of completeness for VOC analyses in soil is presented in Table D-11.

**Table D-11
Completeness for VOCs in Soil Samples**

Analyte	Samples Planned	Samples Taken	Analytes per Sample	Number of Results					Completeness			
				Total	Non-Contract Compliant	Rejected	Estimated due to QC	Estimated due to >MDL but <PQL	Contract Compliance	Technical	Analytical*	Sampling
All	10	10	75	750	99	8	281	21	86.8%	98.9%	61.5%	100.0%

* Note: Estimations due to results <PQL do not affect the calculated completeness

D.6.2 Volatile Organics and Oxygenates in Water Samples. Five water samples and five trip blanks were collected for VOCs and oxygenates analysis by Method SW8260. All water samples were collected in 40-ml volatile organics analysis (VOA) vials and preserved with hydrochloric acid. The water samples were analyzed by EMAX in four laboratory batches: two for VOCs and two for oxygenates. For a tabulated count of the samples and the batch QC samples, see Appendix D.

Preservation and Holding Times. Samples were collected in the proper containers and preserved correctly at 6°C. Sample pH readings were within the acceptance limit (pH less than 2) for VOCs. Preserved water samples were analyzed within the prescribed holding time of 14 days from the date of collection.

Laboratory Method Blanks and Field QC Blanks. Laboratory method blanks were analyzed at the required frequency of one method blank per laboratory batch. VOCs were not detected above the MDL in any of the method blanks or trip blanks.

MS/MSD Recoveries and Precision. Sample B073TR001-W01 was designated for MS/MSD analysis and was included in batch VOF1502 for VOCs and batch VOF2503 for oxygenates. All MS/MSD recoveries were within the project control limits for accuracy found in Table C-14 of QAPP with the exception of a low recovery for TCE in the MS: the parent sample was flagged J. MS/MSD precision was within the RPD maximum limit of 25 percent for VOCs and oxygenates in water by Method SW8015B. The second set of batches, VOF1302 for VOCs and VOF1803 for oxygenates, did not include an MS/MSD pair.

LCS/LCSD Recoveries and Precision. LCS/LCSD pairs were prepared and analyzed at the appropriate frequency of one pair per lab batch when an MS/MSD pair is not present and a minimum of one LCS in each batch that contains matrix spikes. All recoveries were within the project control limits for accuracy of 65-135 percent recovery. LCS/LCSD precision was within the RPD maximum limit of 25 percent for VOCs and oxygenates in water by Method SW8260B.

Field Duplicate Precision. There were no field duplicate water samples collected for VOCs and oxygenates analysis by Method SW8260B. Compliance with the criteria for field duplicate precision defined in the Table E-2 of the QAPP could not be evaluated. The frequency requirement for field duplicate collection of 10 percent was not met. The field duplicate was inadvertently omitted due to the small number of samples collected. Failing to collect field duplicates impacts the qualitative assessment of completeness, which is reflective of the percentage for field completeness.

Laboratory Replicate Precision. Laboratory replicates are not required for this method.

Surrogate Recoveries. Surrogate compounds 1-bromo-4-fluorobenzene (BFB), toluene-d8 (BZME) and 1,2-dichloroethane-d4 (12DCA), were added to environmental and lab QC samples and used to measure method performance on a sample-specific basis. All surrogate recoveries were within project control limits of 70-130 percent.

Instrument Calibration and Internal Standards. The laboratory did not report any calibration problems based on the criteria for laboratory self-evaluation and corrective action listed in Appendix B of the QAPP. Issues not addressed in the laboratory narrative were identified during full validation of work order 99F079 using the criteria set forth in Appendix E of the

QAPP. The data validation guidance included additional criteria beyond those specified in the section the laboratory was required to follow. This resulted in the re-evaluation of all data packages. The following problems, which resulted in flagged yet contract compliant data, were noted.

A separate initial calibration curve was generated for the oxygenate analytes and the non-oxygenate analytes. For a majority of analytes, the %RSD was less than 30 percent and the average response factor was used for sample quantitation. For analytes with a %RSD > 30, a first order curve was generated and the correlation coefficient was evaluated. The acrolein correlation coefficient (0.982) was less than the minimum requirement of 0.990. The minimum RRF was met for all analytes except acrolein and acrylonitrile. All acrolein results were rejected (UR) due to poor correlation of initial calibration data and all acrylonitrile results were estimated (UJ) due to a low RRF. (Acrolein results would also have been estimated for low RRF if they had not already been rejected.)

The laboratory identified the ICV as the second source standard. Acrolein, acrylonitrile, and hexachlorobutadiene did not meet all second-source ICV requirements. The minimum RRF for acrolein and acrylonitrile was <0.01. Since all acrolein results were previously rejected (UR) due to poor correlation of initial calibration data and all acrylonitrile results were previously estimated (UJ) due to a low RRF, no additional data qualification was necessary. The %D for hexachlorobutadiene was >25% but <50% and therefore, all hexachlorobutadiene results were estimated (UJ), but are still considered usable for site evaluation. All other percent differences calculated between the two sources were within 25 percent.

CCV standards were analyzed prior to each analytical sequence. For batch VOF1502, the following analytes did not meet the CCV percent difference (%D) acceptance criteria: acrolein, n-butylbenzene, sec-butylbenzene, p-cymene, and hexachlorobutadiene. In addition, acrolein and acrylonitrile did not meet the minimum RRF requirement of 0.01. Since all acrolein results were previously rejected (UR) due to poor correlation of initial calibration data and all acrylonitrile results were previously estimated (UJ) due to a low RRF, no additional data qualification was necessary for these analytes. The results for other analytes were estimated (UJ) in the associated water samples. For batch VOF1302, the %D for the acrolein CCV exceeded the maximum 20%D limit and also, acrolein and acrylonitrile did not meet the minimum RRF requirement. Since all acrolein results were previously rejected (UR) due to poor correlation of initial calibration data and all acrylonitrile results were previously estimated (UJ) due to a low RRF, no additional data qualification was necessary. For a summary of qualified results, refer to Appendix F of this report (n-butylbenzene pg. 32, sec-butylbenzene pg. 31, p-cymene pg. 31, and hexachlorobutadiene pg. 30).

Analyte Identification and Analyte Quantitation. An MDL study was performed and some of the laboratory reported PQL values did not meet the required PQL values listed in Table A-15 of the QAPP. Acrolein and trans-1,4-dichloro-2-butene results were reported with a water PQL of 50 ug/L. Table A-15 of the QAPP lists the water PQL at 1.0 ug/L for these analytes. Table A-15 of the QAPP is currently being updated to include laboratory variances to the PQLs. There are no primary or secondary MCLs for these compounds. The tap water PRG for acrolein is 42 ug/L. Because the MDL for acrolein is below 42 ug/L, impact to data usability appears to be insignificant.

Analyte identification was performed using a relative retention time as established in Method SW8260B. Acetonitrile, which is specified in Table A-15 of the QAPP, was not reported by the laboratory.

Overall Assessment and Completeness. Overall, the data met the requirements of the method and the QAPP, and are considered usable for project decision-making. A summary of completeness for VOC analyses in water is presented in Table D-12.

**Table D-12
Completeness for VOCs in Water Samples**

Analyte	Samples Planned	Samples Taken	Analytes per Sample	Total	Number of Results				Completeness			
					Non-Contract Compliant	Rejected	Estimated due to QC	Estimated due to >MDL but <PQL	Contract Compliance	Technical	Analytical*	Sampling
All	11	10	75	750	8	4	19	15	98.9%	99.5%	96.9%	90.9%

* Note: Estimations due to results <PQL do not affect the calculated completeness

* Samples Planned and taken include the 5 trip blanks, one per cooler to EMAX.

5.7 Semi-Volatile Organic Compounds by Method SW8270C

5.7.1 Semi-Volatile Organic Compounds in Soil Samples. One soil sample was collected for semi-volatile organic compounds (SVOCs) analysis by Method SW8270C. The sample was collected in a six-inch stainless-steel sleeve and transported cold to EMAX where it was analyzed by Method SW8270C. The soil sample was extracted with 1:1 methylene chloride/acetone using sonication Method SW3550B in one laboratory batch and analyzed by GC/MS Method SW8270. For a tabulated count of the samples and the associated batch QC samples, see Appendix D.

Preservation and Holding Times. Samples were collected in the proper containers and preserved correctly by being maintained at a temperature of <6°C until extracted within the prescribed holding time of 14 days from the date of collection. The soil sample extract was then analyzed within the prescribed holding time of 40 days from the date of extraction.

Laboratory Method Blanks and Field QC Blanks. A laboratory method blank was analyzed at the required frequency of one method blank per laboratory batch. SVOCs were not detected above the MDL in the method blank. There were no equipment blanks associated with the sample analyzed for SVOCs in soil by Method SW8270C.

MS/MSD Recoveries and Precision. Sample B073TR001-S03 was designated for MS/MSD analysis and was included in batch SVF026S. The MS and MSD were prepared by spiking two separate additional aliquots of the sample that all were taken from the same soil sleeve at the same time. The laboratory had a problem with the MS/MSD extracts. When the MS/MSD samples were extracted, a single phase was obtained; however, prior to analysis two phases formed: a dark brown upper layer and a viscous lower layer. The laboratory analyzed the lower viscous layer for the MS/MSD analysis when attempts to re-homogenize the extracts failed.

Over 50 percent of the spiked compounds in the MS and the MSD samples were outside the acceptance criteria. The MS/MSD samples also had problems with the internal standards. Three of the six internal standards were below the acceptable recovery level in the MS sample, while all six internal standards were below acceptance criteria in the MSD sample. The soil MS/MSD analyses were rejected due to QC failures. The soil sample was not evaluated in comparison to the MS/MSD, since the parent sample extract did not exhibit any of the problems found on the MS/MSD extracts. This left the batch without a measure of accuracy in the matrix. Since only the parent sample rather than the whole batch is flagged for MS problems, only this one sample was affected.

LCS/LCSD Recoveries and Precision. An LCS/LCSD pair for SVOCs was prepared and analyzed at the appropriate frequency of one pair per lab batch when an MS/MSD pair is not present and a minimum of one LCS in each batch that contains matrix spikes. All recoveries were within the project control limits for accuracy of 30-150 percent recovery. Since the laboratory extracted an MS/MSD pair, only an LCS was analyzed. LCS/LCSD precision for SVOCs in soil by Method SW8270C could not be calculated.

Field Duplicate Precision. There were no soil field duplicate samples collected for SVOCs by Method SW8270C, therefore, compliance with the criteria for field duplicate precision defined in the Table E-2 of the QAPP could not be evaluated and the frequency requirement for field duplicate collection of 10 percent was not met. The field duplicate was inadvertently omitted due to the small number of samples collected. Failing to collect field duplicates impacts the qualitative assessment of completeness, which is reflective of the percentage for field completeness.

Laboratory Replicate Precision. Laboratory replicates are not required for this method.

Surrogate Recoveries. Six surrogate compounds, nitrobenzene-d5, 2,4,6-tribromophenol, 2-fluorophenol, phenol-d5, 2-fluorobiphenyl and terphenyl-d14, were added to environmental and lab QC samples and used to measure method performance on a sample-specific basis. All six surrogate recoveries in the soil sample were within project control limits of 45-135 percent for base/neutral and 35-140 percent for acid surrogates.

Instrument Calibration and Internal Standards. The laboratory did not report any calibration problems in the case narratives. During full validation of work order 99F079, it was observed that benzoic acid did not meet the second-source criteria for the soil calibration on 06/25/99. All other analytes in the secondary-source verification standard were within the maximum acceptance criteria of 25 percent difference for the initial calibration (ICAL). The benzoic acid result for the soil sample was flagged UJ. The internal standards for the soil sample were within acceptance criteria. Only the internal standards for the MS/MSD were outside of acceptance criteria.

Analyte Identification and Analyte Quantitation. The soil PQL values reported by the laboratory were at the soil PQL values listed in Table A-16 of the QAPP. The laboratory did not report any analyte identification problems, nor were any identified during full validation of work order 99F079. The soil sample had no detected concentrations of SVOCs.

Overall Assessment and Completeness. Overall, the data are considered usable for project decision-making. A summary of completeness for SVOC analysis in soil is presented in Table D-13.

**Table D-13
Completeness for SVOCs in Soil Samples**

Analyte	Samples Planned	Samples Taken	Analytes per Sample	Total	Number of Results					Completeness			
					Non-Contract Compliant	Rejected	Estimated due to QC	Estimated due to >MDL but <PQL	Contract Compliance	Technical	Analytical*	Sampling	
All	2	1	52	52	1	0	1	0	98.1%	100.0%	98.1%	50.0%	
* Note: Estimations due to results <PQL do not affect the calculated completeness													

D.7.2 Semi-Volatile Organic Compounds in Water Samples. One water sample was collected for SVOC analysis by Method SW8270C. The sample was collected in one-liter amber bottle and transported cold to EMAX where it was analyzed by Method SW8270C. The water sample was extracted with methylene chloride using continuous liquid-liquid extraction Method SW3520C in one laboratory batch and analyzed by GC/MS Method SW8270.

Preservation and Holding Times. Samples were collected in the proper containers and preserved correctly by being maintained at a temperature of <6°C until extracted within the prescribed holding time of 7 days from date of collection. The water sample extract was then analyzed within the prescribed holding time of 40 days from the date of extraction.

Laboratory Method Blanks and Field QC Blanks. A laboratory method blank was analyzed at the required frequency of one method blank per laboratory batch. SVOCs were not detected above the MDL in the method blank. There were no equipment blanks associated with the sample analyzed for SVOCs in water by Method SW8270C.

MS/MSD Recoveries and Precision. Sample B073TR001-W01 was designated for MS/MSD analysis and was included in batch SVF020W. All recoveries were within the project control limits for accuracy of 45-135 percent recovery. MS/MSD precision was within the RPD maximum limit of 25 percent for SVOCs in water by Method SW8270C.

Field Duplicate Precision. There were no water field duplicate samples collected for SVOCs by Method SW8270C, therefore, compliance with the criteria for field duplicate precision defined in the Table E-2 of the QAPP could not be evaluated and the frequency requirement for field duplicate collection of 10 percent was not met. The field duplicate was inadvertently omitted due to the small number of samples collected. Failing to collect field duplicates impacts the qualitative assessment of completeness, which is reflective of the percentage for field completeness.

LCS/LCSD Recoveries and Precision. An LCS/LCSD pair was prepared and analyzed at the appropriate frequency of one pair per lab batch when an MS/MSD pair is not present and a minimum of one LCS in each batch that contains matrix spikes. All recoveries were within the project control limits for accuracy of 20-150 percent recovery. LCS/LCSD precision was within the RPD maximum limit of 25 percent for SVOCs in water by Method SW8270C.

Laboratory Replicate Precision. Laboratory replicates are not required for this method.

Surrogate Recoveries. Six surrogate compounds, nitrobenzene-d5, 2,4,6-tribromophenol, 2-fluorophenol, phenol-d5, 2-fluorobiphenyl and terphenyl-d14, were added to environmental and lab QC samples and used to measure method performance on a sample-specific basis. All six surrogate recoveries in the water sample were within project control limits of 45-135 percent for base/neutral and 35-135 percent for acid surrogates (35-140 percent for 2,4,6-tribromophenol).

Instrument Calibration and Internal Standards. The laboratory did not report any calibration problems in the case narratives and none were observed during full validation of work order 99F079. Internal standards were within acceptance criteria for all samples for this method.

Analyte Identification and Analyte Quantitation. The soil PQL values reported by the laboratory were at the soil PQL values listed in Table A-16 of the QAPP. The laboratory did not report any analyte identification problems, nor were any identified during full validation of work order 99F079. The water sample had no detected concentrations of SVOCs.

Overall Assessment and Completeness. Overall, the data met the requirements of the method and the QAPP and are usable for project decision-making. A summary of completeness for SVOC analyses in water is presented in Table D-14.

**Table D-14
Completeness for SVOCs in Water Samples**

Analyte	Samples Planned	Samples Taken	Analytes per Sample	Total	Number of Results				Completeness			
					Non-Contract Compliant	Rejected	Estimated due to QC	Estimated due to >MDL but <PQL	Contract Compliance	Technical	Analytical*	Sampling
All	2	1	52	52	0	0	0	0	100.0%	100.0%	100.0%	50.0%

* Note: Estimations due to results <PQL do not affect the calculated completeness

D.8 Polynuclear Aromatic Hydrocarbons by Method SW8310

D.8.1 Polynuclear Aromatic Hydrocarbons in Soil Samples. Ten environmental soil samples plus a field duplicate were collected for polynuclear aromatic hydrocarbons (PAHs) analysis by Method SW8310. The samples were collected in six-inch metal sleeves and transported cold to EMAX where they were Soxhlet extracted with methylene chloride in one batch using Method SW3540C. The extracts were silica gel cleaned by Method SW3630B and analyzed by high performance liquid chromatography (HPLC) Method SW8310. For a tabulated count of the samples and the associated batch QC samples, see Appendix D.

Preservation and Holding Times. Samples were collected in the proper containers and preserved correctly by being maintained at a temperature of <6°C until extracted by Method SW3540. Soil samples were extracted within the prescribed holding time of 14 days from the date of collection and analyzed within 40 days of extraction.

Laboratory Method Blanks and Field QC Blanks. Laboratory method blanks were analyzed at the required frequency of one method blank per laboratory batch. PAHs were not detected above the MDL in the method blank. There were no equipment blanks associated with any of the samples analyzed for PAHs in soil by Method SW8310.

MS/MSD Recoveries and Precision. Sample B103TR003-S06 was designated for MS/MSD analysis with the single preparation batch. PAH recoveries for all five of the spiked analytes were below the project control limits for accuracy of 40-140 percent recovery; three of the five spiked compounds (fluorene, naphthalene, and pyrene) had zero recovery. For the three spiked compounds that had zero recovery, MS/MSD precision could not be calculated. For the other two spiked analytes (benzo(a)pyrene (BAP) and indeno(1,2,3-c,d)pyrene (INP123), the precision requirement of less than 40 percent RPD for PAHs in soil by Method SW8310 was met.

Following the guidelines for qualification in the QAPP, all results in the parent sample (including analytes not spiked in the MS) were rejected, since the recoveries of >50 percent of the spiked compounds were below the lower control limit.

LCS/LCSD Recoveries and Precision. Only an LCS without an LCSD was prepared and analyzed since an MS/MSD pair was present in the batch. The recoveries for all five PAHs spiked in the LCS were below the project control limits for accuracy of 55-135 percent recovery for PAHs in soil by Method SW8310.

Following the guidelines for qualification in the QAPP, all soil sample results, including analytes not spiked in the LCS, were rejected since the recoveries of >50 percent of the spiked compounds were below the lower control limit.

The laboratory did not identify the problem until the holding time was expired. They did not re-analyze the samples because they thought that data were automatically rejected when analyzed past the holding time. They were unaware of the QAPP flagging criteria that only estimated data generated between 1-2X the holding time. This was conveyed in a meeting with the laboratory after the data had been reviewed. In the future, they have agreed to perform required corrective actions even if the holding time has expired. Also for future analyses, the laboratory agreed to spike all analytes, not just a shorted spiking list, in the preparation of LCS and MS samples.

Further investigation identified that the problem appeared to be related to the laboratory-prepared silica gel cleanup columns that were used to clean the extracts prior to analysis. The laboratory also suggested switching to a procedure similar to that used in USEPA Method 418.1 (for recoverable TPH) that performs a cleanup by shaking the extract with granular silica gel rather than pouring the extract through a column of silica gel. When the lab's proposal was turned down by the USACE, they agreed to purchase commercially prepared silica gel columns for the next round of analyses.

Field Duplicate Precision. Sample B154TR007-S06 was a field duplicate of sample B154TR007-S03. Samples B154TR007-S03 and B154TR007-S06 were both non-detect for PAHs. The field duplicate precision control limit of <50 percent RPD for PAHs in soil by Method SW8310 could not be evaluated. The required 10 percent collection frequency for field duplicates was met.

Laboratory Replicate Precision. The laboratory analyzed replicates for samples B154TR002-S03, B154TR003-S03 and B154TR006-S03. The laboratory replicates were Soxhlet extracted by Method SW3540C, but instead of being cleaned by Method SW3630B the replicates were cleaned following the silica gel procedure found in Method 418.1. The laboratory did not analyze any QC samples using the same silica gel cleanup procedure. Although the surrogate recoveries for the replicates were within the acceptance criteria, while the surrogate recoveries for the original samples were below acceptance criteria, all the replicate samples were rejected due to the absence of supporting QC. Replicate precision was not evaluated due to the difference in the preparation procedures.

Surrogate Recoveries. The surrogate terphenyl-d14 was added to all environmental and lab QC samples to measure method performance on a sample-specific basis. Five samples and the field duplicate had surrogate recoveries below the project control limits of 40-140 percent. The flagging criterion in the QAPP for low surrogate recovery specifies that PAHs results would be flagged J as estimated if all other QC requirements had been met. The soil results for these samples were already rejected due to the LCS accuracy deficiency.

Qualified Data Due to Surrogate Recovery

Location	Depth	Terphenyl-d14 Recovery	Flag
B053TR001	6.25	30%	(J)
B103TR003	6	15%	(J)
B154TR003	4	26%	(J)
B154TR006	3.5	32%	(J)
B154TR007	4.8	22%	(J)
B154TR007FD	5	18%	(J)

Instrument Calibration and Internal Standards. The laboratory did not report any calibration problems in the case narratives. The following problems were observed during full validation of work order 99F079. After calibration, the laboratory ran a secondary-source initial calibration verification standard. Acenaphthene and phenanthrene in the fluorescence detector were not within the RPD maximum acceptance criterion of 15 percent. Acenaphthene and phenanthrene in the fluorescence detector were also above the maximum limit of 15 percent difference in the continuing calibration verification standards. The fluorescence detector was primarily used for analyte confirmation. Qualification was not required since all results for PAHs in soil are rejected due to the LCS accuracy deficiency. Internal standards are not applicable to this method.

Analyte Identification and Analyte Quantitation. The laboratory reported PQL values higher than the PQL values listed in Table A-19 of the QAPP, due to the requirement that the PQL must be at least three times the MDL values. The PQLs were raised to meet the 3X MDL requirement based on the most recent MDL study. The analytes that needed to have the PQL adjusted were: acenaphthene, anthracene, BAP, benzo(b)fluoranthene, chrysene, fluoranthene, fluorene and naphthalene. This had no affect since the data were rejected based on poor LCS recoveries.

Overall Assessment and Completeness. The data did not meet the requirements of the method and the QAPP and are not considered usable for project decision-making, with one exception. Positive results, while not quantitative, are indicators of minimum concentrations of PAHs present and may be used to indicate the presence of PAHs. This is also supported by the

presence of PAHs (non-rejected results) in the water samples collected at the base of several of the boreholes from which these soil samples were collected. A summary of completeness for PAH analyses in soil is presented in Table D-15.

Table D-15
Completeness for PAHs in Soil Samples

Analyte	Samples Planned	Samples Taken	Analytes per Sample	Number of Results					Completeness			
				Total	Non-Contract Compliant	Rejected	Estimated due to QC	Estimated due to >MDL but <PQL	Contract Compliance	Technical	Analytical*	Sampling
All	11	11	16	176	176	176	0	0	0.0%	0.0%	0.0%	100.0%

* Note: Estimations due to results <PQL do not affect the calculated completeness

5.8.2 Polynuclear Aromatic Hydrocarbons in Water Samples. Five water samples were collected for PAH analysis by Method SW8310. The samples were collected in one-liter amber bottles and transported cold to EMAX where they were extracted in two batches, PAF006W and PAF009W, using continuous liquid-liquid extraction Method SW3520C. The extracts were silica gel cleaned by Method SW3630B and analyzed by HPLC Method SW8310.

Preservation and Holding Times. Samples were collected in the proper containers and preserved correctly by being maintained at a temperature of <6°C until extracted by Method SW3520C. Water samples were extracted within the prescribed holding time of 7 days from the date of collection and analyzed within 40 days of extraction.

Laboratory Method Blanks and Field QC Blanks. Laboratory method blanks were analyzed at the required frequency of one method blank per laboratory batch. PAHs were not detected above the MDL in the method blanks. There were no equipment blanks associated with any of the samples analyzed for PAHs in water by Method SW8310.

MS/MSD Recoveries and Precision. Sample B073TR001-W01 was designated for MS/MSD analysis, and was extracted with the PAF009W preparation batch. Recoveries were within the project control limits for accuracy of 40-140 percent recovery. MS/MSD precision was within the RPD maximum limit of 25 percent for PAHs in water by Method SW8310.

LCS/LCSD Recoveries and Precision. An LCS/LCSD pair was prepared and analyzed with each of the lab batches for PAHs. All recoveries were within the project control limits for accuracy of 55-135 percent recovery. LCS/LCSD precision was within the RPD maximum limit of 25 percent for PAHs in water by Method SW8310.

Field Duplicate Precision. There were no water field duplicate samples collected for PAHs analysis by Method SW8310. Compliance with the criteria for field duplicate precision defined in the Table E-2 of the QAPP could not be evaluated. The frequency requirement for field duplicate collection of 10 percent was not met. The field duplicate was inadvertently omitted due to the small number of samples collected. Failing to collect field duplicates impacts the qualitative assessment of completeness, which is reflective of the percentage for field completeness.

Laboratory Replicate Precision. Laboratory replicates are not required for this method.

Surrogate Recoveries. Surrogate terphenyl-d14 was added to environmental and lab QC samples to measure method performance on a sample-specific basis. All surrogate recoveries were within project control limits of 40-140 percent for all samples.

Instrument Calibration and Internal Standards. The laboratory did not report any calibration problems. The following problems were observed during full validation of work order 99F079. After initial calibration, the laboratory ran a secondary-source initial calibration verification standard, acenaphthene and phenanthrene in the fluorescence detector were not within the RPD maximum acceptance criterion of 15 percent. Acenaphthene and phenanthrene in the fluorescence detector were also above the RPD maximum limit of 15 percent in the continuing calibration verification standards. The fluorescence detector was primarily used for analyte confirmation. The acenaphthene detection for water sample B073TR001-W01 is the only result associated with the failed initial calibration verification (ICV) and continuing calibration verification (CCV) of the fluorescence detector. This result is flagged J as estimated. Internal standards are not applicable to this method. All other acenaphthene and phenanthrene results were reported from the ultraviolet (UV) detector, which had acceptable ICV/CCV results.

Analyte Identification and Analyte Quantitation. The laboratory reported PQL values matched the PQL values listed in Table A-19 of the QAPP, with the exception of benzo(a)pyrene. The lowest calibration standard for BAP in waters was 0.25 ug/L. This value was higher than the required PQL value of 0.2 ug/L. All water results for BAP were reported with a raised PQL value of 0.25 ug/L.

The second-column confirmation precision for acenaphthene in three samples (B053TR001-W01, B154TR003-W01, B073TR001-W01), for fluorene in one sample (B053TR001-W01) and for benzo(k)fluoranthene and chrysene in another sample (B154TR002-W01) were above the 40 percent RPD limit specified in SW-846. In keeping with the requirement of SW-846 Update III, the higher of the two values was reported for each sample. The results were flagged J as estimated.

With the exception of acenaphthylene, all compounds detected by the UV detector were confirmed by a fluorescence detector. Acenaphthylene, which does not respond to the fluorescence detector, was detected in two samples, B154TR002-W01 and B154TR003-W01. The results for acenaphthylene in these two samples were N flagged as a presumptive identification since they could not be confirmed.

Overall Assessment and Completeness. Overall, the data are considered usable for project decision-making. A summary of completeness for PAH analyses in water is presented in Table D-16.

**Table D-16
Completeness for PAHs in Water Samples**

Analyte	Samples Planned	Samples Taken	Analytes per Sample	Number of Results					Completeness			
				Total	Non-Contract Compliant	Rejected	Estimated due to QC	Estimated due to >MDL but <PQL	Contract Compliance	Technical	Analytical*	Sampling
All	6	5	16	80	1	0	7	7	98.8%	100.0%	91.3%	83.3%

* Note: Estimations due to results <PQL do not affect the calculated completeness