WYOMING DEPARTMENT OF
ENVIRONMENTAL
QUALITY

NATIONAL GROUNDWATER MONITORING NETWORK PROJECT FINAL REPORT

February 27, 2025

Award Number: G21AC10410-01 NGWMN 2021

Term: July 15, 2021 through July 14, 2024

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Attachment B Pace Analytical Quality Assurance Project Plan 2017-2024

Acronyms

°C	Degrees Celsius
AGWMP	Ambient Groundwater Monitoring Program
e.g.	For example
mL	Milliliter
NGWMN	National Groundwater Monitoring Network
PLSS	Public Land Survey System
QAPP	Quality Assurance Project Plan
USEPA	United States Environmental Protection Agency
USGS	United States Geologic Survey
WQD	Water Quality Division
WDEQ	Wyoming Department of Environmental Quality
WSEO	Wyoming State Engineer's Office

1.0 PROJECT OVERVIEW

The Wyoming Department of Environmental Quality, Water Quality Division (WDEQ/WQD) applied for and received a grant award to continue as a data provider for the United States Geologic Survey (USGS) National Groundwater Monitoring Network (NGWMN). The performance period for the project was from July 15, 2021 through July 14, 2024. This project is an expansion of the Award Number G17AC00169 NGWMN 2017 and includes selection of wells from counties not previously included in the NGWMN selection process, populating the NGWMN Well registry with the additional selected locations, documenting data-collection and data management processes, and producing a final report. WDEQ/WQD became a new data provider under Award Number G17AC00169 NGWMN 2017 which included the development of web services to share water quality data from wells sampled as part of the Ambient Groundwater Monitoring Program (AGWMP) to be incorporated into a state groundwater monitoring network and input of that data to the NGWMN Portal. The purpose of the state groundwater monitoring network is an extension of the AGWMP to develop long-term monitoring data sets necessary to establish background conditions and/or document changes in water quality in the state's high priority aquifers.

The WDEQ/WQD established an AGWMP, working cooperatively with the USGS Wyoming-Montana Water Science Center. Since its inception, groundwater samples have been collected from over 400 private water wells (domestic and livestock) volunteered by Wyoming citizens. The creation of the AGWMP followed the development of the Wyoming Groundwater Vulnerability Assessment Project prepared for the WDEQ/WQD by the Wyoming Water Resources Center of the University of Wyoming and Wyoming State Geologic Survey with assistance from the University of Wyoming Spatial Data and Visualization Center, WDEQ/WQD, Wyoming State Engineer's Office (WSEO), and the United States Environmental Protection Agency (USEPA) in the late 1990s. One of the primary work products of this project was the development of aquifer sensitivity maps for the State of Wyoming. The AGWMP was subsequently launched to collect groundwater samples from private wells permitted by the WSEO within the state's priority aquifers. Aquifer prioritization was based on the aquifer's importance as a drinking water source, susceptibility to pollution, current use of the aquifer, land use (e.g. agricultural land, urban land, mining, oil and gas fields, and known contaminant sources), and aquifer sensitivity (e.g. soil type, vadose zone properties, land surface slope, hydrogeologic setting, aquifer recharge, and depth to groundwater).

The overarching goal of the AGWMP is to collect water quality samples from 20-30 wells within each of the 33 groundwater priority areas. Groundwater monitoring relies heavily upon the use of existing landowner wells to minimize the cost of the sampling program, as well as to provide water quality data to participating landowners. To date, groundwater has been collected from the following principal and/or major aquifers as part of the AGWMP within all 23 counties of Wyoming:

- High Plains aquifers (Ogallala, Arikaree, and White River aquifers)
- Colorado Plateaus aquifer (Mesa Verde aquifer)
- Other Wyoming Tertiary aquifers (Bridger, Fort Union, Wasatch, Browns Park, and Alkali Creek aquifers)
- Upper Cretaceous aquifers (Lance, Niobrara, and Fox Hills aquifers)
- Lower Cretaceous aquifers (Lakota, Cloverly, and Sundance aquifers)
- Paleozoic aquifers (Hartville, Casper, and Minnelusa aquifers)
- Precambrian aquifers (undifferentiated Precambrian rocks)
- Other Wyoming aquifers (Nugget aquifer)

The well selection process of the NGWMN project is an extension of the AGWMP and provides the starting place for the creation of a state groundwater monitoring network. For this project, wells already sampled as part of the AGWMP and not previously included in the NGWMN selection will be evaluated for inclusion in the expansion of the state groundwater monitoring network to improve long-term data coverage in the state's high priority aquifers. In addition, wells that had previously been selected and included from Wyoming to the NGWMN, will be updated with recent sampling information.

The WDEQ/WQD previously participated in the NGWMN Grant from 2017 to become a new data provider and create web-services to flow data to the NGWMN Portal. Over 400 wells have been reviewed to determine if they met data quality objectives for the NGWMN. The state groundwater monitoring network was proposed as a surveillance monitoring network as defined in the National Framework for Groundwater Monitoring in the United States (Framework Document) (The Subcommittee on Groundwater of The Advisory Comittee on Water Information, 2013). A surveillance monitoring network includes monitoring of groundwater quality at a minimum frequency of once every five to 10 years.

2.0 OBJECTIVE 2B: SUPPORT PERSISTENT DATA SERVICE FROM EXISTING DATA PROVIDERS

This objective under the Grant included activities specific to support additional work which may include upgrade of web services, addition of new fields to existing services that have been requested by the NGWMN Portal staff, or expand the number of sites in the NGWMN, to name a few. The following subsections provide further details regarding the work completed to meet the requirements of Objective 2B.

2.1 WELL SELECTION AND NETWORK CLASSIFICATION

Award Number G17AC00169 NGWMN 2017

Two hundred eighty-nine wells sampled as part of the AGWMP were evaluated for potential inclusion in a state groundwater monitoring network. All of these wells are located in moderate to high priority aquifers, and the wells were evaluated based on the well having the minimum criteria outlined in the Framework Document. Well construction records were used as the primary basis for state groundwater monitoring network suitability screening. Based on this evaluation, 116 wells were selected as candidates for inclusion in a state groundwater monitoring network. These wells have construction records demonstrating that seals are present to prevent contamination from surface run-off and that any overlying aquifers are isolated from one another. Of the 116 wells, a subset of 51 wells were included in the final well selection as the best candidates. These wells were selected based on their spatial distribution within Wyoming's priority aquifers to achieve the best coverage. Specifically, wells were selected in or down-gradient from the portions of the priority aquifers with the greatest sensitivity to contamination, and where available, wells were selected up- and/or down- gradient relative to regional groundwater flow patterns.

Table 1 provides information on wells selected for each principal aquifer system. Figure 1 depicts the location of selected wells relative to the priority aquifer layer developed as part of the Wyoming Groundwater Vulnerability Assessment Project.

The selected wells are classified as a "surveillance" monitoring network with a minimum sampling frequency of once every five to 10 years. The minimum sampling frequency was modified to a frequency of once every 10 years by the Subcommittee on Groundwater in 2019. Surveillance monitoring provides data to assess long-term natural trends or the effect of slowly changing anthropogenic activities and can be thought of as a periodic "census" of groundwater quality within the state's priority aquifers. (The Subcommittee on Groundwater of The Advisory Comittee on Water Information, 2013) To date the selected wells have been sampled by the WDEQ/WQD at least one time, 19 wells have been sampled twice. As a result, the wells are all currently listed in the "baseline" subnetwork until sufficient water quality data is available to assign them as part of background, suspected changes, or documented changes subnetworks.

Award Number G21AC10410-00 NGWMN 2021

An additional 77 wells from Sheridan, Johnson, Natrona, Hot Springs, Washakie, Big Horn and Lincoln Counties were sampled as part of the AGWMP between 2018 and 2020. Figure 2 depicts the location of selected wells relative to the priority aquifer layer developed as part of the Wyoming Groundwater Vulnerability Assessment Project. All of these wells are located in moderate to high priority aquifers, and the wells were evaluated based on the well having the minimum criteria outlined in the Framework Document as conducted under the previous Award. Well construction records were used as the primary

basis for state groundwater monitoring network suitability screening. Based on this evaluation, no wells were selected as candidates for inclusion in a state groundwater monitoring network as they did not meet the criteria outlined in the Framework Document.

WSEO well logs were reviewed for the 51 wells included in the state groundwater monitoring network for this project. Nine of the wells were noted to not meet the minimum construction requirements identified in the Framework Document and therefore, replacement wells were identified that were completed in the same formation as the original wells, drilled to the same depths as the original wells (if possible), and met the construction requirements in the Framework Document. One of the nine replacement wells identified has been sampled to date (Table 1). The eight remaining replacement wells will be sampled during future AGWMP sampling events.

A total of 29 wells were sampled as part of the AGWMP for 2021 and 35 wells were sampled in 2022. None of the NGWMP wells were sampled during the 2021 and 2022 field sampling season. Sixteen wells were sampled in 2023 of which 13 were from NGWMN. Fifteen wells were sampled in 2024 of which six were from the NGWMN. Table 1 depicts all wells included in the NGWMN and notes the wells sampled in 2023 and 2024 as part of the NGWMN. While no NGWMP wells are identified in counties Park, Teton, Lincoln, Uinta, Big Horn, Washakie, Hot Springs, Fremont, Natrona, and Weston, all of the principal and/or major aquifers are included in the NGWMN.

2.2 FIELD TECHNIQUES

Representative water samples are obtained from wells by purging groundwater until select field parameters have stabilized. Field sampling was conducted in accordance with Standard Operating Procedures, Volume II of the Groundwater Section Quality Assurance Project Plan (QAPP). (Scott, 2022).

2.3 DATA QUALITY AND QUALITY ASSURANCE PROCESSES

Data quality and quality assurance process is conducted in accordance with the Standard Operating Procedures, Volume II of the Groundwater Section QAPP. (Scott, 2022)

2.4 MINIMUM DATA ELEMENTS

Table 2 summarizes a list of minimum data elements for the project's well selection. The minimum data elements are listed in the Framework Document.

The only minimum data elements that are not recorded for selected wells are the fluid level, measuring

point, and measuring point elevation. These data elements were not recorded as part of well sampling for the AGWMP. These data elements are not anticipated to be recorded for selected wells in the groundwater quality monitoring network since the majority of the selected wells are private domestic wells, and the WDEQ/WQD does not break any well head sanitary seals or lower monitoring equipment into the wells which could damage or become stuck in the well. The minimum data elements for well information are provided through the NGWMN Portal well registry and well construction web services. The minimum data elements for samples are provided through water quality web services.

2.5 ANALYTE LIST AND LABORATORY INFORMATION

Table 3 lists the constituents, laboratory methods, containers, preservatives, and holding times used for the AGWMP. Pace Analytical, located in Lenexa, Kansas, held a contract for laboratory analysis for the AMGWP from 2015 through 2024. Samples collected between 2009 and 2015 were analyzed at the USEPA Region 8 Laboratory in Lakewood, Colorado. The Pace Analytical QAPP is in Attachment B of this report.

2.6 WEB SERVICES

Web services were developed using ArcGIS by creating Web Map Services and Web Feature Services in ArcMap. The ArcMap software was used to create a web service and the Extensible Markup Language or XML code for loading into NGWMN portal. This method was used to create web services for serving well summary, well construction, lithology, and water quality data to the NGWMN portal. The data for the well summary, well construction, lithology, and water quality tables are stored in an ArcSDE database. The detailed step-by-step procedure used for the web services development was included in the 2020 Final Report for Award Number G17AC00169 NGWMN 2017.

No additional web services development was conducted under the current project. The WQD is currently developing an online permitting system and testing its environmental database WaterSTAR, formally RBDMS Environmental. WaterSTAR is being tested for utilization of electronic data deliverables from laboratories which eliminates data entry. The data entered into WaterSTAR has not been linked to the NGWMN Data Portal due to State firewall and Federal cybersecurity concerns. Data is manually uploaded and will be forwarded once data is reviewed and data validation is completed.

3.0 REFERENCE

Scott, J. (2022). *WDEQ/WQD Groundwater Section Quality Assurance Project Plan, Standard Operating Procedures, Volume II.*

The Subcommittee on Groundwater of The Advisory Comittee on Water Information. (2013). *A National Framework for Ground-Water Monitoring in the United States.*

TABLES

Table 1 NGWMN Wells

WSEO Permit Number	County	Local Aquifer	Well Depth (ft)	NGWMN Site Number	Original NGWMN Well[1]
Alluvial					
P191458.0W	Platte	Holocene Alluvium	78	27-068-31aab01	
High Plains					
P94265.0W*	Goshen	Arikaree Formation	460	27-063-06cbb01	
P3621.0P	Goshen	Chadron Formation of the White River Group	130	22-060-31ddb01	P169582.0W
P28791.0W*	Goshen	Chadron Formation of the White River Group	200	24-061-17cdc01	
P66149.0W*	Laramie	Ogallala Formation	170	14-067-27bcc01	
P126562.0W	Laramie	Arikaree Formation	220	16-062-30add01	P33612.0W
P119071.0W	Laramie	Ogallala Formation	460	15-066-31bba01	P142767.0W
P141809.0W*	Laramie	Arikaree Formation	260	13-064-03bbd01	
P20810.0W	Laramie	Brule Formation of White River group	110	14-062-24aad01	P36288.0W
P25404.0W	Laramie	Arikaree Formation	160	31-062-05bdc01	
P142359.0W*	Platte	Arikaree Formation	230	24-067-16ddb01	
P115348.0W*	Platte	Brule Formation of White River group	140	22-065-31baa03	
P164923.0W	Albany	Brule Formation of White River group	185	14-062-24aad01	P155333.0W
Lower Tertiary					
P142611.0W**	Campbell	Wasatch Formation	305	46-072-24dbca01	
P147076.0W**	Campbell	Wasatch Formation	219	50-071-19dca01	
P198216.0W**	Campbell	Wasatch Formation	280	51-075-12bcb01	
P133123.0W	Campbell	Fort Union Formation	420	54-074-23daa01	
P111927.0W	Campbell	Tongue River Member of Fort Union Formation	421	53-072-32cacc01	
P202069.0W	Campbell	Tullock Member of Fort Union Formation	115	48-069-26cbbd01	
P27814.0W	Converse	White River Formation	170	31-070-15ddc01	P45291.0W
P47043.0W*	Converse	Wasatch Formation	155	30-070-15ca01	
P85247.0W	Niobrara	Wasatch Formation	150	35-069-27dbc01	P90506.0W
P99415.0W**	Johnson	Wasatch Formation	180	51-081-19aada01	
P203723.0W	Johnson	Wasatch Formation	305	48-081-15bbad01	
P99215.0W	Sheridan	Wasatch Formation	160	53-080-18daa01	
P123929.0W	Sheridan	Wasatch Formation	370	56-084-14caa02	
P133536.0W	Sheridan	Fort Union Formation	200	54-084-17ccd01	
Colorado Plateau					
P17678.0P	Albany	Mesa Verde Group	120	19-074-26ccc02	P123436.0W
P82199.0W	Carbon	Browns Park Formation	80	15-084-25dac01	
P43944.0W	Carbon	Browns Park Formation	160	17-84-12dbb01	

[1] WSEO well logs reviewed and wells determined to not meet the construction requirements of the Framework Document and therefore were removed from the NGWMN and replaced with another well completed within the same formation, similar completion depths and met the requirements of the Framework Document.

WSEO Permit Number	County	Local Aquifer	Well Depth (ft)	NGWMN Site Number	Original NGWMN Well[1]
P114520.0W	Sheridan	Farson Sandstone Member of Green River Formation	65	32-108-17ada01	
P147900.0W	Sublette	Wasatch Formation	223	34-110-27cdd01	
P110147.0W	Sublette	Wasatch Formation	95	34-112-05cbd01	
P85757.0W	Sublette	Farson Sandstone Member of Green River Formation	97	33-109-09aad01	
P116643.0W	Sublette	Wasatch Formation	237	30-111-31bcc01	
P154136.0W	Sublette	Wasatch Formation	425	30-111-03adc01	
P10506.0P	Sweetwater	Wilkins Peak Member of Green River Formation	190	25-110-21cac01	
Upper and Lower Cretaceous					
P57934.0W*	Albany	Cloverly Formation	200	15-073-06dad01	P89828.0W
P80689.0W	Carbon	Mesa Verde Group	110	19-078-10bbc01	
P110555.0W	Converse	Lance Formation	100	33-075-04baa01	
P9837.0W**	Crook	Lance Formation	143	49-067-06caa01	
P71104.0W	Crook	Sundance Formation	60	53-062-13bdc01	
P174468.0W**	Crook	Sundance Formation	360	54-063-24adb01	
P6254.0W	Niobrara	Lance Formation	166	38-064-18da01	
Paleozoic					
P24708.0W*	Albany	Casper Formation	150	17-073-29dcd01	
P96994.0W*	Albany	Casper Formation	300	15-072-07bba01	
P123401.0W	Campbell	Fountain Formation	90	13-077-02cac01	
Other					
P195888.0W*	Albany	Precambrian Erathem	120	12-078-04cba01	
P185395.0W*	Albany	Precambrian Erathem	140	19-072-18dbd01	
P145304.0W*	Albany	Precambrian Erathem	300	12-073-18bc01	
P193677.0W	Converse	Precambrian Erathem	300	28-071-09aca01	

* Sampled in 2023

** Sampled in 2024

Table 2 Data Elements

Field	Description	Recorded (Yes/No)
Site/Well Information		
Site Name	Unique identifier for each well	Yes
Grid Reference	Latitude/Longitude	Yes
Public Land Survey System (PLSS)	Section, Township, Range, Quarter-Quarter	Yes
Contact Information	Name, address, telephone number for each well	Yes
Operating Interval	Screened or open interval of the well	Yes
Total Depth	Total depth of the well	Yes
Fluid Level	Not recorded as part of the water quality network	No
Pump Status	Recorded if known	Yes
Pump Status Time	Recorded if known	Yes
Well Construction and Lithology	Records obtained from WSEO Records	Yes
Measuring Point	Not recorded since fluid levels are not recorded for the water quality network	No
Measuring Point Elevation	Not recorded since fluid levels are not recorded for the water quality network	No
Special Instructions	Recorded if applicable	Yes
Sampling Information		
Sampling Procedure	Procedure used to collect the sample (described in the Standard Operating Procedures)	Yes
Weather	Record of weather conditions at the time the sample was collected.	Yes
Name of Sampler	Name of the field staff who collected the sample	Yes
Affiliation of Sampler	Agency of the field staff who collected the sample	Yes
Purge Method	Method used to collect the sample	Yes
Purge Volume	Method used to purge water from the well prior to sampling	Yes
Sample Appearance	Description of color, turbidity, or odors observed for the sample	Yes
Preservation	Record of the type and amount of preservative used for sample	Yes
Analyses	List of analyses for the sample	Yes
Method	Laboratory method used for sample analyses	Yes
Transfer Date	Chain of Custody documentation	Yes

Table 3 AGWMP Analytical Information

Constituent	Sample Container(s)	Sample Preservative(s)	Sample Holding Time	Laboratory Method	Comments
Field Parameters					
Dissolved Oxygen	Glass, 300 mL	NA	NA	Optical luminescence (ROX™)	Field Measurement
Oxidation-Reduction Potential	NA	NA	NA	AG/AgCl reference electrodes	Field Measurement
pH	NA	NA	NA	Glass sensing and AG/AgCl reference electrodes	Field Measurement
Salinity	NA	NA	NA	NA (Calculation)	Field Measurement
Specific Conductance	NA	NA	NA	Four electrode cell	Field Measurement
Temperature	NA	NA	NA	Thermistor	Field Measurement
Turbidity	NA	NA	NA	Optical	Field Measurement
Major Cations					
Calcium, Magnesium, Potassium, Sodium	Plastic, 250 mL	Nitric Acid	6 months	SW846 6010B	Field Filtered
Major Anions					
Chloride, Sulfate, Fluoride	Plastic, 250 mL	Ice to ≤6ºC	28 days	EPA 300.0	Field Filtered
Nitrogen, Ammonia	Plastic, 500 mL	pH < 2 H_2SO_4, ≤6ºC	28 days	EPA 350.1	Field Filtered
Nitrogen, Ammonia	Plastic, 500 mL	pH < 2 H_2SO_4, ≤6ºC	28 days	EPA 350.1	Not Filtered
Nitrogen, Nitrate	Plastic, 500 mL	≤6ºC filtered in lab	48 hours	EPA 353.2	Lab Filtered
Nitrogen, Nitrite	Plastic, 500 mL	≤6ºC filtered in lab	48 hours	EPA 353.2	Lab Filtered
Nitrogen, Total Kjeldahl (TKN) Dissolved	Plastic, 500 mL	pH < 2 H_2SO_4, ≤6ºC	28 days	EPA 351.2	Lab Filtered
Phosphorus, Ortho	Plastic, 250 mL	Ice to ≤6ºC	48 hours	EPA 365.2	Field Filtered
Total Organic Carbon	Glass, 300 mL	pH < 2 H_2SO_4 or HCl, ≤6ºC	28 days	SM 5310C	Not Filtered
Total Dissolved Solids	Plastic, 500 mL	Ice to 4ºC	7 days	SM 2450C	Not Filtered
Alkalinity-Bicarbonate, Alkalinity-Carbonate, Alkalinity-Hydroxide, Alkalinity-Total $CaCO_3$	Plastic, 500 mL	Ice to 4ºC	14 days	SM 2320B	Not Filtered
Metals - Total					
Aluminum, Antimony, Arsenic, Barium, Beryllium, Boron, Cadmium, Chromium, Cobalt, Copper, Iron, Lead, Lithium, Manganese, Molybdenum, Nickel, Selenium, Silver, Silica,	Plastic, 500 mL	HNO_3 to pH < 2	6 months	EPA 200.7/200.8 or SW 846 6010C or SW 846 6020	Not Filtered

Constituent	Sample Container(s)	Sample Preservative(s)	Sample Holding Time	Laboratory Method	Comments
Strontium, Thallium, Vanadium, Zinc					
Volatile Organic Compounds					
1,1,1,2-Tetrachloroethane, 1,1,1-Trichloroethane, 1,1,2,2-Tetrachloroethane, 1,1,2-Trichloroethane, 1,1-Dichloroethane, 1,1-Dichloroethene, 1,1-Dichloropropene, 1,2,3-Trichlorobenzene, 1,2,3-Trichloropropane, 1,2,4-Trichlorobenzene, 1,2,4-Trimethylbenzene, 1,2-Dibromo-3-chloropropane, 1,2-Dibromoethane (EDB), 1,2-Dichlorobenzene, 1,2-Dichloroethane, 1,2-Dichloropropane, 1,3,5-Trimethylbenzene, 1,3-Dichlorobenzene, 1,3-Dimethyl adamantane, 1,4-Dichlorobenzene, 2,2-Dichloropropane, 2-Butanone, 2-Chlorotoluene, 2-Hexanone, 4-Chlorotoluene, 4-Methyl-2-pentanone, Acetone, Acrylonitrile, Adamantane, Allyl chloride, Benzene, Bromobenzene, Bromochloromethane, Bromodichloromethane, Bromoform, Bromomethane, Carbon disulfide, Carbon tetrachloride, Chlorobenzene, Chlorodibromomethane, Chloroethane, Chloroform, Chloromethane, cis-1,2-Dichloroethene, cis-1,3-Dichloropropene, Dibromomethane, Dichlorodifluoromethane, Ethyl Ether, Ethylbenzene, Gasoline Range Organics (GRO), Hexachlorobutadiene, Iodomethane, Isopropylbenzene, m,p-Xylene, Methacrylonitrile, Methyl Acrylate, Methyl tert-Butyl Ether, Methylene chloride, Naphthalene, n-Butyl Benzene, n-Propyl Benzene, o-Xylene, p-Isopropyltoluene, sec-Butylbenzene Styrene, tert-Butylbenzene, Tetrachloroethene, Toluene, trans-1,2-Dichloroethene, Dichloropropene, Trichloroethene, Trichlorofluoromethane, Vinyl chloride, Xylenes (total)	Vial, 40 mL	pH<2 HCl; ≤6ºC	14 days	EPA 530B/8260	

Constituent	Sample Container(s)	Sample Preservative(s)	Sample Holding Time	Laboratory Method	Comments
Radionuclides					
Total Uranium (KPS)	Plastic, 500 mL	HNO_3 to pH<2	180 days	ASTM D5174	Not Filtered
Gasses					
Headspace-Methane, Ethane, Ethene (GC/FID)	Vial, 40 mL	pH<2 HCL; ≤6°C	14 days	RSK 175 (old SM3810)	Not Filtered
Supplemental Constituents, Laboratory Methods, Containers, Preservatives, and Holding Times – Field Parameters					
Field Parameters					
Gross Alpha Radioactivity-Aqueous	Glass, 300 mL	HNO_3 to pH<2	72 hours	EPA 900.0	1 sample per area
Gross Beta Radioactivity-Aqueous	Glass, 300 mL	HNO_3 to pH<2	72 hours	EPA 900.0	1 sample per area
Radon-Rn	Glass, 300 mL	HNO_3 to pH<2	4 days	SM7500RnB-1996	1 sample per area

FIGURES

Wyoming National Groundwater Monitoring Network Project: Well Selection Map

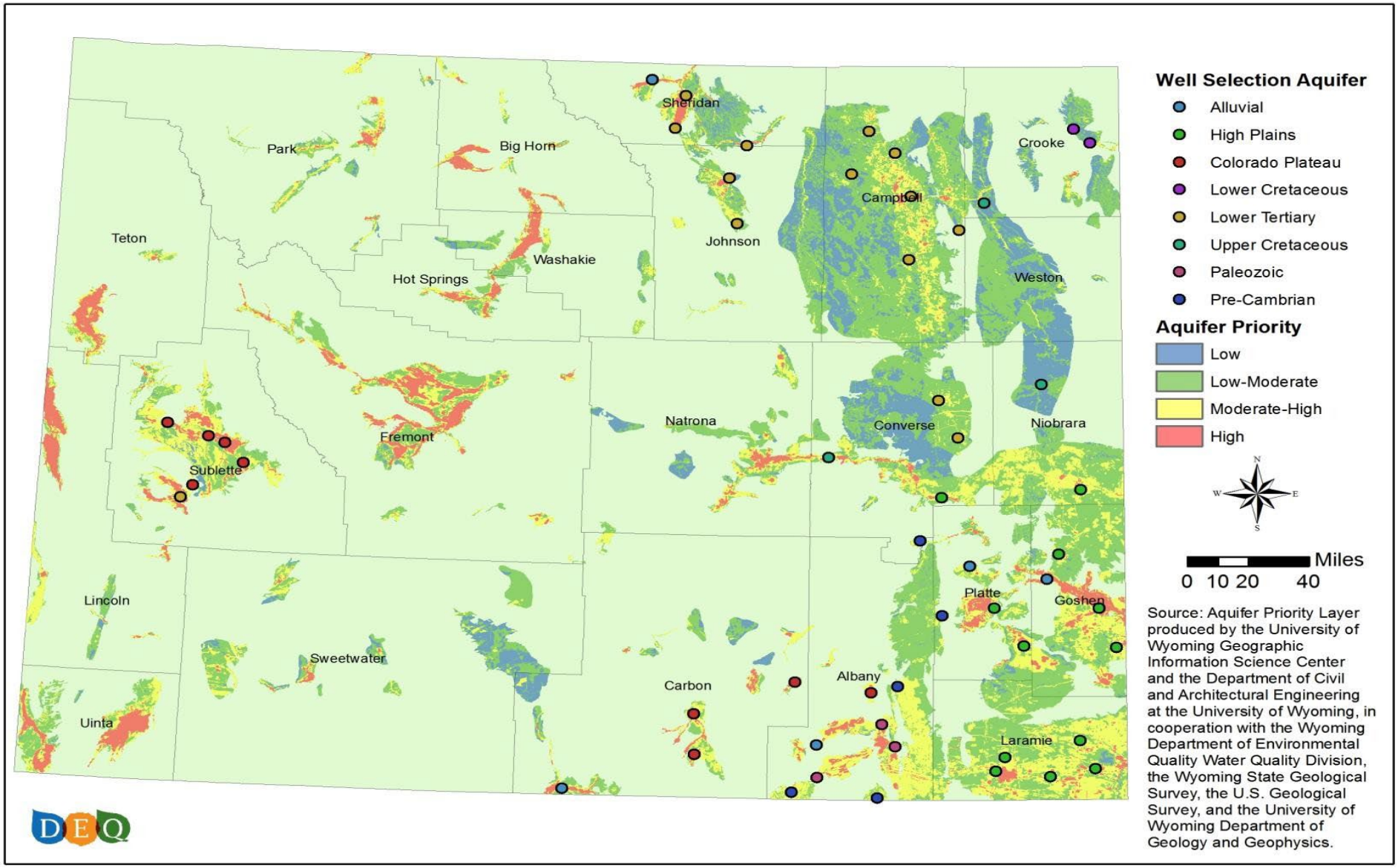

Figure 1 2017 NGWMNP Well Section Map

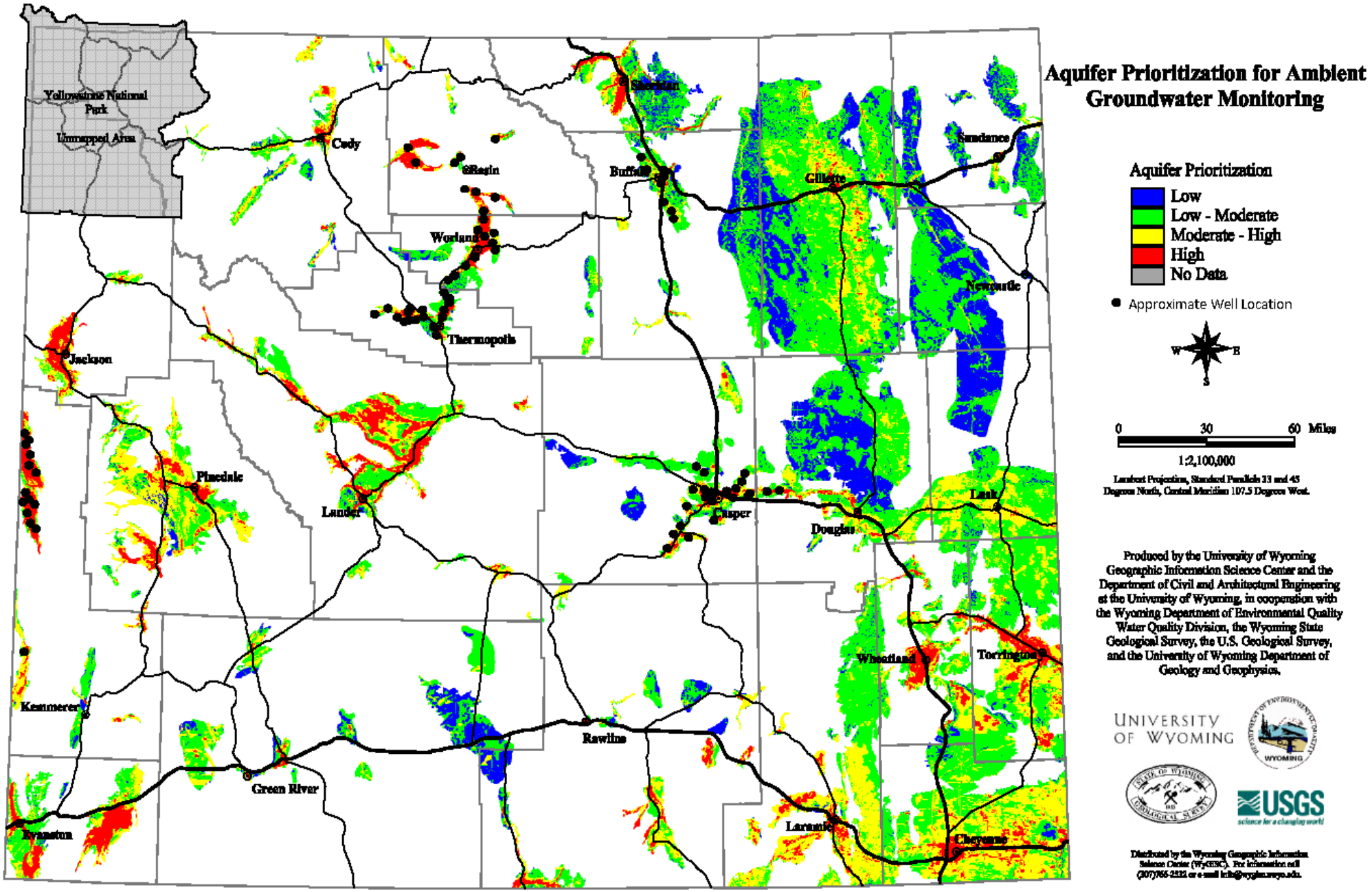

Figure 2 2021 NGWMNP Well Section Map

ATTACHMENTS

Attachment A

Quality Assurance Program Plan, Volume I and Standard Operating Procedures, Volume II; September 2022, Version 4.

WYOMING DEPARTMENT OF ENVIRONMENTAL QUALITY

WATER QUALITY DIVISION

GROUNDWATER SECTION

QUALITY ASSURANCE PROGRAM PLAN

VOLUME I

SEPTEMBER 2022

Our mission: To protect, conserve and enhance the quality of Wyoming's environment for the benefit of current and future generations.

WYOMING DEPARTMENT OF ENVIRONMENTAL QUALITY

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DOCUMENT CONTROL

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ACRONYMS & ABBREVIATIONS

µg/L	micrograms per liter
AGWMP	Ambient Groundwater Quality Monitoring Program
CFR	Code of Federal Regulations
COC	Chain of Custody
CWA	Clean Water Act
DEQ (or WDEQ)	Wyoming Department of Environmental Quality
DQI	Data Quality Indicator
DQO	Data Quality Objective
DUSR	Data Usability Summary Report
EDD	Electronic Data Deliverables
FFP	Federal Facilities Program
FUDs	Formerly Used Defense Sites
GWS	Groundwater Section
LCS	Laboratory Control Spike
MCL	Maximum Contaminant Levels
MDL	Method Detection Limit
mg/L	microgram per liter
MOU	Memorandum of Understanding
MS/MSD	Matrix Spike/Matrix Spike Duplicate
NGS	Next Generation Sequencing
NGWMN	National Groundwater Monitoring Network
QA	Quality Assurance
QAO	Quality Assurance Officer
QAPP	Quality Assurance Project Program Plan
QC	Quality Control
QMP	Quality Management Plan
pCi/L	Picocuries per liter
PAH	Polyaromatic Hydrocarbons
PARCCS	Precision, Accuracy/Bias, Representativeness, Comparability, Completeness, and Sensitivity
PE	Performance Evaluation
P.G.	Professional Geologist
PFAS	Per- and Polyfluoroalkyl Substances
PT	Proficiency Test
PWS	Public Water Systems
RBDMS	Risk Based Data Management System
REM	Registered Environmental Manager
RL	Reporting Limit
RPD	Relative Percent Difference
SAP	Sampling and Analysis Plan

SOP	Standard Operating Procedure
S.U.	Standard Units
SVOC	Semi-Volatile Organic Compounds
UIC	Underground Injection Control
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
VOC	Volatile Organic Compound
VRP	Voluntary Remediation Program
W.S.	Wyoming State Statute
WQD	Water Quality Division
WQL	Water Quality Laboratory
WWQR	Wyoming Water Quality Rules

DISTRIBUTION LIST

The following individuals (or the current position holder) will receive a copy of this Quality Assurance Program Plan (QAPP), along with any subsequent revisions. The QAPP will also be available online and is recommended reading for all Wyoming Department of Environmental Quality (WDEQ) partners and staff within the Water Quality Division (WQD) Groundwater Section collecting, handling, or analyzing environmental data.

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INTRODUCTION & SCOPE

The United States Environmental Protection Agency (USEPA) requires participation in a centrally managed quality assurance (QA) program by all agencies whose monitoring and measurement efforts are supported or mandated through contracts, grants, regulations, or other formalized agreements with the USEPA. To meet this requirement, the State of Wyoming (the State) Department of Environmental Quality (WDEQ) documented its quality system in a Quality Management Plan (QMP). The QMP was approved by USEPA in January 2016 and is currently undergoing review. Under the QMP, a Quality Assurance Project Program Plan (QAPP) is developed for each USEPA-funded WDEQ program that performs data collection, generation, or acquisition activities. Each QAPP must be created as specified in the latest approved version of USEPA QA/R-5 EPA Requirements for Quality Assurance Project Plans (USEPA, 2001). This document meets the QMP requirement for the Water Quality Division (WQD), Groundwater Section (GWS).

This QAPP documents how QA and quality control (QC) are applied to environmental data operations within the GWS to ensure that the results obtained are of a known and suitable quality needed to meet the goals and objectives of the GWS. This QAPP was prepared following USEPA documents: EPA Requirements for Quality Assurance Project Plans, USEPA QA/R-5 (USEPA, 2001) and Guidance for Quality Assurance Project Plans, USEPA QA/G-5 (USEPA, 2002a). This QAPP addresses all of the elements suggested for inclusion by USEPA (see). This document was also developed under the requirements outlined in WDEQ's QMP.

This QAPP is meant to be an umbrella document outlining the minimum QA/QC requirements for environmental data collection within the Program/Section. A Sampling and Analysis Plan (SAP) is a project-specific brief guide and reference for field staff that should describe the purpose and methods used to collect, evaluate, validate, and archive scientifically valid water quality data. The approved SAP is good for five years and should undergo a documented annual review. Revisions to an SAP should be documented through amendments. SAPs are prepared following the USEPA document Sampling and Analysis Plan - Guidance and Template v.4 - General Projects - 04/2014 (USEPA, 2014).

Due to the various and diverse monitoring and assessment projects, specific details for each environmental monitoring project that differs from this QAPP will be outlined in project-specific SAPs rather than requiring individual project-specific QAPPs. SAPs will be prepared before environmental data collection begins and may be revised during the life of a project. An SAP may be written for a specific project, for activities at a particular sampling site, or for activities falling under a more extensive monitoring program.

Project-specific SAPs must align with this QAPP. A project-specific SAP should address specific project aspects such as the purpose and objectives of monitoring, project-specific Data Quality Objectives (DQOs) and measurement criteria, number and locations of representative samples, frequency of sample collection, sample types and collection methods, analytical methods, sample handling and chain of custody (COC), any project-specific QA requirements such as type and frequency of QC samples; assessment and review; record keeping;

data handling and storage; and field staff's specialized training, experience and project responsibilities. Project-specific SAPs will be reviewed and approved by the appropriate GWS program supervisor or appointed staff. Select laboratory COCs are provided in Appendix A.

Project managers are responsible for designing monitoring studies, setting project-specific DQOs if needed, and developing project-specific SAPs. Project managers and program supervisors are accountable for ensuring all staff involved with the project are briefed and trained on appropriate methods and procedures. SAPs are prepared using USEPA document Sampling and Analysis Plan - Guidance and Template v.4 - General Projects - 04/2014 (USEPA, 2014). All data collected for use support determination must meet credible data requirements defined in Wyoming State Statutes (WS.) W.S. §§ 35-11-103(c)(xix), 35-11-302 (b)(i) and 35-11-302 (b)(ii).

Projects that collect data using federal funding administered through the WQD/GWS (e.g., Section 106 supplemental funding) must do so under an approved SAP. WDEQ also recommends that SAPs be created for projects that do not specifically require an approved SAP.

Both the QAPP and SAPs will reference detailed standard operating procedures (SOPs). The GWS generates SOPs for sample collection, processing, handling, and data management procedures that become routine, even when published methods are utilized. The use of SOPs ensures data comparability, defensibility, accuracy and bias. The most current version of the SOPs can be found on the WDEQ website.

Table 1. List of USEPA QAPP Elements

Group A Elements: Project Management		Group B Elements: Data Generation and Acquisition		Group C Elements: Assessment and Oversight		Group D Elements: Data Validation and Usability	
A1	Title and Approval Sheet	B1	Sampling Process Design (Experimental Design)	C1	Assessments and Response Actions	D1	Data Review, Verification and Validation
A2	Table of Contents	B2	Sampling Methods	C2	Reports to Management	D2	Verification and Validation Methods
A3	Distribution List	B3	Sample Handling and Custody			D3	Reconciliation with User Requirements
A4	Project/Task Organization	B4	Analytical Methods				
A5	Problem Definition and Background	B5	Quality Control				
A6	Project/Task Description	B6	Instrument/Equipment Testing, Inspection and Maintenance				
A7	Quality Objectives and Criteria	B7	Instrument/Equipment Calibration and Frequency				
A8	Special Training/ Certifications	B8	Inspection/Acceptance of Supplies and Consumables				
A9	Documentation and Records	B9	Non-direct Measurements				
		B10	Data Management				

A. PROGRAM MANAGEMENT

This first section of the QAPP addresses program administrative functions and program concerns, goals and approaches to be followed.

A.1 Title and Approval Sheet

See Pages i - iii.

A.2 Table of Contents

See Pages v - vii.

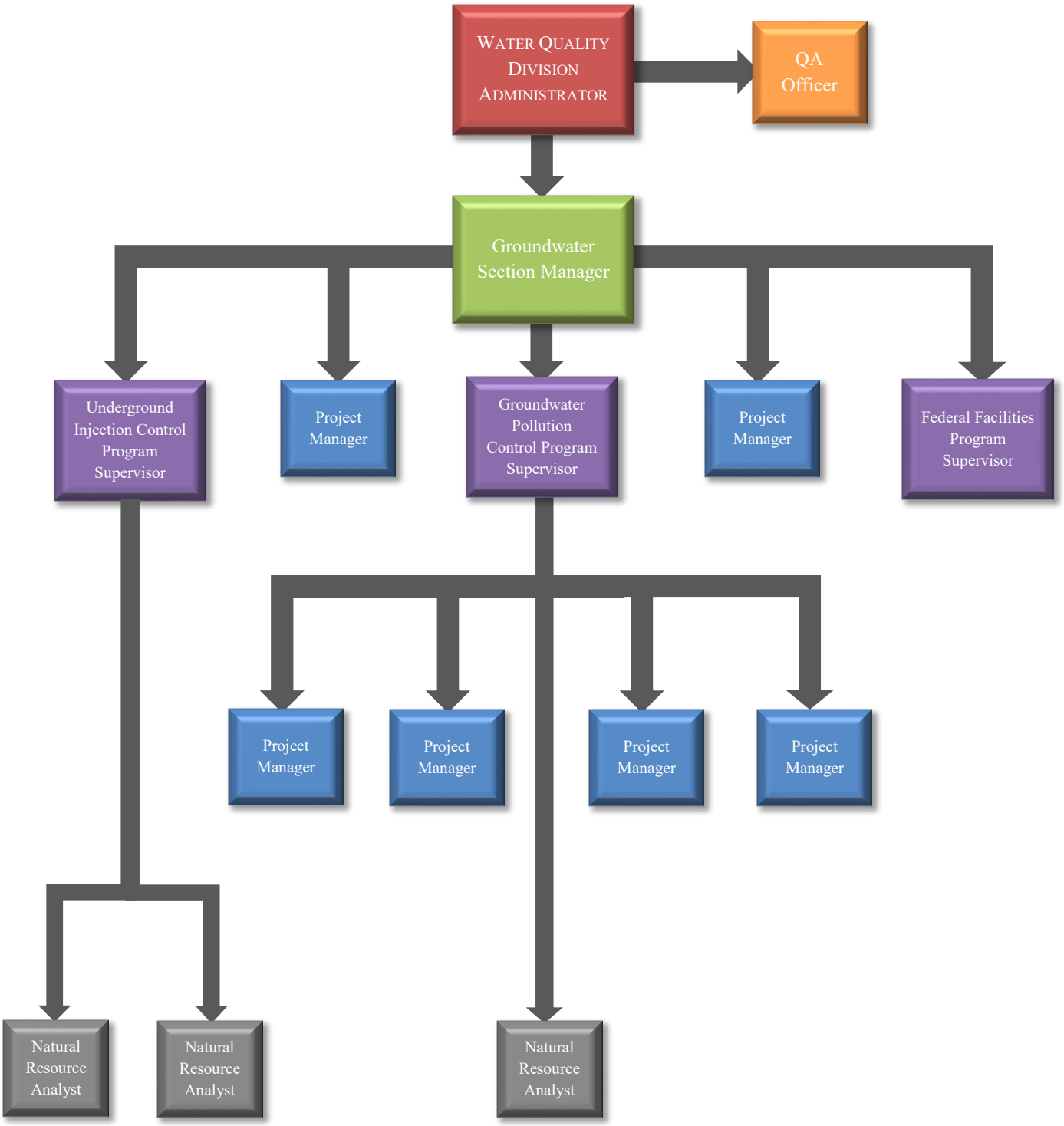
A.3 Distribution List

See Page x.

A.4 Project/Task Organization

The WQD administers water quality programs for the State of Wyoming. The GWS (Figure 1) was established to prevent, reduce and eliminate contamination of groundwater that can result from discharges to the groundwater. The GWS manages the Ambient Groundwater Quality Monitoring Program (AGWMP), Groundwater Pollution Control Program (GPC), Special Projects, Emerging Contaminants (i.e., 1,4-Dioxane, Per- and polyfluoroalkyl substances (PFAS)) and Underground Injection Control (UIC) Program. These programs/projects receive funding or support from the USEPA. The Federal Facilities Program (FFP) is also managed by the GWS and receives funding via the Defense and State Memorandum of Agreement program and project-specific Memorandums of Agreements. All GWS programs are covered under this QAPP. Work in these programs may involve staff from the GWS, environmental contractors and federal partners (USEPA Region 8, United States Air Force, Air National Guard, Army National Guard and United States Army Corp of Engineers). Listed below are some tasks performed by GWS staff, environmental contractors and laboratories (with corresponding GWS programs in parentheses).

Figure 1. GWS Organization Chart (September 2022)



A.4.1 GWS Staff

- Provide policy oversight and training (AGWMP, GPC, PFAS, UIC);
- Provide technical assistance and/or oversight (AGWMP, GPC, FFP, PFAS, UIC);
- Secure funding and track budgets (AGWMP, PFAS);
- Serve as project managers (AGWMP, FFP, GPC, PFAS, UIC);
- Communicate with the USEPA Region 8 Project Officer about project progress and/or technical assistance (FFP, UIC, AGWMP, PFAS);
- Develop site-specific SAPs, assemble project teams, implement fieldwork and coordinate sample analyses for GWS projects (AGWMP, GPC, PFAS);
- Train GWS staff and environmental contractors on the requirements of this QAPP and site-specific SAPs (AGWMP, PFAS);
- Review and approve site-specific SAPs (and potentially QAPPs) prepared by environmental contractors performing work for the GWS projects [PFAS (GPC and FFP)];
- Oversee GWS and environmental contractors on their field implementation, including sample management, for GWS projects (AGWMP, GPC, FFP, PFAS);
- For projects performed by GWS staff, communicate project Data Quality Objectives (DQOs) to contract laboratories analyzing samples collected during GWS projects (AGWMP, GPC, PFAS);
- Develop objectives for the sampling program and verify that the sampling program is designed to meet those objectives and that sampling objectives are described in the project SAP (AGWMP, GPC, PFAS);
- Assess laboratory performance in satisfying the specified project DQOs (AGWMP, GPC, PFAS);
- Prepare and/or review reports evaluating and summarizing project activities, sample results, corrective actions (if any) and recommendations for further actions, if any (AGWMP, GPC, FFP, PFAS);
- Update GWS project database promptly (AGWMP, PFAS);
- Perform and/or review data verification, validation and data usability reports consistent with QA requirements outlined in this plan and site-specific project plans (AGWMP, GPC, PFAS);
- Communicate with and report laboratory results to stakeholders (AGWMP, GPC, PFAS);
- Review permit applications for completeness and technical soundness within the specified deadline and contact the permittee for additional information if needed (UIC);
- Prepare draft permits for issuance or letter for denial (UIC);
- Perform classification of groundwater for the area of injection (UIC);
- Initiate and renew financial assurance requirements for facilities (UIC);
- Review monitoring reports and pressure fall-off reports (UIC);
- Witness mechanical integrity tests and review test results (UIC);
- Collect split samples for quality assurance and quality control (UIC and FFP);
- Inspect Class I and Class V wells (UIC); and
- Prepare and manage enforcement actions for non-compliance with permits (UIC).

A.4.2 Environmental Contractors

- Develop site-specific SAPs following this QAPP, working closely with the GWS project manager to ensure the sampling program will meet sampling objectives (AGWMP, GPC, PFAS, UIC);
- Communicate DQOs to contract laboratories analyzing samples collected during GWS projects (AGWMP, GPC, PFAS, UIC);
- Assemble project teams, implement fieldwork and coordinate sample collection and analyses (AGWMP, GPC, PFAS, UIC);
- Verify the proper functioning of all equipment before beginning field activities (AGWMP, GPC, PFAS, UIC);
- Ensure that the appropriate number, type and quantity of sample containers, including preservation requirements, are available for field activities (AGWMP, GPC, PFAS, UIC);
- Follow standard sampling protocols as defined in this QAPP or the site-specific SAP (AGWMP, GPC, PFAS, UIC);
- Record all field data in the manner specified in this QAPP (AGWMP, FFP, GPC, PFAS, UIC);
- Follow applicable SOPs, ensure that all samples are collected, preserved, labeled, packaged and shipped to laboratories in a form acceptable to USEPA Region 8 (AGWMP, GPC, PFAS, UIC); and
- Prepare reports evaluating and summarizing project activities, sample results and further action needs (AGWMP, GPC, PFAS, UIC).

A.4.3 Laboratories

- Understand and follow the sampling procedures and DQOs outlined in this QAPP and site-specific SAPs (AGWMP, GPC, PFAS, UIC);
- Perform requested analyses using appropriate test methods specified in the QAPP and SAP (AGWMP, GPC, PFAS, UIC);
- Satisfy all laboratory and analytical (QA/QC) objectives and activities (AGWMP, GPC, PFAS, UIC);
- Prepare laboratory reports for the GWS project manager or environmental contractor project officer, including all relevant data and QC reports (AGWMP, GPC, PFAS, UIC);
- Perform data validation consistent with QA requirements outlined in this plan and site-specific project plans (AGWMP, GPC, PFAS, UIC);
- Provide electronic data deliverables on request from the GWS project manager, in a format specified by the GWS project manager (AGWMP, GPC, PFAS, UIC);
- Communicate any analytical problems, issues, or concerns to the project manager and environmental contractor promptly (AGWMP, GPC, PFAS, UIC); and
- Initiate corrective action when deficiencies in sample collection, preservation, handling, test methods, or documentation are identified internally, by the contract laboratory or the project manager (AGWMP, GPC, PFAS, UIC).

A.5 Problem Definition/Background

The WQD GWS works to protect and preserve Wyoming's groundwater by evaluating water quality in priority aquifers, permitting and monitoring UIC facilities and investigating and cleaning up known or suspected releases.

The WS §§ 35-11-301 to §§ 35-11-318 sets forth the regulatory authority for the programs in the WQD. WQR Chapter 8, Quality Standards for Wyoming Groundwaters, was promulgated under § 35-11-301, and no person shall cause, threaten, or allow violation of any water quality standard. WQR Chapter 8 contains groundwater classifications and suitability standards for domestic, agriculture and livestock uses. WQR Chapter 27, Underground UIC Program, fulfills Wyoming state obligations under Section 1422 of the Federal Safe Drinking Water Act and Federal UIC regulation found in 40 Code of Federal Regulations (CFR) 124 and 40 CFR 144-148 (both as of December 7, 1999).

Water quality data collected and/or assessed by the GWS staff provides information for programmatic needs for the AGWMP, FFP, GPC, PFAS and UIC Programs. The GWS staff will use data obtained under this QAPP, site-specific SAPs and SOPs to evaluate the status of groundwater resources in each of the programs/projects listed below.

A.5.1 Ambient Groundwater Monitoring Program

Under the Clean Water Act (CWA), states have primary responsibility for implementing programs to manage water quality. This responsibility includes establishing water quality standards, monitoring and assessing the quality of their waters and developing and implementing clean-up plans for waters that do not meet standards. The USEPA encourages the collection of ambient groundwater quality monitoring data to support groundwater protection and management. Since adopting its 1984 Groundwater Protection Strategy, the USEPA has provided technical and financial assistance under the CWA to comprehensively build State capacity to protect groundwater.

The goal of the AGWMP is to collect groundwater quality data from a network of wells having medium-high and high vulnerability to contamination. The wells in this Network receive groundwater from shallow aquifers, which are vulnerable to point source (e.g., spills or releases) or non-point source (e.g., agricultural activities, construction erosion) degradation. Data collected at these sites may be used to compare to water quality standards and classification standards, inform water quality modeling, or compare with other ambient water quality monitoring data.

The USEPA provides funding for the AGWMP project through Section 106 Grants matched with WDEQ general funds.

In addition to the AGWMP, the GWS participates in the National Groundwater Monitoring Network (NGWMN). The NGWMN has envisioned an integrated data collection system, management and reporting to help address present and future groundwater management questions. In this program, the GWS evaluates the construction of wells sampled in the AGWMP against the minimum data elements outlined in the National Framework for Ground-Water Monitoring in the United States (The Subcommittee on Ground Water of The Advisory Committee on Water Information, July 2013). The GWS samples a select number of wells that meet NGWMN criteria. The water quality data from the wells are validated and uploaded into the United States Geological Survey (USGS) data portal. The NGWMN provides data that can be used to assess baseline conditions and long-term trends in

water levels and water quality in important aquifers on a national, multistate and regional scale. The USGS provides funding for the NGWMN project, matched with WDEQ general funds.

A.5.2 Federal Facilities Program

The FFP provides state reviews of federal facility clean-up sites, mostly military sites, located throughout Wyoming. The FFP works with federal partners such as the USEPA, the United States Army Corps of Engineers and the United States Department of Defense to investigate, quantify and clean up soil and water contamination (primarily trichloroethylene plumes and PFAS) on these sites.

A.5.2.a Active Federal Sites

The military discovered soil and groundwater contamination at F.E. Warren Air Force Base, located west of Cheyenne, in the 1980s. Contaminated soil and groundwater have been removed or treated and continued remediation/long-term monitoring is ongoing to address the remaining contamination.

The Wyoming Air National Guard has been cleaning up contaminated properties, such as the site located at the Cheyenne Municipal Airport, since 2001. Long-term plans are in place for ongoing clean-up where soil or groundwater contamination still exists. Funding for active FFP sites is provided through the Defense and State Memorandum of Agreement Grant and Memorandum of Agreements with the Wyoming Air National or Army National Guards.

The USEPA is the lead on these projects, and DEQ provides State oversight. The WQD may collect split samples and have them analyzed.

A.5.2.b Formerly Used Defense Sites

When the military inactivates or decommissions a site, they become known as Formerly Used Defense Sites (FUDs). The FFP and federal partners work with current landowners to find acceptable clean-up methods for these sites. There are currently several dozen FUDs located in Wyoming. Top priority sites for clean-up include those which impact drinking water supplies. The DSMOA Grant provides funding for FUDs.

A.5.3 Emerging Contaminants Program (PFAS)

PFAS is a group of over 4,000 human-made chemicals that have been used in a variety of industrial, commercial and consumer products. Under its Unregulated Contaminant Rule, the USEPA has required sampling of a limited number of Public Water Systems (PWS) nationwide, including sampling pre-and post-treated drinking water associated with PWS in some larger Wyoming communities between 2013 and 2015. No PFAS compounds were detected in Wyoming PWS.

The Wyoming PFAS Response and Implementation Strategy was implemented in June 2018. The Strategy identified actions that should be taken to evaluate the potential for PFAS impacts on public and private drinking water supplies in Wyoming. Critical elements of WDEQ's PFAS Response and Implementation Strategy are to:

- Develop an inventory and location map of potentially contaminant sites where PFAS has been used or disposed of;
- Prioritize sites for further investigation based upon site potential to impact drinking water supplies utilizing WQD's Aquifer Prioritization Map, site history and location;
- Develop and implement a plan to sample private and/or public water wells to assess potential impacts to drinking water supplies from prioritized sites;
- Investigate options to build analytical capacity in WDEQ's Water Quality Laboratory to assist with PFAS sample analysis using USEPA Method 537;
- Develop and implement a communication plan to keep Wyoming citizens apprised of the status of investigations and findings;
- Develop and implement a public education and outreach program where the aim is to bring awareness to personal safety, proper use and disposal of products containing PFAS compounds and;
- Continue coordination with USEPA, State environmental agencies and national organizations to keep abreast with the latest scientific and regulatory developments relating to PFAS.

The USEPA Water Pollution Control (Section 106) Grants provide funding for the PFAS project matched with WDEQ general funds.

A.5.4 Underground Injection Control Program

The passage of the Safe Drinking Water Act in 1974 provides the foundation for regulating underground injection in the United States. The USEPA delegated Class I, III and V UIC wells to the WDEQ in 1983. In 2020, the WDEQ obtained primacy of Class VI UIC wells (except those located on Indian lands). The UIC Program regulates Class I, Class V, and Class VI injection wells for permitting, compliance and enforcement to protect current and future uses of Underground Sources of Drinking Water. A description of those wells is provided below:

- Class I: Deep disposal of industrial, commercial, or municipal waste below the deepest usable aquifer, including all wells which dispose of waste on a commercial basis, even if the waste would otherwise be injected into a Class II well.
- Class V: All other facilities not included in Classes I-IV that dispose of fluids or other material into the subsurface, including, but not limited to heat pumps, remedial injections, underground stormwater disposal systems, Coal Bed Methane produced water, commercial septic systems and other large-capacity septic systems; and;
- Class VI: Facilities inject carbon dioxide for long-term storage, also known as the Geologic Sequestration of CO_2.

The GWS staff evaluates data for all UIC Program functions and collects samples during designated activities. Quality data are required for regulatory decisions regarding permitting, compliance monitoring and enforcement activities. A description of UIC Program functions is provided below.

A.5.4.a Permitting

Permit applications must contain sufficient technical data to enable the reviewer to determine whether it meets the requirements contained within WQRR Chapter 27 and that a site will not contaminate groundwater.

A.5.4.b Compliance Monitoring

The purpose of compliance reviews and inspections determine whether there is compliance with conditions specified in the permit, order or applicable WQRR. Compliance reviews include a review of required monitoring reports submitted by a permittee or responsible party and inspections. The UIC staff may collect samples of injectate, groundwater monitoring wells, supply wells, surface water, or other sample points during inspections. Samples are submitted to the WQD Water Quality Laboratory for analysis or a commercial laboratory if needed. All Class I waste injection wells in Wyoming are required by the UIC permit and 40 CFR 146.68(d) to demonstrate mechanical integrity. The UIC staff observe mechanical integrity tests and review reports. UIC staff also monitors well construction and plugging operations and collects required water samples and data when necessary. Schedules for monitoring events are specified within UIC permits and Chapter 27 of the WQRR. Data generated are used in the day-to-day management, monitoring, compliance and enforcement of the State of Wyoming's UIC Program.

A.5.4.c Enforcement

Sites not in compliance with permit conditions violate WS § 35-11-301-308. If a violation exists, conference and conciliation should be employed to eliminate the source or cause of the violation. Failure to correct the violation may result in a notice of violation and possibly enforcement (WQD Enforcement Guidance for Groundwater and Water and Wastewater Programs, WDEQ 2021).

A.6 Project/Task Description

The GWS QAPP shall provide the framework for environmental staff to evaluate environmental analytical laboratory data derived from field sample collection. This data collected for the GWS programs shall ensure that conclusions drawn from the sample collection data are accurate and precise. Environmental analytical laboratory data collected in the field shall be utilized by GWS staff to legally protect Underground Sources of Drinking Water and/or Wyoming's groundwater. Environmental samples to be collected shall depend upon the type of well and/or facility and the contaminants of concern. Laboratories utilize USEPA-approved environmental analytical laboratory methods or other scientifically defensible methods identified by WDEQ to analyze for contaminants of concern. The sampling frequency will depend upon the permit conditions or the need for compliance and enforcement split-sampling and/or monitoring to ensure facility/operator compliance with State and Federal Regulations. Reports shall be submitted to GWS staff as required by permits, SAPs, corrective action and enforcement action(s).

A.7 Quality Objectives and Criteria

The ultimate goal of the GWS water quality monitoring programs is to provide data of the appropriate type, quality and quantity for the GWS's decision-making and assessment purposes, compliance functions and other

project-specific goals. DQOs are qualitative and quantitative statements derived from the systematic planning process that (1) clarify the study objective, (2) determine the most appropriate type of data to collect, (3) determine the most appropriate conditions from which to collect the data, and (4) specify the level of uncertainty that decision-makers are willing to accept in the collected monitoring data while still meeting the project objectives, thereby establishing the quantity and quality of the data needed.

Many GWS programs have similar DQOs, focused on assessing and ensuring Wyoming's Water Quality Standards. Refer to WWQR Chapter 8 for these standards. However, some GWS projects/programs also have project-specific DQOs that must be included in project-specific SAPs. Each project manager can develop DQOs for their programs/projects and is encouraged to follow USEPA's Guidance on Systematic Planning Using the Data Quality Objective Process, USEPA QA/G-4 (USEPA, 2006).

All environmental data collected by and for GWS programmatic decisions must meet the minimum requirements discussed in the following sections. Environmental data must be collected and processed according to credible data requirements defined in WS §§ 35-11-103(c)(xix), 35-11-302 (b)(i), and 35-11-302 (b)(ii) by well-trained staff. Laboratories must be certified for the specific methods used. Where method modifications are necessary to meet project objectives (e.g., lower detection limit), modifications must be evaluated against laboratory capabilities and approved by the appropriate WQD Quality Assurance Officer (QAO) or program supervisor.

A.7.1 Performance Criteria

Performance criteria are expressed in Data Quality Indicators (DQIs). The principal indicators of data quality are precision, accuracy/bias, representativeness, comparability, completeness and sensitivity (PARCCs). Definitions for the field and laboratory DQIs described below and in Table 2 come from USEPA's Guidance for Quality Assurance Project Plans, USEPA QA/G-5 (USEPA, 2002a) and USEPA's SW-846-Chapter 1: Project Quality Assurance And Quality Control (USEPA, 2014). SAPs should incorporate DQIs by reference to this QAPP or include a table listing DQIs, how they will be measured and the performance criteria that will be evaluated.

A.7.1.a Precision

Precision is the degree of agreement among repeated measurements of the same property under identical or substantially similar conditions, calculated as relative percent difference (RPD). Field precision is assessed through the collection and analysis of field duplicates. Analytical precision is estimated by duplicate/replicate analyses, usually on laboratory control samples, spiked samples and/or field samples.

The equation used for calculating RPD for precision is given below:

$$RPD = \left| \frac{(absolute\ (X1 - X2))}{\left(\frac{X1 + X2}{2}\right)} \right| * 100$$

Where: X1 = first measured value and X2 = second measured value

A.7.1.b Accuracy / Bias

Accuracy is the closeness of a measured result to an accepted reference value. Accuracy is usually calculated as percent recovery. QC analyses used to measure accuracy include standard recoveries, laboratory control samples, spiked samples and surrogates.

Bias is a statistical measurement of correctness and includes multiple components of systematic error. The systematic error has bias and imprecision associated with sampling methodology, specification of the sampling unit, sample handling, storage, preservation, identification, instrumentation, etc. A measurement is considered unbiased when the value reported does not differ from the true value. Bias is defined as a deviation of an analytical result value from the true value caused by systematic errors in a procedure (field or laboratory). Field instruments are calibrated, maintained, and checked against standard reference materials to ensure bias is not introduced when measuring water quality parameters. Bias is also reduced in the field through the use of and adherence to SOPs. Field audits of field personnel collecting data are used to assess bias qualitatively. Laboratories test their instruments with reference materials and analyze spiked matrix samples to ensure that instruments/instrument calibration or reagents and matrix effects, respectively, do not introduce bias during analysis. Accuracy and bias have different acceptance criteria depending on the DQI. See Table 2 for specific information.

A.7.1.c Representativeness

Sample representativeness expresses the degree to which data accurately and precisely represents a characteristic of a population, parameter variations at a sampling point, a process condition, or an environmental condition. Representativeness is addressed through standardized sample SOPs and adherence to the sample locations, times and hydrologic conditions determined during the SAP development. Site photos and field notes are also important for describing any unusual conditions at the sampling location (e.g., extremely high or low flow, a contamination event, etc.) that may affect the representativeness of the sample collected during that time. The acceptance criteria for representativeness is 100%.

A.7.1.d Comparability

Comparability expresses the measure of confidence that one data set can be compared to another. It depends on the proper design of the sampling program and will be satisfied by ensuring that the approved plans are followed, and appropriate sampling and analysis techniques are applied. Further, when assessing comparability, data sets should be of known and documented quality. GWS will ensure data are comparable with staff adhering to WQD-approved SAPs, SOPs, and audits. The acceptance criteria for comparability is 100%.

A.7.1.e Completeness

Completeness is a measure of the amount of valid data collected compared to the amount planned. Measurements are considered to be useful if they are unqualified or qualified as estimated data during validation. Field completeness is a measure of the number of samples collected versus the number of samples planned. Laboratory completeness is a measure of the number of valid data compared to the total data intended. Acceptance criteria for completeness are 95% of the scheduled data set.

A.7.1.f Sensitivity

Sensitivity is an instrument's or method's minimum concentration that can be reliably measured or reported. Laboratories utilized for GWS projects must be below reporting limits (RLs) below standards. Project-specific SAPs should clearly define standards and required RLs. The GWS adheres to the following groundwater standards: USEPA maximum contaminant levels (MCL), calculated drinking water equivalent levels (DWELs), and WWQR Chapter 8 Table 1 levels. See Table 3 for sensitivity acceptance criteria.

Table 2. Data Quality Indicators

Method	QC Sample	Data Quality Indicator	Description	Acceptance Criteria	Corrective Action
FIELD					
NA	Field Duplicate	Precision	1/20 field samples	+/- 30% RPD	Investigate the source of variability and document. Correct sampling/analytical protocols unless a matrix effect is indicated.
NA	Trip Blanks	Accuracy & Bias (contamination)	One per VOC cooler storing aqueous samples.	< RL for each compound	Investigate the source of contamination and document: correct sampling or handling protocols. Qualifying samples are needed.
NA	Equipment Blank	Accuracy & Bias (contamination)	1/20 field samples for non-dedicated equipment. Dedicated equipment does not need a field blank. PFAS samples: one field blank per sample, have laboratory hold field blank and analyze if the sample has PFAS detection.	< RL for each compound	Investigate the source of contamination and document: correct sampling or handling protocols. Qualify related samples and assess data usability.
LABORATORY					
All methods (not applicable to Isotopic Gases, NGS)	Laboratory Duplicate	Precision	1 per batch of up to 20 samples	RPD </= 20% for concentrations >5 x QL	Qualify related samples and assess data usability.
All methods (not applicable to Isotopic Gases, NGS)	Method Blank	Accuracy / Bias (contamination)	1 per batch of up to 20 samples	concentration <½ QL or associated sample concentration >10x blank value	Re-prep and reanalyze. If the problem recurs, re-prep and reanalyze blank and all associated samples.

Method	QC Sample	Data Quality Indicator	Description	Acceptance Criteria	Corrective Action
All methods (not applicable to Isotopic Gases, NGS)	Laboratory Control Sample	Accuracy / bias (recovery)	1 per batch of up to 20 samples	70-130% recovery of true value	Review with lab manager. Reanalyze or justify
All methods (not applicable to Isotopic Gases, NGS)	Matrix spike/ matrix spike duplicate:	Accuracy / bias (recovery)	1 per batch of up to 20 samples	70-130% recovery of true value	Re-prep and reanalyze. If the problem recurs, justify it in the data report.
Organic Methods (VOCs, SVOCs, PAHs, Pesticides)	Surrogate Spikes	Accuracy / bias (recovery)	1 per matrix per sample set.	Surrogate recoveries must be within QC criteria for method blanks and LCSs to demonstrate acceptable method performance. Surrogate recoveries that are outside QC criteria for a sample indicate a potential matrix effect.	If surrogate recoveries are outside QC criteria for method blanks or LCSs, corrective action is required, and the Project manager should be notified. Matrix effects must be verified based on a review of recoveries in the method blank or LCS, sample reanalysis, or evaluation of interfering compounds.

Abbreviations: RL – Reporting Limit, RPD – Relative Percent Difference, QC = quantification level, LCS = laboratory control sample, NGS = Next generation sequencing, VOCs= Volatile Organic Compounds, SVOCs = Semi-Volatile Organic Compounds, PAHs = polyaromatic hydrocarbons, QC = quality control.

[1] Unless otherwise justified and approved in a project-specific SAP

[2] This list is not inclusive of all of the QC checks/samples run by analyzing laboratory; see laboratory QAPP

Table 3. Maximum Analytical Detection Limits (Instrument Sensitivity)

CAS No.	Analyte	Standard (µg/L)
	VOLATILE ORGANIC COMPOUNDS (VOCS)	
67-64-1	Acetone	30000
71-43-2	Benzene	5
75-27-4	Bromodichloromethane	80
75-25-2	Bromoform (tribromomethane)	80
74-83-9	Bromomethane (Methyl bromide)	46.7
71-36-3	1-Butanol	3300
75-15-0	Carbon disulfide	3300
56-23-5	Carbon tetrachloride	5
108-90-7	Chlorobenzene	100
67-66-3	Chloroform	80
124-48-1	Dibromochloromethane (THM)	80
107-06-2	1,2-Dichloroethane (EDC)	5
75-35-4	1,1-Dichloroethylene	7
156-59-2	1,2-Dichloroethylene (cis)	70
156-60-5	1,2-Dichloroethylene (trans)	100
78-87-5	1,2-Dichloropropane	5
542-75-6	1,3-Dichloropropene	0.897
123-91-1	1,4-Dioxane	0.897
100-41-4	Ethylbenzene	700
67-56-1	Methanol	66700
75-09-2	Methylene chloride	5
78-93-3	Methyl ethyl ketone (2-Butanone)	20000
1634-04-4	Methyl tertbutyl ether (MTBE)	49.9
100-42-5	Styrene	100
79-34-5	1,1,2,2-Tetrachloroethane	0.449
127-18-4	Tetrachloroethylene (PCE)	5
108-88-3	Toluene	1000
71-55-6	1,1,1-Trichloroethane	200
79-00-5	1,1,2-Trichloroethane	5
79-01-6	Trichloroethylene (TCE)	5
95-63-6	1,2,4-Trimethylbenzene	333
108-67-8	1,3,5-Trimethylbenzene	1670
108-05-4	Vinyl acetate	33300
75-01-4	Vinyl chloride	2
1330-20-7	Xylenes	10000
108-38-3	m-Xylene	6670
95-47-6	o-Xylene	6670
106-42-3	p-Xylene	6670
	SEMI-VOLATILE ORGANIC COMPOUNDS (SVOCS)	
83-32-9	Acenaphthene (PAH)	2000
120-12-7	Anthracene (PAH)	10000
56-55-3	Benz[a]anthracene (PAH)	0.89

CAS No.	Analyte	Standard (µg/L)
205-99-2	Benzo[b]fluoranthene (PAH)	0.89
207-08-9	Benzo[k]fluoranthene (PAH)	8.9
50-32-8	Benzo[a]pyrene (PAH)	0.2
111-44-4	Bis(2-chloroethyl)ether	0.0816
117-81-7	Bis(2-ethylhexyl)phthalate	6
85-68-7	Butyl benzyl phthalate	6670
106-47-8	4-Chloroaniline	133
218-01-9	Chrysene (PAH)	89
53-70-3	Dibenz[ah]anthracene (PAH)	0.089
84-74-2	Dibutyl phthalate (di-n-butyl phthalate)	3330
95-50-1	1,2-Dichlorobenzene	600
106-46-7	1,4-Dichlorobenzene	75
91-94-1	3,3-Dichlorobenzidine	0.199
84-66-2	Diethyl phthalate	26700
105-67-9	2,4-Dimethylphenol	667
121-14-2	2,4-Dinitrotoluene	66.7
606-20-2	2,6-Dinitrotoluene	33.3
107-21-1	Ethylene glycol	66700
206-44-0	Fluoranthene (PAH)	1330
86-73-7	Fluorene (PAH)	1330
87-68-3	Hexachlorobutadiene	1.15
77-47-4	Hexachlorocyclopentadiene	50
67-72-1	Hexachloroethane	2.2
193-39-5	Indeno[1,2,3-cd]pyrene (PAH)	0.89
78-59-1	Isophorone	94.5
91-57-6	2-Methylnaphthalene	133
95-48-7	2-Methylphenol (o-Cresol)	1670
108-39-4	3-Methylphenol (m-Cresol)	1670
106-44-5	4-Methylphenol (p-Cresol)	3330
91-20-3	Naphthalene (PAH)	667
98-95-3	Nitrobenzene	66.7
86-30-6	N-Nitrosodiphenylamine	18.3
621-64-7	N-Nitroso di-n-propylamine	0.0128
87-86-5	Pentachlorophenol	1
108-95-2	Phenol	10000
129-00-0	Pyrene (PAH)	1000
110-86-1	Pyridine	33.3
120-82-1	1,2,4-Trichlorobenzene	70
PESTICIDES		
309-00-2	Aldrin	0.00528
12789-03-6	Chlordane	2
72-54-8	DDD	0.374
72-55-9	DDE	0.264
50-29-3	DDT	0.264
60-57-1	Dieldrin	0.00561

CAS No.	Analyte	Standard (µg/L)
115-29-7	Endosulfan	200
72-20-8	Endrin	2
76-44-8	Heptachlor	0.4
1024-57-3	Heptachlor epoxide	0.2
118-74-1	Hexachlorobenzene	1
319-84-6	HCH (alpha) Lindane	0.0142
319-85-7	HCH (beta) Lindane	0.0499
58-89-9	HCH (gamma) Lindane	0.2
72-43-5	Methoxychlor	40
8001-35-2	Toxaphene	3
PCBs		
12674-11-2	Aroclor-1016	0.5
11104-28-2	Aroclor-1221	0.5
11141-16-5	Aroclor-1232	0.5
53469-21-9	Aroclor-1242	0.5
12672-29-6	Aroclor-1248	0.5
11097-69-1	Aroclor-1254	0.5
11096-82-5	Aroclor-1260	0.5
DIOXINS		
1746-01-6	2,3,7,8-TCDD (Dioxin)	0.00003
PETROLEUM PRODUCTS		
	Gasoline-range organics (GRO)	6600
	Diesel-range organics (DRO)	1000
	Crude oil	1000
METALS		
7429-90-5	Aluminum	33000
7440-36-0	Antimony	6
7440-38-2	Arsenic, Inorganic	10
7440-39-3	Barium	2000
7740-41-7	Beryllium	4
7440-42-8	Boron	750
7440-43-9	Cadmium	5
7440-43-3	Total Chromium (1:6 ratio - Cr VI:Cr III)	100
16065-83-1	Chromium III	50000
18540-29-9	Chromium VI	100
7440-48-4	Cobalt	10
7440-50-8	Copper	1300
57-12-5	Cyanide (amenable) (CN-)	667
57-12-5	Cyanide (free)	200
74-90-8	Cyanide (hydrogen)	667
7782-41-4	Fluorine (soluble fluoride)	2000
7439-89-6	Iron	300
7439-92-1	Lead	15
78-00-2	Lead (tetraethyl)	0.00333
7439-93-2	Lithium	66.7

CAS No.	Analyte	Standard (µg/L)
7439-96-5	Manganese	50
7487-94-7	Mercury Chloride	2
7439-97-6	Mercury (elemental)	2
22967-92-6	Mercury (methyl)	3.33
7439-98-7	Molybdenum	167
7440-02-0	Nickel (soluble salts)	667
7782-49-2	Selenium	50
7440-22-4	Silver	100
7440-24-6	Strontium, stable	20000
7440-28-0	Thallium	2
7440-31-5	Tin	20000
7440-61-1	Uranium	30
7440-62-2	Vanadium	233
7440-66-6	Zinc	5000
GENERAL CHEMISTRY		
7664-41-7	Ammonia	500
7773-06-0	Ammonium sulfamate	6670
15541-45-4	Bromate	10
16887-00-6	Chloride	250000
7782-50-5	Chlorine	4000
10049-04-4	Chlorine Dioxide	800
7758-19-2	Chlorite	1000
506-77-4	Cyanogen chloride	1670
16984-48-8	Fluoride	4000
7783-06-4	Hydrogen Sulfide	50
10599-90-3	Monochloramine	4000
14797-55-8	Nitrate	10000
14797-65-0	Nitrite	1000
	Nitrate + Nitrite	10000
7790-98-9	Perchlorate	23.3
143-33-9	Sodium Cyanide	200
14808-79-8	Sulfate	250000
	Total Dissolved Solids	500000
	pH	6.5 - 8.5 S.U.
	Radium 226/228	5 pCi/L

Notes:

[1] Screening values were used from the 2018 WDEQ Voluntary Remediation Program (VRP) Factsheet #12 Cleanup Look-up Table.

Abbreviations: µg/L = micrograms per liter, S.U. = Standard Units, pCi/L = picocuries per liter.

A.8 Special Training/Certifications

GWS field staff must be experienced field team members or under the direct supervision of an experienced team member; or have received training from a field team leader or project manager on requirements for sampling, including proper use and maintenance of all sampling equipment, sample processing and handling, field documentation, file management and database entry. GWS field staff must review this QAPP, project SOPs and SAPs they will work from before any data collection efforts. Each GWS field team member will have applicable health and safety training and will comply with Occupational Safety and Health Administration regulations (see the WDEQ Safety Policy (#20)). GWS field staff and other staff will also participate in training workshops intended as refreshers or reviews, including new or updated SOPs and SAPs.

All laboratories analyzing GWS samples maintain their own documented QAPP/ QMP, including training and certification requirements for their staff.

Non-WDEQ project managers ensure that field staff collecting data for their programs/projects are notified of any special conditions and have received the appropriate technical and safety training. For WDEQ projects, the program supervisor is responsible for ensuring and documenting that staff has proper technical and safety training.

Whether internal or USEPA-led, field audits are additional training opportunities to ensure that field staff follows SOPs and project-specific requirements outlined in the SAP.

A.9 Documentation and Records

A.9.1 QA Documentation, Dissemination and Maintenance

The WQD QAO is responsible for maintaining, updating and editing this QAPP and its associated quality documents, including SOPs. The QAO is responsible for ensuring that GWS staff receive the most recently approved QAPP, SOPs and other documents applicable to environmental data collection. Electronic copies will be distributed and posted online, and notifications will be sent out via email. The QAO formally reviews the GWS QAPP every five years; however, the QAPP and SOPs are periodically reviewed and revised, if needed. The GWS staff are encouraged to make suggestions for changes throughout the year. The most current version of the QAPP will be posted on the WDEQ website and GWS SharePoint.

A.9.2 Field Documentation

Field records shall be generated and stored as specified in method-specific SOPs and project-specific SAPs. Any deviation in an SOP when obtaining, processing, or holding environmental samples must be documented and explained in field notes and/or project or site files. COC forms should accompany each sample to the laboratory. Handwritten field data sheets, field notes and copies of COC forms are scanned and stored on the WQD GWS SharePoint site. Electronic field data are stored on the GWS SharePoint sites and DEQ ArcGIS Online.

A.9.3 Laboratory Documentation

Laboratory documentation procedures and requirements are discussed in each laboratory's QAPP/QMP. The laboratory receives information from the GWS project manager what documentation will be needed during a project, typically, this information is defined in a service contract or Memorandum of Understanding (MOU).

A.9.4 Record Storage and Retention

All field and laboratory data are stored on WDEQ servers or SharePoint sites. These sites are backed up routinely by the Wyoming Department of Enterprise Technology Services. After field and laboratory data have been reviewed, verified and/or validated, they are uploaded and stored in the WDEQ server, GWS SharePoint sites and Risk-Based Data Management System (RBDMS). Records will be kept at least as long as required by the retention schedule. However, project-specific SAPs may define a longer or indefinite retention schedule.

B. DATA GENERATION & ACQUISITION

This section of the QAPP addresses data generation and data acquisition and management activities.

B.1 Sampling Process Design

Sampling processes are designed during the project planning, and DQO process and are individualized to each GWS monitoring project/program. Project-specific SAPs should outline sampling design details for specific projects and include the items covered in the USEPA document Sampling and Analysis Plan - Guidance and Template v.4 - General Projects - 04/2014 (USEPA, 2014). DQOs should be prepared using USEPA document Guidance on Systematic Planning Using the Data Quality Objectives Process, EPA QA/G-4 (USEPA, 2006).

B.2 Sampling Methods

The use of standardized methods and trained staff help to ensure samples are collected consistently between sampling locations and teams. Although there are several sampling programs/projects within GWS, sampling methods employed by the GWS are standardized, consistently applied, and adhere to USEPA or USEPA-approved methods, unless a modification has been scientifically justified and approved by the GWS program supervisor or the QAO. All project-specific SAPs must list all sampling/field methods to be used for the program/project.

SOPs are written for each GWS sampling method (or field sample processing method), with the possible exception of methods used only infrequently or for research projects that test new sample collection methods. In these cases, sampling methods are carefully documented and kept on file with the GWS. If any method gains routine use within the GWS, an SOP is developed. An SOP may be drafted by any GWS staff member but must be approved by the QAO. GWS SOPs are written following USEPA's Guidance for Preparing Standard Operating Procedures (SOPs), USEPA QA/G-6 (USEPA, 2007). GWS's SOPs are available in Volume II – SOPs. Sampling forms are provided in Appendix A.

B.2.1 Corrective Actions for Problems Occurring in the Field

Backup plans should always be made in case of equipment malfunction, breakage or loss, vehicle breakdowns, dropped bottles, etc. The GWS field staff carry contact numbers for vehicle problems and for reaching technical support for specialized equipment. Tool kits are packed to allow battery replacement, probe replacement and maintenance of field instruments. Additional calibration standards are brought into the field to allow for recalibrations of field water quality meters. Extra bottles are packed in case of bottle breakage or sample loss. Additionally, corrective actions, and equipment and supply lists, are included in individual SOPs and project-specific SAPs. The project manager or supervisor is the point of contact for all issues in the field that the field staff cannot readily solve. GWS's SOPs are available in Volume II – SOPs. A field meter calibration form is provided in Appendix A.

B.3 Sample Handling and Custody

B.3.1 Sample Containers

The sample volumes, container types, and holding times required for sampling activities are summarized in Table 4. The laboratory will provide prewashed sample containers. The laboratory must use an approved specialty container supplier that prepares containers following USEPA bottle washing procedures. The laboratory must maintain a record of the sample bottle lot numbers that were shipped in a contamination problem.

B.3.2 Sample Handling

The transportation and handling of samples must be accomplished in a manner that protects the integrity of samples and prevents detrimental effects due to the nature of the samples. Regulations for packaging, marking, labeling, and shipping of hazardous materials are promulgated by the United States Department of Transportation in 49 Code of Federal Regulations 171 through 177. WDEQ trains staff responsible for the shipment of samples in these regulations. Procedures for sample packing and shipping are available in Volume II – SOPs.

Table 4. Summary of Analytical Methods, Preservatives, and Holding Times

Parameter	Method	Containers/Preservatives for Aqueous Samples[1]	Holding Time for Solid Samples[1]
Dissolved Isotopic Gases	DGIA-1	5 – 40 mL vials w/ HCl & 5 – 40 mL amber vials w/ benzalkonium chloride	14 days
Major Cations and Metals	SW-846 6010/6020	1 – 250 mL HDPE bottle w/ HNO_3 to pH <2	6 months
Major Anions (Br, Cl, F, SO_4)	EPA 300.0	1 – 250 mL HDPE	28 days
Major Anions (NO_2 and NO_3)	EPA 300.0		48 hours
Alkalinity	SM 2320B	1 – 250 mL HDPE	14 days
Total Dissolved Solids	SM 2540C	1 – 500 mL HDPE	7 days
Volatile Organic Compounds	SW-846 8260B	3 – 40 mL vials w HCl to pH <2	14 days
Semi-volatile Organic Compounds	SW-846 8270D	2 – 1 L amber glass bottle	7 days from collection to extraction; 40 days from extraction to analysis
Polycyclic Aromatic Hydrocarbons (PAH)	SW-846 8270D-SIM	2 – 1 L amber glass bottle	7 days from collection to extraction; 40 days from extraction to analysis

Parameter	Method	Containers/Preservatives for Aqueous Samples[1]	Holding Time for Solid Samples[1]
Pentachlorophenol (PCP)	SW-846 8270D-SIM	2 – 1 L amber glass bottle	7 days from collection to extraction; 40 days from extraction to analysis

B.3.3 Sample Custody

Formal sample custody procedures begin when the pre-cleaned sample containers leave the laboratory or upon receipt from the container vendor. The laboratory must follow written and approved SOPs for shipping, receiving, logging, and internally transferring samples. Sample identification documents must be carefully prepared to maintain sample identification and chain-of-custody (COC) and control sample disposition.

The primary objective of COC procedures is to provide an accurate written or computerized record that can be used to trace the possession and handling of a sample from sampling through the completion of all required analyses. A sample is in custody if it is:

- In a team member's physical possession;
- In a team member's view;
- Locked up; or
- Kept in a secured area that is restricted to authorized personnel.

The COC form must be completed in full by the field technician designated by the PM as responsible for sample shipment to the appropriate laboratory for analysis.

B.4 Analytical Methods

All analytical methods and analyses used for GWS programmatic decisions will follow test procedures listed in Title 40, Code of Federal Regulations, Part 136, or other scientifically defensible methods identified by the WDEQ and detailed in the project-specific SAP. The more common analytical methods are listed in Table 5. Analytical methods appropriate for the sample matrix and range of expected values for the analyzed constituents will be used. For water chemistry analysis, RLs must be at or below the water quality standard. All compliance-related water chemistry samples must be analyzed at a laboratory meeting the minimum standards. Each laboratory utilized by GWS must also have analytical method protocol documentation available for GWS to review. Routinely-used analytical methods are also described in many GWS SOPs for sample collection. All project-specific SAPs must list all analytical methods for the program/project. When analytical failures occur, whether recognized by the project manager or WQD's QAO, the issue will be addressed with the analyzing laboratory to remedy the error/issue. In addition, any issues with analytical data will be communicated to the GWS program supervisor so that they can isolate potentially problematic data before it is uploaded to the water quality database (RBDMS).

Table 5. Analytical Methods

Analytical Method	Method No.
Major Cations and Metals	SW-846 6010/6020
Major Anions (Br, Cl, F, NO_2, NO_3, SO_4)	EPA 300.0
Alkalinity (Bicarbonate, Carbonate, Hydroxide, Total	SM 2320B
Total Dissolved Solids	SM 2540C
Volatile Organic Compounds SIM/Scan	SW-846 8260BSIM/Scan
Semi-volatile Organic Compounds	SW-846 8270D
PAHs	SW-846 8270DSIM
PCP	SW-846 8270DSIM
Pesticides	SW-846 8081B
Acrylamide	SW-846 8316

B.5 Quality Control

QC data are necessary to determine precision and accuracy and demonstrate the absence of interferences and/or contamination of glassware and reagents. Field and laboratory QC samples are summarized in Tables 6 and 7, respectively.

Table 6. Field Quality Control Samples

QC Sample	Description	Acceptance Criteria	Corrective Action
Field Duplicate	One per matrix per 20 samples for each analysis.	RPDs of 40% for aqueous samples	Qualify related samples and assess data usability.
Matrix Spike / Matrix Spike Duplicate	One per matrix per 20 samples for each analysis (except isotopic gases, TDS, NGS, and ferrous iron and sulfide)	Per laboratory criteria	Qualify related samples and assess for data impacts related to matrix interference.
Trip Blanks	One per cooler containing samples for dissolved gases analysis and/or volatile organic compound analysis.	No positive detections for analytes.	Qualify related samples and assess data usability.
Field Equipment Blank	One per equipment set per 20 samples for each analysis. Only equipment sets that are subject to decontamination require equipment blanks. Dedicated or disposable equipment does not require equipment blanks.	Equipment blanks are not required because field equipment will not come in contact with the sample during collection.	Qualify related samples and assess data usability. If time permits, modify equipment decontamination procedures.

Table 7. Laboratory Quality Control Samples

Methods	Quality Check	Frequency	Acceptance Criteria	Corrective Action
All methods (not applicable to Isotopic Gases, NGS)	Method Blank	One per matrix per preparation batch.	The goal is for method blanks to be free of contamination. Low-level contamination may be present but must be less than the reporting limit.	If contamination is greater than reporting limit, samples will be reanalyzed. No further action is required if contaminants are present in the method blank but not in project samples.
All methods (not applicable to Isotopic Gases, NGS)	LCS	One per matrix per preparation batch for each analysis. The LCS must contain all target analytes of concern at the site.	The LCS recovery must be within method control limits to demonstrate acceptable method performance. Sporadic marginal failures of a few target analytes are allowed when more than five target analytes are reported.	If LCS recoveries are outside QC criteria for more than a few target analytes, recoveries are significantly low, or the compounds were detected in the samples, then corrective action is required per the laboratory SOP. Corrective action usually is to extract and reanalyze the batch if within holding times.
Organic Methods (VOCs, SVOCs, PAHs, Pesticides)	Surrogate Spikes	All samples and QC checks.	Surrogate recoveries must be within QC criteria for method blanks and LCSs to demonstrate acceptable method performance. Surrogate recoveries that are outside QC criteria for a sample indicate a potential matrix effect.	If surrogate recoveries are outside QC criteria for method blanks or LCSs, corrective action is required, and the Project manager should be notified. Matrix effects must be verified based on a review of recoveries in the method blank or LCS, sample reanalysis, or evaluation of interfering compounds.
All methods (not applicable to TDS, Isotopic Gases, NGS)	MS/MSD	One per matrix per SDG for each analysis. The spike solution must contain a broad range of the analytes of concern at the site. The overall frequency of MS/MSD on Project samples must be at least one set per 20 samples.	Method QC criteria or LCS criteria if not specified. MS recoveries outside the control limits applied to the LCS indicate matrix effects. QC criteria for MSD RPDs are 20% except for SVOCs unless the laboratory provides additional statistical criteria.	Sample clean-up procedures may be warranted for samples with severe matrix effects.

B.6 Instrument/Equipment Testing, Inspection and Maintenance

The GWS SOPs and project-specific SAPs describe maintenance, inspection and testing procedures for flow meters, water quality meters, sampling equipment and other instruments/equipment. GWS field staff are assigned to these tasks and are responsible for sending out equipment when it needs repair and ordering replacement parts. The project-specific SAP must include documentation for each instrument utilized including; make, model, serial number, as well as calibration and maintenance logs. Calibration and maintenance logs are kept with each meter or in the appropriate GWS project files. GWS field staff are also assigned to vehicle maintenance and inspection tasks. GWS field staff with these duties reports to the GWS program supervisor. In addition, field staff must record instrument/equipment problems or needs in the project field notes as a reminder to address the issues upon returning from the field and notify the project manager and program supervisor.

B.7 Instrument/Equipment Calibration and Frequency

Instruments and equipment used during sampling and analysis will be operated and calibrated according to the manufacturer's guidelines and recommendations, as well as criteria outlined in applicable analytical methodology references (see Table 2-6). Personnel adequately trained in these procedures will perform operation and calibration of all instruments. Documentation of field maintenance and calibration information will be maintained in the field logbook. The field tests for ferrous iron and sulfide will be performed using Hach measurement kits per the manufacturer's instructions. Operation and calibration of analytical instrumentation will be conducted following laboratory SOPs.

Table 8. Field Equipment and Calibration Procedures

Instrument	Description	Field Calibration Procedure	Acceptability Performance Criteria
Water Quality Meter	YSI ProDSS, or equivalent	Calibration – Once per day at the start of each day before sample collection. Maintenance – As needed. Testing – Readings collected on each water sample.	pH ± 0.1 pH S.U. Conductivity ± 5% Temperature ± 0.5° C Dissolved Oxygen ± 0.3 mg/L
Turbidity Meter	HF Scientific MicroTPI, or equivalent	Calibration – Once per day at the start of each day before sample collection. Maintenance – As needed. Testing – Readings are collected on each water sample.	Turbidity ± 10% or ± 1 Nephelometric Turbidity Unit, whichever is greater
Water Level Meter	Keck / Geotech Water Level Meter, or equivalent	Testing – As needed to measure the amount of water in wells.	Not applicable

B.8 Inspection/Acceptance of Supplies and Equipment

Individual GWS field staff are assigned to order and maintain stocks of supplies and equipment. These individuals interact with the vendor, track receipt of supplies/equipment, verify that supplies/equipment are in the condition expected, are responsible for maintaining and restocking the supplies/equipment, pay close attention to product expiration dates and interact with the program supervisor to anticipate supply/equipment needs during the field season. Analyzing laboratories prepare bottles and preservatives for water chemistry analyses, and GWS field staff frequently pick up batches of bottles and preservatives to use in the field. Deionized reagent-free water used during instrument calibration and equipment rinsing in the field, is prepared and provided to GWS by the WDEQ Water Quality Laboratory (WQL) and contract laboratories.

B.9 Use of Existing Data (Non-direct Measurements)

The majority of data from outside sources is water quality data from permittees and consultants. Data from external sources must use standard State or Federal sampling procedures, coupled with chemical analyses performed at State or Federally-certified labs. In general, these data sources are expected to be of sufficient quality to be comparable with GWS data, such that they could be used for assessment purposes, provided all QA/QC and sampling methodology requirements are met. If it is determined that data are insufficient quality and comparability to be used by GWS for programmatic purposes, the GWS may reject the data. Data, regardless of source, must meet credible data requirements of credible data requirements defined in WS §§ 35-11-103(c)(xix), 35-11-302 (b)(i) and 35-11-302 (b)(ii) to be used for GWS programs.

B.10 Data Management

All environmental data collected in the field and obtained through laboratory analysis will be checked throughout the data report generation process. All data (electronic data deliverables, reports and logbooks will be kept on the WDEQ server or Smartsheets until the GWS Staff checks it for completeness. Final documents are kept on the GWS SharePoint site and data may be migrated to RBDMS (Table 9). All original documents are maintained by program staff and records experts as per the designated retention schedule.

Table 9. Summary of Data Management Procedures

Data Type	Data Collection Method	Data Processing	QC Checks	Data Management
Well Purge Logs	Purge logs and field logbook	Scanned and saved to the WDEQ Server or Smartsheets	Checked for completeness	Final documents are stored on the GWS SharePoint site.
Chemical Results	Chain of Custody	PDF report and EDD from the laboratory	Data validation GWS staff	Final documents are stored on the GWS SharePoint site and or uploaded to RBDMS

C. ASSESSMENT & OVERSIGHT

This section of the QAPP addresses assessments or evaluations to occur both during and after data collection. The purpose of this is to determine whether the project plan is being implemented as approved.

C.1 Assessment and Response Actions

Project managers are responsible for assessing the quality of the work done for their program/project. Assessment activities may be initiated by project managers, the QAO, or the program supervisor. Examples of assessment activities performed by GWS staff include independent assessments of field and laboratory activities conducted by a third party, internal GWS field and laboratory audits, data validation of selected data sets by GWS or contractor staff, or internal audits performed by contractors at the direction of GWS staff. In addition, any project manager, QAO, or GWS program supervisor may initiate an assessment activity at any time throughout a project/program. Any improvement needs will be addressed at the staff level with the project manager. Issues that cannot be resolved at this level shall be brought to the attention of the WQD QAO. Changes will be made to environmental data collection operations to improve quality. These corrective actions will be documented and kept in project files by the project manager, or if systematic changes are made, they will be recorded and kept on file by the QAO.

C.1.1 Field Assessments

Field audits will be performed as often as is appropriate and practical during field sampling, at a frequency defined by a project manager in a project-specific SAP or as initiated by the QAO or GWS program supervisor. If field audits reveal systemic field data quality issues, the QAO and the GWS program supervisor will be notified. Results of field audits will be documented by the QAO and maintained by the project manager in the project files.

Field data is assessed continuously by field staff both in the field and in the office. For instance, suppose temperature, dissolved oxygen, or pH readings are illogical (based on best judgment) for the sampled site. In that case, GWS staff will check or recalibrate the field instrument to ensure the values are measured. Recalibration guidelines may depend on the instrument being used and the best judgment of the field staff. Upon returning from the field, field staff reviews their field data and sample collection completion using checklists.

C.1.2 Laboratory Audits

Internal and external laboratory audits will be performed as defined in each laboratory's QAPP/QMP and are the laboratory's responsibility. Results of these audits are kept on file by the laboratory. GWS project managers may request a copy of the laboratory's audit as part of the project-specific SAP. If possible, audits relating to project-specific performance criteria should be discussed with the laboratory during the project planning stages. In addition, the GWS staff may submit performance evaluation (PE) samples. PE samples are commercially purchased target analytes at known concentrations and are submitted "blind" to the laboratory for analysis.
The Water Quality Lab and most commercial laboratories analyze bi-annual proficiency test (PT) samples purchased from a PT provider on analytical parameters. At the start of a monitoring project, the project manager

should discuss laboratory audits with the analyzing laboratories, especially for laboratories performing new, non-USEPA-approved, or research methods.

C.1.3 Record Checks

Record checks will be performed by the GWS field staff at a frequency defined by a project manager in a project-specific SAP, or at a minimum, on an annual basis. If record checks reveal systemic data management issues, the GWS project manager will notify the QAO or the GWS program supervisor.

C.2 Reports to Management

The project-specific SAP should identify the authors, recipient, contents, frequency and distribution of reports to inform management of project status and QA issues. Projects of short duration may have only one final report. Ongoing monitoring projects may have regular reporting, such as quarterly or semi-annual reports. If reports reveal data quality issues or identify that DQOs are not being met, the project manager will make the appropriate changes to improve quality. Problems that cannot be resolved at the project manager level will be brought to the attention of the QAO, the GWS program supervisor and/or the GWS manager.

Resolution disputes will be brought to the GWS manager as soon as possible after problems are identified, corrective actions are recommended/implemented, and/or upon special request. The GWS manager will be copied with the QAO as the designated recipient of the report. Each report will incorporate the following items:

- A statement identifying issues and potential violations.
- Project status.
- Results of performance and system audits.
- Results of periodic data quality assessments.
- Significant quality assurance problems and recommended corrective actions.

D. DATA VALIDATION & USABILITY

Data validation is an integral part of quality management in the GWS. The data review, validation and verification procedures described in this section will ensure: (1) complete documentation is maintained following Section B10 of this document; (2) transcription and data reduction errors are minimized; (3) the data are reviewed with results documented, and (4) the reported results are qualified if necessary. Data verification and validation SOPs are available in the Volume II – SOPs.

D.1 Data Review, Verification and Validation

The data will be reviewed against the QA/QC requirements in the QAPP. Nonconformance issues or deficiencies affecting data precision or accuracy are identified and considered when assessing whether the result is sufficient to achieve DQOs. Other data collected as part of this project will be evaluated for consistency with this QAPP. Data review checks for the project are described below:

- Field data, such as sample identifications and sample dates, will be checked against the planned field activities;
- Analytical reporting limits and target compounds and QC summary data for surrogates, method blanks, laboratory control samples, and MS/MSD samples will be compared to limits listed as described in Section 4.2; and
- At a minimum, level I will be performed on all data.

D.2 Verification and Validation Methods

The field data will be reviewed as described in Section 4.1. For the analytical data, the laboratory is responsible for performing internal data reviews. All levels of laboratory review must be fully documented and available for review if requested. After receipt from the laboratory, project data will be validated using the steps in the following subsections.

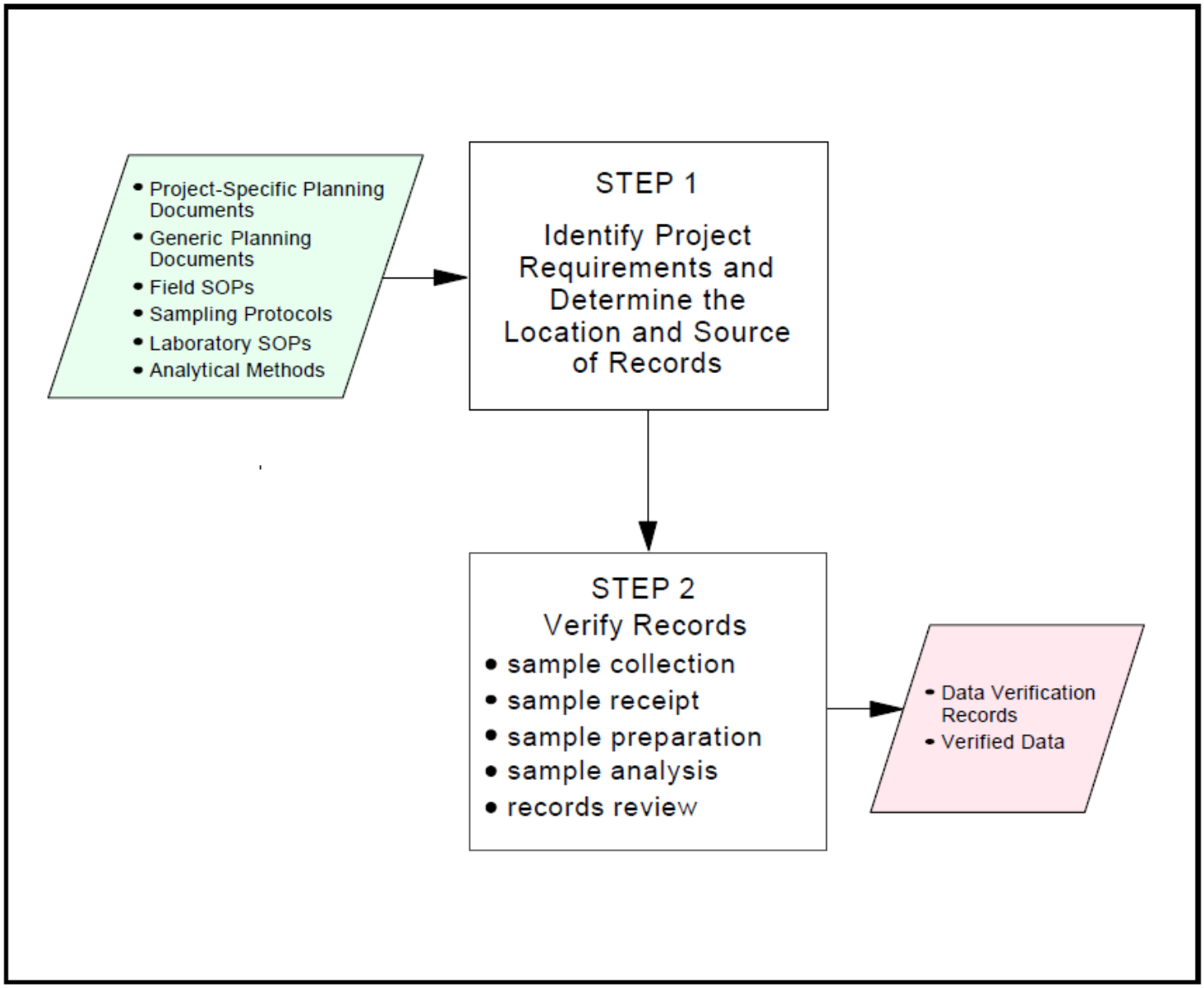
D.2.1 Evaluation for Completeness

The data reviewer will check the electronic files for compliance with the standard format and the QAPP (Figure 2). If loading errors are found, revised electronic data deliverables (EDDs) will be requested from the laboratory. The reviewer also verifies that the laboratory information matches the field information and that the following items are included in the hard copy data package:

- COC forms and sample summary forms;
- Case narrative describing any out-of-control events and summarizing analytical procedures;
- Sample analysis data sheet; and
- QA/QC summary forms.

If the data package is incomplete, the data reviewer or project manager will contact the laboratory, which must provide all missing information as soon as reasonably possible.

Figure 2. Data Verification Process



From Guidance on Environmental Data Verification and Data Validation, USEPA QA/G-8

D.2.2 Evaluation of Compliance

The data reviewer will follow SOPs for data review, complete checklists, process electronic data, and assign qualifiers if outliers are noted (Figure 3). Additional compliance checks on representative portions of the data are briefly outlined below:

- Ensure that analytical problems and corrections are reported in the case narrative and that appropriate laboratory qualifier is added;
- For identified problems, review concerns with the laboratory, obtain additional information if necessary, and check related data to determine the extent of the error; and
- Review non-analytical data on field data sheets as outlined in Section 3.1. The data reviewer will follow qualification guidelines in National Functional Guidelines for Organic Superfund Methods Data Review (EPA-540-R-2017-002) (USEPA 2017a) and National Functional Guidelines Inorganic Superfund Methods Data Review (EPA-540-R-2017-001) (USEPA 2017b).

D.2.2 Data Review Reporting

The reviewer will perform the following reporting functions:

- Alert the GWS Project manager of QC problems, apparent anomalous values, or discrepancies between the field and laboratory data that may impact data usability;
- Discuss QC problems in a Data Usability Summary Report (DUSR) for each laboratory report; and
- Prepare analytical data summary tables of qualified data that summarize all sample results.

D.2.3 Reconciliation with User Requirements

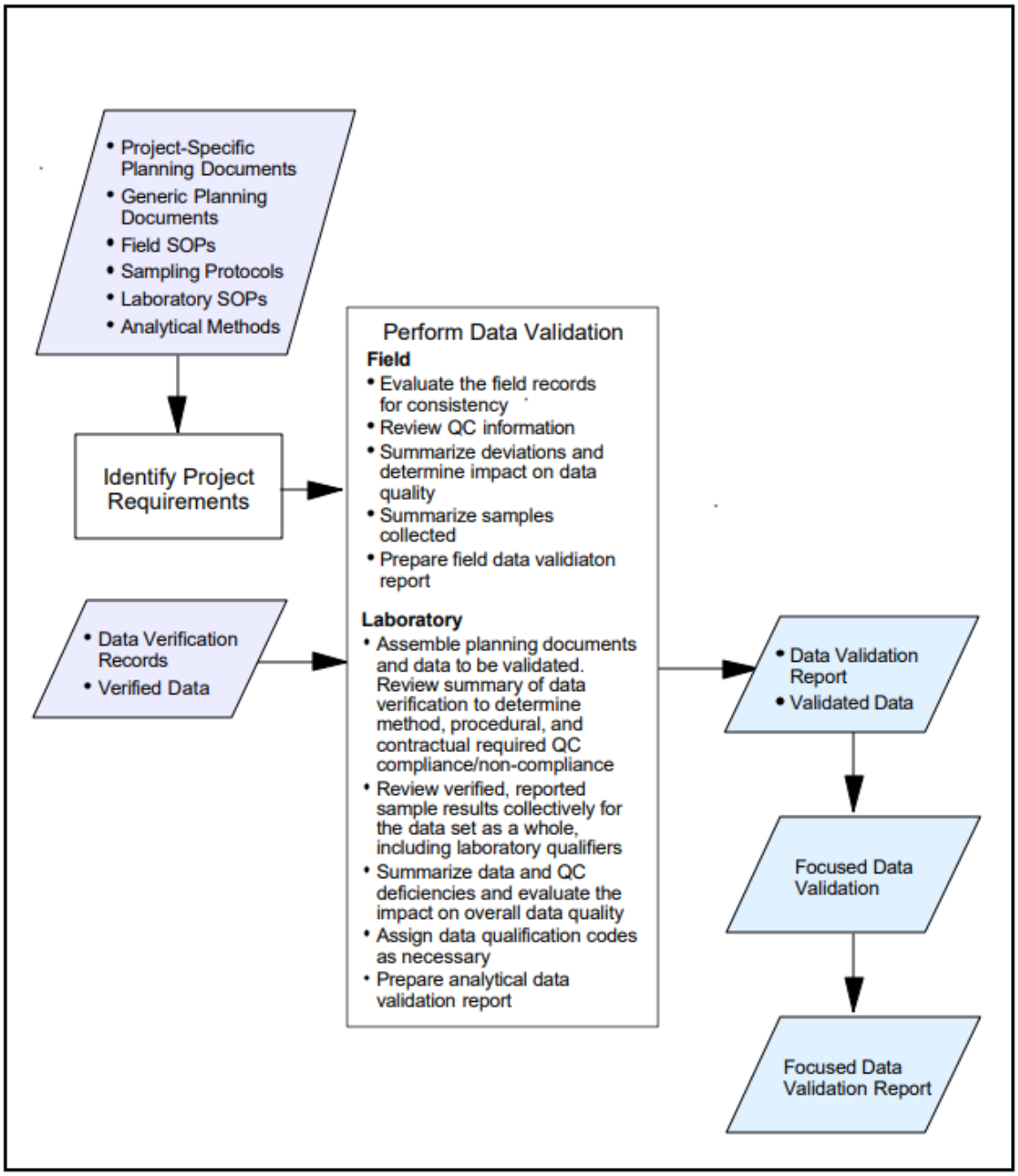
Deviations from analytical performance criteria or quality objectives for the project will be documented in the DUSR provided to the data users for the project.

The data reviewer will work with the final users of the data in performing data quality assessments. The data quality assessment may include some or all of the following steps:

- Data determined to be incomplete or not usable for the project will be discussed with the GWS Project manager. If critical data points impact the ability to complete project objectives, the data reviewer will report immediately to the GWS Project manager. The GWS Project manager will discuss possible resolutions to the issue with GWS Supervisor or QAO (if necessary), and implement necessary corrective actions (e.g., re-sampling);
- Data that are non-detect with DLs less than the screening criteria will be considered usable for project decision-making;
- Data that are qualified as estimated will be used for project decision-making;
- The data assessment process involves comparing results to known or expected values, regulatory criteria or standards, and/or background concentrations. The following data assessment procedures are anticipated for GWS projects:

- Analytical results will be compared to the following criteria:
  -USEPA MCLs (USEPA, 2009);
  -WWQR Chapter 8 (WDEQ/WQD 2018b), Table 1, Class I Groundwater Quality Standard;
  -WY DWELs for non-carcinogenic chemicals and ADWL3 for suspected and known carcinogenic chemicals are calculated following equations contained in Wyoming Solid and Hazardous Waste Division Rules and Regulations, Chapter 1 Storage Tank Program (WDEQ/SHWD 2018c) and using the most current USEPA Regional Screening Levels with a carcinogenic target risk (TR) of 1E-06 and a hazard quotient of 1. For chemicals not on EPA May 2016 RSL tables, values are obtained from RSLs of closely related chemicals or other published information, and
  -USEPA Secondary Drinking Water Standards.

Figure 3. Data Validation Process



From Guidance on Environmental Data Verification and Data Validation, USEPA QA/G-8

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USEPA, 2017b. National Functional Guidelines for Inorganic Superfund Methods Data Review (ISM02.4). USEPA-540-R-2017-001.

APPENDICES

APPENDIX A: LABORATORY CHAIN OF CUSTODY FORMS

Pace Analytical™
www.pacelabs.com

CHAIN-OF-CUSTODY / Analytical Request Document

The Chain-of-Custody is a LEGAL DOCUMENT. All relevant fields must be completed accurately.

Page: of

Section A **Required** Client Information:

Company:	
Address:	
Email To:	
Phone:	Fax
Requested Due Date/TAT:	

Section B **Required** Project Information:

Report To:
Copy To:
Purchase Order No.:
Project Name:
Project Number:

Section C Invoice Information:

Attention:
Company Na
Address:
Pace Quote Reference
Pace Project Manager:
Pace Profile #:

REGULATORY AGENCY

☐ NPDES ☐ GROUND WATER ☐ DRINKING WATER

☐ UST ☐ RCRA ☐ OTHER_SPILL___

SITE LOCATION ☐ GA ☐ IL ☐ IN ☐ MI ☐ NC ☐ OH ☐ SC ☐ WI ☐ OTHER_MN

Filtered (Y/N)

Requested Ana

Pace Project No. Lab I.D.

Section D **Required** Client Information

SAMPLE ID

One Character per box.
(A-Z, 0-9 / ,-)
Sample IDs MUST BE UNIQUE

Valid Matrix Codes

MATRIX	CODE
DRINKING WATER	DW
WATER	WT
WASTE WATER	WW
PRODUCT	P
SOIL/SOLID	SL
OIL	OL
WIPE	WP
AIR	AR
OTHER	OT
TISSUE	TS

ITEM #	MATRIX CODE	SAMPLE TYPE G=GRAB C=COMP	COLLECTED COMPOSITE START DATE	COLLECTED COMPOSITE START TIME	COLLECTED COMPOSITE END/GRAB DATE	COLLECTED COMPOSITE END/GRAB TIME	SAMPLE TEMP AT COLLECTION	# OF CONTAINERS	Preservatives: Unpreserved	H_2SO_4	HNO_3	HCl	NaOH	$Na_2S_2O_3$	Methanol	Other
1																
2																
3																
4																
5																
6																
7																
8																
9																
10																
11																
12																

Additional Comments:

RELINQUISHED BY / AFFILIATION	DATE	TIME	ACCEPTED BY / AFFILIATION	DATE	TIME

SAMPLE CONDITIONS

	Y/N	Y/N	Y/N
	Y/N	Y/N	Y/N
	Y/N	Y/N	Y/N
	Y/N	Y/N	Y/N

SAMPLER NAME AND SIGNATURE

PRINT Name of SAMPLER:

SIGNATURE of SAMPLER: DATE Signed (MM / DD / YY)

Temp in °C | Received on Ice | Custody Sealed Cooler | Samples Intact

Chain of Custody & Analytical Request Record

ENERGY LABORATORIES — Trust our People. Trust our Data.

www.energylab.com

Page _____ of _____

Account Information *(Billing information)*

Company/Name		
Contact		
Phone		
Mailing Address		
City, State, Zip		
Email		
Receive Invoice ☐Hard Copy ☐Email	Receive Report ☐Hard Copy ☐Email	
Purchase Order	Quote	Bottle Order

Report Information *(if different than Account Information)*

Company/Name
Contact
Phone
Mailing Address
City, State, Zip
Email
Receive Report ☐Hard Copy ☐Email
Special Report/Formats: ☐ LEVEL IV ☐ NELAC ☐ EDD/EDT *(contact laboratory)* ☐ Other_____

Comments

Project Information

Project Name, PWSID, Permit, etc.	
Sampler Name	Sampler Phone
Sample Origin State	EPA/State Compliance ☐ Yes ☐ No

URANIUM MINING CLIENTS MUST indicate sample type.
☐ NOT Source or Byproduct Material
☐ Source/Processed Ore (Ground or Refined) **CALL BEFORE SENDING
☐ 11e.(2) Byproduct Material (Can ONLY be Submitted to ELI Casper Location)

Matrix Codes

A - Air
W- Water
S - Soils/ Solids
V - Vegetation
B - Bioassay
O - Other
DW - Drinking Water

All turnaround times are standard unless marked as RUSH.

Energy Laboratories MUST be contacted prior to RUSH sample submittal for charges and scheduling – See Instructions Page

Sample Identification *(Name, Location, Interval, etc.)*	Collection Date	Collection Time	Number of Containers	Matrix *(See Codes Above)*	Analysis Requested	See Attached	RUSH TAT	ELI LAB ID *Laboratory Use Only*
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								

Custody Record MUST be signed	Relinquished by (print)	Date/Time	Signature	Received by (print)	Date/Time	Signature
	Relinquished by (print)	Date/Time	Signature	**Received by Laboratory (print)**	**Date/Time**	**Signature**

LABORATORY USE ONLY

Shipped By	Cooler ID(s)	Custody Seals Y N C B	Intact Y N	Receipt Temp °C	Temp Blank Y N	On Ice Y N	Payment Type CC Cash Check_____	Amount $	Receipt Number *(cash/check only)*

In certain circumstances, samples submitted to Energy Laboratories, Inc. may be subcontracted to other certified laboratories in order to complete the analysis requested. This serves as notice of this possibility. All subcontracted data will be clearly notated on your analytical report.

STATE OF WYOMING
DEPARTMENT OF ENVIRONMENTAL QUALITY
WATER QUALITY DIVISION
UNDERGROUND INJECTION CONTROL PROGRAM

CHAIN OF CUSTODY

SITE: _____ **LOCATION:** _____
FACILITY ID: _____ **PERMIT #:** _____

SAMPLE ID	SAMPLE DATE	SAMPLE TIME	No. of Bottles	Sample pH	Requested Analysis / Preservative						Comments

Relinquished By: _____ **Date:** _____ **Time:** _____

Received By: _____ **Date:** _____ **Time:** _____

Report Data To: _____ **Email:** _____

APPENDIX B: GWS SAMPLING FORM

Site Specific Data Verification & Field Notes/Observations

Reported Well Information (use boxes to confirm verified information)

Site/Well ID: _____ Wellhead Lat/Long: _____

Well Depth: _____ Use: _____ Status: _____

Dedicated Pump: _____ Reported GW Depths: _____

Sampling Point: _____

Pump: _____ Pump Type (if applicable): _____

Treatment System: _____ Treatment Type (if applicable): _____

Sampled Before Pressure Tank: _____ Sampled Before Treatment: _____

Access Port (GW Measurement): _____

Casing Diameter: _____ Pump Depth: _____

Surface Casing Depth: _____ Screened Interval: _____ Casing Material: _____

Top of Casing Elevation (Above Ground Surface): _____

Reported Ground Surface Elevation (Approximate): _____

Reported Well Yield: _____

Land Use

Land Use: _____

Reported Petroleum Storage / Usage Onsite: _____

_____

Irrigation: _____

Septic System: _____

_____

Reported Chemical Usage: _____

_____

Oil and Gas Production Infrastructure: _____

_____

_____

Livestock: _____

Changes to Historical Information

_____

_____

_____

_____

Site Entry Information

Date: _____ Time: _____

Field Team #:_____ Field Team Members:_____

Point of Contact: _____

Temp (F):_____Wind Direction: _____ Wind Speed:_____ Weather:_____

Names and Affiliation of Other People Present During Sampling: _____

_____

Field Sketch (not to scale); include north arrow, topography, buildings, well, etc.

LEGEND:

Sample Collection Field Data / Observations — NO PURGE

Time	pH	Temp. (°C)	Oxidation Reduction Potential (mV)	Specific Conductance (µS/cm²)	Dissolved Oxygen (mg/L)	Turbidity (NTU)	Ferrous Iron (mg/L)	Sulfide (mg/L)

Sample ID: _____ Sample Start Time: _____ Sample End Time: _____

Collected By: _____ QA Sample ID (if applicable): _____

Sample Notes — NO PURGE

Depth to Water (ft bgs prior to sample): _____

Clarity: _____ Color: _____ Odor: _____

Effervescent: Yes ☐ No ☐

Additional Notes: _____

_____

Sample Collection Field Data / Observations — PURGE

Depth to Water (ft bgs prior to sample): _____

Clarity: _____ Color: _____ Odor: _____

Effervescent: Yes ☐ No ☐ _____

Purge Water Disposition: _____

_____

Note observable changes in water quality, purge volume, etc. below: _____

Sample Collection Field Data / Observations — PURGE

Time	pH	Temp. (°C)	Oxidation Reduction Potential (mV)	Specific Conductance (µS/cm²)	Dissolved Oxygen (mg/L)	Turbidity (NTU)	Purge Volume (gal/min)

Ambient Groundwater
Project Name/Number: Monitoring Program ___ Sample ID: _____

Sample Collection Field Data / Observations — PURGE

Sample ID:_____ Sample Start Time:_____ Sample End Time: _____

Collected By:_____ QA Sample ID (if applicable): _____

Depth to Water (ft bgs after sample):_____ Total Volume Purged:_____

Sample Collected After: Stabilization Parameter Criteria: ☐
Sufficient Volume Purged: ☐

Water column volume equation (ft^3): *V = (Total Well Depth - Depth to Groundwater)(π)(r^2)*

1 ft^3 = 7.48 gal

Additional Notes (document any onsite issues encountered): _____

_____

_____

_____

_____

_____

_____

_____

Photo Log

Number	Time	Subject	Was whiteboard used?	Description

Chain of Custody & Shipping

COC Number: _____

Lab (specify lab location): _____

_____

Shipping Carrier: _____

Shipment Confirmation / Tracking Number: _____

Attach the shipping receipt in the space provided below:

Tiered Review Protocol (initial next to each item)

Samples were preserved according to method requirements: _____

Notes were reviewed for accuracy and corrected in the field prior to departing site: _____

Sample bottle labels were reviewed in the field prior to packaging for shipment: _____

Sample IDs, times, etc. on sample bottles and COCs were reviewed for consistency: _____

Samples were stored on ice immediately after sampling was completed: _____

Samples were packaged with a sufficient volume of ice to ensure that temp. criteria are met: _____

Samples were packaged using sufficient insulation to minimize breakage (within reason): _____

Custody seals were signed, dated, and appropriately attached to the ice chest: _____

The ice chest used for shipping was tightly secured using packing tape: _____

Signatures

Field Technical Staff: _____ Date: _____

Field Team Lead: _____ Date: _____

Time Offsite: _____

WDEQ UIC PROGRAM GROUNDWATER SAMPLING FORM

SITE:		**LOCATION:**		**FACILITY ID:**	**PERMIT #:**
WDEQ Personnel:		**WEATHER:**			**DATE:**
WELL ID:		**SAMPLE LOCATION TYPE:** MON DOM SPNG STK IRR		**Other?:**	

PURGING DATA

Well Diameter: inches **Completion Type:** Flush Stick-up **Length of Stick-up:** ft **Purged By:** Bailer Pump		
Depth to Water: ft-btoc	**Total Depth:** ft-btoc	**Well Capacity (gal/ft):** **2"** = 0.163; **4"** = 0.653; **6"** = 1.47; **8"** = 2.61
1 WELL VOLUME PURGE (if applicable) = (TOTAL WELL DEPTH – DEPTH TO WATER) X WELL CAPACITY **= (ft-btoc – ft-btoc) X gallons/foot = gallons**		
Minimum Purge Volume = 1 well volume x 3 = **gallons x 3 = gallons**		

Time	Depth to Water (ft-btoc)	Total Volume Purged (gal)	Purge Rate (gal/min)	pH (S.U.)	Temp (circle units) (°F or °C)	Conductivity (circle units) (µmhos/cm or µS/cm)	Description of Water (odor/color/sheen)

Total Volume Purged: gallons **Sample Parameters:**

Sample Date and Time: **Sample ID:**

NOTE: Use back of form for additional comments

OFFICIAL PHOTOGRAPH

WATER QUALITY DIVISION/WYOMING DEPARTMENT OF ENVIRONMENTAL QUALITY
UNDERGROUND INJECTION CONTROL PROGRAM

Photograph Number	
Subject	
Location	
County	
Date	
Approximate Time	
Photographer	
Witness	
View Direction	
Weather	
Path	
Comments	

Photo Goes Here

APPENDIX C: FIELD INSTRUMENT CALIBRATION

CALIBRATION LOG

Equipment Type	Serial Number	Calibration Method	Calibration Date	Signature	Notes

APPENDIX D: DATA USABILITY SUMMARY REPORT

REPLACE YELLOW HIGHLIGHTED ITEMS WITH INFORMATION FROM PROJECT.

Wyoming Department Of Environmental Quality

Tier I and II Data Validation Report Summary for Ambient Groundwater Sampling

Project Name:	Primary Laboratory:
Sample Matrix:	Sample Start Date:
Samplers:	Sample End Date:
Date Validated:	Lab Package ID:
Data Validator:	
Analytes/Methods:	

Data Evaluation Summary

A Tier II Data Validation was performed by Wyoming Department of Environmental Quality (WDEQ) Water Quality Division-Groundwater Section on the analytical data report package generated by [Insert laboratory and city/state] evaluating samples from the [Insert project name]. [Insert subcontract laboratory name and city/state] was subcontracted to analyze [Insert analyte names] due to [Insert reason for subcontractor analysis].

Precision, accuracy, method compliance, and completeness of this data package were assessed during this data review. Precision was determined by evaluating the calculated relative percent difference (RPD) values from:

- Field duplicate pairs
- Matrix spike (MS) and matrix spike duplicate (MSD) pairs
- Laboratory control sample (LCS) and laboratory control sample duplicate (LCSD) pairs

Laboratory accuracy was established by reviewing the demonstrated percent recoveries (%R) of the following items to verify that data are not biased:

- MS/MSD samples
- LCS/LCSD samples
- Organic system monitoring compounds (surrogates)

Method compliance was established by reviewing sample integrity, holding times, detection limits, surrogate recoveries, laboratory blanks, initial and continuing calibrations (where applicable), and the LCS/LCSD percent recoveries against method-specific requirements.

Completeness was evaluated by determining the overall ratio of the number of samples and analyses planned versus the number of samples with valid analyses. Determination of completeness included a review of the chain-of-custody (CoC), laboratory analytical methods, and other laboratory and field documents associated with this analytical data set.

SAMPLE NUMBERS TABLE FOR LABORATORY PACKET [Insert #]

Laboratory Sample Number	Client Sample ID	Collect Date/Time

The samples were received at the laboratory on [Insert date and time]. The laboratory data were reviewed to evaluate compliance with the methods and the quality of the reported data. Assessment of CoC completeness is included in Item 3 of the Data Validation Checklist. A check mark (✓) indicates that the referenced validation criteria were deemed acceptable, whereas a crossed circle (⊗) indicates validation criteria for which the data have been qualified by the data validator. An empty circle (O) indicates that the specified criterion does not apply to the reviewed data. Details are noted in the tables below.

Validation Criteria

- ✓ Data Completeness
- ✓ CoC Documentation (Item 3)
- ⊗ Holding Times and Preservation (Items 6 and 7)
- ✓ Initial and Continuing Calibrations (Item 9)
- ⊗ Laboratory Blanks (Item 10)
- ✓ MS/MSD (Item 12)
- ✓ LCS/LCSD (Item 14)
- O System Monitoring Compounds (i.e., Surrogates) (Item 16)
- O Field, Equipment, and Trip Blanks (Item 17)
- O Field Duplicate (Item 19)
- ✓ Laboratory Duplicates (Item 21)

Guidance References

Chemical data validation was conducted in accordance with the United States Environmental Protection Agency (USEPA) Contract Laboratory Program (CLP) National Functional Guidelines for the analyses listed below, or by the appropriate method if not covered in the National Functional Guidelines.

- Data for inorganic analyses were evaluated according to validation criteria set forth in the USEPA CLP National Functional Guidelines for Inorganic Superfund Methods Data Review (ISM02.4), document number EPA-540-R-2017-001, January 2017.
- Data for organic analyses were evaluated according to validation criteria set forth in the USEPA CLP National Functional Guidelines for Organic Superfund Methods Data Review (SOM02.4), document number 540-R-2017-002, January 2017.

OVERALL DATA PACKAGE ASSESSMENT

Based on a data validation review, the data are acceptable as delivered. Data qualified by the laboratory are discussed in Item 2 of the Validation Criteria Checklist.

The purpose of validating data and assigning qualifiers is to assist in proper data interpretation. Data that are not qualified meet the site data quality objectives. If values are assigned qualifiers other than an R (rejected, data not usable), the data may be used for site evaluation; however, consideration should be given to the reasons for qualification when interpreting sample concentrations. Data points that are assigned an R qualifier should not be used for site evaluation purposes.

Text identified in bold font in the Validation Criteria Checklist indicates that further action and/or qualification of the data were required. Data validation qualifiers were added for the items noted with crossed circles in the Validation Criteria section above. Please see the Data Qualification Summary table at the end of this report for a complete list of samples and analytes qualified.

Data qualifiers used during this validation are included in the following table.

Qualifier	Definition

Data Completeness

The analyses were performed as requested on the CoC records. The associated samples were received by the laboratory and analyzed properly unless otherwise noted in the Criteria Checklist below. The complete data package consisted of 28 data points. No data points were rejected. The data completeness measure for this data package is calculated to be 100% and is acceptable.

VALIDATION CRITERIA CHECKLIST	
1. Was the report free of non-conformances identified by the laboratory? Comment: [Insert comment if answer is "no"]	No
2. Were the data free of data qualification flags and/or notes used by the laboratory? Comment: [Insert comment if answer is "no"]	No
3. Were sample CoC forms and procedures complete?	Yes
4. Were detection limits in accordance with the quality assurance project plan (QAPP), permit, or method, or indicated as acceptable?	Yes
5. Were the reported analytical methods and constituents in compliance with the QAPP, permit, or CoC? Were any analytes reported by more than one method?	No
6. Were samples received in good condition within method-specified requirements?	Yes
7. Were samples prepared and analyzed within method-specified or technical holding times?	Yes
8. Were reported units appropriate for the sample matrix/matrices and analytical method(s)?	Yes
9. Was there indication from the laboratory that the initial or continuing calibration verification results were within acceptable limits?	Yes
10. Was the total number of laboratory blank samples prepared equal to at least 5% of the total number of samples or analyzed as required by the method?	Yes
11. Were laboratory blank samples reported to be free of target analyte contamination?	Yes

12. Was the total number of MS samples prepared equal to at least 5% of the total number of samples or analyzed as required by the method?	Yes
13. For MS/MSDs prepared from project samples, were percent recoveries and RPDs within data validation or laboratory quality control (QC) limits? Comment: [Insert comment if answer is "no" or NA]	No
14. Was the total number of LCSs analyzed equal to at least 5% of the total number of samples or analyzed as required by the method?	Yes
15. Were LCS/LCSD percent recoveries and LCS/LCSD RPDs within data validation or laboratory QC limits?	Yes
16. Were surrogate recoveries within laboratory QC limits? Comment: [Insert comment if answer is "no" or NA]	N/A
17. Were the number of trip blank, field blank, and/or equipment blank samples collected equal to at least 10% of the total number of samples or as required by the project guidelines, QAPP, SAP, or permit? Comment: [Insert comment if answer is "no" or NA]	No
18. Were the trip blank, field blank, and/or equipment blank samples reported to be free of target analyte contamination? Comment: [Insert comment if answer is "no" or NA]	N/A
19. Was the number of field duplicates collected equal to at least 10% of the total number of samples or as required by the project guidelines, QAPP, SAP, or permit? Comment: [Insert comment if answer is "no" or NA]	No
20. Were field duplicate RPD values within data validation QC limits (soil 0-50%, water 0-30%, or air 0-25%)? Comment: [Insert comment if answer is "no" or NA]	N/A
21. For laboratory duplicates prepared from project samples, were RPDs within laboratory QC limits?	Yes

Summary of Findings – Data Usability
The sample results for oxygen and nitrogen were J qualified as estimated due to positive trip blank detections.

Table 1 - List of Laboratory Non-Conformances Not on Following Tables.

Table 2 – List of Positive Results for Blank Samples – None

Method	Sample ID	Sample Type	Analyte	Result	Qualifier	Units	MDL	PQL

Table 2A – List of Samples Qualified for Blank Contamination

Method	Method Blank	Matrix	Analyte	Blank Result	Sample Result	Lab Qualifier	PQL	Affected Samples	Sample Qualifier

Table 3 –Samples with Surrogates outside Control Limits None.

Table 4 - MS/MSD Recoveries outside Control Limits None.

Table 4A –RPDs outside Control Limits None.

Table 4B –Laboratory Replicate outside Control Limits None.

Table 5 - LCS Recoveries outside Control Limits None.

Table 5A –RPDs outside Control Limits None.

Table 6 – Samples that were Reanalyzed/Diluted

Sample ID	Lab ID	Method	Sample Type	Action

Table 7 – Summary of Field Duplicate Results

Method	Analyte	PQL	PGDW41A-05032018 Result	PGDW41A-05032018Q Results	Unit	RPD	RPD Rating	Sample Qual

WYOMING DEPARTMENT OF ENVIRONMENTAL QUALITY

WATER QUALITY DIVISION

GROUNDWATER SECTION

STANDARD OPERATING PROCEDURES

VOLUME II

SEPTEMBER 2022

Our mission: To protect, conserve and enhance the quality of Wyoming's environment for the benefit of current and future generations.

WYOMING DEPARTMENT OF ENVIRONMENTAL QUALITY

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ABBREVIATIONS AND ACRONYMS

°C	Degrees Celsius
°F	Degrees Fahrenheit
µg/L	Microgram Per Liter
µm	Micron
µmhos/cm	Micromhos Per Centimeter
µs/cm	Microsiemens Per Centimeter
Ag	Silver
Al	Aluminum
APHA	American Public Health Association
As	Arsenic
ASTM	American Society for Testing and Materials
B	Boron
Ba	Barium
Be	Beryllium
BLM	Bureau of Land Management
BMP	Best Management Practice
BOD	Biochemical Oxygen Demand
Br	Bromide
BTEX	Benzene, Toluene, Ethylbenzene, Xylene
Ca	Calcium
CaCO3	Calcium Carbonate
cBOD	Carbonaceous Biochemical Oxygen Demand
CCV	Continuing Calibration Verification
Cd	Cadmium
CF	Conversion Factor
cfs	Cubic Feet Per Second
CHC	Chlorinated Hydrocarbons
Cl	Chloride
cm	Centimeter
CN	Cyanide
Co	Cobalt
CO_3	Carbonate
COC	Chain of Custody
COD	Chemical Oxygen Demand
Cr	Chromium
Cr^{6+}	Hexavalent Chromium
Cu	Copper
CV	Coefficient of Variation

DI	Deionized
DO	Dissolved Oxygen
DOC	Dissolved Organic Carbon
DQO	Data Quality Objective
E. coli	*Escherichia coli*
EPA	United States Environmental Protection Agency
F^-	Fluoride
Fe	Iron
FM	Field Measurement
ft	Feet
ft/s	Feet Per Second
GIS	Geographic Information System
GPS	Global Positioning System
GWS	Groundwater Section
H_2SO_4	Sulfuric Acid
H_2S	Hydrogen Sulfide
HCl	Hydrochloric Acid
HCO_3	Bicarbonate
HCS	Hazard Communication Standard
Hg	Mercury
HNO_3	Nitric Acid
HDPE	High-Density Polyethylene
K	Potassium
KCl	Potassium Chloride
KI	Potassium Iodide
L	Liter
LIMS	Laboratory Information Management System
M	Macrophytes
m	Meter
MBAS	Methylene Blue Active Substances, Surfactants
MDL	Method Detection Limit
Mg	Magnesium
mg/L	Milligram Per Liter
mL	Milliliter
Mn	Manganese
Mo	Molybdenum
MPN	Most Probable Number
MRL	Method Reporting Limit
mS/cm	Millisiemens Per Centimeter
mV	Millivolt
N/A	Not Applicable

Na	Sodium
$Na_2S_2O_3$	Sodium Thiosulfate
NaOH	Sodium Hydroxide
NH_3-N	Ammonia-Nitrogen
Ni	Nickel
NO_3-NO_2	Nitrate-Nitrite
NTU	Nephelometric Turbidity Unit
O&G	Oil and Grease
ORP	Oxidation Reduction Potential
OSHA	Occupational Safety and Health Administration
oz	Ounce
PAH	Polycyclic Aromatic Hydrocarbons
Pb	Lead
PBMS	Performance Based Method System
PCB	Polychlorinated Biphenyls
PET	Polyethylene Terephthalate
PETG	Polyethylene Terephthalate Glycol
PPM	Parts Per Million
PQL	Practical Quantitation Limit
PVC	Polyvinyl Chloride
QA	Quality Assurance
QC	Quality Control
QAPP	Quality Assurance Program Plan
QA/QC	Quality Assurance/Quality Control
RCRA	Resource Conservation and Recovery Act
RL	Reporting Limit
RPD	Relative Percent Difference
SAP	Sampling and Analysis Plan
Sb	Antimony
SDS	Safety Data Sheet
Se	Selenium
SI	International System of Units
SM	Standard Methods
SO_4	Sulfate
SOP	Standard Operating Procedure
Sr	Strontium
SU	Standard Units
SWM	Surface Water Monitoring
TDS	Total Dissolved Solids
TKN	Total Kjeldahl Nitrogen
Tl	Thallium

TN	Total Nitrogen
TOC	Total Organic Carbon
TP	Total Phosphorus
TPH	Total Petroleum Hydrocarbons
TS	Total Solids
TSS	Total Suspended Solids
U	Uranium
USEPA	United States Environmental Protection Agency
V	Vanadium
VOA	Volatile Organic Analysis
VOC	Volatile Organic Compound
WDEQ	Wyoming Department of Environmental Quality
WQD	Water Quality Division
WQL	Water Quality Laboratory
Zn	Zinc
ZnAc	Zinc Acetate

INTRODUCTION

BACKGROUND

Each year federal, state, private and public groups or agencies, industry, academic researchers, and interested citizen organizations spend increasing amounts of time and money on water quality monitoring, data analyses, and interpretation. For the information gathered to be useful to other interested parties and to be used for an accurate, cost-effective, and efficient assessment of water quality, all monitoring data must come from comparable project design, methods (including Quality Assurance/Quality Control (QA/QC), analyses, and interpretation. Collaboration among water quality monitoring programs, and organizations is possible if there is a technical and administrative framework to promote data comparability and to assure data of known quality. In addition, environmental issues and related data operations are becoming increasingly complex. Existing and anticipated environmental decision-making objectives drive the need to establish a systematic process and structure. This systematic process assures data consistency and quality, which decision-makers must have to have confidence in the data which supports their decisions.

The United States Environmental Protection Agency (USEPA) policy requires that the collection of environmental data by and on behalf of the Agency be supported by a mandatory quality system that includes the Standard Operating Procedures (SOPs) to be used during sampling, analysis, and related administrative and technical work. No work funded by USEPA and involving the acquisition of environmental data generated from direct measurement activities can be implemented without SOPs in place. Work performed on behalf of USEPA includes activities performed under contracts, assistance agreements (cooperative agreements, grants), and interagency agreements. These agreements are in response to statutory or regulatory requirements and in some cases consent orders and/or agreements negotiated as part of enforcement actions.

PURPOSE

The purpose of this manual is to provide a reference that documents:

- Standard sampling and analysis methods, procedures, and techniques.
- Data handling (electronic and paper).
- Field equipment.
- Sampling methods.

References are used to collect environmental data by the Groundwater Section (GWS) and any groups or organizations that collect environmental data on behalf of the Wyoming Department of Environmental Quality, Water Quality Division (WDEQ-WQD), GWS under contracts, assistance agreements (cooperative agreements, grants), interagency agreements, in response to statutory or regulatory requirements and in some cases consent orders and/or agreements negotiated as part of enforcement actions. Environmental data include any measurements or information used to

describe environmental processes, location, or conditions; ecological or health effects and consequences; or the performance of environmental technology; information collected directly from measurements and/or produced from models. Environmental data quality assurance and quality control are achieved by adhering to the methods, procedures, and techniques in this manual.

One of the goals of GWS monitoring is to produce data of known and documented quality that conforms to the credible data requirements defined in Wyoming State Statute (W.S.) § 35-11-103 (c)(xix).

Definition

An SOP describes in detail the method to be used to perform routine or repetitive administrative and technical activities. SOPs provide a framework that helps to ensure the quality, consistency, and defensibility of the data, and to reduce the work effort, errors, and training time required to deliver the product. The development and use of SOPs for both technical (measurement) and administrative work is a required part of a quality system. SOPs ensure consistency for activities covered by the GWS' Quality Assurance Program Plan (QAPP) and project-specific Sampling and Analysis Plans (SAPs).

Document Organization

The SOPs Volume II is divided into three parts. It consists of Part 1: Sampling: General Procedures; Part 2: Sampling: Specific Parameters; and Part 3: Quality Control, Custody, and Reporting. The effective date is listed under the title of each SOP. As SOPs are revised, the revision date will be documented on the SOP.

Use of SOPs

SOPs promote quality by assuring consistency that can be independent of personnel changes. SOPs can, therefore, be used as part of a training program, to reconstruct the project activities when no references are available, and to improve data comparability, credibility, and defensibility. SOPs do not, however, guarantee that the information collected with them accurately portrays the overall large system associated with the sampling sites because a sample and its resulting data are representative only of the site and field conditions at the time the sample was taken.

Even with SOPs, analytical methods and instruments are never absolutely perfect. It is understood that any measurement can only estimate the true value of an environmental sample. The term ***measurement error*** refers to a combination of random and systematic errors that inevitably arise during the various steps in the measurement process: sample collection, handling, preparation, and analysis; data entry, reduction, and verification.

The population (or condition) being sampled varies over time and space. Limited sampling, even if it follows SOPs, will miss some features of this natural variation. It is impossible or impractical

to measure every point of a condition. ***Sampling design error*** occurs when a sampling design cannot capture the complete extent of natural variability that occurs in the environment.

Scientific Validity

Collected data must be scientifically valid if it is to be useful. The data should be valid quantitatively and qualitatively and be representative of the environment in which it was collected. Sampling and Analysis Plans (SAPs) should be written to help ensure that the data collected will provide the necessary information for the project. The methodologies used should be reproducible and accepted by the scientific community.

Quality Control

A description of the Quality Control (QC) is given in each SOP that does not have a Method Reporting Limit (MRL) and is included in the summary SOPs in Part 3. Quality control is achieved and maintained when all persons collecting data on behalf of WDEQ-WQD GWS follow the SOPs so that sample collection, chains of custody, data entry, sample handling, and sample processing are consistent from one sampler and/or location to another. The WDEQ Water Quality Laboratory (WQL) or commercial laboratory analytical methods follow USEPA-approved test protocols with quality control parameters listed in each method. Contract laboratory methods are determined to be either comparable to or USEPA-approved before samples are submitted for analysis. Reporting limits are given in the parameter SOP. Documenting quality control allows users of the data to determine the quality of a given data set, as well as determine whether different methods produce data of comparable quality. This is referred to as a Performance-Based Method System (PBMS).

Users of this manual should keep in mind that data comparability is an ongoing challenge. There are many different versions of standard methods used and published by federal, state, and private groups, it is not uncommon for data collection entities to use standard methods that have been improved by the use of unique adaptations or for samplers to apply unique on-the-fly revisions which may not be documented. The result is widespread, often undocumented, differences in field and laboratory methods that can affect data comparability and quality.

Comparability

The GWS strives to produce data that is comparable to previous sample collections and data from other entities. Comparability is a qualitative evaluation of the degree of confidence a data collection entity has in the ability of data users to compare its data with another data set. Comparability for an environmental data operation is achieved by: (1) adhering to standard methods for data collection and analysis through the use of SOPs; (2) using standard units, reporting formats, field data collection forms, data qualification codes, and definitions of terms; (3) consistent quality assurance and quality control for field and laboratory activities; (4) documenting the precision and accuracy of the data set; (5) performance evaluations and audits;

(6) regular, structured record-keeping, data archiving, and report writing during the life of the project.

For this manual and the QAPP, the standard definitions from ANSI/ASQC E4-1994, Specifications and Guidelines for Quality Systems for Environmental Data Collection and Environmental Technology Programs of the terms *shall*, *must*, *should* and *may*, quoted below, are used:

- shall, must - when the element is required and deviation from the specification will constitute nonconformance with the standard; conformance is measured by completion or implementation of the action specified
- should - when the element is recommended
- may - when the element is optional

Safety

Each Field Office has a binder of Safety Data Sheets (SDS) for the chemicals and/or substances used in monitoring work.

Updates

Analytical and sampling methods change frequently. Either entire SOPs or individual pages may be revised. The date that an individual SOP was incorporated into the manual or updated will be noted at the top of the first page under the SOP title. Persons who need to know whether a revision is in progress on an SOP or a new SOP has not yet been released should contact the GWS, using the information on the inside of the cover page. Persons, groups, or organizations that collect data on behalf of WDEQ-WQD GWS, under contracts, assistance agreements (cooperative agreements, grants), or interagency agreements, in response to statutory or regulatory requirements are responsible for knowing and applying the information this manual contains, and for maintaining an up-to-date manual.

Disclaimer

This document has been reviewed, approved, and released in compliance with the WDEQ-WQD GWS policy. Reference to any specific commercial product, process, or service by trade name, trademark, or manufacturer does not necessarily constitute or imply its endorsement by WDEQ-WQD GWS. Every reasonable effort is made to accurately describe the actual technical and administrative activities and to check for errors in the descriptions, methods, and chemical reagents. Users should read each SOP carefully and question any possible errors. The WDEQ-WQD GWS does not claim that this document is free of errors.

Audits

USEPA Project Manager(s) or Quality Assurance (QA) staff may request and conduct a technical audit at any time during a grant period. A technical audit can consist of site visits to

evaluate sample collection or laboratory activities, a technical review, or an evaluation of performance.

Incorporated References

The references listed below apply to this document. Copies of USEPA documents can be requested from USEPA (800 490-9198) or downloaded/viewed from the Internet at one or more of the following sites:

- https://www.epa.gov
- https://nepis.epa.gov/

The SOP Volume II will be available electronically on the WDEQ-WQD GWS website.

1. Handbook for Sampling and Sample Preservation of Water and Wastewater, United States Environmental Protection Agency, Environmental Monitoring and Support Laboratory, Cincinnati, Ohio 45268, EPA-600/4-82-029, September 1982.
2. United States Environmental Protection Agency, 40 CFR Part 136.7 Quality Assurances and Quality Control, e-CFR data current as of January 4, 2021.
3. United States Environmental Protection Agency, 40 CFR Part 136.3 Table II – Required Containers, Preservation Techniques, and Holding Times, e-CFR data current as of January 4, 2021.
4. State of Wyoming Water Quality Rules and Regulations, Chapter 8, Wyoming Department of Environmental Quality, Water Quality Division, 2018.
5. State of Wyoming Water Quality Rules and Regulations, Chapter 24, Wyoming Department of Environmental Quality, Water Quality Division, 2021.
6. State of Wyoming Water Quality Rules and Regulations, Chapter 26, Wyoming Department of Environmental Quality, Water Quality Division, 2018.
7. State of Wyoming Water Quality Rules and Regulations, Chapter 27, Wyoming Department of Environmental Quality, Water Quality Division, 2018.
8. Guidance on Evaluation, Resolution and Documentation of Analytical Problems Associated with Compliance Monitoring, United States Environmental Protection Agency, Office of Water Engineering and Analysis Division (WH-552), Washington D.C. 20460, EPA 821-B-93-001, June 1993.
9. Guidance on the Documentation and Evaluation of Trace Metals Data Collected for Clean Water Act Compliance Monitoring, United States Environmental Protection Agency, Office of Surface Technology, EPA 821B-96-002, April 1995.
10. Methods for the Determination of Organic Compounds in Drinking Water, United States Environmental Protection Agency, Office of Research and Development, Washington D.C. 20460, EPA/600/4-88/039, July 1991.

PART 1 – SAMPLING: GENERAL PROCEDURES

Quality Control

Samplers follow the Standard Operating Procedure (SOP), make required entries in field log books, and fill out all fields on the field data sheets, collection, and analytical test forms. Any possible contamination of samples or equipment should be noted so that results can be qualified if necessary.

Procedure

Aseptic technique means using practices and procedures to prevent contamination from pathogens. The procedures applied to the aseptic technique are described in the United States Environmental Protection Agency (USEPA) method referenced in this SOP. The WQD Water Quality Laboratory (WQL) or a commercial laboratory furnishes samplers with pre-sterilized, disposable items for this work.

Samplers must make every effort to ensure that only the outside of bags, glassware, instruments, and any other necessary materials are handled and that no contamination of samples occurs. If the sample comes in contact with any surface that is not sterile, (i.e., hands, other samples, used glassware, etc.) the sample must be discarded and the reason documented.

All glassware must be sterilized before use. At no time should the same glassware be used for different samples without sterilization between uses.

Whirl-Pak™ plastic bags, IDEXX™ plastic containers, disposable pipettes, and other disposable items should never be used more than once and should be properly disposed of after use.

Where sample processing occurs, all surfaces must be washed with a disinfecting soap or solution before use and when the analysis is finished.

Work spaces should be kept clean, and any spills, drips, or other contamination of an area or glassware, must be disinfected before working with another sample.

Reference

United States Environmental Protection Agency, Microbiological Methods for Monitoring the Environment, Water and Wastes, EPA-600/8-78-017

Revision History

Date	Details of Revision	Revised by:
4/1/2021	Revision of September 2004 version	J. Scott
9/2/2021	Cherrie Nelson revised to meet Groundwater Section needs	Cherrie Nelson

Quality Control

As part of conducting its mission, the Groundwater Section (GWS) routinely accesses private lands. The GWS obtains legal access to private lands in one of two ways: A) Directly from the landowner or his/her authorized agent; or B) indirectly via another entity or individual. Procedures for both approaches are explained in this standard operating procedure (SOP). Each procedural step is required unless noted otherwise. For purposes of this SOP, legal access encompasses both access to the private land site of interest and across any private lands required to be traversed to reach the site of interest. The DEQ Access Agreement Policy and Forms are in **Appendix A**.

Procedure:

Direct authorization by the landowner or his/her authorized agent

1. Obtain land ownership and contact information from the applicable county assessor's office, Wyoming Statewide Parcel Viewer, or county online Geographic Information System (GIS) map server, unless land ownership information is already known or has been provided by another entity or individual.
2. Send a letter to the landowner or their authorized agent explaining the reasons for requesting access, including a map showing the specific areas where access is desired (recommended). Retain copies of all correspondence in a permanent file.
3. Contact the landowner or their authorized agent by phone to formally request access. If the landowner or authorized agent cannot be reached, a local manager or leaseholder should be contacted. If these persons cannot be contacted by phone, a personal visit to the residence of the landowner, agent, manager, or leaseholder may be used at the discretion of GWS staff.
4. If access is granted, record the authorizing party's name, address, and phone number, special conditions imposed by the authorizing party, dates, and specific locations for which access was granted, and the date that access was given in a log book or another permanent record.
5. Before accessing the private land, the authorizing party is again contacted as a courtesy to provide the specific date and time that GWS staff will be on the private property. This call also allows the authorizing party to add or change special conditions or rescind access altogether. These calls also are documented in a log book or other permanent record.
6. While accessing or crossing private land, all special conditions imposed by the authorizing party are followed, without exception.

The GWS plans access routes before visiting private land sites. Routes are planned using a combination of United States Forest Service forest and motorized route maps, Bureau of Land Management maps, state and county general highway maps, the Wyoming Statewide Parcel Viewer, and aerial photography. The county clerk/recorder, county roads department, and federal agency offices may be consulted if legal road access is uncertain. For any routes where additional private road access is needed (to either access other private land or landlocked public land site of interest), the landowner(s) or their authorized agents are contacted using procedure A. above, with the exception that step#2 is an option used solely at the discretion of GWS staff.

Indirectly through another entity or individual.

1. GWS staff may request that another entity or individual obtain legal access on their behalf or another entity or individual may offer to obtain legal access on behalf of GWS staff.
2. Legal access may be obtained on behalf of the GWS via verbal or written means, though the GWS may prescribe the method of legal access and associated documentation deemed necessary for a specific circumstance.
3. If legal access has not been confirmed by the entity or individual within 2 weeks before accessing the private land, contact the entity or individual to confirm that legal access (including routes) has been obtained on behalf of GWS staff. If legal access was obtained in writing, request a copy of the written authorization and place it in a permanent file. Record the name, address, and phone number of the entity's representative or individual, special conditions imposed by the authorizing party, dates and specific locations for which access was granted, and the date(s) that access was given, in a log book or another permanent record.

References None required; internal standard

Date	Details of Revision	Revised by:
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Quality Control

Samplers follow the standard operating procedure (SOP), complete all entries and signatures on the appropriate chain of custody (COC) form (Water Quality Laboratory [WQL] or commercial laboratory), and submit it with the samples. Copies of the COCs are filed with the monitoring site records. The original COCs are kept on file by the WQL or commercial laboratory. A complete and signed COC must be provided with all samples. Several COCs are provided in **Appendix B**.

Procedure

Groundwater Section collects and tests samples based on the assumption that the test results may be subject to litigation. The purpose of this SOP is to assure that an accurate written record is created by the field samplers, which will be accepted as valid evidence to trace samples from the moment of collection through laboratory analysis and reporting of test results.

Definition of Chain of Custody: A COC includes not only the form, but all references to a sample or samples in any form, document, or log book. A COC allows tracing the sample back to its collection and will document possession of the sample(s) from the time of collection until the analytical results are received.

Definition of Custody: A sample is considered to be in custody if it is in the actual physical possession of the Wyoming Department of Environmental Quality – Water Quality Division (WDEQ-WQD) Groundwater Section, or any person(s) sampling on its behalf, is in view after being in physical possession.

Chain of Custody Forms for Water Quality Testing: The COC must be completed in its entirety and placed in a water-tight plastic bag inside the shipping cooler. The bag can be taped to the inside of the lid. Samplers are responsible for having and using the proper form.

Custody Seal: A minimum of one laboratory custody seal will be placed on the front of the cooler from the lid to the main body of the cooler, in such a way that the container cannot be opened without damaging the seal. The sampler must then seal the shipping cooler with plastic tape or strapping tape. Clear tape should be placed over the seal. The seal serves as an indication to laboratory personnel that the sample container has not been altered after leaving the sampler's custody.

Waiver of Custody Seal use: The use of a custody seal may be waived if the samples are in the custody of the sampler at all times (see Definition of Custody

above). Custody must be maintained from the time of sample collection until the samples are hand-delivered to the laboratory. The Field Log book or datasheet must document if this occurred.

Transport: The sampler may deliver the cooler to the lab or send it to the laboratory by way of a common carrier. When a common carrier is used, the sampler will retain the shipping receipt as proof of the transfer of custody.

Laboratory: Laboratory personnel determines that the seal and tag are intact, opens the cooler, removes the COC, and makes the required entries for temperature, condition of the sample containers, and holding time. Laboratory personnel must document the date and time of sample receipt and sign each page of the COC submitted. If the seal appears to have been tampered with or the temperature is above parameter compliance, laboratory personnel enter that information on the COC and notify the Laboratory Supervisor and/or the sampler, who jointly decide whether to test the samples.

Disposition of Form: A copy of the original COC will be returned to the sampler with the results. The original COC is typically retained by the laboratory. The copy of the COC will be stored and retained indefinitely.

Reference

United States Environmental Protection Agency, 40 CFR Part 136.7 Quality Assurances and Quality Control, e-CFR data current as of January 4, 2021

Revision History

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6/22/2021	Revised to meet Groundwater Section needs	Cherrie Nelson

FIELD LOG BOOKS
(EFFECTIVE DATE: APRIL 2021)

Scope

Work funded by or performed on behalf of the United States Environmental Protection Agency (USEPA), which involves the acquisition of environmental data generated from direct measurement activities is subject to USEPA quality control/quality assurance procedures and audits. Such work includes activities performed under contracts, assistance agreements (cooperative agreements, grants), interagency agreements, in response to statutory or regulatory requirements, and in some cases, consent orders or agreements negotiated as part of enforcement actions. Each person who conducts or participates in environmental data collection must initiate and maintain a chronological, permanently bound field log book record.

Quality Control

The outside front cover of the log book must contain the following information: the sampler's printed name, the from-to date periods covered by the log book (mm/dd/yy), and the sequential log book number. If field log books have a permanent, pre-dated year printed on the front cover, the log book is to be used for that year only, and the from-to month and day must be shown.

The inside front cover is used for signature identification of the sampler and all other persons who make entries in the log book. The sampler's signature and a chosen set of written (not printed) identifying initials must be shown. The sampler's identifying initials, written as shown on the inside front cover, must be used for sample labeling (see the standard operating procedure (SOP) for **Sample Labeling**), as well as any activity which requires sign-off. Any person who makes an entry in the log book must sign the inside front cover with their full name and identifying initials and use those initials as shown for all entries in the log book.

Numbering Log Books and Book Pages: All field log books and pages are numbered sequentially and no pages should be intentionally removed.

Pen: Entries must be in permanent ink unless sampling conditions require using a pencil. If a pencil is used, the reason should be noted in the entry.

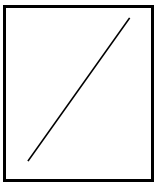
Corrections: Corrections are made with **one** line through the incorrect information, drawn in such a way that the original information can still be read. The correct information is written in the next available space.

Example: ~~3.5 ft~~ 5.5 ft

All corrections must be initialed and dated on the same line. All persons who make entries in the log book must sign and date the entry in the field provided.

If an entire page contains incorrect information, **one** diagonal line is drawn on the page with the sampler's initials, and the correct information must be recorded in the next available space. All corrections must be initialed as described above and dated.

Example:



Archiving Log Books: Samplers who resign or transfer to another position must leave all field log books in chronological order in their respective field office in a designated filing area. Before the employee leaves, the program supervisor or project manager should verify that all log books are complete, numbered, accounted for, and filed.

Log Book Audit**:** All field log books are subject to audit and inspection for accuracy and completeness.

Procedure

Samplers will exercise their best professional judgment about the information and the level of detail recorded in a log book. Information may include photographs, drawings, measurements, calculations, locational data, local conditions, incidental equipment used, difficulties encountered, and/or protective equipment worn. **The information must include sampler names, collection date and time, weather and environmental conditions, problems with equipment if applicable, and justification for any modifications to the Sampling and Analysis Plan if any of these items are not captured on a Field Data Sheet.**

Sampler's Initials: All persons other than the sampler who make entries in the sampler's log book must initial and date the entry. If a field crew appoints one member as the data recorder, all participants involved in the collection of that data must sign the inside front cover, show their chosen initials beneath their signature, and initial and date the field log book entries.

Tape Recorded Sampling Records and Data: Due to sampling, weather conditions, or workload, it may be necessary for a sampler to conduct some data collection under conditions that make it impossible to write entries in a field log book. Under those conditions, a tape recorder will be used by the sampler, and the information will be entered in the field log book after the data are collected. These log book entries must include information to indicate that the initial data collection was taped and later transcribed and the reason why.

Field data may subsequently be transferred to data sheets, forms, or databases. Samplers should anticipate and plan for future uses of the information they record and use their best professional judgment about the information they include.

Reference

United States Environmental Protection Agency, 40 CFR Part 136.7 Quality Assurances and Quality Control, e-CFR data current as of January 4, 2021

Intergovernmental Task Force on Monitoring Water Quality (ITFM) Final Report: Strategy for Improving Water Quality Monitoring in the United States, OFR-95-742, 1995, Office of Water Data Coordination, United States Geologic Survey, Reston, Virginia

Revision History

Date	Details of Revision	Revised by:
5/1/2016	Revision of March 2001 version	C. Norris
4/1/2021	Revision of May 2016 version	J. Scott
6/22/2021	Cherrie Nelson revised to meet Groundwater Section needs	Cherrie Nelson

Quality Control

Samplers follow parameter-specific SOP.

Required field measurements are dictated by the needs of the sampling design and available equipment. Chemical and physical parameters that are typically acquired include pH, dissolved oxygen (DO), specific conductance, temperature, oxygen reduction potential (ORP), and turbidity. Measurements should be made with an instrument that is calibrated and operated according to the manufacturer's recommendations. Measurements with instrument probes may be taken either in situ or from a secondary collection vessel that has been cleaned and rinsed with effluent water three times. If a secondary vessel is used, take the measurements as quickly as possible. Individual standard operating procedures (SOPs) can be referenced for each parameter.

Procedure

1. Record the model and the serial number of instruments used on the field data sheets or log book. The Instrument Calibration Log sheet is in **Appendix C**.
2. Record the date the instrument was last calibrated on the field data sheets or log book.
3. Measure the check standard and record the measured value along with the actual value of the check standard on the field data sheets or log book.
4. Rinse the probe, place it in the water to be tested, and allow it to equilibrate.
5. Record the value obtained on the field data sheets.
6. Sequential replicate measurements (from the same meter which is turned off and on between measurements) should be obtained at a minimum of 10% of sample sites and should be measured within 5 minutes of the original value.
7. Sequential duplicate measurements (from two separate multi-probe meters) should be obtained where resources and opportunities present themselves.
8. Clean and store probe and meter as recommended by the manufacturer.

Reference

United States Geological Survey, National Field Manual for the Collection of Water-Quality Data (NFM), 2003.

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Quality Control

Samplers follow the standard operating procedure (SOP). Use the aseptic technique while filtering (refer to SOP for **Aseptic Technique**). This is a field-based method for filtration of water samples for analysis of dissolved analytes. Any possible contamination of samples or equipment should be noted so that results can be qualified if necessary.

Samples must be filtered before adding preservatives for any dissolved analyte parameter.

Collect the appropriate quality control samples (i.e., blanks and duplicates) following the procedures below. If using the Direct Measurement Procedure, an 'equipment blank' using one of the dedicated site syringes should be performed at least once per season.

Direct Measurement Procedure

Set-up & Filtering

Filtered grab water samples are collected for dissolved parameters using a 60 microliter (mL) syringe with a 0.45 micron (µm) disposable filter. Each site will have a dedicated syringe that will be cleaned after each use to reduce cost and waste. A 1.0 µm pre-filter can be used before the 0.45 µm for turbid samples as long as all steps below are taken with each filter.

1. Rinse the dedicated site syringe three times with ambient stream water.
2. Fill the syringe with 60 mL of ambient stream water. Place a new disposable 0.45 µm filter onto the syringe, and rinse the 250 mL sample bottle three times with at least 15 – 20 mL of filtered stream water for each rinse. Discard the rinsate water downstream.
3. After rinsing the bottle, remove the filter, and dispose of it.
4. Refill the syringe with 60 mL of stream water by lowering it down to approximately 0.6 times the total depth and orient the tip of the syringe upstream so that water flows into it taking care not to disturb the sediment.
5. Place a new filter (either 1.0 or 0.45 µm depending on the turbidity of the stream) on the syringe and rinse the filter with 10 mL of the ambient stream water discarding the rinsate downstream.
6. Filter the remaining 50 mL collecting it into the pre-rinsed 250 mL bottle.
7. Repeat the steps above replacing filters as needed until the desired volume is collected. If the water is very turbid, several filters may be needed.
8. After the sample container is filled, add the appropriate volume of preservative if applicable for that analyte (refer to SOPs for **Metals, Total**

and Dissolved, and specific parameter(s) to be analyzed). Attach the appropriate label and store it on ice (refer to SOPs for **Sample Labeling** and **Sample Parameters, Methods, Preservation, and Holding Times**).

9. Remove the disposable filter and discard it appropriately (**disposable filters can only be used once**).

Sterilization

1. To clean the syringe in between uses, set up three containers labeled 'bath', 'rinse', and 'water'. The 'bath' container should contain a 10% Nitric Acid solution (**Note**: another acid might be required if nutrient analysis is part of the sampling objectives), the 'rinse' container should be empty, and the 'water' container should contain deionized water.
2. Plunge the used syringe into the 'bath' container and draw up 60 mL of the 10% acid.
3. Discard the acid into the 'rinse' container.
4. Repeat steps 2 through 3, three times.
5. Next, plunge the sterilized syringe into the 'water' container and draw up 60 mL of the deionized water.
6. Discard the deionized water into the 'rinse' container.
7. Repeat steps 5 through 6 three times.

Peristaltic Pump Procedure

Set-up

1. Clean the area surrounding the filtration workstation.
2. Set up Geotech Geopump™ peristaltic pump or similar device on a level surface and plug into a power source.
3. Insert 2-3 ft silicone tube into Easy-Load® pump head. Make sure the filter direction is set to 'Forward'. The plastic dispos-a-filter™ Universal Sample Tubing Adapter screw attachment should be at the output end of the tube (right end).
4. Set up three containers labeled 'bath', 'rinse', and 'water'. The 'bath' and 'rinse' containers each contain 10% Nitric Acid (**Note**: another acid might be required if a nutrient analysis is part of the sampling objectives) whereas deionized water is stored in the 'water' container.
5. Place a bucket beneath the output end of the silicone tube to capture filtrate for proper disposal later.
6. Wear latex or nitrile gloves for the remainder of the procedure to minimize contamination.

Sterilization

1. Insert the input end of the silicone tube into the 'bath' that contains the 10% acid solution. Rotate and agitate the bottle to ensure that the entire outside surface of the silicone tube input end has contacted the 10% acid solution.
2. Insert the input end of the silicone tube into the 'rinse' that contains 10% acid solution. Turn on the pump and run the 'rinse' through the tube for approximately two seconds. Before turning off the pump, remove the input end of the silicone tube from the 'rinse' allowing the pump to extract the remaining 10% acid solution from the tube.
3. Rinse the outside of the input end of the silicone tube with deionized water from the 'water' container. Insert the input end of the tube into the 'water' container. Turn on the pump and run the deionized water through the tube for approximately two seconds. Before turning off the pump, remove the input end of the silicone tube from the 'water' allowing the pump to extract the remaining deionized water from the tube.

Filter

1. Attach a 0.45 µm Geotech dispos-a-filter™ to the end of the silicone tube. Use a 0.45 Micron Medium-Capacity dispos-a-filter™ for turbid samples if available.
2. Turn on the pump and run a small volume of sample through to saturate the tube and filter.
3. Run a small amount of the sample through the filter into an appropriately sized polyethylene container. Stop filtering, cap the container, and rinse thoroughly. Discard rinse into the bucket.
4. Repeat Step 3 two more times.
5. Fill the polyethylene container and add the appropriate volume of preservative, if applicable, for that analyte (refer to SOPs for **Metals, Total and Dissolved,** and specific parameter(s) to be analyzed). Attach the appropriate label and store it on ice (refer to SOPs for **Sample Labeling** and **Sample Parameters, Methods, Preservation, and Holding Times**).
6. Remove the disposable filter and discard it appropriately (**disposable filters can only be used once**).
7. Repeat the sterilization process for the next sample and before storage of equipment.

Cleaning Acids

Some acids should not be used for cleaning if they could potentially affect the results of the parameters of interest. Use the following table to determine what acid cleaning guidelines should be followed for each project-specific study objective:

Acidification Guidelines for Project-Specific Study Objectives		
Study Objective Parameter:	Appropriate Cleaning Acid (Yes/No):	
	10% Nitric Acid	10% Hydrochloric Acid
Dissolved Metals	Yes (preferred)	Yes
Dissolved Nutrient Parameters	No	Yes
Dissolved Ions (Cl, SO_4, and F)	Yes	No
Dissolved Organic Carbon (DOC)	Yes (preferred)	Yes
Orthophosphate	Yes (preferred)	Yes

For difficult cleaning situations, use a solution made with 10% nitric and 5% hydrochloric acid. In most cases, this should clean/make soluble most elements, except for boron.

Reference United States Geological Survey, National Field Manual for the Collection of Water-Quality Data (NFM), 2003.

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6/22/2021	Cherrie Nelson revised to meet Groundwater Section needs	Cherrie Nelson

Scope

The procedures contained in this document are to be used by field personnel when collecting and handling groundwater samples in the field. On the occasion that the Wyoming Department of Environmental Quality (WDEQ) Water Quality Division (WQD) Groundwater Section field personnel determine that any of the procedures described are either inappropriate, inadequate, or impractical. The WDEQ-WQD field personnel may determine if another procedure must be used to obtain a groundwater sample. The variant procedure will be documented in the field log book, along with a description of the circumstances requiring its use. Mention of trade names or commercial products in this operating procedure does not constitute endorsement or recommendation for use. The GWS Sampling Forms are in **Appendix C**.

The WQD generally uses bailers to purge groundwater for sample collection. Bailers are the simplest purging device used and have many advantages. They generally consist of a rigid length of tube with a ball check-valve at the bottom. A line is used to lower the bailer into the well to retrieve a volume of water.

Equipment

- Water level indicator/sensor
- Keys for well lock(s)
- Log book
- Calculator
- Sample labels
- Chain of Custody records and custody seals
- Sample containers
- Sharp knife (with locking blade)
- Toolbox containing screwdrivers, pliers, a hammer, a flashlight, etc.
- Leather work gloves
- Surgical gloves
- Personal Protective Equipment (PPE)
- Five-gallon bucket(s)
- Shipping containers
- Packing materials
- Ziploc plastic bags

- Decontamination solutions (e.g. Liqui-Nox)
- Bailers of appropriate size and construction material
- Nylon twine
- Pen

Considerations

Office Preparation

1. Identify all sampling locations.
2. Contact the laboratory and place a bottle order.
3. Inspect the bottle order received from the laboratory against what analytes need to be evaluated. Ensure all supplies were received such as sample labels, COCs, custody seals, and the correct quantity and types of bottles for the requested analytes, appropriate preservatives, and coolers.
4. Obtain necessary sampling and monitoring equipment and supplies.
5. Check the expiration dates of calibration solutions.
6. Prepare a schedule and coordinate with staff, permittees and/or well owners, and the laboratory.
7. Obtain signed access agreements (see SOP).
8. Decontaminate all equipment before use, and ensure that equipment is in working order and ready to use.
9. Obtain all necessary forms, SOPs, sampling and analysis plans, safety forms, and a log book.
10. Gather appropriate PPE.

Field Preparation

1. Remove the lock on the well cap and note the location, time of day, and date in the field log book.
2. Remove the well-casing cap (allow 3-5 seconds to prevent exposure to vapors).
3. Lower the water level indicator/sensor into the well until the water surface is encountered.
4. Measure the distance from the water surface to the reference measuring point on the well casing or protective barrier post, and record the measurement in the log book. Alternatively, if there is no reference point, note that water-level measurement is from the top of the steel casing, the top of the PVC riser pipe from the ground surface, or some other position on the wellhead.
5. Measure the total depth of the well (at least twice to confirm measurement) and record it in the log book. Note whether a hard or soft bottom is detected.

Well Purge by Parameter Stabilization

Before sampling a monitor well, the well must be purged to remove water that may have been stagnant which allows the introduction of fresh groundwater into the well for sampling. Below are some items to consider while preparing the well for collecting samples.

1. At a minimum, three (3) well volumes should be purged if recharge to the well is sufficient; The Procedures Section below shows all calculations necessary to determine the well volume.
2. While the well is being purged, field parameters (i.e., pH, temperature, and electrical conductivity) should be measured and recorded following the removal of each well volume until the readings stabilize. This is done to ensure that fresh groundwater is entering the well.
3. Field parameters are stable when there is less than 0.2 pH unit change and less than 10% change in conductivity and temperature for three consecutive measurements.
4. For wells that can be bailed to dryness, the well should be evacuated and allowed to recover before sample withdrawal. If the recovery rate is relatively rapid and time allows, evacuation of more than one well volume of water is preferred. If recovery is slow, on the order of several hours to several days, sample the well upon recovery after one evacuation.

Procedure

Well Purge by Volume

1. Calculate the volume of water in the well and the volume to be purged. To calculate the water volume of a well (in gallons of water per foot of casing) utilize the following equation:

Water volume = pr^2h (cf) [Equation 1]

Where: p = pi (approximately 3.14)
r = radius of monitoring well (feet)
h = height of the water column (feet) [This may be determined by subtracting the depth to water from the total depth of the well as measured from the same reference point.]
cf = conversion factor (gal/ft^3) = 7.48 gal/ft^3 [In this equation, 7.48 gal/ft^3 is the necessary conversion factor.]

If the diameter of the monitor well is known, there are a number of standard conversion factors which can be used to simplify the equation above.

The volume, in gallons per linear foot, for various standard monitor well diameters can be calculated as follows:

Volume (in gal/ft) = pr^2 (cf) [Equation 2]

Where: p = pi (approximately 3.14)
r = radius of monitoring well (feet)
cf = conversion factor (7.48 gal/ft^3)

For a 2-inch diameter well, the volume per linear foot can be calculated as follows:

Volume (in gal/ft) = pr^2 (cf) [Equation 2]
= 3.14 (1/12 ft)^2 7.48 gal/ft^3
= 0.1632 gal/ft

Remember that the well diameter in inches must be converted to a radius in feet to use the equation. Reference the table below for some examples of volumes in gallons per linear foot for different well diameters (Schedule 40 PVC).

Well Diameter	2 inches	3 inches	4 inches	6 inches
Approximate Volume (gal./ft.)	0.1632	0.3672	0.6528	1.4688

If volumes in gallons per foot, such as those in the table above are utilized, then Equation 1 should be modified as follows:

Water Volume = (h) volume (in gal/ft) [Equation 3]

Where: h = height of water column (feet)

The water volume of a well is typically tripled to determine the volume to be purged.

2. Record measurements, calculations, and field parameter readings on the WDEQ-WQD GWS Sampling Form.
3. Attach the line to the bailer and slowly lower it until the bailer is completely submerged, being careful not to drop the bailer to the water, causing turbulence and the possible loss of volatile-organic contaminants.
4. Pull the bailer out, ensuring that the line either falls onto a clean area of plastic sheeting or is wound onto a clean reel or spool and never touches the ground.
5. Empty the bailer into a graduated vessel or container of known volume to determine the number of bails necessary to achieve the required purge volume.
6. Collect samples after each well volume to determine if field parameters such as pH, temperature, and electrical conductivity have stabilized.
7. Pour the water into a container and dispose of purge water as specified in the site-specific sampling plan.

Sampling

1. Surround the monitoring well with clean plastic sheeting or other suitable material.
2. Assemble and label appropriate sample containers.
3. Attach a line to a clean, decontaminated bailer.
4. Lower the bailer slowly and gently into the well, taking care not to shake the casing side or splash the bailer into the water. Stop lowering at a point adjacent to the screen.
5. Allow the bailer to fill and then slowly and gently retrieve the bailer from the well, avoiding contact with the casing to not knock flakes of rust or other foreign materials into the bailer.
6. Remove the cap from the sample container and place it in a location where it won't become contaminated. See the section below for Special Considerations on Volatile Organic Compound Sampling.
7. Begin slowly pouring from the bailer into the pre-labeled sample container or filtering device.
8. Filter and preserve samples, if required, by the sampling plan.
9. Cap the sample container tightly and place the pre-labeled sample container in a cooler on ice.
10. Replace the well cap.
11. Log all samples in the log book.
12. Package samples, complete the COC (see SOP for Sample Packaging), and ship or hand-deliver to the analytical laboratory.

Post Sampling

1. Decontaminate all equipment in the field, if appropriate (See SOP for Sampling Equipment Decontamination).
2. Replace sampling equipment in storage containers.
3. Prepare and transport samples on ice to the shipping location or laboratory. (See SOP for Sample Management).
4. Make sure samples are properly packed on ice for shipment.
5. Ship samples or hand-deliver them to the laboratory with the COC.

Special Considerations

Filtering for Dissolved Analytes

As a standard practice, groundwater samples will not be filtered for routine analysis. Filtering will usually only be performed to determine the fraction of major ions and trace metals passing the filter and used for flow system analysis and geochemical speciation modeling. See SOP on **Filtration for Dissolved Analytes** for further guidance.

Filtering is not allowed for samples that are to be analyzed for organic compounds.

PFAS (per- and polyfluoroalkyl substances) Sampling

Potential sources for PFAS cross-contamination include items and materials used within the sampling environment, such as sampling equipment, field clothing, personal protective equipment (PPE), sun and biological protection products, personal hygiene, personal care products (PCPs), and food packaging. Therefore, a special SOP for sampling groundwater for PFAS has been developed and is provided in Part 2 of this SOP Manual along with SOPS for sampling groundwater for individual analytes.

Volatile Organic Compound (VOC) Sampling

The proper collection of a sample for VOC analysis requires minimal disturbance of the sample to limit volatilization and therefore a minimal loss of volatiles from the sample. The focus of concern must be to provide a valid sample for analysis, one which has been subjected to the least amount of turbulence possible. The following procedures should be followed:

1. Open the vial, set the cap in a clean place, and collect the sample. When collecting duplicates, collect both samples at the same time.

2. Fill the vial to just overflowing. Do not rinse the vial or excessively overflow it. There should be a convex meniscus on the top of the vial. This will prevent headspace when placing the cap.
3. Check that the cap has not been contaminated (splashed) and carefully cap the vial. Place the cap directly over the top and screw it down firmly. Do not over-tighten as it may break the cap.
4. Invert the vial and tap gently. Observe the vial for at least 10 seconds. If an air bubble appears, discard the sample and vial and restart at Step 1. Ensure that there is no entrapped air or headspace in the sample vial.
5. Immediately place the vial in the protective foam sleeve and place it into the cooler.
6. Samples, packed on ice, should be shipped or delivered to the laboratory daily so as not to exceed the holding time or recommended storage temperature.

Samples that Effervesce

Groundwater that has a high amount of dissolved limestone, i.e., is highly calcareous, will most likely produce an effervescent reaction (large numbers of fine bubbles) when added to the sample bottles containing the preservative hydrochloric acid. This will render the sample unacceptable.
In this case, unpreserved vials should be used and arrangements must be confirmed with the laboratory to ensure that they can accept the unpreserved vials and meet the shorter sample holding times.

Trace Contaminant Groundwater Sampling

A clean pair of new, non-powdered, disposable gloves will be worn each time a different location is sampled and the gloves should be donned immediately before sampling. The gloves should not come in contact with the media being sampled and should be changed at any time during sample collection when their cleanliness is compromised.
Sample containers for samples suspected of containing high concentrations of contaminants shall be stored separately.
Sample collection activities shall proceed progressively from the least suspected contaminated area to the most suspected contaminated area if sampling devices are to be reused. Samples of waste or highly contaminated media must not be placed in the same ice chest as environmental (i.e., containing low contaminant levels) or background samples.
If possible, one member of the field sampling team should take all the notes and photographs, fill out tags, etc., while the other members collect the samples.

Clean plastic sheeting will be placed on the ground at each sample location to minimize contamination of sampling equipment by accidental contact with the ground surface.
Samplers must use new, certified-clean disposable or non-disposable equipment.

Reference

United States Environmental Protection Agency, RCRA Waste Sampling Draft Technical Guidance: Planning, Implementation, and Assessment. EPA530-D-02-002, August 2002.

United States Geological Survey, National Field Manual for the Collection of Water-Quality Data (NFM), 2003.

Revision History

Date	Details of Revision	Revised by:
6/22/2021	Added SOP	Cherrie Nelson

Scope

This is a technical procedure for sampling private water-supply wells. This procedure is written for typical well construction that supplies domestic water for a private residence and/or small-scale irrigation or livestock supply. The water-supply system typically includes:

- A water-supply well with a casing less than 10 inches in diameter.
- A submersible pump or jet pump.
- A wellhead completion on the surface or in a shallow pit, possibly with a pitless adapter in cold climates.
- A pressure tank is for domestic use, either near the well or inside the residence.

To collect representative groundwater samples, a sampling point must include the following
characteristics:

- Upstream of the pressure tank, when possible.
- Upstream of treatment systems or other equipment, unless these can be bypassed.
- A spigot or drain to which a fitting for sampling equipment may be attached, and is located in an accessible location.

Where possible, the sample location should be identified during a site reconnaissance ahead of the scheduled sampling time. Items to assess include site access, the location of the sampling point, adjoining land use, the location of the well, the current well use, well construction information if available, the configuration of the wellhead including access ports for sounding devices, and a location for purge water discharge.

This procedure assumes that no modification to the water-supply system will be made. Based on project-specific requirements and access arrangements with property owners, modifications such as the addition of sampling ports may be provided separately.

This procedure also assumes that the well is not equipped with a dedicated sampling port, which is not a typical configuration. If a sampling port meets the above criteria, the portion of the sample manifold for the water-quality

measurements and sample collection may be fitted to the sampling port, while the discharge hose and flow totalizer may be connected to a separate downstream spigot.

Equipment

- Keys and/or tools to access the sampling location.
- Dedicated sampling manifold consisting of:
  - A connection fitting for the sampling point (typically 0 inch).
  - A reducing tee with a hose fitting connected to the large discharge end.
  - A flow-regulating valve.
  - A 3-way valve.
  - Tubing to connect the fittings and the flow-through cell and to fill sample containers. **Note:** Fittings, valves, and tubing will consist of pre-cleaned fluoropolymer or food-grade polyethylene.
- Bag for storing dedicated sampling equipment, labeled with well name.
- Multi-parameter water-quality meter for measuring field parameters (temperature, specific conductance, pH, dissolved oxygen, and turbidity) equipped with a flow-through cell.
- A hose to convey groundwater discharge from purging to the designated disposal location.
- A totalizing flowmeter with fittings to connect to the discharge of the sample manifold and the discharge hose. A flow-regulating valve should be included at the discharge end to regulate flow if needed.
- Bucket to collect purge water from the flow-through cell at the sample collection location.
- Sample containers, pre-cleaned and containing preservatives, when required.
- Pre-cleaned cartridge filters with fittings to match the sample collection tubing, when samples are to be filtered for analysis of dissolved constituents.
- Supplies for field quality assurance samples, such as trip blank samples in 40 mL VOA vials, and distilled/deionized water for field blank samples.
- Disposable nitrile gloves.
- Ice for samples.
- Sample coolers and packing material.

Procedure

1. Review the Job Safety Analysis for this task.
2. Prepare Sampling Location
   a. If feasible, request the owner to operate the well within 3 hours before the scheduled sampling event.

b. Clear the work area of obstructions.
c. Position vehicles and/or equipment near the work area (downwind).
d. Check that the sampling location spigot or drain is clear of obstructions and remove the aerator if present.
e. Attach the discharge hose to the spigot or hydrant.
f. Prepare the water quality field meters.
g. If required by the sampling analysis plan, prepare a clean and protected work location for obtaining other field water quality measurements, and prepare the equipment.
h. Purge the well (Refer to the Standard Operating Procedure (SOP) for **Well Purging**).

3. Collect the sample
   a. Maintain the pumping rate, do not decrease. Decreasing the pumping rate may cause cycling of the pump and possible backflow of water from the plumbing system and/or pressure tank.
   b. Implement clean hands/dirty hands (CH/DH) for collecting samples. Delegate one team member to don fresh disposable gloves and handle the sample containers and discharge tubing.
   c. Adjust flow for filling sample containers: approximately 500 mL/minute for large containers, and approximately 150 mL/minute for VOAs and other small containers.
   d. Do not touch the lip of sample containers or the inside edges of the caps.
   e. For samples WITHOUT preservatives, rinse the bottle with sample water by filling 1/10 full, shaking, and discarding the contents to the bucket. DO NOT rinse bottles with preservatives.
   f. Fill sample containers from the discharge tube while minimizing aeration of the sample. Do not overfill containers containing preservatives. Fill VOA vials to form a meniscus and check that there are no air bubbles once the cap is in place.
   g. In general, fill sample containers in the following order:
      i. Volatile organic compounds (VOC)
      ii. Semi-volatile organic compounds (SVOC)
      iii. Trace and major element cations
      iv. General chemistry (nutrients, major anions, alkalinity)
      v. Radiochemicals and isotopes
      vi. Filtered dissolved organic carbon
      vii. Microorganisms.
   h. For samples requiring field filtration, attach the filter cartridge to the end of the sample fill tubing. Allow the initial flow from the filter to discharge to waste before filling the sample container.

4. Prepare the sample for transport from the site. (See SOP for **Sample Management**).
5. Remove equipment and clean up the sampling area.
    a. Place the dedicated sampling manifold in a bag labeled with the well name and store it for use during the next sampling event.
    b. Remove plastic sheeting from the sample location.
    c. Restore the site to its original condition.

References

United States Environmental Protection Agency, RCRA Waste Sampling Draft Technical Guidance: Planning, Implementation, and Assessment. EPA530-D-02-002, August 2002.

United States Geological Survey, National Field Manual for the Collection of Water-Quality Data (NFM), 2003.

Revision History

Date	Details of Revision	Revised by:
6/22/2021	Added SOP	Cherrie Nelson

PHOTOGRAPHIC DOCUMENTATION
(EFFECTIVE DATE: MARCH 2001)

Quality Control — Samplers follow the standard operating procedure (SOP). Photographs are recorded in the Field Log Book.

Procedure — In general, photographs should be identified with: the photograph number, date, and time, even if the photographs are automatically date stamped by the camera; the subject; the location in narrative format and lat/long coordinates; the photographer; witnesses; the location where the photograph was taken; and a short narrative related to the photograph. The Photograph Log Form is located in **Appendix E**.

Monitoring: Photographic documentation has been done at all Groundwater Section or bioassessment sites since 1992. Each sampling site must be documented with a series of photographs to establish site conditions. These photographs will be used to accurately locate monitoring sites and to document habitat conditions at the time the sample was collected. Individual photographs are taken looking upstream and downstream from the base of the sampling reach. Individual photographs should also be taken of cross-sectional surveys. Photos should be taken looking upstream at the cross-section, and laterally from one end pin to the opposite end pin. In addition, a multi-photo panoramic set of photographs is taken for the reach. Additional photographs of landmarks, potential or actual pollution sources, or other items should also be included in the photographic documentation.

Reporting — Transfer photographs to Photo Log

References — None required; internal standard

Date	Details of Revision	Revised by:
4/1/2021	Revision of March 2001 version	J. Scott
6/22/2021	Revised to meet Groundwater Section needs	Cherrie Nelson

SAFETY DATA SHEETS (SDS)
(EFFECTIVE DATE: APRIL 2021)

Quality Control

Samplers know where to obtain Safety Data Sheets (SDS) for all substances used in their field sampling and observe the safety precautions and safe handling of all chemicals.

Procedure

Safety Data Sheets have been required by the Occupational Safety and Health Administration (OSHA) for manufacturing operations since 1983 and for all employers since 1987 in compliance with Public Law 85-742 and its amendments and by the Wyoming Occupational Safety and Health Administration which is part of the Department of Workforce Services. Wyoming OSHA has primacy for the administration and enforcement of equivalent regulations. An SDS is designed to provide employees and emergency personnel with standardized information about proper handling procedures, toxicity, health effects, first aid, reactivity, storage, disposal, and protective equipment information about a substance.

An SDS is prepared by the manufacturer of a substance. Each SDS contains these 16 sections:

Section 1: Identification
Section 2: Hazard(s) Identification (e.g., flammable liquid, category as defined in the Hazard Communication Standard (HCS), is any substance, or a mixture of substances)
Section 3: Composition/Information on Ingredients
Section 4: First-Aid Measures
Section 5: Fire-Fighting Measures
Section 6: Accidental Release Measures
Section 7: Handling and Storage
Section 8: Exposure Controls/Personal Protection
Section 9: Physical and Chemical Properties (e.g., vapor pressure, solubility, relative density)
Section 10: Stability and Reactivity
Section 11: Toxicological Information
Section 12: Ecological Information (non-mandatory)
Section 13: Disposal Considerations (non-mandatory)
Section 14: Transport Information (non-mandatory)
Section 15: Regulatory Information (non-mandatory)
Section 16: Other Information (e.g., information on preparation and revision of the SDS)

Copies of SDS Sheets can be obtained from the following sources:

- The manufacturer or distributor from which the chemical was purchased.
- Water Quality Laboratory (WQL) for preservative SDS information.
- An SDS binder in each field office.
- Local Health Department.
- Internet Resources (many have links to additional sites):
    - https://www.osha.gov/
    - ilpi.com/msds/index.html
    - https://ehs.cornell.edu
    - https://www.osha.gov/Publications/OSHA3514.html

Location of Groundwater Section SDS Sheets: The Cheyenne office, each field office, and the WQL have designated locations for SDS information. In the field offices, the information is stored in a binder and labeled. One person in each office is designated to know the location of the binder, update it, and advise anyone handling chemicals as part of Groundwater Section monitoring where the binder is and that they may read it at any time.

Reference OSHA; standard safety and laboratory practices

http://wyomingworkforce.org/businesses/osha/

Revision History

Date	Details of Revision	Revised by:
4/1/2021	Revision of March 2001 version	J. Scott
6/22/2021	Revised to meet Groundwater Section needs	Cherrie Nelson

Quality Control

It is the responsibility of the sampler to obtain, maintain, and use all appropriate safety equipment. Safety training will be provided periodically to all personnel, or they may request such training from the program supervisor or another appropriate person.

Procedure

The personal safety of the sampler and that of any persons who accompany the sampler must be the primary concern at all times and in all sampling situations. In any marginal or questionable situation, samplers are required to assume worst-case conditions and use safety precautions and equipment appropriate to that situation. Samplers who encounter conditions that in their best professional judgment, may exceed the protection of their safety equipment or may in any way represent a potential hazard to human health and safety should immediately leave the area and contact their section manager, program supervisor, or their project manager.

Toxic substances can be absorbed through the skin or inhaled into the lungs. Vapors can be adsorbed onto foods. Never have food near samples or sample containers, and always wash hands and arms thoroughly before handling food.

Pathogenic microorganisms may be accidentally ingested or inhaled. The primary dangers associated with microbiological hazards are hand-to-mouth contact, skin, or eye contact. Frequent hand washing, gloves, and not touching nearby surfaces without gloves will control the possibility of contact exposure. Food and drinks should not be consumed or stored near microbiological samples. (Refer to the Standard Operating Procedure (SOP) for ***Escherichia coli* & Total Coliform Bacteria Colilert® - Defined Enzyme Substrate Method**.)

Some property owners may require the use of certain items of safety equipment, and the sampler must comply with all such requests. However, the sampler must use their best professional judgment and add additional safety equipment as the situation requires. In no case is an oil production or processing unit to be sampled unless the sampler is carrying a hydrogen sulfide monitor. Calibration of the hydrogen sulfide monitor is the sampler's responsibility.

Safety equipment may include but is not limited to: safety glasses, laboratory fume hood, hard hat, safety boots, gloves, chemical spill kit, fire extinguisher, cell phone, first aid kit, monitoring equipment, or protective clothing.

Reference — Refer to Policy #20 dated July 7, 2014, for the full Departmental policy on Safety Equipment. Refer to Groundwater Section Safety Policy dated August 16, 2013

Revision History

Date	Details of Revision	Revised by:
4/1/2021	Revision of November 2011 version	J. Scott/ J. ZumBerge
6/22/2021	Revised to meet Groundwater Section needs	Cherrie Nelson

SAMPLE LABELING
(EFFECTIVE DATE: MAY 2016)

Quality Control

Samplers follow the standard operating procedure (SOP). Each sample or blank sent to the laboratory must be labeled on the container in a permanent, waterproof marking pen (such as a Sharpie™), which can withstand long-term exposure to water. This identification must cross-reference to the Chain of Custody form and the sampler's Field Log book/Data Sheet.

Procedure

Sample Labeling: In general, sample labels should include the following information: Sampler's initials, analyses, preservatives, sample collection date and time, and unique sample ID. Information on the label should match the information in the **Field Log Book**.

Unique Sample ID number: In general, the unique sample ID number should include:

Collection Date – standard calendar date in YYYYMMDD
Dash –
Collection Time – 24-hour Clock

For example, a sample collected on June 9, 2021, at 10:35 am will have the unique sample ID number **20210609-1035**.

Reference

United States Environmental Protection Agency, 40 CFR Part 136.7 Quality Assurances and Quality Control, e-CFR data current as of January 4, 2021

Revision History

Date	Details of Revision	Revised by:
5/1/2016	Revision of March 2001 version	C. Norris
6/22/2021	Cherrie Nelson revised to meet Groundwater Section needs	Cherrie Nelson

SAMPLING EQUIPMENT DECONTAMINATION
(EFFECTIVE DATE: JUNE 2021)

Quality Control

Each non-disposable (not for single-use) piece of equipment used in conjunction with WDEQ sampling activities shall be decontaminated as per the manufacturer's recommendations.

Procedure

For items that have no manufacturer's recommendations, one or more of the following procedures shall be used:

- The equipment may be wiped clean if the contamination is on a surface that does not contact sample material (e.g., on equipment housing or casing) and the contamination is minimal.
- The equipment may be water-rinsed using distilled water if the contamination is minimal and a small area of the equipment (e.g., a glass or metal probe) is the only part of the equipment that contacted the sample.
- The equipment may be washed with a non-depositing detergent (e.g., "Simple Green™" or "Alkanox™") and water, followed by a tap water rinse and then a distilled water rinse.

Although not expected to occur, if a re-usable piece of equipment becomes heavily contaminated or contaminated with a substance that cannot be removed by using one of the three (3) methods listed above, WDEQ personnel shall contact the manufacturer of the equipment or a person familiar with heavy contamination equipment rehabilitation for recommendations on how to clean the equipment.

References: None, internal procedure

Revision History:

Date	Details of Revision	Revised by:
6/22/2021	Added SOP	Cherrie Nelson

WASTE DISPOSAL
(EFFECTIVE DATE: APRIL 2021)

Quality Control

Solid and liquid wastes generated by Groundwater Section field sampling activities are properly disposed of.

Procedure

Unless waste liquid is known and documented to be non-hazardous, it may not be disposed of at the sampling site or poured down any private or municipal drain. Solid waste products (e.g., disposable gloves, sample containers, etc.) from sampling activities must not be disposed of in private or municipal waste collection facilities unless approved by the program supervisor, the site owner, or another responsible party.

Samplers are required to have a sufficient quantity of appropriate waste disposal and storage containers on each trip and to use them.

Total Coliform & *Escherichia coli (E. coli)* Waste Materials: Total coliform and *E. coli* contaminated wastes must be decontaminated before disposal. Bathing the materials in a 10% solution of bleach for a brief period (1/2 hour) will disinfect them. Alternately, the materials may be placed in the sun or under a strong Ultraviolet (UV) source for 4 hours or more before disposal.

Ambient Monitoring: Water coming out of a hydrant or spigot can be disposed of at the direction of the landowner. If the landowner is not present, purge water is directed away from the house and other structures.

Sampling and Analysis Plans (SAPs): If field waste becomes hazardous, the project-specific sampling analysis plan (SAP) should contain a section that describes how all wastes (liquid and solid) generated in the field by the project will be properly disposed of, and who will supply the appropriate waste containers.

Reference

United States Environmental Protection Agency; OSHA
https://www.epa.gov/rcra

Revision History

Date	Details of Revision	Revised by:
4/1/2021	Revision of March 2001 version	J. Scott/ J. ZumBerge
6/22/2021	Revised to meet Groundwater Section needs	Cherrie Nelson

WELL PURGING
(EFFECTIVE DATE: JUNE 2021)

Scope

Water that stands within a monitoring well for a long period may become unrepresentative of formation water, as a chemical or biochemical change may alter water quality or the formation water quality may change over time (see Guide D 6452). Even if it is unchanged from the time it entered the well, the stagnant water may not be representative of formation water at the time of sampling. Wells can be purged of stagnant water using two different procedures: 1. Purge by Volume and; 2. Purge by Stability of Field Parameters.

Procedure

Purge by Volume

The minimum purge volume required is three casing volumes. One casing volume is defined to consist of the entire water column within the casing plus the water within the screened interval, extending from the water surface to the bottom of the well. The volume of the filter pack is not considered part of the casing volume but is part of the total well volume.

Depth to water (DTW) is measured before purging to allow calculation of one casing volume. The total well depth (TWD) should be known from well construction diagrams. To avoid disturbing the water column and increasing turbidity, TWD should not be measured before sampling, but may be measured before purging. However, TWD should be verified by measuring after sampling is complete, and if the screen is silted up, redevelopment may be appropriate. The equations to calculate one casing volume in gallons are as follows:

(TWD – DTW) = HWC (ft) HWC = height of water column in the well

R = casing radius (in) $\pi = 3.1416$

1 casing volume (gal) = HWC (ft) x π x 0.052

Or use the following:

1 casing volume (gal) = HWC x conversion factor (below)

(TWD – DTW) = HWC (ft) HWC = height of water column in the well

R = casing radius (in) $\pi = 3.1416$

1 casing volume (gal) = HWC (ft) x π x 0.052

Or use the following:

1 casing volume (gal) = HWC x conversion factor (below)

Casing Diameter (in)	Conversion to gallons
¾	0.023
1	0.04
1½	0.09
2	0.16
3	0.37
4	0.67
6	1.47

Purge by Stability of Field Parameters

A minimum of six (6) parameter measurements shall be collected. If field parameters have not stabilized between the last three readings, purging and parameter measurement shall continue until stabilization has been achieved. Stabilization can be demonstrated by a variance of no more than +/- 10% for temperature, turbidity (if >10 NTU), dissolved oxygen (if > 0.5 mg/L), and specific conductance; +/- 10 mV for oxidation reduction potential; and +/-0.2 standard units for pH over two successive measurements made 3 minutes apart.

To measure the purge rate of the well, a 5-gallon bucket and a timer capable of measuring time to seconds should be used. Flow rate is estimated by recording the time it takes to fill a 5-gallon bucket, and converting it to gallons per minute (GPM) reading.

Parameter	**Measurement Sensitivity**
Temperature	0.1 degrees Celsius or Fahrenheit
Turbidity	0.1 NTU
Dissolved Oxygen	0.01 mg/L
Specific Conductance	1 µS/cm or 0.01 mS/cm
pH	0.1 S.U.
Oxidation-reduction Potential	1 mV

Reporting — Document the method for purging wells, including calculations used if the well is purged by volume, and stability readings must be recorded on the Sampling Form (See **Appendix D**).

References — *Data Quality Objectives Process for Hazardous Waste Site Investigations,* EPA QA/G-4HW, EPA/600/R-00/007, U.S. EPA, January 2000.

Standard Guide for Sampling Ground-Water Monitoring Wells, ASTM D4448-01, November 2001.

Revision History:

Date	Details of Revision	Revised by:
6/22/2021	Added SOP	Cherrie Nelson

PART 2 – SAMPLING: SPECIFIC PARAMETERS

Quality Control

Coliform bacteria water samples are collected and processed following aseptic handling techniques (refer to standard operating procedure (SOP) for **Aseptic Technique**). The use of pre-sterilized sampling supplies is required to provide good quality assurance and uniformity. Field blanks and duplicate samples are required. This SOP applies only to grab sampling. Compositing bacteriological water samples is not allowed. Specific sampling situation instructions are provided below.

- Lab Blanks - (if samples are not sent to a commercial lab for processing) one per incubator batch
- Field Blank – a minimum of 10% of samples
- Duplicates - a minimum of 10% of samples

Containers

Sterile plastic Whirl-Pak® bags (4 oz/120 mL or 18 oz/540 mL capacities) and IDEXX® plastic bottles (100mL) are generally used for sample collection. Properly cleaned glassware that has been sterilized for 15 minutes at 121°C is also acceptable.

Sample Volume

A sample volume sufficient to perform the required tests should be collected, but preferably not less than 100 mL. Ample air space should be provided in the container/bag to facilitate sample mixing by shaking before analysis.

Field Duplicates

Required – At least ten percent (10%) of all samples collected must consist of duplicate samples (e.g., 2 duplicates for 11 to 20 samples, 3 duplicates for 21 to 30 samples, etc.). More duplicate samples may be collected depending on water sample characteristics, sampling conditions, data requirements, and assessment objectives.

Field Blanks

Required – One field blank must be prepared for 10% of all samples collected (e.g., 1 blank for 1 to 10 samples, 2 blanks for 11 to 20 samples, etc.). It is **recommended** to use sterile, non-buffered water for all *E. coli* or total coliform bacteria blanks prepared. If any of the samples collected require a dilution, a field and laboratory blank using sterile, non-buffered water **must** be prepared. The field blank is prepared at the sampling site and the laboratory blank is prepared at the time of analysis.

Dechlorination

A reducing agent must be used for samples presumed to contain residual chlorine or other halogens. Sodium thiosulfate ($Na_2S_2O_3 \bullet 5HOH$) is a satisfactory dechlorinating agent that neutralizes any residual halogen,

preventing bactericidal action during sample transit. Whirl-Pak® bags and IDEXX® containers containing sodium thiosulfate tablets are available.

Preservative

Samples must be placed on wet ice immediately and kept at a temperature <10°C until initiation of processing and incubation. Sample containers cannot be immersed in water (e.g. melted ice water) during transit or storage.

Holding Time

Freshwater samples should be held no longer than 8 hours between the time of collection and incubation of samples. Preferably, samples should be examined as soon as possible after collection to avoid unpredictable changes in the microbial population. Microbial organisms in sewage samples and organically-rich waters are particularly susceptible to rapid increases or die-offs over time. In situations where the 8-hour holding time cannot be met, the use of field laboratory facilities may be required.

Procedure

Note: Compositing of water samples for bacterial analysis is not permitted.

Sample Site Location: Site locations should be determined per the purpose or objective(s) that necessitate sampling.

Number of Samples: The number of samples and the sample site locations for each project should be the minimum number that adequately reflects the effluent or body of water from which they are taken. Both are determined before sampling and are a part of each project's objectives, the Sampling and Analysis Plan (SAP) and the Quality Assurance Project Plan (QAPP).

Aseptic Technique: Follow the SOP for **Aseptic Technique** to avoid sample contamination. The sampler must avoid touching the opening or cap of the sample collection container and must avoid having the sample come in contact with hands or arms when filling a container.

General sample collection procedure using plastic Whirl-Pak® bags:

1. Label bag to ensure proper sample identification.
2. Using the aseptic technique, tear off top of plastic bag at perforation and pull tape tabs outward to open bag. Bag is held by ends of wire closure with both hands to collect a sample.
3. Facing upstream, with both hands holding wire ends, quickly plunge opened bag below water surface. Sample should be collected in one swift motion to prevent loss of thiosulfate tablet (if required). Dip bag into water as far out in front of sampler as possible. Avoid contact with stream bed or bank to prevent fouling water. In streams with slow currents, sampler may have to wait for suspended sediment disturbed from channel bottom to clear from sampling location.

4. If water level in bag is above fill line, dispense water from bag until appropriate sample volume is contained. An ample amount of airspace is needed to facilitate mixing by shaking once bag is closed.
5. Pull wire ends to close bag. Holding wire ends firmly with both hands, whirl or spin bag three (3) revolutions to seal bag. Ensure airspace is available for mixing in lab. Bend ends of wire closure inward and opposite of bag fold. Twist wire ends together to secure.
6. Immediately pack sample carefully on wet ice.

If the sodium thiosulfate tablet is washed out or if surface debris or streambed sediment is collected, discard the sample and re-collect with a new bag.

General sample collection procedure using plastic IDEXX® bottles:

1. Label bottle to ensure proper sample identification.
2. Using the aseptic technique, remove the plastic protective wrap from the bottle. Remove cap from plastic bottle. Do not touch the inside of the cap or the opening of the bottle.
3. Facing upstream, quickly plunge open bottle below water surface. Sample should be collected in one swift motion to prevent loss of thiosulfate (if required). Dip bottle into water as far out in front of sampler as possible. Avoid contact with stream bed or bank to prevent fouling water. In streams with slow currents, sampler may have to wait for suspended sediment disturbed from channel bottom to clear from sampling location.
4. If water level in the bottle is above fill line, dispense water from bottle until appropriate sample volume is contained. An ample amount of airspace is needed to facilitate mixing by shaking once bottle is closed.
5. Immediately pack sample carefully on wet ice.

If the sodium thiosulfate is washed out or if surface debris or streambed sediment is collected, discard the sample and re-collect with a new bottle.

Surface Water: If extensive water sampling is conducted for stream studies to determine the source and extent of pollution, use a consistent sampling technique for the entire study which is appropriate to the sampling site, method and time. Collect samples that are representative of the water being examined. In assessing wastewater dispersion in receiving waters, conduct sampling at locations where mixing is determined complete. Preliminary cross-section studies may be required to identify locations of complete mixing. Avoid collecting surface debris or organic matter with the water sample or walking in the stream channel before sample collection. Bacteria may concentrate on floating material and resuspended bottom sediment, which is not representative of undisturbed, subsurface water conditions. Grab samples collected from flowing waters (streams and rivers) should be collected from well-mixed sections of the channel below the water surface. When collecting surface water

samples using capped containers (glass or plastic bottles), hold the bottle near its base and plunge the bottle mouth down into the water to avoid introducing surface scum. Direct the bottle mouth toward the current and tip the bottle until the neck is directed slightly upwards to allow air to escape and water to enter. In static waters with no current, push bottle forward in a horizontal direction away from sampler. Avoid contact with stream bed or bank to prevent fouling water. Tightly cap and label the container.

Potable Water: If the sample is taken from a distribution system directly from a tap, choose a tap that is supplied directly from the main. Open tap fully and let it run for three minutes. Then reduce flow to prevent splashing when the sample container is filled. Samples must not be collected from spigots that leak around their stems, or that contain aeration devices or screens unless the device(s) can be removed before the sample is collected.

Wells: Pump for five minutes or three casing volumes before collecting a sample.

Raw Water Supply: If the water sample is taken directly from a river, stream, lake, reservoir, spring, or shallow well, obtain samples representative of the source. Non-representative samples include those taken too near the bank, too far from the point of draw-off, or at a depth above or below the point of draw-off.

Natural Bathing Beaches**:** Collect samples of bathing beach water at locations and time(s) of greatest bather load, and in natural bathing places. In areas of greatest bather load, collect samples from a uniform depth of approximately 0.3 to 1 meter. Consider collecting sediment samples at the water-beach (soil) interface where exposure of young children occurs.

Record Keeping: Record the sample site location, waterbody name, date and time sample was collected, names of samplers, weather conditions, any problems with equipment, any modifications made to the SAP or SOPs, and other relevant measurements, information and observations which could influence sample results. All documentation should be recorded in field log books or field data sheets and archived accordingly (See SOP for **Data Archiving**).

Safety Precaution

The analyst's personal safety and that of any accompanying personnel must be of primary concern at all times and situations. In any marginal or questionable situation, analysts are required to assume worst-case conditions.

Although coliforms are not usually pathogenic themselves, their presence is an indicator of potentially pathogenic bacterial contamination. Sampling in locations of known or suspected high coliform concentrations requires the use of gloves and safety glasses. Hands and lower arms must be washed thoroughly

with a germicidal soap after sampling. Refer to the SOP for **Waste Disposal, Field** for waste material disposal instructions.

Reference

American Public Health Association (APHA), American Water Works Association, Water Environment Federation, 1998, Standard methods for the examination of water and wastewater, 20th ed., Eaton, A.D., L.S. Clesceri and A.E. Greenburg, eds., Washington, DC: APHA.

Biskie, H. A. et. al., Fate of organisms from manure point loading into a rangeland stream, 1988, ASAE Paper No 88-2081, St. Joseph, MI 49805.

Bordner R., Winter J. and Scarpino P., 1978, Microbiological methods for monitoring the environment: water and wastes, Environmental Monitoring and Support Laboratory, Office of Research and Development, U.S. Environmental Protection Agency (USEPA), Cincinnati, OH, EPA-600/8-78/017.

Gerba, C.P., and McLeod, Effect of sediments on the survival of *Escherichia coli* in marine waters, Applied Environmental Microbiology 32, 1976, p. 114-120.

Moore, J. A. et. al., Impact of water location on the bacterial quality of rangeland streams, 1990, Cooperative State Research Service Report 90-38300-5311, Oregon State University, Corvallis, OR.

Sherer, B. M. et. al, Indicator bacterial survival in stream sediments, Journal of Environmental Quality 21(4), 1992, p. 591-595.

United States Environmental Protection Agency, 40 CFR Part 136.3 Table II – Required Containers, Preservation Techniques, and Holding Times, e-CFR data current as of January 4, 2021

Revision History

Date	Details of Revision	Revised by:
11/4/2016	Revision to blank and duplicate requirements, and other minor corrections to February 2015 version	C. Norris
4/1/2021	Revision to March 2017 version	J. Scott
6/22/2021	Cherrie Nelson revised to meet Groundwater Section needs	Cherrie Nelson

CHLORINE, TOTAL RESIDUAL
(EFFECTIVE DATE: APRIL 2021)

Quality Control	This is a colorimetric test. There are limitations to an individual's ability to use visual comparators. Color blindness is a definite problem with visual color comparison methods. Most manufacturers formulate their color standards using natural daylight. Incandescent, fluorescent, and direct sunlight are unacceptable and may produce errors. Certain shades of yellow and blue are extremely difficult to discern. With the aid of electronic meters that pass light through a photodiode, the results can be displayed on a meter that eliminates the need for visual interpretation, concerns about lighting, and results in more accurate and precise test results.
Container	Clean, sealed, disposable, polyethylene with locking screw cap bottles should be used for sample collection.
Sample Volume	200 mL
Preservative	None. Must be analyzed on-site.
Holding Time	15 minutes.
Notes	The presence of oxidizing agents, turbidity, or color will interfere with this test. Use Hach 100 spectrophotometer (colorimeter) and N, N-diethyl-p-phenylenediamine (DPD) pellet supplied by the WQL. Follow the instructions supplied with the meter.
Analytical Method	Standard Method 4500-Cl G
Reporting Limit	0.02 mg/L
Reference	American Public Health Association. Standard Methods for the Examination of Water and Wastewater - SM 4500-Cl G-2011, online. Washington, D.C.

Revision History:

Date	Details of Revision	Revised by:
4/1/2021	Revision of September 2004 version	J. Scott
6/22/2021	Revised to meet Groundwater Section needs	Cherrie Nelson

CHROMIUM, HEXAVALENT (CHROMIUM VI)
(EFFECTIVE DATE: APRIL 2021)

Quality Control	This is a colorimetric test. There are limitations to an individual's ability to use visual comparators. Color blindness is a definite problem with visual color comparison methods. Most manufacturers formulate their color standards using natural daylight. Incandescent, fluorescent, and direct sunlight are unacceptable and may produce errors. Certain shades of yellow and blue are extremely difficult to discern. With the aid of electronic meters which pass light through a photodiode, the results can be displayed on a meter which eliminates the need for visual interpretation, concerns about lighting, and results in more accurate and precise test results.
Container	Clean, sealed, disposable, High-Density Polyethylene (HDPE) with locking screw cap bottles should be used for sample collection.
Sample Volume	200 mL
Preservative	The sample should be cooled to ≤ 6 °C immediately after it is collected (Colorimetric Method). Filter sample through a 0.45 µm filter. Use a portion of the sample to rinse the syringe filter unit and filter, then collect the required volume of filtrate. Adjust pH to between 9.3 and 9.7 by adding 1 mL buffer plus 600 µL 5 N NaOH per 100 mL of sample. More NaOH may be required to bring the sample to the proper pH. Cool samples to ≤ 6 °C immediately after preservation (Ion Chromatography Method).
Holding Time	24 hours (Colorimetric Method)/28 days (Ion Chromatography Method)
Procedure	See the applicable Standard Operating Procedure (SOP) (**Groundwater Sampling – Monitoring** or **Groundwater Sampling – Water Supply Wells**) or defer to the Water Quality Laboratory SOP 190.06 *Hexavalent Chromium ($^{+}$6)* for the analytical standard operating procedure.
Analytical Method	Standard Method 3500-Cr B (Colorimetric Method) or Standard Method 3500-Cr C (Ion Chromatography Method)
Reporting Limit	Depends on method; however, 10 µg/L
Reference	American Public Health Association. Standard Methods for the Examination of Water and Wastewater - SM 3500-Cr B-2011, online. Washington, D.C.

American Public Health Association. Standard Methods for the Examination of Water and Wastewater - SM 3500-Cr C-2011, online. Washington, D.C.

Revision History

Date	Details of Revision	Revised by:
4/1/2021	Revision of April 2016 version	J. Scott
6/22/2021	Cherrie Nelson revised to meet Groundwater Section needs	Cherrie Nelson

Quality Control

Samplers are responsible for following the calibration, decontamination, and meter use instructions in the user manual. The sampler will adhere to standard operating procedures (SOPs) for **Duplicate Samples**.

Calibration: Meters are calibrated at least weekly by samplers. A continuing calibration verification (CCV) check is required once per day typically with 1413 µs/cm or equivalent standard. An acceptable field check is a reading that is ± 10% of the standard. A calibration log is required (refer to the SOP for **Instrument Calibration and Calibration Logs**).

Calibration Standard**:** Accuracy is specific to each manufacturer and is stated in the product literature or on the bottle. A potassium chloride (KCl) standard that has an expiration date on the label and conductivity of ≈ 1413 µs/cm at 25°C (the exact conductivity for the solution is stated on the label) is commercially purchased at the beginning of each field season and as needed during the season. **Do not reuse calibration standards.**

Meter Accuracy and Sensitivity: Accuracy and sensitivity are instrument-specific and stated in the instrument instruction manual. Meter age, time in use, and maintenance may all affect accuracy.

Temperature Compensation**:** Meters used for monitoring have temperature compensation built into the probe. Temperature is read directly from the sample. Specific conductance varies with temperature; therefore, values are corrected to 25°C. In a dilute solution, a 1°C temperature increase will increase the specific conductance by about 2 percent.

Correlating Data to the Instrument: Samplers record the make, model, serial number, and state ID tag number of the meter in their field log books and calibration logs (refer to SOPs for **Field Log Books** and **Instrument Calibration and Calibration Logs**) so data can be traced back to a specific instrument, calibration log, and maintenance history. Field log books and a calibration and maintenance log are required.

Instrument Decontamination: The electrode is rinsed three times with deionized water after each measurement is taken. Additional field cleaning may be done according to the instructions supplied with the instrument.

Container	Typically measured in the field. If the sample is taken to the laboratory, a sealed, clean, disposable High-Density Polyethylene (HDPE) plastic container with a locking cap should be used for sample collection.
Sample Volume	Typically measured in the field. If the sample is taken to the WQL, a minimum of 200 mL is required.
Preservative	Typically measured in the field. If the sample is taken to the WQL, cool to ≤ 6°C.
Holding Time	Typically measured in the field. If the sample is taken to the WQL, there is a 28-day holding time.
Procedure	See the applicable SOP (**Groundwater Sampling – Monitoring** or **Groundwater Sampling – Water Supply Wells**) or defer to the Water Quality Division Laboratory SOP 170.05 *Conductivity* for the analytical standard operating procedure.
Analytical Method	Standard Method 2510 B.
Reporting Limit	± 0.10 µS/cm, if the sample is taken to the WQL, the reporting limit is 10.0 µS/cm.
Reference	American Public Health Association. Standard Methods for the Examination of Water and Wastewater - SM 2510-B-2011. Washington, D.C.

Revision History

Date	Details of Revision	Revised by:
4/1/2021	Revision of September 2004 version	J. Scott/ J. ZumBerge
6/22/2021	Cherrie Nelson revised to meet Groundwater Section needs	Cherrie Nelson

DISSOLVED OXYGEN (DO)
(EFFECTIVE DATE: APRIL 2021)

Quality Control	If a Dissolved Oxygen (DO) probe is used, the calibration method is critical especially if the samples vary in Total Dissolved Solids (TDS), salts, organic matter, and oxidizing/reducing compounds. Probes must be carefully cleaned and maintained. Samplers must know and document the altitude at which the meter is being used. The meter measures the temperature and calibrates automatically based on the altitude. The field check is required daily. Readings are generally ±10% and are instrument specific.
Calibration	Calibrate optical sensors at least once per week or for every 500-ft change in elevation. A CCV is performed once daily using air-saturated water.
Container	None. Must be measured on-site.
Sample Volume	N/A (not applicable).
Preservative	None. Must be measured on-site.
Holding Time	15 minutes.
Procedure	Temperature and dissolved oxygen are inversely related. As temperature rises, the dissolved oxygen concentration decreases. Temperature compensation is required if the analysis is not immediate. Temperature compensation instructions are specific to the instrument and type of membrane and are provided with the meter. In general, membrane probes have a temperature coefficient of 4 to 6 percent per degree C. There are several possible interferences to the dissolved oxygen analysis, including organic matter, nitrate ion, ferrous iron, salts, chlorine, and other oxidizing and reducing agents. The DO probe method (United States Environmental Protection Agency [USEPA] Method 360.1 or Standard Methods 4500-O) is recommended for monitoring streams, lakes, outfalls, etc., where a continuous dissolved oxygen content record is needed. For precision performance of a DO meter, water turbulence should be constant. DO probes measure the partial pressure of oxygen dissolved in the water as a function of its percent saturation. Temperature and dissolved solids affect the saturation concentration. Some probes are temperature compensated, and some have a compensation

adjustment for salinity (a form of TDS). Dissolved organic matter is not known to interfere with measurements using DO probes, however, dissolved inorganic salts will affect performance and reactive compounds can also interfere. Conversion factors for specific inorganic salts may be developed experimentally.

Analytical Method

American Society for Testing and Materials (ASTM D) 885-05 (optical); Standard Method 4500-O G and EPA 360.1(membrane).

Reporting Limit Depends on DO probe/instrument used. Typically, 0.01 mg/L.

Reference American Public Health Association. Standard Methods for the Examination of Water and Wastewater - SM 4500-O G-2011, online. Washington, D.C.

Revision History

Date	Details of Revision	Revised by:
4/1/2021	Revision of September 2004 version	J. Scott/J. ZumBerge
6/22/2021	Cherrie Nelson revised to meet Groundwater Section needs	Cherrie Nelson

Quality Control	Sampler follows the standard operating procedure (SOP).

Blanks: A minimum of one laboratory blank must be prepared for each sample batch. A batch is defined as an analysis in which all of the samples collected undergo the same testing process and are incubated at the same time or sequentially. Additional laboratory blanks may be made at the discretion of the analyst (e.g., before sample analysis or every tenth sample analyzed). The purpose of a laboratory blank is to establish that no contaminants are introduced into a sample during the analytical process.

A minimum of one field blank must be prepared for 10% of the total *Escherichia coli* (*E. coli*) and total coliform bacteria samples collected in a field season.

It is **recommended** to use sterile, non-buffered water for all *E. coli* and total coliform bacteria blanks prepared. If any of the samples collected require a dilution, a field and laboratory blank using sterile, non-buffered water **must** be prepared.

Duplicates: A minimum of 10% of the *E. coli* and total coliform bacteria samples collected in a field season must have duplicates collected as well. More duplicate samples may be analyzed depending on water sample characteristics, sampling conditions, data requirements, and assessment objectives.

Colilert® Medium Validation: For targeted *E. coli* studies, each lot of medium used should be verified by testing with known positive and negative control cultures for both Total Coliform and *E. coli*. Validation of the media for sterility and effectiveness before use is significant for credibility purposes. If positive or negative controls produce incorrect results then the media should be retested. If the results are still incorrect then the lot of media should be discarded.

Incubation Temperature: 35°C ± 0.5°C. For this method, temperature is used to distinguish *E. coli*; therefore, checking and maintaining incubator temperature is critical. If the temperature is not maintained for the entire test time, the test results are not valid and must be reported as "not valid" including the reason described in the *Remarks* section of the Analysis Log Form.

Incubation time	26 hours ± 2 hours (results definitive after 24 hours)

Holding Times

Fresh water samples should be held no longer than 8 hours between the time of collection and incubation of samples. All processed samples should be placed into the incubator within 30 minutes after the medium is added to the sample.

Equipment

- Incubator- equipped with a thermometer, graduated in increments of 0.5°C, or temperature-recording instrument (Includes incubators with thermostat controls)
- Ultraviolet (UV) Lamp- long-wavelength (365-nm) UV (6-watt bulb)
- Quanti-Tray® Sealer and Rubber Inserts- for sealing multi-well trays

Pre-packaged, sterilized supplies and reagents:

- Sterile 120 mL IDEXX bottles with or without sodium thiosulfate
- Sterile Whirl-Paks
- Sterile, disposable pipettes (if performing serial dilutions)
- Disposable multi-well trays- Quanti-Tray® or Quanti-Tray®/2000 (IDEXX Catalog No. 98-21675-00)
- Culture medium- Colilert® enzyme substrate in Snap Paks for 100 mL water samples (IDEXX Catalog No. 98-12973-00)
- Colilert Quanti-Tray®/2000 Comparator (IDEXX Catalog No. 98-09227-00)
- Quanti-Cult Verification Kit (IDEXX Catalog No. 98-29000-00)
- Sterile, non-buffered dilution water (if performing serial dilutions)

Other supplies and materials:

- Deionized water
- Non-powdered latex gloves
- Most Probable Number (MPN) Tables- for Quanti-Tray® and Quanti-Tray®/2000
- Analysis Log Forms

Refer to instructions in **Waste Disposal** SOP for handling disposable items and other used materials.

Analytical error

Any events during the analytical process which fall outside the SOP or standard analytical procedures must be reported as "no result" with reasons given in the Remarks section of the Analysis Log Form.

Reporting Limit

Detects total coliform and *E. coli* at 1 organism/100 mL (1 Most Probable Number (MPN)/100 mL).

Precision/Accuracy

The Relative Percent Difference (RPD) between the MPN of duplicate samples should be <50% for MPNs > 100. Due to the increased variability for MPNs <

100, no RPD limit is required for duplicate pairs in which at least one of the MPNs is below 100. Duplicate counts of the number of positive wells identified from a Quanti-Tray® sample for the same analyst should agree within 20%.

Analysis Log Form

Required – A sample form is included with this SOP. Forms are permanently filed with the site information in each field office. Any events during the analytical process which fall outside the SOP or standard analytical procedures presented herein below must be reported as "no result," with a reason given in the Remarks Section of the form.

Containers — Sterile, sample/reagent mixture containers (glass or disposable plastic), and disposable multi-well trays. Quanti-Tray® has 51 wells that provide MPN counts from 1 to 200 MPN/100 mL. Quanti-Tray®/2000 has 97 wells, providing a higher counting range up to 2,419.6 MPN/100 mL.

Sample Volume — 100 mL. Compositing samples is not allowed. For dilutions, **use only** sterile, non-buffered, water.

Safety Precaution — The analyst's personal safety and that of any accompanying personnel must be of primary concern at all times and situations. In any marginal or questionable situation, analysts are required to assume worst-case conditions.

Although coliforms are not usually pathogenic themselves, their presence is an indicator of potentially pathogenic bacterial contamination. Testing samples from locations of known or suspected high coliform concentrations requires the use of gloves and safety glasses. Hands and lower arms should be washed thoroughly with a germicidal detergent after preparing and handling samples. Viable cultures should not be washed into the sink or placed in trash receptacles. Refer to the SOP for **Waste Disposal**.

Procedure — Colilert® Medium Validation Procedure**:**

1. Remove organism vials from freezer and allow them to equilibrate to room temperature for 10-15 minutes.
2. Open each vial and aseptically transfer each colored organism disc to a sterile 120 mL IDEXX bottle containing 100 mL of sterile, non-buffered water.
3. Swirl the sample and allow it to stand for 10 – 15 minutes. After the disc dissolves completely, gently invert the sample 10 times.
4. Pour sample mixture into Quanti-Tray®/2000 and seal in Quanti-Tray® Sealer using appropriate rubber insert.
5. Incubate sealed tray at 35°C ± 0.5°C for 26 ± 2 hours.
6. Read and record results according to the Control Culture Interpretation Table below. Count the number of positive wells and refer to lot

activity information on the certificate of analysis to determine enumeration values.

Control Culture Interpretation:

Bacteria:	**Expected Results:**
Escherichia coli	Yellow, fluorescent
Klebsiella variicola	Yellow, no fluorescent
Pseudomonas aeruginosa	Clear, no fluorescent

Presence-Absence Procedure:

1. Aseptically add contents of Colilert® reagent to 100 mL of sample, or sample aliquot diluted to 100 mL, in a sterile, transparent, non-fluorescing container.
2. Cap container and shake until powder is dissolved.
3. Incubate at 35°C ± 0.5°C for 26 ± 2 hours.
4. Read and record results according to the Result Interpretation Table below.

Quanti-Tray® Enumeration Procedure:

1. Aseptically add contents of Colilert® reagent to 100 mL of sample, or sample aliquot diluted to 100 mL, in a sterile, transparent, non-fluorescing container.
2. Cap and shake container until powder is dissolved.
3. Pour sample/reagent mixture into Quanti-Tray® or Quanti-Tray®/2000 and seal in Quanti-Tray® Sealer using appropriate rubber insert. Note: Ensure reagent is completely dissolved in sample before pouring into tray. If samples are cold, this may take 2 – 3 minutes.
4. Incubate sealed tray at 35°C ± 0.5°C for 26 ± 2 hours.
5. Read and record results according to the Result Interpretation Table below. Count the number of positive wells and refer to the appropriate MPN table to obtain a Most Probable Number (MPN/100 mL).

Result Interpretation:

Appearance	**Result**
Less yellow than the comparator and no fluorescence	Negative for total coliforms and *E. coli*
Yellow is equal to or greater than the comparator	Positive for total coliforms
Yellow is equal to or greater than the comparator and fluorescence is equal to or greater than the comparator	Positive for *E. coli*

To check fluorescence, illuminate sample container or tray with 6-watt, 366 nm, UV light within 5 inches of sample, in a dark environment. Face light towards sample and away from eyes.

Sample Dilution

The ideal sample volume, or aliquot, of non-potable water or wastewater required to obtain accurate coliform bacteria estimates is primarily governed by bacterial density in the source water. Where coliform densities are suspected to be high, sample dilutions may be cultured to obtain more accurate estimates. Serial dilutions of the sample may be required for highly contaminated waters. When testing sample volumes of 1 mL or less, the samples should be prepared from a serial dilution process. The dilution factor needed to obtain accurate estimates depends on the sampler's best professional judgment and knowledge of the source water and sample location.

General Dilution Technique:

1. Shake sample collection container vigorously for 10 seconds to mix sample.
2. Using a pre-sterilized pipette, transfer the required amount of sample into a bottle containing the desired volume of sterile dilution water needed to obtain the dilution factor.
3. Recap the dilution water bottle and shake vigorously for 10 seconds to mix.

Dilution Series Preparation for Colilert® Samples:

A. If a 1:10 sample dilution is required:
Transfer 11 mL aliquot of sample into 99 mL of sterile dilution water. Mix 100 mL of this dilution with Colilert® reagent. The resulting MPN value for the sample is multiplied by 10 to obtain the final bacteria density estimate.

B. If a 1:100 sample dilution is required:
Transfer 11 mL of the diluted sample prepared in *step A* into 99 mL of sterile dilution water. Mix 100 mL of this dilution with Colilert® reagent. The resulting MPN value for the sample is multiplied by 100 to obtain the final bacteria density estimate.

C. If a 1:1,000 sample dilution is required:
Transfer 11 mL of the diluted sample prepared in *step B* into 99 mL of sterile dilution water. Mix 100 mL of this dilution with Colilert® reagent. The resulting MPN value for the sample is multiplied by 1,000 to obtain the final bacteria density estimate.

D. If a 1:10,000 sample dilution is required:
Transfer 11 mL of the diluted sample prepared in *step C* into 99 mL of sterile dilution water. Mix 100 mL of this dilution with Colilert® reagent. The resulting MPN value for the sample is multiplied by 10,000 to obtain the final bacteria density estimate.

E. If a 1:100,000 sample dilution is required:
Transfer 11 mL of the diluted sample prepared in *step D* into 99 mL of sterile dilution water. Mix 100 mL of this dilution with Colilert® reagent.

The resulting MPN value for the sample is multiplied by 100,000 to obtain the final bacteria density estimate.

Reporting — Results are documented as MPN values per 100 mL of sample on the Analysis Log Form.

Reference — American Public Health Association (APHA), American Water Works Association, Water Environment Federation, 1998, Standard methods for the examination of water and wastewater, 20th ed., Eaton, A.D., L.S. Clesceri and A.E. Greenburg, eds., Washington, DC: APHA.
IDEXX Laboratories, Inc., Colilert Test Kit, 2002, One IDEXX Drive, Westbrook, Maine 04092, www.idex.com.

Enzyme Substrate Coliform Test (MPN procedure); Colilert® Test, IDEXX Laboratories, Inc. Bordner R., Winter J. and Scarpino P., 1978, Microbiological methods for monitoring the environment: water and wastes, Environmental Monitoring and Support Laboratory, Office of Research and Development, U.S. Environmental Protection Agency (USEPA), Cincinnati, OH, EPA-600/8-78/017.

United States Environmental Protection Agency, 40 CFR Part 136.3 Table II – Required Containers, Preservation Techniques, and Holding Times, e-CFR data current as of January 4, 2021

Revision History

Date	Details of Revision	Revised by:
11/8/2016	Revisions to February 2015 version	C. Norris
4/1/2021	Revision to March 2017 version	J. Scott
6/22/2021	Cherrie Nelson revised to meet Groundwater Section needs	Cherrie Nelson

State of Wyoming

Department of Environmental Quality- Water Quality Division

Total Coliform and *Escherichia coli* Analysis Log (Colilert®-Defined Enzyme Substrate Method using Quanti-Tray/2000)

Incubator Brand/Model and Serial No:	**Field Sampler:**	**Incubator Temp (°C) In:** **Out:**
	Analyzed By:	**Analysis Date (m/d/y):**

Site Name/Location (GPS, Narrative) **Analysis Information (blanks, duplicates, splits)**	**Sample Collection Date (m/d/y)**	**Sample Collection Time (24 hour)**	**Sample Volume (mL)**	**Colilert® Reagent Addition Time (24 hour)**	**In Incubator**		**Out Incubator**		**26 ±2-hour Incubation (Y/N)**	**# Positive Wells**				**MPN/100 mL (Refer to MPN Table)**	
										Total Coliform (Yellow)		***E. coli* (Fluorescence)**			
					Date (m/d/y)	**Time (24 hour)**	**Date (m/d/y)**	**Time (24 hour)**		**# Large Wells**	**# Small Wells**	**# Large Wells**	**# Small Wells**	**Total Coliform**	***E. coli***
Remarks and Analytical Notes:															

Quality Control	Samplers follow Standard Operating Procedure (SOP). Blanks - minimum of 10% of samples Duplicates - minimum of 10% of samples
Container	Amber glass with Teflon™ lined caps; no plastic. As with most organic sampling, the sampler must prevent the sample from contacting any plastics. The phthalate esters in plastics may contaminate the sample. In situations where a Teflon™ lined cap is not available, methanol or isopropanol rinsed aluminum foil may be used as a liner. However, highly acidic or basic samples may react with aluminum causing eventual contamination of the sample.
Sample Volume	1000 mL sample volume (or the receiving contract laboratory sample volume requirement) for herbicides or pesticides.
Preservative	Cool to 4 - 6°C immediately and maintain at that temperature.
Holding Time	For most pesticides and herbicides a 14-day holding time to sample extraction is required (Organochlorine Pesticides and Chlorinated Herbicides have a 7-day holding time to sample extraction), contact the Water Quality Laboratory (WQL)or commercial laboratory supervisor for specific information.
Notes	Sample containers should be filled with care to prevent any portion of the collected sample from coming in contact with the sampler's gloves as gloves will cause contamination. Samples should not be collected or stored in the presence of exhaust fumes. If the sample comes in contact with a sampling device (e.g. if an automatic sampler is used), run dilution water through the device and use the water as a field blank (Refer to SOP for **Blank Samples**).
Analytical Method	The WQL has not finalized the methodology for this class of compounds. In the interim, samples will be sent to outside laboratories for analysis.

CFR Title 40 – Chapter 1 – Subchapter D – Part 136 – Section 3

Table IG—Test Methods for Pesticide Active Ingredients (40 CFR Part 455)

EPA survey code	Pesticide name	CAS No.	EPA analytical method No.(s)[3]
8	Triadimefon	43121-43-3	507/633/525.1/525.2/1656
12	Dichlorvos	62-73-7	1657/507/622/525.1/525.2
16	2,4-D; 2,4-D Salts and Esters [2,4-Dichloro-phenoxyacetic acid]	94-75-7	1658/515.1/615/515.2/555
17	2,4-DB; 2,4-DB Salts and Esters [2,4-Dichlorophenoxybutyric acid]	94-82-6	1658/515.1/615/515.2/555
22	Mevinphos	7786-34-7	1657/507/622/525.1/525.2
25	Cyanazine	21725-46-2	629/507
26	Propachlor	1918-16-7	1656/508/608.1/525.1/525.2
27	MCPA; MCPA Salts and Esters [2-Methyl-4-chlorophenoxyacetic acid]	94-74-6	1658/615/555
30	Dichlorprop; Dichlorprop Salts and Esters [2-(2,4-Dichlorophenoxy) propionic acid]	120-36-5	1658/515.1/615/515.2/555
31	MCPP; MCPP Salts and Esters [2-(2-Methyl-4-chlorophenoxy) propionic acid]	93-65-2	1658/615/555
35	TCMTB [2-(Thiocyanomethylthio) benzo-thiazole]	21564-17-0	637
39	Pronamide	23950-58-5	525.1/525.2/507/633.1
41	Propanil	709-98-8	632.1/1656
45	Metribuzin	21087-64-9	507/633/525.1/525.2/1656
52	Acephate	30560-19-1	1656/1657
53	Acifluorfen	50594-66-6	515.1/515.2/555
54	Alachlor	15972-60-8	505/507/645/525.1/525.2/1656
55	Aldicarb	116-06-3	531.1

EPA survey code	Pesticide name	CAS No.	EPA analytical method No.(s)[3]
58	Ametryn	834-12-8	507/619/525.2
60	Atrazine	1912-24-9	505/507/619/525.1/525.2/1656
62	Benomyl	17804-35-2	631
68	Bromacil; Bromacil Salts and Esters	314-40-9	507/633/525.1/525.2/1656
69	Bromoxynil	1689-84-5	1625/1661
69	Bromoxynil octanoate	1689-99-2	1656
70	Butachlor	23184-66-9	507/645/525.1/525.2/1656
73	Captafol	2425-06-1	1656
75	Carbaryl [Sevin]	63-25-2	531.1/632/553
76	Carbofuran	1563-66-2	531.1/632
80	Chloroneb	2675-77-6	1656/508/608.1/525.1/525.2
82	Chlorothalonil	1897-45-6	508/608.2/525.1/525.2/1656
84	Stirofos	961-11-5	1657/507/622/525.1/525.2
86	Chlorpyrifos	2921-88-2	1657/508/622
90	Fenvalerate	51630-58-1	1660
103	Diazinon	333-41-5	1657/507/614/622/525.2
107	Parathion methyl	298-00-0	1657/614/622
110	DCPA [Dimethyl 2,3,5,6-tetrachloro-terephthalate]	1861-32-1	508/608.2/525.1/525.2/515.1[2]/515.2[2]/1656
112	Dinoseb	88-85-7	1658/515.1/615/515.2/555
113	Dioxathion	78-34-2	1657/614.1
118	Nabonate [Disodium cyanodithio-imidocarbonate]	138-93-2	630.1
119	Diuron	330-54-1	632/553
123	Endothall	145-73-3	548/548.1
124	Endrin	72-20-8	1656/505/508/608/617/525.1/525.2
125	Ethalfluralin	55283-68-6	1656/627 See footnote 1
126	Ethion	563-12-2	1657/614/614.1

EPA survey code	Pesticide name	CAS No.	EPA analytical method No.(s)[3]
127	Ethoprop	13194-48-4	1657/507/622/525.1/525.2
132	Fenarimol	60168-88-9	507/633.1/525.1/525.2/1656
133	Fenthion	55-38-9	1657/622
138	Glyphosate [N-(Phosphonomethyl) glycine]	1071-83-6	547
140	Heptachlor	76-44-8	1656/505/508/608/617/525.1/525.2
144	Isopropalin	33820-53-0	1656/627
148	Linuron	330-55-2	553/632
150	Malathion	121-75-5	1657/614
154	Methamidophos	10265-92-6	1657
156	Methomyl	16752-77-5	531.1/632
158	Methoxychlor	72-43-5	1656/505/508/608.2/617/525.1/525.2
172	Nabam	142-59-6	630/630.1
173	Naled	300-76-5	1657/622
175	Norflurazon	27314-13-2	507/645/525.1/525.2/1656
178	Benfluralin	1861-40-1	1656/627 See footnote 1
182	Fensulfothion	115-90-2	1657/622
183	Disulfoton	298-04-4	1657/507/614/622/525.2
185	Phosmet	732-11-6	1657/622.1
186	Azinphos Methyl	86-50-0	1657/614/622
192	Organo-tin pesticides	12379-54-3	Ind-01/200.7/200.9
197	Bolstar	35400-43-2	1657/622
203	Parathion	56-38-2	1657/614
204	Pendimethalin	40487-42-1	1656
205	Pentachloronitrobenzene	82-68-8	1656/608.1/617
206	Pentachlorophenol	87-86-5	625/1625/515.2/555/515.1/525.1/525.2
208	Permethrin	52645-53-1	608.2/508/525.1/525.2/1656/1660
212	Phorate	298-02-2	1657/622

EPA survey code	Pesticide name	CAS No.	EPA analytical method No.(s)[3]
218	Busan 85 [Potassium dimethyldithiocarbamate]	128-03-0	630/630.1
219	Busan 40 [Potassium N-hydroxymethyl-N-methyldithiocarbamate]	51026-28-9	630/630.1
220	KN Methyl [Potassium N-methyl-dithiocarbamate]	137-41-7	630/630.1
223	Prometon	1610-18-0	507/619/525.2
224	Prometryn	7287-19-6	507/619/525.1/525.2
226	Propazine	139-40-2	507/619/525.1/525.2/1656
230	Pyrethrin I	121-21-1	1660
232	Pyrethrin II	121-29-9	1660
236	DEF [S,S,S-Tributyl phosphorotrithioate]	78-48-8	1657
239	Simazine	122-34-9	505/507/619/525.1/525.2/1656
241	Carbam-S [Sodium dimethyldithio-carbamate]	128-04-1	630/630.1
243	Vapam [Sodium methyldithiocarbamate]	137-42-8	630/630.1
252	Tebuthiuron	34014-18-1	507/525.1/525.2
254	Terbacil	5902-51-2	507/633/525.1/525.2/1656
255	Terbufos	13071-79-9	1657/507/614.1/525.1/525.2
256	Terbuthylazine	5915-41-3	619/1656
257	Terbutryn	886-50-0	507/619/525.1/525.2
259	Dazomet	533-74-4	630/630.1/1659
262	Toxaphene	8001-35-2	1656/505/508/608/617/525.1/525.2
263	Merphos [Tributyl phosphorotrithioate]	150-50-5	1657/507/525.1/525.2/622
264	Trifluralin[1]	1582-09-8	1656/508/617/627/525.2
268	Ziram [Zinc dimethyldithiocarbamate]	137-30-4	630/630.1

Table 1G notes:
[1]Monitor and report as total Trifluralin.
[2]Applicable to the analysis of DCPA degradates.
[3]EPA Methods 608.1 through 645, 1645 through 1661, and Ind-01 are available in Methods for The Determination of Nonconventional Pesticides in Municipal and Industrial Wastewater, Volume I, EPA 821-R-93-010A, Revision I, August 1993, U.S. EPA. EPA Methods 200.9 and 505 through 555 are available in Methods for The Determination of Nonconventional Pesticides in Municipal and Industrial Wastewater, Volume II, EPA 821-R-93-010B, August 1993, U.S. EPA. The full text of Methods 608, 625, and 1625 are provided in Appendix A of this Part 136. The full text of Method 200.7 is provided in Appendix C of this part 136.
Revised April 2016. Previous version September 2004.

Reference https://www.ecfr.gov/cgi-bin/text-idx?SID=a6bb8a02b6d783f9356758b5ff0ed106&mc=true&node=pt40.25.136&rgn=div5#se40.25.136_13

Revision History

Date	Details of Revision	Revised by:
4/1/2021	Revision of April 2016 version	J. Scott
6/22/2021	Cherrie Nelson revised to meet Groundwater Section needs	Cherrie Nelson

METALS, TOTAL AND DISSOLVED
(INSTRUCTIONS **DO NOT** APPLY TO MERCURY OR CHROMIUM VI)
(**EFFECTIVE DATE:** APRIL 2021)

Quality Control — Samplers follow the Standard Operating Procedure (SOP).

Container — Sealed, clean, disposable High-Density Polyethylene (HDPE) plastic with a locking cap should be used for sample collection

Sample Volume — Generally, 500 mL
Except:
1. if a large number of different metal analyses are needed, 1 L
2. if the sample is particularly contaminated, 1 L

Preservative — Nitric acid (HNO_3) to a pH of $\leq$ 2. Do not over-preserve.

Determine and record the pH of the sample. Note: For dissolved metals analysis, the samples must be filtered as soon as practical after being collected and pH tested.

Acidify the sample. For dissolved metals analysis, acid is added after the sample is filtered (see SOP for **Filtration Procedure for Dissolved Analytes)**. Acid is used as a preservative to prevent bacterial transformation of sample constituents, including metals. For total metals analysis, acid is added to dissolve the metals out of whatever matrix materials are present, as well as to prevent bacterial transformation.

NOTE: Adding too much acid may cause the laboratory to have to discard the sample and could result in no analytical data.

The amount of acid is dependent on the initial pH of the sample and its buffering capacity. The table below is an estimate of the amount of preservative needed by volume to acidify a fairly neutral sample.

Acidification Guideline Table for sample pH <2 (provided by the Water Quality Laboratory)				
Acid Name	250mL sample (8 oz plastic container)	500 mL sample (16 oz plastic container)	1000 mL sample (1L) (32 oz plastic container)	2000 mL sample (2L) 64 oz plastic container)
1:1 Nitric/ mL acid addition:	0.7	1.3	1.7	3.0

For **total metals** analysis, acidify the sample without filtering.

1. Thoroughly rinse the sample container 3 times with a sample, pour out, and refill with a sample.
2. Acid should be added to the bottle after collection. Using the preservative vials provided by the Water Quality Division Laboratory, add the 1:1 nitric acid to the sample. The commonly used guideline is that if the previously measured sample pH was approximately 6 - 8, **1.7 mL of acid for each 1L** of a sample will lower the pH to <2. Refer to the table above.

3. Test the pH of the acidified sample, using pH paper supplied by the WQL or commercial laboratory. **This step is required.** Shake the bottle three to four times to homogenize the sample. The pH must be between 1.5 and 2. If it is above 2, add more 1:1 nitric acid dropwise to the sample, homogenizing the sample after each addition, and re-test until the pH is within the required range. If the pH is below 1.5, re-collect the sample.

Holding Time — 6 months

Procedure — See applicable SOP (**Groundwater Sampling – Monitoring** or **Groundwater Sampling – Water Supply Wells** or defer to the Water Quality Division Laboratory SOP 210.01 *Cations by ICP (SARs)* or SOP 220.01 *Metals by ICP-MS* for the analytical standard operating procedure.

Analytical Method

EPA 200.7 or EPA 200.8

References — United States Environmental Protection Agency, Methods for Chemical Analysis of Water and Wastes, EPA-600/4-79-020, with revisions and amendments; internal acidification guideline from the WQL

United States Environmental Protection Agency, 40 CFR Part 136.3 Identification of Test Procedures, e-CFR data current as of January 4, 2021

Revision History

Date	Details of Revision	Revised by:
4/1/2021	Revision of March 2016 version	J. Scott
6/22/2021	Cherrie Nelson revised to meet Groundwater Section needs	Cherrie Nelson

ORTHOPHOSPHATE
(EFFECTIVE DATE: APRIL 2021)

Quality Control	This is a colorimetric test. Most manufacturers formulate their color standards using natural daylight. Incandescent, fluorescent, and direct sunlight are unacceptable and may produce errors. Certain shades of yellow and blue are extremely difficult to discern. With the aid of electronic meters which pass light through a photodiode, the results can be displayed on a meter which eliminates the need for visual interpretation, concerns about lighting, and results in more accurate and precise test results.
Container	Clean, sealed, disposable, polyethylene with locking screw cap bottles should be used for sample collection
Volume Required	100 mL
Preservative	Filter sample within 15 minutes through a 0.45 µm filter. Cool to ≤ 6°C
Holding Time	48 hours
Procedure	See applicable Standard Operating Procedure (SOP) (**Groundwater Sampling – Monitoring** or **Groundwater Sampling – Water Supply Wells** or defer to the Water Quality Division Laboratory SOP 190.06 *Orthophosphate via Single Reagent, Ascorbic Acid Method* for the analytical standard operating procedure. Filter the sample, using apparatus and filters supplied by WQL. Phosphorus occurs in natural waters and wastewaters almost solely as phosphates. These are classified as orthophosphates, condensed phosphates, and organically bound phosphates. The method for total phosphorus includes a persulfate and sulfuric acid digestion which converts phosphorus forms to orthophosphate. Field samplers should note possible high concentrations of iron and arsenates which could yield low results. These interferences can be dealt with in the lab if detected before analysis. The sample is measured directly as orthophosphate, which will react chemically to form an intensely blue-colored complex after undergoing a series of oxidation-reduction reactions.

Analytical Method

Standard Method 4500-P G or Standard Method 4500-P E

Reporting Limit 10 µg/L

Reference American Public Health Association. Standard Methods for the Examination of Water and Wastewater - SM 4500-P G-2011, online. Washington, D.C.

American Public Health Association. Standard Methods for the Examination of Water and Wastewater - SM 4500-P E-2011, online. Washington, D.C.

Revision History

Date	Details of Revision	Revised by:
4/1/2021	Revision of September 2004 version	J. Scott/ J. ZumBerge
6/22/2021	Cherrie Nelson revised to meet Groundwater Section needs	Cherrie Nelson

PERFLUOROALKYL SUBSTANCES (PFAS)
(EFFECTIVE DATE: APRIL 2021)

Scope	All WDEQ contractor personnel and subcontractors who collect or otherwise handle samples for PFAS analysis should review this SOP before performing any fieldwork and carefully adhere to the procedures set forth herein.
Container	250 mL wide-mouth high-density polyethylene (HDPE) bottles fitted with an unlined (no Teflon®) polypropylene or HDPE screw cap.
Sample Volume	Two (2), 1000 mL amber glass bottles with screw-caps with polytetrafluoroethylene (PTFE)-lined septa per sample location.
Preservative	Trizma buffer
Holding Time	14 days
Considerations	PFAS are analyzed with detection limits that are three orders of magnitude lower than those used for trace elements typical of water samples (e.g., ppt vs. ppb). To put the parts-per-trillion (ppt) scale into context, one part per trillion is about 1 inch in 250 square miles, 1 second in 32,000 years, or 1 ounce in 7.5 billion gallons of water. This requires that field personnel be especially aware of their surroundings and equipment. The Sampling SOP is closely followed to minimize the potential for cross-contamination and analytical false positives. Attachment 1 includes a list of prohibited and acceptable products for PFAS sampling events, and Attachment 2 provides a PFAS sampling checklist.

Sampling Team

1. **Two-person sampling teams are highly recommended.** Distributing the workload to ensure attention to the Sampling SOP is easier with a two-person team. Also, having another team member present will increase awareness of conditions and actions that can adversely affect the quality of the sampling effort. Team members should watch each other's movement and activities where possible and immediately identify if someone is observed not following protocol.

2. **Work distribution for a two-person sample team.** When sampling for PFAS, a two-person team allows one person to be a dedicated "sample" handler and the other person the dedicated "document" handler.
    a. The "**Sample**" team member will:
        i. Maintain an uncompromised and uncontaminated sample area
        ii. Be the only team member to handle/manage/label sample containers until they are filled and capped
        iii. Maintain coolers with ice
        iv. Not handle field log books, forms, or non-essential sampling materials or equipment (e.g., cell phones, clipboards, hand tools, etc.) during the sampling process
        v. Not wear wristwatches, wristband fitness trackers, or bracelets during the sampling process (i.e., nothing around the wrists)
    b. The "**Document**" team member will:
        i. Maintain the sampling and field log books
        ii. Complete required field documentation including the chain-of-custody (COC) form, field log, and sample shipping paperwork
        iii. Photograph sampling locations
        iv. Perform other tasks not directly related to sample collection and handling

Sample Site

1. **Split sample site into two parts**
    a. Staging Area (greater than 10 feet away from sample points, i.e., PWS taps, as far as reasonably possible as space allows). This is where all non-essential items should be kept: trucks/vehicles, food, drink, handwashing area, etc.
    b. Sampling Area (area within a minimum distance of 10 feet of the sampling point or large as reasonably possible as space allows). Only essential materials, personnel, and equipment should be brought inside this boundary.

Personal Hygiene

1. On sampling days, avoid using soaps, body washes, shampoos, or other personal hygiene products that may contain PFAS. Do not use cosmetics, moisturizers, hand creams, or similar products as these may contain PFAS.
2. Many sunblock and insect repellents contain PFAS. Attachment 1 includes a list of acceptable products. To help avoid using sunblock and insect repellents, wear long sleeve cotton shirts and wide-brimmed hats.

3. Always wash hands after eating, preferably with plain soap (without moisturizing lotions).
4. Avoid contact with PFAS-containing products or materials before sampling activities. Always wash hands with non-PFAS detergent (Liquinox®, Alconox®, or plain bar soap recommended) before sampling. Use water from the tap to be sampled for handwashing.[1] **Do not use distilled or bottled water.** Dry hands with a clean paper towel.

Field Equipment

1. **Do not use waterproof field books.** Prepare field reports on loose paper on Masonite or aluminum clipboards. Avoid plastic clipboards, binders, or spiral hardcover notebooks.
2. **Do not use markers.** Use a ballpoint pen or pencil, but no permanent markers.
3. **Do not use Post-It Notes® or similar adhesive products.**
4. **Do not use "Blue Ice"** for sample cooling or storage of food and drink.

Field Gear, Clothing, and Personal Protective Equipment

1. Disposable powderless nitrile gloves must be worn at all times and changed every time a new (different) activity is undertaken: "When in doubt, change gloves."
2. **A new pair of nitrile gloves must be donned before the following activities at each location:**
   a. Contact with sampling bottles or the field reagent blank (PFAS-free water)
   b. Sample collection and handling
   c. QA/QC sample collection and handling (field reagent blanks, duplicates, matrix spike/matrix spike duplicates)
3. **Do not wear synthetic, stain-resistant (stain-treated), or waterproofed (water-resistance) clothing during sampling.** Field clothing should be restricted to natural fibers (preferably cotton). Field clothing should be well-laundered, avoiding the use of fabric softeners and dryer sheets. Avoid PFAS-containing clothing such as Gore-Tex®, as well as windbreakers, boots, and other apparel that have been treated for water resistance. **Do not wear Tyvek® clothing.**
4. **Do not wear boots containing Gore-Tex™.** Most field footwear is made with some type of synthetic fiber. They are also commonly treated for

[1] In general, dermal contact with water is not a health concern because PFAS are not readily absorbed through the skin.

water resistance to some degree. Be aware to avoid contact with your footwear in the vicinity of the sample site, and always change nitrile gloves donned when changing footwear, tightening laces, etc. Leather boots that have not been treated with PFAS-containing waterproofing are acceptable.

5. If wet conditions are encountered, appropriate clothing that will not risk cross-contamination should be considered. Fabrics that have been treated with water repellents should be avoided because they may contain PFAS. Rain gear made from polyurethane and wax-coated materials may be used.

Field Vehicle

1. The field vehicle seats may be treated with stain-resistant products and represent a source of cross-contamination. The seats should be covered with well-laundered cotton blankets or sheets, especially if sample containers are handled on the vehicle seats. If donning gloves while entering the vehicle, always change gloves after exiting the vehicle.
2. A well-laundered cotton blanket or sheet should be available for use in any vehicle area where samples are handled, including the back of an SUV or the bed of a pickup truck.
3. The field vehicles should be clean, including the bed/cap area if it is a pickup truck or any part of the vehicle that may hold the cooler containing samples. “Clean” means no potential sources of PFAS (e.g., fast food wrappers), trash, used sampling gloves, excessive dirt or soil, or materials or equipment that are not necessary for PWS PFAS sampling.

Food Breaks

1. Food packaging has historically been treated with PFAS to resist wetting, such as sandwich wrappers, paper cups, coated papers, etc. Field personnel are not to bring any food items into the sampling area for this reason. In addition, any food items must be stored separately from sampling equipment and supplies (i.e., use a designated cooler for food and drink).
2. Snacks and meals are not to be eaten in the field vehicle or when sampling. Food breaks should only be taken off-site before, after, or between individual PWS sampling events.
3. Samplers should always wash their hands after eating lunch or snacks.

Visitors

1. Due to the high risk of inadvertent cross-contamination, visitors to the site should remain at a reasonable distance (at least 30 ft) from the sampling area.

2. The PWS operator or designated contact should be at least 10 ft from the sample tap or as far as reasonably possible, but they may fall within the 30 ft radius required for visitors.
3. If approached by a press member, an elected official, or other visitors who have questions regarding the sampling activities, politely refer them to WDEQ's Public Information Officer (Kimberly Mazza) and the GWS Manager.

Samplers should maintain awareness of all materials that physically contact the sample tap and all sampling equipment. It is important that "muscle memory" not take over and allow a procedure that might be acceptable for other sample constituents but would compromise PFAS sampling.

Laboratory

1. The designated laboratory will furnish field personnel with appropriate sampling supplies, including but not limited to sample containers, quality assurance/quality control (QA/QC) containers, chain-of-custody (COC) forms, and PFAS-free reagent grade water as required by Method 537.1.
2. Samplers are to fill the number of sample and QA/QC containers requested by the laboratory and follow any associated instructions provided by the laboratory. Be aware that there may be some differences between laboratories, e.g., one versus two containers per sample, use of a temperature blank in the sample cooler, etc. If in doubt, contact the laboratory for instructions. If additional assistance is needed, contact the GWS project manager.

Sample Containers and Labels

1. Sample containers will be 250 mL wide-mouth high-density polyethylene (HDPE) bottles fitted with an unlined (no Teflon®) polypropylene or HDPE screw cap. Only laboratory-provided sample bottles may be used.
2. Sample (and QA/QC) containers are to be pre-preserved following Method 537.1 and should appear in the bottle as a white crystalline powder.
3. The laboratory will provide PFAS-free sample labels. Only labels supplied by the laboratory may be used (be aware that some common "waterproof" labels may contain PFAS). Labels should be completed using ballpoint pens (no permanent markers).

Procedure

See SOP for **Groundwater Sampling – Monitoring Wells**

See SOP for **Groundwater Sampling – Water Supply Wells**

Public Water Supplies (PWS):

PWS EP and Active RS Tap Sampling Locations

1. At least one PWS Entry Point (EP) tap sample will be collected, and if possible, one PWS Raw Source (RS) tap sample will be collected. EP and RS tap sampling locations are defined as follows:
   a. EP Tap Sampling Location: tap is located after the pressure tank, treatment, or chemical addition, but before the PWS distribution system
   b. RS Tap Sampling Location: tap is located before the pressure tank, treatment, or chemical addition

System Purging for PWS EP and Active RS Tap Sampling

1. Determine which wells and/or intakes are operational at the time of sampling and the wells and/or intakes that were operational in the past 24 hours. Record this information on the field form or log book. No additional purging is necessary if the sources have been running for a reasonable amount of time (at least 20 minutes). If not, purge the source for 20 minutes.
2. Flush sample taps for 2 minutes before collecting the sample.
   a. Use a bucket to collect water during flushing to avoid spilling water on the floor of the sampling area.
   b. **Do not flush the tap (the tap should be OFF) when collecting the field reagent blank (FRB).**

Tap Grab Sampling

1. Before sampling, field staff should:
   a. Prepare the sample cooler with ice, leaving adequate room for the sample containers so that ice does not need to be removed from the cooler after the filled and bagged sample containers are returned to it. The cooler should be lined with a large plastic bag, or ice should be contained in double plastic (e.g., 1- or 2-gallon Ziplock™) bags.
   b. Inspect EP and RS taps sampling locations for ease of access, safety concerns, and the presence of materials or conditions that may cause PFAS cross-contamination. If there appear to be logistical or safety conditions under which sampling cannot be performed or conditions that are likely to affect sample quality adversely, include documentation of the situation in the field notes **and contact the GWS project manager immediately for direction before sampling.**

c. Remove tubing or hoses from sampling taps (if possible). If the PWS representative is available, they may remove hoses and tubing for the sample team.
d. Inspect the tap. Suppose grease, oil, Teflon tape/paste, or other foreign substances appear to be present on the tap threads. In that case, include documentation of the condition in the field notes **and contact the GWS project manager immediately for direction before sampling.**
e. Take close-up photographs of the EP and RS sampling taps. The tap photos should include the completed field form (header section) for reference. Additional photos of the sampling areas may be taken at the contractor's discretion to document field sampling conditions. If notes need to be included in the photo, use a plain white paper page (8.5 x 11") and a ballpoint pen or pencil. All photos should include GIS location data (latitude, longitude). Photos may be taken before or after sampling but not during sampling.
f. Before beginning the sampling process at each site (i.e., before collecting the FRB), wash hands[2] using Liquinox®, Alconox®, or plain bar soap (no moisturizers) and water from the tap to be sampled **(do not use distilled or bottled water).** Dry hands using a clean disposable (single-use) paper towel. If using bar soap, discard the bar after use, and use a new (unused) bar at the following sampling site (we don't want to potentially transport PFAS cross-contamination from one site to another via the bar soap).
g. Don new nitrile gloves (multiple layering of clean gloves is acceptable).
h. Document the lot numbers from all sampling bottles and the expiration date (if applicable) for the field reagent blank (FRB, PFAS-free water) on the field form or in the field log book.
i. Complete all labels of bottles using a ballpoint pen or pencil at any point before sampling.

2. The GWS recommends that the "Document" team member (Section 4.0) perform tasks 1 through 7 above and that the "Sample" team member (Section 4.0) perform tasks 6 through 9.

<u>Sampling Procedures</u>

1. The GWS recommends using a clean five-gallon PVC bucket to transport the sample bottles (in plastic bags) from the sample cooler to and from the sampling locations (taps). Use of the bucket will help reduce the potential

[2] In general, dermal contact with water is not a health concern because PFAS are not readily absorbed through the skin.

for cross-contamination during the sampling process, i.e., bottles can remain in the bucket and not be placed on floors or other potentially contaminated surfaces. The bucket can be placed near the tap to be sampled (i.e., within five to 10 feet), but care should be taken to avoid splashing tap water into the bucket. This bucket should never be used to capture flushed water.

2. The sample bottles should remain closed until immediately before sample collection and be closed tightly immediately after sample collection. If possible, the sampler should hold the bottle cap during sample collection. After filling, replace the cap securely and shake it to dissolve the preservative completely.
3. Do not rinse the pre-preserved PFAS sample bottle with sample water before sample collection.
4. Each PWS sample site (the PWS being sampled) is accompanied by an FRB, taken immediately before the EP tap sample.
5. The sample sequence will be field reagent blank (FRB), EP tap, QA/QC samples (see Section 6.0), and RS tap.
6. Disposal of empty bottles, paper towels, gloves, and other one-time-use items should occur after all samples have been completed, not during the sampling process.
7. To begin the sampling sequence, obtain the FRB:
   a. **Don't flush the tap while collecting the FRB.**
   b. Don a clean pair of nitrile gloves (multiple layering of clean gloves is acceptable).
   c. Remove the bottles from the bag and verify the label on the empty FRB.
   d. Uncap the empty FRB and the pre-filled PFAS-free water bottles.
   e. Within one minute of uncapping the bottles, slowly pour the PFAS-free water from the pre-filled bottle into the empty FRB bottle, cap the FRB bottle securely and return it to the bag. Place the bag in the cooler and dispose of the empty pre-filled bottle.
8. To obtain the EP or RS tap sample:
   a. Turn on the tap. Reduce the water flow to a near-laminar stream (about 200 to 300 mL/min where possible). Taps should be flushed for 2 minutes. Use a bucket to contain the water from the tap if necessary (i.e., a sink or floor drain is not present); do not allow water to spill over the sampling area floor.
   b. Don a clean pair of nitrile gloves (multiple layering of gloves is acceptable).
   c. Remove sample bottles from the bag and verify the label.

d. Have all sample bottles within reach (again, using a five-gallon PVC bucket is recommended to avoid placing bottles on the ground or floor). Fill each bottle to its neck, one after the other. Avoid splashing/spilling sample water out of the bottle. Cap all bottles tightly.
e. Ensure the rim of the sample bottle does not contact the sample tap or other equipment during sample collection.
f. Once tightly capped, shake the bottles to dissolve the preservative completely.
g. Return bottles to the bag.

9. Record label information, including the sample identification, sample collection date, sample collection time, and any other information the laboratory requires on the chain of custody (COC) form. The "Document" team member should be responsible for maintaining the COC.
   a. Bagged samples are to be stored on ice as soon as reasonably possible, given the site conditions. Remove excess air from bags as the samples are packed (air acts as an insulator).
10. If required (if sample bottles are provided), field duplicate, laboratory fortified sample matrix, or laboratory fortified sample matrix duplicate QA/QC samples should be collected after the EP tap sample following the procedures described above for EP tap sampling.
11. The PWS may want to collect their PFAS samples during the WDEQ GWS's sampling event. If this is the case, the PWS personnel should wait until after the completion of WDEQ GWS's sampling. **Do not attempt to collect split samples with the PWS. WDEQ GWS's contractor personnel should not handle PWS sampling containers, and PWS personnel should not handle WDEQ GWS's sampling containers.**
12. All sampling materials should be treated as single-use and disposed of following the completion of sampling at each sample site.
13. See Section 7.0 for shipping procedures.

Quality Assurance/Quality Control

The QA/QC samples required for Method 537.1 are summarized below:

Field Reagent Blank (FRB) - A field reagent blank consists of a single 250 mL bottle of PFAS-free reagent grade water with a preservative. This water is to be transferred into an empty 250 mL bottle absent of any preservative. The FRB should be collected immediately before the EP sample and collected per Section 5.0.

Field Duplicate (FD) - A FD will consist of one or more 250 mL bottles of sample water. The FD should be collected immediately after the EP tap sample and collected in the same manner as the sample in Section 5.0. Per Method

537.1, FDs will be collected at a rate of one per 20 samples. FD bottles will be provided by the laboratory as needed to meet Method 537.1 requirements.
Laboratory Fortified Sample Matrix (SM) - A SM will consist of one or more 250 mL bottles of sample water. The SM should be collected immediately after the EP tap sample and collected in the same manner as the sample in Section 5.0. Per Method 537.1, SMs will be collected at a rate of one per 20 samples. SM bottles will be provided by the laboratory as needed to meet Method 537.1 requirements.
Laboratory Fortified Sample Matrix Duplicate (SMD) - A SMD will consist of one or more 250 mL bottles of sample water. The SMD should be collected immediately after the EP tap sample and collected in the same manner as the sample in Section 5.0. Per Method 537.1, SMDs will be collected at a rate of one per 20 samples. SMD bottles will be provided by the laboratory as needed to meet Method 537.1 requirements.
Temperature Blank - Depending on the lab, a temperature blank may accompany each cooler. A temperature blank is simply a water-filled sample bottle that accompanies each cooler. The blank temperature was measured to ensure that all samples were received at 10°C or less when received at the laboratory. The temperature blank allows the laboratory to make this determination without compromising one of the samples.
Trip Blanks - No trip blanks should be required to accompany PFAS samples.

Shipping

1. Place all sample bags into the cooler with ice (see page 7). If using a cooler liner, squeeze the air out of the liner and tie it off tightly. Ice should not be placed outside of the cooler liner or, the cooler may leak as the ice melts. If a sample cooler leaks during shipment, the shipper:
   a. may stop or delay delivery to the laboratory. Ice may be contained in double-plastic bags as an alternative to a cooler liner (e.g., 1- or 2-gallon Ziplock™ bags).
2. Samples must be chilled during shipment and should not exceed 10°C during the first 48 hours after sample collection per Method 537.1.
3. Sample temperature must be confirmed when the samples are received at the laboratory per Method 537.1 and should be at or below 10°C.
4. The samples for each site (PWS) should be listed on separate (site-specific) chains of custody (COC). Samples from multiple locations may be included in the same sampling cooler, but the cooler should include a separate COC for each site sampled.

5. Same-day pre-paid contract agent shipping is recommended. Note that Method 537.1 holding time for PFAS is 14 days.

Documentation

1. Ensure that the COC information and other field documentation are complete and accurate before leaving a PWS sampling location.
2. All necessary documentation for sample custody and submission to the laboratory must meet laboratory requirements.
3. All photographs are to be provided to WDEQ GWS.
4. Copies of all COCs, field notes, photographs, or other field sampling documentation are provided to WDEQ GWS.

Analytical Methods

Method 537.1: Determination of Selected PFAS in Drinking Water by SPE and LC/MS/MS (2018/2020)
Method 537.1: Determination of Selected PFAS in Drinking Water by SPE and LC/MS/MS (2018/2020)
Method 533: Determination of PFAS in Drinking Water by Isotope Dilution Anion Exchange SPE and LC/MS/MS (2019)
Method 8327: PFAS Using External Standard Calibration and MRM LC/MS/MS (2019) for Non-potable Water and other Environmental Media
Draft Method 1633 for Non-potable Water and other Environmental Media (EPA and the Department of Defense are collaborating on the development of this method)

References

ITRC, 2021. Per- and Polyfluoroalkyl Substances (PFAS-1): Chapter 11 Sampling and Analysis. Interstate Technology and Regulatory Council, May 2021.

OEPA, 2020. DDAGW Standard Operating Procedure For Per- and Polyfluorinated Alkyl Substances Sampling at Public Water Systems, Ohio Environmental Protection Agency, March 2020.

USEPA 2021. PFAS Analytical Methods Development and Sampling Research, USEPA website.

USEPA 2019. Perfluoroalkyl and Polyfluoroalkyl Substances (PFAS): Methods and guidance for sampling and analyzing water and other environmental media, USEPA EPA/600/F-17/022f, June 2019.

Revision History

Date	Details of Revision	Revised by:
4/1/2021	New SOP	J. Scott
6/22/2021	Cherrie Nelson revised to meet Groundwater Section needs	Cherrie Nelson

Quality Control

Samplers are responsible for following the calibration, decontamination, and meter use instructions in the manual.

Calibration: A two-point meter check, as described in the instruction manual for the meter, is **required** a minimum of once per week (or more often if the sampler has reason to believe that the meter may be malfunctioning or has shown drift) with pH 7 and 10 buffer standards (calibration standards). An additional calibration with pH 7 and pH 4 buffer standards may be necessary when the sample pH measurement is at or near pH 7 or the sampler has reason to believe that the pH may be below 7.

A continuing calibration verification (CCV) is performed once per day using pH 7 and pH 10 buffer standards. An acceptable field CCV check is a reading that is ± 0.3 standard units of the pH buffer standard. A calibration log is required (refer to the Standard Operating Procedure (SOP) for **Instrument Calibration and Calibration Logs**).

Calibration standards (buffer solutions): Accuracy is specific to each manufacturer and is stated in the product literature or on the bottle. Typical calibration accuracy is ±0.1 at 25°C (77 °F). Calibration standards can be supplied to the samplers by the Water Quality Lab (WQL) or commercial laboratory at the beginning of each field season and as needed during the season or are commercially available for purchase. Do not re-use calibration standards.

Meter accuracy: Accuracy and sensitivity are instrument-specific and are stated in the instrument instruction manual. In general, modern (manufactured within the past 10 years) pH meters were designed to read pH ±0.01 - 0.02 units at 25°C (77°F). Meter age, time in use, and maintenance may all affect accuracy.

Temperature compensation: Buffer pH is affected by temperature. Because the buffer is used by the meter as an internal reference, any variation in buffer pH will affect the meter reading of the sample pH if the measuring system does not have automatic temperature compensation or the readings are taken so quickly

that thermal equilibrium is not reached. Since approximately 1990, meters supplied by the WQL or commercial laboratory perform automatic temperature compensation.

Correlating data to an instrument: Samplers record the make, model, serial number, and state ID tag number of the meter in their field log books and calibration logs (refer to SOPs for **Field Log Books** and **Instrument Calibration and Calibration Logs**) so data can be traced back to a specific instrument, calibration log and maintenance history. Field log books and a calibration and maintenance log are required.

Instrument decontamination: Meters used by monitoring field samplers require a specific probe. Probe cleaning procedures are specific to the probe; therefore, the sampler is required to use the decontamination instructions for the meter probe. **Field electrode cleaning - oily samples:** Oily samples will leave a deposit on the membrane of the electrode. The electrode must be cleaned off as quickly as possible after the pH reading is taken. The electrode should be immediately wiped off, and then washed with detergent (any commercial detergent or RBS-35 if available) and warm water, followed by a thorough deionized water (dilution water) rinse.

Natural pH fluctuation: Daily (diurnal) changes in stream pH are common. Any evaluation of pH data must consider the amount and kind of vegetation and aquatic organisms recorded for the site, and the time of day, temperature, cloud cover, flow conditions, and stream bed conditions when the pH measurement was taken. This information is included on the monitoring Field Data Sheets or in the sampler's Field Log Book and is used to evaluate the test results.

Container	None. Must be measured on-site.
Sample Volume	None. Must be measured on-site.
Preservative	None. Must be measured on-site.
Holding Time	Analyze within 15 minutes.; pH must be measured with the sample at the actual temperature of the water from which it was taken. If circumstances prevent this, the source water temperature and the sample temperature must be measured and recorded.
Procedure	See applicable SOP (**Groundwater Sampling – Monitoring** or **Groundwater Sampling – Water Supply Wells**), or defer to the Water Quality Division Laboratory SOP 170.04 *pH by the Electrometric Method* for the analytical standard operating procedure.

Useful electrode life: Electrode life is specific to the manufacturer and type of use, but a typical life is 6-24 months. Drifting values, unrepeatable readings

(which can also be caused by a dirty electrode), and/or slow readings may be observed when an electrode is near the end of its useful life. Refer to the instrument manual for more detailed information.

Automatic temperature compensation: Temperature can be the most common cause of error in pH measurements, due either to the temperature of the reference solution or sample temperature. pH meters and calibration solutions are designed to be used at 25°C (77°F). At a pH of ≈7 and 25°C (77°F), there is no temperature error in a pH measurement. A pH electrode measures hydrogen ion activity; ions become more active as temperature increases. Since approximately 1990, meters supplied to field samplers by WQL or a commercial laboratory have had built-in automatic temperature compensation for buffer solutions and samples that are not at 25°C (77°F). Equilibration instructions are in each meter manual.

Maintenance and repair: Electrode replacement, extensive electrode cleaning, instrument repair, and pre-season calibration checks are performed by the monitoring staff or by the WQL as needed during the season and at the end of each field season for routine annual maintenance and repair.

Analytical Method

Standard Method 4500-H^+ B

Reference

American Public Health Association. Standard Methods for the Examination of Water and Wastewater - SM 4500-H+ B-2011, online. Washington, D.C.

Revision History

Date	Details of Revision	Revised by:
4/1/2021	Revision of September 2004 version	J. Scott/ J. ZumBerge
6/22/2021	Cherrie Nelson revised to meet Groundwater Section needs	Cherrie Nelson

PHENOLS (4-AAP METHOD)
(EFFECTIVE DATE: APRIL 2021)

Quality Control	This is a colorimetric test. Most manufacturers formulate their color standards using natural daylight. Incandescent, fluorescent, and direct sunlight are unacceptable and may produce errors. Certain shades of yellow and blue are extremely difficult to discern. With the aid of electronic meters that pass light through a photodiode, the results can be displayed on a meter that eliminates the need for visual interpretation and addresses concerns about lighting, which result in more accurate and precise test results.
Container	Amber glass is preferred; container must be glass; contact Water Quality Laboratory (WQL)or commercial laboratory for instructions.
Sample Volume	1000 mL
Preservative	Sulfuric acid (H_2SO_4) to pH ≈ 2 Refer to the Standard Operating Procedure (SOP) for **Sample Parameters, Methods, Reporting Limits, Preservation and Holding Time**, for an Acidification Guideline Table
Holding Time	28 days
Procedure	See applicable SOP (**Groundwater Sampling – Monitoring** or **Groundwater Sampling – Water Supply Wells**), or defer to the Water Quality Division Laboratory SOP 190.05 *Total Recoverable Phenolics* for the analytical standard operating procedure. Phenolics are oxidized or their analysis is interfered with in the presence of sulfur compounds and chlorine. Procedures for dealing with possible interferences of this nature are outlined in the United States Environmental Protection Agency (USEPA) method 420.1. The field sampler will have to deal with these interferences at the time of sampling.
Analytical Method	EPA 420.1: Determination of Total Recoverable Phenolics by Semi-automated Colorimetry
Reporting Limit	0.05 mg/L
Reference	http://water.epa.gov/scitech/methods/cwa/methods_index.cfm

Revision History

Date	Details of Revision	Revised by:
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6/22/2021	Cherrie Nelson revised to meet Groundwater Section needs	Cherrie Nelson

SEMI-VOLATILE ORGANIC COMPOUNDS (SVOC)

(EFFECTIVE DATE: APRIL 2021)

Container	1000 mL amber glass bottles with screw-caps with polytetrafluoroethylene (PTFE)-lined septa.
Sample Volume	Two – 1000 mL amber glass bottles with screw-caps with polytetrafluoroethylene (PTFE)-lined septa per sample location.
Preservative	Add sodium thiosulfate to chlorinated samples. Cool to 4-6°C and protect from the light.
Holding Time	7 days to extraction/40 days to analysis
Procedure	Plastic containers or lids may NOT be used for the storage of samples due to the possibility of sample contamination from the phthalate esters and other hydrocarbons within the plastic. Samples should be filled with care to prevent any portion of the collected sample from coming in contact with the sampler's gloves causing contamination. The screw-top lid with the septum (PTFE) is tightened onto the bottle, and the bottle is stored out of the light and immediately put on ice. Bottles should NOT be filled near a running engine, any type of exhaust system, airport runway, or high traffic area as discharged fumes and vapors may contaminate the samples. Glass containers should be wrapped in bubble wrap during storage and shipment.
Analytical Method	EPA 625.1/SW 8270C **Samplers should reach out to the Water Quality Lab (WQL) or commercial laboratory to determine what method is appropriate based on project data quality objectives.**
Reference	Base/Neutrals and Acid by GC/MS, United States Environmental Protection Agency, Washington, D.C. 20460, EPA 821-R-16-007, December 2016.

Semivolatile Organic Compound by Gas Chromatography/Mass Spectrometry (GC/MS). United States Environmental Protection Agency, Washington, D.C. 20460, December 1996.

Revision History

Date	Details of Revision	Revised by:
4/1/2021	New SOP	J. Scott
6/22/2021	Cherrie Nelson revised to meet Groundwater Section needs	Cherrie Nelson

TEMPERATURE, WATER
(EFFECTIVE DATE: APRIL 2021)

Quality Control	The thermometer will be calibrated and recorded annually by the Water Quality Laboratory (WQL), commercial laboratory, or field personnel against an International System of Units (SI) traceable through the National Metrological Institute (NMI) certified thermometer. Temperature readings for incubators must be on the calibration mark.
Container	None. Must be measured on-site.
Sample Volume	Measured *in situ* or in a bucket.
Preservative	None. Must be measured on-site.
Holding Time	Analyze immediately.
Procedure	See applicable Standard Operating Procedure (SOP) (**Groundwater Sampling – Monitoring** or **Groundwater Sampling – Water Supply Wells**). Temperature measurement may be made with an accurate thermometer having a scale marked for at least every 0.1°C or a digital electronic device capable of at least 0.1°C precision. The thermometer should be immersed in the water *in situ* or a bucket, immediately after it has been filled, to a depth above the minimum at which the thermometer is operational. The thermometer must be allowed to come to equilibrium before the temperature is read and recorded to the nearest 0.1°C.
Analytical Method	Standard Method 2550 B
Reference	American Public Health Association. Standard Methods for the Examination of Water and Wastewater - SM 2550-B-2011, online. Washington, D.C.

Revision History

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6/22/2021	Cherrie Nelson revised to meet Groundwater Section needs	Cherrie Nelson

TOTAL DISSOLVED SOLIDS (TDS)
(EFFECTIVE DATE: APRIL 2021)

Container	Clean, sealed, disposable, polyethylene with locking screw cap bottles should be used for sample collection.
Sample Volume	200 mL
Preservative	Cool to ≤ 6°C
Holding Time	7 days
Procedure	See applicable Standard Operating Procedure (SOP) (**Groundwater Sampling – Monitoring** or **Groundwater Sampling – Water Supply Wells** or defer to the WQL SOP 150.02 *Total Dissolved Solids Dried at 108º ºC* for the analytical standard operating procedure. Total dissolved solids are the sum of all of the ion particles that can pass through a < 2.0 µm filter, and are often correlated to salinity and conductivity. The filtrate is dried at 180°C to a constant weight in a pre-weighed evaporative dish. The increase in weight represents the total dissolved solids of the sample. Changes in Total Dissolved Solids (TDS) concentrations can be harmful to aquatic life, will have an effect on the palatability of water, and can change the overall water hardness.
Analytical Method	Standard Method 2540 C
Reporting Limit	10 mg/L
Reference	American Public Health Association. Standard Methods for the Examination of Water and Wastewater - SM 2540-C-2011, online. Washington, D.C.

Revision History

Date	Details of Revision	Revised by:
4/1/2021	New SOP	J. Scott
6/22/2021	Cherrie Nelson revised to meet Groundwater Section needs	Cherrie Nelson

TOTAL SUSPENDED SOLIDS (TSS)
(EFFECTIVE DATE: APRIL 2021)

Container	Clean, sealed, disposable, polyethylene with a locking screw cap bottles should be used for sample collection
Sample Volume	200 mL
Preservative	Cool to ≤ 6°C
Holding Time	7 days
Procedure	See applicable Standard Operating Procedure (SOP) (**Groundwater Sampling – Monitoring** or **Groundwater Sampling – Water Supply Wells** or defer to the WQL SOP 150.01 *Total Suspended Solids Dried at 103 – 105°C* for the analytical standard operating procedure. Total Suspended Solids (TSS) levels are seasonally variable. The highest concentrations generally occur during spring runoff and after precipitation events. Maximum TSS concentration may occur just before peak current velocity and decline with the falling hydrograph. Maximum TSS and suspended sediment transport during these periods is a normal stream function and in the absence of significant upland and riparian habitat disturbance, serve to promote the creation and maintenance of stable stream channels and riparian areas. However, high TSS concentrations introduced during low current velocity regimes result in sediment deposition to the stream bed. Samples should exclude large floating particles or submerged agglomerates of nonhomogeneous materials.
Analytical Method	Standard Method 2540 D: Total suspended solids dried at 103-105°C
Reporting Limit	2 mg/L
Reference	American Public Health Association. Standard Methods for the Examination of Water and Wastewater - SM 2540-D-2011, online. Washington, D.C.

Revision History

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6/22/2021	Cherrie Nelson revised to meet Groundwater Section needs	Cherrie Nelson

Quality Control	Samplers are responsible for following the calibration, decontamination, and meter use instructions in the manual. Calibration**:** Calibration should be conducted, as described in the instruction manual for the turbidimeter, and is **required** a minimum of once per month (or more often if the sampler has reason to believe that the meter may be drifting) typically with a <0.1 nephelometric turbidity unit (NTU), 20.0 NTU, 100 NTU, and 1000 NTU range standards (other applicable standard ranges may apply). A continuing calibration verification (CCV) check should be completed at least once daily with a mid-range standard (20 NTU or 100 NTU). An acceptable field CCV check is a reading that is ± 20% of the turbidity standard. A calibration log is required (refer to the Standard Operating Procedure (SOP) for **Instrument Calibration and Calibration Logs**). Calibration standards**:** Calibration accuracy is specific to each manufacturer and is stated in the product literature or on the calibration standard bottle. Typically, either a formazin or GelEx® standard is used to calibrate for turbidity. Instrument decontamination: Sample tubes are clear, colorless glass and must be kept scrupulously clean, both inside and out, and discarded when they become scratched. To clean the vials, rinse three times with distilled deionized water (dilution water). Visually inspect the cell to be sure it is clean. If the cell appears to be extremely contaminated, rinse it with methanol and inspect it again.
Container	Clean, sealed, disposable, polyethylene with locking screw cap bottles should be used for sample collection.
Sample Volume	100 mL
Preservative	None (Cool to ≤6°C if not analyzed immediately.)
Holding Time	Turbidity should be measured immediately for the greatest accuracy. If this is not practical, the sample must be kept at ≤6°C and analyzed within 48 hours.
Procedure	See applicable SOP (**Groundwater Sampling – Monitoring** or **Groundwater Sampling – Water Supply Wells**)for samples collected. Turbidity does not measure color, but the optical property that causes light to be scattered and

absorbed. A turbidimeter with the proper sensitivity should be used to measure the NTU of the sample.

Field log book/datasheet notes: The presence of natural water colors due to high mineral content (i.e. iron, sulfates, and chlorides) which may affect turbidity measurements should be noted in field logs and on field data sheets as an aid to interpreting the data.

Turbidimeter Sample Measurement

1. Gently agitate and invert the sample to not introduce air bubbles but to ensure a properly homogenized sample.
2. Pour off the representative sample into the cell and cap the cell.
3. Wipe the cell with a soft, lint-free cloth to remove any water spots or fingerprints.
4. Gently invert the sample cell again and insert it into the instrument cell compartment so the markings on the instrument align with the markings on the sample cell. **Make sure to close the lid.**
5. Press the **Read** button and record the result that is displayed.
6. Repeat steps 1 through 5 three times discarding each sample in between.

The average of the three results will be the final result reported.

In-Situ Meter Sample Measurement

1. Place the probe in the water to be tested and allow it to equilibrate.
2. Record the value obtained on the field data sheets.
3. Sequential replicate measurements (from the same meter which is turned off and on between measurements) should be obtained at a minimum of 10% of sample sites and should be measured within 5 minutes of the original value.
4. Sequential duplicate measurements (from two separate multi-probe meters) should be obtained where resources and opportunities present themselves.
5. Clean and store probe and meter as recommended by the manufacturer.

Analytical Method

Standard Method 2130-B: Nephelometric Method

Reporting Limit Meter/Laboratory specific, typically 0.02 NTU (field)/0.1 NTU (laboratory)

Reference American Public Health Association. Standard Methods for the Examination of Water and Wastewater - SM 2130-B-2011, online. Washington, D.C.

Revision History

Date	Details of Revision	Revised by:
5/2016	Revision of September 2004 version	C. Norris
4/1/2021	Revision of May 2016 version	J. Scott/ J. ZumBerge
6/22/2021	Cherrie Nelson revised to meet Groundwater Section needs	Cherrie Nelson

Container	40 mL Volatile Organic Analysis (VOA) amber glass vial with screw top Teflon™ septum (required to prevent contamination of the sample by the cap)
Sample Volume	Three 40 mL VOA vials per sample location completely full with no air bubbles, plus a trip blank prepared from deionized water
Preservative	Add ascorbic acid to chlorinated samples. Preserve with 5 – 10 drops of hydrochloric acid (HCl) to a pH < 2; cool to 4-6°C
Holding Time	14 Days
Procedure	To monitor possible contamination, a trip blank prepared in a VOA glass vial from distilled deionized water must be carried throughout the sampling, storage, and shipping process. Refer to the SOP for **Blank Samples**. Sample liquids should be introduced into the vials gently to reduce agitation, which might drive off volatile compounds. Samples must be poured into the vial without introducing any air bubbles within the vial as it is being filled. If air bubbles occur as a result of violent pouring, the sample must be poured out and the vial refilled. Each VOA vial should be filled until it is completely full with no air bubbles. Label immediately, at the point at which the sample is collected. The screw-top lid with the septum (Teflon™ side toward the sample) is tightened onto the vial, then the vial is inverted and tapped to check for air bubbles. If there are any air bubbles present, the sample must be retaken. Vials should NOT be filled near a running engine, any type of exhaust system, airport runway, or high traffic area as discharged fumes and vapors may contaminate the samples. VOA samples may also be contaminated by diffusion of volatile organics through the septum during shipment and storage. The three vials from each sampling location should be sealed in separate plastic bags to prevent cross-contamination between samples, particularly if the sampled waste is suspected of containing high levels of volatile organics (activated carbon may also be included in the bags to prevent cross-contamination from highly contaminated samples). Glass containers should be wrapped in bubble wrap during storage and shipment.
Analytical Method	

EPA 524.2

Samplers should reach out to the Water Quality Lab (WQL) or commercial laboratory to determine what method is appropriate based on project data quality objectives.

Reference

Methods for the Determination of Organic Compounds in Drinking Water, United States Environmental Protection Agency, Office of Research and Development, Washington D.C. 20460, EPA/600/4-88/039, July 1991.

Measurement of Purgeable Organic Compounds in Water by Capillary Column Gas Chromatography/Mass Spectrometry, United States Environmental Protection Agency, Cincinnati, Ohio 45268. Method 524.2

Revision History

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4/1/2021	Revision of September 2004 version	J. Scott
6/22/2021	Cherrie Nelson revised to meet Groundwater Section needs	Cherrie Nelson

VOLATILE ORGANIC HYDROCARBONS, PURGEABLE AROMATICS (BENZENE, TOLUENE, ETHYLBENZENE, MP-XYLENE, O-XYLENE) OR "BTEX" (EFFECTIVE DATE: APRIL 2021)

Container	40 mL Volatile Organic Analysis (VOA) glass vials with Teflon™ lined caps
Sample Volume	Three 40 mL VOA vials per sample location completely full with no air bubbles.
Preservative	Add ascorbic acid to chlorinated samples. Preserve with 5 – 10 drops of hydrochloric acid (HCl) to a pH < 2; cool to 4-6°C
Holding Time	14 days
Procedure	Fill vials completely. There must not be any air space in the vial when it is capped. Glass containers should be wrapped in bubble wrap during storage and shipment. Vials must be placed in a plastic bag and sealed. Samples are run through a purge and trap concentrator before being analyzed by gas chromatography (GC) using a capillary column and a photoionization detector (PID). Purge and Trap Hydrocarbons Method - Helium is forced through the sample which drives off the organic compounds. The organics are captured and then measured using GC. The total of all the various compounds measured by the GC is the purge and trap hydrocarbon value. Comments - Equipment maintenance, cleaning problems, and low volatility make this method unsuitable for heavy oil and grease measurements. This is the preferred method for determining overall gross contamination from light hydrocarbons including gasoline and/or solvents. BTEX (Benzene, Toluene, Ethylbenzene, Xylene) Method – The method is the same as for Purge and Trap Hydrocarbons, except that the GC peaks for the specific compound's benzene, ethylbenzene, toluene, and xylene are read and quantified. Comments - BTEX isomers are present in gasoline and most diesel fuels. The BETX analysis is most useful in the investigation of Leaking Underground Storage Tank (LUST) sites and spills of diesel and gasoline when the material is

not weathered. Benzene is by far the most significant contaminant from a public health standpoint.

Analytical Method

EPA 602 (GC), EPA 624.1 (GC/MS)/SW 8260B
Samplers should reach out to the Water Quality Lab (WQL) or commercial laboratory to determine what method is appropriate based on project data quality objectives.

Reporting Limit 0.5 – 1.0 µg/L

Reference

Methods for Organic Chemical Analysis of Municipal and Industrial Wastewater, Appendix A to Part 136 – Method 602 – Purgeable Aromatics. United States Environmental Protection Agency, Cincinnati, Ohio 45268. Method 602.

Method 624.1: Purgeables by GC/MS, Appendix A to Part 136 – Method 624.1 – Purgeables by GC/MS. United States Environmental Protection Agency, Cincinnati, Ohio 45268. Method 624.1.

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VOLATILE ORGANICS, HALOGENATED (COMMON SOLVENTS)(CARBON TETRACHLORIDE; METHYLENE CHLORIDE; 1,2-DICHCHLOROMETHANE; BROMOFORM; TRICHLOROETHYLENE; TETRACHLOROETHYLENE; 1,1,2,2-TETRACHLOROETHANE;1,1,1-TRICHLOROETHANE; 1,2-DICHLOROETHYLENE; CHLOROFORM) (**EFFECTIVE DATE**: APRIL 2021)

Container	40 mL Volatile Organic Analysis (VOA) amber glass vials with Teflon™ lined caps (required to prevent contamination of the sample by the cap)
Sample Volume	Three 40 mL vials for each sampling location completely full with no air bubbles, plus a trip blank prepared from deionized water
Preservative	Add ascorbic acid to chlorinated samples. Preserve with 5 – 10 drops of hydrochloric acid (HCl) to a pH < 2; cool to 4-6°C
Holding Time	14 days
Procedure	Sample liquids should be introduced into the vials gently to reduce agitation, which might drive off volatile compounds. Samples must be poured into the vial without introducing any air bubbles within the vial as it is being filled. If air bubbles occur as a result of violent pouring, the sample must be poured out and the vial refilled. The screw-top lid with the septum (Teflon™ side toward the sample) is tightened onto the vial, then the vial is inverted and tapped to check for air bubbles. If there are any air bubbles present, the sample must be retaken. Fill vials completely. There must not be any air space in the vial when it is capped. Each VOA vial should be filled until there is a meniscus over the lip of the vial. Label immediately, at the point at which the sample is collected. Vials should NOT be filled near a running engine, any type of exhaust system, airport runway, or high traffic area as discharged fumes and vapors may contaminate the samples. VOA samples may also be contaminated by diffusion of volatile organics through the septum during shipment and storage. The two vials from each sampling location should be sealed in separate plastic bags to prevent cross-contamination between samples, particularly if the sampled waste is suspected of containing high levels of volatile organics (activated carbon may also be

included in the bags to prevent cross-contamination from highly contaminated samples).

Glass containers should be wrapped in bubble wrap during storage and shipment. Vials must be placed in a plastic bag and sealed.

Samples are run through a purge and trap concentrator before being analyzed by Gas Chromatography using a capillary column and an External Cavity Diode Laser (ECDL) detector.

Analytical Method

EPA 524.2/ EPA 502.2
Samplers should reach out to the Water Quality Lab (WQL) or commercial laboratory to determine what method is appropriate based on project data quality objectives.

Reporting Limit 0.5 µg/L

Reference Volatile Organic Compounds in Water by Purge and Trap Capillary Column Gas Chromatography with Photoionization and Electrolytic Conductivity Detectors in Series. United States Environmental Protection Agency, Cincinnati, Ohio 45268. Method 502.2

Measurement of Purgeable Organic Compounds in Water by Capillary Column Gas Chromatography/Mass Spectrometry, United States Environmental Protection Agency, Cincinnati, Ohio 45268. Method 524.2

Revision History

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6/22/2021	Cherrie Nelson revised to meet Groundwater Section needs	Cherrie Nelson

PART 3 - QUALITY CONTROL, CUSTODY, AND REPORTING

ABBREVIATIONS, APPROVED FOR TEST PARAMETERS

(EFFECTIVE DATE: APRIL 2021)

Quality Control — Samplers follow the Standard Operating Procedure (SOP).

Procedure — The table below is a list of approved abbreviations to be used on field data sheets, field log books, sample containers, and Chain of Custody forms.

List of Approved Water Quality Division Abbreviations	
°C	Degrees Celsius
°F	Degrees Fahrenheit
µg/L	Microgram per liter
µS/cm	Microsiemens per centimeter
Ag	Silver
Al	Aluminum
ALK ($CaCO_3$)	Alkalinity
As	Arsenic
B	Boron
Ba	Barium
Be	Beryllium
BOD	Biochemical Oxygen Demand
Br	Bromide
BTEX	Benzene, Toluene, Ethylbenzene, Xylene
Ca	Calcium
cBOD	Carbonaceous Biochemical Oxygen Demand
Cd	Cadmium
CFU	Colony Forming Unit
CHC	Chlorinated Hydrocarbons
Cl	Chloride
CN	Cyanide
Co	Cobalt
CO_3	Carbonate
COD	Chemical Oxygen Demand
Cr	Chromium
Cr 6+	Hexavalent Chromium
Cu	Copper
DO	Dissolved Oxygen

List of Approved Water Quality Division Abbreviations	
DOC	Dissolved Organic Carbon
F^-	Fluoride
Fe	Iron
H_2S	Sulfides or Hydrogen Sulfides
HCO_3	Bicarbonate
Hg	Mercury
IR	Infrared Spectrometry
K	Potassium
MBAS	Methylene Blue Active Substances, Surfactants
Mg	Magnesium
mg/L	Milligram per liter
mg/m^2	Milligram per meter squared
Mn	Manganese
Mo	Molybdenum
MPN	Most Probable Number
mV	Millivolt
Na	Sodium
NH_3-N	Ammonia-Nitrogen
Ni	Nickel
NO_3-NO_2	Nitrate-Nitrite
NTU	Nephelometric Turbidity Unit
O&G	Oil and Grease
ORP	Oxidation-Reduction Potential
PAH	Polycyclic Aromatic Hydrocarbons
Pb	Lead
PCB	Polychlorinated Biphenyls
PPM	Parts per million
Sb	Antimony
Se	Selenium
SO_4	Sulfate
Sr	Strontium
SSC	Suspended Sediment Concentration
SU	Standard Units (pH)
TDS	Total Dissolved Solids
TKN	Total Kjeldahl Nitrogen
Tl	Thallium
TN	Total Nitrogen
TOC	Total Organic Carbon

List of Approved Water Quality Division Abbreviations	
TP	Total Phosphorus
TPH	Total Petroleum Hydrocarbons
TS	Total Solids
TSS	Total Suspended Solids
U	Uranium
V	Vanadium
VOA	Volatile Organic Analysis
Zn	Zinc

Revision History

Date	Details of Revision	Revised by:
4/1/2021	Revision of March 2001 version	J. Scott
6/22/2021	Cherrie Nelson revised to meet Groundwater Section needs	Cherrie Nelson

BLANK SAMPLES
(EFFECTIVE DATE: APRIL 2021)

Quality Control

Samplers follow the Standard Operating Procedure (SOP). Blanks are a part of Quality Control (QC) and are required for all sampling activities. Their creation should be noted in the field log book or datasheet. Blanks document that there is no sample contamination from the containers during custody, transportation, and or pre-analysis preparation either in the field or in the laboratory. The laboratory supplies the samplers with pre-cleaned, lot-checked sampling bottles as described in each applicable SOP. The laboratory and samplers use de-ionized water and certified preservatives. There should be no contamination from the acids used to preserve a sample. The field offices may provide their own de-ionized water. Samples of field office de-ionized water are sent to a laboratory annually for testing.

Sample containers: The laboratory supplies the samplers with clean, sealed, disposable, polyethylene with locking screw cap bottles or with clean glass bottles (brown or clear) when the parameter SOP calls for glass. If samplers have any reason to suspect that sampling bottles may contribute to contamination, a bottle blank is used at each sampling site.

Acceptance criteria: Acceptance criteria for blanks are specified in the project-specific Sampling and Analysis Plan (SAP) or the Wyoming Department of Environmental Quality (WDEQ) Water Quality Laboratory analytical method SOP. In general, a blank must show that for the parameter or preservative of interest, the constituent tested below the reporting limit for the method and analytical instrument used.

Procedure

Purpose: Blanks document the concentration of constituents, if any, introduced into a sample by the sampling method, equipment, site conditions, atmospheric conditions, preservatives, or containers. The number and type of blanks are determined in the project-specific sampling and analysis plan and are consistent with the Groundwater Section Quality Assurance Program Plan.

Additional field blanks are required any time a field sampler suspects or have reason to believe that sampling equipment, containers, or preservatives have been contaminated.

Blanks fall into two general categories: laboratory and field blanks.

Laboratory Blanks: Laboratory blanks are covered by the Water Quality Laboratory (WQL) or commercial laboratory Quality Assurance/Quality Control (QA/QC) Plan and United States Environmental Protection Agency (USEPA)

laboratory test method documents. Laboratory blanks establish that no contamination is introduced into a sample above laboratory reporting limits during the analysis process. A laboratory duplicate and a matrix-spiked sample are run for every ten samples to verify recovery and sample matrix interferences. Laboratory blanks are run at the beginning of the sample batch, and after every tenth sample, if greater than ten samples are analyzed. Blanks are analyzed in the laboratory for the same parameters as the monitoring sample(s) to which they apply. The analytical result for a blank must be less than the reporting limit for the laboratory instrument being used. Blanks, percent recovery for spikes, and relative percent difference (RPD) are shown on the laboratory analysis report, which is supplied to the field sampler who submitted the samples. Copies of these reports are a permanent part of the site file. The originals are retained for five years in the WQL files. The WQL supervisor takes immediate corrective action on any laboratory test results that are out of compliance.

Contract laboratories: Each contract laboratory used for Groundwater Section work must have a QA/QC Plan which describes the number, kind, and frequency of laboratory duplicates, blanks, and spikes, and describes the summary statistics and corrective actions to be taken when results are outside of the acceptance criteria. The laboratory analytical report must show analysis results for the duplicates, blanks, spikes, the analysis method(s), and the results for the summary quality control statistical calculations.

Field Blanks

Total coliform and *E. coli* blanks: Blanks are required (refer to SOP for ***Escherichia coli* & Total Coliform Bacteria Colilert®-Defined Enzyme Substrate Method**) to verify that the samples are not being contaminated and are providing accurate results. The analysis can be performed in a contract laboratory or by the Groundwater Section field samplers. Groundwater Section typically analyzes for total coliform and *E. coli* in the field but may have some samples tested by a contract laboratory as needed.

Field blanks: Field blanks are created at the sampling site. The purpose of a field blank is to establish that a sample has not been contaminated by conditions associated with the collection or custody of a sample, or by cross-contamination during sample shipment. Potential field contamination sources are ambient air pollution, sample collection equipment, sample collection procedures, storage, and transport conditions, or filtering equipment.

Field filter blank: If a sample is filtered in the field, a blank should also be filtered, **at the site**, so that the blank shows the conditions under which the sample was filtered and to rule out equipment contamination.

Field sampling conditions blank: These are also called **ambient blanks**. If a sampler has any reason to suspect that ambient air pollution (from metals,

nitrates/nitrites, carbonates, for example) has the potential to contaminate water quality samples, a field sampling conditions blank should be prepared. A sample bottle containing only de-ionized water is left open near the sample collection site, downwind from the suspected source, during the time that the water chemistry samples are being collected and put into sample bottles. This type of blank is used to attempt to detect the influence of ambient air conditions on test results. Sampling conditions blanks are not used if the sample is being tested only for organics. See also the topics Trip Blank and Volatile Organic Compound (VOC) Blank below.

VOC blank: VOC blanks are used to assess the amount of contamination introduced into the sample from ambient VOC sources such as motors, heavy vehicle traffic areas, runways, and fumes from stored volatile organic compounds. VOC blanks may be prepared in the field office before a trip if the purpose is to assess the potential for contamination during the sampling trip. If the purpose of the blank is to assess the effect of ambient air conditions at the site, the blank is prepared by pouring organic-free reagent water into a 40 mL VOC glass sampling vial/bottle, which is handled and transported under the same conditions as the samples. These blanks are prepared downwind from the suspected contamination source. VOC blanks are analyzed only for VOC-type parameters.

Field equipment decontamination blank: A decontamination blank is used to verify that field equipment cleaning procedures work, that there is no cross-contamination among samples and that there is no contamination from the sample collection method. After the equipment is cleaned, it is rinsed with deionized water, which is collected in a sample bottle and submitted for analysis. This blank is especially useful for evaluating field cleaning procedures if it is prepared after sampling at a site known to be highly contaminated. Field equipment decontamination blanks are not used if the sample is being tested only for organics.

Trip blank: Trip blanks are created in the sampler's field office or field office laboratory, as part of the preparation for a sampling trip. The purpose of a trip blank is to establish that a sample is not being contaminated by the sample container, preservative(s), or storage and transport conditions. To create a trip blank, the sampler fills one container for each type of preservative used with deionized water and then adds the appropriate preservative. This is done before the trip. The trip blank stays unopened, is stored, and is shipped to the lab with the collected samples. See also the topic VOC blank above.

Preservative blank: A preservative blank is used any time a field sampler suspects or has reason to know that a preservative may be contributing to sample contamination or may be contributing to matrix effects. The preservative, in the usual amount for the parameter, is included in a pre-cleaned sample bottle filled

with de-ionized water of known quality. A preservative blank differs from a trip blank in that it is not subjected to field storage and transport conditions.

Bottle blank: Any time sample collection bottles of uncertain quality or from a new source are used for collecting samples, a bottle blank must be prepared. A bottle is filled with deionized water (dilution water) only and submitted to the laboratory for analysis.

Reference

United States Environmental Protection Agency, 40 CFR Part 136.7 Quality Assurances and Quality Control, e-CFR data current as of January 4, 2021

WDEQ/WQD, 2021. QAPP

United States Environmental Protection Agency Region IV, Environmental Investigations Standard Operating Procedures and Quality Assurance Manual, May 1996

Revision History

Date	Details of Revision	Revised by:
4/1/2021	Revision of September 2004 version	J. Scott
6/22/2021	Cherrie Nelson revised to meet Groundwater Section needs	Cherrie Nelson

COMPLETENESS
(EFFECTIVE DATE: SEPTEMBER 2004)

Quality Control

Completeness calculations for all Groundwater Section samples follow the Standard Operating Procedure (SOP).

Procedure

Definition of Completeness: Completeness is the percent of valid data for the project, field sampling season, parameter, method, or laboratory. For field samples and the laboratory, completeness is estimated and reported for each parameter. If different methods are used to analyze a parameter, completeness is calculated for each analytical method. Qualified data affect the completeness of the data set.

Calculating Completeness: The general calculation (ratio) for percent completeness is:

$$\frac{\text{number of valid (non-qualified) data points}}{\text{number of possible data points}} \text{ X } 100$$

Groundwater Section calculates completeness for several situations. Examples are:

1. Water Quality Laboratory (WQL) or commercial laboratory sample completeness (based on laboratory records) is reported in the annual Data Validation Report.
2. Completeness for the year for total samples submitted to the WQL non-qualified data points, and at the Supervisor's request, reported by parameter.
3. The program supervisor may choose to report field season completeness as the gross number of samples collected and/or the number of samples scheduled to be collected.

Reference

Natural Resources Conservation Service, National Handbook of Water Quality Monitoring, May 1998

Revision History

Date	Details of Revision	Revised by:
6/22/2021	Cherrie Nelson revised to meet Groundwater Section needs	Cherrie Nelson

CONVERSION FACTORS
(EFFECTIVE DATE: MARCH 2001)

Quality Control — Samplers use conversion factors supplied in Standard Operating Procedure (SOP).

Procedure — Common conversion factors are listed below.

Units of Length

If you have:	Multiply by:	To convert to:
centimeters	0.01	meters
centimeters	10	millimeters
centimeters	0.0328	feet
centimeters	0.3937	inches
feet	0.0001894	miles
feet	0.3333	yards
feet	30.48	centimeters
feet	0.3048	meters
inches	0.0833	feet
inches	25.4	millimeters
inches	2.54	centimeters
inches	0.0254	meters
inches	0.0278	yards
kilometers	0.621	miles
kilometers	3281	feet
kilometers	1000	meters
meters	3.281	feet
meters	1,000	millimeters
meters	100	centimeters
meters	0.001	kilometers
miles	1.609	kilometers
miles	1,609	meters
yards	0.9144	meters

Units of Volume

If you have:	Multiply by:	To convert to:
acre-foot	7.53×10^{7}	cubic inch
acre-foot	1230	cubic meter
cubic feet	2.832×10^{-2}	cubic meters
cubic feet	7.481	gallons
cubic feet	28.32	liters
cubic meters	264	gallons
cubic meters	1.308	cubic yards
cubic meters	1,000	liters
cubic inches	16.39	cubic centimeters
cubic inches	16.39	milliliters
cubic inches	0.016387	liters
cubic yards	0.7646	cubic meters
cubic centimeters	6.102×10^{-2}	cubic inches
cubic meters	35.31	cubic feet
cubic yards	0.7645549	cubic meters
gallons	3.785×10^{-3}	cubic meters
gallons	3.785	liters
gallons	1.337×10^{-1}	cubic feet
gallons	0.00378	cubic meters
liters	3.531×10^{-2}	cubic feet
liters	0.001	cubic meters
liters	4.226	cups
liters	2.113	pints
liters	1,000	milliliters
liters	1.057	quarts
liters	0.2642	gallons
pints, liquid	473.176	milliliters
quarts, liquid	0.946353	liters

Units for Flow and Discharge

If you have:	Multiply by:	To convert to:
acre-foot / day	226	gallons / minute
acre-foot / day	3.26×10^{5}	gallons / day
acre-foot/day	0.504	cubic feet / second
centimeters / second	2.128×10^{4}	gallons / day / square foot
cubic meters / day	0.1834	gallons / minute
cubic feet / day	7.48	gallons / day
cubic feet / day	1.16×10^{-5}	cubic feet / second
cubic feet / day	3.28×10^{-7}	cubic meters / second
cubic feet / second (cfs)	2.832×10^{-1}	liters / second
cubic feet / second (cfs)	6.46×10^{5}	gallons / day
cubic feet / second (cfs)	86,400	cubic feet / day
cubic feet / second (cfs)	449	gallons / minute
cubic feet / second (cfs)	1.98	acre feet / day
cubic feet / second (cfs)	0.0283	cubic meters / second
feet / day	7.479	gallons / day / square foot
gallons / day / square foot	4.716×10^{-5}	centimeters / second
gallons / day / square foot	4.075×10^{-2}	meters / day
gallons / minute (gpm)	6.309×10^{-2}	liters / second
gallons / minute (gpm)	193	cubic feet / day
gallons / day / square foot	0.1337	feet / day
gallons / minute (gpm)	2.23×10^{-3}	cubic feet / second
gallons / minute (gpm)	6.31×10^{-5}	cubic meters / second
liters / second	3.531×10^{-2}	cubic feet / second (cfs)
liters / second	15.85	gallons / minute
meters / day	24.54	gallons / day / square foot

Units of Temperature

If you have:	Multiply by:	To convert to:
degrees C (°C)	9/5 (ºC) + 32	°F
degrees F (°F)	5/9 (ºF) - 32	°C

Units of Area

If you have:	Multiply by:	To convert to:
acres	0.4047	hectares
acres	0.004046	square kilometers
acres	4,406.856	square meters
hectares	3.861×10^{-3}	square miles
hectares	2.471	acres
hectares	0.01	square kilometers
hectares	10,000	square meters
square centimeters	0.0001	square meters
square inches	6.4516	square centimeters
square inches	0.000645	square meters
square feet	929.0304	square centimeters
square meters	10.77	square feet
square miles	259	hectares
square miles	2.59	square kilometers
square kilometers	100	hectares
square feet	9.29×10^{-2}	square meters
square kilometers	0.3861	square miles
square yards	0.836127	square meters

Units of Mass

If you have:	Multiply by:	To convert to:
grams	0.035	ounces
grams	0.002	pounds
grams	0.001	kilograms
kilograms	1000	grams
kilograms	35.274	ounces
kilograms	2.205	pounds
ounces	28.35	grams
ounces	0.028349	kilograms
pounds	453.59	grams
pounds	.454	kilograms
pounds	0.00045359	metric tons

Miscellaneous conversions

1 inch of runoff per square mile =
53.3 acre-feet
2,323,200 cubic feet

1 cubic foot per second = 0.9917 acre-inch per hour

1 foot per second = 0.6818 miles per hour

1:24,000 map scale =
2.64 inches per mile
0.3788 miles per inch
0.1435 square miles per square inch

1:125,000 map scale =
0.5069 inches per mile
1.9728 miles per inch
3.892 square miles per square inch

Reference None required; internal information

Quality Control

Records are archived following the Standard Operating Procedure (SOP).

Procedure

Groundwater Section sampling data and associated records are archived according to the procedures at the Wyoming State Archives, the State Agency Crosswalk Schedule from the Wyoming State Archives, and the Wyoming Department of Environmental Quality (WDEQ) Water Quality Division (WQD) associated policies.

All state agency records, which are no longer needed in offices for conducting current business but must be kept for legal, administrative, or informational purposes, are typically scanned and uploaded to the WQD SharePoint site

All public records are the property of the state, but for records management, records remain the property of the agency of record (WDEQ) during the time they are stored.

Retrieving records: Records can be retrieved by making public records requests through the NextRequest system or contacting the WQD Information Management Services (IMS) team to help track down a particular record.

Retention Time: The Wyoming State Archives publish a records retention schedule accessible through their website (link above). WDEQ retention schedules have a Government and Compliance (GAC) number associated with each type of record. Examples of the GAC numbers and retention descriptions for the WQD are in the table below. Retention times are subject to reevaluation and change.

State of Wyoming Records Retention

Retention Schedule	Type of Record	Retention Description
GAC-ENV-08	Water quality enforcement files (previously AR 8044)	Retain 99 years after calendar year-end then destroy
GAC-ENV-08	Water quality monitoring reports (previously AR 8047)	Retain 99 years after calendar year-end then destroy
GAC-ENV-09	Water sample records (previously AR 8048)	Retain 5 years after completion then destroy ('Completion' for these records is the date of the final report)

Retention Schedule	Type of Record	Retention Description
GAC-ENV-14	Chronological files (previously AR 91-274)	Retain 15 years after calendar year-end then destroy (See WQD Policy #6)
GAC-ENV-07	Quality Assurance Program Plans (QAPPs), Sampling and Analysis Plans (SAPs), etc.	Retain 10 years until expiration then destroy

Reference State Agency Crosswalk Schedule, State of Wyoming, State Archives, Records Management Services. January 2020.

Revision History

Date	Details of Revision	Revised by:
4/1/2021	Revision of March 2001 version.	J. Scott
6/22/2021	Cherrie Nelson revised to meet Groundwater Section needs	Cherrie Nelson

Quality Control

Data validation is the process that determines whether data analysis or data collection Quality Control (QC) objectives were met. The result of the data validation process for each data set is a decision to accept the data unconditionally, to qualify the data set, or to reject it. Data that are rejected cannot be used at all. Data that may or may not be useable are qualified, and the reasons for the qualification are given so that the data set users can evaluate its suitability. The qualification codes are a part of the metadata file which accompanies each data set and should be archived with the data for possible future use.

Procedure

Data Qualifier Codes

The following codes should be used when reporting or archiving sample data values that do not meet the applicable quality control criteria specified for the contract laboratory or field data collection methods. These codes should be added to sample results during the data review process that is conducted by either the Quality Assurance (QA) Officer, other qualified responsible parties, or persons under their supervision, which will result in data of a known, identified, and defensible analytical and sampling quality.

Data Qualifier Codes	
Qualifier:	Definition:
WQD Laboratory Method Analysis Qualifiers	
D	The reported value is from a dilution or raised reporting limit.
I	Internal standard performance was unsatisfactory.
H	The EPA recommended holding time was exceeded.
M	Method/Prep method used not listed in 40 CFR Part 136, alternate method chosen is acceptable based on passing quality control samples taken through the same process as the samples.
Laboratory Concentration Qualifiers	
J	The reported value was obtained from a reading that was less than the Practical Quantitation Limit (PQL) but greater than or equal to the Method Detection Limit (MDL).
U	The analyte was present but was not detected above the MDL.
WQD Laboratory Data Quality Qualifiers	
*	Quality control analyses are outside of the control limits.
B	The laboratory reagent blank exceeds the reporting limit for that analyte.
E	The reported value is estimated due to the presence of interference. NOTE: A case narrative section should be included if a qualifier is used.

Data Qualifier Codes	
Qualifier:	Definition:
Q	Laboratory duplicate analysis is not within control limits.
S	Spike and/or spike duplicate sample recovery not within the control limits.
R	The sample results are rejected due to serious deficiencies in the ability to analyze the sample and meet quality control criteria. The presence or absence of the analyte cannot be verified.
TP	The total phosphorus results are less than the orthophosphate results, and the difference between the two is greater than the error ratio of the analytical methods or the method reporting limits.
WQD Field Data Quality Qualifiers	
FD	Field duplicate results are not within the control limits.
FB	The field/equipment blank exceeds the reporting limit for that analyte.
TB	The trip blank exceeds the reporting limit for that analyte.
TE	The sample was received above the recommended temperature. NOTE: A case narrative section should be included if a qualifier is used. If a sample was received frozen or if a sample did not have sufficient time to reach recommended temperature but it was noted that it was on ice, then this should be documented.
P	Sample was received with improper or insufficient chemical preservative.
T	The difference between the higher dissolved result and the total result is greater than the error ratio of the analytical method or method reporting limit.

Reference None, internal standard.

Revision History

Date	Details of Revision	Revised by:
4/1/2021	New SOP	J. Scott
6/22/2021	Cherrie Nelson revised to meet Groundwater Section needs	Cherrie Nelson

DATA VALIDATION
(EFFECTIVE DATE: APRIL 2021)

Quality Control

Data validation is performed by the Quality Assurance (QA) Officer, other qualified, responsible parties, or persons under their supervision after data verification is complete and will result in data of a known, identified, and defensible analytical and sampling quality. Data cannot be used for Groundwater Section decision-making until after the data validation process is complete and documented in a Data Validation Report (see Standard Operating Procedure (SOP) for **Data Validation Report**).

Data validation does not make determinations about the overall usability of the data for a specific project. Only the end-user (internal or external) can make that decision based on the documented measurement error and sampling variability of the data set of interest. The purpose of data validation is to demonstrate, by using a documented systematic set of assessment criteria, that a data set meets project monitoring requirements and that data comply with the Section Quality Assurance Program Plan (QAPP), project-specific Sampling and Analysis Plan (SAP), credible data requirements defined at Wyoming State Statute 35-11-103 (c) (xix).

Procedure

The data validation assessment process addresses data accuracy, precision, completeness, and usability. The data validation process described in this SOP applies to any data, chemical, biological or physical, which is to be incorporated in Groundwater Section databases or considered in Groundwater Section decision-making.

Monitoring: Refer to the Groundwater Section QAPP for a list of program decisions.

Turnaround Time: Laboratory data validation must be complete within one month from receipt of analytical results from the laboratory. All data validation steps (see below) for a data set must be completed and reported out within an additional four working days if possible.

Data qualification: Data validation is the process that determines whether data analysis or data collection Quality Control (QC) objectives were met. The result of the data validation process for each data set is a decision to accept the data unconditionally, to qualify the data set, or to reject it. Data that are rejected cannot be used at all. Data that may or may not be useable are qualified, and the reasons for the qualification are given so that data set users can evaluate its suitability. The qualification codes (see SOP for **Data Qualifier Procedure**) are a part of the metadata file which accompanies each data set and should be

archived with the data for possible future use. Data Validation also includes a decision about the usability of data that does not meet project-specific data criteria.

Data Validation Process: Groundwater Section data validation steps are:

1. Review the project data and all information associated with its collection. Be sure that all required documents and forms (including laboratory forms) were filled out correctly and completely, including Field Log Books, Monitoring or other field data forms and supporting documentation, equipment calibration logs, and Chain of Custody forms. Verify that chain of custody was maintained as described in the SOP for **Chain of Custody (COC)**. This step ensures that the data are legally defensible. Any data set has the potential of being used in court.
2. Verify that all field quality control samples were collected at the frequency specified by the project Data Quality Objectives (DQOs) documented in the project SAP. Validate that the laboratory quality control standards are within compliance, and results are included in the data package. Items to be verified include but are not limited to holding times, sample preservation and storage, sampling techniques, and QC sample results (duplicates, spikes, blanks). Any QC issues or findings (laboratory or field) must be discussed in the Data Validation Report (see SOP for **Data Validation Report**).
3. Examine the raw data and verify calculations and the transfer accuracy of about 10% of all raw data unless errors are found. If errors are identified, another 10% of the raw data must be examined.
4. Examine the raw data for very high or very low values, or unexpected values, which may result from misplaced decimal points, transcription errors, rounding errors, operator errors, or instrument malfunction. Discrepancies must be resolved, and the discrepancy and the resolution process must be described in the Validation Report (see SOP for **Data Validation Report**) and included in the data set metadata document.

Non-compliant laboratory data: For contract sample analyses, any non-compliant (based on laboratory analytical technical specifications in the contract) data that are unusable (based on project data objectives) are rejected and returned to the contract laboratory. The analytical results are listed as "rejected" in the Data Validation Report and qualified in the database. The contract laboratory may be able to demonstrate the resolution of the non-compliant data utilizing a written response, which must be provided within 30 days of the data rejection notification. If the issues are resolved, the data are reclassified.

Sampling error, measurement error, and total uncertainty: Data validation identifies all possible analytical errors and/ or sampling errors associated with the data. Examples of sampling errors are contaminated blanks, incorrect storage or preservation, improper sampling techniques, improper containers, missing or

incomplete COCs, missing or incomplete field QC samples, and incorrect sample labeling and operator error. The sum of the analytical error and sampling error is called the measurement error. Total error or total uncertainty of the data is the sum of the measurement error and the sampling (spatial) variability. Total error/total uncertainty is used to determine whether the data meet project objectives.

Analytical data validation: Groundwater Section analytical data validation is carried out by the Water Quality Laboratory (WQL) or commercial laboratory and by any contract laboratory used by the Program for sample analysis. Validation results are sent to the appropriate project manager.

Sampling data validation: Groundwater Section sampling data validation is performed by the field sampler who collected the data EXCEPT for total coliform and *Escherichia coli (E. coli)* samples, which must be validated by another sampler (refer to SOP for ***Escherichia coli* & Total Coliform Bacteria Colilert ® Defined-Enzyme Substrate Method**).

Independent review: An independent third party in the Groundwater Section reviews results from both the analytical and sampling data validations.

Field data Quality Control (QC): The number and type of field QC samples should comply with project objectives. Field QC samples provide information to the data validator about sampling conditions, sampling techniques, field precision, and sample homogeneity. The data validator confirms that field QC samples were sent to the laboratory at the required frequency. If they were not, the data validator must note this deviation in the Data Validation Report (see SOP for **Data Validation Report**) and summary memo. Properly completed and submitted Chain of Custody forms are a required part of field data QC. The data validator may not be responsible for evaluating field sampling notes; however, they are required as part of data validation, and copies may be included in the Data Validation Report. All field notes and sampling forms must be legible and conform to the requirements in their SOPs to support potential litigation.

Data Validation Report: Refer to the SOP for a **Data Validation Report** for the content, format, and report frequency.

Corrective actions: Corrective actions may eliminate the need to qualify or reject data. All corrective actions and their results must be documented in the data validation report, the Quality Assurance/Quality Control (QA/QC) files, the database, and the QAPP annual review.

Monitoring: The data validator should note blanks or duplicates are not identified correctly on the Chain of Custody form, samples are not identified correctly (refer to the SOP for **Sample Labeling**), sample temperature is not in compliance (refer to the SOP for **Temperature Blank**), COC is not maintained

(refer to the SOP for **Chain of Custody (COC)**), or contamination is found (refer to the SOP for **Blank Samples**). These deviations from the required field QC are a part of the Data Validation Report.

The WQL or contract laboratory supervisors are responsible for determining, implementing, monitoring, and reporting on the continued effectiveness of all corrective actions. The program supervisor is responsible for obtaining re-testing samples for all non-compliant data, if possible, and determining whether the degree of measurement error compromises data usability as defined in the Program QAPP or project SAP. All corrective action decisions and their effectiveness are documented in the Data Validation Report and QAPP annual review.

Reference

United States Environmental Protection Agency, EPA Requirements for Quality Assurance Project Plans for Environmental Data Operations, QA/R-5, October 1998.

United States Environmental Protection Agency, The Volunteer Monitor's Guide to Quality Assurance Project Plans, EPA 841-B-96-003, September 1996.

United States Environmental Protection Agency, Region 1 Data Validation Guidance, November 1998.

United States Environmental Protection Agency, Region 4 Environmental Investigations Standard Operating Procedures and Quality Assurance Manual, May 1996.

United States Environmental Protection Agency, Guidance on Environmental Data Verification and Validation, QA/G-8, Draft August 1999

Revision History

Date	Details of Revision	Revised by:
4/1/2021	Revision of September 2004 version	J. Scott
6/22/2021	Cherrie Nelson revised to meet Groundwater Section needs	Cherrie Nelson

Quality Control

The Data Validation Report addresses analytical deficiencies and field Quality Control non-compliance. A report is prepared annually by the Quality Assurance (QA) Officer. A Data Validation Report helps ensure that data comply with the credible data requirements defined in Wyoming State Statute 35-11-103 (c) (xix).

Monitoring: Based on the data uses defined in the Section Quality Assurance Program Plan (QAPP) and project Sampling and Analysis Plan (SAP), the Data Validation Report documents the degree to which the amount of sampling error and measurement error associated with the data has the potential to compromise data usability. The Monitoring Data Validation Report is based on laboratory analytical results and field sampling information from field logs and Chain of Custody forms. The Data Validation Report is submitted to the program supervisor and project manager, who use it to initiate the corrective action(s) described in the Program QAPP and the project SAP, track their effect, and report on their implementation.

Procedure

A partially complete Data Validation Report may be produced to meet project needs, and later amended to include the missing information.

Report Contents:
Cover Page: project title, the organization responsible for the generation of the data, report date, and name of the person preparing the report.

Assessment of Data Usability: the assignment of data qualification codes and a narrative statement of usability of data results based on QAPP.

The GWS Data Validation and Usability Summary Report Form is in **Appendix F.**

Summary of Sample Results (optional)

Summary of Quality Assurance/Quality Control (QA/QC) Results: precision (field and laboratory), analytical accuracy, decontamination, and cross-contamination issues (if any), method conformance, a narrative that discusses any deviations from the QAPP, including quality control failures, and the impact of those failures on the data.

Sampling Error and Analytical Error: The data validation report should differentiate between sampling error (field) and analytical error (laboratory).

Examples of sampling errors are contaminated blanks, incorrect preservation, incorrect sampling procedure, headspace in volatile organics sample containers, and exceeding holding times.

Non-Compliance: All non-compliance (laboratory and field) must be documented by the validator to determine data usability for project monitoring objectives. If, for example, holding times were exceeded, the data validator assesses and reports on the reduced worth of the data. Any sample results other than "unconditionally accepted" must be identified and qualified.

The report must document all factors contributing to analytical error and sampling error. Non-compliant data that do not meet project requirements together with potential methods or Quality Control (QC) problems are identified. Each qualified sample number must be listed individually, and the data evaluation grouped by the sampler.

Summary: Summary information is provided in tables wherever possible. Issues addressed in the report include the data validation criteria (refer to Standard Operating Procedure (SOP) for **Data Validation**); field QC samples (refer to SOPs for **Duplicate Samples**, **Blank Samples**, and **Spike Samples**); completeness, laboratory, and field (refer to the SOP for **Completeness**); sampling error, determined from duplicate samples (refer to the SOP for **Precision (Field Duplicates)**); maintenance of Chain of Custody (refer to SOP for **Chain of Custody (COC)**); preservation or holding time exceedances (refer to SOP for **Sample Parameters, Methods, Preservation, and Holding Times**); calibration records (refer to the SOP for **Instrument Calibration and Calibration Logs**); legibility of forms, labels, and log book entries; correct and complete identification of all samples (refer to SOP for **Sample Labeling**); the existence of applicable Field Log Books and notes (refer to SOP for **Field Log Books**); and recommended corrective actions. This does not include evaluation of the log books for completeness, correctness, and proper archiving, which is under the oversight of the program supervisor.

Disposition of Report: Copies are sent to the appropriate project manager. The report is a permanent part of the project file.

Reference

United States Environmental Protection Agency, Region 1 Revised Data Validation Guidance, November 1998.

United States Environmental Protection Agency, Region 4 Environmental Investigations Standard Operating Procedures and Quality Assurance Manual, May 1996.

United States Environmental Protection Agency, EPA Requirements for Quality Assurance Project Plans for Environmental Data Operations, EPA QA/R-5, October 1998.

United States Environmental Protection Agency, Guidance on Environmental Data Verification and Validation, QA/G-8, Draft August 1999.

Revision History

Date	Details of Revision	Revised by:
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6/22/2021	Cherrie Nelson revised to meet Groundwater Section needs	Cherrie Nelson

DATA VERIFICATION
(EFFECTIVE DATE: APRIL 2021)

Quality Control

Data verification is required and must be done before Data Validation or before any monitoring data are used for project/program decision making. Data verification must be completed to reduce the possibility of repetitive errors within seven working days after receipt of the laboratory analytical report results for a set of samples.

A random 10% of all computer entries for a data set will be spot-checked for errors. If no errors are found, the computer entries are accepted. If errors are found, another 10% will be checked until the sub-set is error-free. All error corrections must be documented. The program supervisor is responsible for the final review and sign-off of monitoring Field Data Sheets.

Procedure

Purpose: Data verification demonstrates that a data set meets a specified set of criteria that are described in the Section Quality Assurance Program Plan (QAPP) and project-specific Sampling and Analysis Plan (SAP), and that data comply with credible data requirements defined at Wyoming State Statute 35-11-103 (c) (xix). Data verification is performed **before** data validation (refer to Standard Operating Procedure (SOP) for **Data Validation**) initially by the person who collected the data and is spot-checked by their supervisor(s). This systematic process evaluates data collection performance and compliance against a set of project standards for completeness, correctness, and consistency.

Examples of data verification activities:

Procedure or Step	Purpose	Responsible Party Groundwater Section Monitoring
Sampler training	Verifies that project staff are qualified to perform the work to be done	Program Supervisor
Field data collection audit	Verifies that applicable SOPs are followed for sample collection	Quality Assurance (QA) Officer
Field blank and duplicate sample collection	Verifies that the required number of blanks and duplicates are collected	Field Sampler/ Program Supervisor/QA Officer
Calibration and calibration log (field equipment)	Verifies that field instruments have been calibrated according to the manufacturer's instructions and that the calibration is documented in the log	Field Sampler/QA Officer

Procedure or Step	Purpose	Responsible Party Groundwater Section Monitoring
Calibration corrective action	Verifies that the appropriate action is taken if the calibration/calibration log fails to meet acceptance criteria	Program Supervisor
Sample preservation and handling	Verifies sample integrity (temperature, macroinvertebrate preservation, chain of custody form entries, custody seal)	Field Sampler/ Water Quality Division (WQD) Laboratory/Contract Laboratory/QA Officer
Instrument inspection and maintenance	Verifies that all sampling equipment is in proper operating condition and that logs are correctly filled out	Field Sampler/ Program supervisor/QA Officer
Data entry	Verifies that the internal checks used to ensure correct data entry, consistent data elements, and the procedures for documenting and correcting data entry errors are followed	Program Supervisor
Calculations	Verifies correctness of calculation methods and results	Field Sampler/ Program Supervisor
Raw data	Examine raw data (including Field Data Sheets) for anomalies (transcription errors, calculation errors, outliers) and missing information	Field Sampler/WQD Laboratory Supervisor/ Program Supervisor /QA Officer
Chain of Custody documentation	Verifies that a complete chain of custody exists for the sample from the time of collection until disposal and that all documentation is complete and properly filed	Program Supervisor /QA Officer
Sample records documentation	Verifies that an accurate record (field data sheets and field log) was maintained and is properly filed for sample collection and treatment (preservation and shipping) from time of collection until disposal	Field Sampler/ Program Supervisor /QA Officer
Documentation of Quality Control (QC) results	Document effectiveness of QC measures (instrument calibration verification, field data sheets, log books, QC samples, or laboratory QC) in corrective action reports	QA Officer/ Program Supervisor or other responsible parties
Documentation of field corrective action	Reports that corrective actions were taken and the effectiveness when SOPs or other standard field practices are not followed	Program Supervisor

Procedure or Step	Purpose	Responsible Party Groundwater Section Monitoring
Field sampler self-assessments	Deficiencies and problems recorded during monitoring activities are reported to the program supervisor or other responsible party	Field Sampler
Document location and format of computer files	Verifies that the location, format, media, and platform of original computer files and backup copies are a part of project records	Program Supervisor

These activities are performed in a logical sequence best suited to maintain workflow.

Error Correction Procedures:

Monitoring: All error correction is performed under the supervision of the program supervisor, who determines, initiates, and documents the applicable corrective action, and reviews the corrective action(s) for adequacy. Decisions to discard or qualify data are made by the program supervisor and Quality Assurance Officer.

Examples of error correction procedures are:

- Report any readings or analytical results that do not make sense and take a second sample as quickly as possible
- Correct data entry errors
- Flag outliers and inconsistent values for further review, or discard them investigate and, if possible, repair any missing data
- Personnel performance evaluations by the program supervisor
- Document all error corrections

Reference

United States Environmental Protection Agency, EPA Requirements for Quality Assurance Project Plans for Environmental Data Operations, QA/R-5, October 1998.

United States Environmental Protection Agency, The Volunteer Monitor's Guide to Quality Assurance Project Plans, EPA 841-B-96-003, September 1996.

United States Environmental Protection Agency, Region 1 Data Validation Guidance, November 1998.

United States Environmental Protection Agency, Region 4 Environmental Investigations Standard Operating Procedures and Quality Assurance Manual, May 1996.

United States Environmental Protection Agency, Guidance on Environmental Data Verification and Validation, QA/G-8, (Draft) August 1999.

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6/22/2021	Cherrie Nelson revised to meet Groundwater Section needs	Cherrie Nelson

Quality Control

The Data Verification Report addresses quality control: deviations from the Quality Assurance Program Plan (QAPP), analytical methods, or Standard Operating Procedures (SOPs). A report is prepared during the sampling season by the Quality Assurance (QA) Officer, program supervisor, or another responsible party, based in part on laboratory analytical reports from the Water Quality Laboratory (WQL) and contract laboratory reports. A Data Verification Report helps ensure that data comply with the QAPP, project Sampling and Analysis Plans (SAPs), and credible data requirements defined in Wyoming State Statute 35-11-103 (c) (xix).

Monitoring: Data verification activities to be reported on are described in Table 3, Data Quality Indicators for Groundwater Section Environmental Data Collection, of the QAPP, and the project SOP for **Data Verification**. The Data Verification Report is either prepared by or submitted to the program supervisor and project manager, who use it to initiate the corrective action(s) described in the QAPP and project SAP, track their effect and report on their implementation. These actions are documented in the annual QAPP review.

Procedure

A partially complete Data Validation Report may be produced to meet project needs and later amended to include the missing information.

Report Contents:

- Cover Page: project title, the organization responsible for the generation of the data, report date, name of the person preparing the report
- Data Verification: headings for issues to be addressed are:
  - Sample Collection
  - Field Measurements
  - Sample Custody, Preservation, Holding Times, and, Tracking
  - Instrument Calibration and Maintenance
- Data Reduction and Reporting
- Quality Control Results: assess the compliance with the analytical methods, SOPs, and general quality systems
- Corrective Actions: for each finding of non-compliance in the Data Verification section, the responsible party must be identified and the corrective action documented; this information can be presented in a table

The data verifier or other responsible party and program supervisor will make all possible efforts to recover missing data/information and to correct existing incomplete or inaccurate information which is identified in this report.

Report Format: Summary information is provided in tables wherever possible.

Disposition of Report: Copies are sent to the program supervisor and the project manager. The report is a permanent part of the project file.

Reference

United States Environmental Protection Agency, Region 1 Revised Data Validation Guidance, November 1998.

United States Environmental Protection Agency, Region 4 Environmental Investigations Standard Operating Procedures and Quality Assurance Manual, May 1996.

United States Environmental Protection Agency, EPA Requirements for Quality Assurance Project Plans for Environmental Data Operations, EPA QA/R-5, October 1998.

United States Environmental Protection Agency, Guidance on Environmental Data Verification and Validation, QA/G-8, Draft August 1999.

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DUPLICATE SAMPLES
(EFFECTIVE DATE: APRIL 2021)

Quality Control

Duplicate samples are used for Quality Control (QC) in the laboratory and field to verify the precision of laboratory or field equipment, sampling methods, and the representativeness of the sample. Duplicate samples should be collected at random times during the day, week, and sampling season to provide a meaningful evaluation of sampling precision.

Quality control samples are required and must be collected.

Procedure

Definition of field duplicate samples: Duplicate water quality samples are usually defined as:

- Two or more samples collected concurrently (sample bottles filled at the same time) or consecutively (sample bottles filled one immediately after the other) at the same site.
- Two or more samples from one sample collection pail.
- Two or more measurements made concurrently or consecutively with a field instrument.

The sample collection procedure for each field sample identified as a duplicate must be documented in the sampler's Field Log Book or Field Data Sheet as an aid in interpreting analytical results.

Purpose of duplicate samples: The purpose of a duplicate sample is to estimate the inherent variability of a procedure, technique, characteristic, or pollutant.

When to do duplicate field samples/analyses: Duplicate sample collection and analysis may be conducted in the field: 1) as a form of field quality control; 2) to measure or quantify the homogeneity of the sample, the stability, and representativeness of a monitoring site, the sample collection method(s), or the sampler's technique. If a site is being repetitively sampled at close intervals by the same person, or, if a site is being repetitively sampled by multiple persons who are randomly chosen from among a group, collecting duplicate samples has a Quality Assurance/Quality Control (QA/QC) value. The decision of whether, when, and how to collect duplicate samples is project-specific. The duplicate sampling protocol is described below.

Water Quality Laboratory (WQL) QC duplicate analyses: The WQL typically performs a duplicate quality control sample on every tenth sample for each analysis requested, as documented in the laboratory QA/QC plan. Duplicates are analyzed in the laboratory for the same parameters as the monitoring sample to

which they apply. Laboratory duplicates that exceed QA/QC standards for the parameter or analytical method are reanalyzed. If they still exceed laboratory QC limits, the analytical results are reported and qualified. All field duplicate sample data that exceed project precision criteria for duplicates, as described above, must be evaluated as field sampling errors. Field duplicate sample analytical results are shown on the laboratory analysis report, which is supplied to the field sampler who submitted the samples. The laboratory analytical report must show quality control results for the laboratory duplicates, laboratory reagent blanks, and matrix spikes for each of the analytical method/parameter requests, and the summary results for quality control statistical calculations. Copies of these analytical reports are a permanent part of the site file. The WQL will retain the analytical report for at least five years. Blind duplicates are not required in the WQL because the laboratory assigns its sample numbers for testing. The Laboratory Supervisor takes immediate corrective action on any laboratory test results issues.

Contract Laboratory QC duplicate analyses: Each contract laboratory used for Groundwater Section work must have an approved QA/QC Plan which describes the number, kind, and frequency of laboratory duplicates, laboratory reagent blanks, and matrix spikes, the precision for duplicates, the acceptance criteria for matrix spikes and additional control standards, for each parameter/analytical method, and describes the summary statistics and corrective actions to be taken when out of compliance. The laboratory analytical report must show results for the laboratory duplicates, laboratory reagent blanks, and matrix spikes, for each of the analytical method/parameter requests, and the summary results for quality control statistical calculations. The laboratory must define whether blind duplicates are required.

Monitoring duplicate field biological or water chemistry samples: For water chemistry samples, a duplicate sample means two sample collection bottles filled consecutively or concurrently at the same site, or from one sample collection pail at the same site by the same person, preserved and transported the same way, and submitted to the WQL or commercial laboratory for the same parameter(s)/analysis(es). Duplicate field samples must be collected every tenth sample and have a passing precision Relative Percent Difference (RPDs) (refer to the Standard Operating Procedure (SOP) for **Precision (Field Duplicates)**).

For monitoring biological or water chemistry, every tenth sample collected means:

- For a field sampler working alone, every tenth site visited must be sampled in duplicate unless the sampler is scheduled to sample at ten or fewer sites, in which case one of them must be sampled in duplicate;
- For a field sampler working as part of a crew, every tenth site visited by the crew must be sampled in duplicate unless the crew is scheduled to

sample at ten or fewer sites, in which case one of them must be sampled in duplicate;
- Unless for either a) or b), a site is scheduled for multiple sampling, in which case one sample must be duplicated if ten or fewer sampling events are scheduled, or every tenth sample must be duplicated if more than ten sampling events are scheduled.

Field equipment duplicate field parameter samples: parameter measurements made in the field can be duplicated to estimate the precision of the equipment. Every tenth measurement may be duplicated, and the results of both measurements are recorded and evaluated as an RPD or RSD (refer to the SOP for **Precision [Field Duplicates]**). The result can be compared with the stated precision of the instrument.

Using duplicate sample analytical results: Results from duplicate field samples or field tests can be used to estimate sampling precision (analytical precision is determined by the laboratory). Precision is defined as how closely repeated measurements agree with each other. Interpreting the precision of some parameter results may depend upon knowing how the duplicate sample was collected (refer to the topic Definition of Field Duplicate Samples, above). However, if the sample is representative and the sampling methods are consistent (two samples collected consecutively or concurrently at the same site, two samples from one sample collection pail at the same site, or two measurements made consecutively or concurrently with a field instrument), the precision RPDs usually agree very closely. Refer to the SOP for **Precision (Field Duplicates)** for acceptable RPD percentages and calculation methods.

Reference

United States Environmental Protection Agency, 40 CFR Part 136.7 Quality Assurances and Quality Control, e-CFR data current as of January 4, 2021

Revision to Rapid Bioassessment Protocols for use in Streams and rivers: Periphyton, Benthic Macroinvertebrates and Fish, United States Environmental Protection Agency, EPA 841-D-97-002, May 1999.

Natural Resources Conservation Service, National Handbook of Water Quality Monitoring, May 1998.

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6/22/2021	Cherrie Nelson revised to meet Groundwater Section needs	Cherrie Nelson

HOLDING TIME, DEFINITION
(EFFECTIVE DATE: APRIL 2021)

Quality Control

Field personnel are responsible for submitting samples in time for the laboratory to meet analysis method holding time requirements.

A notation should be made in the Remarks section of the Chain of Custody Form if any samples exceed the method holding time(s) before laboratory receipt. The holding time exceedances should also be noted in the laboratory analytical report, either as a qualifier or as a notation for the parameter associated with the holding time exceedance.

The Quality Assurance (QA) Officer and the Program Manager for whom the data were collected decide whether to use the data based on program/project Data Quality Objectives.

Procedure

Holding time begins when a sample is collected.

Holding time is the United States Environmental Protection Agency (USEPA) recommended time (days, hours, etc.) that a sample can be kept before analysis must be performed. If this time is exceeded, the results must be qualified. Refer to the Standard Operating Procedure (SOP) for **Sample Parameters, Methods, Preservation, and Holding Times** for the specific holding times for each parameter.

Reference

United States Environmental Protection Agency, 40 CFR Part 136.3 Table II – Required Containers, Preservation Techniques, and Holding Times, e-CFR data current as of January 4, 2021

Revision History

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Quality Control

Each instrument must have a log in the form of a permanently bound log book or a standard calibration log form. The Wyoming Department of Environmental Quality (WDEQ) calibration log form can be found in **Appendix B** of this manual. The cover of the log book or log form must contain the following information: the instrument make, model, and serial number; the State of Wyoming Property Tag number (if applicable); the date the instrument was placed in service, and the date it is taken out of service; and the name of the sampler to whom it is assigned. All standard calibration log forms for each instrument must be completed and stored within a 3-ring binder or another suitable storage unit.

If information related to the instrument occupies more than one log book, the books must be numbered sequentially, and no pages may be removed.

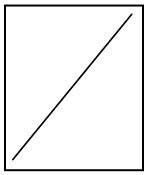
The inside front cover is used for signature identification of the sampler and all other persons who make entries in the log book. The sampler's signature and a chosen set of written (not printed) identifying initials must be shown. The sampler's identifying initials, written as shown on the inside front cover, must be used for any activity which requires sign-off. Any person who makes an entry in the log book must sign the inside front cover with their full name and identifying initials and use those initials as shown for all entries in the log book.

Calibration log books or standard calibration logs are hereafter referenced as 'log' within this Standard Operating Procedure (SOP).

Corrections: Corrections to instrument calibration logs are made by making one line through the incorrect information in such a way that the incorrect information can still be read and write the correct information in the next available space.

Example: ~~elevation 3,476 ft~~ elevation 5,470 ft

If an entire page contains incorrect information, **one** diagonal line is drawn on the page, and the correct information is recorded in the next available space.



All corrections must be initialed and dated. All persons who make entries in the log must sign and date the entry in the field provided.

Calibration and maintenance: The log must be kept with the instrument during any internal repairs, maintenance, or calibrations. All repairs, maintenance, or calibrations will be recorded in sequence with the applicable information, rather than in a separate section or on a separate page.

Log archiving: When the instrument is taken out of service, the log must be retained with the Water Quality Division (WQD) for seven years and be available on demand for audit or inspection. Logs will be filed in chronological order by date of use.

Procedure

Calibration, field checks, and repair or maintenance information are recorded in sequence in the log.

Calibration and Maintenance: All instrument calibration procedures and scheduled maintenance are conducted per the manufacturer's recommendations or approved analytical method(s) listed in individual SOPs in this manual. At a minimum, all field instruments are returned to the WQD at the end of each field season to be inspected, cleaned, repaired if necessary, and calibrated by WQD monitoring personnel. They are returned to the field before the next field sampling season. If specific instruments require more frequent calibrations or field checks due to intense use, environmental conditions that exceed normal operating conditions, or suspected stability problems, both calibration and maintenance may exceed the manufacturer's recommendations. Malfunctioning instruments are returned to the manufacturer for maintenance, repair, or replacement.

Field Checks: Refer to the SOP for **Quality Control Measures, Summary of** an individual instrument SOPs.

Reference

United States Environmental Protection Agency, 40 CFR Part 136.7 Quality Assurances and Quality Control, e-CFR data current as of January 4, 2021

Intergovernmental Task Force on Monitoring Water Quality (ITFM) Final Report: Strategy for Improving Water Quality Monitoring in the United States, OFR-95-742, 1995, Office of Water Data Coordination, United States Geologic Survey, Reston, Virginia

Revision History

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PRECISION (FIELD DUPLICATES)
(EFFECTIVE DATE: APRIL 2021)

Quality Control

Precision is calculated using duplicate samples collected from one sampling event as described in the Procedure section (below). Field duplicates are a means of Quality Control (QC) used to evaluate the precision of field analytical instruments or sampling equipment and sampling methods. Laboratory duplicate analyses and precision limits are defined in the laboratory quality assurance plan. *Escherichia coli* duplicate analysis is also described in the ***Escherichia coli* & Total Coliform Bacteria Colilert®-Defined Enzyme Substrate Method** Standard Operating Procedure (SOP). This "Precision (Field Duplicates)" SOP describes how to evaluate precision for field duplicate samples. For these field duplicates, sampling precision (sampling error) must be at or below the Relative Percent Difference (RPD) values presented in Table 1 if the data are unjustified or unqualified.

Table 1 – Analyte-specific Relative Percent Difference (RPD) Requirements.

<table>
<tr><th colspan="6">Water Chemistry Parameters</th></tr>
<tr><th>Sample & Duplicate Result Relative to Reporting Limit (RL)</th><th>Sulfate, Alkalinity, & Total Suspended Solids (TSS)</th><th>Hardness & Chloride</th><th>Nitrate-Nitrite</th><th>Total Phosphorus & Total Nitrogen</th><th>All Other Parameters with Reporting Limits</th></tr>
<tr><td>RL ≤ 3X RL</td><td rowspan="2">None</td><td rowspan="2">None</td><td>None</td><td>None</td><td>None</td></tr>
<tr><td>3X RL ≤ 10X RL</td><td>20%</td><td>30%</td><td>20%</td></tr>
<tr><td>≥ 10X RL</td><td>20%</td><td>10%</td><td>20%</td><td>20%</td><td>20%</td></tr>
<tr><th colspan="6">Field Parameters</th></tr>
<tr><th>Sample & Duplicate Result Relative to Reporting Limit (RL)</th><th>pH</th><th>Temperature</th><th>Dissolved Oxygen (DO)</th><th>Conductance</th><th>Turbidity</th></tr>
<tr><td>RL ≤ 3X RL</td><td rowspan="3">+/- 0.3 S.U.</td><td rowspan="3">10%</td><td rowspan="3">10%</td><td>None</td><td rowspan="2">None</td></tr>
<tr><td>3X RL ≤ 10X RL</td><td>10%</td></tr>
<tr><td>≥ 10X RL</td><td>10%</td><td>20%</td></tr>
<tr><th colspan="6">Biological Parameters</th></tr>
</table>

Escherichia coli (*E. coli*)	
E. coli MPN Sample & Duplicate Results Greater than 100	50%

Procedure

Definition of Precision**:** Precision is defined as the degree of agreement between two concurrent or closely repeated measurements (refer to the **Duplicate Samples** SOP). Precision measures reproducibility and repeatability of two or more measurements under unchanged conditions. If the sampling methods are consistent, two or more water samples taken concurrently (sample bottles filled at the same time) or consecutively (sample bottles filled one immediately after the other) at the same site, two or more water samples split from one sample collection vessel, or two or more measurements made consecutively or concurrently with a field instrument usually agree very closely. Estimates of precision are also known as sampling error.

Purpose of Duplicate Samples: Duplicate samples are collected to estimate the inherent or human-induced variability of a procedure, technique, measurement result, characteristic, or contaminant (refer to **Duplicate Samples** SOP). Low precision may result from a single factor or combination of factors; the occurrence of low precision simply serves as an indicator that the measurement result may not reliably represent the true value.

Relative Percent Difference (RPD): A measure of precision for two duplicate samples is defined as the difference of two duplicate values divided by the mean of the duplicate values expressed as a percentage difference relative to the mean.

$$RPD = \left| \frac{(absolute\ (X1 - X2))}{\left(\frac{X1+X2}{2}\right)} \right| * 100$$

Where: X1 = first measured value and X2 = second measured value

Interpreting precision: Interpreting precision estimates may require knowing how the duplicate samples were collected. Refer to the **Duplicate Samples** SOP.

Reference

United States Environmental Protection Agency, 40 CFR Part 136.7 Quality Assurances and Quality Control, e-CFR data current as of January 4, 2021

U.S. Environmental Protection Agency. 2004. USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review; EPA-540-R-04-004.

U.S. Environmental Protection Agency. 1999. USEPA Contract Laboratory Program National Functional Guidelines for Organic Data Review; EPA540/R-99/008.

Revision History

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Quality Control

Samplers follow the Standard Operating Procedure (SOP). The program supervisor or project manager furnishes an annual season summary report, bacteria logs (when applicable), and calibration logs for each field office to the Quality Assurance (QA) Officer to confirm that the required routine quality control criteria and project data quality objectives are being met.

Procedure

Certain regulatory programs may require additional mandatory quality control measures.

The following table is a summary of the Quality Control (QC) checks and corrective actions for different QC measures covered in individual SOPs.

Precision is defined as the degree of agreement between two concurrent or closely repeated measurements or among replicate analyses of a single sample aliquot. Precision is generally expressed as the relative percent difference between duplicate or replicate samples. If an overall standard deviation has been established, the number of samples required based on the tolerable level of uncertainty can be calculated. A replicate is two or more analyses for the same parameter from a single sample aliquot. For macroinvertebrates, precision is determined by having duplicate samples collected at a randomly selected percent of the sampling sites. For qualitative habitat evaluations, precision is determined by having two or more samplers complete habitat evaluations at a percent of the sampling sites.

Bias is defined as a deviation of an analytical result value from the true value, which is caused by systematic errors in a procedure (field or laboratory) or by matrix interference. For example, percent recovery above or below the acceptance criteria of a particular analytical method in a spiked sample establishes bias.

QC Measure	QC Check	Frequency	Acceptable Range	Corrective Action
Blanks, field, equipment, and trip (bottle, preservative, filter)	Contamination that might affect analytical results	One (1) per trip for bacteria, 10% for all other applicable sample parameters collected	Results below the method reporting limit for all applicable parameters	Notify sampler and appropriate management; repeat blank with another bottle from same sampler and retest; find contamination source; management decides whether data associated

QC Measure	QC Check	Frequency	Acceptable Range	Corrective Action
				with blank is useable for the project
Chain of Custody form (COC)	Laboratory Supervisor/staff notes errors and omissions and documents them on the COC and in the Laboratory Information Management System (LIMS)	Each group of samples shipped to the lab	No errors or omissions. COC must have all applicable signatures, date and time of sample relinquishment/ receipt and the temperature at which the samples were received	Notify sampler and appropriate management; audit and train the field sampler; test results from samples that are sent to the laboratory without a COC form are not suitable for use in legal actions
Duplicates	Used for Quality Control (QC) in the field to verify the precision of sampling equipment, methods	One (1) per trip for bacteria or 10% if more than 10 samples per trip, 10% of all samples per parameter	See SOP for **Precision (Field Duplicates)**	Notify sampler and appropriate management if missing; audit and train field sampler; managers decide whether data can be used without this Quality Check, based on Data Quality Objectives (DQOs)
Sample preservation	Sample labels and COC agrees with parameter SOP; Laboratory Supervisor/ staff notes errors or omissions on COC	All samples	No errors or omissions	Notify sampler and management; audit and train sampler; resample; data is flagged to indicate that it should not be entered in a database or used for decision making
Sample labeling	Label contains the required information in the SOP **Sample Labeling**	All labels	No errors or omissions	Audit and train sampler
Spikes (field)	Materials and equipment commercially purchased; sample is not identified as a spike	As needed	Spike recovery ±20%	Repeat spike test; check sample preservatives and sample bottles for contamination; verify sample collection method; check lab equipment and

QC Measure	QC Check	Frequency	Acceptable Range	Corrective Action
				spike materials; audit and train field sampler
Splits	Analysis(es) by two or more different laboratories or two different samplers	As needed	±20% between labs; ±10% within a lab	Repeat test; check sample preservatives and sample collection bottles for contamination; calibrate laboratory equipment; audit and train field sampler; managers decide what to do with the data based on DQOs

The following table is a summary of instrument calibration checks and corrective actions for individual parameters covered by SOPs. Refer to the parameter SOP for detailed information. All field instrument preventative maintenance and repairs are performed per manufacturer recommendations at the end of the field season or as needed. Refer to the SOP for **Instrument Calibration and Calibration Logs**.

Parameter	Calibration Frequency	Continuing Calibration Verification (CCV) Check Frequency	Acceptance Range	Corrective Action
Field Meters:				
Conductivity	At least once weekly with Potassium chloride (KCl) standards commercially purchased.	At least once daily with KCl standards commercially purchased.	± 10% of standard concentration	Repeat field check
pH	2-point meter calibration with pH 7 and 10 buffer standards purchased commercially at least once weekly	2-point meter calibration with pH 7 and 10 buffer standards purchased commercially at least once daily	± 0.3 Standard Units (SU)	Repeat field check; consult manufacturer for corrective action
Temperature (Instantaneous)	An annual check against a reference thermometer (International System of Units (SI) traceable	None	On the calibration mark	Repeat measurement with different thermometer

Parameter	Calibration Frequency	Continuing Calibration Verification (CCV) Check Frequency	Acceptance Range	Corrective Action
	through the National Metrological Institute (NMI))			
Dissolved Oxygen (DO)	Written record of altitude; single point at 100% (in air or water); zero calibration at least once weekly	At least once daily or with each 500 ft. change in elevation with air-saturated water at a known barometric pressure	Instrument specific; generally, ±0.1 mg/L or 10%	Verify altitude; if still not correct consult manufacturer for corrective action
Turbidimeters:				
Turbidity	Typically, < 0.1, 20, 100, & 800 Nephelometric Turbidity Unit (NTU) standards at least once monthly	At least once daily with a mid-range standard	Specific to instrument; generally, ±20%	Repeat field check; consult manufacturer for corrective action.
Incubators:				
Total Coliform and *E. coli*	Verify correct temperature (35°C for *Escherichia coli (E. coli)*) with calibrated thermometer	Written documentation of compliance at the beginning, throughout sample incubation, and at the end of each analytical batch of samples processed	35°C, ± 0.5°C	Repeat temperature check with different thermometer; consult manufacturer for corrective action

Reference Refer to individual SOPs

Revision History

Date	Details of Revision	Revised by:
4/1/2021	Revision of February 2015 version	J. Scott
6/22/2021	Cherrie Nelson revised to meet Groundwater Section needs	Cherrie Nelson

Quality Control

Sample preservation methods maintain sample integrity. Proper preservation will act to:

- retard biological activity;
- retard hydrolysis of chemical compounds and complexes;
- reduce the volatility of constituents, or
- reduce absorption effects,

and is limited to adding chemicals, pH control, refrigeration, or freezing. The three most convenient and widely used preservatives are acids, bases, and ice (refrigeration).

Field personnel responsibilities**:** Field personnel are responsible for adding the appropriate preservative, immediately placing samples that require cooling in an insulated container with wet or dry ice, and delivering/shipping the samples as quickly as possible to the Water Quality Lab (WQL) or commercial laboratory ensuring that there is sufficient time for sample analysis to be performed within the Environmental Protection Agency (EPA) recommended holding time. It is also important to use a sufficient amount of wet or dry ice to ensure that the samples are received at the laboratory at the required temperature. Refer to the summary table on the following pages for an alphabetic list of parameters, sampling, analytical methods, reporting limits and units, preservatives, and holding times.

Temperature check: Each cooler may include one sample bottle containing a minimum of 200 mL de-ionized or tap water. This bottle is labeled "Temperature Blank". Refer to the SOP **Temperature Blank** for more specifics. In absence of a temperature blank, a regular sample may be used. The temperature of this water will be measured and recorded on the Chain of Custody when the samples arrive at the WQL or commercial laboratory before the samples are analyzed. This temperature check will be used as a quality control measure to verify that the samples arrived at the laboratory at the required temperature and will serve as an indicator that the samples were maintained at that temperature after being collected.

Metals: Refer to the SOP for **Metals, Total and Dissolved** for filtering requirements.

NOTE: The WQL or commercial laboratory presumes that samples that have no preservative recorded on the sample label and Chain of Custody form are unpreserved.

Procedure

Proper sample preservation is effective against these possible changes in samples:

1. Acidifying with nitric acid to a pH < 2.0 minimizes the precipitation and adsorption of aluminum, cadmium, chromium, copper, iron, lead, manganese, silver, and zinc and prevents bacterial growth and transformation of metals in the sample.
2. Temperature changes: pH may change significantly in minutes; dissolved oxygen may be lost.
3. Changes in the combination of pH, alkalinity, carbon dioxide, and calcium carbonate may precipitate and cause a decrease in the analytical results for calcium and total hardness.
4. Microbiological activity may change the nitrate-nitrite or ammonia content, decrease BOD, or reduce sulfate to sulfide. These changes can be slowed by keeping the sample in the dark and at a low temperature.
5. Oxidation may cause a decrease in the following: sulfide, sulfite, ferrous iron, and cyanide.
6. Zero headspace in the sampling bottle is mandatory to prevent the loss of volatile organics.

Wet ice means crushed or cubed ice or ice substitutes. Dry ice should not be used

Use reagent-grade chemical preservatives supplied by the Water Quality Division Laboratory or follow the Acidification Guidelines Table below. After adding a preservative, homogenize the sample bottle to mix the contents thoroughly. Previous testing and analysis have shown that the ampoules provided by the lab are sufficient to lower the pH to < 2 for most ambient waters; however, field testing of pH in preserved samples is recommended to ensure that the pH is adjusted accordingly. The WQL checks the pH of one sample of each batch received at the laboratory.

Cooling the sample and maintaining the compliance temperature are required for proper sample preservation. If the analytical parameter requires cooling the sample, place it on wet ice (or dry ice if cooling chlorophyll-a or cyanotoxin samples) immediately after it is collected and maintain it on wet ice until delivered to the lab or shipping facility. Collected samples should not be placed in the sun or in a hot vehicle for an amount of time which could increase the temperature of the sample. If the monitoring site is more than a ten-minute hike to the cooler, take sufficient wet/dry ice to the site to ensure an increase in the sample temperature will not occur. If the samples must be shipped, pack

an appropriate amount of wet or dry ice so that the samples will be received at the required temperature by the receiving laboratory.

Acidification Guidelines Table: for sample pH < 2 (provided by the WQL)

Acid Name	250 mL sample (8 oz plastic container) add mL acid	500 mL sample (16 oz plastic container) add mL acid	1000 mL sample (1L) (32 oz plastic container) add mL acid	2000 mL sample (2L) 64 oz plastic container) add mL acid
1:1 Nitric	0.7	1.3	1.7	3.0
1:1 Hydrochloric	0.9	1.3	2.4	4.5
1:1 Sulfuric	0.3	0.5	1.1	1.9

Summary table: For analytes not listed below, see 40 CFR Part 136.3-Table II. For method approval year, see CFR 40:136.3 Tables 1A-1H=. Most of the methods listed are those used by Pace Analytical.

Group Analysis	Bottle	Preservative	Holding Time (days)	Prep/Analysis Method
Major Cations				
Calcium, Magnesium, Potassium, Sodium	Plastic, 250 mL	Nitric Acid	180	EPA 3010/6010
Major Anions				
Chloride, Sulfate, Fluoride	Plastic, 250 mL	Ice to ≤6°C	28	EPA 300.0
Nutrients				
Nitrogen, Ammonia	Plastic, 500 mL	pH<2 H2SO4, ≤6°C	28	EPA 350.1
Nitrogen, Nitrate+Nitrite	Plastic, 500 mL	≤6°C	28	EPA 353.2
Nitrogen, Total Kjeldahl	Plastic, 500 mL	pH<2 H2SO4, ≤6°C"	28	EPA 351.2
Nitrogen, Total	NA	NA	NA	Calculation (TKN+NO3+NO2)
Phosphorus, Total	Plastic/Glass	Ice to ≤6°C	28	EPA 365.4
Other				
Total Organic Carbon	Glass	pH<2 H2SO4 or HCl, ≤6°C	28	SM 5310C
Total Dissolved Solids	Plastic, 500 mL	Ice to 4° C	7	SM 2450C
Alkalinity-Bicarbonate, Alkalinity-Carbonate, Alkalinity-Total CaCO3	Plastic, 500 mL	Ice to 4° C	14	SM 2320B
Hardness	NA	NA	NA	Calculation
Metals - Total or Dissolved				
Aluminum	Plastic, 500 mL	HNO_3 to pH < 2	180	EPA 3010/6010
Arsenic	Plastic, 500 mL	HNO_3 to pH < 2	180	EPA 3010/6010
Barium	Plastic, 500 mL	HNO_3 to pH < 2	180	EPA 3010/6010
Beryllium	Plastic, 500 mL	HNO_3 to pH < 2	180	EPA 3010/6010
Boron	Plastic, 500 mL	HNO_3 to pH < 2	180	EPA 3010/6010
Cadmium	Plastic, 500 mL	HNO_3 to pH < 2	180	EPA 3010/6010
Chromium	Plastic, 500 mL	HNO_3 to pH < 2	180	EPA 3010/6010
Cobalt	Plastic, 500 mL	HNO_3 to pH < 2	180	EPA 3010/6010
Copper	Plastic, 500 mL	HNO_3 to pH < 2	180	EPA 3010/6010
Iron	Plastic, 500 mL	HNO_3 to pH < 2	180	EPA 3010/6010

Group Analysis	Bottle	Preservative	Holding Time (days)	Prep/Analysis Method
Lead	Plastic, 500 mL	HNO_3 to pH < 2	180	EPA 3010/6010
Lithium	Plastic, 500 mL	HNO_3 to pH < 2	180	EPA 3010/6010
Manganese	Plastic, 500 mL	HNO_3 to pH < 2	180	EPA 3010/6010
Molybdenum	Plastic, 500 mL	HNO_3 to pH < 2	180	EPA 3010/6010
Nickel	Plastic, 500 mL	HNO_3 to pH < 2	180	EPA 3010/6010
Selenium	Plastic, 500 mL	HNO_3 to pH < 2	180	EPA 3010/6010
Silver	Plastic, 500 mL	HNO_3 to pH < 2	180	EPA 3010/6010
Silica	Plastic, 500 mL	HNO_3 to pH < 2	180	EPA 3010/6010
Strontium	Plastic, 500 mL	HNO_3 to pH < 2	180	EPA 3010/6010
Vanadium	Plastic, 500 mL	HNO_3 to pH < 2	180	EPA 3010/6010
Zinc	Plastic, 500 mL	HNO_3 to pH < 2	180	EPA 3010/6010
Antimony, Thallium, Uranium				EPA 3010/6020
TPH-DRO	Amber Glass, 1 Liter	≤6°C, $Na_2S_2O_3$ if Cl present	7*	EPA 3511/8015C
TPH-GRO	Glass, 40 mL	pH<2 HCI; ≤6°C	14	EPA 8260/OA1
Volatile Organic Compounds - SIM/Scan	Glass, 40 mL	pH<2 HCI; ≤6°C	14	SW-846 8260BSIM/Scan
Volatile Organic Compounds – Low Level	Glass, 40 mL	pH<2 HCI; ≤6°C	14	SW-846 8260B
Semi-Volatile Organic Compounds	Amber Glass, 1 Liter		7*	SW-846 8270D
Headspace Gasses: Methane, Ethane, Ethene	Glass, 40 mL	pH<2 HCI; ≤6°C	14	RSK 175
Deuterium and O18 Isotopic Analyses	Plastic, 250 mL	Cool to ≤6°C	Indefinite	Lab proprietary methods
Gross Alpha and Gross Beta	Glass, 300 mL	pH<2 HNO3; Cool to ≤6°C	180	EPA 900.0
Tritium	Glass	Cool to ≤6°C	180	EPA 906.0
Radon-Rn	Glass, 40 mL	Cool to ≤6°C	3	SM 7500-Rn
Radium 226/228	Polyethylene, 500 mL	pH<2 HNO3; Cool to ≤6°C	180	SM 7500-Ra / EPA 904
PFAS Compounds (21+)	Polypropylene, 500 mL	5.0g/L Trizma	14 /28	537
Bacteriological				
Total Coliform	IDEXX, 100 mL	Cool to ≤10°C, $Na_2S_2O_3$ if Cl present	8 hours	SM 9223
Escherichia coli (E. coli)	IDEXX, 100 mL	Cool to ≤10°C, $Na_2S_2O_3$ if Cl present	8 hours	SM 9223

Notes:
* days for extraction; 40 days after extraction
Abbreviations: SM – Standard Methods; CaCO3 - Calcium Carbonate, H_2SO_4 - Sulfuric Acid; HCl - Hydrochloric Acid; HNO_3 – Nitric Acid; ZnAc – Zinc Acetate; NaOH – Sodium Hydroxide; $Na_2S_2O_3$ - Sodium Thiosulfate; VOA – Volatile Organic Analysis

Data collection methods typically follow referenced standard operating procedures; however, modifications may be made on a case-by-case basis. Modifications to the method will be documented either in the SAP or within the Methods section of publications presenting the data.

Reference

Standard Methods Online -- Standard Methods for the Examination of Water and Wastewater. http://standardmethods.org/

United States Environmental Protection Agency, 40 CFR Part 136.3 Table II – Required Containers, Preservation Techniques, and Holding Times, e-CFR data current as of January 4, 2021

United States Environmental Protection Agency, 40 CFR Part 136.7 Quality Assurances and Quality Control, e-CFR data current as of January 4, 2021

Revision History

Date	Details of Revision	Revised by:
4/2/16	Revision of February 2015 version	C Norris
3/15/18	Added TOC	C Norris
4/1/2021	Revision of March 2018 version	J. Scott
6/22/2021	Cherrie Nelson revised to meet Groundwater Section needs	Cherrie Nelson

Wyoming Department of Environmental Quality, Water Quality Division
Groundwater Section

STANDARD OPERATING PROCEDURE (SOP) REVIEW AND APPROVAL PROCESS
(EFFECTIVE DATE: APRIL 2021)

Introduction

Standard Operating Procedures (SOPs) undergo scheduled review but may be modified at any time. New SOPs are developed as necessary.

Procedure

1. Groundwater Section personnel may initiate or be directed to review or develop new SOPs.
2. A new or modified SOP must be reviewed by the Program Supervisor or Quality Assurance (QA) Officer.
3. A new or modified SOP may be presented for external or peer review at any point before approval.
4. After review, a new or modified SOP that pertains to sampling and analysis is reviewed by the QA Officer for Quality Assurance/Quality Control (QA/QC) compliance. If the SOP passes the QA/QC review, it is approved by the QA Officer.
5. Laboratory SOPs are tracked in an online shared folder. Sampling and analysis SOPs are tracked individually and within the Wyoming Department of Environmental Quality (WDEQ) *Manual of Standard Operating Procedures for Sample Collection and Analysis* which is typically updated once a year or as needed.

Revision History

Date	Details of Revision	Revised by:
2/9/2017	New	C. Norris
4/1/2021	Minor updates to March 2017 version	J. Scott
6/22/2021	Cherrie Nelson revised to meet Groundwater Section needs	Cherrie Nelson

SPIKE SAMPLES
(EFFECTIVE DATE: SEPTEMBER 2004)

Quality Control

Spiked field samples are used to verify that: equipment (including sample bottles) and preservatives are not contaminated; laboratory and field equipment is functioning correctly; samples are not being contaminated during shipping; laboratory recovery is complete, and that sampling procedures are being followed. Quality control samples are required.

Procedure

Samplers select the site to be used for spiked samples. The site should be representative of the parameter(s) being spiked, with the parameter to be analyzed known to be represented at a median level in the original sample.

Spiked field samples are collected as needed to verify laboratory performance. The Water Quality Laboratory (WQL) or commercial laboratory staff will provide all necessary materials and equipment (bottles, glassware, filters, syringes), including sealed vials of the reagent(s) to be used for spiking, and specific directions for preparing each spiked sample.

The general procedure is that the sampler takes independent simultaneous samples (side-by-side grab samples). One sample is split into two equal-volume samples. The other sample is also split into two equal volume samples, and the spike is added to one of these. Preservative(s) for the test parameter is added to all samples as described in the relevant Standard Operating Procedure (SOP).

Sample bottle labeling, the Chain of Custody form, and the Ambient Monitoring Report form should **not** indicate that the sample includes a spike. This provides a blind test of laboratory recovery. Samplers must record the spiked sample number in their Field Log Books/Data Sheets and be prepared to notify the laboratory after the samples are analyzed which one(s) contained the spiking reagent(s).

Reference

United States Environmental Protection Agency, 40 CFR Part 136.7 Quality Assurances and Quality Control, e-CFR data current as of January 4, 2021.

Date	Details of Revision	Revised by:
4/1/2021	Revision of March 2001 version	J. Scott
6/22/2021	Cherrie Nelson revised to meet Groundwater Section needs	Cherrie Nelson

SPLIT SAMPLES
(EFFECTIVE DATE: APRIL 2021)

Quality Control

Sample splits are analyzed by two or more different laboratories or two different samplers. Results are compared to determine the precision, recognizing that split samples are never really identical. Split sample analyses are performed as required or requested by United States Environmental Protection Agency (USEPA). The correlation should be ±20% between laboratories and ±10% within a laboratory.

Procedure

The term split sample refers to **one** original sample that is divided into two or more individual samples. The divided samples are sometimes referred to as aliquots or replicates of the original sample. Some USEPA-funded programs require split sample analyses, and splits are also used to allow the USEPA to analyze the same sample that the Wyoming Department of Environmental Quality (WDEQ) is analyzing.

Split samples (also sometimes called replicates) are a form of subsampling or repeated subsampling whose results are sometimes used as a measure of variance. Analytical results are often used to compute the standard error of the full sample or to provide information about variability in the analytical process.

The crucial issue for split samples is that the original sample must be homogeneous, and very few samples are. All split sample analytical results must be used and evaluated, keeping in mind how homogeneous the original sample was.

Groundwater Section sampling may require field splits or laboratory analysis splits. A laboratory split is sometimes referred to as a replicate or duplicate.

Reference

United States Environmental Protection Agency, 40 CFR Part 136.7 Quality Assurances and Quality Control, e-CFR data current as of January 4, 2021

Revision History

Date	Details of Revision	Revised by:
4/1/2021	Revision of March 2001 version	J. Scott
6/22/2021	Cherrie Nelson revised to meet Groundwater Section needs	Cherrie Nelson

TEMPERATURE BLANK
(EFFECTIVE DATE: APRIL 2021)

Quality Control

A temperature blank is used to determine the internal temperature of the samples upon receipt of the cooler at the Water Quality Laboratory (WQL) in Cheyenne, Wyoming, or another commercial laboratory. Temperature blanks are not required; however, if wet ice is used in the cooler, it is sufficient to note that ice is present in the cooler at the time of opening it. Ice must be packed around and above samples for efficient cooling to take place.

Procedure

One 250 mL sample collection bottle for each cooler is filled with tap or deionized water, labeled as a temperature blank, and placed in the cooler. The field sampler must verify that the temperature of the water is at or below 6°C (or 10°C for *Escherichia coli (E. coli*)) and document in one of the spaces provided on the Chain of Custody (COC) form that a temperature blank is submitted for temperature compliance checks before placing the COC form in the cooler and sealing it.

When the cooler arrives at the laboratory, laboratory personnel will verify that the temperature blank is still at or below 6°C (or 10°C for *E. coli*) and note that in the space provided on the COC form. If the sample temperature exceeds preservative requirements for the parameter, the laboratory must flag the data in its analytical results report and the project supervisor must either qualify the results in the project database (refer to the Standard Operating Procedure (SOP) for **Data Qualifier Procedure**) or reject the data.

Alternately, the laboratory personnel will verify that solid ice remains in the cooler and note the condition on the COC form.

Monitoring: If the sample temperature exceeds preservative requirements for the parameter, the WQL or commercial laboratory will still run the samples but will qualify/flag the analytical result in its database and on the analytical report. The appropriate Groundwater Section supervisor will be notified of the incorrect sample preservation. The data will be qualified (refer to the SOP for **Data Qualifier Procedure**) in all Groundwater Section databases. The program supervisor will make the final decision as to the appropriate use(s) of the qualified data, including rejecting it.

Reference

none required; standard environmental sample Quality Control (QC) practice

Revision History

Date	Details of Revision	Revised by:
4/1/2021	Revision of September 2004 version	J. Scott
6/22/2021	Cherrie Nelson revised to meet Groundwater Section needs	Cherrie Nelson

Quality Control — Sampler follows Standard Operating Procedure (SOP).

Procedure — For the purpose of deciding on an SOP, volatile organics are listed below and broken down into three categories: halogenated, non-halogenated, and aromatic.

Volatile Organics		
Halogenated Volatile Organics	Non-halogenated Volatile Organics	Aromatic Volatile Organics
Benzyl chloride	Acrylamide	Benzene
Bis(2-Chloroethoxy) methane	Diethyl ether	Chlorobenzene
Bis(2-Chloroisopropy) ether	Methyl ethyl ketone	Ethylbenzene
Bromobenzene	Methyl isobutyl ketone	Toluene
Bromodichloromethane	Paraldehyde or 2,4,6-Trimethyl-1,3,5-trioxane	Xylenes
Bromomethane		
Carbon tetrachloride		
Chloroacetaldehyde		
Chlorobenzene		
Chloroethane		
Chloroform		
1-Chlorohexane		
2-Chloroethyl vinyl ether		
Chloromethane		
Chloromethyl ether		
Chlorotoluene		
Dibromoethane		
Dibromochloromethane		
1,2-Dichlorobenzene		
1,3-Dichlorobenzene		
1,4-Dichlorobenzene		
Dichlorodifluoromethane		

Volatile Organics		
Halogenated Volatile Organics	Non-halogenated Volatile Organics	Aromatic Volatile Organics
1,1-Dichloroethane		
1,2-Dichloroethane		
1,1-Dichloroethylene		
Trans-1,2-Dichloroethylene		
Dichloropropane		
Trans-1,3-Dichloroethylene		
1,1,2,2-Tetrachloroethane		
1,1,1,2-Tetrachloroethane		
Tetrachloroethylene		
1,1,1-Trichloroethane		
1,1,2-Trichloroethane		
Trichlorofluoromethane		
Trichloropropane		
Vinyl chloride		

APPENDICES

APPENDIX A – WDEQ ACCESS AGREEMENT

The WDEQ Access Agreement is available at the following link:
https://wyomingcloud.sharepoint.com/:b:/s/020DEQ-ADM/Eb9qEuzUNA5Ah8TEaUjsL6ABRXKCXaGz7lqxk4YA4jfsLA?e=qhlHxV

DEPARTMENT POLICY

DATE: July 5 2016 **POLICY # 30**

SUBJECT: Access to Private Property.

Director

This policy supersedes all previous Departmental policy statements concerning this subject.

This policy establishes procedures to be followed by Wyoming Department of Environmental Quality (Department) employees when seeking access to private lands to conduct official agency business that involves the collection of resource data. The procedures set forth in this policy are intended to provide Department employees clear direction for ensuring that they have permission to cross, enter, and access private lands for the purpose of collecting resource data when conducting official agency business. This policy is not intended to describe every single situation that may arise. If the facts of a particular situation appear to require legal advice, channel legal questions to the Attorney General's Office by notifying supervisors of situations as they arise.

Standard Operating Procedure for Accessing Private Property

1. **Determine if the Department can collect the information it needs while standing on public property without crossing or entering private property.**

For example, take photographs while standing on a public highway.

2. **Determine land ownership.**

If it is necessary to cross or enter private land, identify the landowners who own the parcels. Use the GIS system to map out an access route and identify all the landowners. It may save time to begin working with the operator to identify landowners, but verify that the information an operator provides is valid and current through the agency GIS system. It may be appropriate to take an alternate route to avoid crossing certain parcels of private land.

3. **Determine whether the Department already has permission to access the property and conduct the applicable activity.**

Locate any permits, surface use agreements, or existing access permission forms that the Department has for the property. It may be appropriate to ask other Divisions for documents. Review the documents

to determine whether the landowner(s) have already granted the Department permission to cross over or enter the land in question. If the Department already has a landowner's permission, agency staff should notify the landowner prior to entering the land. This is both a courtesy to the landowner and an opportunity for the Department to determine whether the existing permission is still valid.

It is important to confirm that the existing permission is valid for the specific purpose of the planned visit. For example, the Department may have existing permission to inspect a property, but it may not have permission to use an auger to drill for soil samples. Or the Department may have existing permission to cross over property, but it may not have permission to cross over the property for the purpose of collecting resource data from a neighboring property. If it is unclear whether the Department has current, valid permission to access a property **and** collect the resource data that it needs to obtain, discuss the situation with your supervisor.

4. **Obtain access.**

If the Department is working with a landowner, ask the landowner for permission to access the land in question. If the owner is willing to provide written access, provide two copies of the form for his or her signature (one copy for the owner and one copy for the Department). If the landowner prefers verbal authorization, document the identity of the person granting access, his or her relationship to the property, the date and time the access was granted, and the identity of any witness to the conversation. It is preferable to use the standard form (Form A) to obtain access permission that will apply to the entire Department for the future, but there is also a Form B for use by a landowner who is only willing to grant time-limited permission. Both forms are attached to this policy.

If the Department is working with the operator rather than the landowner, ask the operator to get permission from the landowner(s) for the Department to access the property. If the operator has a surface use agreement or other form of written access permission from the landowner, review the document, and if it is unclear, ask a supervisor to determine if the agreement applies to the Department.

If the operator declines or is otherwise unable to assist the Department in obtaining access permission from neighboring landowner(s), ask the operator for assistance in identifying the landowner(s) whose land must be crossed to reach the facility. Then, verify land ownership through the agency GIS system and contact the landowner(s) to obtain access. It may be appropriate to take an alternate route to avoid crossing certain parcels of private land.

5. **New, Modified or Amended Permits, Authorizations or Activities**

New, modified or amended actions will contain requirements to ensure that DEQ is granted access to perform all necessary actions to implement the provisions of the Environmental Quality Act and associated agency rules.

6. **Refer access denials to a supervisor**.

If an operator refuses to allow the Department access onto its site to perform a compliance inspection, refer the situation to your supervisor.

If a landowner denies permission or restricts access, document the situation, and refer it to a supervisor. It is not necessary to refer to a supervisor if a landowner makes reasonable restrictions related to calving or breeding season, muddy roads, or hunting season. All demands for payment or severe time restrictions must be referred to a supervisor.

If at any time during agency activities consent is withdrawn or staff are asked to leave, leave the premises immediately and notify your supervisor.

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Mark Gordon, Governor

Department of Environmental Quality

To protect, conserve and enhance the quality of Wyoming's environment for the benefit of current and future generations.

Todd Parfitt, Director

CONSENT TO ACCESS PRIVATE PROPERTY

I hereby grant access to my property located at _____
to employees of the Wyoming Department of Environmental Quality for the purpose of collecting resource data while conducting official business of the State of Wyoming Department of Environmental Quality.

Printed name: _____

Signature: _____ Date: _____

FORM A

Mark Gordon, Governor

Department of Environmental Quality

To protect, conserve and enhance the quality of Wyoming's environment for the benefit of current and future generations.

Todd Parfitt, Director

CONSENT TO ACCESS PRIVATE PROPERTY

I, _____, am the owner or agent of owner of _____

(Name) *(Property Address*

_____, and I hereby consent and authorize Wyoming Department of

or Legal Description)

Environmental Quality employee(s) _____ to access the

(Employee Name(s), if necessary)

Property described above for the purpose of _____

_____.

(Data to be collected or Purpose of Visit)

This consent and authorization shall remain in effect until _____

(Date Access no Longer Needed)

or

("Revoked in Writing")

Signature: _____ Date: _____

FORM B

APPENDIX B – CHAIN OF CUSTODY FORMS

Pace Analytical™
www.pacelabs.com

CHAIN-OF-CUSTODY / Analytical Request Document

The Chain-of-Custody is a LEGAL DOCUMENT. All relevant fields must be completed accurately.

Page: of

Section A **Required** Client Information:

Company:	
Address:	
Email To:	
Phone:	Fax
Requested Due Date/TAT:	

Section B **Required** Project Information:

Report To:
Copy To:
Purchase Order No.:
Project Name:
Project Number:

Section C Invoice Information:

Attention:
Company Na
Address:
Pace Quote Reference
Pace Project Manager:
Pace Profile #:

REGULATORY AGENCY

☐ NPDES ☐ GROUND WATER ☐ DRINKING WATER

☐ UST ☐ RCRA ☐ OTHER_SPILL___

SITE LOCATION ☐ GA ☐ IL ☐ IN ☐ MI ☐ NC ☐ OH ☐ SC ☐ WI ☐ OTHER_MN

Filtered (Y/N)

Requested Ana

Pace Project No. Lab I.D.

Section D **Required** Client Information

SAMPLE ID

One Character per box.
(A-Z, 0-9 / ,-)
Sample IDs MUST BE UNIQUE

Valid Matrix Codes

MATRIX	CODE
DRINKING WATER	DW
WATER	WT
WASTE WATER	WW
PRODUCT	P
SOIL/SOLID	SL
OIL	OL
WIPE	WP
AIR	AR
OTHER	OT
TISSUE	TS

ITEM #	MATRIX CODE	SAMPLE TYPE G=GRAB C=COMP	COLLECTED COMPOSITE START DATE	COLLECTED COMPOSITE START TIME	COLLECTED COMPOSITE END/GRAB DATE	COLLECTED COMPOSITE END/GRAB TIME	SAMPLE TEMP AT COLLECTION	# OF CONTAINERS	Preservatives: Unpreserved	H_2SO_4	HNO_3	HCl	NaOH	$Na_2S_2O_3$	Methanol	Other
1																
2																
3																
4																
5																
6																
7																
8																
9																
10																
11																
12																

Additional Comments:

RELINQUISHED BY / AFFILIATION	DATE	TIME	ACCEPTED BY / AFFILIATION	DATE	TIME

SAMPLE CONDITIONS

	Y/N	Y/N	Y/N
	Y/N	Y/N	Y/N
	Y/N	Y/N	Y/N
	Y/N	Y/N	Y/N

SAMPLER NAME AND SIGNATURE

PRINT Name of SAMPLER:

SIGNATURE of SAMPLER: DATE Signed (MM / DD / YY)

Temp in °C | Received on Ice | Custody Sealed Cooler | Samples Intact

Chain of Custody & Analytical Request Record

ENERGY LABORATORIES — Trust our People. Trust our Data.

www.energylab.com

Page _____ of _____

Account Information *(Billing information)*

Company/Name		
Contact		
Phone		
Mailing Address		
City, State, Zip		
Email		
Receive Invoice ☐Hard Copy ☐Email	Receive Report ☐Hard Copy ☐Email	
Purchase Order	Quote	Bottle Order

Report Information *(if different than Account Information)*

Company/Name
Contact
Phone
Mailing Address
City, State, Zip
Email
Receive Report ☐Hard Copy ☐Email
Special Report/Formats: ☐ LEVEL IV ☐ NELAC ☐ EDD/EDT *(contact laboratory)* ☐ Other_____

Comments

Project Information

Project Name, PWSID, Permit, etc.	
Sampler Name	Sampler Phone
Sample Origin State	EPA/State Compliance ☐ Yes ☐ No

URANIUM MINING CLIENTS MUST indicate sample type.
☐ NOT Source or Byproduct Material
☐ Source/Processed Ore (Ground or Refined) **CALL BEFORE SENDING
☐ 11e.(2) Byproduct Material (Can ONLY be Submitted to ELI Casper Location)

Matrix Codes

A - Air
W- Water
S - Soils/ Solids
V - Vegetation
B - Bioassay
O - Other
DW - Drinking Water

All turnaround times are standard unless marked as RUSH.

Energy Laboratories MUST be contacted prior to RUSH sample submittal for charges and scheduling – See Instructions Page

Sample Identification *(Name, Location, Interval, etc.)*	Collection Date	Collection Time	Number of Containers	Matrix *(See Codes Above)*	Analysis Requested	See Attached	RUSH TAT	ELI LAB ID *Laboratory Use Only*
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								

Custody Record MUST be signed	Relinquished by (print)	Date/Time	Signature	Received by (print)	Date/Time	Signature
	Relinquished by (print)	Date/Time	Signature	**Received by Laboratory (print)**	**Date/Time**	**Signature**

LABORATORY USE ONLY

Shipped By	Cooler ID(s)	Custody Seals Y N C B	Intact Y N	Receipt Temp °C	Temp Blank Y N	On Ice Y N	Payment Type CC Cash Check_____	Amount $	Receipt Number *(cash/check only)*

In certain circumstances, samples submitted to Energy Laboratories, Inc. may be subcontracted to other certified laboratories in order to complete the analysis requested. This serves as notice of this possibility. All subcontracted data will be clearly notated on your analytical report.

STATE OF WYOMING
DEPARTMENT OF ENVIRONMENTAL QUALITY
WATER QUALITY DIVISION
UNDERGROUND INJECTION CONTROL PROGRAM

CHAIN OF CUSTODY

SITE: _____ **LOCATION:** _____
FACILITY ID: _____ **PERMIT #:** _____

SAMPLE ID	SAMPLE DATE	SAMPLE TIME	No. of Bottles	Sample pH	Requested Analysis / Preservative						Comments

Relinquished By: _____ **Date:** _____ **Time:** _____

Received By: _____ **Date:** _____ **Time:** _____

Report Data To: _____ **Email:** _____

APPENDIX C – INSTRUMENT CALIBRATION LOG

CALIBRATION LOG

Equipment Type	Serial Number	Calibration Method	Calibration Date	Signature	Notes

APPENDIX D – GROUNDWATER SAMPLE COLLECTION FORM

Site Specific Data Verification & Field Notes/Observations

Reported Well Information (use boxes to confirm verified information)

Site/Well ID: _____ Wellhead Lat/Long: _____

Well Depth: _____ Use: _____ Status: _____

Dedicated Pump: _____ Reported GW Depths: _____

Sampling Point: _____

Pump: _____ Pump Type (if applicable): _____

Treatment System: _____ Treatment Type (if applicable): _____

Sampled Before Pressure Tank: _____ Sampled Before Treatment: _____

Access Port (GW Measurement): _____

Casing Diameter: _____ Pump Depth: _____

Surface Casing Depth: _____ Screened Interval: _____ Casing Material: _____

Top of Casing Elevation (Above Ground Surface): _____

Reported Ground Surface Elevation (Approximate): _____

Reported Well Yield: _____

Land Use

Land Use: _____

Reported Petroleum Storage / Usage Onsite: _____

_____

Irrigation: _____

Septic System: _____

_____

Reported Chemical Usage: _____

_____

Oil and Gas Production Infrastructure: _____

_____

_____

Livestock: _____

Changes to Historical Information

_____

_____

_____

_____

Site Entry Information

Date: _____ Time: _____

Field Team #:_____ Field Team Members:_____

Point of Contact: _____

Temp (F):_____Wind Direction: _____ Wind Speed:_____ Weather:_____

Names and Affiliation of Other People Present During Sampling: _____

_____

Field Sketch (not to scale); include north arrow, topography, buildings, well, etc.

LEGEND:

Sample Collection Field Data / Observations — NO PURGE

Time	pH	Temp. (°C)	Oxidation Reduction Potential (mV)	Specific Conductance (µS/cm²)	Dissolved Oxygen (mg/L)	Turbidity (NTU)	Ferrous Iron (mg/L)	Sulfide (mg/L)

Sample ID: _____ Sample Start Time: _____ Sample End Time: _____

Collected By: _____ QA Sample ID (if applicable): _____

Sample Notes — NO PURGE

Depth to Water (ft bgs prior to sample): _____

Clarity: _____ Color: _____ Odor: _____

Effervescent: Yes ☐ No ☐

Additional Notes: _____

_____

Sample Collection Field Data / Observations — PURGE

Depth to Water (ft bgs prior to sample): _____

Clarity: _____ Color: _____ Odor: _____

Effervescent: Yes ☐ No ☐ _____

Purge Water Disposition: _____

_____

Note observable changes in water quality, purge volume, etc. below: _____

Sample Collection Field Data / Observations — PURGE

Time	pH	Temp. (°C)	Oxidation Reduction Potential (mV)	Specific Conductance (µS/cm²)	Dissolved Oxygen (mg/L)	Turbidity (NTU)	Purge Volume (gal/min)

Ambient Groundwater
Project Name/Number: Monitoring Program ___ Sample ID: _____

Sample Collection Field Data / Observations — PURGE

Sample ID:_____ Sample Start Time:_____ Sample End Time: _____

Collected By:_____ QA Sample ID (if applicable): _____

Depth to Water (ft bgs after sample):_____ Total Volume Purged:_____

Sample Collected After: Stabilization Parameter Criteria: ☐
Sufficient Volume Purged: ☐

Water column volume equation (ft^3): *V = (Total Well Depth - Depth to Groundwater)(π)(r^2)*

1 ft^3 = 7.48 gal

Additional Notes (document any onsite issues encountered): _____

_____

_____

_____

_____

_____

_____

_____

Photo Log

Number	Time	Subject	Was whiteboard used?	Description

Chain of Custody & Shipping

COC Number: _____

Lab (specify lab location): _____

_____

Shipping Carrier: _____

Shipment Confirmation / Tracking Number: _____

Attach the shipping receipt in the space provided below:

Tiered Review Protocol (initial next to each item)

Samples were preserved according to method requirements: _____

Notes were reviewed for accuracy and corrected in the field prior to departing site: _____

Sample bottle labels were reviewed in the field prior to packaging for shipment: _____

Sample IDs, times, etc. on sample bottles and COCs were reviewed for consistency: _____

Samples were stored on ice immediately after sampling was completed: _____

Samples were packaged with a sufficient volume of ice to ensure that temp. criteria are met: _____

Samples were packaged using sufficient insulation to minimize breakage (within reason): _____

Custody seals were signed, dated, and appropriately attached to the ice chest: _____

The ice chest used for shipping was tightly secured using packing tape: _____

Signatures

Field Technical Staff: _____ Date: _____

Field Team Lead: _____ Date: _____

Time Offsite: _____

WDEQ UIC PROGRAM GROUNDWATER SAMPLING FORM

SITE:		**LOCATION:**		**FACILITY ID:**	**PERMIT #:**
WDEQ Personnel:		**WEATHER:**			**DATE:**
WELL ID:		**SAMPLE LOCATION TYPE:** MON DOM SPNG STK IRR		**Other?:**	

PURGING DATA

Well Diameter: inches **Completion Type:** Flush Stick-up **Length of Stick-up:** ft **Purged By:** Bailer Pump		
Depth to Water: ft-btoc	**Total Depth:** ft-btoc	**Well Capacity (gal/ft):** **2"** = 0.163; **4"** = 0.653; **6"** = 1.47; **8"** = 2.61
1 WELL VOLUME PURGE (if applicable) = (TOTAL WELL DEPTH – DEPTH TO WATER) X WELL CAPACITY **= (ft-btoc – ft-btoc) X gallons/foot = gallons**		
Minimum Purge Volume = 1 well volume x 3 = **gallons x 3 = gallons**		

Time	Depth to Water (ft-btoc)	Total Volume Purged (gal)	Purge Rate (gal/min)	pH (S.U.)	Temp (circle units) (°F or °C)	Conductivity (circle units) (µmhos/cm or µS/cm)	Description of Water (odor/color/sheen)

Total Volume Purged: gallons **Sample Parameters:**

Sample Date and Time: **Sample ID:**

NOTE: Use back of form for additional comments

APPENDIX E – PHOTOGRAPH FORM

OFFICIAL PHOTOGRAPH

WATER QUALITY DIVISION/WYOMING DEPARTMENT OF ENVIRONMENTAL QUALITY
UNDERGROUND INJECTION CONTROL PROGRAM

Photograph Number	
Subject	
Location	
County	
Date	
Approximate Time	
Photographer	
Witness	
View Direction	
Weather	
Path	
Comments	

Photo Goes Here

APPENDIX F – DATA VALIDATION AND USABILITY SUMMARY REPORT (DUSR)

REPLACE YELLOW HIGHLIGHTED ITEMS WITH INFORMATION FROM PROJECT.

Wyoming Department Of Environmental Quality

Tier I and II Data Validation Report Summary for Ambient Groundwater Sampling

Project Name:	Primary Laboratory:
Sample Matrix:	Sample Start Date:
Samplers:	Sample End Date:
Date Validated:	Lab Package ID:
Data Validator:	
Analytes/Methods:	

Data Evaluation Summary

A Tier II Data Validation was performed by Wyoming Department of Environmental Quality (WDEQ) Water Quality Division-Groundwater Section on the analytical data report package generated by [Insert laboratory and city/state] evaluating samples from the [Insert project name]. [Insert subcontract laboratory name and city/state] was subcontracted to analyze [Insert analyte names] due to [Insert reason for subcontractor analysis].

Precision, accuracy, method compliance, and completeness of this data package were assessed during this data review. Precision was determined by evaluating the calculated relative percent difference (RPD) values from:

- Field duplicate pairs
- Matrix spike (MS) and matrix spike duplicate (MSD) pairs
- Laboratory control sample (LCS) and laboratory control sample duplicate (LCSD) pairs

Laboratory accuracy was established by reviewing the demonstrated percent recoveries (%R) of the following items to verify that data are not biased:

- MS/MSD samples
- LCS/LCSD samples
- Organic system monitoring compounds (surrogates)

Method compliance was established by reviewing sample integrity, holding times, detection limits, surrogate recoveries, laboratory blanks, initial and continuing calibrations (where applicable), and the LCS/LCSD percent recoveries against method-specific requirements.

Completeness was evaluated by determining the overall ratio of the number of samples and analyses planned versus the number of samples with valid analyses. Determination of completeness included a review of the chain-of-custody (CoC), laboratory analytical methods, and other laboratory and field documents associated with this analytical data set.

SAMPLE NUMBERS TABLE FOR LABORATORY PACKET [Insert #]

Laboratory Sample Number	Client Sample ID	Collect Date/Time

The samples were received at the laboratory on [Insert date and time]. The laboratory data were reviewed to evaluate compliance with the methods and the quality of the reported data. Assessment of CoC completeness is included in Item 3 of the Data Validation Checklist. A check mark (✓) indicates that the referenced validation criteria were deemed acceptable, whereas a crossed circle (⊗) indicates validation criteria for which the data have been qualified by the data validator. An empty circle (O) indicates that the specified criterion does not apply to the reviewed data. Details are noted in the tables below.

Validation Criteria

- ✓ Data Completeness
- ✓ CoC Documentation (Item 3)
- ⊗ Holding Times and Preservation (Items 6 and 7)
- ✓ Initial and Continuing Calibrations (Item 9)
- ⊗ Laboratory Blanks (Item 10)
- ✓ MS/MSD (Item 12)
- ✓ LCS/LCSD (Item 14)
- O System Monitoring Compounds (i.e., Surrogates) (Item 16)
- O Field, Equipment, and Trip Blanks (Item 17)
- O Field Duplicate (Item 19)
- ✓ Laboratory Duplicates (Item 21)

Guidance References

Chemical data validation was conducted in accordance with the United States Environmental Protection Agency (USEPA) Contract Laboratory Program (CLP) National Functional Guidelines for the analyses listed below, or by the appropriate method if not covered in the National Functional Guidelines.

- Data for inorganic analyses were evaluated according to validation criteria set forth in the USEPA CLP National Functional Guidelines for Inorganic Superfund Methods Data Review (ISM02.4), document number EPA-540-R-2017-001, January 2017.
- Data for organic analyses were evaluated according to validation criteria set forth in the USEPA CLP National Functional Guidelines for Organic Superfund Methods Data Review (SOM02.4), document number 540-R-2017-002, January 2017.

OVERALL DATA PACKAGE ASSESSMENT

Based on a data validation review, the data are acceptable as delivered. Data qualified by the laboratory are discussed in Item 2 of the Validation Criteria Checklist.

The purpose of validating data and assigning qualifiers is to assist in proper data interpretation. Data that are not qualified meet the site data quality objectives. If values are assigned qualifiers other than an R (rejected, data not usable), the data may be used for site evaluation; however, consideration should be given to the reasons for qualification when interpreting sample concentrations. Data points that are assigned an R qualifier should not be used for site evaluation purposes.

Text identified in bold font in the Validation Criteria Checklist indicates that further action and/or qualification of the data were required. Data validation qualifiers were added for the items noted with crossed circles in the Validation Criteria section above. Please see the Data Qualification Summary table at the end of this report for a complete list of samples and analytes qualified.

Data qualifiers used during this validation are included in the following table.

Qualifier	Definition

Data Completeness

The analyses were performed as requested on the CoC records. The associated samples were received by the laboratory and analyzed properly unless otherwise noted in the Criteria Checklist below. The complete data package consisted of 28 data points. No data points were rejected. The data completeness measure for this data package is calculated to be 100% and is acceptable.

VALIDATION CRITERIA CHECKLIST	
1. Was the report free of non-conformances identified by the laboratory? Comment: [Insert comment if answer is "no"]	No
2. Were the data free of data qualification flags and/or notes used by the laboratory? Comment: [Insert comment if answer is "no"]	No
3. Were sample CoC forms and procedures complete?	Yes
4. Were detection limits in accordance with the quality assurance project plan (QAPP), permit, or method, or indicated as acceptable?	Yes
5. Were the reported analytical methods and constituents in compliance with the QAPP, permit, or CoC? Were any analytes reported by more than one method?	No
6. Were samples received in good condition within method-specified requirements?	Yes
7. Were samples prepared and analyzed within method-specified or technical holding times?	Yes
8. Were reported units appropriate for the sample matrix/matrices and analytical method(s)?	Yes
9. Was there indication from the laboratory that the initial or continuing calibration verification results were within acceptable limits?	Yes
10. Was the total number of laboratory blank samples prepared equal to at least 5% of the total number of samples or analyzed as required by the method?	Yes
11. Were laboratory blank samples reported to be free of target analyte contamination?	Yes

12. Was the total number of MS samples prepared equal to at least 5% of the total number of samples or analyzed as required by the method?	Yes
13. For MS/MSDs prepared from project samples, were percent recoveries and RPDs within data validation or laboratory quality control (QC) limits? Comment: [Insert comment if answer is "no" or NA]	No
14. Was the total number of LCSs analyzed equal to at least 5% of the total number of samples or analyzed as required by the method?	Yes
15. Were LCS/LCSD percent recoveries and LCS/LCSD RPDs within data validation or laboratory QC limits?	Yes
16. Were surrogate recoveries within laboratory QC limits? Comment: [Insert comment if answer is "no" or NA]	N/A
17. Were the number of trip blank, field blank, and/or equipment blank samples collected equal to at least 10% of the total number of samples or as required by the project guidelines, QAPP, SAP, or permit? Comment: [Insert comment if answer is "no" or NA]	No
18. Were the trip blank, field blank, and/or equipment blank samples reported to be free of target analyte contamination? Comment: [Insert comment if answer is "no" or NA]	N/A
19. Was the number of field duplicates collected equal to at least 10% of the total number of samples or as required by the project guidelines, QAPP, SAP, or permit? Comment: [Insert comment if answer is "no" or NA]	No
20. Were field duplicate RPD values within data validation QC limits (soil 0-50%, water 0-30%, or air 0-25%)? Comment: [Insert comment if answer is "no" or NA]	N/A
21. For laboratory duplicates prepared from project samples, were RPDs within laboratory QC limits?	Yes

Summary of Findings – Data Usability
The sample results for oxygen and nitrogen were J qualified as estimated due to positive trip blank detections.

Table 1 - List of Laboratory Non-Conformances Not on Following Tables.

Table 2 – List of Positive Results for Blank Samples – None

Method	Sample ID	Sample Type	Analyte	Result	Qualifier	Units	MDL	PQL

Table 2A – List of Samples Qualified for Blank Contamination

Method	Method Blank	Matrix	Analyte	Blank Result	Sample Result	Lab Qualifier	PQL	Affected Samples	Sample Qualifier

Table 3 –Samples with Surrogates outside Control Limits None.

Table 4 - MS/MSD Recoveries outside Control Limits None.

Table 4A –RPDs outside Control Limits None.

Table 4B –Laboratory Replicate outside Control Limits None.

Table 5 - LCS Recoveries outside Control Limits None.

Table 5A –RPDs outside Control Limits None.

Table 6 – Samples that were Reanalyzed/Diluted

Sample ID	Lab ID	Method	Sample Type	Action

Table 7 – Summary of Field Duplicate Results

Method	Analyte	PQL	PGDW41A-05032018 Result	PGDW41A-05032018Q Results	Unit	RPD	RPD Rating	Sample Qual

Attachment B
Pace Analytical Quality Assurance Project Plan

PROPOSAL FOR ANALYTICAL SERVICES

Prepared for the Wyoming Department of Environmental Quality
Request for Proposal (RFP) 0347-B

Pace Analytical
9608 Loiret Blvd.
Lenexa, KS 66219

Table of Contents

A. RFP Pace Analytical Response

1. **Offeror's Company Name**
2. **Offeror's Point of Contact**
3. **Offeror's Business History**
4. **Offeror's Expertise**
5. **Offeror's Quality Assurance Plan Overview**
6. **Pricing/Method References**
7. **Conclusion**

B. Attachments

a. **Compound List and Pace Analytical Pricing**
b. **Pace Reporting Limits**
c. **Pace and Sub Lab Certifications**
d. **Pace Example Report**
e. **Pace Sampling Guide**

1. ***Offeror's company name, business form***
   Pace Analytical (Pace) is pleased to submit this proposal to the Wyoming Department of Environmental Quality. This proposal has been prepared in response to requirements established in the Request for Proposal (RFP).

The offeror is identified as:
Pace Analytical
9608 Loiret Blvd.
Lenexa, KS 66219

2. ***Name, title, mailing address, e-mail address and telephone number of Offeror's point of contact for purposes of this RFP and any resulting contract:***

Points of Contact

Richard Mannz
Project Manager
Pace Analytical
4120 Seven Hills Dr.
Florissant, MO 63033
richard.mannz@pacelabs.com
314-838-7223

Kaleb Meihls
Account Executive
Pace Analytical
9608 Loiret Blvd.
Lenexa, KS 66219
kaleb.meihls@pacelabs.com
303-522-9706

3. Offerer's Business History: Pace Analytical (Pace) has offered environmental analytical services for 38 years, having been incorporated in 1978 as PACE, Inc. In 1995, Pace Analytical Services Incorporated was formed from the purchase of the assets of PACE, Inc. During the period 1978 through 2017, Pace has acquired regional laboratories and opened other locations based on customer needs. Pace currently owns and operates close to 30 laboratories, including

specialty services such as radiochemistry and air testing, and close to 30 service centers throughout the United States. All work performed under this contract will be coordinated by the Lenexa, KS Laboratory with the following locations lending support as necessary:

- Pace Minneapolis, MN
- Pace Pittsburgh, PA
- Eurofins, PA – subbed VOC compounds
- Pacific Agriculture Labs, Oregon – subbed DEET testing

The operation of each Pace laboratory is governed by a corporate quality management system, has centralized treasury functions, uses or is being transitioned to use EPIC Pro lab management software for sample management and is managed by a team of Senior General Managers, General Managers and Lab Managers under the direction of the CEO Mr. Steve Vanderboom, COO Mr. Mike Fuller and Executive Vice President/CSO Mr. Greg Whitman.

3. Offeror's Expertise

For the purpose of this project, Pace will assign a Project Manager, Richard Mannz, to oversee lab analyses. The project manager will be managed by the Lenexa, KS Client Services Manager. The laboratory analysis will jointly be managed by the Lab Manager, the Quality Manager and the Project Manager.

Richard Mannz, Pace Project Manager, has his BS in Environmental Biology/Zoology from Eastern Illinois University and his MS in Environmental Science from Southern Illinois University. Richard has worked in the environmental industry for 39 years, starting with the Peabody Coal Company as an Assistant Chemist and later as a Company Biologist. He made the jump to the contract laboratory business in 1985, serving in many laboratory management positions. Richard has served Pace since 2014 and has a firm grasp on Pace's quality system and importance of quick and accurate responses and data.

Pace has experience working on multiple projects in WY, including similar projects as this. Trihydro Corporation based out of Laramie, WY can be contacted as a reference for quality of work, accuracy of data, data deliverables, etc. Contact information included below:

Pace Analytical
9608 Loiret Blvd.
Lenexa, KS 66219

Christina Hiegel

Trihydro Corporation

307-745-7474

chiegel@trihydro.com

5. ***Offeror's Quality Assurance Plan***

Pace's Quality Assurance Plan is based on NELAC (formerly National Environmental Laboratory Accreditation Council) requirements, has been subject to auditor review and is mature in its application in the laboratory. The written plan (available to you upon request) consists of nine sections that provide structure and organization to the purpose, management and operation of Pace's quality procedures. The following is a synopsis of the plan with a description of its application to the laboratory operation.

1.0 Introduction and Organizational Structure addresses the purpose of the organization, the quality policy statement and the goals of the quality system. Our core values, code of ethics and standards of conduct are clearly defined in this section. Our President, Mr. Steve Vanderboom, asks us to refer to these when we make decisions for Pace. Also in this section, the laboratory organization, job descriptions, training, safety and confidentiality of information are addressed.

2.0 Our rules on Sample Custodies are defined in this section of the manual. Requirements for how samples are received, tracked through the laboratory, stored and disposed of are given here.

3.0 Our Analytical Capabilities are defined in this section. The equipment we operate, the method sources we use and our actual practices are defined in this part of our plan. Guidance for the documentation of our internal practices called "Standard Operating Procedures", method validation and demonstration of analyst and equipment capability are available upon request.

4.0 Control of the quality of the work is described in the Quality Control Procedures section of the quality assurance plan. Maintaining data integrity is clearly addressed as an integral part of our laboratory operation. Use of quality control samples such as method blanks, laboratory control samples, matrix spikes and duplicates is prescribed with frequency and control limits. Suggestions and requirements for field quality control samples are also described. Demonstration of our ability to test samples and report

sample concentrations correctly is supported by the use of proficiency testing studies administered by outside sources. Requirements associated with that activity are included.

5.0 Document Management and Change Control are critical aspects of laboratory operation. The control of documents used in a laboratory provide assurance to management and clients that all our employees are "on the same page" when it comes to methods, quality policies, regulatory requirements and operational guidance. When it's time to change an aspect of our business, control of the change by management is important. When change occurs, documentation is important for tracking the effects of the change on clients, samples and our business.

6.0 Equipment and Measurement Traceability is required because "no man is an island". Our weights, volumes and measures must be equal to those of the rest of the world. To assure this, the documentation that connects measurements with the calibration of the measuring devices is critical to proper laboratory operation. When instruments are maintained, repaired and or recalibrated, documentation of those activities connects the condition of the equipment with the test results produced. This documentation is used to verify the test results are produced using a well maintained and properly calibrated instrument.

7.0 Through careful Control of Data, Pace can assure its clients that data produced in our well controlled system is reported and stored correctly for as long as the data has potential value for its users. Pace's system of result processing, verification, report generation and data storage assures our clients and regulators that evidence required to support our work will be available for years to come. Our practices for disposal of data when its archival age has been reached, protects the regulatory and regulated communities.

8.0 Our quality system is maintained as state of the industry through frequent Quality System Audits and Reviews. Internal audits are performed by Pace staff knowledgeable in the current practices expected of environmental analytical laboratories. External audits of our operations are frequently performed by regulatory agencies and our customers. Recommendations made by them are followed and tracked through our management of change process. Quarterly reports to management by the quality systems manager and subsequent annual management reviews help maintain the entire laboratory system in top condition.

9.0 Corrective Action is sometimes called for in order to improve our work. Audit findings may be the cause of corrective action, but our continuous improvement committees work within Pace's structure to provide recommendations for improvement as well.

In addition, Pace staff go through an integrated approach for continuous improvement. We are committed to a training program for all project management, technical and support staff. To accomplish this, Pace embarked on our 3P Process: Process, Productivity and Performance. 3P gives us a process to monitor our business through key performance metrics that include all of the stakeholders in our company, including our customers and vendors. By measuring our performance against industry benchmarks, competitors and internal goals and objects, Pace can stay on the leading edge of providing cost effective services, excellent quality data, competitive turnaround times and innovative services for our customers and employees.

6. Pricing/Methods

All prices include:

- Containers, preservatives, coolers, cooler liners, pre-printed labels, pre-printed chains of custody and temperature blanks (Pace does not provide micron filters but can provide information on suppliers)
- Standard Electronic Deliverables via email
- Access to Data via PacePort https://paceport.pacelabs.com/ClientPortal/

7.Conclusion

We look forward to providing the services needed and are thankful for the opportunity. With our quality driven structure and like-minded work force, we believe we are a great fit for the Wyoming Department of Environmental Quality and look forward to building a relationship for years to come.

while meeting the associated reporting limits, quality standards, and providing accurate data in hard copy laboratory reports and electronic data deliverables. Table 1 below lists analytes and WDEQ action levels for which the samples will be analyzed. Reporting limits must be below the WDEQ action levels.

Table 1.

Analysis Group	Analyte	CAS Number	Action Levels (ug/L)
Bacteria	E. Coli		NA*
Bacteria	Total coliform		NA
Dissolved hydrocarbon gases	Ethane	74-84-0	NA
Dissolved hydrocarbon gases	Ethene	74-85-1	NA
Dissolved hydrocarbon gases	Methane	74-82-8	NA
Environmental Isotopes	$^{18}O/^{16}O$		NA
Environmental Isotopes	$^{2}H/^{1}H$		NA
Environmental Isotopes	Tritium, Total	10028-17-8	NA
General chemistry	Bicarbonate (mg/L as HCO3)	144-55-8	NA
General chemistry	Carbonate (mg/L as CO3)		NA
General chemistry	Alkalinity, total (mg/L as CaCO3)	3812-32-6	NA
General chemistry	Hardness		NA
Major Ions (total)	Magnesium	7439-95-4	NA
Major Ions (total)	Sodium	7440-23-5	20,000
Major Ions (dissolved)	Calcium	7440-70-2	NA
Major Ions (dissolved)	Chloride	16887-00-6	250,000
Major Ions (dissolved)	Fluoride	16984-48-8	4,000
Major Ions (dissolved)	Magnesium	7439-95-4	NA
Major Ions (dissolved)	Potassium	7440-09-7	NA
Major Ions (dissolved)	Silica (SiO2)	763-18-69	NA
Major Ions (dissolved)	Sodium	7440-23-5	20,000
Major Ions (dissolved)	Sulfate as SO4	148-08-798	250,000
Major Ions (dissolved)	Total Dissolved Solids (TDS)		500,000
Major Ions (total)	Calcium	7440-70-2	NA
Major Ions (total)	Chloride	16887-00-6	250,000
Major Ions (total)	Fluoride	16984-48-8	4,000
Major Ions (total)	Potassium	7440-09-7	NA
Major Ions (total)	Silica (SiO2)	763-18-69	NA
Major Ions (total)	Sulfate as SO4	148-08-798	250,000
Nutrients	Ammonia as Nitrogen	7664-41-7	0.5
Nutrients	Dissolved Organic Carbon	7440-44-0	NA
Nutrients	Nitrate as Nitrogen	14797-55-8	10,000
Nutrients	Nitrite as Nitrogen	14797-65-0	1,000
Nutrients	Nitrogen, Total (TN)		NA
Nutrients	Orthophosphate as P	14265-44-2	NA
Radionuclides	Radon 222, Total (pCi/L ± csu)		NA
Radionuclides (dissolved)	Gross alpha radioactivity		NA
Radionuclides (dissolved)	Gross beta radioactivity		NA
Radionuclides (total)	Uranium 238		30
TOC - TN	Nitrogen, Total		NA
Trace Elements (dissolved)	Aluminum	7429-90-5	33,333
Trace Elements (dissolved)	Antimony	7440-36-0	6

Analysis Group	Analyte	CAS Number	Action Levels (ug/L)
Trace Elements (dissolved)	Arsenic	7440-38-2	10
Trace Elements (dissolved)	Barium	7440-39-3	2,000
Trace Elements (dissolved)	Beryllium	7440-41-7	4
Trace Elements (dissolved)	Boron	7440-42-8	750
Trace Elements (dissolved)	Cadmium	7440-43-9	5
Trace Elements (dissolved)	Chromium	7440-47-3	100
Trace Elements (dissolved)	Cobalt	7440-48-4	10
Trace Elements (dissolved)	Copper	7440-50-8	1,000
Trace Elements (dissolved)	Iron	7439-89-6	300
Trace Elements (dissolved)	Lead	7439-92-1	15
Trace Elements (dissolved)	Lithium	7439-93-2	NA
Trace Elements (dissolved)	Manganese	7439-96-5	50
Trace Elements (dissolved)	Molybdenum	7439-98-7	167
Trace Elements (dissolved)	Nickel	7440-02-0	667
Trace Elements (dissolved)	Selenium	7782-49-2	50
Trace Elements (dissolved)	Silver	7440-22-4	100
Trace Elements (dissolved)	Strontium	7440-24-6	8,000
Trace Elements (dissolved)	Thallium	7440-28-0	2
Trace Elements (dissolved)	Vanadium	7440-62-2	167
Trace Elements (dissolved)	Zinc	7440-66-6	5,000
Trace Elements (total)	Aluminum	7429-90-5	33,333
Trace Elements (total)	Antimony	7440-36-0	6
Trace Elements (total)	Arsenic	7440-38-2	10
Trace Elements (total)	Barium	7440-39-3	2,000
Trace Elements (total)	Beryllium	7440-41-7	4
Trace Elements (total)	Boron	7440-42-8	750
Trace Elements (total)	Cadmium	7440-43-9	5
Trace Elements (total)	Chromium	7440-47-3	100
Trace Elements (total)	Cobalt	7440-48-4	10
Trace Elements (total)	Copper	7440-50-8	1,000
Trace Elements (total)	Iron	7439-89-6	300
Trace Elements (total)	Lead	7439-92-1	15
Trace Elements (total)	Lithium	7439-93-2	NA
Trace Elements (total)	Manganese	7439-96-5	50
Trace Elements (total)	Molybdenum	7439-98-7	167
Trace Elements (total)	Nickel	7440-02-0	667
Trace Elements (total)	Selenium	7782-49-2	50
Trace Elements (total)	Silver	7440-22-4	100
Trace Elements (total)	Strontium	7440-24-6	8,000
Trace Elements (total)	Thallium	7440-28-0	2
Trace Elements (total)	Vanadium	7440-62-2	167
Trace Elements (total)	Zinc	7440-66-6	5,000
VOCs	1,1,1,2-Tetrachloroethane	630-20-6	3.45
VOCs	1,1,1-Trichloroethane	71-55-6	200
VOCs	1,1,2,2-Tetrachloroethane	79-34-5	0.45
VOCs	1,1,2-Trichloroethane	79-00-5	5
VOCs	1,1-Dichloroethane	75-34-3	15.7

Analysis Group	Analyte	CAS Number	Action Levels (ug/L)
VOCs	1,1-Dichloroethene	75-35-4	7
VOCs	1,1-Dichloropropene	563-58-6	0.897
VOCs	1,2,3-Trichlorobenzene	87-61-6	26.7
VOCs	1,2,3-Trichloropropane	96-18-4	0.003
VOCs	1,2,4-Trichlorobenzene	120-82-1	70
VOCs	1,2,4-Trimethylbenzene	95-63-6	333
VOCs	1,2-Dibromo-3-chloropropane	96-12-8	0.2
VOCs	1,2-Dibromoethane (EDB)	106-93-4	0.05
VOCs	1,2-Dichlorobenzene	95-50-1	600
VOCs	1,2-Dichloroethane	107-06-2	5
VOCs	1,2-Dichloropropane	78-87-5	5
VOCs	1,3,5-Trimethylbenzene	108-67-8	333
VOCs	1,3-Dichlorobenzene	541-73-1	75
VOCs	1,3-Dichloropropane	142-28-9	667
VOCs	1,3-Dimethyl adamantane	702-79-4	26,000
VOCs	1,4-Dichlorobenzene	106-46-7	75
VOCs	2,2-Dichloropropane	594-20-7	2.49
VOCs	2-Butanone	78-93-3	20,000
VOCs	2-Chlorotoluene	95-49-8	667
VOCs	2-Hexanone	591-78-6	167
VOCs	4-Chlorotoluene	106-43-4	667
VOCs	4-Methyl-2-pentanone	108-10-1	NA
VOCs	Acetone	67-64-1	30,000
VOCs	Acrylonitrile	107-13-1	0.0000002**
VOCs	Adamantane	281-23-2	26,000
VOCs	Allyl chloride	107-05-1	0.000004**
VOCs	Benzene	71-43-2	5
VOCs	Bromobenzene	108-86-1	267
VOCs	Bromochloromethane	74-97-5	1.45
VOCs	Bromodichloromethane	75-27-4	81
VOCs	Bromoform	75-25-2	81
VOCs	Bromomethane	74-83-9	46.7
VOCs	Carbon disulfide	75-15-0	3,333
VOCs	Carbon tetrachloride	56-23-5	5
VOCs	Chlorobenzene	108-90-7	100
VOCs	Chlorodibromomethane	124-48-1	80
VOCs	Chloroethane	75-00-3	NA
VOCs	Chloroform	67-66-3	81
VOCs	Chloromethane	74-87-3	NA
VOCs	cis-1,2-Dichloroethene	156-59-4	70
VOCs	cis-1,3-Dichloropropene	10061-01-5	0.9
VOCs	Dibromomethane	74-95-3	15.7
VOCs	Dichlorodifluoromethane	75-71-8	6.67
VOCs	DRO		10,000
VOCs	Ethyl Ether	60-29-7	0.007
VOCs	Ethylbenzene	100-41-4	700
VOCs	GRO	8006-61-9	6,600

Analysis Group	Analyte	CAS Number	Action Levels (ug/L)
VOCs	Hexachlorobutadiene	87-68-3	1.15
VOCs	Iodomethane	74-88-4	NA
VOCs	Isopropylbenzene	98-82-8	3,333
VOCs	m,p-Xylene	179601-23-1	10,000
VOCs	Methacrylonitrile	126-98-7	0.000003**
VOCs	Methyl Acrylate	96-33-3	NA
VOCs	Methyl tert-Butyl Ether	1634-04-4	50
VOCs	Methylene chloride	75-09-2	5
VOCs	Naphthalene	91-20-3	667
VOCs	n-Butyl Benzene	104-51-8	1,667
VOCs	n-Propyl Benzene	103-65-1	3,333
VOCs	o-Xylene	95-47-6	6,667
VOCs	p-Isopropyltoluene	99-87-6	2,667
VOCs	sec-Butylbenzene	135-98-8	3,333
VOCs	Styrene	100-42-5	100
VOCs	tert-Butylbenzene	98-06-6	3,333
VOCs	Tetrachloroethene	127-18-4	5
VOCs	Toluene	108-88-3	1,000
VOCs	trans-1,2-Dichloroethene	156-60-5	100
VOCs	trans-1,3-Dichloropropene	10061-02-6	0.9
VOCs	Trichloroethene	79-01-6	5
VOCs	Trichlorofluoromethane	75-69-4	10,000
VOCs	Vinyl chloride	75-01-4	2
VOCs	Xylenes (total)	1330-20-7	10,000
Wastewater compounds	Benzophenone	119-61-9	NA
Wastewater compounds	N,N-diethyl-meta-toluamide (DEET)	134-62-3	NA
Wastewater compounds	Phenanthrene	85-01-8	NA

*NA = WDEQ Action level is not available. Reporting limit should be standard reporting limit for the analyte.
** Extremely low action level. Reporting limit may be able to reach action level but needs to be as low as possible.

In addition to using methods that are sensitive enough to meet the required reporting limits at or below the WDEQ action levels, the following inclusions should be considered while preparing a response to the RFP:

1. Ground shipping costs for coolers and empty bottle sets from the laboratory to WDEQ and overnight shipping costs for full bottle sets from closest shipping store to the sampling site back to the laboratory.
2. Coolers and bottle sets with appropriate preservatives (including bottles for isotopic analysis), pre-printed sample bottle labels, chain of custody forms and tape, plastic bags for ice and samples, temperature blanks, and disposable high flow 0.45-micrometer (µm) pore-size filters for field filtration of water samples for dissolved ion and metal analysis.
3. Analysis performed by accredited/certified/registered laboratories, including subcontract laboratories (provided with proposal), using validated analytical methods. Note that WDEQ accepts and encourages microextration (EPA method 3511) to prepare samples for some organic analysis, where appropriate.
4. Standard (Level II) quality control (QC) package.
5. Quality Assurance Project Plan (QAPP) explaining at a minimum:
   5.1. Accreditations and Certifications;

PROPOSAL PRICE SHEET

The undersigned agrees to provide groundwater sample preparation and analysis for the Department of Environmental Quality, Ambient Groundwater Monitoring Program in accordance with the Request for Proposal, General Provisions, Special Provisions and Proposal Price Sheet for Request for Proposal No. 0347-B.

RFP- 0347-B

DESCRIPTION	LUMP SUM PRICE (Written in Words and Number)
Individual proposed costs should be submitted (preferably on one table) for the following items:	
Total for each Analysis Type	See attached quote $ -
Total for One Sampling Location for analytes listed in Table 1	One thousand four hundred ninety eight and "no $ 1,498
Total for Thirty Sampling Location in 2017 for analytes listed in Table 1	Forty four thousand one hundred ninety and "no $ 44,190 (includes 15 sample shipments, if applicable)
Total for Fifty (50) Sampling Location for analytes listed in Table 1, for years 2018 through 2022	Three hundred sixty eight thousand two hundred fifty $ 368,250 (includes 25 sample shipments/year, if applicable)
TOTAL:	$ 412,440 (2017-2022)

1. BY SUBMISSION OF A PROPOSAL, THE PROPOSER CERTIFIES:

   1.1 Prices in this proposal have been arrived at independently, without consultation, communication or agreement for the purpose of restricting competition.

   1.2 No attempt has been made nor will be by the proposer to induce any other person or firm to submit a proposal for the purpose of restricting competition.

   1.3 The person signing this proposal certifies that he/she is authorized to represent the company and is legally responsible for the decision as to the price and supporting documentation provided as a result of this advertisement.

   1.4 Proposer will comply with all Federal regulations, policies, guidelines and requirements.

   1.5 Prices in this proposal have not been knowingly disclosed by the proposer and will not be prior to award to any other proposer.

2. GENERAL INFORMATION:

Proposer Name Kaleb Meihls Phone ( ) 303-522-9706

Email Address kaleb.meihls@pacelabs.com FAX ( )

Mailing Address 268 E. 40th Ave.

City Denver State Co Zip 80205

Employer Identification Number 41-1821617

3. OWNERSHIP AND CONTROL:

Proposer's Legal Structure:

_____Sole Proprietorship _____General Partnership

_____Corporation _____Limited Partnership

✓ Limited Liability _____Other_____

If Proposer is a sole proprietorship, list:

Owner Name_____ Phone ( )_____

Mailing Address_____

City_____ State_____ Zip_____

Employer Identification Number_____

Beginning date as owner of sole proprietorship_____

Provide the names of all individuals authorized to sign for the Proposer:

NAME (printed or typed)	TITLE
Charles Girgin	General Manager

VERIFICATION

I certify under penalty of perjury, that I am a responsible official (as identified above) for the business entity described above as Proposer, that I have personally examined and am familiar with the information submitted in this disclosure and all attachments, and that the information is true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including criminal sanctions which can lead to imposition of a fine and/or imprisonment.

Charles Girgin

(Signature)

Charles Girgus, General Manager 6/26/17

(Name and Title) (Typed or Printed) (Date)

Pace Analytical Services, LLC
9608 Loiret Boulevard
Lenexa, KS 66219
Phone: 913-599-5665
Fax: 913-599-1759

Contact Information

Contact Name	Angela Morson	Quote Number	00038581
Account Name	Wyoming DEQ	Prepared By	Kaleb Meihls
Phone	(307) 777-6705	Email	kaleb.meihls@pacelabs.com
Email	angela.morson@wyo.gov		

Project Information

Quote Name	170626_WYDEQ_RFP 0347-B - GW Monitoring_38581	Created Date	6/27/2017
		Shipping Information	If shipment is over $500 analytical, Pace will cover shipping
Project Duration	5 years		
Project Location	WY	Report Level	Level 2
Turn Around Time	Standard TAT - 7-10 business days 3-5 day TAT - 50% rush surcharge 1-2 day TAT - 100% rush surcharge	EDD Requirements	WDEQ format
Special Instructions	2017 - 30 sites 2018 - 2022 - 50 sites/year NO BID: Total coliform E.coli 1,3 dimethyl adamantane (702-79-4) Adamantane (281-23-2) Benzophenone (119-61-9)		

Address Information

Bill To Name	Wyoming DEQ	Ship To Name	Wyoming DEQ
Bill To	122 West 25th Street Herschler Building 4W Cheyenne, WY 82002		

Quote Details

Quantity	Method	Product	Line Item Description	Sales Price	Sub-Total	Total-Price
1.00	SM 2320B	Alkalinity, as CaCO3 (bicarbonate/carbonate) - water		$10.00	$10.00	$10.00
1.00	EPA 300.0	Chloride (water)		$10.00	$10.00	$10.00
1.00	EPA 300.0	Chloride (water)	Dissolved, filtered in the field	$10.00	$10.00	$10.00
1.00	EPA 6010	Dissolved Metals, Field Filtered	See list for metals needed	$144.00	$144.00	$144.00
		Dissolved Metals, Field				

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1.00	EPA 6020	Filtered	Dissolved Sb and Tl	$23.00	$23.00	$23.00
1.00	SM 5310	Dissolved Organic Carbon (DOC)	Filtered in the field, single run	$30.00	$30.00	$30.00
1.00	EPA 300.0	Fluoride (water)		$20.00	$20.00	$20.00
1.00	EPA 300.0	Fluoride (water)	Dissolved, filtered in the field	$20.00	$20.00	$20.00
1.00	EPA 900.0	Gross Alpha Radioactivity-Aqueous	Dissolved, filtered in the field, subbed to Pace Pittsburgh, PA	$22.00	$22.00	$22.00
1.00	EPA 900.0	Gross Beta Radioactivity-Aqueous	Dissolved, filtered in the field, subbed to Pace Pittsburgh, PA	$22.00	$22.00	$22.00
1.00	SM 2340	Hardness, total (water) (Calculation Only)		$10.00	$10.00	$10.00
1.00	RSK 175 (old SM3810)	Headspace-Methane, Ethane, Ethene (GC/FID)	Subbed to Pace Minneapolis, MN	$70.00	$70.00	$70.00
1.00	EPA 6010B/ 200.7 (ICP)	Metal Analysis (First Metal)	Silica	$10.00	$10.00	$10.00
1.00	EPA 6010B/ 200.7 (ICP)	Metal Analysis (First Metal)	Dissolved silica, filtered in the field	$10.00	$10.00	$10.00
1.00	EPA 6010B (ICP)	Metal Analysis: 9+ Metals (Incl. digestion)	See list for metals needed	$150.00	$150.00	$150.00
1.00		Miscellaneous	O and H isotopes, no EPA method reference is available for this analysis (Pace SOP is being used), 6-8 week turn around time, subbed to Pace Energy Pittsburgh, PA	$100.00	$100.00	$100.00
1.00		Miscellaneous	NO BID DUE TO CAPABILITIES - 1,3 dimethyl adamantane (702-79-4), adamantane (281-23-2), benzophenone (119-61-9)	$0.00	$0.00	$0.00
1.00		Miscellaneous	DEET testing, method 8321, report limit of 1 ug/L, subbed to Pacific Ag. Labs, Oregon	$160.00	$160.00	$160.00
1.00	EPA 350.1	Nitrogen, Ammonia (water)		$15.00	$15.00	$15.00
1.00	EPA 353.2	Nitrogen, Nitrate (water)		$10.00	$10.00	$10.00
1.00	EPA 353.2	Nitrogen, Nitrite (water)		$10.00	$10.00	$10.00
1.00	EPA 353.2 + 351.2	Nitrogen, Total	Calculation only	$10.00	$10.00	$10.00
	EPA	Nitrogen, Total Kjeldahl				

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1.00	351.2	(TKN) (water)		$20.00	$20.00	$20.00
1.00	N/A	Per Cooler Shipping: Flat Rate	FedEx, if shipment is over $500 analytical, Pace will cover shipping	$50.00	$50.00	$50.00
1.00	EPA 365.2	Phosphorus, Ortho		$15.00	$15.00	$15.00
1.00	SM 7500-Rn	Radon-Rn (Liquid Scintillation Method)	Total radon 222, subbed to Pace Pittsburgh, PA	$40.00	$40.00	$40.00
1.00	EPA 8270	Semi-Volatile Organics (full list SVOCs) (Water)	Phenanthrene only	$150.00	$150.00	$150.00
1.00	SM 2540C	Solids, Total Dissolved (TDS)		$10.00	$10.00	$10.00
1.00	EPA 300.0	Sulfate - Water		$10.00	$10.00	$10.00
1.00	EPA 300.0	Sulfate - Water	Dissolved, filtered in the field	$10.00	$10.00	$10.00
1.00	SM 9223B	Total Coliforms, Bacteria (Colilert w/E. Coli)	NO BID DUE TO SHORT HOLD TIME	$0.00	$0.00	$0.00
1.00	EPA 6020	Total Metals (water)	TI only	$13.00	$13.00	$13.00
1.00	SM 5310C	Total Organic Carbon (TOC) (Water)	Single run	$30.00	$30.00	$30.00
1.00	ASTM D5174	Total Uranium (KPS) - Aqueous Only	.25 ug/L, Subbed to Pace Pittsburgh, PA	$35.00	$35.00	$35.00
1.00	EPA 8015M	TPH as Diesel (TPH-DRO)(Water)		$30.00	$30.00	$30.00
1.00	EPA 906.0	Tritium - Aqueous or Solid	Reported in pCi/L, 6-8 weeks turn around time, subbed to Pace Pittsburgh, PA	$75.00	$75.00	$75.00
1.00	EPA 8260	Volatile Organic Compounds (VOCs) (Water)	See list for compounds needed, GRO included	$75.00	$75.00	$75.00
1.00	EPA 8260	Volatile Organic Compounds (VOCs) (Water)	Allyl chloride, methacrylonitrile, methyl acrylate, subbed to Eurofins, Lancaster, PA	$69.00	$69.00	$69.00

Grand-Total $1,498.00

Additional Pricing Considerations:

If you have specific questions about any conditions noted below, please contact your Pace Analytical Representative.
•Proposal expires 60 days from created date above, unless accepted, signed and returned.
• Quoted prices include standard Pace Analytical QA/QC, reporting limits, compound lists and standard report format unless noted otherwise.
• If project specific MS/MSD samples are submitted, they may be billable.
• TAT (Turn Around Time) is in working days unless otherwise specified above.
• TCLP/SPLP Rotations will incur a surcharge of $100 per fraction for Rush TAT requests.
• To ensure requested TAT is available, please coordinate with your Pace Analytical representative at time of sample submittal.

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- Any deviation from the above quoted scope of work, including sample arrival date and volume, may result in adjustment of prices.
- Please include Quote Number on Chain-of-custody to ensure proper billing.
- Pricing includes standard delivery of bottle/sample kits and coolers.
- Charges will apply for non-standard shipping and for projects where shipping exceeds 10% of the total analytical costs of the shipment.

_____ _____
Client Signature Date

Terms and Conditions

Pace Analytical Services, Inc.: Terms and Conditions

1. **Controlling Provisions** - These Standard Terms and Conditions ("Terms") govern the agreed-upon services (the "Project) that Pace Analytical _____("Pace") will perform on behalf of _____("Client") (collectively, the Parties) and superseded any other written provisions (including purchase/work orders) related to the Project, as well as prior discussions, courses of dealing, or performance.

2. **Warranty** - Pace hereby warrants that it will: 1) conduct all tests and observations using the protocols and laboratory procedures as specified in accepted task orders, scopes of work, proposals, or written instructions ("Contract Paperwork"); and 2) uphold the reasonable scientific and engineering standards in effect in the industry at the time the service/s is/are performed. If Client subsequently, including pursuant to an executed amendment, direct different procedures and/or protocols, which may or may not involve the use of any third-party laboratory or contractor, Pace cannot warrant the results and Client shall hold Pace harmless from all claims, damages, and expenses arising from Client's direction.

3. **Data** - Pace will provide Cilent with data as specifed in the Contract Paperwork. Following final report issuance, Pace will retain back-up data for up to three (3) years and final reports for up to five (5) years. Pending Client's payment in full for Pace's contracted services, Pace may retain any Client data not already released.

4. **Intellectual Property/Ownership** - Pace shall retain sole ownership of any new method, procedure, or equipment it develops or discovers while performing services pursuant to the Contract Paperwork.

5. **Non-competition** - Client shall not solicit or recruit Pace personnel for at least 12months following the termination of the Project governed by these Terms.

6. **Sample Delivery, Accpetance, and Containers** - Client shall provide Pace with at least 10 business days' prior written notice of the delivery of any sample(s). Within 72 hours following Client's notice, Pace shall issue a written rejection of the sample(s) or its acceptance may be presumed. Notwithstanding the foregoing, Client shall remain liable for any loss or damage to the sample(s) until Pace evidences its acceptance on the chain of custody documents. Pace reserves the right to charge for any sample container(s) that are: a) provided to, but not used, by Client; or b) received by Pace, but not analyzed at Client's request.

7. **Sample Storage and Disposal** - Pace shall dispose of any non-hazardous sample(s) within 30 days following the issuance of Client's final report. In addition, Pace may return, and Client must accept, any/all highly hazardous, acutely toxic, or radioactive sample(s), sample containers, and residues, as well as any/all sample(s) for which no approved method of disposal exists.

8. **Non-Assignment** - Neither party may assign or transfer any rights or obligations existing under these Terms without prior written notice to the other party, except that Pace may, without notice to its Client: a) transfer the Project to another Pace laboratory; or 2) subcontract the Project to a third-party laboratory.

9. **Time of Completion; Force Majeure** - Pace shall use its best efforts to accomplish the Project within any specified time limiations. Pace shall not be held responsible for any non-performance or delay caused by Client, Client's employee, agents, or contractors, or factors or events beyond Pace's control, such as government shutdowns, natural disasters, labor strikes or acts of God.

10. **Compensation -**
a) The pricing offered to Client by Pace is predicated upon Client's acceptance of these Terms. In most cases, the pricing includes all sample containers and preservatives as prescribed by the analytical method requested for each determination. Credit worthiness will be determined based upon an assessment of Client's payment history, credit reports, financial stability, and/or other factors. If Pace is serving as a subcontractor for Client, Pace may seek and receive information about the Prime Client prior to granting credit. If credit is not granted, Client must pay Pace prior to initiation of the Project.

b) Client agrees to pay for services as documented by Pace and accepted by Client. Payment terms for uncontested invoice items are net 30 days. Client must notifiy Pace in writing within 15 days of its receipt of the invoice in order to suspend its payment and interest obligations for any disputed invoice items pending resolution. Beginning 30 days after the invoice date, Pace may charge interest on all unpaid and undisputed balances at the rate of 1.5% per month, not to exceed the maximum rate allowed by law. Client may ask Pace to invoice a third party, although Client shall remain ultimately responsible for the payment of any outstanding balance.

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c) Client's failure to pay within 60 days of Pace's dated invoice shall constitute a material breach of these Terms, for which Pace may terminate all of its duties hereunder without liability. If Pace must subsequently take action to collect payment, Client shall pay all associated costs thereof, including attorneys' fees. Any significant changes to the scope of work following the submittal of a price quotation or the delivery of samples to the laboratory are subject to a renegotiation of prices and/or terms relating to the original scope of work. Qualifying changes may include, but are not limited to: QA/QC requirements and procedures: detection limits; samples received and stored, but not analyzed; a decrease in quantity of samples delivered compared to quantity quoted; and reporting and other deliverable format requirements. Pace shall not be required to comply with such changes unless Pace agrees to them in writing.

11. **Risk Allocation and Damages** - Client accepts that the Project may involve inherent risks and that Pace cannot always guarantee satisfactory results. Notwithstanding the foregoing, if a court of competent jurisdiction finds that Pace failed to meet applicable standards and if Client suffers damages as a result, Pace's aggregate liability for its negligence or unintentional breach of contract shall not exceed the total fee paid for its services.

This limitation shall not apply to losses arising from Pace's negligence or willful misconduct, so long as:

1. Client notifies Pace within: 30 days from the date of discovery of Pace's claimed negligence or misconduct; or two years from the date of the Client's claimed losses; and
2. Pace is allowed to investigate and, insofar as possible, mitigate Client's claimed losses.

Neither Pace nor Client shall be liable to the other for special, incidental, consequential, or punitive losses, except as allowed in Section 12. Client Responsibilities below.

12. **Client Responsibilities** - Client shall:
a) Provide Pace with full and complete information about all known or reasonably knowable factors that could affect Pace's ability to perform its obligations, and promptly notifiy Pace if it discovers same following Project initiation;
b) Enable access by Pace personnel and/or subcontractor to any site where Pace is to perform work, and to all Client personnel who are critical to the success of the Project;
c) Obtain, on behalf of Pace, any authority or permission required by any third party;
d) Provide Pace with at least 10 business day's notice of any known or reasonably knowable delay regarding the start-up, progress, or completion fo the Project; and
e) Pay for Pace's reasonable costs to perform any out-of-scope services, such as compliance audits, responding to subpoenas, etc.

If Client defaults on any of these responsibilities and Pace incurs labor and/or material costs as a result, Client shall reimburse Pace for its actual expenses, as well as any lost profits directly attributable to Client's default.

13. **Indemnification** - Pace shall indemnify and hold Client harmless from and against any demads, losses, damages, and expenses caused by Pace's negligence or willful misconduct, as well as by the negligence and willful misconduct by persons for whom Pace is legally responsible. Client shall likewise indemnify and hold Pace harmless from and against the demands, losses, damages, and expenses caused by Client's negligence or willful misconduct, including Client's use of Pace's name and/or registered mark for anything other than the specific purpose for which it was intended. In addition, Client shall fully indemnify Pace from and against any and all claims by a third party, as well as for all related losses, costs, fees, damages, liabilities or expenses arising out of or relating to Client's breach of these Terms or its violation of applicable laws.

14. **Insurance** - Pace carries liability insurance with limits as follows:

- General Liability - $1,000,000 each occurrence: $2,000,000 general aggregate;
- Personal and Advertising Injury - $1,000,000;
- Automobile Liability - $1,000,000 combined single limit;
- Excess Liability Umbrella - $5,000,000 aggregate; $5,000,000 each occurrence;
- Worker's Compensation Insurance - statutory limits; and
- Professional Liability - $5,000,000 aggregate, $5,000,000 per claim

Pace will, at Client's request, submit certificates of insurance showing limits of coverage.

15. **Amendments/Change Orders** - Any attempt to modify, vary, supplement, or clarify any provision of these Terms is of no effect unless reduced to writing and signed by both Parties. Any such changes may increase the amount due Pace and affect Pace's obligations towards Client (see Section 2. Warranty).

16. **Confidentiality** - Each party agrees that if, during the performance of the Project, it becomes aware of any confidential or proprietary information of the other, it will not disclose such information except to those employees, subcontractors, or agents who have expressly agreed to maintain confidentiality.

17. **Miscellaneous Provisions** -
a) These Terms supersede all prior negotiations and agreements, written or oral, between Pace and Client with respect to this matter; in no event will other terms - excepting those contained in any individual task order(s) relating to this matter - be considered part of these Terms.
b) In the abscence of an executed agreement between the Parties, the delivery of any sample(s) to a Pace laboratory will constitute

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acceptance of these Terms by Client.
c) These Terms shall be construed and interpreted in accordance with the laws of the State of Minnesota without giving effect to the principles of conflicts of law thereof.
d) Client may publicly identify Pace's role as its testing laboratory so long as it immediately retracts or eliminates all such references upon termination of these Terms or Pace's written request.
e) For purposes of these Terms, the Parties may use and rely upon electronic signatures and documents for the execution and delivery of these Terms and any amendments, notices, records, disclosures, or other documents of any type sent or received in accordance with these Terms.
f) Pace is an independent contractor; no employer/employee relationship shall arise as a result of the Project.
g) These Terms shall be binding upon, and inure to the benefit of, the Parties and their respective successors and assigns.

Detection Limits

PASI Kansas Laboratory

For Acode: 3000 W28 300.0 IC Anions 28 Days

ID	Limits Type	Matrix	Analytical Method	Preparation Method	Sample Type	Instr. Name	Effective Date	Stop Date	Other Criteria
40514	MDL	Water	EPA 300.0				2/8/2017	2/8/2018	

#	Analyte	CAS Number	MDL	Units
1	Bromide	24959-67-9	0.5	mg/L
2	Chloride	16887-00-6	0.5	mg/L
3	Fluoride	16984-48-8	0.1	mg/L
4	Sulfate	14808-79-8	0.5	mg/L

Detection Limits

PASI Kansas Laboratory

For Acode: **2540C W** **2540C Total Dissolved Solids**

ID	Limits Type	Matrix	Analytical Method	Preparation Method	Sample Type	Instr. Name	Effective Date	Stop Date	Other Criteria
9753	MDL	Water	SM 2540C				4/1/2007		

#	Analyte	CAS Number	MDL	Units
1	Total Dissolved Solids		5	mg/L

Detection Limits

PASI Kansas Laboratory

For Acode: **3501 W** **350.1 Ammonia**

ID	Limits Type	Matrix	Analytical Method	Preparation Method	Sample Type	Instr. Name	Effective Date	Stop Date	Other Criteria
40251	MDL	Water	EPA 350.1			60WTA0	9/26/2016		

#	Analyte	CAS Number	MDL	Units
1	Nitrogen, Ammonia	7664-41-7	0.0132	mg/L

Detection Limits

PASI Kansas Laboratory

For Acode: 3532 W **353.2 Nitrogen, NO2/NO3 unpres**

ID	Limits Type	Matrix	Analytical Method	Preparation Method	Sample Type	Instr. Name	Effective Date	Stop Date	Other Criteria
23288	MDL	Water	EPA 353.2			60WTAB	2/11/2016		

#	Analyte	CAS Number	MDL	Units
1	Nitrogen, NO2 plus NO3		0.012	mg/L
2	Nitrogen, Nitrate		0.012	mg/L
3	Nitrogen, Nitrite		0.0103	mg/L

							LCS		
Matrix	Method	Analyte	CAS Number	RL	MDL	Units	Recovery Low	Recovery High	Units
Soil	6010B	Aluminum	7429-90-5	7.5	2.0	mg/kg	80	120	%
Soil	6010B	Antimony	7440-36-0	1.0	0.39	mg/kg	80	120	%
Soil	6010B	Arsenic	7440-38-2	1.0	0.41	mg/kg	80	120	%
Soil	6010B	Barium	7440-39-3	1.0	0.031	mg/kg	80	120	%
Soil	6010B	Beryllium	7440-41-7	0.10	0.027	mg/kg	80	120	%
Soil	6010B	Boron	7440-42-8	10	0.54	mg/kg	80	120	%
Soil	6010B	Cadmium	7440-43-9	0.50	0.037	mg/kg	80	120	%
Soil	6010B	Calcium	7440-70-2	10	2.1	mg/kg	80	120	%
Soil	6010B	Chromium	7440-47-3	0.50	0.10	mg/kg	80	120	%
Soil	6010B	Cobalt	7440-48-4	0.50	0.039	mg/kg	80	120	%
Soil	6010B	Copper	7440-50-8	1.0	0.49	mg/kg	80	120	%
Soil	6010B	Iron	7439-89-6	5.0	0.91	mg/kg	80	120	%
Soil	6010B	Lead	7439-92-1	1.0	0.21	mg/kg	80	120	%
Soil	6010B	Magnesium	7439-95-4	5.0	1.7	mg/kg	80	120	%
Soil	6010B	Manganese	7439-96-5	0.50	0.045	mg/kg	80	120	%
Soil	6010B	Molybdenum	7439-98-7	2.0	0.050	mg/kg	80	120	%
Soil	6010B	Nickel	7440-02-0	0.50	0.10	mg/kg	80	120	%
Soil	6010B	Potassium	7440-09-7	50	5.7	mg/kg	80	120	%
Soil	6010B	Selenium	7782-49-2	1.5	0.75	mg/kg	80	120	%
Soil	6010B	Silver	7440-22-4	0.7	0.17	mg/kg	80	120	%
Soil	6010B	Sodium	7440-23-5	50	2.3	mg/kg	80	120	%
Soil	6010B	Strontium	7440-24-6	1.0	0.027	mg/kg	80	120	%
Soil	6010B	Thallium	7440-28-0	2.0	0.28	mg/kg	80	120	%
Soil	6010B	Tin	7440-31-5	5.0	0.30	mg/kg	80	120	%
Soil	6010B	Titanium	7440-32-6	1.0	0.15	mg/kg	80	120	%
Soil	6010B	Vanadium	7440-62-2	1.0	0.39	mg/kg	80	120	%
Soil	6010B	Zinc	7440-66-6	10	0.26	mg/kg	80	120	%
Water	6010B	Aluminum	7429-90-5	75	28.8	ug/L	80	120	%
Water	6010B	Antimony	7440-36-0	10	3.4	ug/L	80	120	%
Water	6010B	Arsenic	7440-38-2	10	4.2	ug/L	80	120	%
Water	6010B	Barium	7440-39-3	10	0.91	ug/L	80	120	%

Water	6010B	Beryllium	7440-41-7	1.0	0.16	ug/L	80	120	%
Water	6010B	Boron	7440-42-8	100	3.5	ug/L	80	120	%
Water	6010B	Cadmium	7440-43-9	5.0	0.64	ug/L	80	120	%
Water	6010B	Calcium	7440-70-2	100	36.0	ug/L	80	120	%
Water	6010B	Chromium	7440-47-3	5.0	0.72	ug/L	80	120	%
Water	6010B	Cobalt	7440-48-4	5.0	0.73	ug/L	80	120	%
Water	6010B	Copper	7440-50-8	10	4.8	ug/L	80	120	%
Water	6010B	Iron	7439-89-6	50	12.4	ug/L	80	120	%
Water	6010B	Lead	7439-92-1	5.0	2.4	ug/L	80	120	%
Water	6010B	Lithium	7439-93-2	10	2.9	ug/L	80	120	%
Water	6010B	Magnesium	7439-95-4	50	15.4	ug/L	80	120	%
Water	6010B	Manganese	7439-96-5	5.0	1.8	ug/L	80	120	%
Water	6010B	Molybdenum	7439-98-7	20	1.3	ug/L	80	120	%
Water	6010B	Nickel	7440-02-0	5.0	2.2	ug/L	80	120	%
Water	6010B	Potassium	7440-09-7	500	52.3	ug/L	80	120	%
Water	6010B	Selenium	7782-49-2	15	3.4	ug/L	80	120	%
Water	6010B	Silicon	7440-21-3	500	15.0	ug/L	80	120	%
Water	6010B	Silver	7440-22-4	7.0	1.9	ug/L	80	120	%
Water	6010B	Sodium	7440-23-5	500	28.4	ug/L	80	120	%
Water	6010B	Strontium	7440-24-6	10	0.75	ug/L	80	120	%
Water	6010B	Thallium	7440-28-0	20	3.1	ug/L	80	120	%
Water	6010B	Tin	7440-31-5	50	2.8	ug/L	80	120	%
Water	6010B	Titanium	7440-32-6	10	1.6	ug/L	80	120	%
Water	6010B	Vanadium	7440-62-2	10	2.7	ug/L	80	120	%
Water	6010B	Zinc	7440-66-6	50	11.2	ug/L	80	120	%
Soil	6020A	Aluminum	7429-90-5	0.20	16.2	mg/kg	80	120	%
Soil	6020A	Antimony	7440-36-0	0.05	0.032	mg/kg	80	120	%
Soil	6020A	Arsenic	7440-38-2	1.0	0.12	mg/kg	80	120	%
Soil	6020A	Barium	7440-39-3	1.0	0.13	mg/kg	80	120	%
Soil	6020A	Beryllium	7440-41-7	0.50	0.053	mg/kg	80	120	%
Soil	6020A	Cadmium	7440-43-9	0.50	0.075	mg/kg	80	120	%
Soil	6020A	Chromium	7440-47-3	1.0	0.13	mg/kg	80	120	%
Soil	6020A	Cobalt	7440-48-4	1.0	0.050	mg/kg	80	120	%
Soil	6020A	Copper	7440-50-8	2.0	0.13	mg/kg	80	120	%

Soil	6020A	Iron	7439-89-6	50	1.6	mg/kg	80	120	%
Soil	6020A	Lead	7439-92-1	1.0	0.076	mg/kg	80	120	%
Soil	6020A	Manganese	7439-96-5	1.0	0.087	mg/kg	80	120	%
Soil	6020A	Molybdenum	7439-98-7	1.0	0.058	mg/kg	80	120	%
Soil	6020A	Nickel	7440-02-0	1.0	0.26	mg/kg	80	120	%
Soil	6020A	Selenium	7782-49-2	1.0	0.28	mg/kg	80	120	%
Soil	6020A	Silver	7440-22-4	0.50	0.026	mg/kg	80	120	%
Soil	6020A	Strontium	7440-24-6	1.0	0.10	mg/kg	80	120	%
Soil	6020A	Thallium	7440-28-0	1.0	0.013	mg/kg	80	120	%
Soil	6020A	Tin	7440-31-5	1.0	0.40	mg/kg	80	120	%
Soil	6020A	Titanium	7440-32-6	2.0	0.66	mg/kg	80	120	%
Soil	6020A	Vanadium	7440-62-2	2.0	0.19	mg/kg	80	120	%
Soil	6020A	Zinc	7440-66-6	20.0	10.0	mg/kg	80	120	%
Water	6020A	Aluminum	7429-90-5	50	2.2	ug/L	80	120	%
Water	6020A	Antimony	7440-36-0	1.0	0.026	ug/L	80	120	%
Water	6020A	Arsenic	7440-38-2	1.0	0.052	ug/L	80	120	%
Water	6020A	Barium	7440-39-3	1.0	0.095	ug/L	80	120	%
Water	6020A	Beryllium	7440-41-7	0.50	0.012	ug/L	80	120	%
Water	6020A	Cadmium	7440-43-9	0.50	0.018	ug/L	80	120	%
Water	6020A	Chromium	7440-47-3	1.0	0.054	ug/L	80	120	%
Water	6020A	Cobalt	7440-48-4	1.0	0.014	ug/L	80	120	%
Water	6020A	Copper	7440-50-8	1.0	0.045	ug/L	80	120	%
Water	6020A	Iron	7439-89-6	50	10	ug/L	80	120	%
Water	6020A	Lead	7439-92-1	1.0	0.033	ug/L	80	120	%
Water	6020A	Manganese	7439-96-5	1.0	0.070	ug/L	80	120	%
Water	6020A	Molybdenum	7439-98-7	1.0	0.058	ug/L	80	120	%
Water	6020A	Nickel	7440-02-0	1.0	0.070	ug/L	80	120	%
Water	6020A	Selenium	7782-49-2	1.0	0.086	ug/L	80	120	%
Water	6020A	Silver	7440-22-4	0.50	0.016	ug/L	80	120	%
Water	6020A	Strontium	7440-24-6	1.0	0.071	ug/L	80	120	%
Water	6020A	Thallium	7440-28-0	1.0	0.037	ug/L	80	120	%
Water	6020A	Tin	7440-31-5	5.0	0.11	ug/L	80	120	%
Water	6020A	Vanadium	7440-62-2	1.0	0.35	ug/L	80	120	%
Water	6020A	Zinc	7440-66-6	10	0.53	ug/L	80	120	%

Water	7470A	Mercury	7439-97-6	0.20	0.055	ug/L	80	120	%
Soil	7471A	Mercury	7439-97-6	0.05	0.0063	mg/kg	80	120	%
Soil	8260B	1,1,1,2-Tetrachloroethane	630-20-6	5.0	2.5	ug/kg	79	124	%
Soil	8260B	1,1,1-Trichloroethane	71-55-6	5.0	2.5	ug/kg	72	131	%
Soil	8260B	1,1,2,2-Tetrachloroethane	79-34-5	5.0	2.5	ug/kg	64	129	%
Soil	8260B	1,1,2-Trichloroethane	79-00-5	5.0	2.5	ug/kg	77	115	%
Soil	8260B	1,1,2-Trichlorotrifluoroethane	76-13-1	5.0	2.5		71	127	%
Soil	8260B	1,1-Dichloroethane	75-34-3	5.0	2.5	ug/kg	70	126	%
Soil	8260B	1,1-Dichloroethene	75-35-4	5.0	2.5	ug/kg	64	129	%
Soil	8260B	1,1-Dichloropropene	563-58-6	5.0	2.5	ug/kg	72	129	%
Soil	8260B	1,2,3-Trichlorobenzene	87-61-6	5.0	2.5	ug/kg	70	128	%
Soil	8260B	1,2,3-Trichloropropane	96-18-4	5.0	2.5	ug/kg	68	121	%
Soil	8260B	1,2,4-Trichlorobenzene	120-82-1	5.0	2.5	ug/kg	71	130	%
Soil	8260B	1,2,4-Trimethylbenzene	95-63-6	5.0	2.5	ug/kg	71	121	%
Soil	8260B	1,2-Dibromo-3-chloropropane	96-12-8	10	5.0	ug/kg	63	136	%
Soil	8260B	1,2-Dibromoethane (EDB)	106-93-4	5.0	2.5	ug/kg	80	118	%
Soil	8260B	1,2-Dichlorobenzene	95-50-1	5.0	2.5	ug/kg	77	119	%
Soil	8260B	1,2-Dichloroethane	107-06-2	5.0	2.5	ug/kg	78	115	%
Soil	8260B	1,2-Dichloroethene (Total)	540-59-0	5.0	2.5	ug/kg	74	121	%
Soil	8260B	1,2-Dichloropropane	78-87-5	5.0	2.5	ug/kg	78	116	%
Soil	8260B	1,3,5-Trimethylbenzene	108-67-8	5.0	2.5	ug/kg	70	125	%
Soil	8260B	1,3-Dichlorobenzene	541-73-1	5.0	2.5	ug/kg	75	120	%
Soil	8260B	1,3-Dichloropropane	142-28-9	5.0	2.5	ug/kg	77	117	%
Soil	8260B	1,4-Dichlorobenzene	106-46-7	5.0	2.5	ug/kg	76	120	%
Soil	8260B	2,2-Dichloropropane	594-20-7	5.0	2.5	ug/kg	55	151	%
Soil	8260B	2-Butanone (MEK)	78-93-3	10	5.0	ug/kg	61	125	%
Soil	8260B	2-Chloroethylvinyl ether	110-75-8	5.0	2.5	ug/kg	10	190	%
Soil	8260B	2-Chlorotoluene	95-49-8	5.0	2.5	ug/kg	69	123	%
Soil	8260B	2-Hexanone	591-78-6	20	10	ug/kg	68	125	%
Soil	8260B	4-Chlorotoluene	106-43-4	5.0	2.5	ug/kg	73	123	%
Soil	8260B	4-Methyl-2-pentanone (MIBK)	108-10-1	10	5.0	ug/kg	68	125	%
Soil	8260B	Acetone	67-64-1	20	10	ug/kg	53	130	%
Soil	8260B	Acrolein	107-02-8	100	50	ug/kg	21	166	%
Soil	8260B	Acrylonitrile	107-13-1	100	50	ug/kg	69	120	%

Soil	8260B	Benzene	71-43-2	5.0	2.5	ug/kg	81	115	%
Soil	8260B	Bromobenzene	108-86-1	5.0	2.5	ug/kg	70	128	%
Soil	8260B	Bromochloromethane	74-97-5	5.0	2.5	ug/kg	68	123	%
Soil	8260B	Bromodichloromethane	75-27-4	5.0	2.5	ug/kg	82	121	%
Soil	8260B	Bromoform	75-25-2	5.0	2.5	ug/kg	65	136	%
Soil	8260B	Bromomethane	74-83-9	5.0	2.5	ug/kg	29	146	%
Soil	8260B	Carbon disulfide	75-15-0	5.0	2.5	ug/kg	57	129	%
Soil	8260B	Carbon tetrachloride	56-23-5	5.0	2.5	ug/kg	70	137	%
Soil	8260B	Chlorobenzene	108-90-7	5.0	2.5	ug/kg	79	116	%
Soil	8260B	Chloroethane	75-00-3	5.0	2.5	ug/kg	54	135	%
Soil	8260B	Chloroform	67-66-3	5.0	2.5	ug/kg	72	120	%
Soil	8260B	Chloromethane	74-87-3	5.0	2.5	ug/kg	36	143	%
Soil	8260B	cis-1,2-Dichloroethene	156-59-2	5.0	2.5	ug/kg	74	121	%
Soil	8260B	cis-1,3-Dichloropropene	10061-01-5	5.0	2.5	ug/kg	80	120	%
Soil	8260B	Dibromochloromethane	124-48-1	5.0	2.5	ug/kg	79	125	%
Soil	8260B	Dibromomethane	74-95-3	5.0	2.5	ug/kg	80	116	%
Soil	8260B	Dichlorodifluoromethane	75-71-8	5.0	2.5	ug/kg	10	172	%
Soil	8260B	Diethyl ether (Ethyl ether)	60-29-7	5.0	2.5	ug/kg	70	102	%
Soil	8260B	Diisopropyl ether	108-20-3	5.0	2.5	ug/kg	74	116	%
Soil	8260B	Ethyl tert-butyl ether	637-92-3	5.0	2.5	ug/kg	70	126	%
Soil	8260B	Ethylbenzene	100-41-4	5.0	2.5	ug/kg	76	119	%
Soil	8260B	Hexachloro-1,3-butadiene	87-68-3	5.0	2.5	ug/kg	63	140	%
Soil	8260B	Isopropylbenzene (Cumene)	98-82-8	5.0	2.5	ug/kg	75	127	%
Soil	8260B	m,p-Xylene	179601-23-1	5.0	2.5	ug/kg	75	121	%
Soil	8260B	Methyl acetate	79-20-9	5.0	2.5	ug/kg	66	93	%
Soil	8260B	Methyl tert-butyl ether	1634-04-4	5.0	2.5	ug/kg	68	118	%
Soil	8260B	Methylene chloride	75-09-2	5.0	2.5	ug/kg	65	123	%
Soil	8260B	Naphthalene	91-20-3	10	5.0	ug/kg	68	122	%
Soil	8260B	n-Butylbenzene	104-51-8	5.0	2.5	ug/kg	66	133	%
Soil	8260B	n-Hexane	110-54-3	5.0	2.5	ug/kg	81	123	%
Soil	8260B	n-Propylbenzene	103-65-1	5.0	2.5	ug/kg	69	128	%
Soil	8260B	o-Xylene	95-47-6	5.0	2.5	ug/kg	76	120	%
Soil	8260B	p-Isopropyltoluene	99-87-6	5.0	2.5	ug/kg	69	129	%
Soil	8260B	sec-Butylbenzene	135-98-8	5.0	2.5	ug/kg	66	130	%

Soil	8260B	Styrene	100-42-5	5.0	2.5	ug/kg	78	122	%
Soil	8260B	tert-Amyl methyl ether	994-05-8	5.0	2.5	ug/kg	69	129	%
Soil	8260B	tert-Butyl alcohol	75-65-0	10	5.0	ug/kg	54	129	%
Soil	8260B	tert-Butylbenzene	98-06-6	5.0	2.5	ug/kg	69	128	%
Soil	8260B	Tetrachloroethene	127-18-4	5.0	2.5	ug/kg	71	130	%
Soil	8260B	Toluene	108-88-3	5.0	2.5	ug/kg	77	116	%
Soil	8260B	trans-1,2-Dichloroethene	156-60-5	5.0	2.5	ug/kg	71	124	%
Soil	8260B	trans-1,3-Dichloropropene	10061-02-6	5.0	2.5	ug/kg	77	127	%
Soil	8260B	Trichloroethene	79-01-6	5.0	2.5	ug/kg	69	121	%
Soil	8260B	Trichlorofluoromethane	75-69-4	5.0	2.5	ug/kg	60	148	%
Soil	8260B	Vinyl acetate	108-05-4	100	50	ug/kg	37	126	%
Soil	8260B	Vinyl chloride	75-01-4	5.0	2.5	ug/kg	45	139	%
Soil	8260B	Xylene (Total)	1330-20-7	5.0	2.5	ug/kg	76	121	%
Soil	8260B	1,2-Dichloroethane-d4 (S)	17060-07-0	--	--	--	--	--	--
Soil	8260B	4-Bromofluorobenzene (S)	460-00-4	--	--	--	--	--	--
Soil	8260B	Toluene-d8 (S)	2037-26-5	--	--	--	--	--	--
Water	8260B	1,1,1,2-Tetrachloroethane	630-20-6	1.0	0.15	ug/L	85	113	%
Water	8260B	1,1,1-Trichloroethane	71-55-6	1.0	0.11	ug/L	80	121	%
Water	8260B	1,1,2,2-Tetrachloroethane	79-34-5	1.0	0.15	ug/L	74	124	%
Water	8260B	1,1,2-Trichloroethane	79-00-5	1.0	0.20	ug/L	81	118	%
Water	8260B	1,1,2-Trichlorotrifluoroethane	76-13-1	1.0	0.34	ug/L	79	123	%
Water	8260B	1,1-Dichloroethane	75-34-3	1.0	0.050	ug/L	82	122	%
Water	8260B	1,1-Dichloroethene	75-35-4	1.0	0.20	ug/L	78	123	%
Water	8260B	1,1-Dichloropropene	563-58-6	1.0	0.090	ug/L	82	120	%
Water	8260B	1,2,3-Trichlorobenzene	87-61-6	1.0	0.12	ug/L	71	123	%
Water	8260B	1,2,3-Trichloropropane	96-18-4	2.5	0.19	ug/L	74	122	%
Water	8260B	1,2,3-Trimethylbenzene	526-73-8	1.0	0.62	ug/L	89	116	%
Water	8260B	1,2,4-Trichlorobenzene	120-82-1	1.0	0.10	ug/L	75	122	%
Water	8260B	1,2,4-Trimethylbenzene	95-63-6	1.0	0.090	ug/L	85	116	%
Water	8260B	1,2-Dibromo-3-chloropropane	96-12-8	2.5	0.59	ug/L	58	145	%
Water	8260B	1,2-Dibromoethane (EDB)	106-93-4	1.0	0.17	ug/L	83	118	%
Water	8260B	1,2-Dichlorobenzene	95-50-1	1.0	0.050	ug/L	85	117	%
Water	8260B	1,2-Dichloroethane	107-06-2	1.0	0.12	ug/L	78	117	%
Water	8260B	1,2-Dichloroethene (Total)	540-59-0	1.0	0.28	ug/L	80	119	%

Water	8260B	1,2-Dichloropropane	78-87-5	1.0	0.16	ug/L	81	118	%
Water	8260B	1,3,5-Trimethylbenzene	108-67-8	1.0	0.10	ug/L	83	118	%
Water	8260B	1,3-Dichlorobenzene	541-73-1	1.0	0.070	ug/L	83	115	%
Water	8260B	1,3-Dichloropropane	142-28-9	1.0	0.17	ug/L	85	124	%
Water	8260B	1,4-Dichlorobenzene	106-46-7	1.0	0.060	ug/L	85	115	%
Water	8260B	1-Methylnaphthalene	90-12-0	5.0	0.23	ug/L	59	146	%
Water	8260B	2,2-Dichloropropane	594-20-7	1.0	0.19	ug/L	46	144	%
Water	8260B	2-Butanone (MEK)	78-93-3	10	0.59	ug/L	72	117	%
Water	8260B	2-Chloroethylvinyl ether	110-75-8	10	0.13	ug/L	62	131	%
Water	8260B	2-Chlorotoluene	95-49-8	1.0	0.12	ug/L	82	116	%
Water	8260B	2-Hexanone	591-78-6	10	1.19	ug/L	78	118	%
Water	8260B	2-Methylnaphthalene	91-57-6	5.0	0.23	ug/L	59	146	%
Water	8260B	4-Chlorotoluene	106-43-4	1.0	0.14	ug/L	82	116	%
Water	8260B	4-Methyl-2-pentanone (MIBK)	108-10-1	10	0.42	ug/L	77	124	%
Water	8260B	Acetone	67-64-1	10	1.9	ug/L	66	127	%
Water	8260B	Acetonitrile	75-05-8	10	2.8	ug/L	76	119	%
Water	8260B	Acrolein	107-02-8	100	5.0	ug/L	10	201	%
Water	8260B	Acrylonitrile	107-13-1	20	1.1	ug/L	76	124	%
Water	8260B	Benzene	71-43-2	1.0	0.060	ug/L	82	115	%
Water	8260B	Bromobenzene	108-86-1	1.0	0.10	ug/L	84	114	%
Water	8260B	Bromochloromethane	74-97-5	1.0	0.15	ug/L	76	122	%
Water	8260B	Bromodichloromethane	75-27-4	1.0	0.19	ug/L	83	123	%
Water	8260B	Bromoform	75-25-2	1.0	0.070	ug/L	79	126	%
Water	8260B	Bromomethane	74-83-9	5.0	0.16	ug/L	39	146	%
Water	8260B	Carbon disulfide	75-15-0	5.0	0.12	ug/L	75	121	%
Water	8260B	Carbon tetrachloride	56-23-5	1.0	0.18	ug/L	82	117	%
Water	8260B	Chlorobenzene	108-90-7	1.0	0.21	ug/L	89	114	%
Water	8260B	Chloroethane	75-00-3	1.0	0.15	ug/L	71	133	%
Water	8260B	Chloroform	67-66-3	1.0	0.14	ug/L	78	117	%
Water	8260B	Chloromethane	74-87-3	1.0	0.080	ug/L	19	181	%
Water	8260B	cis-1,2-Dichloroethene	156-59-2	1.0	0.080	ug/L	78	119	%
Water	8260B	cis-1,3-Dichloropropene	10061-01-5	1.0	0.14	ug/L	81	116	%
Water	8260B	Dibromochloromethane	124-48-1	1.0	0.21	ug/L	81	122	%
Water	8260B	Dibromomethane	74-95-3	1.0	0.18	ug/L	79	120	%

Water	8260B	Dichlorodifluoromethane	75-71-8	1.0	0.21	ug/L	64	147	%
Water	8260B	Diethyl ether (Ethyl ether)	60-29-7	1.0	0.28	ug/L	81	115	%
Water	8260B	Diisopropyl ether	108-20-3	1.0	0.080	ug/L	78	122	%
Water	8260B	Ethyl tert-butyl ether	637-92-3	1.0	0.1	ug/L	76	122	%
Water	8260B	Ethylbenzene	100-41-4	1.0	0.18	ug/L	83	112	%
Water	8260B	Hexachloro-1,3-butadiene	87-68-3	1.0	0.18	ug/L	72	122	%
Water	8260B	Iodomethane	74-88-4	10	0.05	ug/L	40	144	%
Water	8260B	Isopropylbenzene (Cumene)	98-82-8	1.0	0.07	ug/L	87	117	%
Water	8260B	m,p-Xylene	179601-23-1	2.0	0.27	ug/L	83	114	%
Water	8260B	Methyl tert-butyl ether	1634-04-4	1.0	0.06	ug/L	73	118	%
Water	8260B	Methylene chloride	75-09-2	1.0	0.15	ug/L	78	127	%
Water	8260B	Naphthalene	91-20-3	10	0.16	ug/L	67	118	%
Water	8260B	n-Butylbenzene	104-51-8	1.0	0.10	ug/L	79	117	%
Water	8260B	n-Heptane	142-82-5	10	0.34	ug/L	69	129	%
Water	8260B	n-Hexane	110-54-3	10	0.24	ug/L	53	143	%
Water	8260B	n-Propylbenzene	103-65-1	1.0	0.10	ug/L	82	117	%
Water	8260B	o-Xylene	95-47-6	1.0	0.15	ug/L	83	114	%
Water	8260B	p-Isopropyltoluene	99-87-6	1.0	0.10	ug/L	85	116	%
Water	8260B	sec-Butylbenzene	135-98-8	1.0	0.050	ug/L	82	112	%
Water	8260B	Styrene	100-42-5	1.0	0.12	ug/L	88	117	%
Water	8260B	tert-Amyl methyl ether	994-05-8	1.0	0.12	ug/L	76	122	%
Water	8260B	tert-Butyl alcohol	75-65-0	10	2.2	ug/L	60	136	%
Water	8260B	tert-Butylbenzene	98-06-6	1.0	0.34	ug/L	85	115	%
Water	8260B	Tetrachloroethene	127-18-4	1.0	0.10	ug/L	80	121	%
Water	8260B	Toluene	108-88-3	1.0	0.17	ug/L	78	113	%
Water	8260B	trans-1,2-Dichloroethene	156-60-5	1.0	0.20	ug/L	79	120	%
Water	8260B	trans-1,3-Dichloropropene	10061-02-6	1.0	0.12	ug/L	81	119	%
Water	8260B	trans-1,4-Dichloro-2-butene	110-57-6	20	0.30	ug/L	66	131	%
Water	8260B	Trichloroethene	79-01-6	1.0	0.17	ug/L	78	118	%
Water	8260B	Trichlorofluoromethane	75-69-4	1.0	0.34	ug/L	80	135	%
Water	8260B	Vinyl acetate	108-05-4	20	0.14	ug/L	60	130	%
Water	8260B	Vinyl chloride	75-01-4	1.0	0.13	ug/L	66	133	%
Water	8260B	Xylene (Total)	1330-20-7	3.0	0.42	ug/L	83	114	%
Water	8260B	1,2-Dichloroethane-d4 (S)	17060-07-0	--	--	--	--	--	--

Water	8260B	4-Bromofluorobenzene (S)	460-00-4	--	--	--	--	--	--
Water	8260B	Toluene-d8 (S)	2037-26-5	--	--	--	--	--	--
Soil	8270C	1,2,4-Trichlorobenzene	120-82-1	330	165	ug/kg	27	115	%
Soil	8270C	1,2-Dichlorobenzene	95-50-1	330	165	ug/kg	27	111	%
Soil	8270C	1,2-Diphenylhydrazine	122-66-7	330	165	ug/kg	40	102	%
Soil	8270C	1,3-Dichlorobenzene	541-73-1	330	165	ug/kg	26	109	%
Soil	8270C	1,4-Dichlorobenzene	106-46-7	330	165	ug/kg	26	109	%
Soil	8270C	1-Methylnaphthalene	90-12-0	330	165	ug/kg	10	154	%
Soil	8270C	2,2'-Oxybis(1-chloropropane)	108-60-1	330	165	ug/kg	40	120	%
Soil	8270C	2,3,4,6-Tetrachlorophenol	58-90-2	330	165	ug/kg	40	95	%
Soil	8270C	2,4,5-Trichlorophenol	95-95-4	330	165	ug/kg	30	128	%
Soil	8270C	2,4,6-Trichlorophenol	88-06-2	330	165	ug/kg	29	128	%
Soil	8270C	2,4-Dichlorophenol	120-83-2	330	165	ug/kg	29	121	%
Soil	8270C	2,4-Dimethylphenol	105-67-9	330	165	ug/kg	29	113	%
Soil	8270C	2,4-Dinitrophenol	51-28-5	1670	835	ug/kg	19	142	%
Soil	8270C	2,4-Dinitrotoluene	121-14-2	330	165	ug/kg	31	135	%
Soil	8270C	2,6-Dinitrotoluene	606-20-2	330	165	ug/kg	31	132	%
Soil	8270C	2-Chloronaphthalene	91-58-7	330	165	ug/kg	29	122	%
Soil	8270C	2-Chlorophenol	95-57-8	330	165	ug/kg	26	111	%
Soil	8270C	2-Methylnaphthalene	91-57-6	330	165	ug/kg	30	121	%
Soil	8270C	2-Methylphenol (o-Cresol)	95-48-7	330	165	ug/kg	26	100	%
Soil	8270C	2-Nitroaniline	88-74-4	660	330	ug/kg	30	132	%
Soil	8270C	2-Nitrophenol	88-75-5	330	165	ug/kg	27	128	%
Soil	8270C	3,3'-Dichlorobenzidine	91-94-1	660	330	ug/kg	18	189	%
Soil	8270C	3,4-Methylphenol (m,p Cresol)	multiple	330	165	ug/kg	22	95	%
Soil	8270C	3-Nitroaniline	99-09-2	660	330	ug/kg	31	149	%
Soil	8270C	4,6-Dinitro-2-methylphenol	534-52-1	1670	835	ug/kg	25	141	%
Soil	8270C	4-Bromophenylphenyl ether	101-55-3	330	165	ug/kg	30	131	%
Soil	8270C	4-Chloro-3-methylphenol	59-50-7	660	330	ug/kg	29	124	%
Soil	8270C	4-Chloroaniline	106-47-8	660	330	ug/kg	26	142	%
Soil	8270C	4-Chlorophenylphenyl ether	7005-72-3	330	165	ug/kg	31	127	%
Soil	8270C	4-Nitroaniline	100-01-6	660	330	ug/kg	29	136	%
Soil	8270C	4-Nitrophenol	100-02-7	1670	835	ug/kg	30	100	%
Soil	8270C	Acenaphthene	83-32-9	330	165	ug/kg	30	127	%

Soil	8270C	Acenaphthylene	208-96-8	330	165	ug/kg	29	126	%
Soil	8270C	Aniline	62-53-3	660	330	ug/kg	26	122	%
Soil	8270C	Anthracene	120-12-7	330	165	ug/kg	32	131	%
Soil	8270C	Azobenzene	103-33-3	330	165	ug/kg	10	168	%
Soil	8270C	Benzidine	92-87-5	1670	835	ug/kg	10	66	%
Soil	8270C	Benzo(a)anthracene	56-55-3	330	165	ug/kg	32	131	%
Soil	8270C	Benzo(a)pyrene	50-32-8	330	165	ug/kg	30	131	%
Soil	8270C	Benzo(b)fluoranthene	205-99-2	330	165	ug/kg	31	134	%
Soil	8270C	Benzo(g,h,i)perylene	191-24-2	330	165	ug/kg	29	133	%
Soil	8270C	Benzo(k)fluoranthene	207-08-9	330	165	ug/kg	30	133	%
Soil	8270C	Benzoic acid	65-85-0	1670	835	ug/kg	10	64	%
Soil	8270C	Benzyl alcohol	100-51-6	660	330	ug/kg	19	106	%
Soil	8270C	bis(2-Chloroethoxy)methane	111-91-1	330	165	ug/kg	29	122	%
Soil	8270C	bis(2-Chloroethyl) ether	111-44-4	330	165	ug/kg	25	122	%
Soil	8270C	bis(2-Ethylhexyl)phthalate	117-81-7	330	165	ug/kg	34	139	%
Soil	8270C	Butylbenzylphthalate	85-68-7	330	165	ug/kg	30	142	%
Soil	8270C	Carbazole	86-74-8	330	165	ug/kg	31	133	%
Soil	8270C	Chrysene	218-01-9	330	165	ug/kg	32	133	%
Soil	8270C	Dibenz(a,h)anthracene	53-70-3	330	165	ug/kg	30	133	%
Soil	8270C	Dibenzofuran	132-64-9	330	165	ug/kg	30	126	%
Soil	8270C	Diethylphthalate	84-66-2	330	165	ug/kg	34	129	%
Soil	8270C	Dimethylphthalate	131-11-3	330	165	ug/kg	34	127	%
Soil	8270C	Di-n-butylphthalate	84-74-2	330	165	ug/kg	35	135	%
Soil	8270C	Di-n-octylphthalate	117-84-0	330	165	ug/kg	31	139	%
Soil	8270C	Fluoranthene	206-44-0	330	165	ug/kg	32	134	%
Soil	8270C	Fluorene	86-73-7	330	165	ug/kg	31	128	%
Soil	8270C	Hexachloro-1,3-butadiene	87-68-3	330	165	ug/kg	25	112	%
Soil	8270C	Hexachlorobenzene	118-74-1	330	165	ug/kg	30	130	%
Soil	8270C	Hexachlorocyclopentadiene	77-47-4	330	165	ug/kg	10	61	%
Soil	8270C	Hexachloroethane	67-72-1	330	165	ug/kg	24	107	%
Soil	8270C	Indeno(1,2,3-cd)pyrene	193-39-5	330	165	ug/kg	30	131	%
Soil	8270C	Isophorone	78-59-1	330	165	ug/kg	29	125	%
Soil	8270C	Naphthalene	91-20-3	330	165	ug/kg	30	118	%
Soil	8270C	Nitrobenzene	98-95-3	330	165	ug/kg	28	123	%

Soil	8270C	N-Nitrosodimethylamine	62-75-9	330	165	ug/kg	10	102	%
Soil	8270C	N-Nitroso-di-n-propylamine	621-64-7	330	165	ug/kg	29	123	%
Soil	8270C	N-Nitrosodiphenylamine	86-30-6	330	165	ug/kg	31	129	%
Soil	8270C	Pentachlorophenol	87-86-5	1670	835	ug/kg	27	136	%
Soil	8270C	Phenanthrene	85-01-8	330	165	ug/kg	32	130	%
Soil	8270C	Phenol	108-95-2	330	165	ug/kg	10	61	%
Soil	8270C	Pyrene	129-00-0	330	165	ug/kg	32	132	%
Soil	8270C	Pyridine	110-86-1	330	165	ug/kg	10	66	%
Soil	8270C	Quinoline	91-22-5	330	165	ug/kg	50	90	%
Soil	8270C	2,4,6-Tribromophenol (S)	118-79-6	--	--	--	--	--	--
Soil	8270C	2-Fluorobiphenyl (S)	321-60-8	--	--	--	--	--	--
Soil	8270C	2-Fluorophenol (S)	367-12-4	--	--	--	--	--	--
Soil	8270C	Nitrobenzene-d5 (S)	4165-60-0	--	--	--	--	--	--
Soil	8270C	Phenol-d6 (S)	13127-88-3	--	--	--	--	--	--
Soil	8270C	Terphenyl-d14 (S)	1718-51-0	--	--	--	--	--	--
Water	8270C	1,2,4-Trichlorobenzene	120-82-1	10	0.52	ug/L	62	98	%
Water	8270C	1,2-Dichlorobenzene	95-50-1	10	0.51	ug/L	61	97	%
Water	8270C	1,2-Diphenylhydrazine	122-66-7	10	0.58	ug/L	68	114	%
Water	8270C	1,3-Dichlorobenzene	541-73-1	10	0.67	ug/L	59	95	%
Water	8270C	1,4-Dichlorobenzene	106-46-7	10	0.62	ug/L	59	96	%
Water	8270C	1-Methylnaphthalene	90-12-0	10	0.57	ug/L	59	107	%
Water	8270C	2,2'-Oxybis(1-chloropropane)	108-60-1	10	0.89	ug/L	58	101	%
Water	8270C	2,3,4,6-Tetrachlorophenol	58-90-2	50	0.56	ug/L	59	117	%
Water	8270C	2,4,5-Trichlorophenol	95-95-4	50	0.76	ug/L	70	108	%
Water	8270C	2,4,6-Trichlorophenol	88-06-2	10	0.62	ug/L	68	108	%
Water	8270C	2,4-Dichlorophenol	120-83-2	10	0.72	ug/L	65	101	%
Water	8270C	2,4-Dimethylphenol	105-67-9	10	1.1	ug/L	57	98	%
Water	8270C	2,4-Dinitrophenol	51-28-5	50	5.0	ug/L	35	142	%
Water	8270C	2,4-Dinitrotoluene	121-14-2	10	0.68	ug/L	70	116	%
Water	8270C	2,6-Dinitrotoluene	606-20-2	10	0.64	ug/L	69	113	%
Water	8270C	2-Chloronaphthalene	91-58-7	10	0.57	ug/L	66	104	%
Water	8270C	2-Chlorophenol	95-57-8	10	0.67	ug/L	60	96	%
Water	8270C	2-Methylnaphthalene	91-57-6	10	0.68	ug/L	59	111	%
Water	8270C	2-Methylphenol (o-Cresol)	95-48-7	10	0.56	ug/L	51	89	%

Water	8270C	2-Nitroaniline	88-74-4	50	0.64	ug/L	67	117	%
Water	8270C	2-Nitrophenol	88-75-5	10	0.60	ug/L	60	118	%
Water	8270C	3,3'-Dichlorobenzidine	91-94-1	20	5.0	ug/L	22	241	%
Water	8270C	3,4-Methylphenol (m,p Cresol)	multiple	10	0.73	ug/L	44	85	%
Water	8270C	3-Nitroaniline	99-09-2	50	0.69	ug/L	34	190	%
Water	8270C	4,6-Dinitro-2-methylphenol	534-52-1	50	0.62	ug/L	40	151	%
Water	8270C	4-Bromophenylphenyl ether	101-55-3	10	0.71	ug/L	69	109	%
Water	8270C	4-Chloro-3-methylphenol	59-50-7	20	10	ug/L	66	103	%
Water	8270C	4-Chloroaniline	106-47-8	20	0.70	ug/L	13	204	%
Water	8270C	4-Chlorophenylphenyl ether	7005-72-3	10	0.70	ug/L	69	106	%
Water	8270C	4-Nitroaniline	100-01-6	50	0.68	ug/L	68	118	%
Water	8270C	4-Nitrophenol	100-02-7	50	25	ug/L	13	63	%
Water	8270C	Acenaphthene	83-32-9	10	0.51	ug/L	68	105	%
Water	8270C	Acenaphthylene	208-96-8	10	0.55	ug/L	66	109	%
Water	8270C	Aniline	62-53-3	20	0.55	ug/L	34	123	%
Water	8270C	Anthracene	120-12-7	10	0.67	ug/L	70	111	%
Water	8270C	Azobenzene	103-33-3	10	0.58	ug/L	30	156	%
Water	8270C	Benzidine	92-87-5	50	1.1	ug/L	10	75	%
Water	8270C	Benzo(a)anthracene	56-55-3	10	0.60	ug/L	71	111	%
Water	8270C	Benzo(a)pyrene	50-32-8	10	0.84	ug/L	70	111	%
Water	8270C	Benzo(b)fluoranthene	205-99-2	10	0.53	ug/L	69	115	%
Water	8270C	Benzo(g,h,i)perylene	191-24-2	10	0.70	ug/L	65	117	%
Water	8270C	Benzo(k)fluoranthene	207-08-9	10	0.84	ug/L	69	113	%
Water	8270C	Benzoic acid	65-85-0	50	0.82	ug/L	10	69	%
Water	8270C	Benzyl alcohol	100-51-6	20	0.62	ug/L	32	115	%
Water	8270C	Biphenyl	92-52-4	10	5.0	ug/L	50	150	%
Water	8270C	bis(2-Chloroethoxy)methane	111-91-1	10	0.51	ug/L	65	105	%
Water	8270C	bis(2-Chloroethyl)ether	111-44-4	10	0.59	ug/L	63	104	%
Water	8270C	bis(2-Chloroisopropyl) ether	39638-32-9	10	0.89	ug/L	55	115	%
Water	8270C	bis(2-ethylhexyl)adipate	103-23-1	10	0.78	ug/L	56	120	%
Water	8270C	bis(2-Ethylhexyl)phthalate	117-81-7	10	1.9	ug/L	69	122	%
Water	8270C	Butylbenzylphthalate	85-68-7	10	0.60	ug/L	69	121	%
Water	8270C	Carbazole	86-74-8	10	0.56	ug/L	69	112	%
Water	8270C	Chrysene	218-01-9	10	0.68	ug/L	71	111	%

Water	8270C	Dibenz(a,h)anthracene	53-70-3	10	0.68	ug/L	68	114	%
Water	8270C	Dibenzofuran	132-64-9	10	0.59	ug/L	69	106	%
Water	8270C	Diethylphthalate	84-66-2	10	0.57	ug/L	69	110	%
Water	8270C	Dimethylphthalate	131-11-3	10	0.57	ug/L	68	108	%
Water	8270C	Di-n-butylphthalate	84-74-2	10	0.56	ug/L	70	117	%
Water	8270C	Di-n-octylphthalate	117-84-0	10	0.53	ug/L	68	124	%
Water	8270C	Fluoranthene	206-44-0	10	0.56	ug/L	71	112	%
Water	8270C	Fluorene	86-73-7	10	0.52	ug/L	69	107	%
Water	8270C	Hexachloro-1,3-butadiene	87-68-3	10	0.98	ug/L	57	97	%
Water	8270C	Hexachlorobenzene	118-74-1	10	5.0	ug/L	68	110	%
Water	8270C	Hexachlorocyclopentadiene	77-47-4	10	0.74	ug/L	19	59	%
Water	8270C	Hexachloroethane	67-72-1	10	0.74	ug/L	56	96	%
Water	8270C	Indeno(1,2,3-cd)pyrene	193-39-5	10	0.72	ug/L	67	114	%
Water	8270C	Isophorone	78-59-1	10	0.50	ug/L	66	106	%
Water	8270C	Naphthalene	91-20-3	10	0.62	ug/L	65	101	%
Water	8270C	Nitrobenzene	98-95-3	10	0.70	ug/L	62	108	%
Water	8270C	N-Nitrosodimethylamine	62-75-9	10	0.55	ug/L	10	113	%
Water	8270C	N-Nitroso-di-n-propylamine	621-64-7	10	0.61	ug/L	64	108	%
Water	8270C	N-Nitrosodiphenylamine	86-30-6	10	0.55	ug/L	69	108	%
Water	8270C	Pentachlorophenol	87-86-5	50	0.59	ug/L	58	126	%
Water	8270C	Phenanthrene	85-01-8	10	0.65	ug/L	69	111	%
Water	8270C	Phenol	108-95-2	10	5.0	ug/L	15	57	%
Water	8270C	Pyrene	129-00-0	10	0.63	ug/L	71	113	%
Water	8270C	Pyridine	110-86-1	10	5.0	ug/L	10	69	%
Water	8270C	2,4,6-Tribromophenol (S)	118-79-6	--	--	--	--	--	--
Water	8270C	2-Fluorobiphenyl (S)	321-60-8	--	--	--	--	--	--
Water	8270C	2-Fluorophenol (S)	367-12-4	--	--	--	--	--	--
Water	8270C	Nitrobenzene-d5 (S)	4165-60-0	--	--	--	--	--	--
Water	8270C	Phenol-d6 (S)	13127-88-3	--	--	--	--	--	--
Water	8270C	Terphenyl-d14 (S)	1718-51-0	--	--	--	--	--	--
Water	8260B	LRH (C5-C8)	N/A	0.050	0.025	mg/L	80	120	%
Soil	8260B	LRH (C5-C8)	N/A	25.0	4.1	mg/kg	80	120	%
Soil	6020A	Uranium-238	7440-61-1	1.0	0.0030	mg/kg	80	120	%

MS / MSD				Surrogates		
Recovery Low	Recovery High	MS/MSD RPD	Units	Recovery Low	Recovery High	Units
75	125	20	%	--	--	--
75	125	20	%	--	--	--
75	125	20	%	--	--	--

75	125	20	%	--	--	--
75	125	20	%	--	--	--
75	125	20	%	--	--	--

75	125	20	%	--	--	--
75	125	20	%	--	--	--
75	125	20	%	--	--	--

75	125	20	%	--	--	--
75	125	20	%	--	--	--
10	142	44	%	--	--	--
45	127	37	%	--	--	--
10	154	51	%	--	--	--
10	140	42	%	--	--	--
51	177	50	%	--	--	--
30	132	32	%	--	--	--
42	130	35	%	--	--	--
39	124	35	%	--	--	--
10	141	52	%	--	--	--
10	146	48	%	--	--	--
10	141	58	%	--	--	--
10	138	50	%	--	--	--
10	154	51	%	--	--	--
13	143	39	%	--	--	--
10	145	53	%	--	--	--
19	138	35	%	--	--	--
11	146	33	%	--	--	--
21	131	34	%	--	--	--
10	137	42	%	--	--	--
10	140	54	%	--	--	--
10	138	40	%	--	--	--
10	143	52	%	--	--	--
26	145	35	%	--	--	--
10	146	50	%	--	--	--
10	202	50	%	--	--	--
10	141	48	%	--	--	--
10	150	44	%	--	--	--
10	136	43	%	--	--	--
10	147	39	%	--	--	--
10	151	43	%	--	--	--
10	164	50	%	--	--	--
10	162	31	%	--	--	--

34	137	31	%	--	--	--
10	155	48	%	--	--	--
10	143	38	%	--	--	--
13	141	36	%	--	--	--
10	148	45	%	--	--	--
10	136	43	%	--	--	--
30	125	35	%	--	--	--
38	135	37	%	--	--	--
10	143	41	%	--	--	--
19	138	35	%	--	--	--
23	136	36	%	--	--	--
16	133	51	%	--	--	--
25	133	34	%	--	--	--
11	137	40	%	--	--	--
10	148	43	%	--	--	--
11	139	36	%	--	--	--
10	153	42	%	--	--	--
70	110	50	%	--	--	--
26	130	37	%	--	--	--
16	147	55	%	--	--	--
11	150	33	%	--	--	--
10	141	51	%	--	--	--
10	142	44	%	--	--	--
10	157	38	%	--	--	--
12	115	50	%	--	--	--
18	140	34	%	--	--	--
19	136	36	%	--	--	--
10	171	46	%	--	--	--
10	139	50	%	--	--	--
29	183	21	%	--	--	--
10	138	42	%	--	--	--
10	156	35	%	--	--	--
10	140	51	%	--	--	--
10	138	48	%	--	--	--

10	144	49	%	--	--	--
10	155	25	%	--	--	--
18	146	38	%	--	--	--
10	140	44	%	--	--	--
15	143	39	%	--	--	--
20	142	34	%	--	--	--
34	129	34	%	--	--	--
10	145	41	%	--	--	--
13	144	35	%	--	--	--
36	147	38	%	--	--	--
10	128	35	%	--	--	--
23	132	33	%	--	--	--
10	155	38	%	--	--	--
--	--	--	--	85	115	%
--	--	--	--	87	115	%
--	--	--	--	87	112	%
77	117	12	%	--	--	--
49	167	11	%	--	--	--
75	118	17	%	--	--	--
76	116	13	%	--	--	--
84	129	13	%	--	--	--
82	127	15	%	--	--	--
79	136	14	%	--	--	--
82	128	11	%	--	--	--
65	121	22	%	--	--	--
67	124	19	%	--	--	--
85	119	13	%			
67	121	16	%	--	--	--
66	133	10	%	--	--	--
59	131	22	%	--	--	--
64	127	52	%	--	--	--
76	120	11	%	--	--	--
58	133	14	%	--	--	--
80	124	12	%	--	--	--

81	117	11	%	--	--	--
61	140	21	%	--	--	--
79	114	11	%	--	--	--
73	124	13	%	--	--	--
81	115	10	%	--	--	--
46	139	61	%	--	--	--
24	138	15	%	--	--	--
64	114	21	%	--	--	--
10	136	15	%	--	--	--
71	128	9	%	--	--	--
71	113	15	%	--	--	--
46	141	60	%	--	--	--
73	123	21	%	--	--	--
64	127	14	%	--	--	--
61	113	33	%	--	--	--
61	116	35	%	--	--	--
27	199	33	%	--	--	--
74	118	14	%	--	--	--
55	145	18	%	--	--	--
75	121	12	%	--	--	--
69	124	14	%	--	--	--
81	120	11	%	--	--	--
72	117	16	%	--	--	--
39	145	37	%	--	--	--
82	129	11	%	--	--	--
85	125	11	%	--	--	--
87	115	10	%	--	--	--
62	157	20	%	--	--	--
79	117	12	%	--	--	--
22	194	59	%	--	--	--
70	134	12	%	--	--	--
70	117	12	%	--	--	--
56	135	14	%	--	--	--
74	120	21	%	--	--	--

48	164	13	%	--	--	--
72	119	10	%	--	--	--
26	163	30	%	--	--	--
25	166	30	%	--	--	--
45	152	11	%	--	--	--
64	127	21	%	--	--	--
10	168	36	%	--	--	--
80	129	10	%	--	--	--
48	151	13	%	--	--	--
40	141	21	%			
77	123	13	%	--	--	--
27	155	41	%	--	--	--
74	124	20	%	--	--	--
45	138	14	%	--	--	--
50	149	19	%	--	--	--
73	128	12	%	--	--	--
55	144	13	%	--	--	--
79	123	9	%	--	--	--
73	129	10	%	--	--	--
64	134	11	%	--	--	--
25	162	30	%	--	--	--
11	174	30	%	--	--	--
81	124	10	%	--	--	--
81	126	11	%	--	--	--
52	144	12	%	--	--	--
80	126	12	%	--	--	--
72	114	15	%	--	--	--
54	121	12	%	--	--	--
70	131	16	%	--	--	--
84	143	10	%	--	--	--
69	115	30	%	--	--	--
64	153	23	%	--	--	--
54	146	12	%	--	--	--
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--	--	--	--	80	113	%
--	--	--	--	80	108	%
47	93	24	%	--	--	--
47	89	18	%	--	--	--
40	120	20	%	--	--	--
46	87	24	%	--	--	--
47	88	20	%	--	--	--
56	93	20	%	--	--	--
40	100	20	%	--	--	--
10	90	30	%	--	--	--
57	102	20	%	--	--	--
56	100	19	%	--	--	--
54	94	21	%	--	--	--
49	94	22	%	--	--	--
10	147	20	%	--	--	--
57	105	19	%	--	--	--
57	102	20	%	--	--	--
52	98	21	%	--	--	--
49	89	19	%	--	--	--
52	97	21	%	--	--	--
38	85	21	%	--	--	--
59	107	20	%	--	--	--
34	118	23	%	--	--	--
10	171	19	%	--	--	--
30	83	20	%	--	--	--
53	125	20	%	--	--	--
10	151	20	%	--	--	--
54	104	21	%	--	--	--
41	116	19	%	--	--	--
10	159	23	%	--	--	--
43	109	16	%	--	--	--
28	126	20	%	--	--	--
10	62	20	%	--	--	--
59	97	20	%	--	--	--

33	111	21	%	--	--	--
40	160	20	%	--	--	--
54	103	18	%	--	--	--
40	100	20	%	--	--	--
10	60	30	%	--	--	--
55	104	18	%	--	--	--
53	104	17	%	--	--	--
52	108	21	%	--	--	--
51	103	20	%	--	--	--
50	112	20	%	--	--	--
10	116	25	%	--	--	--
35	90	14	%	--	--	--
48	103	22	%	--	--	--
48	97	23	%	--	--	--
51	120	19	%	--	--	--
54	119	21	%	--	--	--
56	104	20	%	--	--	--
55	105	17	%	--	--	--
50	106	19	%	--	--	--
53	102	19	%	--	--	--
57	101	20	%	--	--	--
56	98	19	%	--	--	--
58	108	16	%	--	--	--
50	127	17	%	--	--	--
54	105	18	%	--	--	--
60	98	20	%	--	--	--
43	91	27	%	--	--	--
51	103	19	%	--	--	--
10	66	26	%	--	--	--
32	96	29	%	--	--	--
51	103	19	%	--	--	--
50	101	23	%	--	--	--
50	95	22	%	--	--	--
48	103	23	%	--	--	--

23	65	20	%	--	--	--
49	102	13	%	--	--	--
55	102	15	%	--	--	--
33	133	21	%	--	--	--
56	103	18	%	--	--	--
13	48	24	%	--	--	--
53	110	20	%	--	--	--
10	63	36	%	--	--	--
47	92	20	%	--	--	--
--	--	--	--	39	112	%
--	--	--	--	17	58	%
--	--	--	--	10	43	%
--	--	--	--	30	100	%
--	--	--	--	32	99	%
--	--	--	--	38	117	%
31	109	30	%	--	--	--
29	109	30	%	--	--	--
53	129	40	%	--	--	--
38	98	32	%	--	--	--
34	102	31	%	--	--	--
39	113	44	%	--	--	--
31	97	21	%	--	--	--
11	140	30	%	--	--	--
35	122	30	%	--	--	--
36	120	33	%	--	--	--
33	114	34	%	--	--	--
20	122	39	%	--	--	--
10	159	25	%	--	--	--
30	140	33	%	--	--	--
41	123	31	%	--	--	--
42	111	26	%	--	--	--
34	99	39	%	--	--	--
41	108	27	%	--	--	--
29	94	29	%	--	--	--

44	126	27	%	--	--	--
16	143	28	%	--	--	--
10	220	83	%	--	--	--
23	90	30	%	--	--	--
14	159	26	%	--	--	--
10	155	22	%	--	--	--
38	127	29	%	--	--	--
36	119	27	%	--	--	--
10	159	35	%	--	--	--
43	113	23	%	--	--	--
10	149	36	%	--	--	--
10	67	31	%	--	--	--
42	112	24	%	--	--	--
12	126	42	%	--	--	--
34	123	30	%	--	--	--
44	120	28	%	--	--	--
37	141	65	%	--	--	--
10	22	30	%	--	--	--
47	118	29	%	--	--	--
45	117	31	%	--	--	--
30	140	33	%	--	--	--
42	118	32	%	--	--	--
30	129	27	%	--	--	--
10	91	18	%	--	--	--
14	98	34	%	--	--	--
50	150	30	%	--	--	--
39	113	27	%	--	--	--
36	112	29	%	--	--	--
31	119	29	%	--	--	--
42	120	20	%	--	--	--
52	129	29	%	--	--	--
45	139	25	%	--	--	--
42	122	34	%	--	--	--
46	118	34	%	--	--	--

44	117	30	%	--	--	--
39	115	24	%	--	--	--
50	116	23	%	--	--	--
48	114	26	%	--	--	--
50	123	24	%	--	--	--
49	137	28	%	--	--	--
45	118	25	%	--	--	--
40	117	24	%	--	--	--
32	104	30	%	--	--	--
43	117	28	%	--	--	--
10	87	39	%	--	--	--
29	105	32	%	--	--	--
45	115	30	%	--	--	--
45	105	27	%	--	--	--
37	109	27	%	--	--	--
24	130	29	%	--	--	--
32	84	14	%	--	--	--
18	126	29	%	--	--	--
28	136	24	%	--	--	--
22	147	20	%	--	--	--
38	126	28	%	--	--	--
10	49	36	%	--	--	--
45	126	30	%	--	--	--
10	72	76	%	--	--	--
--	--	--	--	10	169	%
--	--	--	--	24	123	%
--	--	--	--	13	73	%
--	--	--	--	26	105	%
--	--	--	--	10	63	%
--	--	--	--	43	123	%
70	130	25	%	--	--	--
70	130	25	%	--	--	--
75	125	20	%	--	--	--

eurofins | Lancaster Laboratories Environmental

Group Analysis	Analyte	CASNumber	Analytical Method Used	Method Reporting Limit (LOQ; ug/L)
VOCs	Allyl chloride	107-05-1	SW-846 8260B (25 mL purge)	0.5
VOCs	Methacrylonitrile	126-98-7	SW-846 8260B (25 mL purge)	5
VOCs	Methyl Acrylate	96-33-3	SW-846 8260B (25 mL purge)	5

Accredited Laboratory

A2LA has accredited

PACE ANALYTICAL SERVICES, INC.

Lenexa, KS

for technical competence in the field of

Environmental Testing

This laboratory is accredited in accordance with the recognized International Standard ISO/IEC 17025:2005 *General requirements for the competence of testing and calibration laboratories*. This laboratory also meets the requirements of any additional program requirements in the Environmental field. This accreditation demonstrates technical competence for a defined scope and the operation of a laboratory quality management system (*refer to joint ISO-ILAC-IAF Communiqué dated 8 January 2009*).

Presented this 5th day of July 2016.

Senior Director of Quality and Communications
For the Accreditation Council
Certificate Number 2456.01
Valid to July 31, 2018

For the tests to which this accreditation applies, please refer to the laboratory's Environmental Scope of Accreditation.

SCOPE OF ACCREDITATION TO ISO/IEC 17025:2005

PACE ANALYTICAL SERVICES, INC.
9608 Loiret Blvd
Lenexa, KS 66219
Charles Girgin Phone: (913) 599- 5665
Charles.Girgin@pacelabs.com

ENVIRONMENTAL

Valid To: July 31, 2018 Certificate Number: 2456.01

In recognition of the successful completion of the A2LA evaluation process, accreditation is granted to this laboratory to perform recognized EPA methods using the following testing technologies and in the analyte categories identified below; and for the test methods applicable to the Wyoming Storage Tank Remediation Laboratory Accreditation Program:

Testing Technologies

ICP-AES Spectrometry, Gas Chromatography, Gas Chromatography / Mass Spectrometry

Parameter/Analyte	Nonpotable Water	Solid Hazardous Waste	
		Aqueous	Solid
Metals			
Cadmium	EPA 6010B[1] & C	EPA 6010B[1] & C	EPA 6010B[1] & C
Chromium	EPA 6010B[1] & C	EPA 6010B[1] & C	EPA 6010B[1] & C
Lead	EPA 6010B[1] & C	EPA 6010B[1] & C	EPA 6010B[1] & C
Purgeable Organics (Volatiles)			
Benzene	EPA 8260B	EPA 8260B	EPA 8260B
Diisopropyl ether	EPA 8260B	EPA 8260B	EPA 8260B
1,2-Dichloroethane	EPA 8260B	EPA 8260B	EPA 8260B
Ethanol[1]	EPA 8260B	EPA 8260B	EPA 8260B
Ethyl benzene	EPA 8260B	EPA 8260B	EPA 8260B
Ethyl-t-butyl ether	EPA 8260B	EPA 8260B	EPA 8260B
Ethylene Dibromide (EDB)	EPA 8260B	EPA 8260B	EPA 8260B
Gas Range Organics C_6-C_{10}	EPA 8015C EPA 8260B	EPA 8015C EPA 8260B	EPA 8015C EPA 8260B
Methyl-t-butyl ether (MTBE)	EPA 8260B	EPA 8260B	EPA 8260B
Naphthalene	EPA 8260B	EPA 8260B	EPA 8260B
Toluene	EPA 8260B	EPA 8260B	EPA 8260B
t-amyl methyl ether	EPA 8260B	EPA 8260B	EPA 8260B
t-butyl alcohol	EPA 8260B	EPA 8260B	EPA 8260B
Xylenes, total	EPA 8260B	EPA 8260B	EPA 8260B
1,2-Xylene	EPA 8260B	EPA 8260B	EPA 8260B
1,3-Xylene	EPA 8260B	EPA 8260B	EPA 8260B
1,4-Xylene	EPA 8260B	EPA 8260B	EPA 8260B

Parameter/Analyte	Nonpotable Water	Solid Hazardous Waste	
		Aqueous	Solid
Extractable Organics			
Diesel Range Organics C_{10}-C_{32}	EPA 8015C	EPA 8015C	EPA 8015C
Ethylene Dibromide (EDB)	EPA 8011	EPA 8011	EPA 8011

[1] Test Method 6010B and Ethanol are not included under the Wyoming Storage Tank Remediation Laboratory Accreditation Program.

SCOPE OF ACCREDITATION TO ISO/IEC 17025:2005

PACE ANALYTICAL SERVICES, LLC.
1700 Elm Street SE, Suite 200
Minneapolis, MN 55414
Janielle Ward Phone: 612-607-6352

ENVIRONMENTAL

Valid To: October 31, 2017 Certificate Number: 2926.01

Chemical Tests—Non-environmental testing

In recognition of the successful completion of the A2LA evaluation process, accreditation is granted to this laboratory to perform the following tests on dietary supplements, food products, and animal feed stocks:

Test and Technology	Test Method(s)
PCB Congeners	EPA 1668A
Dioxins and Furans	EPA 8290A and EPA 1613B

Environmental Tests

In recognition of the successful completion of the A2LA evaluation process, (including an assessment of the laboratory's compliance with ISO IEC 17025:2005, the 2009 TNI Environmental Testing Laboratory Standard, and the requirements of the DoD Environmental Laboratory Accreditation Program (DoD ELAP) as detailed in version 5.0 of the DoD Quality Systems Manual for Environmental Laboratories) accreditation is granted to this laboratory to perform recognized EPA methods using the following testing technologies and in the analyte categories identified below:

Testing Technologies

Gas Chromatography/Mass Spectrometry, High Resolution Gas Chromatography/Mass Spectrometry, Gas Chromatography-Flame Ionization Detector, Gas Chromatography-Photo Ionization Detector, Inductively Coupled Plasma-Mass Spectrometry, Inductively Coupled Plasma-Mass Spectrometry, Manual Cold Vapor Atomic Absorption, Colorimetric, Electrometric

Parameter/Analyte	**Potable Water**	**Nonpotable Water**	**Solid Hazardous Waste**	**Tissue**
Extractable Organics				
2,3,7,8-TCDD	EPA 1613B	EPA 1613B/8290A/8290	EPA 1613B/8290A/8290	EPA 1613B/8290A/ 8290
2,3,7,8-TCDF	----------	EPA 1613B/8290A/8290	EPA 1613B/8290A/8290	EPA 1613B/8290A/8290
1,2,3,7,8-PeCDF	----------	EPA 1613B/8290A/8290	EPA 1613B/8290A/8290	EPA 1613B/8290A/8290
2,3,4,7,8-PeCDF	----------	EPA 1613B/8290A/8290	EPA 1613B/8290A/8290	EPA 1613B/8290A/ 8290
1,2,3,7,8-PeCDD	----------	EPA 1613B/8290A/8290	EPA 1613B/8290A/8290	EPA 1613B/8290A/ 8290
1,2,3,4,7,8-HxCDF	----------	EPA 1613B/8290A/8290	EPA 1613B/8290A/8290	EPA 1613B/8290A/ 8290
1,2,3,6,7,8-HxCDF	----------	EPA 1613B/8290A/8290	EPA 1613B/8290A/8290	EPA 1613B/8290A/ 8290

Parameter/Analyte	Potable Water	Nonpotable Water	Solid Hazardous Waste	Tissue
2,3,4,6,7,8-HxCDF	----------	EPA 1613B/8290A/8290	EPA 1613B/8290A/8290	EPA 1613B/8290A/ 8290
1,2,3,7,8,9-HxCDF	----------	EPA 1613B/8290A/8290	EPA 1613B/8290A/8290	EPA 1613B/8290A/ 8290
1,2,3,4,7,8-HxCDD	----------	EPA 1613B/8290A/8290	EPA 1613B/8290A/8290	EPA 1613B/8290A/ 8290
1,2,3,6,7,8-HxCDD	----------	EPA 1613B/8290A/8290	EPA 1613B/8290A/8290	EPA 1613B/8290A/ 8290
1,2,3,7,8,9-HxCDD	----------	EPA 1613B/8290A/8290	EPA 1613B/8290A/8290	EPA 1613B/8290A/ 8290
1,2,3,4,6,7,8-HpCDF	----------	EPA 1613B/8290A/8290	EPA 1613B/8290A/8290	EPA 1613B/8290A/ 8290
1,2,3,4,7,8,9-HpCDF	----------	EPA 1613B/8290A/8290	EPA 1613B/8290A/8290	EPA 1613B/8290A/ 8290
1,2,3,4,6,7,8-HpCDD	----------	EPA 1613B/8290A/8290	EPA 1613B/8290A/8290	EPA 1613B/8290A/ 8290
OCDF	----------	EPA 1613B/8290A/8290	EPA 1613B/8290A/8290	EPA 1613B/8290A/ 8290
OCDD	----------	EPA 1613B/8290A/8290	EPA 1613B/8290A/8290	EPA 1613B/8290A/ 8290
Total HpCDD	----------	EPA 1613B/8290A/8290	EPA 1613B/8290A/8290	EPA 1613B/8290A/ 8290
Total HpCDF	----------	EPA 1613B/8290A/8290	EPA 1613B/8290A/8290	EPA 1613B/8290A/ 8290
Total HxCDD	----------	EPA 1613B/8290A/8290	EPA 1613B/8290A/8290	EPA 1613B/8290A/ 8290
Total HxCDF	----------	EPA 1613B/8290A/8290	EPA 1613B/8290A/8290	EPA 1613B/8290A/ 8290
Total PeCDD	----------	EPA 1613B/8290A/8290	EPA 1613B/8290A/8290	EPA 1613B/8290A/ 8290
Total PeCDF	----------	EPA 1613B/8290A/8290	EPA 1613B/8290A/8290	EPA 1613B/8290A/ 8290
Total TCDD	----------	EPA 1613B/8290A/8290	EPA 1613B/8290A/8290	EPA 1613B/8290A/ 8290
Total TCDF	----------	EPA 1613B/8290A/8290	EPA 1613B/8290A/8290	EPA 1613B/8290A/ 8290

Parameter/Analyte	PCB	Nonpotable Water	Solid Hazardous Waste	Tissue
Extractable Organics PCB Congeners				
2-Chlorobiphenyl	PCB-1	EPA 1668A	EPA 1668A	EPA 1668A
3-Chlorobiphenyl	PCB-2	EPA 1668A	EPA 1668A	EPA 1668A
4-Chlorobiphenyl	PCB-3	EPA 1668A	EPA 1668A	EPA 1668A
2,2'-Dichlorobiphenyl	PCB-4	EPA 1668A	EPA 1668A	EPA 1668A
2,6-Dichlorobiphenyl	PCB-10	EPA 1668A	EPA 1668A	EPA 1668A
2,5-Dichlorobiphenyl	PCB-9	EPA 1668A	EPA 1668A	EPA 1668A
2,4-Dichlorobiphenyl	PCB-7	EPA 1668A	EPA 1668A	EPA 1668A
2,3'-Dichlorobiphenyl	PCB-6	EPA 1668A	EPA 1668A	EPA 1668A
2,3-Dichlorobiphenyl	PCB-5	EPA 1668A	EPA 1668A	EPA 1668A
2,4'-Dichlorobiphenyl	PCB-8	EPA 1668A	EPA 1668A	EPA 1668A
3,5-Dichlorobiphenyl	PCB-14	EPA 1668A	EPA 1668A	EPA 1668A
3,3'-Dichlorobiphenyl	PCB-11	EPA 1668A	EPA 1668A	EPA 1668A
PCB-(13/12)	PCB-(13/12)	EPA 1668A	EPA 1668A	EPA 1668A
4,4'-Dichlorobiphenyl	PCB-15	EPA 1668A	EPA 1668A	EPA 1668A
2,2',6-Trichlorobiphenyl	PCB-19	EPA 1668A	EPA 1668A	EPA 1668A
PCB-(30/18)	PCB-(30/18)	EPA 1668A	EPA 1668A	EPA 1668A
2,2',4-Trichlorobiphenyl	PCB-17	EPA 1668A	EPA 1668A	EPA 1668A
2,3',6-Trichlorobiphenyl	PCB-27	EPA 1668A	EPA 1668A	EPA 1668A
2,3,6-Trichlorobiphenyl	PCB-24	EPA 1668A	EPA 1668A	EPA 1668A
2,2',3-Trichlorobiphenyl	PCB-16	EPA 1668A	EPA 1668A	EPA 1668A
2,4',6-Trichlorobiphenyl	PCB-32	EPA 1668A	EPA 1668A	EPA 1668A
2',3,5-Trichlorobiphenyl	PCB-34	EPA 1668A	EPA 1668A	EPA 1668A
2,3,5-Trichlorobiphenyl	PCB-23	EPA 1668A	EPA 1668A	EPA 1668A
PCB-(26/29)	PCB-(26/29)	EPA 1668A	EPA 1668A	EPA 1668A

Parameter/Analyte	PCB	Nonpotable Water	Solid Hazardous Waste	Tissue
2,3',4-Trichlorobiphenyl	PCB-25	EPA 1668A	EPA 1668A	EPA 1668A
2,4',5-Trichlorobiphenyl	PCB-31	EPA 1668A	EPA 1668A	EPA 1668A
PCB-(28/20)	PCB-(28/20)	EPA 1668A	EPA 1668A	EPA 1668A
PCB-(21/33)	PCB-(21/33)	EPA 1668A	EPA 1668A	EPA 1668A
2,3,4'-Trichlorobiphenyl	PCB-22	EPA 1668A	EPA 1668A	EPA 1668A
3,3',5-Trichlorbiphenyl	PCB-36	EPA 1668A	EPA 1668A	EPA 1668A
3,4',5-Trichlorobiphenyl	PCB-39	EPA 1668A	EPA 1668A	EPA 1668A
3,4,5-Trichlorobiphenyl	PCB-38	EPA 1668A	EPA 1668A	EPA 1668A
3,3',4-Trichlorobiphenyl	PCB-35	EPA 1668A	EPA 1668A	EPA 1668A
3,4,4'-Trichlorobiphenyl	PCB-37	EPA 1668A	EPA 1668A	EPA 1668A
2,2',6,6'-Tetrachlorbiphenyl	PCB-54	EPA 1668A	EPA 1668A	EPA 1668A
PCB-(50/53)	PCB-(50/53)	EPA 1668A	EPA 1668A	EPA 1668A
PCB-(45/51)	PCB-(45/51)	EPA 1668A	EPA 1668A	EPA 1668A
2,2',3,6'-Tetrachlorobiphenyl	PCB-46	EPA 1668A	EPA 1668A	EPA 1668A
2,2',5,5'-Tetrachlorobiphenyl	PCB-52	EPA 1668A	EPA 1668A	EPA 1668A
2,3',5',6-Tetrachlorobiphenyl	PCB-(73/43)	EPA 1668A	EPA 1668A	EPA 1668A
PCB-(69/49)	PCB-(69/49)	EPA 1668A	EPA 1668A	EPA 1668A
2,2',4,5-Tetrachlorobiphenyl	PCB-48	EPA 1668A	EPA 1668A	EPA 1668A
PCB-(44/47/65)	PCB-(44/47/65)	EPA 1668A	EPA 1668A	EPA 1668A
PCB-(59/62/75)	PCB-(59/62/75)	EPA 1668A	EPA 1668A	EPA 1668A
2,2',3,4'-Tetrachlorobiphenyl	PCB-42	EPA 1668A	EPA 1668A	EPA 1668A
PCB-(41/40/71)	PCB-(41/40/71)	EPA 1668A	EPA 1668A	EPA 1668A
2,3,4',6-Tetrachlorobiphenyl	PCB-64	EPA 1668A	EPA 1668A	EPA 1668A
2,3',5,5'-Tetrachlorobiphenyl	PCB-72	EPA 1668A	EPA 1668A	EPA 1668A
2,3',4,5'-Tetrachlorobiphenyl	PCB-68	EPA 1668A	EPA 1668A	EPA 1668A
2,3,3',5-Tetrachlorobiphenyl	PCB-57	EPA 1668A	EPA 1668A	EPA 1668A
2,3,3',5'-Tetrachlorobiphenyl	PCB-58	EPA 1668A	EPA 1668A	EPA 1668A
2,3',4,5-Tetrachlorobiphenyl	PCB-67	EPA 1668A	EPA 1668A	EPA 1668A
2,3,4',5-Tetrachlorobiphenyl	PCB-63	EPA 1668A	EPA 1668A	EPA 1668A
PCB-(61/70/74/76)	PCB-(61/70/74/76)	EPA 1668A	EPA 1668A	EPA 1668A
2,3',4,4'-Tetrachlorobiphenyl	PCB-66	EPA 1668A	EPA 1668A	EPA 1668A
2,3,3',4-Tetrachlorobiphenyl	PCB-55	EPA 1668A	EPA 1668A	EPA 1668A
2,3,3',4'-Tetrachlorobiphenyl	PCB-56	EPA 1668A	EPA 1668A	EPA 1668A
2,3,4,4'-Tetrachlorobiphenyl	PCB-60	EPA 1668A	EPA 1668A	EPA 1668A
3,3',5,5'-Tetrachlorobiphenyl	PCB-80	EPA 1668A	EPA 1668A	EPA 1668A
3,3',4,5'-Tetrachlorobiphenyl	PCB-79	EPA 1668A	EPA 1668A	EPA 1668A
3,3',4,5-Tetrachlorobiphenyl	PCB-78	EPA 1668A	EPA 1668A	EPA 1668A
3,4,4',5-Tetrachlorobiphenyl	PCB-81	EPA 1668A	EPA 1668A	EPA 1668A
3,3',4,4'-Tetrachlorobiphenyl	PCB-77	EPA 1668A	EPA 1668A	EPA 1668A
2,2',4,6,6'-Pentachlorobiphenyl	PCB-104	EPA 1668A	EPA 1668A	EPA 1668A
2,2',3,6,6'-Pentachlorobiphenyl	PCB-96	EPA 1668A	EPA 1668A	EPA 1668A
2,2',4,5',6-Pentachlorobiphenyl	PCB-103	EPA 1668A	EPA 1668A	EPA 1668A
2,2',3,5,6'-Pentachlorobiphenyl	PCB-94	EPA 1668A	EPA 1668A	EPA 1668A
2,2',3,5',6-Pentachlorobiphenyl	PCB-95	EPA 1668A	EPA 1668A	EPA 1668A
PCB-(100/93/102/98)	PCB-(100/93/102/98)	EPA 1668A	EPA 1668A	EPA 1668A
PCB-(88/91)	PCB-(88/91)	EPA 1668A	EPA 1668A	EPA 1668A
2,2',3,3',6-Pentachlorobiphenyl	PCB-84	EPA 1668A	EPA 1668A	EPA 1668A
2,2',3,4,6'-Pentachlorobiphenyl	PCB-89	EPA 1668A	EPA 1668A	EPA 1668A
2,3',4,5',6-Pentachlorobiphenyl	PCB-121	EPA 1668A	EPA 1668A	EPA 1668A
2,2',3,5,5'-Pentachlorobiphenyl	PCB-92	EPA 1668A	EPA 1668A	EPA 1668A

Parameter/Analyte	PCB	Nonpotable Water	Solid Hazardous Waste	Tissue
PCB-(113/90/101)	PCB-(113/90/101)	EPA 1668A	EPA 1668A	EPA 1668A
2,2',3,3',5-Pentachlorobiphenyl	PCB-83	EPA 1668A	EPA 1668A	EPA 1668A
2,2',4,4',5-Pentachlorobiphenyl	PCB-99	EPA 1668A	EPA 1668A	EPA 1668A
2,3,3',5,6-Pentachlorobiphenyl	PCB-112	EPA 1668A	EPA 1668A	EPA 1668A
PCB-(108/119/86/97/125/87)	PCB-(108/119/86/97/125/87)	EPA 1668A	EPA 1668A	EPA 1668A
PCB-(117/116/85)	PCB-(117/116/85)	EPA 1668A	EPA 1668A	EPA 1668A
PCB-(110/115)	PCB-(110/115)	EPA 1668A	EPA 1668A	EPA 1668A
2,2',3,3',4-Pentachlorobiphenyl	PCB-82	EPA 1668A	EPA 1668A	EPA 1668A
2,3,3',5,5'-Pentachlorobiphenyl	PCB-111	EPA 1668A	EPA 1668A	EPA 1668A
2,3',4,5,5'-Pentachlorobiphenyl	PCB-120	EPA 1668A	EPA 1668A	EPA 1668A
PCB-(107/124)	PCB-(107/124)	EPA 1668A	EPA 1668A	EPA 1668A
2,3,3',4,6-Pentachlorobiphenyl	PCB-109	EPA 1668A	EPA 1668A	EPA 1668A
2,3',4,4',5'-Pentachlorobiphenyl	PCB-123	EPA 1668A	EPA 1668A	EPA 1668A
2,3,3',4,5-Pentachlorobiphenyl	PCB-106	EPA 1668A	EPA 1668A	EPA 1668A
2,3',4,4',5-Pentachlorobiphenyl	PCB-118	EPA 1668A	EPA 1668A	EPA 1668A
2,3,3',4',5'-Pentachlorobiphenyl	PCB-122	EPA 1668A	EPA 1668A	EPA 1668A
2,3,4,4',5-Pentachlorobiphenyl	PCB-114	EPA 1668A	EPA 1668A	EPA 1668A
2,3,3',4,4'-Pentachlorobiphenyl	PCB-105	EPA 1668A	EPA 1668A	EPA 1668A
3,3',4,5,5'-Pentachlorobiphenyl	PCB-127	EPA 1668A	EPA 1668A	EPA 1668A
3,3',4,4',5-Pentachlorobiphenyl	PCB-126	EPA 1668A	EPA 1668A	EPA 1668A
2,2',4,4',6,6'-Hexachlorobiphenyl	PCB-155	EPA 1668A	EPA 1668A	EPA 1668A
2,2',3,5,6,6'-Hexachlorobiphenyl	PCB-152	EPA 1668A	EPA 1668A	EPA 1668A
2,2',3,4',6,6'-Hexachlorobiphenyl	PCB-150	EPA 1668A	EPA 1668A	EPA 1668A
2,2',3,3',6,6'-Hexachlorobiphenyl	PCB-136	EPA 1668A	EPA 1668A	EPA 1668A
2,2',3,4,6,6'-Hexachlorobiphenyl	PCB-145	EPA 1668A	EPA 1668A	EPA 1668A
2,2',3,4',5,6'-Hexachlorobiphenyl	PCB-148	EPA 1668A	EPA 1668A	EPA 1668A
PCB-(151/135)	PCB-(151/135)	EPA 1668A	EPA 1668A	EPA 1668A
2,2'4,4',5,6'-Hexachlorobiphenyl	PCB-154	EPA 1668A	EPA 1668A	EPA 1668A
2,2',3,4,5',6-Hexachlorobiphenyl	PCB-144	EPA 1668A	EPA 1668A	EPA 1668A
PCB-(147/149)	PCB-(147/149)	EPA 1668A	EPA 1668A	EPA 1668A
PCB-(134/143)	PCB-(134/143)	EPA 1668A	EPA 1668A	EPA 1668A
PCB-(139/140)	PCB-(139/140)	EPA 1668A	EPA 1668A	EPA 1668A
2,2'3,3',4,6-Hexachlorobiphenyl	PCB-131	EPA 1668A	EPA 1668A	EPA 1668A
2,2',3,4,5,6-Hexachlorobiphenyl	PCB-142	EPA 1668A	EPA 1668A	EPA 1668A
2,2',3,3',4,6'-Hexachlorobiphenyl	PCB-132	EPA 1668A	EPA 1668A	EPA 1668A
2,2',3,3',5,5'-Hexachlorobiphenyl	PCB-133	EPA 1668A	EPA 1668A	EPA 1668A
2,3,3',5,5',6-Hexachlorobiphenyl	PCB-165	EPA 1668A	EPA 1668A	EPA 1668A
2,2',3,4',5,5'-Hexachlorobiphenyl	PCB-146	EPA 1668A	EPA 1668A	EPA 1668A
2,3,3',4,5',6-Hexachlorobiphenyl	PCB-161	EPA 1668A	EPA 1668A	EPA 1668A
PCB-(153/168)	PCB-(153/168)	EPA 1668A	EPA 1668A	EPA 1668A
2,2',3,4,5,5'-Hexachlorobiphenyl	PCB-141	EPA 1668A	EPA 1668A	EPA 1668A
2,2',3,3',4,5'-Hexachlorobiphenyl	PCB-130	EPA 1668A	EPA 1668A	EPA 1668A
2,2',3,4,4',5-Hexachlorobiphenyl	PCB-137	EPA 1668A	EPA 1668A	EPA 1668A
2,3,3',4',5',6-Hexachlorobiphenyl	PCB-164	EPA 1668A	EPA 1668A	EPA 1668A
PCB-(138/163/129)	PCB-(138/163/129)	EPA 1668A	EPA 1668A	EPA 1668A
2,3,3',4,5,6-Hexachlorobiphenyl	PCB-160	EPA 1668A	EPA 1668A	EPA 1668A
2,3,3',4,4',6-Hexachlorobiphenyl	PCB-158	EPA 1668A	EPA 1668A	EPA 1668A
PCB-(128/166)	PCB-(128/166)	EPA 1668A	EPA 1668A	EPA 1668A
2,3,3',4,5,5'-Hexachlorobiphenyl	PCB-159	EPA 1668A	EPA 1668A	EPA 1668A
2,3,3',4',5,5'-Hexachlorobiphenyl	PCB-162	EPA 1668A	EPA 1668A	EPA 1668A

Parameter/Analyte	PCB	Nonpotable Water	Solid Hazardous Waste	Tissue
2,3',4,4',5,5'-Hexachlorobiphenyl	PCB-167	EPA 1668A	EPA 1668A	EPA 1668A
PCB-(156/157)	PCB-(156/157)	EPA 1668A	EPA 1668A	EPA 1668A
3,3',4,4',5,5'-Hexachlorobiphenyl	PCB-169	EPA 1668A	EPA 1668A	EPA 1668A
2,2',3,4',5,6,6'-Heptachlorobiphenyl	PCB-188	EPA 1668A	EPA 1668A	EPA 1668A
2,2',3,3',5,6,6'-Heptachlorobiphenyl	PCB-179	EPA 1668A	EPA 1668A	EPA 1668A
2,2',3,4,4',6,6'-Heptachlorobiphenyl	PCB-184	EPA 1668A	EPA 1668A	EPA 1668A
2,2',3,3',4,6,6'-Heptachlorobiphenyl	PCB-176	EPA 1668A	EPA 1668A	EPA 1668A
2,2',3,4,4',5,6'-Heptachlorobiphenyl	PCB-186	EPA 1668A	EPA 1668A	EPA 1668A
2,2',3,4,5,6,6'-Heptachlorobiphenyl	PCB-178	EPA 1668A	EPA 1668A	EPA 1668A
2,2',3,3',5,5',6-Heptachlorobiphenyl	PCB-175	EPA 1668A	EPA 1668A	EPA 1668A
2,2',3,3',4,5',6-Heptachlorobiphenyl	PCB-187	EPA 1668A	EPA 1668A	EPA 1668A
2,2',3,4',5,5',6-Heptachlorobiphenyl	PCB-182	EPA 1668A	EPA 1668A	EPA 1668A
PCB-(183/185)	PCB-(183/185)	EPA 1668A	EPA 1668A	EPA 1668A
2,2',3,3',4,5,6'-Heptachlorobiphenyl	PCB-174	EPA 1668A	EPA 1668A	EPA 1668A
2,2'3,3',4,5',6'-Heptachlorobiphenyl	PCB-177	EPA 1668A	EPA 1668A	EPA 1668A
2,2',3,4,4',5,6-Heptachlorbiphenyl	PCB-181	EPA 1668A	EPA 1668A	EPA 1668A
PCB-(171/173)	PCB-(171/173)	EPA 1668A	EPA 1668A	EPA 1668A
2,2'3,3',4,5,5'-Heptachlorobiphenyl	PCB-172	EPA 1668A	EPA 1668A	EPA 1668A
2,3,3',4,5,5',6-Heptachlorobiphenyl	PCB-192	EPA 1668A	EPA 1668A	EPA 1668A
PCB-(180/193)	PCB-(180/193)	EPA 1668A	EPA 1668A	EPA 1668A
2,3,3',4,4',5',6-Heptachlorobiphenyl	PCB-191	EPA 1668A	EPA 1668A	EPA 1668A
2,2',3,3',4,4',5-Heptachlorobiphenyl	PCB-170	EPA 1668A	EPA 1668A	EPA 1668A
2,3,3',4,4',5,6-Heptachlorobiphenyl	PCB-190	EPA 1668A	EPA 1668A	EPA 1668A
2,3,3',4,4',5,5-Heptachlorobiphenyl	PCB-189	EPA 1668A	EPA 1668A	EPA 1668A
2,2',3,3',5,5',6,6'-Octachlorobiphenyl	PCB-202	EPA 1668A	EPA 1668A	EPA 1668A
2,2',3,3',4,5',6,6'-Octachlorobiphenyl	PCB-201	EPA 1668A	EPA 1668A	EPA 1668A
2,2',3,4,4',5,6,6'-Octachlorobiphenyl	PCB-204	EPA 1668A	EPA 1668A	EPA 1668A
PCB-(197/200)	PCB-(197/200)	EPA 1668A	EPA 1668A	EPA 1668A
PCB-(198/199)	PCB-(198/199)	EPA 1668A	EPA 1668A	EPA 1668A
2,2',3,3',4,4',5,6'-Octachlorobiphenyl	PCB-196	EPA 1668A	EPA 1668A	EPA 1668A
2,2',3,4,4',5,5',6-Octachlorobiphenyl	PCB-203	EPA 1668A	EPA 1668A	EPA 1668A
2,2',3,3',4,4',5,6-Octachlorobiphenyl	PCB-195	EPA 1668A	EPA 1668A	EPA 1668A
2,2',3,3',4,4',5,5'-Octachlorobiphenyl	PCB-194	EPA 1668A	EPA 1668A	EPA 1668A
2,3,3',4,4',5,5',6-Octachlorobiphenyl	PCB-205	EPA 1668A	EPA 1668A	EPA 1668A
2,2',3,3',4,4'5,6,6'-Nonachlorobiphenyl	PCB-208	EPA 1668A	EPA 1668A	EPA 1668A
2,2'3,3',4,4',5,6,6'-Nonachlorobiphenyl	PCB-207	EPA 1668A	EPA 1668A	EPA 1668A
2,2',3,3',4,4',5,5',6-Nonachlorobiphenyl	PCB-206	EPA 1668A	EPA 1668A	EPA 1668A
Decachlorbiphenyl	PCB-209	EPA 1668A	EPA 1668A	EPA 1668A

In addition, in recognition of the successful completion of the A2LA evaluation process, (including an assessment of the laboratory's compliance with ISO IEC 17025:2005 and the 2009 TNI Standard) accreditation is granted to this laboratory to perform recognized EPA methods using the following testing technologies and in the analyte categories identified below:

Parameter/Analyte	Air
Volatile Organic Compounds	
1,1,1-trichloroethane	EPA TO15-1999
1,1,2,2-tetrachloroethane	EPA TO15-1999
1,1,2-trichloroethane	EPA TO15-1999
1,1-dichloroethane	EPA TO15-1999

Parameter/Analyte	Air
1,1-dichloroethene	EPA TO15-1999
1,2,4-trichlorobenzene	EPA TO15-1999
1,2,4-trimethylbenzene	EPA TO15-1999/TO-3
1,2-dibromoethane	EPA TO15-1999
1,2-dichlorobenzene	EPA TO15-1999
1,2-dichloroethane	EPA TO15-1999
1,2-dichloropropane	EPA TO15-1999
1,3,5-trimethylbenzene	EPA TO15-1999/TO-3
1,3-butadiene	EPA TO15-1999
1,3-dichlorobenzene	EPA TO15-1999
1,4-dichlorobenzene	EPA TO15-1999
Benzene	EPA TO15-1999/TO-3
Benzylchloride	EPA TO15-1999
Bromomethane	EPA TO15-1999
Carbon Disulfide	EPA TO15-1999
Carbon Tetrachloride	EPA TO15-1999
Carbon Dioxide	Method 3C
Carbon Monoxide	Method 3C
Chlorobenzene	EPA TO15-1999
Chloroethane (Ethyl Chloride)	EPA TO15-1999
Chloroform	EPA TO15-1999
Chloromethane (Methyl Chloride)	EPA TO15-1999
cis-1,2-dichloroethene	EPA TO15-1999
cis-1,3-dichloropropene	EPA TO15-1999
Dichlorodifluoromethane	EPA TO15-1999
Dichlorotetrafluoroethane Freon 114	EPA TO15-1999
Ethane	EPA TO-3
Ethene	EPA TO-3
Ethylbenzene	EPA TO15-1999/TO-3
Hexachloro-1,3-butadiene	EPA TO15-1999
Isopropylbenzene (Cumene)	EPA TO15-1999
Methane	EPA TO-3/Method 3C
Methylene Chloride	EPA TO15-1999
mp-xylene	EPA TO15-1999/TO-3
o-xylene	EPA TO15-1999/TO-3
Nitrogen	Method 3C
Oxygen	Method 3C
Propylene (methylethylene)	EPA TO15-1999
Styrene	EPA TO15-1999
Tetrachloroethene	EPA TO15-1999
Toluene	EPA TO15-1999/TO-3
Trans-1,3-dichloropropene	EPA TO15-1999
Trichloroethene	EPA TO15-1999
Trichlorofluoromethane (Freon 11)	EPA TO15-1999
Trichlorotrifluoroethane (Freon 113)	EPA TO15-1999
Vinyl Chloride	EPA TO15-1999
2-Butanone (methylethylketone - MEK)	EPA TO15-1999
4-ethyltoluene	EPA TO15-1999
Acetone	EPA TO15-1999

Parameter/Analyte	**Air**
Bromodichloromethane	EPA TO15-1999
Bromoform	EPA TO15-1999
Cyclohexane	EPA TO15-1999
Dibromochloromethane	EPA TO15-1999
Ethanol	EPA TO15-1999
Ethyl Acetate	EPA TO15-1999
Methyl Butyl Ketone	EPA TO15-1999
Methyl Isobutyl Ketone	EPA TO15-1999
Methyl-tert-butyl ether	EPA TO15-1999/TO-3
Naphthalene	EPA TO15-1999
n-heptane	EPA TO15-1999
n-hexane	EPA TO15-1999/TO-3
2-Propanol (IPA)	EPA TO15-1999
Tetrahydrofuran	EPA TO15-1999
Trans-1,2-dichloroethene	EPA TO15-1999
Vinyl Acetate	EPA TO15-1999
THC as Gas	EPA TO-3
Extractable Organics	
2,3,7,8-TCDD	Method 23/TO-9
2,3,7,8-TCDF	Method 23/TO-9
1,2,3,7,8-PeCDF	Method 23/TO-9
2,3,4,7,8-PeCDF	Method 23/TO-9
1,2,3,7,8-PeCDD	Method 23/TO-9
1,2,3,4,7,8-HxCDF	Method 23/TO-9
1,2,3,6,7,8-HxCDF	Method 23/TO-9
2,3,4,6,7,8-HxCDF	Method 23/TO-9
1,2,3,7,8,9-HxCDF	Method 23/TO-9
1,2,3,4,7,8-HxCDD	Method 23/TO-9
1,2,3,6,7,8-HxCDD	Method 23/TO-9
1,2,3,7,8,9-HxCDD	Method 23/TO-9
1,2,3,4,6,7,8-HpCDF	Method 23/TO-9
1,2,3,4,7,8,9-HpCDF	Method 23/TO-9
1,2,3,4,6,7,8-HpCDD	Method 23/TO-9
OCDF	Method 23/TO-9
OCDD	Method 23/TO-9
Total HpCDD	Method 23/TO-9
Total HpCDF	Method 23/TO-9
Total HxCDD	Method 23/TO-9
Total HxCDF	Method 23/TO-9
Total PeCDD	Method 23/TO-9
Total PeCDF	Method 23/TO-9
Total TCDD	Method 23/TO-9
Total TCDF	Method 23/TO-9

Parameter/Analyte	Nonpotable Water	Solid Hazardous Waste
Metals		
Aluminum	EPA 6010B/6010C/6020/6020A	EPA 6010B/6010C/6020/6020A
Antimony	EPA 6010B/6010C/6020/6020A	EPA 6010B/6010C/6020/6020A
Arsenic	EPA 6010B/6010C/6020/6020A	EPA 6010B/6010C/6020/6020A
Barium	EPA 6010B/6010C/6020/6020A	EPA 6010B/6010C/6020/6020A
Beryllium	EPA 6010B/6010C/6020/6020A	EPA 6010B/6010C/6020/6020A
Bismuth	EPA 6010B/6010C/6020/6020A	EPA 6010B/6010C/6020/6020A
Boron	EPA 6010B/6010C/6020/6020A	EPA 6010B/6010C/6020/6020A
Cadmium	EPA 6010B/6010C/6020/6020A	EPA 6010B/6010C/6020/6020A
Calcium	EPA 6010B/6010C/6020/6020A	EPA 6010B/6010C/6020/6020A
Chromium	EPA 6010B/6010C/6020/6020A	EPA 6010B/6010C/6020/6020A
Cobalt	EPA 6010B/6010C/6020/6020A	EPA 6010B/6010C/6020/6020A
Copper	EPA 6010B/6010C/6020/6020A	EPA 6010B/6010C/6020/6020A
Iron	EPA 6010B/6010C/6020/6020A	EPA 6010B/6010C/6020/6020A
Lead	EPA 6010B/6010C/6020/6020A	EPA 6010B/6010C/6020/6020A
Lithium	EPA 6010B/6010C/6020/6020A	EPA 6010B/6010C/6020/6020A
Magnesium	EPA 6010B/6010C/6020/6020A	EPA 6010B/6010C/6020/6020A
Manganese	EPA 6010B/6010C/6020/6020A	EPA 6010B/6010C/6020/6020A
Mercury	EPA 6010B/6010C/7470/7470A	EPA 6010B/6010C/7471A/7471B
Molybdenum	EPA 6010B/6010C/6020/6020A	EPA 6010B/6010C/6020/6020A
Nickel	EPA 6010B/6010C/6020/6020A	EPA 6010B/6010C/6020/6020A
Platinum	EPA 6020/6020A	EPA 6020/6020A
Potassium	EPA 6010B/6010C/6020/6020A	EPA 6010B/6010C/6020/6020A
Selenium	EPA 6010B/6010C/6020/6020A	EPA 6010B/6010C/6020/6020A
Silica	EPA 6020/6020A	EPA 6020/6020A
Silicon	EPA 6020/6020A	EPA 6020/6020A
Silver	EPA 6010B/6010C/6020/6020A	EPA 6010B/6010C/6020/6020A
Sodium	EPA 6010B/6010C/6020/6020A	EPA 6010B/6010C/6020/6020A
Strontium	EPA 6020/6020A	EPA 6020/6020A
Thallium	EPA 6010B/6010C/6020/6020A	EPA 6010B/6010C/6020/6020A
Tin	EPA 6010B/6010C/6020/6020A	EPA 6010B/6010C/6020/6020A
Titanium	EPA 6010B/6010C/6020/6020A	EPA 6010B/6010C/6020/6020A
Uranium	EPA 6020/6020A	EPA 6020/6020A
Vanadium	EPA 6010B/6010C/6020/6020A	EPA 6010B/6010C/6020/6020A
Zinc	EPA 6010B/6010C/6020/6020A	EPA 6010B/6010C/6020/6020A
Inorganic		
Chloride	SM 4500 Cl-E	----------
Chemical Oxygen Demand – COD	SM 5220D	----------
Cyanide	SM 4500 CN-E	----------
Hardness	EPA 2340B	----------
Nitrate	EPA 353.2	----------
Nitrate-Nitrate	EPA 353.2	----------
Nitrite	EPA 353.2 SM 4500 NO2-B	----------
Oil and Grease	EPA 1664A	EPA 9071B
pH	SM4500 H+B	EPA 9045D
Total Petroleum Hydrocarbons - TPH	EPA 1664A	EPA 9071B
Alkalinity	SM2320B	----------

Parameter/Analyte	**Nonpotable Water**	**Solid Hazardous Waste**
Ammonia	EPA 350.1	----------
Conductivity	EPA 120.1	----------
Fluoride	SM4500 F-C	----------
Paint Filters	----------	EPA 9095B
Sulfate	ASTM D516-02	----------
Total Phosphorus	SM 4500 P-E	----------
Settleable Solids	SM 2540F	----------
Total Dissolved Solids	SM 2540C	----------
Total Solids	SM 2540B	----------
Total Suspended Solids	SM 2540D	----------
Total Volatile Solids	EPA 160.4	----------
Turbidity	EPA 180.1	----------
Organic		
Alkylated PAHs	S-MN-O-561	S-MN-O-561
Diesel Range Organics - DRO	EPA 8015B	EPA 8015B
Gasoline Range Organics - GRO	EPA 8015B	EPA 8015B
1,2,4-Trimethylbenzene	EPA 8021B	EPA 8021B
1,3,5-Trimethylbenzene	EPA 8021B	EPA 8021B
Methyl-tert-butyl ether	EPA 8021B	EPA 8021B
Benzene	EPA 8021B	EPA 8021B
Toluene	EPA 8021B	EPA 8021B
Ethylbenzene	EPA 8021B	EPA 8021B
Total Xylene	EPA 8021B	EPA 8021B
Aldrin	EPA 8081B	EPA 8081B
alpha-BHC	EPA 8081B	EPA 8081B
beta-BHC	EPA 8081B	EPA 8081B
gamma-BHC (Lindane)	EPA 8081B	EPA 8081B
alpha-Chlordane	EPA 8081B	EPA 8081B
gamma-Chordane	EPA 8081B	EPA 8081B
4,4'-DDD	EPA 8081B	EPA 8081B
4,4'-DDE	EPA 8081B	EPA 8081B
4,4'-DDT	EPA 8081B	EPA 8081B
Dieldrin	EPA 8081B	EPA 8081B
Endosulfan I	EPA 8081B	EPA 8081B
Endosulfan II	EPA 8081B	EPA 8081B
Endosulfan Sulfate	EPA 8081B	EPA 8081B
Endrin	EPA 8081B	EPA 8081B
Endrin Aldehyde	EPA 8081B	EPA 8081B
Endrin Ketone	EPA 8081B	EPA 8081B
Heptachlor	EPA 8081B	EPA 8081B
Heptachlor Epoxide	EPA 8081B	EPA 8081B
Methoxychlor	EPA 8081B	EPA 8081B
Toxaphene	EPA 8081B	EPA 8081B
Chlordane (Technical)	EPA 8081B	EPA 8081B
PCB-1016 (Aroclor 1016)	EPA 8082/8082A	EPA 8082/8082A
PCB-1221 (Aroclor 1221)	EPA 8082/8082A	EPA 8082/8082A
PCB-1232 (Aroclor 1232)	EPA 8082/8082A	EPA 8082/8082A
PCB-1242 (Aroclor 1242)	EPA 8082/8082A	EPA 8082/8082A

Parameter/Analyte	Nonpotable Water	Solid Hazardous Waste
PCB-1248 (Aroclor 1248)	EPA 8082/8082A	EPA 8082/8082A
PCB-1254 (Aroclor 1254)	EPA 8082/8082A	EPA 8082/8082A
PCB-1260 (Aroclor 1260)	EPA 8082/8082A	EPA 8082/8082A
PCB-1262 (Aroclor 1262)	EPA 8082/8082A	EPA 8082/8082A
PCB-1268 (Aroclor 1268)	EPA 8082/8082A	EPA 8082/8082A
1,2-Dibromo-3-chloropropane	EPA 8011	----------
1,2-Dibromoethane (EDB)	EPA 8011	----------
1,2,4-Trichlorobenzene	EPA 8270C/8270D	EPA 8270C/8270D
1,2-Dichlorobenzene	EPA 8270C/8270D	EPA 8270C/8270D
1,3-Dichlorobenzene	EPA 8270C/8270D	EPA 8270C/8270D
1,4-Dichlorobenzene	EPA 8270C/8270D	EPA 8270C/8270D
1-Methylnaphthalene	EPA 8270C/8270D/8270C SIM/ 8270D SIM	EPA 8270C/8270D/8270C SIM/ 8270D SIM
2,4,5-Trichlorophenol	EPA 8270C/8270D	EPA 8270C/8270D
2,4,6-Trichlorophenol	EPA 8270C/8270D	EPA 8270C/8270D
2,4-Dichlorophenol	EPA 8270C/8270D	EPA 8270C/8270D
2,4-Dimethylphenol	EPA 8270C/8270D	EPA 8270C/8270D
2,4-Dinitrotoluene	EPA 8270C/8270D	EPA 8270C/8270D
2.4-Dinitrophenol	EPA 8270C/8270D	EPA 8270C/8270D
2.6-Dinitrotoluene	EPA 8270C/8270D	EPA 8270C/8270D
2-Chloronaphthalene	EPA 8270C/8270D	EPA 8270C/8270D
2-Chlorophenol	EPA 8270C/8270D/8270C SIM/ 8270D SIM	EPA 8270C/8270D/8270C SIM/ 8270D SIM
2-Methylnaphthalene	EPA 8270C/8270D/8270C SIM/ 8270D SIM	EPA 8270C/8270D/8270C SIM/ 8270D SIM
2-Methylphenol(o-Cresol)	EPA 8270C/8270D	EPA 8270C/8270D
2-Nitroaniline	EPA 8270C/8270D	EPA 8270C/8270D
2-Nitrophenol	EPA 8270C/8270D	EPA 8270C/8270D
3&4-Methylphenol	EPA 8270C/8270D	EPA 8270C/8270D
3,3'-Dichlorobenzidine	EPA 8270C/8270D	EPA 8270C/8270D
3-Nitroaniline	EPA 8270C/8270D	EPA 8270C/8270D
4,6-Dinitro-2-methylphenol	EPA 8270C/8270D	EPA 8270C/8270D
4-Bromophenylphenyl ether	EPA 8270C/8270D	EPA 8270C/8270D
4-Chloro-3-methylphenol	EPA 8270C/8270D	EPA 8270C/8270D
4-Chlorophenylphenyl ether	EPA 8270C/8270D	EPA 8270C/8270D
4-Nitroaniline	EPA 8270C/8270D	EPA 8270C/8270D
4-Nitrophenol	EPA 8270C/8270D	EPA 8270C/8270D
Acenaphthene	EPA 8270C/8270D/8270C SIM/ 8270D SIM	EPA 8270C/8270D/8270C SIM/ 8270D SIM
Acenaphthylene	EPA 8270C/8270D/8270C SIM/ 8270D SIM	EPA 8270C/8270D/8270C SIM/ 8270D SIM
Anthracene	EPA 8270C/8270D/8270C SIM/ 8270D SIM	EPA 8270C/8270D/8270C SIM/ 8270D SIM
Benzo(a)anthracene	EPA 8270C/8270D/8270C SIM/ 8270D SIM	EPA 8270C/8270D/8270C SIM/ 8270D SIM
Benzo(a)pyrene	EPA 8270C/8270D/8270C SIM/ 8270D SIM	EPA 8270C/8270D/8270C SIM/ 8270D SIM
Benzo(b)fluoranthene	EPA 8270C/8270D/8270C SIM/ 8270D SIM	EPA 8270C/8270D/8270C SIM/ 8270D SIM

Parameter/Analyte	Nonpotable Water	Solid Hazardous Waste
Benzo(e)pyrene	EPA 8270C SIM/8270D SIM	EPA 8270C SIM/8270D SIM
Benzo(g,h,i)perylene	EPA 8270C/8270D/8270C SIM/ 8270D SIM	EPA 8270C/8270D/8270C SIM/ 8270D SIM
Benzo(k)fluoranthene	EPA 8270C/8270D/8270C SIM/ 8270D SIM	EPA 8270C/8270D/8270C SIM/ 8270D SIM
bis(2-Chloroethoxy)methane	EPA 8270C/8270D	EPA 8270C/8270D
bis(2-Chloroisopropyl)ether	EPA 8270C/8270D	EPA 8270C/8270D
bis(2-Ethylhexyl)phthalate	EPA 8270C/8270D	EPA 8270C/8270D
bis(2-Chloroethyl) ether	EPA 8270C/8270D	EPA 8270C/8270D
Butylbenzylphthalate	EPA 8270C/8270D	EPA 8270C/8270D
Carbazole	EPA 8270C/8270D	EPA 8270C/8270D
Chrysene	EPA 8270C/8270D/8270C SIM/ 8270D SIM	EPA 8270C/8270D/8270C SIM/ 8270D SIM
Dibenz(a,h)anthracene	EPA 8270C/8270D/8270C SIM/ 8270D SIM	EPA 8270C/8270D/8270C SIM/ 8270D SIM
Dibenzofuran	EPA 8270C/8270D/8270C SIM/ 8270D SIM	EPA 8270C/8270D/8270C SIM/ 8270D SIM
Diethylphthalate	EPA 8270C/8270D	EPA 8270C/8270D
Dimethylphthalate	EPA 8270C/8270D	EPA 8270C/8270D
Di-n-butylphthalate	EPA 8270C/8270D	EPA 8270C/8270D
Di-n-octylphthalate	EPA 8270C/8270D	EPA 8270C/8270D
Fluoranthene	EPA 8270C/8270D/8270C SIM/ 8270D SIM	EPA 8270C/8270D/8270C SIM/ 8270D SIM
Fluroene	EPA 8270C/8270D/8270C SIM/ 8270D SIM	EPA 8270C/8270D/8270C SIM/ 8270D SIM
Hexachloro-1,3-butadiene	EPA 8270C/8270D	EPA 8270C/8270D
Hexachlorobenzene	EPA 8270C/8270D	EPA 8270C/8270D
Hexachlorocyclopentadiene	----------	EPA 8270C/8270D
Hexachloroethane	EPA 8270C/8270D	EPA 8270C/8270D
Indeno(1,2,3-cd)pyrene	EPA 8270C/8270D/8270C SIM/ 8270D SIM	EPA 8270C/8270D/8270C SIM/ 8270D SIM
Isophorone	EPA 8270C/8270D	EPA 8270C/8270D
Naphthalene	EPA 8270C/8270D/8270C SIM/ 8270D SIM	EPA 8270C/8270D/8270C SIM/ 8270D SIM
Nitrobenzene	EPA 8270C/8270D	EPA 8270C/8270D
N-Nitroso-di-n-propylamine	EPA 8270C/8270D	EPA 8270C/8270D
N-Nitrosodiphenylamine	EPA 8270C/8270D	EPA 8270C/8270D
Pentachlorophenol	EPA 8270C/8270D	EPA 8270C/8270D
Phenanthrene	EPA 8270C/8270D/8270C SIM/ 8270D SIM	EPA 8270C/8270D/8270C SIM/ 8270D SIM
Phenol	EPA 8270C/8270D	EPA 8270C/8270D
Pyrene	EPA 8270C/8270D/8270C SIM/ 8270D SIM	EPA 8270C/8270D/8270C SIM/ 8270D SIM
1,1,1,2-Tetrachloroethane	EPA 8260B	EPA 8260B
1,1,1-Trichloroethane	EPA 8260B	EPA 8260B
1,1,2,2-Tetrachloroethane	EPA 8260B	----------
1,1,2-Trichloroethane	EPA 8260B	EPA 8260B
1,1,2-Trichlorotrifluoroethane	EPA 8260B	EPA 8260B
1,1-Dichloroethane	EPA 8260B	EPA 8260B
1,1-Dichloroethene	EPA 8260B	EPA 8260B

Parameter/Analyte	Nonpotable Water	Solid Hazardous Waste
1,1-Dichloropropene	EPA 8260B	EPA 8260B
1,2,3-Trichlorobenzene	EPA 8260B	EPA 8260B
1,2,3-Trichloropropane	EPA 8260B	EPA 8260B
1,2,4-Trichlorobenzene	EPA 8260B	EPA 8260B
1,2,4-Trimethylbenzene	EPA 8260B	EPA 8260B
1,2-Dibromo-3-chloropropane	EPA 8260B	EPA 8260B
1,2-Dibromoethane (EDB)	EPA 8260B	EPA 8260B
1,2-Dichlorobenzene	EPA 8260B	EPA 8260B
1,2-Dichloroethane	EPA 8260B	EPA 8260B
1,2-Dichloropropane	EPA 8260B	EPA 8260B
1,3,5-Trimethylbenzene	EPA 8260B	EPA 8260B
1,3-Dichlorobenzene	EPA 8260B	EPA 8260B
1,3-Dichloropropane	EPA 8260B	EPA 8260B
1,4-Dichlorobenzene	EPA 8260B	EPA 8260B
2,2-Dichloropropane	EPA 8260B	EPA 8260B
2-Butanone (MEK)	EPA 8260B	EPA 8260B
4-Chlorotoluene	EPA 8260B	EPA 8260B
4-Methyl-2-pentanone (MIBK)	EPA 8260B	EPA 8260B
Acetone	EPA 8260B	----------
Allyl Chloride	EPA 8260B	EPA 8260B
Benzene	EPA 8260B	EPA 8260B
Bromobenzene	EPA 8260B	EPA 8260B
Bromochloromethane	EPA 8260B	EPA 8260B
Bromodichloromethane	EPA 8260B	EPA 8260B
Bromoform	EPA 8260B	EPA 8260B
Bromomethane	EPA 8260B	EPA 8260B
Carbon tetrachloride	EPA 8260B	EPA 8260B
Chlorobenzene	EPA 8260B	EPA 8260B
Chloroethane	EPA 8260B	EPA 8260B
Chloroform	EPA 8260B	EPA 8260B
Chloromethane	EPA 8260B	EPA 8260B
cis-1,3-Dichloropropene	EPA 8260B	EPA 8260B
Dibromochloromethane	EPA 8260B	EPA 8260B
Dibromomethane	EPA 8260B	EPA 8260B
Dichlorodifluoromethane	EPA 8260B	EPA 8260B
Dichlorofluoromethane	EPA 8260B	EPA 8260B
Diethyl ether (Ethyl ether)	EPA 8260B	EPA 8260B
Ethylbenzene	EPA 8260B	EPA 8260B
Hexachloro-1,3-butadiene	EPA 8260B	EPA 8260B
Isopropylbenzene (Cumene)	EPA 8260B	EPA 8260B
Methyl-tert-butyl ether	EPA 8260B	EPA 8260B
Methylene Chloride	EPA 8260B	EPA 8260B
Naphthalene	EPA 8260B	EPA 8260B
Styrene	EPA 8260B	EPA 8260B
Tetrachloroethene	EPA 8260B	----------
Tetrahydrofuran	EPA 8260B	EPA 8260B
Toluene	EPA 8260B	EPA 8260B
Trichloroethene	EPA 8260B	EPA 8260B
Trichlorofluoromethane	EPA 8260B	EPA 8260B
Vinyl chloride	EPA 8260B	EPA 8260B
Xylene (Total)	EPA 8260B	EPA 8260B

Parameter/Analyte	Nonpotable Water	Solid Hazardous Waste
cis-1,2-Dichloroethene	EPA 8260B	EPA 8260B
m&p-Xylene	EPA 8260B	EPA 8260B
n-Butylbenzene	EPA 8260B	EPA 8260B
n-Propylbenzene	EPA 8260B	EPA 8260B
o-Xylene	EPA 8260B	EPA 8260B
p-Isopropyltoluene	EPA 8260B	EPA 8260B
sec-Butylbenzene	EPA 8260B	EPA 8260B
tert-Butylbenzene	EPA 8260B	EPA 8260B
trans-1,3-Dichloropropene	EPA 8260B	EPA 8260B
trans-1,2-Dichloroethene	EPA 8260B	EPA 8260B
Gasoline Range Organics - GRO	AK101	AK101
Diesel Range Organics - DRO	AK102	AK102
Residual Range Organics	AK103	AK103
Ethane	RSK-175	----------
Ethene	RSK-175	----------
Methane	RSK-175	----------

Test Method	Matrix	Extraction Method
8270C, 8270C SIM, 8015B DRO, 8081B , 8082A, 8082, 8270D SIM	Water	EPA 3510C
8270C, 8270D	Water	EPA 3520C
8270C, 8270C SIM, 8015B DRO, 8081B , 8082A, 8082, 8270D SIM	Solid	EPA 3550C
8260B	Solid	EPA 5035A/5030B
8015B GRO, 8021B	Solid	EPA 5030B
6010B/C, 6020, 6020A	Water	EPA 3010A/3020A
6010B,C, 6020, 6020A	Solid	EPA 3050B
8260B, 8270C, 6010B/C, 8270D	Solid/Liquid	EPA 1311 TCLP/1312

*Standard Methods (SM) refers to the current online edition.

Accredited Laboratory

A2LA has accredited

PACE ANALYTICAL SERVICES, LLC.

Minneapolis, MN

for technical competence in the field of

Environmental Testing

In recognition of the successful completion of the A2LA evaluation process that includes an assessment of the laboratory's compliance with ISO/IEC 17025:2005, the 2009 TNI Environmental Testing Laboratory Standard, and the requirements of the Department of Defense Environmental Laboratory Accreditation Program (DoD ELAP) as detailed in version 5.0 of the DoD Quality System Manual for Environmental Laboratories (QSM), accreditation is granted to this laboratory to perform recognized EPA methods as defined on the associated A2LA Environmental Scope of Accreditation. This accreditation demonstrates technical competence for this defined scope and the operation of a laboratory quality management system (refer to joint ISO-ILAC-IAF Communiqué dated 8 January 2009).

Presented this 23rd day of September, 2015.

President and CEO
For the Accreditation Council
Certificate Number 2926.01
Valid to October 31, 2017
Revised November 18, 2016

For the tests to which this accreditation applies, please refer to the laboratory's Environmental Scope of Accreditation.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 8
1595 Wynkoop Street
Denver, CO 80202-1129
Phone 800-227-8917
www.epa.gov/region08

MAY 18 2016

Ref: 8TMS-L

Ms. Nasreen K. DeRubeis
Senior Quality Manager
Pace Analytical Services, Inc. – Pittsburgh
1638 Roseytown Road
Suites 2, 3 & 4
Greensburg, Pennsylvania 15601

Dear Ms. DeRubeis:

In accordance with the authority stated in 40 CFR 141 and 142, Certification Officers from the U.S. Environmental Protection Agency Region 8 have reviewed your request for reciprocal certification of drinking water contaminants along with the documentation that was attached. Based upon the recommendation of my staff, I hereby grant continued reciprocal certification for the state of Wyoming and all tribal public water systems in Region 8 to Pace Analytical Services, Inc. – Pittsburgh located in Greensburg, Pennsylvania, for the parameters listed below. This reciprocal certification is based on the National Environmental Laboratory Accreditation Program (NELAP) accreditation of your laboratory by the commonwealth of Pennsylvania, and on the performance of your laboratory in the analysis of proficiency testing samples.

		Certification		
Parameter	Method(s)	Begin Date	End Date	Status
Group: Radiochemical Contaminants				
	900.0	4/1/2016	3/31/2017	Reciprocal
Gross Alpha	7110 C	4/1/2016	3/31/2017	Reciprocal
Gross Beta	900.0	4/1/2016	3/31/2017	Reciprocal
Radium-226	903.1	4/1/2016	3/31/2017	Reciprocal
Radium-228	904.0	4/1/2016	3/31/2017	Reciprocal
	908.0	4/1/2016	3/31/2017	Reciprocal
Total Uranium	ASTM D5174-97	4/1/2016	3/31/2017	Reciprocal
Radioactive Strontium-90	905.0	4/1/2016	3/31/2017	Reciprocal
Tritium	906.0	4/1/2016	3/31/2017	Reciprocal
Gamma Emitters	901.1	4/1/2016	3/31/2017	Reciprocal

Certification will remain in effect for the above period under the conditions that the laboratory remains accredited by the commonwealth of Pennsylvania NELAP for all of the above parameters, that the laboratory follows the specified methods, and that Water Supply proficiency testing samples are successfully analyzed by the laboratory for each of the above parameters once per year. It is the responsibility of the laboratory to request certification beyond the stated date.

If you have any comments or questions, please contact Marcie Tidd, Region 8 Drinking Water Laboratory Certification Program Manager, at (303) 312-7764 (tidd.marcie@epa.gov).

Sincerely,

Richard D. Buhl
Assistant Regional Administrator
Office of Technical and Management Services

Accredited Laboratory

A2LA has accredited

EUROFINS LANCASTER LABORATORIES ENVIRONMENTAL, LLC

Lancaster, PA

for technical competence in the field of

Environmental Testing

In recognition of the successful completion of the A2LA evaluation process that includes an assessment of the laboratory's compliance with ISO/IEC 17025:2005, the 2009 TNI Environmental Testing Laboratory Standard, and the requirements of the Department of Defense Environmental Laboratory Accreditation Program (DoD ELAP) as detailed in version 5.0 of the DoD Quality System Manual for Environmental Laboratories (QSM), accreditation is granted to this laboratory to perform recognized EPA methods as defined on the associated A2LA Environmental Scope of Accreditation. This accreditation demonstrates technical competence for this defined scope and the operation of a laboratory quality management system (refer to joint ISO-ILAC-IAF Communiqué dated 8 January 2009).

Presented this 27th day of February 2017.

President and CEO
For the Accreditation Council
Certificate Number 0001.01
Valid to November 30, 2018

For the tests to which this accreditation applies, please refer to the laboratory's Environmental Scope of Accreditation.

PERRY JOHNSON LABORATORY ACCREDITATION, INC.

Certificate of Accreditation

Perry Johnson Laboratory Accreditation, Inc. has assessed the Laboratory of:

Pacific Agricultural Laboratory, LLC

21830 SW Alexander Lane, Sherwood, OR 97140

(Hereinafter called the Organization) and hereby declares that Organization is accredited in accordance with the recognized International Standard:

ISO/IEC 17025:2005

& Meets the Requirements of the AOAC International Guidelines for Laboratories Performing Microbiological and Chemical Analyses of Food and Pharmaceutical-2010 & APLAC TC 007 Guidelines for Food Testing Laboratories

This accreditation demonstrates technical competence for a defined scope and the operation of a laboratory quality management system
(as outlined by the joint ISO-ILAC-IAF Communiqué dated January 2009):

Chemical and Environmental Testing

(As detailed in the supplement)

Accreditation claims for such testing and/or calibration services shall only be made from addresses referenced within this certificate. This Accreditation is granted subject to the system rules governing the Accreditation referred to above, and the Organization hereby covenants with the Accreditation body's duty to observe and comply with the said rules.

For PJLA:

Tracy Szerszen
President/Operations Manager

Perry Johnson Laboratory Accreditation, Inc. (PJLA)
755 W. Big Beaver, Suite 1325
Troy, Michigan 48084

Initial Accreditation Date:	*Issue Date:*	*Expiration Date:*
January 7, 2013	August 30, 2016	September 30, 2018
Revision Date:	*Accreditation No.*	*Certificate No.:*
March 15, 2017	64422	L16-362-R1

The validity of this certificate is maintained through ongoing assessments based on a continuous accreditation cycle. The validity of this certificate should be confirmed through the PJLA website: www.pjlabs.com

Pace Analytical Services, Inc.
9608 Loiret Blvd.
Lenexa, KS 66219
(913)599-5665

June 15, 2010

John Doe
Environmental, Inc
111 Avenue A
Suite 3
Sunshine, CO 80333

RE: Project: Monitoring Wells Area A
Pace Project No.: 6661111

Dear John Doe:
Enclosed are the analytical results for sample(s) received by the laboratory on May 13, 2010. The results relate only to the samples included in this report. Results reported herein conform to the most current NELAC standards, where applicable, unless otherwise narrated in the body of the report.

If you have any questions concerning this report, please feel free to contact me.

Sincerely,

Heather M. Wilson

Heather Wilson

heather.wilson@pacelabs.com
Project Manager

Enclosures

Pace Analytical Services, Inc.
9608 Loiret Blvd.
Lenexa, KS 66219
(913)599-5665

CERTIFICATIONS

Project: Monitoring Wells Area A
Pace Project No.: 6661111

Kansas Certification IDs
9608 Loiret Boulevard Lenexa, KS 66219
Washington Certification #: C2069
Utah Certification #: 9135995665
Texas Certification #: T104704407-08-TX
Oregon Certification #: KS200001
Oklahoma Certification #: 9205/9935
Nevada Certification #: KS000212008A
Louisiana Certification #: 03055
Kansas/NELAP Certification #: E-10116
Iowa Certification #: 118
Illinois Certification #: 001191
Arkansas Certification #: 05-008-0
A2LA Certification #: 2456.01

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(913)599-5665

SAMPLE SUMMARY

Project: Monitoring Wells Area A
Pace Project No.: 6661111

Lab ID	Sample ID	Matrix	Date Collected	Date Received
6661111001	**Well A**	Water	05/08/10 16:45	05/13/10 09:30
6661111002	**Well B**	Water	05/08/10 18:10	05/13/10 09:30
6661111003	**Well C**	Water	05/08/10 19:20	05/13/10 09:30
6661111004	**Well D**	Water	05/08/10 19:40	05/13/10 09:30
6661111005	**Well E**	Water	05/09/10 08:50	05/13/10 09:30

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SAMPLE ANALYTE COUNT

Project: Monitoring Wells Area A
Pace Project No.: 6661111

Lab ID	Sample ID	Method	Analysts	Analytes Reported
6661111001	**Well A**	EPA 8015C	CMP	3
		EPA 8260B	NLM	11
6661111002	**Well B**	EPA 8015C	CMP	3
		EPA 8260B	NLM	11
6661111003	**Well C**	EPA 8015C	CMP	3
		EPA 8260B	NLM	11
6661111004	**Well D**	EPA 8015C	CMP	3
		EPA 8260B	ZNF	16
6661111005	**Well E**	EPA 8015C	CMP	3
		EPA 8260B	ZNF	16

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ANALYTICAL RESULTS

Project: Monitoring Wells Area A
Pace Project No.: 6661111

Sample: Well A **Lab ID: 6661111001** Collected: 05/08/10 16:45 Received: 05/13/10 09:30 Matrix: Water

Parameters	Results	Units	Report Limit	DF	Prepared	Analyzed	CAS No.	Qual
8015C Diesel Range Organics	Analytical Method: EPA 8015C Preparation Method: EPA 3510C							
TPH-DRO	ND	mg/L	0.50	1	05/13/10 00:00	05/14/10 21:59		
p-Terphenyl (S)	78	%	40-118	1	05/13/10 00:00	05/14/10 21:59	92-94-4	
n-Tetracosane (S)	68	%	36-120	1	05/13/10 00:00	05/14/10 21:59	646-31-1	
8260 MSV VOCs and Oxygenates	Analytical Method: EPA 8260B							
Benzene	ND	ug/L	1.0	1		05/22/10 04:51	71-43-2	
Ethylbenzene	ND	ug/L	1.0	1		05/22/10 04:51	100-41-4	
Naphthalene	ND	ug/L	20.0	1		05/22/10 04:51	91-20-3	
Toluene	ND	ug/L	1.0	1		05/22/10 04:51	108-88-3	
TPH-GRO	ND	ug/L	500	1		05/22/10 04:51		
Xylene (Total)	ND	ug/L	3.0	1		05/22/10 04:51	1330-20-7	
Dibromofluoromethane (S)	113	%	86-112	1		05/22/10 04:51	1868-53-7	S3
Toluene-d8 (S)	101	%	90-110	1		05/22/10 04:51	2037-26-5	
4-Bromofluorobenzene (S)	97	%	87-113	1		05/22/10 04:51	460-00-4	
1,2-Dichloroethane-d4 (S)	115	%	82-119	1		05/22/10 04:51	17060-07-0	
Preservation pH	**1.0**		0.10	1		05/22/10 04:51		

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ANALYTICAL RESULTS

Project: Monitoring Wells Area A
Pace Project No.: 6661111

Sample: Well C **Lab ID: 6661111003** Collected: 05/08/10 19:20 Received: 05/13/10 09:30 Matrix: Water

Parameters	Results	Units	Report Limit	DF	Prepared	Analyzed	CAS No.	Qual
8015C Diesel Range Organics	Analytical Method: EPA 8015C Preparation Method: EPA 3510C							
TPH-DRO	**0.96**	mg/L	0.50	1	05/13/10 00:00	05/14/10 22:38		
p-Terphenyl (S)	54	%	40-118	1	05/13/10 00:00	05/14/10 22:38	92-94-4	
n-Tetracosane (S)	53	%	36-120	1	05/13/10 00:00	05/14/10 22:38	646-31-1	
8260 MSV VOCs and Oxygenates	Analytical Method: EPA 8260B							
Benzene	ND	ug/L	1.0	1		05/22/10 05:24	71-43-2	
Ethylbenzene	ND	ug/L	1.0	1		05/22/10 05:24	100-41-4	
Naphthalene	ND	ug/L	20.0	1		05/22/10 05:24	91-20-3	
Toluene	ND	ug/L	1.0	1		05/22/10 05:24	108-88-3	
TPH-GRO	ND	ug/L	500	1		05/22/10 05:24		
Xylene (Total)	ND	ug/L	3.0	1		05/22/10 05:24	1330-20-7	
Dibromofluoromethane (S)	114	%	86-112	1		05/22/10 05:24	1868-53-7	S3
Toluene-d8 (S)	100	%	90-110	1		05/22/10 05:24	2037-26-5	
4-Bromofluorobenzene (S)	97	%	87-113	1		05/22/10 05:24	460-00-4	
1,2-Dichloroethane-d4 (S)	119	%	82-119	1		05/22/10 05:24	17060-07-0	
Preservation pH	**1.0**		0.10	1		05/22/10 05:24		

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QUALITY CONTROL DATA

Project: Monitoring Wells Area A
Pace Project No.: 6661111

QC Batch: OEXT/22871 Analysis Method: EPA 8015C
QC Batch Method: EPA 3510C Analysis Description: EPA 8015C
Associated Lab Samples: 6661111001, 6661111002, 66661111003, 6661111004, 666111005

METHOD BLANK: 63112 Matrix: Water
Associated Lab Samples: 6661111001, 6661111002, 6661111003, 6661111004, 6661111005

Parameter	Units	Blank Result	Reporting Limit	Analyzed	Qualifiers
TPH-DRO	mg/L	ND	0.50	05/14/10 21:39	
n-Tetracosane (S)	%	64	36-120	05/14/10 21:39	
p-Terphenyl (S)	%	77	40-118	05/14/10 21:39	

LABORATORY CONTROL SAMPLE: 682413

Parameter	Units	Spike Conc.	LCS Result	LCS % Rec	% Rec Limits	Qualifiers
TPH-DRO	mg/L	2.5	1.8	73	48-119	
n-Tetracosane (S)	%			72	36-120	
p-Terphenyl (S)	%			79	40-118	

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QUALITY CONTROL DATA

Project: Monitoring Wells Area A
Pace Project No.: 666111

QC Batch: MSV/2825 Analysis Method: EPA 8260B
QC Batch Method: EPA 8260B Analysis Description: 8260 MSV WY VOC Oxygenates
Associated Lab Samples: 6661111001, 6661111002, 66661111003

METHOD BLANK: 63239 Matrix: Water
Associated Lab Samples: 6661111001, 6661111002, 6661111003

Parameter	Units	Blank Result	Reporting Limit	Analyzed	Qualifiers
Benzene	ug/L	ND	1.0	05/22/10 04:34	
Ethylbenzene	ug/L	ND	1.0	05/22/10 04:34	
Naphthalene	ug/L	ND	20.0	05/22/10 04:34	
Toluene	ug/L	ND	1.0	05/22/10 04:34	
TPH-GRO	ug/L	ND	500	05/22/10 04:34	
Xylene (Total)	ug/L	ND	3.0	05/22/10 04:34	
1,2-Dichloroethane-d4 (S)	%	114	82-119	05/22/10 04:34	
4-Bromofluorobenzene (S)	%	100	87-113	05/22/10 04:34	
Dibromofluoromethane (S)	%	110	86-112	05/22/10 04:34	
Toluene-d8 (S)	%	100	90-110	05/22/10 04:34	

LABORATORY CONTROL SAMPLE: 62340

Parameter	Units	Spike Conc.	LCS Result	LCS % Rec	% Rec Limits	Qualifiers
Benzene	ug/L	20	18.9	94	79-116	
Ethylbenzene	ug/L	20	18.6	93	76-122	
Naphthalene	ug/L	20	13.5J	67	60-145	
Toluene	ug/L	20	19.4	97	75-120	
TPH-GRO	ug/L	4000	2910	73	62-136	
Xylene (Total)	ug/L	60	53.8	90	74-124	
1,2-Dichloroethane-d4 (S)	%			112	82-119	
4-Bromofluorobenzene (S)	%			93	87-113	
Dibromofluoromethane (S)	%			110	86-112	
Toluene-d8 (S)	%			101	90-110	

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QUALITY CONTROL DATA

Project: Monitoring Wells Area A
Pace Project No.: 6661111

QC Batch: MSV/2306
QC Batch Method: EPA 8260B
Analysis Method: EPA 8260B
Analysis Description: 8260 MSV WY VOC Oxygenates
Associated Lab Samples: 6661111004, 6661111005

METHOD BLANK: 63384
Matrix: Water
Associated Lab Samples: 6661111004, 6661111005

Parameter	Units	Blank Result	Reporting Limit	Analyzed	Qualifiers
Benzene	ug/L	ND	1.0	05/22/10 19:12	
Diisopropyl ether	ug/L	ND	1.0	05/22/10 19:12	
Ethyl-tert-butyl ether	ug/L	ND	1.0	05/22/10 19:12	
Ethylbenzene	ug/L	ND	1.0	05/22/10 19:12	
Methyl-tert-butyl ether	ug/L	ND	1.0	05/22/10 19:12	
Naphthalene	ug/L	ND	20.0	05/22/10 19:12	
tert-Amylmethyl ether	ug/L	ND	1.0	05/22/10 19:12	
tert-Butyl Alcohol	ug/L	ND	20.0	05/22/10 19:12	
Toluene	ug/L	ND	1.0	05/22/10 19:12	
TPH-GRO	ug/L	ND	500	05/22/10 19:12	
Xylene (Total)	ug/L	ND	3.0	05/22/10 19:12	
1,2-Dichloroethane-d4 (S)	%	90	82-119	05/22/10 19:12	
4-Bromofluorobenzene (S)	%	99	87-113	05/22/10 19:12	
Dibromofluoromethane (S)	%	101	86-112	05/22/10 19:12	
Toluene-d8 (S)	%	103	90-110	05/22/10 19:12	

LABORATORY CONTROL SAMPLE: 63085

Parameter	Units	Spike Conc.	LCS Result	LCS % Rec	% Rec Limits	Qualifiers
Benzene	ug/L	20	16.7	83	79-116	
Diisopropyl ether	ug/L	20	14.5	73	71-123	
Ethyl-tert-butyl ether	ug/L	20	15.7	78	70-122	
Ethylbenzene	ug/L	20	17.7	89	76-122	
Methyl-tert-butyl ether	ug/L	20	16.5	82	62-131	
Naphthalene	ug/L	20	19.8J	99	60-145	
tert-Amylmethyl ether	ug/L	20	16.3	81	68-126	
tert-Butyl Alcohol	ug/L	100	74.8	75	36-164	
Toluene	ug/L	20	17.3	87	75-120	
TPH-GRO	ug/L	4000	3880	97	62-136	
Xylene (Total)	ug/L	60	54.5	91	74-124	
1,2-Dichloroethane-d4 (S)	%			93	82-119	
4-Bromofluorobenzene (S)	%			98	87-113	
Dibromofluoromethane (S)	%			101	86-112	
Toluene-d8 (S)	%			108	90-110	

Pace Analytical Services, Inc.
9608 Loiret Blvd.
Lenexa, KS 66219
(913)599-5665

QUALIFIERS

Project: Monitoring Wells Area A
Pace Project No.: 6661111

DEFINITIONS

DF - Dilution Factor, if reported, represents the factor applied to the reported data due to changes in sample preparation, dilution of the sample aliquot, or moisture content.

ND - Not Detected at or above adjusted reporting limit.

J - Estimated concentration above the adjusted method detection limit and below the adjusted reporting limit.

MDL - Adjusted Method Detection Limit.

S - Surrogate

1,2-Diphenylhydrazine (8270 listed analyte) decomposes to Azobenzene.

Consistent with EPA guidelines, unrounded data are displayed and have been used to calculate % recovery and RPD values.

LCS(D) - Laboratory Control Sample (Duplicate)

MS(D) - Matrix Spike (Duplicate)

DUP - Sample Duplicate

RPD - Relative Percent Difference

Pace Analytical is NELAP accredited. Contact your Pace PM for the current list of accredited analytes.

U - Indicates the compound was analyzed for, but not detected.

BATCH QUALIFIERS

Batch: OEXT/2871

[M5] A matrix spike/matrix spike duplicate was not performed for this batch due to insufficient sample volume.

Batch: MSV/2855

[M5] A matrix spike/matrix spike duplicate was not performed for this batch due to insufficient sample volume.

Batch: MSV/2806

[M5] A matrix spike/matrix spike duplicate was not performed for this batch due to insufficient sample volume.

ANALYTE QUALIFIERS

S3 Surrogate recovery exceeded laboratory control limits. Analyte presence below reporting limits in associated samples. Results unaffected by high bias.

Pace Analytical Services, Inc.
9608 Loiret Blvd.
Lenexa, KS 66219
(913)599-5665

QUALITY CONTROL DATA CROSS REFERENCE TABLE

Project: Monitoring Wells Area A
Pace Project No.: 6661111

Lab ID	Sample ID	QC Batch Method	QC Batch	Analytical Method	Analytical Batch
6661111001	**Well A**	EPA 3510C	OEXT/2271	EPA 8015C	GCSV/567
6661111002	**Well B**	EPA 3510C	OEXT/2271	EPA 8015C	GCSV/567
6661111003	**Well C**	EPA 3510C	OEXT/2271	EPA 8015C	GCSV/567
6661111004	**Well D**	EPA 3510C	OEXT/2271	EPA 8015C	GCSV/567
6661111005	**Well E**	EPA 3510C	OEXT/2271	EPA 8015C	GCSV/567
6661111001	**Well A**	EPA 8260B	MSV/2855		
6661111002	**Well B**	EPA 8260B	MSV/2855		
6661111003	**Well C**	EPA 8260B	MSV/2855		
6661111004	**Well D**	EPA 8260B	MSV/2306		
6661111005	**Well E**	EPA 8260B	MSV/2306		

INORGANIC & ORGANIC PARAMETERS IN SOLID SAMPLES

Parameter	EPA Method	Container	Preservative	Max Hold Time
Aromatic and Halogenated Volatiles	8021	5035 vial kit or 4 or 8 oz Glass Jar	see note 1	14 days
Base/Neutrals and Acids	8270	4 or 8 oz Glass Jar	≤6°C	14/40 Days
Diesel Range Organics	8015	4 or 8 oz Glass Jar	≤6°C	14/40 Days
Dioxins and Furans	1613B	4 or 8 oz Glass Jar	≤6°C	1 Year
Explosives	8330/8332	4 or 8 oz Glass Jar	≤6°C	14/40 Days
Gasoline Range Organics	8015	5035 vial kit or 4 or 8 oz Glass Jar	see note 1	14 days
Herbicides, Chlorinated	8151	4 or 8 oz Glass Jar	≤6°C	14/40 days
Mercury	7471	4 or 8 oz Glass Jar	≤6°C	28 days
Metals	6010 / 6020	4 or 8 oz Glass Jar	None	6 months
Pesticides, Organochlorine	8081	4 or 8 oz Glass Jar	≤6°C	14/40 Days
Pesticides, Organophosphorus	8141	4 or 8 oz Glass Jar	≤6°C	14/40 Days
Polynuclear Aromatic Hydrocarbons	8270 SIM	4 or 8 oz Glass Jar	≤6°C	14/40 Days
Volatiles	8260	5035 vial kit or 4 or 8 oz Glass Jar	see note 1	14 days

[1] 5035/5035A Note: 5035 vial kit typically contains 2 vials water, preserved by freezing or, 2 vials aqueous sodium bisulfate preserved at ≤6°C, and one vial methanol stored at ≤6°C, and one container of unpreserved sample stored at ≤6°C

ORGANIC & INORGANIC PARAMETERS IN AIR SAMPLES

Parameter	Method	Container	Max Hold Time
BTEX/Total Hydrocarbons	TO-3	Summa Canister	28 Days
BTEX/Total Hydrocarbons	TO-3	Sampling Bag or equivalent	48 Hours
Condensable Particulate Emissions	EPA 202	Solutions	6 Months
Dioxins & Furans	TO-9	PUF	7/30 Days
Hydrogen Halide & Halogen Emissions	EPA 26 / 26A	Solutions	6 Months
Metals (ICP)	NIOSH 7300A/7303	Filters	6 Months
Methane, Ethane, Ethene	TO3M	Summa Canister	28 days
Methane, Ethane, Ethene	TO3M	Sampling Bag or equivalent	48 Hours
Particulates	PM10	Filters	
PCBs & Pesticides, Organochlorine	TO4/TO10	PUF	7/40 Days
Permanent Gases	EPA 3C	Summa Canister	28 Days
Permanent Gases	EPA 3C	Sampling Bag or equivalent	48 Hours
Polynuclear Aromatic Hydrocarbons	TO13	PUF	7/40 Days
Stationary Source Dioxins & Furans	Method 23	XAD Trap	30/45 Days
Stationary Source Mercury	EPA 101	Filters/Solutions	28 Days
Stationary Source Metals	EPA 29	Filters/Solutions	6 Months, 28 Days for Hg
Stationary Source Particulates	EPA 5	Filter/Solutions	
Stationary Source PM10	EPA 201A	Filters	6 Months
Volatiles	TO14	Summa Canister	28 Days
Volatiles	TO14	Sampling Bag or equivalent	48 Hours
Volatiles	TO15	Summa Canister	28 Days
Volatiles, short list PAH, DRO	TO17	TD Tube	28 Days
Volatiles	TO17M	Radiello Tube	14 days

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Analytical Guide

ORGANIC PARAMETERS IN AQUEOUS SAMPLES

Parameter	Method			Container	Preservative	Max Hold Time
	EPA Drinking Water	EPA Water	EPA Waste SW-846			
Aromatic and Halogenated Volatiles		601/602	8021	3 - 40mL vials	pH<2 HCl, ≤6°C, $Na_2S_2O_3$ if Cl present	14 Days (7 days for aromatics if unpreserved)
Base/Neutrals and Acids		625	8270	1L Amber Glass	≤6°C, $Na_2S_2O_3$ if Cl present	7/40 Days
Base/Neutrals, Acids & Pesticides	525.2			1L Amber Glass	pH <HCl, sodium sulfite if Cl present	14/30 Days
Diesel Range Organics			8015	1L Amber Glass	≤6°C, $Na_2S_2O_3$ if Cl present	7/40 Days – see note 3
Dioxins and Furans	1613B			1L Amber Glass	≤6°C, $Na_2S_2O_3$ if Cl present	1 Year
Dioxins and Furans			8290	1L Amber Glass	≤6°C, $Na_2S_2O_3$ if Cl present	30/45 Days
EDB & DBCP	504.1		8011	40mL vials	≤6°C, $Na_2S_2O_3$ if Cl present	14 Days
Explosives			8330/8332	1L Amber Glass	≤6°C	7/40 Days
Gasoline Range Organics			8015	40mL vials	pH<2 HCl	14 Days – see note 3
Haloacetic Acids	552.1/552.2			40mL Amber vials	NH_4Cl, ≤6°C	14/7 Days if extracts stored at ≤6°C or 14/14 Days if extracts stored at ≤-10°C
Herbicides, Chlorinated	515.1/515.3		8151	1L Amber Glass	≤6°C, $Na_2S_2O_3$ if Cl present	7/40 Days for 8151; 14/28 Days for 515.1/515.3
PCBs, Organochlorine			8082	1L Amber Glass	≤6°C; $Na_2S_2O_3$ if Cl present	1 Year/1Year
PCBs & Pesticides, Organochlorine		608		1L Amber Glass	≤6°C; $Na_2S_2O_3$ if Cl present	7/40 Days
Pesticides, Organochlorine			8081	1L Amber Glass	≤6°C, $Na_2S_2O_3$ if Cl present	7/40 Days
Pesticides, Organophosphorus			8141	1L Amber Glass	pH 5-8 with NaOH or H_2SO_4; ≤6°C, $Na_2S_2O_3$ if Cl Present	7/40 Days
Polynuclear Aromatic Hydrocarbons			8270 SIM	1L Amber Glass	≤6°C, $Na_2S_2O_3$ if Cl present	7/40 Days
Volatiles		624	8260	3 - 40mL vials	pH<2 HCl; ≤6°C	14 Days (7 Days for aromatics if unpreserved)
Volatiles (see note 2)	524.2			40mL vials (in duplicate)	pH<2 HCl, ≤6°C, $Na_2S_2O_3$ if Cl present	14 Days

[2] Method 524.2 lists ascorbic acid as the preservative when residual chlorine is suspected, unless gases or Table 7 compounds are NOT compounds of interest and then sodium thiosulfate is the preservative recommended.
[3] States may have specific method requirements.

INORGANIC PARAMETERS IN AQUEOUS SAMPLES

Parameter	Method			Container	Preservative	Max Hold Time
	EPA Water	Standard Methods	EPA Waste SW-846			
Acidity		SM2310B		Plastic/Glass	≤6°C	14 Days
Alkalinity	310.2	SM2320B		Plastic/Glass	≤6°C	14 Days
Anions by IC, including Br, Cl, F, NO2, NO3,o-Phos, SO4, bromate, chlorite, chlorate)	300.0			Plastic/Glass	≤6°C	All analytes 28 days except NO2, NO3, o-Phos (48 hours); chlorite (immediate); NO2/NO3 combo 28 days
Bacteria, Total Plate Count		SM9221D		Plastic/WK	≤6°C, $Na_2S_2O_3$	24 Hours
BOD/cBOD		SM5210B/Hach 10360		Plastic/Glass	≤6°C	48 hours
Chloride		SM4500Cl-C,E		Plastic/Glass	None	28 Days
Chlorine, Residual	330.5	SM4500Cl-D, E, G / Hach 8167		Plastic/Glass	None	15 minutes
COD	410.4	SM5220C, D / Hach 8000		Plastic/Glass	pH<2 H_2SO_4, ≤6°C	28 Days
Color		SM2120B,E		Covered Plastic, Acid Washed Amber Glass	≤6°C	24 Hours
Cyanide, Reactive			Chapter 7	Plastic/Glass	None	28 Days
Cyanide, Total and Amenable	335.4	SM4500CN-A,B,C,D,E,G,I,N	9010/9012	Plastic/Glass	pH>12 NaOH; ≤6°C ascorbic acid if Cl present	14 Days (24 hrs if sulfide present - applies to SM4500CN only)
Ferrous Iron		SM3500Fe-D		Glass	None	Immediate
Flashpoint/Ignitability			1010	Plastic/Glass	None	28 Days
Fluoride		SM4500FI-C,D		Plastic	None	28 Days
Hardness, Total (CaCO3)	130.1	SM2340B,C		Plastic/Glass	pH<2 HNO_3	6 Months
Hexavalent Chromium	218.6	SM3500Cr-C,D	7196	Plastic/Glass	≤6°C	24 Hours, unless preserved per method, then 28 Days
Mercury	245.1/245.2		7470	Plastic/Glass	pH<2 HNO_3	28 Days
Mercury, Low Level	1631E			Fluoropolymer (Glass if Hg is only analyte being tested)	12N HCl or BrCl	48 hours for preservation or analysis; 28 days to preservation if sample oxidized in bottle; 90 days for analysis if preserved
Metals (ICP/ICPMS)	200.7/200.8		6010/6020	Plastic/Glass	pH<2 HNO_3	6 Months
Nitrogen, Ammonia	350.1	SM4500NH3		Plastic/Glass	pH<2 H_2SO_4, ≤6°C	28 Days
Nitrogen, Kjeldahl	351.2	SM4500-Norg		Plastic/Glass	pH<2 H_2SO_4, ≤6°C	28 Days
Nitrogen, Nitrate	352.1	SM4500-NO3		Plastic/Glass	≤6°C	48 Hours
Nitrogen, Nitrate & Nitrite, combined	353.2	SM4500-NO3		Plastic/Glass	pH<2 H_2SO_4, ≤6°C	28 Days
Nitrogen, Organic	351.2 / 350.1	SM4500-Norg		Calculation	pH<2 H_2SO_4, ≤6°C	28 Days
Odor		SM2150B		Glass	≤6°C	24 Hours
Oil and Grease/HEM	1664A	SM5520B	9070	Glass	pH<2 H_2SO_4 or HCl, ≤6°C	28 Days
Oxygen, Dissolved (Probe)		SM4500-O		Glass	None	15 minutes
Paint Filter Liquid Test.			9095	Plastic/Glass	None	N/A

INORGANIC PARAMETERS IN AQUEOUS SAMPLES

Parameter	**Method**			**Container**	**Preservative**	**Max Hold Time**
	EPA Water	**Standard Methods**	**EPA Waste SW-846**			
Phenol, Total	420.1/420.4		9065/9066	Glass	pH<2 H_2SO_4, ≤6°C	28 Days
Phosphorus, Orthophosphate	365.1/365.3	SM4500P		Plastic	Filter, ≤6°C	Filter within 15 minutes, Analyze within 48 hours
Phosphorus, Total	365.1 / 365.3 / 365.4	SM4500P		Plastic/Glass	pH<2 H_2SO_4, ≤6°C	28 Days
Silica, Dissolved		SM4500Si-D		Plastic	≤6°C	28 Days
Solids, Settleable		SM2540F		Glass	≤6°C	48 Hours
Solids, Total		SM2540B		Plastic/Glass	≤6°C	7 Days
Solids, Total Dissolved		SM2540C		Plastic/Glass	≤6°C	7 Days
Solids, Total Suspended	USGS I-3765-85	SM2540D		Plastic/Glass	≤6°C	7 Days
Specific Conductance	120.1	SM2510B	9050	Plastic/Glass	≤6°C	28 Days
Sulfate	375.2	SM4500S04 / ASTM D516	9036/9038	Plastic/Glass	≤6°C	28 Days
Sulfide, Reactive			Chapter 7	Plastic/Glass	None	28 Days
Sulfide, Total		SM4500S	9030	Plastic/Glass	pH>9 NaOH and ZnOAc; ≤6°C	7 Days
Sulfite		SM4500SO3		Plastic/Glass	None	15 minutes
Surfactants (MBAS)		SM5540C		Plastic/Glass	≤6°C	48 Hours
Total Organic Carbon (TOC)		SM5310B,C,D	9060	Glass	pH<2 H_2SO_4 or HCl, ≤6°C	28 Days
Total Organic Halogen (TOX)		SM5320	9020/9021	Glass (No headspace)	pH<2 H_2SO_4, ≤6°C	14 Days
Turbidity	180.1	SM2130B		Plastic/Glass	≤6°C	48 Hours

RADCHEM PARAMETERS

Parameter	Method			Container	Preservative	Max Hold Time
	EPA Water	Standard Methods	EPA SW-846			
Gamma Emitting Radionuclides (see note 4)	901.1			Plastic/Glass	pH<2 HNO_3	180 days
Gross Alpha (NJ 48Hr Method)	NJAC 7:18-6			Plastic/Glass	pH<2 HNO_3	48 hours
Gross Alpha and Gross Beta (see note 4)	900.0		9310	Plastic/Glass	pH<2 HNO_3	180 days
Radium-226 (see note 4)	903.0/903.1			Plastic/Glass	pH<2 HNO_3	180 days
Radium-228 (see note 4)	904.0		9320	Plastic/Glass	pH<2 HNO_3	180 days
Radioactive Strontium (see note 4)	905.0			Plastic/Glass	pH<2 HNO_3	180 days
Total Alpha Radium (see note 4)	903.0		9315	Plastic/Glass	pH<2 HNO_3	180 days
Total Uranium (see note 4)	908.0	D5174-97		Plastic/Glass	pH<2 HNO3	180 days
Tritium	906.0			Glass	None	180 Days

[4]Methods 9315 and 9320 both state that if samples are unpreserved, the samples should be brought to the lab within 5 days of collection, preserved in the lab, and then allowed to sit for a minimum of 16 hours before sample preparation/analysis.