ENERGY NORTHWEST
COLUMBIA GENERATING STATION
GROUND WATER QUALITY STUDY
QUALITY ASSURANCE PROJECT PLAN UPDATE

prepared by

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in accordance with

NPDES Permit No. WA-002515-1
Special Condition S7.5

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INTRODUCTION

Special Condition S7.5 of the (Columbia Generating Station) CGS National Pollutant Discharge Elimination System (NPDES) Waste Discharge Permit No. WA-002515-1, effective 01 November 2014, requires submittal of a quality assurance project plan (QAPP) update for the groundwater quality study to the Energy Facility Site Evaluation Council (EFSEC) for review and approval.(1) The purpose of the groundwater quality study is to assess effects of plant liquid discharges on the local groundwater, specifically addressing potential effects of the circulating water (CW) and standby service water (SSW) systems while monitoring for impacts from the 618-11 Burial Ground and other Hanford sources.

This QAPP update is a follow-up to the QAPP that was submitted to EFSEC in September, 2007 (2) and the subsequent study report that was submitted in May, 2012.(3) Included in this QAPP is a description of the CW system and SSW system and components of the scope of work specific to the groundwater monitoring plan. This QAPP is based on the findings and recommendations presented in a previous hydrogeology/well evaluation study(4), previous water quality data associated with Outfalls 002 and 003(5), current NPDES permit requirements(1), Department of Ecology guidance(6,7), and the groundwater criteria contained in WAC 173-200.(8)

Aspects of this QAPP applicable to radiological monitoring, including sample collection/handling, QA/QC, analytical methods, and reporting will be performed under procedures/protocols established for the Columbia Generating Station Radiological Environmental Monitoring Program.

BACKGROUND

Since completion of the groundwater quality study in 2012, Outfall 003 has been removed from the NPDES permit. The Storm Drain Pond (Outfall 002) has been replaced by lined evaporation ponds. Monitoring wells MW-7 and MW-8, installed to assess impacts from the Storm Drain Pond, are both dry. Preparation of a scope of work for a groundwater analysis is planned for 2015 per NPDES permit condition S7.3.(1) As part of this scope of work, placement of additional groundwater monitoring wells will be reassessed. Installation of new wells is planned to begin in 2016.

CIRCULATING WATER SYSTEM

The CW system is designed to provide cooling water for the condenser and to utilize the atmosphere as a heat sink via mechanical draft cooling towers. The cooling towers also cool the Plant Service Water (TSW) system during normal operation. The design temperature entering a cooling tower is 104.3°F, leaving is 76.3°F, and the rated flow is 95,000 gpm.(9) Calculated drift losses remain constant at 300 gpm during plant operation.(10)

Circulating water system chemistry is controlled to minimize algae growth, scaling, and general corrosion. Other chemical additives are used to increase the effectiveness of chlorination, to act as a silt dispersant, and to introduce corrosion inhibitors into the raw water.(9) To control bio-fouling, sodium hypochlorite and sodium bromide are added to the system. Sulfuric acid is added to the CW system to control pH. Orthophosphate, AMPS Copolymer, and Tolytriazole are added to inhibit corrosion and scale(10). Tolytriazole is currently under review for removal from the treatment program.

STANDBY SERVICE WATER SYSTEM

The SSW system is designed to remove reactor decay heat during periods of normal shutdown. It provides a heat sink for the Residual Heat Removal (RHR) system and emergency plant equipment. It also provides water to the Reactor Pressure Vessel or to the containment during a post loss of coolant accident condition. With a volume of 13 million gallons, the SSW system consists of two concrete lined basins which provide suction and discharge points for the closed-loop pumping and spray facilities of the system. Operation of the SSW system pumps water through a RHR heat exchanger and other equipment requiring cooling. As water travels through the SSW system, it absorbs heat.(11) Prior to SSW spray pond temperature exceeding 69 °F, the SSW spray header is aligned for service.(12) In order to maintain this requirement, water from the SSW system ponds pass through spray trees (32 in each SSW pond) to capitalize on evaporative cooling. It is during this operation that drift from water passing through spray trees leaves the SSW system and lands on the ground, potentially impacting groundwater.

In order to maintain acceptable heat exchanger performance, maintain control of biological growth in the bulk water, and maintain corrosion rates in the system at or below design limits, chemical treatment is performed. Makeup water for the SSW system is untreated Columbia River water. The following chemicals are added to the SSW system: hydrogen peroxide, Busan 77, and N sodium silicate.(11)

618-11 BURIAL GROUND

The 618-11 Burial Ground, upgradient of and immediately adjacent to the CGS, is the most significant source of groundwater contamination from Hanford Site operations near CGS. Nitrate from the 618-11 Burial Ground to the west of CGS affects groundwater conditions at CGS.(13) A tritium plume originates from the 618-11 Burial Ground. Analysis and surveillance of the plume by the Department of Energy suggests that it is migrating in a northeast trajectory. Reduced tritium concentrations observed near Outfall 002, the cooling towers, and spray ponds suggest that CGS operations and the effluent discharges to the unlined Outfall

002 prevented the tritium plume originating from the 618-11 Burial Ground from migrating into the CGS area.[3]

GROUNDWATER MONITORING PLAN

CURRENT MONITORING WELL NETWORK

The existing network of groundwater monitoring wells (Table 1), will be used in the current groundwater study, with only minor changes as indicated in the following:

- Prior to the installation of the lined evaporation ponds, the Outfall 002 Storm Drain Pond received wastewater and stormwater discharges from the powerblock, fire protection system, reverse-osmosis filtration system, and potable water filter plant. These wastewater sources are now all routed to new lined evaporation ponds and are no longer routed to Outfall 002. Historically, MW-7 and MW-8 were used as the down-gradient wells and MW-9 as the up-gradient well for Outfall 002. Since 2012, the water level in MW-7, and more recently MW-8, has been too low to collect a sample. Although MW-9 has been used as an upgradient well for Outfall 002, the well was influenced hydraulically by discharges to Outfall 002 and other upgradient sources. Continued monitoring of MW-9 will be used to monitor background water quality and potential effects from the 618-11 Burial Ground.

- Previously, MW-6 was used to monitor discharges down-gradient of Outfall 003. Discharges to Outfall 003 are no longer permissible; the Outfall has been removed from the NPDES Permit. However, parameters analyzed from MW-6 indicate it may be influenced by circulating water from operations at the cooling towers and spray pond areas. Monitoring at this location will continue in order to assess hydraulic influences from CW and SSW. MW-5 will be used as the up-gradient well for CW and SSW operations. MW-3 was identified as potentially being influenced by infiltrating water from the CGS cooling tower area. MW-3 will continue to be monitored.

- In order to meet objective 1.3 detailed in Nuclear Energy Institute (NEI) 07-07, five wells were installed in 2008 to meet requirements of an on-site ground water monitoring program to ensure the timely detection of inadvertent radiological releases to ground water. The locations of these wells were selected to reflect systems, structures, or components that have the highest potential for inadvertent radiological releases to ground water.[14] MW-10 (upgradient) and MW-11 and MW-12 (downgradient) locations were selected due to their proximity to the condensate storage tank and its connecting piping. MW-13 (upgradient) and MW-14 (downgradient) locations were selected due to their proximity to the Sanitary Waste Treatment Facility.

Proposed Monitoring Well Network

- Energy Northwest intends to install several new monitoring wells to supplement the existing well network. These new wells will be used to assess local groundwater and hydraulic mounding in the vicinity of the CW and SSW systems. Several on-the-ground operational changes have been made since the completion of the 2012 groundwater study; most notably the elimination of discharges to Outfalls 002 and 003. A groundwater quality study scope of work is planned for 2015 and 2016 to identify location placements for new groundwater monitoring wells.

Frequency and Duration

The proposed monitoring frequency for the continued groundwater quality study is quarterly.

Parameters

The proposed monitoring parameters are presented in Tables 2, 3, and 4. They include parameters required to comply with the NPDES permit as well as the parameters listed in the groundwater criteria (WAC 173-200) that are applicable to CGS.[1,8]

The radiological parameters listed in Table 5 are collected in accordance with the CGS Radiological Environmental Monitoring Program (REMP) and are collected at the same time as NPDES parameters.

Sampling Protocol

Groundwater well sampling will follow standard procedures [15,16] so that accurate, comparable, and quality results are obtained from each sample. Samples will be designated by well number and date.

Water Level Measurements

Groundwater elevations will be measured in the monitoring wells prior to each sampling event. Depth to water will be measured to the nearest 0.05 foot from a surveyed point on the well casing and recorded in a field logbook or on a water level measurement form. Each round of water level measurements will be obtained within a two week period prior to sample collection.

Decontamination

Dedicated groundwater sampling equipment (e.g., pumps, bailers) will be used whenever possible. No decontamination will be required when dedicated equipment is used. When a disposable bailer is used, new bailer cord (polypropylene or monofilament nylon) will be used at each well. Non-dedicated groundwater sampling equipment will be decontaminated with a thorough distilled water rinse before each use.

WELL PURGING

Monitoring wells will be purged of stagnant water before sampling. Each well will be purged with a pump (preferred) or bailer until field parameters stabilize (Table 6). Water generated by purging, equipment rinsing, and sampling will be allowed to infiltrate into the soil in the vicinity of the well.

FIELD MEASUREMENTS

After purging, water from the discharge line will be diverted to a flow-through cell instrumented with a multi-parameter water-quality instrument (YSI 556 MPS or equivalent) designed to minimize sample contact with the atmosphere and report field measurements of temperature, pH, specific conductance, and dissolved oxygen. Measurements will be recorded to the following standards:

- Temperature to nearest 0.1°C
- pH to nearest 0.1 units
- Specific conductance to two significant figures
- Dissolved oxygen to two significant figures

Field meters will be calibrated in the laboratory immediately prior to the sampling event. A calibration check will be performed upon completion of the sampling event. Calibration dates, times, measurements, and field measurement results will be recorded in a field logbook.

SAMPLE COLLECTION

Samplers will wear new laboratory gloves at each sampling station. Groundwater samples will be collected in the following order:

- Field parameters
- VOCs
- SVOCs
- NWTPHDX (MW-10, MW-11, & MW-12 only)
- Anions
- TDS
- Radiological parameters
- Total & dissolved metals

All samples will be field-transferred from the sampling equipment into appropriate laboratory-prepared containers. Sample container types, handling instructions, and preservatives are presented in Table 7. Where appropriate, sample containers will be triple rinsed with the sample water prior to collecting samples for laboratory analyses. Low flow collection techniques will be used for the collection of samples to be analyzed for metals. Labels will be placed on each sample container indicating well number, date and time of sampling, the identity of any added preservatives, required analytical tests, and the sampler's initials.

SAMPLE HANDLING

Samples will be handled and transported with care throughout the monitoring event. Following collection, the sample will be placed in a chilled and insulated cooler and remain in the custody of the sampler or other qualified personnel until transport to the laboratory. Upon transfer of sample containers to subsequent custodians, a chain of custody/analysis request form will be completed. Samples requiring 0.45 micron filtration and additional preservation will receive treatment, by the receiving laboratory, as soon as practicable.

QUALITY CONTROL SAMPLING

Quality control samples (equipment blanks, field blanks, trip blanks, duplicates, and matrix spikes) will be collected and analyzed as described in the quality assurance section.

QUALITY ASSURANCE

The objective of the quality assurance program is to ensure that all analytical measurements produce accurate and precise results representative of the media and conditions measured. The measurement quality objectives (MQO's) for this study are presented in Tables 8 and 9.

QUALITY CONTROL SAMPLES

Quality control samples consisting of equipment blanks, field blanks, trip blanks, and duplicate samples will be included in each sampling event. The number of QC samples will be approximately ten percent of the field samples or, at least, one set of QC samples for each sampling event. Quality control samples, types, and frequency are presented in Table 10.

Duplicate groundwater samples will be obtained by alternately filling like sample containers for two sample sets until all containers are full. The duplicate sample collection location will be chosen at random prior to each sampling event.

Trip blanks for volatile organic compound (VOC) analyses will be prepared in the laboratory, will accompany the shipment of sample containers to the site, and will return to the laboratory for analysis with the field samples. Trip blanks will be filled with deionized water in the laboratory and will remain unopened until returned to the laboratory for analyses.

LABORATORY METHODS AND ACCREDITATION

All laboratory analyses will be performed by a laboratory registered or accredited under the provisions of, *Accreditation of Environmental Laboratories*, Chapter 173-50 WAC. Per NPDES Permit Condition S2.B[1], analytical methods will conform to the latest revision of the *Guidelines Establishing Test Procedures for the Analysis of Pollutants* contained in 40 CFR Part 136.[17] Analytical methods and detection limits (practical quantitation limits – PQL's) for this study are presented in Tables 11, 12, 13, and 14.

LABORATORY REPORTING REQUIREMENTS

The laboratory performing the analyses will be required to submit the following information:

- Cover letter or notes on spreadsheet for each sample batch that includes a summary of any quality control, sample, shipment, or laboratory problems, as well as documentation of all internal decisions. Problems will be outlined and final solutions will be documented.

- Analytical results from samples sent to an outside laboratory will have information on the chain of custody, the analytical method, QA/QC results, and documentation of accreditation for the parameter.

- Analyte concentrations for all samples, including QC samples, will be reported on standard data sheets in proper units and to the appropriate number of significant figures. Detection limits for each compound will also be reported.

- Reports providing data for organic and metal parameters will include the following information: sampling date, sample location, date of analysis, parameter name, CAS number, analytical method/number, method detection limit (MDL), laboratory practical quantitation limit (PQL), reporting units, and concentration detected.

- Surrogate recovery results for organic analyses, including actual spike levels (for each sample analyzed), will be attached.

Prior to issuance, the laboratory report will receive a supervisory or peer review for data validation.

CORRECTIVE ACTION

Corrective actions consist of handling laboratory or field equipment malfunctions, nonconformance or noncompliance with the established QA requirements, and alterations to sampling procedures or locations due to uncontrollable circumstances. Any deviations from the monitoring plan will be documented in a field logbook. Laboratories must adhere to standard operating procedure guidelines and specifications. When instrument response, quality control sample results, or blank analyses indicate exceedance of control limits, the cause of the exceedance must be determined and documented.

FIELD DOCUMENTATION

Accurate documentation of field activities will be maintained by using field logbooks, field data forms, correspondence records, and photographs. Entries will be made in sufficient detail to provide an accurate record of field activities without reliance on memory. Field log entries will include a chronological description of task activities, names of individuals present, names of visitors, weather conditions, etc. All entries will be legibly entered in ink, dated, and initialed. When photographs are taken, the date, picture number, and description of the photograph will be entered in a field logbook.

REPORTING

Results of the groundwater quality study will be reported as per NPDES Permit Special Condition S7.4.[1]

REFERENCES

1. NPDES Permit No. WA002515-1, issued by the Energy Facility Site Evaluation Council (EFSEC), September 30, 2014

2. *Energy Northwest Columbia Generating Station, Ground-Water Quality Study Quality Assurance Project Plan*, Welch, R.E., Energy Northwest – Environmental Services, September 2007

3. *Energy Northwest Columbia Generating Station Groundwater Quality Study Report,* Freestone Environmental Services, Inc., May 2012

4. *Summary of Hydrogeology and Evaluation of Existing Groundwater Monitoring Wells for Outfalls 002 and 003 at the Columbia Generating Station*, Battelle, PNWD-3845, June 2007

5. Fact Sheet for NPDES Permit No. WA-002515-1, issued by the Energy Facility Site Evaluation Council (EFSEC), 2006

6. *Implementation Guidance for the Ground Water Quality Standards*, Washington State Department of Ecology, Pub. No. 96-02, Revised October 2005

7. *Guidelines for Preparing Quality Assurance Project Plans for Environmental Studies,* Washington State Department of Ecology, Pub. No. 04-03-030, July 2004

8. Water Quality Standards for Ground Waters of the State of Washington, WAC 173-200

9. Columbia Generating Station System Description, Volume 2, Chapter 9. Circulating Water and Tower Makeup System. Operations Training, Energy Northwest, October 2014

10. PPM 12.14.3, Circulating Water – Corrosion Inhibition Addition, December 2013

11. *Biofouling Control in An Open Recirculating Service Water System Using Hydrogen Peroxide,* Northstrom, T.E., Washington Public Power Supply System, 1995

12. SOP-SW-SPRAY, Standby Service Water Spray Header Operations, October 2003

13. *Evaluation of the Fate and Transport of Tritium Contaminated Groundwater from the 618-11 Burial Ground,* PNNL-15293, Vermeul, V.

R., Bergeron, M. P., Dresel, P., Freeman, E. J., Peterson, R. E., and Thorne, P. D., Pacific Northwest National Laboratory, 2005

14. *Industry Ground Water Protection Initiative – Final Guidance Document*, Nuclear Energy Institute, Pub. No. NEI 07-07, August 2007

15. SOP 11.11r05, Columbia Generating Station Groundwater Monitoring Program, December 2011

16. SWP-CHE-01, Groundwater Protection Program, July 2012

17. Code of Federal Regulations, Title 40 Part 136, "Guidelines Establishing Test Procedures or the Analysis of Pollutants"

18. Columbia Generating Station Offsite Dose Calculation Manual

TABLE 1. CURRENTLY MONITORED WELL LOCATIONS AND DEPTHS

Well Name	Location Coordinates	Original Depth (ft)*
MW1**	N46.46897, W119.33718	70.05
MW2**	N46.46807, W119.33723	68.10
MW3	N46.46735, W119.33598	62.20
MW4**	N46.46665, W119.33580	76.60
MW5	N46.46738, W119.34082	78.02
MW6	N46.46749, W119.33118	49.16
MW7**	N46.47387, W119.32893	30.35
MW8**	N46.47345, W119.32957	37.74
MW9	N46.47379, W119.33105	39.46
MW10	N46.47206, W119.33575	72.75
MW11	N46.47202, W119.33241	72.04
MW12	N46.47156, W119.33194	72.23
MW13	N46.46456, W119.33112	58.32
MW14	N46.46535, W119.32637	49.65

* depth from the top of the casing

** water level too low to collect at least one sample prior to 2nd quarter 2015

TABLE 2. INORGANIC MONITORING PARAMETERS

Inorganic Parameters	
Conductivity (field)	Chromium
pH (field)	Copper
Temperature (field)	Iron
Bromide	Lead
Chloride	Magnesium
Fluoride	Manganese
Nitrate (as N)	Mercury
Nitrite (as N)	Nickel
Sulfate	Phosphorus (as P), Total
Bicarbonate (alkalinity)	Potassium
Carbonate (alkalinity)	Selenium
Arsenic	Silver
Barium	Sodium
Cadmium	Zinc
Calcium	TDS

TABLE 3. SEMI-VOLATILE ORGANIC MONITORING COMPOUNDS

SVOCs	
1,2,4-Trichlorobenzene	Benzo[a]pyrene
1,2-Dichlorobenzene	Benzo[b]fluoranthene
1,2-Diphenyl hydrazine	Benzo[k]fluoranthene
1,3-Dichlorobenzene	Benzyl alcohol
1,4-Dichlorobenzene	bis(2-Chloroethoxy)methane
1-Methylnaphthalene	bis(2-Chloroethyl)ether
2,3,4,6-Tetrachlorophenol	bis(2-chloroisopropyl)ether
2,3,5,6-Tetrachlorophenol	bis(2-Ethylhexyl)phthalate
2,4,5-Trichlorophenol	Butylbenzylphthalate
2,4,6-Trichlorophenol	Carbazole
2,4-Dichlorophenol	Chrysene
2,4-Dimethylphenol	Di-n-butylphthalate
2,4-Dinitrophenol	Di-n-octylphthalate
2,4-Dinitrotoluene	Dibenz[a,h]anthracene
2,6-Dinitrotoluene	Dibenzofuran
2-Chloronaphthalene	Diesel *
2-Chlorophenol	Diethylphthalate
2-Methylnaphthalene	Dimethylphthalate
2-Methylphenol	Fluoranthene
2-Nitroaniline	Fluorene
2-Nitrophenol	Hexachlorobenzene
3+4-Methylphenol	Hexachlorobutadiene
3,3'-Dichlorobenzidine	Hexachlorocyclopentadiene
3-Nitroaniline	Hexachloroethane
4,6-Dinitro-2-methylphenol	Indeno[1,2,3-cd]pyrene
4-Bromophenyl-phenylether	Isophorone
4-Chloro-3-methylphenol	Lube oil *
4-Chloroaniline	n-Nitroso-di-n-propylamine
4-Chlorophenyl-phenylether	n-Nitrosodiphenylamine
4-Nitroaniline	Naphthalene
4-Nitrophenol	Nitrobenzene
Acenaphthene	Nitrosodimethylamine
Acenaphthylene	Pentachlorophenol
Aniline	Phenanthrene
Anthracene	Phenol
Benzidine	Pyrene
Benzo(ghi)perylene	Pyridine
Benzo[a]anthracene	

* MW-10, MW-11, and MW-12 only

TABLE 4. VOLATILE ORGANIC MONITORING PARAMETERS

VOCs	
1,1,1,2-Tetrachloroethane	Carbon tetrachloride
1,1,1-Trichloroethane	Chlorobenzene
1,1,2,2-Tetrachloroethane	Chloroethane
1,1,2-Trichloroethane	Chloroform
1,1-Dichloroethane	Chloromethane
1,1-Dichloroethene	cis-1,2-Dichloroethene
1,1-Dichloropropene	cis-1,3-Dichloropropene
1,2,3-Trichlorobenzene	Dibromochloromethane
1,2,3-Trichloropropane	Dibromomethane
1,2,4-Trichlorobenzene	Dichlorodifluoromethane
1,2,4-Trimethylbenzene	Ethylbenzene
1,2-Dibromo-3-chloropropane (DBCP)	Hexachlorobutadiene
1,2-Dibromoethane	Isopropylbenzene
1,2-Dichlorobenzene	m+p-Xylene
1,2-Dichloroethane	Methyl ethyl ketone (MEK)
1,2-Dichloropropane	Methyl isobutyl ketone (MIBK)
1,3,5-Trimethylbenzene	Methylene chloride
1,3-Dichlorobenzene	Methyl-t-butyl ether (MTBE)
1,3-Dichloropropane	Naphthalene
1,4-Dichlorobenzene	n-Butylbenzene
2,2-Dichloropropane	n-Propylbenzene
2-Chlorotoluene	o-Xylene
2-Hexanone	p-Isopropyltoluene
4-Chlorotoluene	sec-Butylbenzene
Acetone	Styrene
Acrylonitrile	tert-Butylbenzene
Benzene	Tetrachloroethene
Bromobenzene	Toluene
Bromochloromethane	trans-1,2-Dichloroethene
Bromodichloromethane	trans-1,3-Dichloropropene
Bromoform	Trichloroethene
Bromomethane	Trichloroflouromethane
Carbon disulfide	Vinyl chloride

TABLE 5. RADIOLOGICAL MONITORING PARAMETERS

Radiological Parameters*	
Gamma emitters	Tritium

* Collected in accordance with the CGS REMP

TABLE 6. WELL PURGING CRITERIA

Purge Parameters	Stabilization Criteria
pH	±0.1 standard unit
Temperature	±0.1 °C
Specific Conductance	±10 μmhos/cm for values <1,000 μmhos/cm
	±20 μmhos/cm for values >1,000 μmhos/cm
Dissolved Oxygen	±5% per casing volume removed
Or	
All parameters	<±10% change over 3 consecutive readings at 1 minute intervals

TABLE 7. SAMPLE CONTAINER TYPES, HANDLING, AND PRESERVATIVES

Analyte of Concern	Container Type	Special Handling	Preservative	Maximum Holding Time
VOC	3-40 mL glass vials	Fill with no headspace; store in dark, cooled (4°C) container	HCl (pH<2)	14 days
SVOC	1-L amber glass	Store in dark, cooled (4°C) container	None	7 days
NWTPHDX	1-L amber glass	Store in dark, cooled (4°C) container	HCl (pH~2)	14 days
Anions	1-L polyethylene	Store in cooled (4°C) container	None	28 days; 48 hours Nitrate/Nitrite
TDS	1-L polyethylene	Store in cooled (4°C) container	None	7 days
Tritium	250-mL polyethylene	Store in cooled (4°C) container	None	None
Gamma emitters	1-L cubitainer	Store in cooled (4°C) container	HCl (pH~2)	None
Metals	1-L polyethylene	Collect as low flow; store in cooled (4°C) container	HNO_3 (pH<2); HCl (pH<2); none/H_2SO_4 (pH<2)	6 months; 28 days Mercury; 48 hours/28 days Total Phosphorus

TABLE 8. INORGANIC MEASUREMENT QUALITY OBJECTIVES

Parameter	Check standard (LCS)	Duplicate samples	Matrix samples	Matrix spike duplicates	Surrogate standards	Regulatory level	
	% recovery limits	RPD	% recovery limits	RPD	% recovery limits	units of concentration	
Bromide	80-120	20	80-120	20	N/A	N/A	N/A
Chloride	80-120	20	80-120	20	N/A	250	mg/L
Fluoride	80-120	20	80-120	20	N/A	2	mg/L
Nitrate (as N)	80-120	20	80-120	20	N/A	10	mg/L
Nitrite (as N)	80-120	20	80-120	20	N/A	1	mg/L
Sulfate	80-120	20	80-120	20	N/A	250	mg/L
Bicarbonate (alkalinity)	*	15	N/A	N/A	N/A	N/A	N/A
Carbonate (alkalinity)	*	15	N/A	N/A	N/A	N/A	N/A
Arsenic	85-115	20	70-130	20	N/A	0.05	ug/L
Barium	85-115	20	70-130	20	N/A	1	mg/L
Cadmium	85-115	20	70-130	20	N/A	5	ug/L
Calcium	85-115	20	70-130	20	N/A	N/A	N/A
Chromium	85-115	20	70-130	20	N/A	50	ug/L
Copper	85-115	20	70-130	20	N/A	1	mg/L
Iron	85-115	20	70-130	20	N/A	0.3	mg/L
Lead	85-115	20	70-130	20	N/A	50	ug/L
Magnesium	85-115	20	70-130	20	N/A	N/A	N/A
Manganese	85-115	20	70-130	20	N/A	50	ug/L
Mercury	76-113	18	63-111	18	N/A	2	ug/L
Nickel	85-115	20	70-130	20	N/A	0.1	mg/L
Phosphorus (as P), Total	80-120	N/A	80-120	N/A	N/A	N/A	N/A
Potassium	85-115	20	70-130	20	N/A	N/A	N/A
Selenium	85-115	20	70-130	20	N/A	10	ug/L
Silver	85-115	20	70-130	20	N/A	50	ug/L
Sodium	85-115	20	70-130	20	N/A	20	mg/L
Zinc	85-115	20	70-130	20	N/A	5	mg/L
TDS	85-115	20	N/A	N/A	N/A	500	mg/L

RPD - relative percent difference
* must be within documented range for check standard

TABLE 9. ORGANIC MEASUREMENT QUALITY OBJECTIVES

Parameter	Check standard (LCS)	Duplicate samples	Matrix samples	Matrix spike duplicates	Surrogate standards	Regulatory level	
	% recovery limits	RPD	% recovery limits	RPD	% recovery limits	units of concentration	
SVOC	40-132	39	40-132	39	30-131	*	µg/L
VOC	70-130	50	70-130	50	70-130	*	µg/L

RPD - relative percent difference
* compound specific

TABLE 10. QC SAMPLES, TYPES, AND FREQUENCY

Analyte of Concern	Field Blank	Field Duplicate	Check Standards	Method Blanks	Analytical Duplicates	Matrix Spikes
pH	N/A	N/A	B	N/A	N/A	N/A
Conductivity	N/A	N/A	B	N/A	N/A	N/A
VOCs	A	A	C	C	C	C
SVOCs	A	A	D	C	N/A	N/A
NWTPHDX	N/A	N/A	D	C	N/A	N/A
Anions	A	A	E	E	E	E
TDS	A	A	E	E	N/A	N/A
Tritium	N/A	N/A	F	C	C	C
Gamma emitters	N/A	N/A	F	N/A	N/A	C
Metals	A	A	E	E	E	E

A - 1/sampling event
B - prior to & after event
C - 1/batch
D - 1/batch or every 20 samples
E - 1/batch or every 10 samples
F - daily
N/A - not applicable

TABLE 11. INORGANIC ANALYTICAL METHODS

Analyte of Concern	CAS #	Method	PQL	Units
Conductivity (field)		SM 2510B		µS/cm
pH (field)		SM 4500H		pH units
Temperature (field)				º C
Bromide		EPA 300.0	0.2	mg/L
Chloride	16887-00-6	EPA 300.0	0.1	mg/L
Fluoride	16984-48-8	EPA 300.0	0.04	mg/L
Nitrate (as N)	14797-55-8	EPA 300.0	0.05	mg/L
Nitrite (as N)	14797-65-0	EPA 300.0	0.05	mg/L
Sulfate	14808-79-8	EPA 300.0	0.3	mg/L
Bicarbonate (alkalinity)		SM 2320B	5	mg $CaCO_3$/L
Carbonate (alkalinity)		SM 2320B	5	mg $CaCO_3$/L
Arsenic	7440-38-2	EPA 200.8	0.0005	mg/L
Barium	444-39-3	EPA 200.8	0.002	mg/L
Cadmium	7440-43-9	EPA 200.8	0.0002	mg/L
Calcium	7440-70-2	EPA 200.8	0.2	mg/L
Chromium	7440-47-3	EPA 200.8	0.001	mg/L
Copper	7440-50-8	EPA 200.8	0.001	mg/L
Iron	7439-89-6	EPA 200.8	0.01	mg/L
Lead	7439-92-1	EPA 200.8	0.0002	mg/L
Magnesium	7439-95-4	EPA 200.8	0.2	mg/L
Manganese	7439-96-5	EPA 200.8	0.0002	mg/L
Mercury	7439-97-6	EPA 245.7	0.01	µg/L
Nickel	7440-02-0	EPA 200.8	0.0002	mg/L
Phosphorus (as P), Total		SM 4500-P B5 & E	0.1	mg/L
Potassium	7440-09-7	EPA 200.8	0.2	mg/L
Selenium	7782-49-2	EPA 200.8	0.001	mg/L
Silver	7440-22-4	EPA 200.8	0.0002	mg/L
Sodium	7440-23-5	EPA 200.8	0.2	mg/L
Zinc	7440-66-6	EPA 200.8	0.002	mg/L
TDS		SM 2540C	5	mg/L

TABLE 12. RADIOLOGICAL ANALYTICAL METHODS

Analyte of Concern	CAS #	Method	PQL	Units
Gamma emitters		SM 7120 B	*	pCi/L
Tritium	10028-17-8	SM 7500-3H B	300	pCi/L

* emitter specific; analyzed to meet requirements specified in Table 6.3.1-3 [18]

TABLE 13. SEMIVOLATILE ORGANIC ANALYTICAL METHODS

Parameter	CAS #	Method	PQL	Units
1,2,4-Trichlorobenzene	120-82-1	EPA 8270D	0.5	µg/L
1,2-Dichlorobenzene	95-50-1	EPA 8270D	0.5	µg/L
1,2-Diphenyl hydrazine	122-66-7	EPA 8270D	0.5	µg/L
1,3-Dichlorobenzene	541-73-1	EPA 8270D	0.5	µg/L
1,4-Dichlorobenzene	106-46-7	EPA 8270D	0.5	µg/L
1-Methylnaphthalene	90-12-0	EPA 8270D	0.5	µg/L
2,3,4,6-Tetrachlorophenol	58-90-2	EPA 8270D	0.5	µg/L
2,3,5,6-Tetrachlorophenol	935-95-5	EPA 8270D	0.5	µg/L
2,4,5-Trichlorophenol	95-95-4	EPA 8270D	0.5	µg/L
2,4,6-Trichlorophenol	88-06-2	EPA 8270D	0.5	µg/L
2,4-Dichlorophenol	120-83-2	EPA 8270D	0.5	µg/L
2,4-Dimethylphenol	105-67-9	EPA 8270D	0.5	µg/L
2,4-Dinitrophenol	51-28-5	EPA 8270D	0.5	µg/L
2,4-Dinitrotoluene	121-14-2	EPA 8270D	0.5	µg/L
2,6-Dinitrotoluene	606-20-2	EPA 8270D	0.5	µg/L
2-Chloronaphthalene	91-58-7	EPA 8270D	0.5	µg/L
2-Chlorophenol	95-57-8	EPA 8270D	0.5	µg/L
2-Methylnaphthalene	91-57-6	EPA 8270D	0.5	µg/L
2-Methylphenol	95-48-7	EPA 8270D	0.5	µg/L
2-Nitroaniline	88-74-4	EPA 8270D	0.5	µg/L
2-Nitrophenol	88-75-5	EPA 8270D	0.5	µg/L
3+4-Methylphenol	1319-77-3	EPA 8270D	0.5	µg/L
3,3'-Dichlorobenzidine	91-94-1	EPA 8270D	0.5	µg/L
3-Nitroaniline	99-09-2	EPA 8270D	0.5	µg/L
4,6-Dinitro-2-methylphenol	534-52-1	EPA 8270D	0.5	µg/L
4-Bromophenyl-phenylether	101-55-3	EPA 8270D	0.5	µg/L
4-Chloro-3-methylphenol	59-50-7	EPA 8270D	0.5	µg/L
4-Chloroaniline	106-47-8	EPA 8270D	0.5	µg/L
4-Chlorophenyl-phenylether	7005-72-3	EPA 8270D	0.5	µg/L
4-Nitroaniline	100-01-6	EPA 8270D	0.5	µg/L
4-Nitrophenol	100-02-7	EPA 8270D	0.5	µg/L
Acenaphthene	83-32-9	EPA 8270D	0.5	µg/L
Acenaphthylene	208-96-8	EPA 8270D	0.5	µg/L
Aniline	62-53-3	EPA 8270D	0.5	µg/L
Anthracene	120-12-7	EPA 8270D	0.5	µg/L
Benzidine	92-87-5	EPA 8270D	0.5	µg/L
Benzo(ghi)perylene	191-24-2	EPA 8270D	0.5	µg/L
Benzo[a]anthracene	56-55-3	EPA 8270D	0.5	µg/L
Benzo[a]pyrene	50-32-8	EPA 8270D	0.5	µg/L
Benzo[b]fluoranthene	205-99-2	EPA 8270D	0.5	µg/L

Parameter	CAS #	Method	PQL	Units
Benzo[k]fluoranthene	207-08-9	EPA 8270D	0.5	µg/L
Benzyl alcohol	100-51-6	EPA 8270D	0.5	µg/L
bis(2-Chloroethoxy)methane	111-91-1	EPA 8270D	0.5	µg/L
bis(2-Chloroethyl)ether	111-44-4	EPA 8270D	0.5	µg/L
bis(2-Chloroisopropyl)ether	108-60-1	EPA 8270D	0.5	µg/L
bis(2-Ethylhexyl)phthalate	117-81-7	EPA 8270D	0.5	µg/L
Butyl benzyl phthalate	85-68-7	EPA 8270D	0.5	µg/L
Carbazole	86-74-8	EPA 8270D	0.5	µg/L
Chrysene	218-01-9	EPA 8270D	0.5	µg/L
Di-n-butyl phthalate	84-74-2	EPA 8270D	0.5	µg/L
Di-n-octyl phthalate	117-84-0	EPA 8270D	0.5	µg/L
Dibenz[a,h]anthracene	53-70-3	EPA 8270D	0.5	µg/L
Dibenzofuran	132-64-9	EPA 8270D	0.5	µg/L
Diesel *		NWTPHDX	0.1	mg/L
Diethyl phthalate	84-66-2	EPA 8270D	0.5	µg/L
Dimethyl phthalate	131-11-3	EPA 8270D	0.5	µg/L
Fluoranthene	206-44-0	EPA 8270D	0.5	µg/L
Fluorene	86-73-7	EPA 8270D	0.5	µg/L
Hexachlorobenzene	118-74-1	EPA 8270D	0.5	µg/L
Hexachlorobutadiene	87-68-3	EPA 8270D	0.5	µg/L
Hexachlorocyclopentadiene	77-47-4	EPA 8270D	0.5	µg/L
Hexachloroethane	67-72-1	EPA 8270D	0.5	µg/L
Indeno[1,2,3-cd]pyrene	193-39-5	EPA 8270D	0.5	µg/L
Isophorone	78-59-1	EPA 8270D	0.5	µg/L
Lube oil *		NWTPHDX	0.5	mg/L
n-Nitrosodi-n-propylamine	621-64-7	EPA 8270D	0.5	µg/L
n-Nitrosodiphenylamine	86-30-6	EPA 8270D	0.5	µg/L
Naphthalene	91-20-3	EPA 8270D	0.5	µg/L
Nitrobenzene	98-95-3	EPA 8270D	0.5	µg/L
Nitrosodimethylamine	62-75-9	EPA 8270D	0.5	µg/L
Pentachlorophenol	87-86-5	EPA 8270D	0.5	µg/L
Phenanthrene	85-01-8	EPA 8270D	0.5	µg/L
Phenol	108-95-2	EPA 8270D	0.5	µg/L
Pyrene	129-00-0	EPA 8270D	0.5	µg/L
Pyridine	110-86-1	EPA 8270D	0.5	µg/L

* analyzed for MW-10, MW-11, & MW-12

TABLE 14. VOLATILE ORGANIC ANALYTICAL METHODS

Parameter	CAS #	Method	PQL	Units
1,1,1,2-Tetrachloroethane	630-20-6	EPA 8260C	0.5	µg/L
1,1,1-Trichloroethane	71-55-6	EPA 8260C	0.5	µg/L
1,1,2,2-Tetrachloroethane	79-34-5	EPA 8260C	0.5	µg/L
1,1,2-Trichloroethane	79-00-5	EPA 8260C	0.5	µg/L
1,1-Dichloroethane	75-34-3	EPA 8260C	0.5	µg/L
1,1-Dichloroethene	75-35-4	EPA 8260C	0.5	µg/L
1,1-Dichloropropene	563-58-6	EPA 8260C	0.5	µg/L
1,2,3-Trichlorobenzene	87-61-6	EPA 8260C	0.5	µg/L
1,2,3-Trichloropropane	96-18-4	EPA 8260C	0.5	µg/L
1,2,4-Trichlorobenzene	120-82-1	EPA 8260C	0.5	µg/L
1,2,4-Trimethylbenzene	95-63-6	EPA 8260C	0.5	µg/L
1,2-Dibromo-3-chloropropane (DBCP)	96-12-8	EPA 8260C	0.5	µg/L
1,2-Dibromoethane	106-93-4	EPA 8260C	0.5	µg/L
1,2-Dichlorobenzene	95-50-1	EPA 8260C	0.5	µg/L
1,2-Dichloroethane	107-06-2	EPA 8260C	0.5	µg/L
1,2-Dichloropropane	78-87-5	EPA 8260C	0.5	µg/L
1,3,5-Trimethylbenzene	108-67-8	EPA 8260C	0.5	µg/L
1,3-Dichlorobenzene	541-73-1	EPA 8260C	0.5	µg/L
1,3-Dichloropropane	142-28-9	EPA 8260C	0.5	µg/L
1,4-Dichlorobenzene	106-46-7	EPA 8260C	0.5	µg/L
2,2-Dichloropropane	594-20-7	EPA 8260C	0.5	µg/L
2-Chlorotoluene	95-49-8	EPA 8260C	0.5	µg/L
2-Hexanone	591-78-6	EPA 8260C	20	µg/L
4-Chlorotoluene	106-43-4	EPA 8260C	0.5	µg/L
Acetone	67-64-1	EPA 8260C	20	µg/L
Acrylonitrile	107-13-1	EPA 8260C	0.5	µg/L
Benzene	71-43-2	EPA 8260C	0.5	µg/L
Bromobenzene	108-86-1	EPA 8260C	0.5	µg/L
Bromochloromethane	74-97-5	EPA 8260C	0.5	µg/L
Bromodichloromethane	75-27-4	EPA 8260C	0.5	µg/L
Bromoform	75-25-2	EPA 8260C	0.5	µg/L
Bromomethane	74-83-9	EPA 8260C	0.5	µg/L
Carbon disulfide	75-15-0	EPA 8260C	0.5	µg/L
Carbon tetrachloride	56-23-5	EPA 8260C	0.5	µg/L
Chlorobenzene	108-90-7	EPA 8260C	0.5	µg/L
Chloroethane	75-00-3	EPA 8260C	0.5	µg/L
Chloroform	67-66-3	EPA 8260C	0.5	µg/L
Chloromethane	74-87-3	EPA 8260C	0.5	µg/L
cis-1,2-Dichloroethene	156-59-2	EPA 8260C	0.5	µg/L
cis-1,3-Dichloropropene	10061-01-5	EPA 8260C	0.5	µg/L

Parameter	CAS #	Method	PQL	Units
Dibromochloromethane	124-48-1	EPA 8260C	0.5	µg/L
Dibromomethane	74-95-3	EPA 8260C	0.5	µg/L
Dichlorodifluoromethane	75-71-8	EPA 8260C	0.5	µg/L
Ethylbenzene	100-41-4	EPA 8260C	0.5	µg/L
Hexachlorobutadiene	87-68-3	EPA 8260C	0.5	µg/L
Isopropylbenzene	98-82-8	EPA 8260C	0.5	µg/L
m+p-Xylene	1330-20-7	EPA 8260C	0.5	µg/L
Methyl ethyl ketone (MEK)	78-93-3	EPA 8260C	20	µg/L
Methyl isobutyl ketone (MIBK)	108-10-1	EPA 8260C	20	µg/L
Methylene chloride	75-09-2	EPA 8260C	0.5	µg/L
methyl-t-butyl ether (MTBE)	1634-04-4	EPA 8260C	0.5	µg/L
Naphthalene	91-20-3	EPA 8260C	0.5	µg/L
n-Butylbenzene	104-51-8	EPA 8260C	0.5	µg/L
n-Propylbenzene	103-65-1	EPA 8260C	0.5	µg/L
o-Xylene	95-47-6	EPA 8260C	0.5	µg/L
p-Isopropyltoluene	99-87-6	EPA 8260C	0.5	µg/L
sec-Butylbenzene	135-98-8	EPA 8260C	0.5	µg/L
Styrene	100-42-5	EPA 8260C	0.5	µg/L
tert-Butylbenzene	98-06-6	EPA 8260C	0.5	µg/L
Tetrachloroethene	127-18-4	EPA 8260C	0.5	µg/L
Toluene	108-88-3	EPA 8260C	0.5	µg/L
trans-1,2-Dichloroethene	156-60-5	EPA 8260C	0.5	µg/L
trans-1,3-Dichloropropene	10061-02-6	EPA 8260C	0.5	µg/L
Trichloroethene	79-01-6	EPA 8260C	0.5	µg/L
Trichloroflouromethane	75-69-4	EPA 8260C	0.5	µg/L
Vinyl chloride	75-01-4	EPA 8260C	0.5	µg/L