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Revision 0

Sampling and Analysis Plan for FY 2006 200-BP-5 Groundwater Operable Unit Remedial Investigation/Feasibility Study

Prepared for the U.S. Department of Energy
Assistant Secretary for Environmental Management

U.S. DEPARTMENT OF ENERGY
Richland Operations Office

P.O. Box 550
Richland, Washington 99352

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CONCURRENCE PAGE

Title: Sampling and Analysis Plan for FY 2006 200-BP-5 Groundwater Operable Unit Remedial Investigation/Feasibility Study

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TERMS

ALARA	as-low-as-reasonably-achievable
bgs	below ground surface
CERCLA	*Comprehensive Environmental Response, Compensation, and Liability Act of 1980*
CFR	*Code of Federal Regulations*
COC	contaminant of concern
COPC	contaminant of potential concern
DFSNW	Duratek Federal Services Northwest
DOE	U. S. Department of Energy
DQA	data quality assessment
DQO	data quality objective
DR	decision rule
DS	decision statement
EPA	U.S. Environmental Protection Agency
FH	Fluor Hanford, Inc.
HEIS	Hanford Environmental Information System
Kd	distribution coefficient
MCL	maximum contaminant level
NMLS	neutron moisture logging system
OU	operable unit
PNNL	Pacific Northwest National Laboratory
QA	quality assurance
QAPjP	quality assurance project plan
QC	quality control
RI/FS	Remedial Investigation/Feasibility Study
RL	DOE Richland Operations Office
SAP	sampling and analysis plan
SGLS	spectral gamma logging system
Tri-Party	*Hanford Federal Facility Agreement and Consent Order Agreement*
WAC	*Washington Administrative Code*
WMA	Waste Management Area
WSCF	Waste Sampling and Characterization Facility

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1.0 INTRODUCTION

This sampling and analysis plan (SAP) supports the drilling of three new groundwater monitoring wells for the 200-BP-5 Operable Unit (OU). The locations of the new wells are shown in Figure 1-1. This SAP is part of the characterization work to support the 200-BP-5 Remedial Investigation/Feasibility Study (RI/FS). The *Data Quality Objectives Summary Report in Support of the 200-BP-5 Groundwater Operable Unit Remedial Investigation/Feasibility Study Process* (WMP-28945 Draft A), hereafter referred to as the DQO Summary Report, is currently undergoing regulatory comment resolution. When finalized, the DQO Summary Report will document the basis for characterization activities supporting the 200-BP-5 RI/FS.

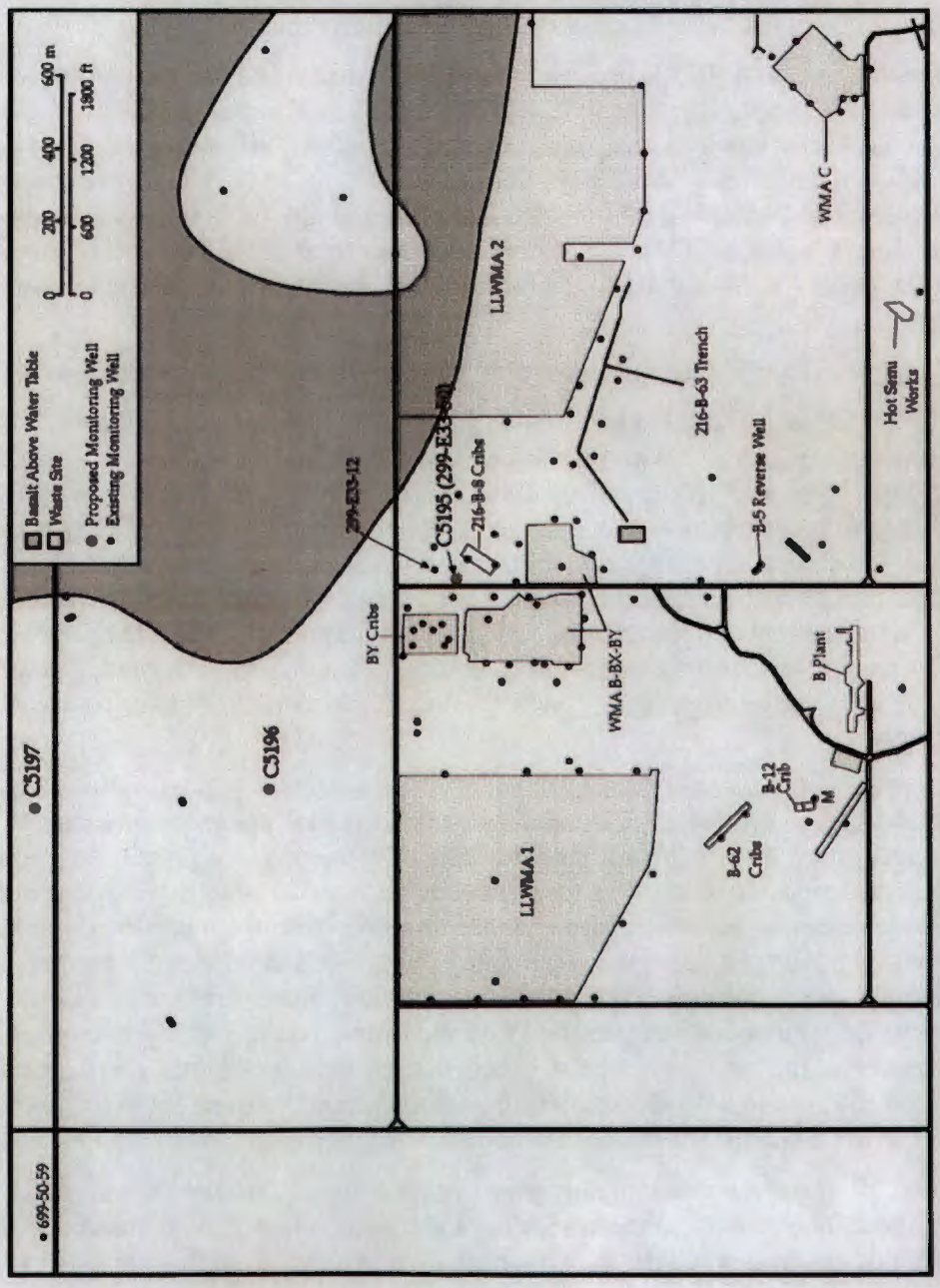
The data quality objective (DQO) process identified the drilling of fourteen groundwater monitoring wells to support the 200-BP-5 RI/FS effort. For planning purposes, each of the proposed wells was assigned an identification using the letters "A" through "M". The three wells associated with this SAP were identified as "F", "I", and "J". The formal assigned well names are 299-E33-50 (C5195), 699-48-50B (C5196), and 699-50-56 (C5197), respectively. The well ID beginning with "C" is the primary identifier used in the Hanford Environmental Information System (HEIS) database. The well ID will be the primary reference for the wells in this document.

The DQO process identified the following rationale for the drilling of the three wells:

- Well C5195 is proposed to be installed south of the present location of well 299-E33-12 and will serve as a monitoring well for the confined aquifer within the Rattlesnake Ridge interbed. This well will establish if contamination measured in well 299-E33-12 is from an upgradient source or is traveling vertically downward through a faulty annular seal. In 1956, the earliest recorded groundwater analytical records for well 299-E33-12 reported significant gross beta concentrations. Later, cobalt-60 concentrations were reported in this well. Although this well was sealed in the early 1980s to halt the downward migration of contaminated unconfined aquifer groundwater to the underlying Rattlesnake Ridge confined aquifer, rising concentrations of technetium-99 have recently been observed.
- Well C5196 is proposed to be installed north of well 299-E33-26 and south of well 699-49-55A to resolve source unit origin of observed uranium groundwater contamination, to provide northern definition for the uranium plume, and to provide an additional measure of the basalt surface. Other possible benefits from this purposed well include resolving possible differing uranium isotopic ratios in the deep vadose zone (past saturated zone), providing moisture content in various unsaturated zone sediment horizons, determining the concentrations of other radionuclide and chemical contaminants in the unsaturated and saturated zone, and providing additional characterization data to refine risk assessment modeling of future contaminant migration. This well can also help identify whether contaminants' movement to the north has ceased or whether contaminant plumes are currently migrating from the north towards the south.
- Well C5197 is proposed to be installed between wells 699-49-55A and 699-52-57 to resolve technetium-99 concentrations in the plume in this area so that concentration isopleths can be better defined. Other possible benefits from this purposed well include

providing additional control for the basalt surface, resolving possible differing uranium isotopic ratios in the deep vadose zone (past saturated zone), determining the concentrations of other radionuclide and chemical contaminants, and providing additional numerical results to refine statistical measurements for modeling risk of contaminant migration in the future. This well may also help identify the location of an erosional channel in the basalt that may be a conduit for potential groundwater flow to the north.

Figure 1-1. Locations of Proposed Wells Associated with 200-BP-5 Operable Unit.



This SAP contains five sections:

- Section 1.0 – Summarizes the recent data quality objectives (DQO) process output and the data needs.
- Section 2.0 – Provides the quality assurance project plan.
- Section 3.0 – Provides the field sampling plan.
- Section 4.0 – Provides the health and safety plan.
- Section 5.0 – Provides a list of the references cited.

1.1 DATA QUALITY OBJECTIVES

The U.S. Environmental Protection Agency's (EPA) *Guidance for the Data Quality Objectives Process* (EPA 2000) was used to support the development of this SAP. The DQO process is a strategic planning approach for defining the criteria that a data collection design should satisfy. The DQO process is used to ensure that the type, quantity, and quality of environmental data used in decision making will be appropriate for the intended application.

This section presents only a summary of the key outputs resulting from the DQO process. Additional details of the DQO process will be documented in the final DQO Summary Report.

1.1.1 Identification of Contaminants of Concern

A list of contaminants of concern (COC) for the 200-BP-5 OU was generated by initially listing all of the COCs identified in the liquid effluent waste site OUs overlying the 200-BP-5 OU. Additional COCs were added from the *200 East Groundwater Aggregate Area Management Study Report* (AAMSR) (DOE/RL-92-19). These reports produced the collective list of contaminants of potential concern (COPC) for the 200-BP-5 OU. Because part of the scope of the 200-BP-5 OU is to investigate the extent of contamination in the lower vadose zone, the DQO evaluated COPCs for the deep vadose zone and groundwater. The following sections describe the development, exclusion, and retention of COC for the groundwater. The vadose zone COCs are not included in this SAP for wells C5196 and C5197 because characterization associated with these wells is limited to far field sediments impacted by historical groundwater. For well C5195, unsaturated sediment samples will be collected above the historical high water mark, however, the samples will only be analyzed for groundwater COCs and associated physical and geochemical properties. The rationale for limiting the analyte list to groundwater COCs for well C5195 is based on location and process knowledge of source units in the area (e.g., 216-B-8 and BY Cribs).

1.1.2 Total List of Contaminants of Potential Concern for the Vadose Zone and Groundwater

Table 1-1 identifies all of the COPCs for groundwater in the 200-BP-5 OU based on the COCs identified in the liquid effluent waste site OU overlying the 200-BP-5 OU and groundwater monitoring information. References used to identify these COPCs include the following:

- DOE/RL-92-19, Rev. 0, *200 East Groundwater Aggregate Area Management Study Report*

- DOE/RL-92-70, Rev. 0, *Phase I Remedial Investigation Report for 200-BP-1 Operable Unit*
- DOE/RL-99-44, Rev. 0, *200-CS-1 Operable Unit RI/FS Work Plan and RCRS TSD Unit Sampling Plan*
- DOE/RL-99-07, Rev. 0, *200-CW-1 Operable Unit RI/FS Work Plan and 216-B-3 RCRA TSD Unit Sampling Plan*
- DOE/RL-2000-38, Rev. 0, *200-TW-1 Scavenged Waste Group Operable Unit and 200-TW-2 Tank Waste Group Operable Unit RI/FS*
- DOE/RL-2000-60, Rev. 0, *200-PW-2 Uranium Rich Process Waste Group Operable Unit RI/FS Work Plan and Process Waste RCRA TSD Unit Sampling Plan*
- DOE/RL-2001-65, Rev. 0, *200-MW-1 Miscellaneous Waste Group Operable Unit RI/FS Work Plan*
- DOE/RL-2001-66, Rev. 0, *Chemical Laboratory Waste Group Operable Unit RI/FS Work Plan.*

Table 1-1. Contaminants of Potential Concern. (2 sheets)

Radioactive COPCs			
Ac-225	Cl-36	Pu-240	Sm-151
Ac-227	Co-60	Pu-241	Se-79
Am-241	Cm-244	Po-210	Sr-90
Am-242	Cm-245	Po-214	Tc-99
Am-242m	Eu-152	Po-215	Tl-207
Am-243	Eu-154	Po-218	Th-227
Sb-125	Eu-155	K-40	Th-229
Sb-126	Fr-221	Pm-147	Th-230
Sb-126m	Fr-223	Pa-231	Th-231
Ba-137m	I-129	Pa-234	Th-232
Be-7	Pb-209	Pa-234m	Th-234
Bi-210	Pb-210	Ra-223	Tritium (H-3)
Bi-211	Pb-211	Ra-224	U-233
Bi-212	Pb-212	Ra-225	U-234
Bi-213	Pb-214	Ra-226	U-235
Bi-214	Nb-93m	Ra-228	U-236
C-14	Np-237	Rn-220	U-238
Ce-144	Np-239	Rh-106	Y-90
Cs-134	Ni-63	Ru-106	Zn-65
Cs-135	Pu-238		Zr-93
Cs-137	Pu-239		Zr-95
Metal COPCs			
Aluminum	Calcium	Lead	Selenium
Antimony	Chromium (total)	Lithium	Silver
Arsenic	Chromium (VI)	Magnesium	Strontium
Barium	Cobalt	Manganese	Thallium
Beryllium	Copper	Mercury	Titanium
Bismuth	Ferrocyanide	Nickel	Uranium (total)
Boron	Iron	Phosphorous	Vanadium
Cadmium	Lanthanum	Potassium	Zinc

Table 1-1. Contaminants of Potential Concern. (2 sheets)

Non-Metal COPCs			
Ammonia/ammonium Ammonium carbonate Bromide Chloride	Cyanide Ferrocyanide Fluoride Hydrofluoric acid	Nitrate Nitric acid Nitrite Phosphate	Silicon Sodium dichromate Sulfate Sulfide
Volatile Organic Analyte COPCs			
Acetone Benzene 1-butanol (butyl alcohol) 2-butanone (MEK) Butylated hydroxyl toluene Carbon tetrachloride	Chlorobenzene Chloroform cis-1,2-dichloroethene Cyclohexanone Decane Dichloromethane (methylene chloride) 1,1-dichloroethane 1,2-dichloroethane	Diethyl ether Ethanol Ethylbenzene Ethylene glycol Halogenated hydrocarbons 4-methyl-2-pentanone (MIBK) n-butyl benzene	Styrene Toluene Trans-1,2-dichloroethene 1,1,1-trichloroethane 1,1,2-trichloroethane Trichloroethene Trichloromonofluoromethane Tetrachloroethene Xylene
Semi-Volatile Organic Analyte COPCs			
Aldrin Aroclor 1260 Benzo(a)anthracene Benzo(a)pyrene Benzo(b)fluoranthene Gamma-BHC Bis(2-ethylhexyl)phthalate Butyl phosphate Chrysene	4-chloro-3-methylphenol 2-chlorophenol DDD DDT Dibenz(a,h)anthracene Dibutylphosphate 2-4-dichlorophenol Dieldrin Dimethoate 2,4- dimethylphenol	2,4-dinitrophenol 2,4-dinitrotoluene Endrin Edrine aldehyde Ethyl cyanide heptachlor Hydrazine indeno(1,2,3-cd)pyrene 4-methylphenol 3-methylphenol Napthalene	2-nitrophenol Pentachlorophenol Phenol Phorate Pyrene 2,3,4,6-tetrachlorophenol Total petroleum hydrocarbons Tributyl phosphate

Notes:
COPC = contaminant of potential concern

1.1.3 Contaminants of Potential Concern Exclusions for Groundwater

Table 1-2 lists all the saturated zone COPCs to be excluded from the investigations and the rationale for exclusion. This exclusion process was a tiered approach pertaining to the 200-BP-5 OU. This approach is discussed in detail in Appendix A. The approach included all contaminants identified from various waste sites and underground tanks overlying the 200-BP-5 OU. Additional consideration was given to waste site source RI characterization results, modeling completed for waste site sources using RI characterization results, and derived distribution coefficient values. Although many of these contaminants were not determined (e.g. through draft remedial investigation (RI) and feasibility study (FS) reports) to impact groundwater now or in the future, none of the contaminants were excluded without review of available groundwater data as shown in Appendix A. Based on review of this data, comparisons between analytical results and compliance standards, determinations were made for COPC exclusions. The results of this approach are also summarized in Table 1-2. A further expansion of the compiled date is provided in tables generated for each category of constituents also in Appendix A.

Table 1-2. Contaminants of Potential Concern Exclusions and Justifications for Groundwater. (4 sheets)

COPCs	Rationale for Exclusion
Radionuclides	
Ac-225, Bi-213, Fr-221, Pb-209, Ra-225 and Th-229	Association with Am-241 and U-233. These constituents are decay products of Cf-249 decay series. Based on secular equilibrium all constituents below U-233 in the decay series would not have significant in growth for thousands of years. Also based on ORIGIN2 calculations none of the constituents made the top 60 actinide product inventories from the reactor generated uranium fuel. Thus these constituents would be more than 10 orders of magnitude less than Am-241. Associated concentrations are significantly below action levels. See Appendix A for further comparison information for each constituent.
Am-242 & Am-242m	By association with Pu-238. Am-242 and Am-242m are associated with the Am-242m decay series. The decay series starts with Am-242m decaying by alpha emission to Np-238 which loses a beta particle being reduced to Pu-238. According to ORIGIN2 the values Am-242 and Am-242m have 2.5 orders of magnitude less inventory than Pu-238 ten and fifty years after discharge. Am-242 and Am-242m have four orders less inventory 50 years after discharge. See Appendix A for further comparison information for each constituent.
Am-243	By length of decay rate for Cm-247 (16 million years) and Bk-247 (1400 years). Am-243 is associated with the Cf-251 and Bk-247 decay series. Based on the decay rate of Cm-247 and Bk-247 there would not be significant decay in growth for hundreds of years. In addition, in inventory comparisons based on ORIGIN2 Am-243 has nearly four orders of magnitude less inventory than Am-241 ten years after discharge. Am-243 has four orders less inventory 50 years after discharge. See Appendix A for further comparison information for each constituent.
Eu-152	No detected values reported. See Appendix A for further comparison information for each constituent.
Eu-154	All detected values reported were before 1992. Since 1992 all 431 results have been non-detect.
Eu-155	All detected values reported were before 1992. Since 1992 all 405 results have been non-detect.
Ac-227, Bi-211, Fr-223, Pb-211, Po-215, Ra-223, Tl-207 and Th-227.	Association with Pu-239 and U-235. These constituents are decay product of the natural U-235 decay series as well as the Cf-251, Bk-247, and Cm-243 decay series. Based on secular equilibrium all constituents below Pa-231 in the decay series would not have significant in growth for thousands of years. According to ORIGIN2 calculations these constituents would range between 3.5 to 5 order of magnitude less inventory than U-235. Associated concentrations are significantly below action levels. See Appendix A for further comparison information for each constituent.

Table 1-2. Contaminants of Potential Concern Exclusions and Justifications for Groundwater. (4 sheets)

COPCs	Rationale for Exclusion
Bi-210, Bi-214, Pb-210, Pb-214, Po-210, Po-214, Po-218, Ra-226, and Th-230.	By association with U-238. These constituents are decay products of natural U-238 decay series and Cm-250, Bk-250 and Cf-250 decay series. Based on secular equilibrium all constituents below U-234 in the decay series would not have significant in growth for approximately 1 million years. According to ORIGIN2 calculations these constituents have approximately 5 orders of magnitude less inventory than U-238. Associated concentrations are significantly below action levels. See Appendix A for further comparison information for each constituent.
Bi-212, Pb-212, Ra-224, Ra-228 and Rn-222.	By association with U-236 and Th-232. These constituents are decay products of natural Th-232 decay series and the Cm-244 and Cm-248 decay series. Based on secular equilibrium all constituents below Th-232 in the decay series would not have significant in growth for at least a million years. According to ORIGIN2 calculations these constituents have approximately 2 orders of magnitude less inventory than U-238. Associated concentrations are significantly below action levels. See Appendix A for further comparison information for each constituent.
Cm-244	No detected values reported. Cm-244 is the initial radionuclide in the Cm-244 decay series. Main parent for Pu-240. Cm-244 has an 18 year half life. Not considered to have significant inventory based on ORIGIN2 calculations and relationship with Pu-240. Inventory concentrations are 1.5 orders of magnitude (20X) less at 10 years and 2.5 orders of magnitude less at 50 years. See Appendix A for further comparison information for each constituent.
Cm-245	Cm-245 is a decay product of Cf-249 in the Cf-249 decay series. Not considered to have significant inventory based on ORIGIN2 calculations and relationship with Am-241. Inventory concentrations are 5.5 orders of magnitude less at 10 years and 6 orders of magnitude less at 50 years. See Appendix A for further comparison information for each constituent.
Ru-106	Since 1995 269 of the 270 results have been non-detect. The only detectable value reported was 17.1 pCi/L, which is below derived 4 mrem regulatory dose standard. Based on this information concentrations appear to have decayed to insignificant values. Not a daughter product of the uranium decay chain. See Appendix A for further comparison information.
Rh-106	By association with Ru-106 (e.g. Half life < 3 years). Not a daughter product of uranium decay chain. Associated concentrations are significantly below action levels. See Appendix A for further comparison information for each constituent.

Table 1-2. Contaminants of Potential Concern Exclusions and Justifications for Groundwater. (4 sheets)

COPCs	Rationale for Exclusion
Pa-231	By association with U-235. Pa-231 is associated with the U-235 natural decay series as well as the Cf-251, Bk-247, and Cm-243 decay series. According to ORIGIN2 derived inventory values Pa-231 is 3 orders of magnitude less than U-235 50 years after being removed from the reactor. Pa-231 is 5 orders of magnitude less than Am-241. Associated concentrations are significantly below action levels. See Appendix A for further comparison information for each constituent.
Pa-234	By association with U-238 and Pa-234m. Pa-234 is associated with the U-238 natural decay series and Cm-250, Bk-250 and Cf-250 decay series. Based on decay rates Pa-234 is generated by less than 1% of the Pa-234m decay. According to ORIGIN2 derived inventory, Pa-234 values are approximately 3 orders of magnitude less than U-238 50 years after removal from the reactor. Associated concentrations are significantly below action levels. See Appendix A for further comparison information for each constituent.
Be-7, Ce-144, Cs-134, Cs-135, Cl-36, Ni-63, Nb-93m, Pm-147, Sm-151, Se-79, and Zr-93.	All of these constituents have no current analytical method or were not analyzed and where therefore evaluated by association with Cs-137 through the ORIGIN2 inventory calculations. These constituents were also evaluated based on Cs-137 reported concentrations for 57 selected wells within the 200-BP-5 OU. Based on ORIGIN2 values derived for Cs-137 and Cs-137 groundwater sample results these constituents ranged from 2 to more than 13 orders of magnitude less than any value reported for Cs-137. Associated concentrations are significantly below action levels. See Appendix A for further comparison information for each constituent.
Sb-125	No detected values reported above derived regulatory limits. All concentrations were significantly less than standards. According to ORIGIN2 values Sb-125 inventory drops 5 orders of magnitude from 10 years to 50 years after production. This constituent is representative of Sb-126 and Sb-126m due to higher initial inventory (5 orders of magnitude > inventory than Sb-126 and Sb-126m after 10 years removal from reactor). It also has the same mobility and that it is within an order of magnitude 50 years after removal from reactor.
Sb-126 and Sb-126m	By association with Sb-125 (see above).
K-40	Naturally occurring isotope of potassium and generally consistent or below background concentrations. See Appendix A for further comparison information for each constituent.
Zn-65	No detected values reported above derived regulatory standards. See Appendix A for further comparison information for each constituent.
Zr-95	All values reported as non-detect. See Appendix A for further comparison information for each constituent.
Metals	

Table 1-2. Contaminants of Potential Concern Exclusions and Justifications for Groundwater. (4 sheets)

COPCs	Rationale for Exclusion
Barium, beryllium, boron, cobalt, copper, lithium, nickel, potassium, silver, strontium, titanium, vanadium, and zinc.	No detected values reports above regulatory limits. See Appendix A for further comparison information for each constituent.
Lead, manganese, mercury and selenium.	No detected values reported above regulatory limits in the past 10 years. Most of the reported values were flagged. See Appendix A for further comparison information for each constituent.
Bismuth	No regulatory requirements. No groundwater data. Mostly insoluble with a high sorption capacity. Only very slightly soluble as a mono sulfide and citrate. Bismuth subnitrate, subcarbonate and subsalicylate are used in medicine. Recommended Dietary Allowance / Intake (RDA / RDI) 2mcg - 30mcg. Therapeutic Range 50mcg - 525mg+.
Calcium	No regulatory requirements. Supplement of 500 mg/day and more, depending on age, are recommended for today's diet. Several wells with concentrations over 2 time's background. Elevated concentrations reported mainly in wells 299-E33-3, E33-7, E33-9 and E34-7, beneath the By cribs and the 216-E-12 burial ground. Also reported values are trending up at C Farm, 299-E27-14. Calcium is required for the body.
Lanthanum	No regulatory requirements. No groundwater data. Lanthanum has various soluble compounds in cold water. Most likely compounds for associated Hanford waste would be Lanthanum chloride, chloride heptahydrate and nitrate. Lanthanum chloride is used for treatment of phosphate in swimming pool. Lanthanum is not absorbed orally. Lanthanum is also taken orally for digestive problems.
Magnesium	No regulatory requirements. Magnesium is required for the body and supplements of 350 mg/day for various reasons are often recommended for today's diets. Significantly exceeds background at 299-E34-7. Exceeds background at BY cribs and BY Tank Farm.
Phosphorous	Evaluated through phosphate a degradation product of phosphorous.
Ferrocyanide	Included with cyanide.
Non-Metals	
Sulfide	All values reported as non-detect. Not stable in site groundwater. See Appendix A for further comparison information for each constituent.
Bromide, fluoride, phosphate and silicon	Consistent with background groundwater levels. See Appendix A for further comparison information for each constituent.
Ammonium carbonate	Included with ammonium
Hydrofluoric acid	Included with fluoride.
Sodium dichromate	Included with hexavalent chromium.

Table 1-2. Contaminants of Potential Concern Exclusions and Justifications for Groundwater. (4 sheets)

COPCs	Rationale for Exclusion
VOAs	
Acetone, 2-butanone, carbon tetrachloride, chloroform, diethyl ether, ethylbenzene, and toluene.	No detected values reported above regulatory limits. See Appendix A for further comparison information for each constituent.
Benzene, 1-butanol, chlorobenzene, cis-1,2-dichloroethylene, decane, 1,1-dichloroethane, 1,2-dichloroethane, ethanol, styrene, tetrachloroethene, TPH-kerosene, trans-1,2-dichloroethylene, 1,1,2-trichloroethane, trichloromonofluoromethane and xylene.	All values reported as non-detect. See Appendix A for further comparison information for each constituent.
n-butyl benzene	No regulatory requirements. By association with benzene and chlorobenzene.
Butylated hydroxyl toluene	No regulatory requirements. By association with toluene and TPH-kerosene.
Cyclohexanone	By association with acetone, 2-butanone, 4-methyl 2 pentanol, and TPH-kerosene.
Halogenated hydrocarbons	By association with trichloroethene and tetrachloroethne.
SVOAs	
Aldrin, aroclor-1260, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, chrysene, 4,4'-DDD, 4,4'DDT, dibenz[a,h]anthracene, 2,4-dichlorophenol, dieldrin, dimethoate, 2,4-dimethylphenol, 2,4-dinitrotoluene, endrin, ethyl cyanide, ethylene glycol, heptachlor, hydrazine, indeno(1,2,3-cd)pyrene, lindane, 3-methylphenol, 4-methylphenol, naphthalene, 2-nitrophenol, phorate, pyrene, 2,3,4,6-tetrachlorophenol, and tributyl phosphate.	All values reported as non-detect. See Appendix A for further comparison information for each constituent.
3-chloro 4-methylphenol, 2-chlorophenol, 2,4-dinitrophenol, endrin aldehyde, and phenol	No detected values reported above regulatory limits. See Appendix A for further comparison information for each constituent.
Bulylated phosphate and dibutyl phosphate.	No regulatory requirements. By association with tributyl phosphate and TPH-kerosene.

Notes:

Complete reference information provided in Section 5.0 of this document.
COPC = contaminant of potential concern
K_d = distribution coefficient
SVOA = semi-volatile organic analyte
VOA = volatile organic analyte
WAC = Washington Administration Code

1.1.4 Contaminants of Potential Concern to be Determined by Calculation for Groundwater

Table 1-3 lists all of the groundwater contaminants that are to be determined by calculation and the rationale for the calculation.

Table 1-3. Contaminants of Potential Concern to be Determined by Calculation for Groundwater.

COPCs	Rationale for Determination by Calculation
Radionuclides	
Ba-137m	Calculation based on Cs-137 concentration (See Appendix A).
Pu-241	Calculation based on Am-241 concentrations (See Appendix A).
Pa-234m	Calculation based on U-238 concentrations (See Appendix A).
Th-231	Calculation based on U-235 concentrations (See Appendix A).
Y-90	Calculation based on Sr-90 concentrations (See Appendix A).
U-236	Calculation based on Th-232 concentrations (See Appendix A).
Notes: COPC = contaminant of potential concern	

1.1.5 Final List of Contaminant of Potential Concern for Groundwater

Table 1-4 presents the final list of COPC that will be carried through the remainder of the DQO process for groundwater and saturated sediment *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA) investigations at the 200-BP-5 OU. Additional parameters that should be monitored as indicators of contamination include pH (maximum contaminant level [MCL] = >8.5 or <4), gross alpha (MCL = 15 pCi/L), and gross beta (MCL = 50 pCi/L).

The primary areas of interest are marked by a superscript for the COPC identified below and noted below the table. These areas are where wells were reported with elevated concentrations for the identified COPC.

Table 1-4. Contaminants of Potential Concern for Groundwater. (2 sheets)

Radionuclide COPCs			
Am-241[a] C-14 Co-60	Np-237 Pu-238 Th-232[a]	Th-234[a] U-233 U-234	U-235 U-238
Metal COPCs			
Aluminum Antimony[c] Arsenic[d]	Cadmium[b] Chromium[b]	Chromium (hexavalent)[b] Iron[b c]	Sodium[b] Thallium
Non-Metal COPCs			
Ammonium[e]	Chloride[b]	Nitrite[b]	
Volatile Organic Analyte COPCs			
Chloroform	Methylene chloride	4-methyl 2-pentanone	1,1,1-trichloroethane[a c] Trichloroethene[a&c]

Table 1-4. Contaminants of Potential Concern for Groundwater. (2 sheets)

Semi-Volatile Organic Analyte COPCs			
Bis(2-ethylhexyl)phthalate	Pentachlorophenol		

Notes:
[a] 216-B-5 reverse well only.
[b] B/BX/BY WMA
[c] 218-E-10 and 218-E-12 burial grounds
[d] 216-B-63 trench
[e] 216-B-62 crib and 218-E-10 burial ground
COPC = contaminant of potential concern

1.1.6 Final List of Contaminants of Concern for Groundwater

Table 1-5 presents the final list of COCs that will be carried through the remainder of the DQO process for groundwater and saturated sediment *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA) investigations at the 200-BP-5 OU.

The primary areas of interest are marked by a superscript for the COC identified below and noted below the table. These areas are where wells were reported with elevated concentrations for the identified COC. Those COC not marked (e.g. I-129 and nitrate) have plumes distributed throughout the 200-BP-5 OU.

Table 1-5. Contaminants of Concern for Groundwater.

Radionuclide COCs			
Cs-137 [a] I-129	Pu-239[a] Pu-240[a]	Sr-90 [a] Tc-99 [bf]	H-3 (tritium) [bc]
Metal COCs			
Uranium (total) [b]			
Non-Metal COCs			
Cyanide [bf]		Nitrate	Sulfate [bc]
Volatile Organic Analyte COCs			
Semi-Volatile Organic Analyte COCs			

Notes:
[a] 216-B-5 reverse well only.
[b] B/BX/BY WMA
[c] 218-E-10 and 218-E-12 burial grounds
[f] C WMA
COC = contaminant of concern

1.1.7 Statement of the Problem

Three problems identified in the DQO process are addressed in this SAP. The first problem is defining uranium and technetium groundwater concentrations north of the 200 East Area. The second problem is refining the relationship between groundwater in the unconfined aquifer and the basalt surface north of the 200 East Area. The third problem is whether well 299-E33-12 continues to be the source of vertical migration of contaminated unconfined aquifer groundwater to the underlying confined aquifer. Data collected during drilling and after construction of the three proposed wells are designed to address these problems. Additionally, the data will either confirm or reject whether conceptual site models are accurate.

1.1.8 Decision Statements and Decision Rules

The decision statements (DS) consolidate potential questions and alternative actions. Decision rules (DR) are generated from the DSs. A DR is an "IF…THEN…" statement that incorporates the parameter of interest, unit of decision making, action level, and action(s) that would result from resolution of the decision. The DSs and DRs were developed by the DQO participants to address data needs associated with the overall 200-BP-5 OU. Tables 1-6 and 1-7 present selected DSs and DRs identified in the DQO process that are specifically addressed by the installation of the three wells described in this SAP.

Table 1-6. Applicable Decision Statements from DQO Process.

DS #	Decision Statement
4	Determine whether groundwater modeling input parameters are sufficiently well known to allow modeling of future movement of COCs in the unconfined aquifer, or if additional data are needed.
5	Determine whether sufficient data are available to determine the horizontal and vertical distribution of COCs in the unconfined aquifer, or if additional data are needed.
6	Determine whether sufficient data are available to allow adequate characterization of the upper confined aquifer.
7	Determine whether the COCs currently measured in the groundwater, or expected to reach the groundwater in the next 1,000 years, exceed applicable risk levels at defined boundaries and therefore require monitoring and/or remediation, or if only long-term monitoring is required.
8	Determine whether sufficient geological and geochemical data are available to develop an acceptable model for predicting future migration of uranium and Tc-99 to groundwater, or if additional data are needed.

Notes:
COC = contaminant of concern
DQO = data quality objective
DS = decision statement

Table 1-7. Applicable Decision Rules from DQO Process. (2 sheets)

DR #	Population Parameter	Sample Statistic	Variable		Unit or Scale of Decision Making	Relationship	Action Level	AA #1	Relationship	AA #2
			Attribute	Unit of Measure						
4	IF saturated zone model input parameters	as estimated by representative values	of data reported in appropriate units		for the saturated sediments and groundwater within the geographic boundaries over the next 2 years	are adequately known	based on professional judgment of DOE, regulatory, and contractor staff	THEN gather no more data	otherwise	gather more data.
5	IF the horizontal and vertical distribution of COCs in the unconfined aquifer	as estimated by spatially defined analytical groundwater results	measured in pCi/L or µg/L or other appropriate units		in the groundwater within the geographic boundaries over the next 2 years	are adequately known in comparison to	the action levels presented in Table 3-3 of DQO	THEN gather no more data	otherwise	gather more data.
6	IF the concentration of COCs in the upper confined aquifer and hydrological characteristics of the confined aquifer	as defined by representative analytical or test data	measured in appropriate units		in the confined aquifer over the next 2 years	are adequately known	based on professional judgment of DOE, regulatory, and contractor staff	THEN gather no more data	otherwise	gather more data.
7	IF the COC risk level in groundwater over the next 1,000 years	as estimated by measurement or modeling and approved risk assessment procedure	of the COCs in pCi/L or µg/L		for the groundwater within the geographic boundaries over the next 1,000 years	is>	the action levels to be defined in the feasibility study and the ROD	THEN monitor and/or remediate	otherwise	conduct only long-term monitoring.

Table 1-7. Applicable Decision Rules from DQO Process. (2 sheets)

DR #	Population Parameter	Sample Statistic	Variable		Unit or Scale of Decision Making	Relationship	Action Level	AA #1	Relationship	AA #2
			Attribute	Unit of Measure						
8	IF the concentration and distribution of uranium and technetium in the vadose zone and associated geological and geochemical data	as estimated by spatially defined vadose zone results	measured in pCi/g or µg/kg or other appropriate units		for the vadose zone within the geographic boundaries over the next 2 years	is adequately known	To develop a geological and geochemical model that adequately predicts uranium and technetium transport through the vadose zone and impact to groundwater	THEN gather no more data	otherwise	gather more data.

Notes:

AA = action level
COC = contaminant of concern
COPC = contaminant of potential concern
DOE = U.S. Department of Energy
DR = decision rule
OU = operable unit
ROD = Record of Decision

1.2 SUMMARY OF DATA QUALITY OBJECTIVE RESULTS (SAMPLING DESIGN)

This section presents a summary of the applicable data that were identified to address the decisions identified in the DQO process and in Table 1-5 above. The data will be gathered during drilling and after construction of the three proposed groundwater monitoring wells associated with this SAP. Table 1-8 summarizes the characterization work to be performed to address the DSs and the potential outcome resulting from the data.

The scope of activities described in this Sampling Design involves the drilling and construction of three groundwater monitoring wells located within and north of the 200 East Area (Figure 1-1). Split-spoon samples of the saturated sediments will be collected and analyzed for radiological and chemical COCs and select physical and hydraulic properties. Groundwater samples collected during drilling and after installation of the permanent pump will be analyzed for radiological and chemical COCs and other select parameters (e.g., major cations, anions, and pH) . Boreholes will be logged using geophysical methods to obtain additional information on the geologic strata and distribution of naturally occurring and man-made gamma-emitting radionuclides (if present).

Table 1-9 identifies the preliminary groundwater action levels for each of the COPCs. Table 1-10 identifies the preliminary groundwater action levels for each of the COCs. At this point in the 200-BP-5 investigation, the preliminary action levels are used as reference concentrations for evaluating whether further characterization is warranted. The final regulatory action levels used for evaluating cleanup alternatives for the 200-BP-5 OU will be established in the FS and interim and/or final Record of Decision. Table 1-11 provides a combination of the COPCs and COCs groundwater radiological analytical performance requirements. Table 1-12 presents a combination of the COPCs and COCs groundwater nonradiological analytical performance requirements.

Table 1-13 presents physical, hydrologic and geochemical data that will be collected from selected unsaturated and saturated sediments at several intervals from selected wells. This information will improve the site-specific data base needed for predictive modeling of contaminant transport and remediation and ultimately will support identification and selection of groundwater remediation alternatives for the 200-BP-5 OU. The properties identified can be placed into the following categories:

- Physical properties (e.g., particle size determination and calcium carbonate content)
- Hydraulic and transport properties (e.g., bulk density, hydraulic conductivity and total porosity)
- Geochemical properties (e.g., cation exchange capacity and distribution coefficient).

Table 1-14 provides a combination of the COPCs and COCs sediment radiological analytical performance requirements. Table 1-15 presents a combination of the COPCs and COCs sediment nonradiological analytical performance requirements.

Table 1-8. Major Sampling Activities and Relationship to DQO Decisions.

Applicable DQO DS #s/ DR#s	Major Activity	Intended Purpose of Wells and Associated Data Collection	Potential Outcome of Data
4, 5, 7, 8/ 4, 5, 7, 8	Drill and construct proposed groundwater monitoring wells C5196 and C5197 north of the 200 East Area (Figure 1-1). Depth to water is anticipated at approximately 45.9 m (151 ft) bgs at well C5196 and 62.9 m (206 ft) bgs at well C5197. Aquifer thickness is anticipated to be approximately 1.9 to 3.7 m (6 to 12 ft); wells will be screened across the total thicknesss of the saturated interval. The sample design for wells C5196 and C5197 are summarized in Tables 3-2, 3-3 and 3-4 and graphically depicted in Figure 3-2.	Determine the concentrations of uranium and technetium-99 in groundwater to the north of the 200 East Area to refine the known uranium and Tc-99plumes. Determine the depth to basalt in data gap areas north of the 200 East Area.	Refine current conceptual model(s) for uranium and Tc-99 plumes and basalt surface.
6/6	Drill and construct proposed groundwater monitoring well C5195 southwest of well 299-E33-12 (Figure 1-1). Based on drilling logs from well 299-E33-12, the depth to the top of the Rattlesnake Ridge interbed is anticipated at approximately 95 m (310 ft) bgs, and the interbed aquifer thickness is anticipated to be approximately 18.3 m (60 ft); the well screen interval will be based on results of the depth-discrete groundwater samples (e.g., gross beta). The sample design for wells C5195 is summarized in Tables 3-1and 3-4 and graphically depicted in Figure 3-1.	The well will serve as a monitoring well for the Rattlesnake Ridge interbed confined aquifer. Groundwater data will be collected to establish if contamination measured in sealed well 299-E33-12 is from an alternate upgradient source.	If the concentrations of technetium-99 are less than the concentrations in well 299-E33-12, then evaluate decommissioning well 299-E33-12. If Tc-99 exceed the concentrations in well 299-E33-12 then re-evaluate the upgradient area to determine the source of the rising Tc-99 concentrations in well 299-E33-12. Update the conceptual site model if measured Tc-99 concentrations in the confined aquifer are different than current model assumptions.

Notes:

bgs = below ground surface
DQO = data quality objective
DR = decision rule
DS = decision statement

Table 1-9. Preliminary Action Levels for Groundwater Contaminants of Potential Concern. (2 sheets)

Contaminant	Preliminary Action Level	Basis for Setting Action Level
Radiological		
Am-241	15 pCi/L	NPDWS
Ba-137	5,160 pCi/L	4-mrem/yr dose standard[a]
C-14	2,000 pCi/L	4-mrem/yr dose standard[a]
Co-60	100 pCi/L	4-mrem/yr dose standard[a]
Np-237	15 pCi/L	NPDWS
Pa-234m	2536 pCi/L	4-mrem/yr dose standard[a]
Pu-238	15 pCi/L	NPDWS
Pu-241	80 pCi/L	4-mrem/yr dose standard[a]
Th-231	4,057 pCi/L	4-mrem/yr dose standard[a]
Th-232	15 pCi/L	NPDWS
Th-234	401 pCi/L	4-mrem/yr dose standard[a]
Uranium (isotopic)	20 pCi/L	4-mrem/yr dose standard[a]
Y-90	510 pCi/L[d]	4-mrem/yr dose standard[a]
Metals		
Aluminum	50-200 µg/L	NSDWS
Antimony	6 µg/L	NPDWS
Arsenic	11.8 µg/L	DOE/RL-96-61
Cadmium	5 µg/L	NPDWS
Chromium (total)	100 µg/L	NPDWS
Chromium (hexavalent)	48 µg/L	CLARC 3.1[b]
Iron	1104 µg/L	DOE/RL-96-61
Sodium	250,000 µg/L[c]	http://en.wikipedia.org/wiki/brackish_water http://en.wikipedia.org/wiki/seawater
Thallium	1.87 µg/L	DOE/RL-96-61
Non-Metals		
Chloride	250,000 µg/L	NSDWS

Table 1-9. Preliminary Action Levels for Groundwater Contaminants of Potential Concern. (2 sheets)

Contaminant	Preliminary Action Level	Basis for Setting Action Level
Nitrite (nitrogen)	1000 µg/L	NPDWS
Volatile Organics COCs		
Chloroform	7.17 µg/L	CLARC 3.1[b]
4-methyl 2-pentanone	640 µg/L	CLARC 3.1[b]
Methylene Chloride	5 µg/L	NPDWS
Trichloroethene	3.98 µg/L[c]	CLARC 3.1[b]
Semi-Volatile Organics		
Bis(2-ethylhexyl)phthalate	6.25 µg/L	CLARC 3.1[b]
Pentachlorophenol	2 µg/L[c]	Practical Quantitation Limit

Notes:

Complete reference information provided in Section 5.0 of this document.

[a] These values taken from *Hanford Site Groundwater Monitoring for Fiscal Year 2005* (PNNL-15670). These EPA drinking water standards for radionuclides were derived based on 4-mrem/yr dose standard using maximum permissible concentrations in water specified in National Bureau of Standards Handbook 69 (U.S. Department of Commerce, as amended August 1963).

[b] CLARC 3.1 refers to *Cleanup Levels and Risk Calculations Under the Model Toxics Control Act Cleanup Regulation (CLARC III)* (Ecology 2001).

[c] The practical quantitation limit is greater than the Model Toxics Control Act Method B derived limit of 0.729 µg/L using CLARC 3.1.

[d] Calculated value based EPA, 1998, *Limiting Values of Radionuclide Intake and Air Concentration and Dose Conversion Factors for Inhalation, Submersion, and Ingestion,* Federal Guidance Report No. 11, EPA-5201/1-88-020, U.S. Environmental Protection Agency, Washington, D.C.

[e]. Calculated based on the percentage of sodium in seawater in accordance with http://en.wikipedia.org/wiki/seawater. Then using that percentage to back calculate a concentrations for the upper limit of saline concentration for freshwater as defined by http://en.wikipedia.org/wiki/brackish_water. DOE/RL-96-61, *Hanford Site Background: Part 3, Groundwater Background.*

NPDWS – National Primary Drinking Water Standard

NSDWS – National Secondary Drinking Water Standards

Table 1-10. Preliminary Action Levels for Groundwater Contaminants of Concern.

Contaminant	Preliminary Action Level	Basis for Setting Action Level
Radiological		
Cs-137	200 pCi/L	4-mrem/yr dose standard[a]
I-129	1 pCi/L	4-mrem/yr dose standard[a]
Pu-239/240	15 pCi/L	NPDWS
Sr-90	8 pCi/L	4-mrem/yr dose standard[a]
Tc-99	900 pCi/L	4-mrem/yr dose standard[a]
Tritium	20,000 pCi/L	4-mrem/yr dose standard[a]
Metals		
Uranium (total)	30 µg/L	NPDWS
Non-Metals		
Cyanide	200 µg/L	NPDWS
Nitrate (nitrogen)	10,000 µg/L	NPDWS
Sulfate	250,000 µg/L	NSDWS
Volatile Organics COCs		
Semi-Volatile Organics		

Notes:

Complete reference information provided in Section 5.0 of this document.

[a] These values taken from *Hanford Site Groundwater Monitoring for Fiscal Year 2005* (PNNL-15670). These EPA drinking water standards for radionuclides were derived based on 4-mrem/yr dose standard using maximum permissible concentrations in water specified in National Bureau of Standards Handbook 69 (U.S. Department of Commerce, as amended August 1963).

[b] CLARC 3.1 refers to *Cleanup Levels and Risk Calculations Under the Model Toxics Control Act Cleanup Regulation (CLARC III)* (Ecology 2001).

NPDWS – National Primary Drinking Water Standard

NSDWS - National Secondary Drinking Water Standard

Table 1-11. Analytical Performance Requirements for Radiological Contaminants of Potential Concern and Contaminants of Concern.

Constituent	CAS #	Preliminary Groundwater Action Level[a] (pCi/L)	Analytical Technology	Target Required Quantitation Limits (pCi/L)	Precision	Accuracy
Am-241	14596-10-2	15	Isotopic Americium– AEA	1	±30%	70-130%
Cesium-137	10045-97-3	200	GEA	15	±30%	70-130%
Cobalt-60	10198-40-0	100	GEA	25	±30%	70-130%
Carbon-14	14762-75-5	2,000	Carbon-14-liquid scintillation	200	±30%	70-130%
Iodine-129	15046-84-1	1	Iodine-129 – liquid scintillation (low-level)	1	±30%	70-130%
Neptunium-237	13994-20-2	15	Neptunium-237 – AEA	1	±30%	70-130%
Pu-238	13981-16-3	15	Isotopic plutonium – AEA	1	±30%	70-130%
Plutonium-239/240	Pu-239/240	15	Isotopic plutonium – AEA	1	±30%	70-130%
Strontium-89/90	RAD-Sr	8	Total beta radiostrontium – GPC	2	±30%	70-130%
Technetium-99	14133-76-7	900	Technetium-99 – liquid scintillation or GPC	15	±30%	70-130%
Thorium-232	Th-232	15	Thorium isotopic – AEA (pCi) ICPMS (mg)	1	±30%	70-130%
Thorium-234	Th-234	401	Thorium isotopic – AEA (pCi) ICPMS (mg)	1	±30%	70-130%
Tritium	10028-17-8	20,000	Tritium – liquid scintillation (mid-level)	400	±30%	70-130%
Uranium-233/234	U-233/234	20	Isotopic uranium – AEA	1	±30%	70-130%
Uranium-235	15117-96-1	20	Isotopic uranium – AEA	1	±30%	70-130%
Uranium-238	U-238	20	Isotopic uranium – AEA	1	±30%	70-130%

Notes:

[a] Table 1-8 gives basis for setting preliminary action level values.

[b] Accuracy criteria for associate batch laboratory control sample percent recoveries. With the exception of GEA, additional analysis-specific evaluations also performed for matrix spikes, tracers, and carriers, as appropriate to the method. Precision criteria for batch laboratory replicate sample analyses.

AEA = alpha energy analysis GEA = gamma energy analysis N/A = not applicable

CAS = Chemical Abstracts Services GPC = gas proportional counting

Table 1-12. Analytical Performance Requirements for Nonradiological Contaminants of Potential Concern and Contaminants of Concern. (2 Sheets)

Constituent	CAS #	Preliminary Groundwater Action Level[a] (µg/L)	Analytical Technology	Target Required Quantitation Limits (µg/L)	Precision	Accuracy
Metals						
Aluminum	7429-90-5	50-200	EPA Method – 6010 EPA Method 200.8	6	±30%[b]	70-130%[b]
Antimony	7440-36-0	6	EPA Method – 6010 EPA Method 200.8	5	±30%[b]	70-130%[b]
Arsenic	7440-38-2	11.8	EPA Method – 6010 EPA Method 200.8	10	±30%[b]	70-130%[b]
Cadmium	7440-43-9	5	EPA Method – 6010 EPA Method 200.8	2	±30%[b]	70-130%[b]
Chromium	7440-47-3	100	EPA Method – 6010 EPA Method 200.8	5	±30%[b]	70-130%[b]
Chromium (hexavalent)	18540-29-9	48	Chromium (hexavalent) – EPA Method - 7196	10	±30%[b]	70-130%[b]
Iron	7439-89-6	1104	EPA Method – 6010	50	±30%[b]	70-130%[b]
Sodium	7440-23-5	250,000[c]	EPA Method – 6010 EPA Method 200.8	50,000	±30%[b]	70-130%[b]
Thallium	7440-28-0	1.87	EPA Method – 6010 EPA Method 200.8	1	±30%[b]	70-130%[b]
Uranium (total)	7440-61-1	30	EPA Method 200.8 Uranium – kinetic phosphorescence absorption	1	±30%[b]	70-130%[b]
Inorganics						
Chloride	16887-00-6	250,000	EPA Method 300.0	200	±30%[b]	70-130%[b]
Cyanide	57-12-5	200	EPA Method 335.N EPA Method 9010 EPA Method 9012	5	±30%[b]	70-130%[b]

Table 1-12. Analytical Performance Requirements for Nonradiological Contaminants of Potential Concern and Contaminants of Concern. (2 Sheets)

Constituent	CAS #	Preliminary Groundwater Action Level[a] (µg/L)	Analytical Technology	Target Required Quantitation Limits (µg/L)	Precision	Accuracy
Nitrate	14797-55-8	10,000	EPA Method 300.0	250	±30%[b]	70-130%[b]
Nitrite	14797-65-0	1,000	EPA Method 300.0	250	±30%[b]	70-130%[b]
Nitrogen in nitrate and nitrite	NO2+NO3-N	4,000	EPA Method 353.N, deionized water extraction for soils analysis	75	±30%[b]	70-130%[b]
Sulfate	14808-79-8	250,000	EPA Method 300.0	500	±30%[b]	70-130%[b]
Volatile Organics						
Chloroform	67-66-3	7.17	EPA Method – 8260	5	±30%[b]	50-150%[b&d]
4-methyl 2 pentanone	108-10-1	640	EPA Method – 8260	5	±30%[b]	50-150%[b&d]
Methylene Chloride	75-09-2	5	EPA Method – 8260	2	±30%[b]	50-150%[b&d]
Trichloroethane	79-01-6	5	EPA Method – 8260	2	±30%[b]	50-150%[b&d]
Semi-Volatile Organics						
Bis(2-ethylhexyl)phthalate	117-81-7	6.25	EPA Method - 8270	5	±30%[b]	50-150%[b&d]
Pentachlorophenol	87-86-5	2	EPA Method 8270	5	±30%[b]	50-150%[b&d]

Notes:

[a] WAC 173-340-720, Method B groundwater cleanup levels.

[b] Precision and accuracy requirements are identified and defined in the referenced EPA procedures. Accuracy criteria for associate batch matrix spike percentage recoveries. Evaluation based on statistical control of laboratory control sample also preformed. Precision criteria based on batch laboratory replicate matrix spike sample analyses or replicate sample analyses.

[c] Represent site background concentration (DOE/RL-92-23)

[d] Accuracy criteria are the minimum for associated batch laboratory control sample percent recoveries. Laboratories must meet statistically based control if more stringent. Additional analyte-specific evaluations also performed for matrix spikes and surrogates as appropriate to the method. Precision criteria are based on batch laboratory replicate matrix spike sample analyses.

CAS = Chemical Abstracts Services CFR= *Code of Federal Regulations* EPA= U.S. Environmental Protection Agency N/A= not applicable WAC= *Washington Administrative Code*

Table 1-13. Performance Requirements for Physical, Hydraulic and Geochemical Testing Methods. (2 sheets)

Property	Parameter	Method	Target Required Quantitation Limts	Precision Required	Accuracy Required
Physical Parameters	Particle size distribution	ASTM D422	N/A	N/A	N/A
	Spectral gamma borehole logging	Borehole logging (16 or 32 ft/hour rate if single-cased, 60 ft/hour if dual-wall casing - TBD)	N/A	N/A	N/A
	Neutron moisture logging	Borehole logging (40 ft/hour rate)	N/A	N/A	N/A
	Bulk density	ASTM D2937	N/A	N/A	N/A
	Lithology	Geologist description	N/A	N/A	N/A
Hydraulic and Transport Parameters	Moisture Content	ASTM D2216	N/A	N/A	N/A
	Saturated Hydraulic conductivity	ASTM D5084	N/A	N/A	N/A
	Unsaturated Hydraulic conductivity (Vadose Zone Analysis)	Methods of Soil Analysis, Part I, Chapter 31. Soil Science Society of America.	N/A	N/A	N/A
	Water level and hydraulic gradient	Field measurement	N/A	±0.006 m	±0.006 m
	Water retention	ASTM D6836-02 and ASTM D2325	TBD	TBD	TBD
	Pumping performance, drawdown, and flow rate	Well development	N/A	N/A	±0.006 m
	Uranium isotopic signatures	Lawrence Berkeley National Lab	N/A	N/A	N/A
	Cation exchange capacity	Routson et al. (1973)	N/A	N/A	N/A
	K_d (contaminant-specific)	ASTM 3987	N/A	N/A	±25%
	Specific conductance	Field measurement	N/A	N/A	N/A
	Temperature	Field measurement	N/A	+1 °C	+1 °C
	Dissolved oxygen	Field measurement	N/A	0.1 mg/L	±25%
	Turbidity	Field measurement	<5 NTU	N/A	±1%

Table 1-13. Performance Requirements for Physical, Hydraulic and Geochemical Testing Methods. (2 sheets)

Property	Parameter	Method	Target Required Quantitation Limts	Precision Required	Accuracy Required
Model Development Parameters	pH	pH Probe	NA	±0.1 pH	±0.1 pH
	Conductivity	Conductivity Probe	N/A	±20%	±10%
	Alkalinity	Titration	5 mg/L	±20%	±10%
	Anions/organic acids	Ion Chromatography	TBD	±20%	±10%
	RCRA metals	Inductively Coupled Plasma – Mass Spectrometry	TBD	±20%	±10%
	Techetium-99, Uranium-238, Iodine-129	Inductively Coupled Plasma – Mass Spectrometry	TBD	±20%	±10%
	Cations	Inductively Coupled Plasma – Optical Emission Spectrometry	TBD	±20%	±10%
	Total organic carbon (sediments)	Combustion/Chemical Oxidation Carbon Analyser	25 mg/kg	±20%	±10%
	Total inorganic carbon (sediments)	Combustion/Chemical Oxidation Carbon Analyser	12.5 mg/kg	±20%	±10%
	Gross alpha/beta	Gas Proportional Counting	5 pCi/g alpha 10 pCi/g beta	±25%	±20%

Notes:

Complete reference information provided in Section 5.0 of this document.

ASTM = American Society for Testing and Materials

K_d = distribution coefficient

N/A = not applicable

NTU = nephelometric turbidity unit

Table 1-14. Sediment Analytical Performance Requirements for Radiological Contaminants of Potential Concern and Contaminants of Concern.

Constituent	CAS #	Preliminary Sediment Action Level[a] (pCi/g)	Analytical Technology	Target Required Quantitation Limits (pCi/g)	Precision[b]	Accuracy[b]
Am-241	14596-10-2	TBD	Isotopic Americium– AEA	1	±30%	70-130%
Cesium-137	10045-97-3	TBD	GEA	0.1	±30%	70-130%
Cobalt-60	10198-40-0	TBD	GEA	0.05	±30%	70-130%
Carbon-14	14762-75-5	322	Carbon-14-liquid scintillation	200	±30%	70-130%
Iodine-129	15046-84-1	TBD	Iodine-129 – liquid scintillation (low-level)	2	±30%	70-130%
Neptunium-237	13994-20-2	TBD	Neptunium-237 – AEA	1	±30%	70-130%
Pu-238	13981-16-3	TBD	Isotopic plutonium – AEA	1	±30%	70-130%
Plutonium-239/240	Pu-239/240	TBD	Isotopic plutonium – AEA	1	±30%	70-130%
Strontium-89/90	RAD-Sr	TBD	Total beta radiostrontium – GPC	2	±30%	70-130%
Technetium-99	14133-76-7	181	Technetium-99 – liquid scintillation or GPC	15	±30%	70-130%
Thorium-232	Th-232	TBD	Thorium isotopic – AEA (pCi) ICPMS (mg)	1	±30%	70-130%
Thorium-234	Th-234	TBD	Thorium isotopic – AEA (pCi) ICPMS (mg)	1	±30%	70-130%
Tritium	10028-17-8	6.00E+13	Tritium – liquid scintillation (mid-level)	400	±30%	70-130%
Uranium-233/234	U-233/234	TBD	Isotopic uranium – AEA	1	±30%	70-130%
Uranium-235	15117-96-1	TBD	Isotopic uranium – AEA	1	±30%	70-130%
Uranium-238	U-238	TBD	Isotopic uranium – AEA	1	±30%	70-130%

[a] The preliminary action level is the regulatory or risk-based value used to determine appropriate analytical requirements (e.g. detection limits). Remedial action levels will be proposed in the FS. The groundwater protection radionuclide values are demonstrated through technical evaluation using RESRAD. Previous RESRAD calculations have determined carbon-14, technetium-99 and tritium have potential for entering the groundwater within the next 1,000 years based on generic site specific profiles. Therefore no current protection of groundwater values for the other radionuclides exists.

[b] Accuracy criteria for associate batch laboratory control sample percent recoveries. With the exception of GEA, additional analysis-specific evaluations also performed for matrix spikes, tracers, and carriers, as appropriate to the method. Precision criteria for batch laboratory replicate sample analyses.

AEA= alpha energy analysis CAS= Chemical Abstracts Services GEA= gamma energy analysis GPC= gas proportional counting N/A= not applicable

Table 1-15. Sediment Analytical Performance Requirements for Nonradiological Contaminants of Potential Concern and Contaminants of Concern. (2 Sheets)

Constituent	CAS #	Preliminary Sediment Action Level (µg/Kg)	Analytical Technology	Target Required Quantitation Limits (µg/Kg)	Precision	Accuracy
Metals						
Aluminum	7429-90-5	45,200[a]	EPA Method – 6010 EPA Method 200.8	5000	±30%[b]	70-130%[b]
Antimony	7440-36-0	5,400[a]	EPA Method – 6010 EPA Method 200.8	5000	±30%[b]	70-130%[b]
Arsenic	7440-38-2	20,000[a]	EPA Method – 6010 EPA Method 200.8	10,000	±30%[b]	70-130%[b]
Cadmium	7440-43-9	690[a]	EPA Method – 6010 EPA Method 200.8	500	±30%[b]	70-130%[b]
Chromium	7440-47-3	2,000,000[a]	EPA Method – 6010 EPA Method 200.8	1000	±30%[b]	70-130%[b]
Chromium (hexavalent)	18540-29-9	18,400[a]	Chromium (hexavalent) – EPA Method - 7196	10	±30%[b]	70-130%[b]
Iron	7439-89-6	152,000[a]	EPA Method – 6010	5000	±30%[b]	70-130%[b]
Sodium	7440-23-5	TBD	EPA Method – 6010 EPA Method 200.8	50,000	±30%[b]	70-130%[b]
Thallium	7440-28-0	TBD	EPA Method – 6010 EPA Method 200.8	500	±30%[b]	70-130%[b]
Uranium (total)	7440-61-1	1,320[a]	EPA Method 200.8 Uranium – kinetic phosphorescence absorption	1000	±30%[b]	70-130%[b]
Inorganics						
Chloride	16887-00-6	1,000,000[a]	EPA Method 300.0	2000	±30%[b]	70-130%[b]
Cyanide	57-12-5	800[a]	EPA Method 335.N EPA Method 9010 EPA Method 9012	500	±30%[b]	70-130%[b]

Table 1-15. Sediment Analytical Performance Requirements for Nonradiological Contaminants of Potential Concern and Contaminants of Concern. (2 Sheets)

Constituent	CAS #	Preliminary Sediment Action Level (µg/Kg)	Analytical Technology	Target Required Quantitation Limits (µg/Kg)	Precision	Accuracy
Nitrate	14797-55-8	40,000[a]	EPA Method 300.0	2500	±30%[b]	70-130%[b]
Nitrite	14797-65-0	4,000[a]	EPA Method 300.0	2500	±30%[b]	70-130%[b]
Nitrogen in nitrate and nitrite	NO2+NO3-N	4,000[a]	EPA Method 353.N, deionized water extraction for soils analysis	2500	±30%[b]	70-130%[b]
Sulfate	14808-79-8	1,030,000[a]	EPA Method 300.0	5000	±30%[b]	70-130%[b]
Volatile Organics						
Chloroform	67-66-3	38.2[a]	EPA Method – 8260	5	±30%[b]	50-150%[b&d]
4-methyl 2 pentanone	108-10-1	2,170[a]	EPA Method – 8260	10	±30%[b]	50-150%[b&d]
Methylene Chloride	75-09-2	21.8[a]	EPA Method – 8260	5	±30%[b]	50-150%[b&d]
Trichloroethane	79-01-6	26.3[a]	EPA Method – 8260	2	±30%[b]	50-150%[b&d]
Semi-Volatile Organics						
Bis(2-ethylhexyl)phthalate	117-81-7	13,900[a]	Semi-Volatiles - 8270	330	±30%[b]	50-150%[b&d]
Pentachlorophenol	87-86-5	330[c]	EPA Method 8270	330	±30%[b]	50-150%[b&d]

Notes:

[a] WAC 173-340-720, Method B soil protection of groundwater levels.

[b] Accuracy criteria for associate batch matrix spike percentage recoveries. Evaluation based on statistical control of laboratory control sample also preformed. Precision criteria based on batch laboratory replicate matrix spike sample analyses or replicate sample analyses

[c] The practical quantitation limit is greater than the Model Toxics Control Act Method B derived limit of 11.5 µg/Kg using CLARC 3.1.

[d] Accuracy criteria are the minimum for associated batch laboratory control sample percent recoveries. Laboratories must meet statistically based control if more stringent. Additional analyte-specific evaluations also performed for matrix spikes and surrogates as appropriate to the method. Precision criteria are based on batch laboratory replicate matrix spike sample analyses.

CAS = Chemical Abstracts Services
CFR = *Code of Federal Regulations*
EPA = U.S. Environmental Protection Agency
N/A = not applicable
WAC = *Washington Administrative Code*

2.0 QUALITY ASSURANCE PROJECT PLAN

The quality assurance project plan (QAPjP) establishes the quality requirements for environmental data collection, including sampling, field measurements, and laboratory analysis. The QAPjP complies with the requirements of the following:

- U.S. Department of Energy (DOE) Directive CRD 414.1A, *Quality Assurance*
- 10 CFR 830.120, "Quality Assurance Requirements"
- EPA/240/B-01/003, *EPA Requirements for Quality Assurance Project Plans*, EPA QA/R-5.

The following sections describe the quality requirements and controls applicable to this investigation. Correlation between EPA/240/B-01/003 (EPA QA/R-5) requirements and information in this chapter is provided in Table 2-1.

Table 2-1. Correlation Between EPA QA/R-5 Requirements and the Sampling and Analysis Plan.

EPA QA/R-5 Criteria	EPA QA/R-5 Title	Reference Section
Project Management	Project/Task Organization	2.1
	Problem Definition/Background	1.0, 1.1.6
	Project/Task Description	1.0
	Quality Objectives and Criteria	2.2
	Special Training/Certification	2.3
	Documents and Records	2.4
Data Generation and Acquisition	Sampling Process Design	2.5, 3.1, 3.2
	Sampling Methods	2.5.1
	Sample Handling and Custody	2.5.3
	Analytical Methods	2.5.5, Tables 1-9,1-10, and 1-11
	Quality Control	2.5.6
	Instrument/Equipment Testing, Inspection, and Maintenance	2.5.7
	Instrument/Equipment Calibration and Frequency	2.5.8
	Inspection/Acceptance of Supplies and Consumables	2.5.9
	Non-direct Measurements	2.5.10
	Data Management	2.5.11
Assessment and Oversight	Assessments and Response Actions	2.6.1
	Reports to Management	2.6.2
Data Validation and Usability	Data Review, Verification, and Validation	2.7
	Verification and Validation Methods	2.7.1, 2.7.2
	Reconciliation with User Requirements	2.7.2

Quality assurance (QA) requirements are implemented according to the internal Fluor Hanford, Inc. (FH) QA program. The QA Program description document describes how FH implements the QA requirements conveyed in U.S. Department of Energy Order 414.1A (Quality Assurance) and "Nuclear Safety Management" (10 CFR 830.121) and how the *Hanford Federal Facility Agreement and Consent Order* (Tri-Party Agreement) (Ecology et al. 2003) and Hanford Site internal laboratory QA requirements apply to FH environmental QA program plans.

All work performed under this SAP will be performed in compliance with the FH QA Program plan, the FH Groundwater Remediation Project plan or subsequent and equivalent FH quality program plans. Field sample collection and documentation activities will be performed according to applicable FH procedures. Groundwater sample collection and documentation after well completion will be performed by FH's subcontractor Duratek Federal Services Northwest (DFSNW) according to DFSNW internal procedures.

2.1 PROJECT/TASK ORGANIZATION

The project organization is described in the subsections that follow and is shown in Figure 2-1.

2.1.1 Waste Site Remediation Manager

The Waste Site Remediation manager provides oversight for all activities and coordinates with DOE-Richland Operations Office (RL) and regulators in support of sampling activities. In addition, support is provided to the task lead to ensure that the work is performed safely and cost-effectively.

2.1.2 Remediation Task Lead

The Remediation task lead is responsible for direct management of sampling documents and requirements, field activities, and subcontracted tasks. The task lead ensures that the field team lead, samplers, and others responsible for implementation of this SAP are provided with current copies of this document and any revisions thereto. The task lead works closely with QA, health and safety, and the field team leader to integrate these and the other lead disciplines in planning and implementing the workscope. The task lead also coordinates with, and reports to, DOE-RL, regulators, and the Hanford Management Contractor on all sampling activities.

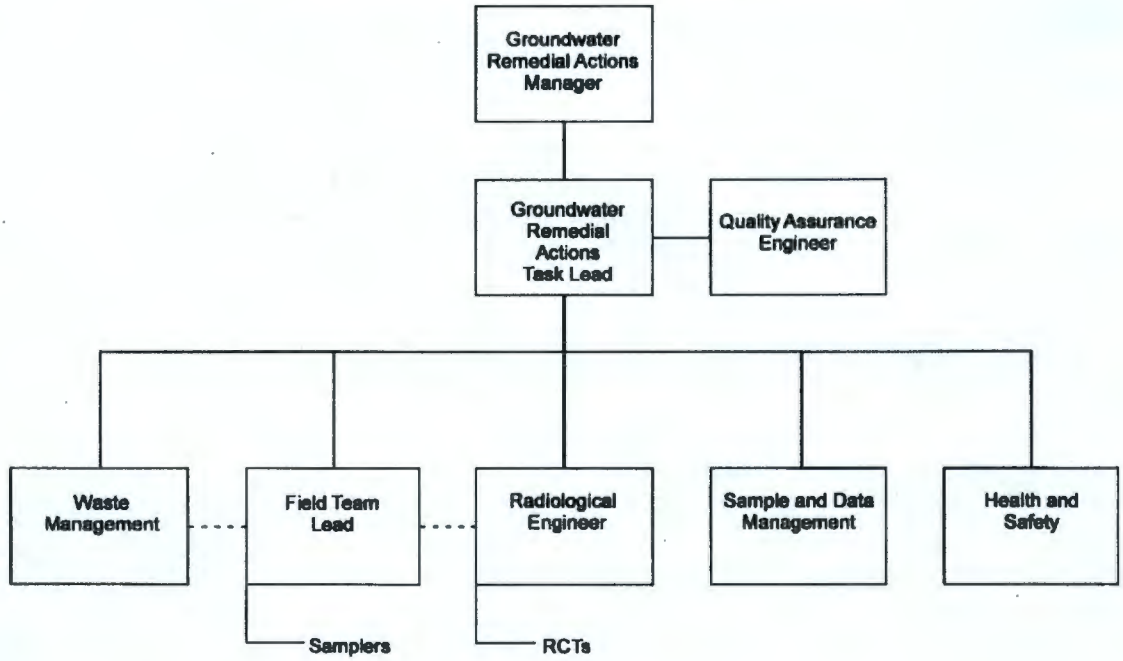
2.1.3 Quality Assurance Engineer

The Quality Assurance engineer is matrixed to the Remediation task lead and is responsible for QA issues on the project. Responsibilities include oversight of implementation of the project QA requirements; review of project documents, including SAPs (and the QAPjP); and participation in QA assessments on sample collection and analysis activities, as appropriate.

2.1.4 Waste Management

The Waste Management lead communicates policies and procedures and ensures project compliance for storage, transportation, disposal, and waste tracking in a safe and cost-effective manner. Other responsibilities include identifying waste management sampling/characterization requirements to ensure regulatory compliance interpretation (i.e., with WAC 173-303) of the characterization data to generate waste designations, profiles, and other documents that confirm compliance with the applicable waste control plan.

Figure 2-1. 200-BP-5 Project/Task Organization.



2.1.5 Field Team Leader

The field team leader has the overall responsibility for the planning, coordination, and execution of the field characterization activities. Specific responsibilities include converting the sampling design requirements into field task instructions that provide specific direction for field activities. Responsibilities also include directing training, mock-ups, and practice sessions with field personnel to ensure that the sampling design is understood and can be performed as specified. The field team leader communicates with the Remediation task lead to identify field constraints that could affect the sampling design. In addition, the field team leader directs the procurement and installation of materials and equipment needed to support the field work.

The field team leader oversees field-sampling activities that include sample collection, packaging, provision of certified clean sampling bottles/containers, documentation of sampling activities in controlled logbooks, chain-of-custody documentation, and packaging and transportation of samples to the laboratory or shipping center.

The field team leads, samplers, and others responsible for implementation of this SAP and the QAPjP will be provided with current copies of this document and any revisions thereto.

2.1.6 Radiological Engineering

The Radiological Engineering lead is responsible for the radiological engineering and health physics support within the project. Specific responsibilities include conducting as-low-as-reasonably-achievable (ALARA) reviews, exposure and release modeling, and

radiological controls optimization for all work planning. In addition, radiological hazards are identified and appropriate controls are implemented to maintain worker exposures to the hazards ALARA. Radiological Engineering interfaces with the project safety and health representative and plans and directs radiological control technician support for all activities.

2.1.7 Sample and Data Management

The Sample and Data Management organization selects the laboratories that perform the analyses. This organization also ensures that the laboratories conform to Hanford Site internal laboratory QA requirements, or their equivalent, as approved by DOE-RL, EPA, and the Washington State Department of Ecology. The Sample and Data Management organization initiates audits of the laboratories periodically to assure compliance. Sample and Data Management receives the analytical data from the laboratories, makes the data entry into HEIS database, and arranges for data validation. Validation will be performed on completed data packages (including quality control [QC] samples) by FH's Environmental Information Services group or by a qualified independent contractor.

2.1.8 Health and Safety

Responsibilities include coordination of industrial safety and health support within the project as carried out through safety and health plans, job hazard analyses, and other pertinent safety documents required by Federal regulation or by internal FH work requirements. In addition, assistance is provided to project personnel in complying with applicable health and safety standards and requirements. Personnel protective clothing requirements are coordinated with Radiological Engineering.

2.2 QUALITY OBJECTIVES AND CRITERIA FOR MEASUREMENT DATA

Laboratory analytical detection limits and the precision and accuracy requirements for each analysis to be performed are summarized Tables 1-9 and 1-10. Performance criteria for physical, hydrologic and geochemical testing are found in Table 1-11.

2.3 SPECIAL TRAINING REQUIREMENTS AND CERTIFICATION

Training or certification requirements for sampling personnel shall be in accordance with the requirements specified in the Hanford Site internal laboratory QA requirements.

Field personnel will typically have completed the following training before starting work:

- Occupational Safety and Health Administration 40-Hour Hazardous Waste Worker Training
- 8-Hour Hazardous Waste Worker Refresher Training (as required)
- Radiation Worker II Training
- Hanford General Employee Training.

2.4 DOCUMENTATION AND RECORDS

As indicated in Section 2.12, The FH Groundwater Remedial Actions task lead task is responsible for ensuring that the field team lead, samplers, and others responsible for implementation of this SAP are provided with current copies of this document and any revisions thereto.

Field sampling and well-site activity documentation will be performed in accordance with FH and DFSNW procedures pertaining to the following:

- Notebooks and Logbooks
- Geologic Logging
- Groundwater Sampling
- Calibration of Field Equipment
- Sampling Documentation
- Geophysical Logging (S.M. Stoller procedures)
- Chain of Custody/Sample Analysis Requests
- Sample Packaging and Shipping.

Laboratory analytical documentation will be in accordance with the *Statement of Work for Environmental and Waste Characterization Analytical Services* (RFS 1999) for groundwater sampling. Overall project documentation will be in accordance with the FH procedures standards-based management system.

Data and information generated from the sampling activities will be used to support characterization efforts and to evaluate remedial alternatives for the 200-BP-5 OU. This data and information will be incorporated into project documents including a borehole summary report and remedial investigation report. Data and information from this sampling activity may also be included (if available at time of document preparation) in the feasibility study planning documents for the 200-BP-5 OU.

2.5 DATA/MEASUREMENT ACQUISITION

The following subsections present the requirements for sampling methods, sample handling and custody, analytical methods, and field and laboratory QC. The requirements for instrument calibration and maintenance, supply inspections, and data management are also addressed.

2.5.1 Sampling Methods Requirements

Sampling associated with this SAP will be performed in accordance with established sampling practices and requirements pertaining to sample collection, collection equipment, and sample handling. The procedures to be implemented in the field should be in accordance with those outlined in the Hanford Site internal laboratory QA requirements and the applicable FH and DFSNW procedures for the sampling activities listed in Section 3.4 of this SAP.

The field team leader and the Task Lead are responsible for ensuring that all field procedures are followed completely and that field personnel are trained adequately. The field team leader and

the Task Lead must document situations that may impair the usability of the samples and/or data in the field logbook or nonconformance report forms in accordance with internal corrective action procedures, as appropriate. The field team leader will note any deviations from the standard procedures for sample collection, contaminants of potential concern, sample transport, or monitoring that occurs.

2.5.2 Sampling Identification

A sample and data-tracking database will be used to track the samples from the point of collection through the laboratory analysis process. The HEIS database is the repository for laboratory analytical results. The HEIS sample numbers will be issued to the sampling organization for this project. The HEIS numbers are to be carried through the laboratory data-tracking system.

2.5.3 Sample Handling, Shipping, and Custody Requirements

All sample handling, shipping, and custody requirements will be performed in accordance the applicable FH and DFSNW procedures pertaining to Sample Packaging and Shipping and Chain of Custody/Sample Analysis Requests.

2.5.4 Sample Preservation, Containers, and Holding Times

Sample preservation, container, and holding time requirements will be prepared for specific sample events as specified on the sampling authorization forms and chain-of-custody forms in accordance with the requirements specified in RFS (1999) and the specific analytical method.

2.5.5 Analytical Methods Requirements

Analytical parameters and methods are listed in Tables 1-9 through 1-11. Laboratory-specific standard operating procedures for analytical methods are described in the Hanford Site internal laboratory QA requirements.

Errors reported by the laboratories are reported to the Sample Management Project Coordinator, who initiates a Sample Disposition Record in accordance with FH procedures. This process is used to document analytical errors and to establish resolution with the Project Task Lead .

2.5.6 Quality Control Requirements

The QC procedures described in the Hanford Site internal laboratory QA requirements, must be followed in the field and laboratory to ensure that reliable data are obtained. When performing this field sampling effort, care should be taken to prevent the cross-contamination of sampling equipment, sample bottles, and other equipment that could compromise sample integrity.

Table 2-2 lists the field QC requirements for sampling. If only disposable equipment is used or equipment is dedicated to a particular well, then an equipment rinsate blank is not required. If no volatile organic compound samples are collected, then a field transfer blank is not required. Field transfer blanks are not required when simply transferring samples to the field gas chromatograph for analysis.

Laboratory QC sample requirements are specified in RFS (1999).

Table 2-2. Field Quality Control Requirements.

Sample Type	Frequency	Purpose
Duplicate	5% (1 sample in 20)	To check the precision of the laboratory analyses.
Equipment rinsate	One per 10 well trips	To check the effectiveness of the decontamination process.
Field transfer blank	One per day when volatile organics are sampled	To check for contamination during transport.

2.5.7 Instrument/Equipment Testing, Inspection, and Maintenance Requirements

All onsite environmental instruments shall be tested, inspected, and maintained in accordance with manufacturer's specifications and FH and DFSNW procedures pertaining to control and calibration of field and monitoring instruments. The results from all testing, inspection, and maintenance activities shall be recorded in a bound logbook in accordance with applicable FH and DFSNW procedures.

2.5.8 Instrument Calibration and Frequency

All onsite environmental instruments shall be calibrated in accordance with manufacturer's specifications and FH and DFSNW procedures pertaining to the following:

- Calibration requirements of field measurement equipment
- Control of monitoring instruments.

The results from all testing, inspection, and maintenance activities shall be recorded in a bound logbook in accordance with applicable FH and DFSNW procedures. Tags will be attached to all field screening and onsite analytical instruments, noting the date when the instrument was last calibrated and the calibration expiration date.

2.5.9 Inspection/Acceptance Requirements for Supplies and Consumables

All subject activities shall meet requirements of the Hanford Site internal laboratory QA requirements. The lot number from the manufacturer-certified, pre-cleaned sample containers shall be recorded in the sampler's logbook.

Supplies and consumables procured by FH that are used in support of sampling and analysis activities are procured in accordance with internal work requirements and processes that describe the FH acquisition system and the responsibilities and interfaces necessary to ensure that structures, systems, and components, or other items and services procured/acquired for FH meet the specific technical and quality requirements. The procurement process ensures that purchased items and services comply with applicable procurement specifications. Supplies and consumables are checked and accepted by users prior to use.

Supplies and consumables procured by the analytical laboratories are procured, checked, and used in accordance with the laboratories' QA plan.

2.5.10 Non Direct Measurements

Non-measurement sources such as computer data bases, programs, and literature files were used during the DQO process to assist with well placement decisions and development of

contaminants of concern. No further use of non direct measurements are required to support the scope of this SAP.

2.5.11 Data Management

Data resulting from the implementation of this QAPjP shall be managed and stored in accordance with applicable programmatic requirements governing data management procedures. At the direction of the task lead, all analytical data packages shall be subject to final technical review by qualified personnel before the results are submitted to the regulatory agencies or before inclusion in reports. Electronic data access, when appropriate, shall be via a database (e.g., HEIS or a project-specific database). Where electronic data are not available, hard copies shall be provided in accordance with Section 9.6 of the Tri-Party Agreement (Ecology et al. 2003).

Planning for sample collection and analysis shall be in accordance with the programmatic requirements governing fixed laboratory sample collection activities as discussed in the sample teams procedures. In the event that specific procedures do not exist for a particular work evolution, or if additional guidance to complete certain tasks is needed, a work package will be developed to adequately control the activities, as appropriate. Examples of the sample teams' requirements include the activities associated with the following:

- Chain of custody/sample analysis requests
- Project and sample identification for sampling services
- Control of certificates of analysis
- Logbooks, checklists
- Sample packaging and shipping.

Approved work control packages and procedures will be used to document radiological measurements when implementing this SAP. Examples of the types of documentation for field radiological data include the following:

- Instructions regarding the minimum requirements for documenting radiological controls information as per 10 CFR 835, "Occupational Radiation Protection"
- Instructions for managing the identification, creation, review, approval, storage, transfer, and retrieval of Hanford Site radiological records
- The minimum standards and practices necessary for preparing, performing, and retaining radiological-related records
- The indoctrination of personnel on the development and implementation of survey/sample plans
- The requirements associated with preparing and transporting regulated material.

Data will be cross referenced between laboratory analytical data and radiation measurements to facilitate interpreting the investigation results.

2.6 ASSESSMENT/OVERSIGHT

2.6.1 Assessments and Response Action

The FH Compliance and Quality Programs group may conduct random surveillance and assessments to verify compliance with the requirements outlined in this SAP, project work packages, the project quality management plan, procedures, and regulatory requirements.

Deficiencies identified during these assessments shall be reported to the FH technical project lead. When appropriate, corrective actions will be taken by the project lead in accordance with the Hanford Site internal laboratory QA requirements to minimize recurrence.

2.6.2 Reports to Management

Management shall be made aware of all deficiencies identified by self-assessments. Identified deficiencies shall be reported to the FH technical project lead.

2.7 DATA REVIEW, VERIFICATION, VALIDATION, AND USABILITY REQUIREMENTS

2.7.1 Data Verification and Usability Methods

Data review and verification are performed by the laboratory to confirm that sampling and chain-of-custody documentation are complete. This review shall include tying sample numbers to specific sampling location, reviewing sample collection dates and sample preparation and analysis dates to assess whether or not holding times have been met, and reviewing QC data to determine whether analyses met the data quality requirements specified in this SAP.

All data verification and usability assessments shall be performed in accordance with the Hanford Site internal laboratory QA requirements.

2.7.2 Data Validation

Data validation is performed either by an independent third party not involved in sampling, analysis, or assessment; or by the Waste Disposal/Groundwater Remediation Projects; or by PNNL using applicable data validation procedures. Five percent of the results will undergo Level C validation, as defined by these validation procedures.

2.7.3 Data Quality Assessment

The data quality assessment (DQA) process compares completed field sampling activities to those proposed in corresponding sampling documents and provides an evaluation of the resulting data. The purpose of the data evaluation is to determine if quantitative data are of the correct type and are of adequate quality and quantity to meet the project DQOs. The EPA DQA process, EPA/600/R-96/084, 2000, *Guidance for Data Quality Assessment,* EPA QA/G-9, identifies five steps for evaluating data generated from this project, as summarized below:

Step 1. Review DQOs and Sampling Design. This step requires a comprehensive review of the sampling and analytical requirements outlined in the project-specific DQO workbook and SAP.

Step 2. Conduct a Preliminary Data Review. In this step, a comparison is made between the actual QA/QC achieved (e.g., detection limits, precision, accuracy) and the requirements determined during the DQO. Any significant deviations will be documented. Basic statistics will be calculated from the analytical data at this point, as appropriate to the data set, including an evaluation of the distribution of the data and in accordance with the DQOs.

Step 3. Select the Statistical Test. Using the data evaluated in Step 2, an appropriate statistical hypothesis test is selected and justified.

Step 4. Verify the Assumptions. In this step, the validity of the data analyses is assessed by determining if the data support the underlying assumptions necessary for the analyses or if the data set must be modified (e.g., transposed, augmented with additional data) before further analysis. If one or more assumptions are questioned, Step 3 is repeated.

Step 5. Draw Conclusions from the Data. The statistical test is applied in this step, and the results either reject the null hypothesis or fail to reject the null hypothesis. If the latter is true, the data should be analyzed further. If the null hypothesis is rejected, the overall performance of the sampling design should be evaluated by performing a statistical power calculation to assess the adequacy of the sampling design.

3.0 FIELD SAMPLING PLAN

3.1 SAMPLING OBJECTIVES

The objective of the field sampling plan is to clearly identify project sampling and analysis activities. The field sampling plan uses the sampling design identified during the DQO process and presents the design primarily using figures and tables whenever possible to identify sampling locations, the total number of samples to be collected, sampling procedures to be implemented, analyses to be performed, and sample bottle requirements.

3.2 WELL DRILLING AND DESIGN

Well drilling and construction will be performed in compliance with requirements defined in the Washington Administrative Code (WAC) 173-160, "Minimum Standards for Construction and Maintenance of Wells." The boreholes will be drilled such that they can be constructed as groundwater monitoring wells for the 200-BP-5 OU. The borehole shall be drilled at least 3 ft into the upper-most basalt unit (Elephant Mountain member) for wells C5196 and C5197 and at least 3 ft into the second basalt unit (Pomona member) for well C5195 (Figures 3.1 and 3.2, respectively). The final well construction design will be finalized by the FH Groundwater Remediation Project task lead depending on the observed hydrogeologic conditions and sample analyses results. For well C5195 the final well design (i.e., screen interval) will be selected according to the following major criteria (listed in descending order of importance):

1. Analytical Results. Analytical results from depth discrete sediment and groundwater samples (see Section 3.3.1) will be evaluated and the screened interval will be placed adjacent to the zone exhibiting the highest concentrations of COCs. If no contamination is detected, then criteria 2 will be used.
2. Uppermost High Permeability Zone. The screened interval will be placed adjacent to the uppermost high permeability zone to monitor the zone most likely to be affected by contaminant migration.

For well C5195, the drilling Contractor will drill and case the borehole 5 ft into the uppermost basalt surface (Elephant Mountain member) and reduce casing size in order to properly seal the unconfined aquifer from the deeper Rattlesnake Ridge interbed confined aquifer. All temporary casing shall be removed from the borehole during well completion so that annular completion materials can be placed from surface to the bottom of the borehole.

3.3 SAMPLING LOCATIONS AND FREQUENCY

Figure 1-1 shows the location of the three proposed new groundwater wells associated with this SAP. Borehole sample collection shall be guided by the sampling scheme illustrated in Figures 3-3 and 3-4 and as summarized in Tables 3-1 through 3-4. Sample collection will be conducted according to internal FH procedures. In general, sediment samples will be collected using standard grab or split spoon methods and groundwater samples will be collected using a depth discrete KABIS sampler or by pumping. Well-specific sampling designs are summarized in the following two sections (e.g. 3.3.1 and 3.3.2). Sampling requirements for all three wells (i.e., geophysical logging) is summarized in Section 3.3.3.

Figure 3-1. Proposed Design for Wells C5196 and C5197.

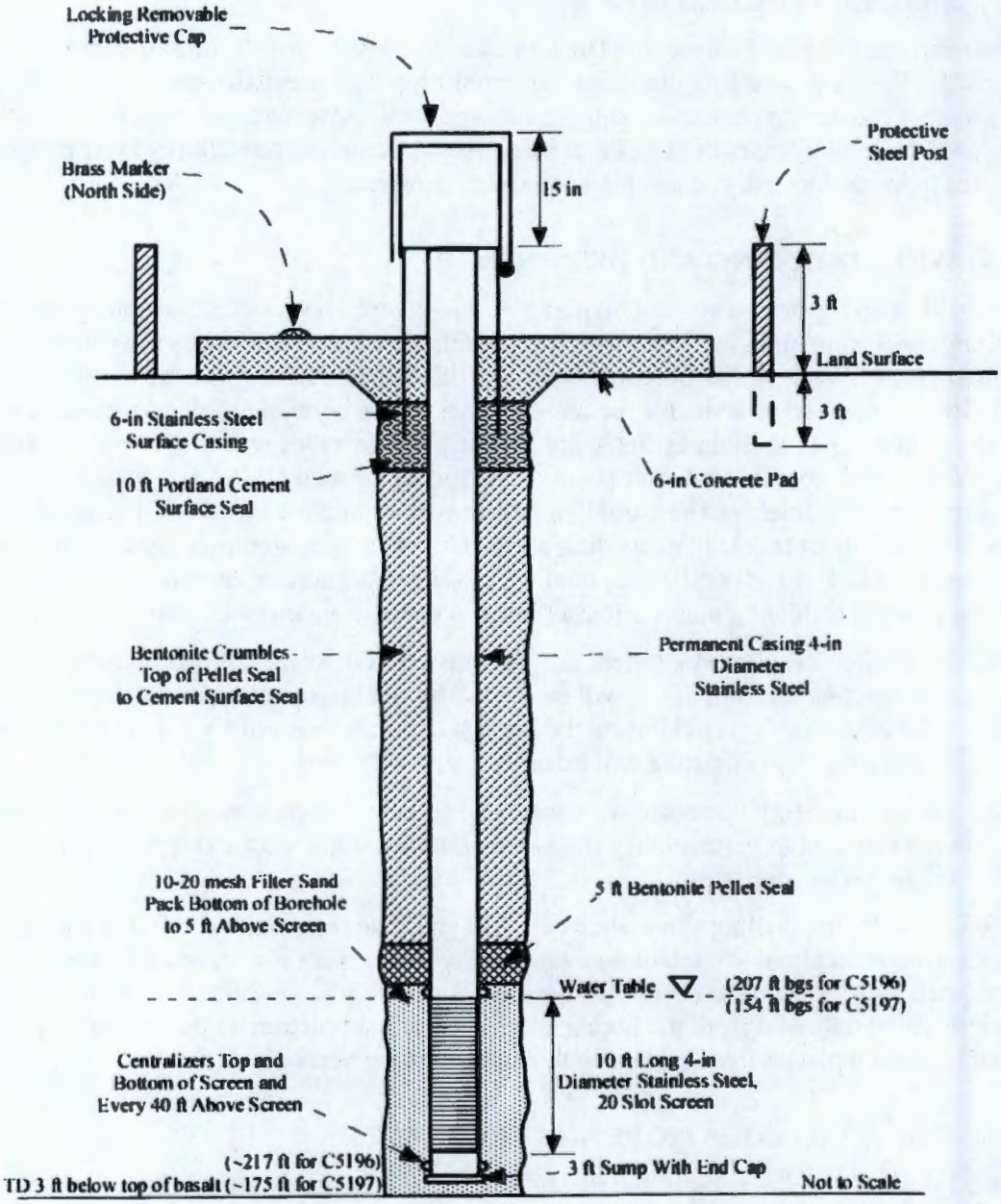


Figure 3-2. Proposed Design and Expected Geology for Well C5195.

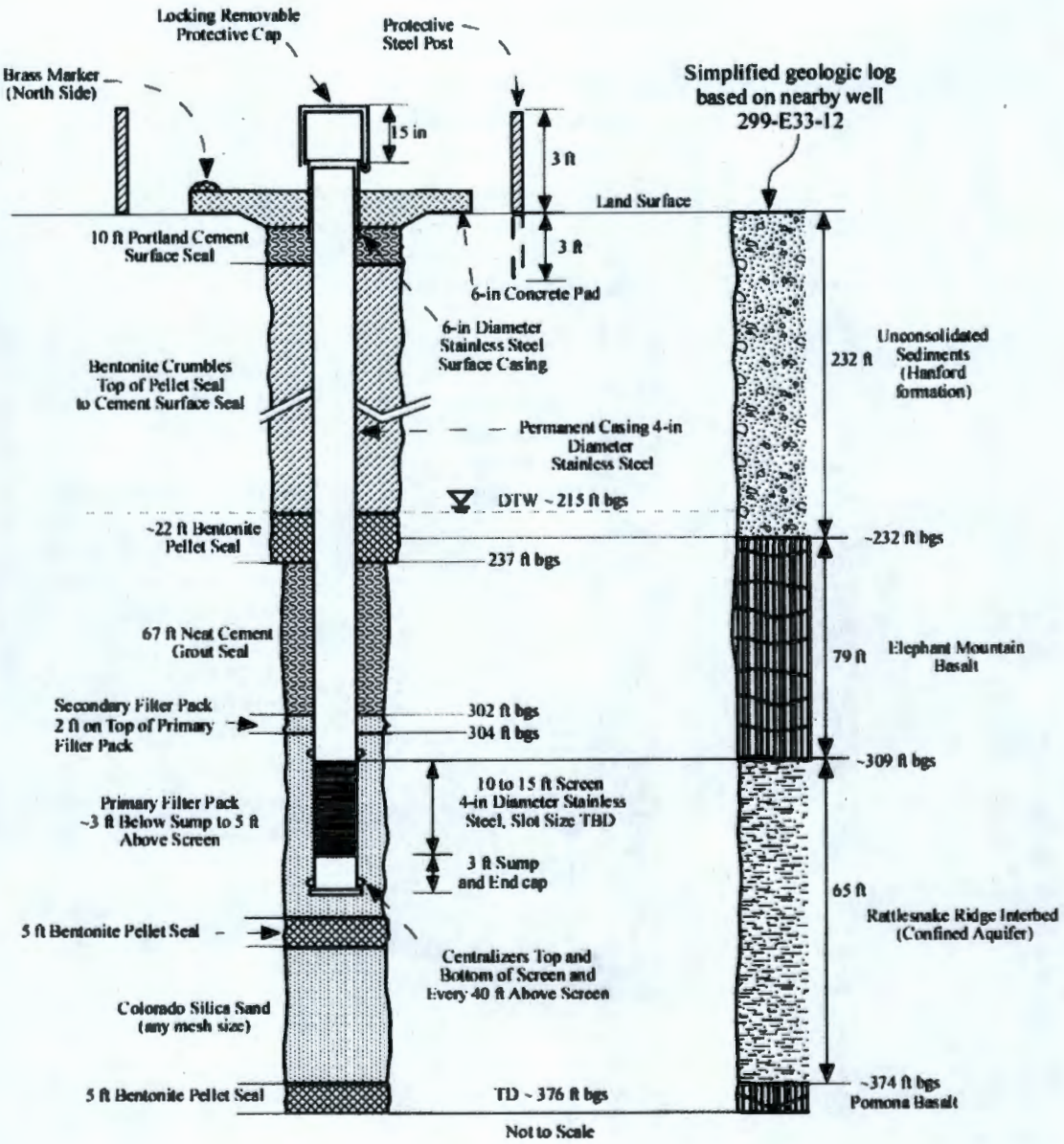
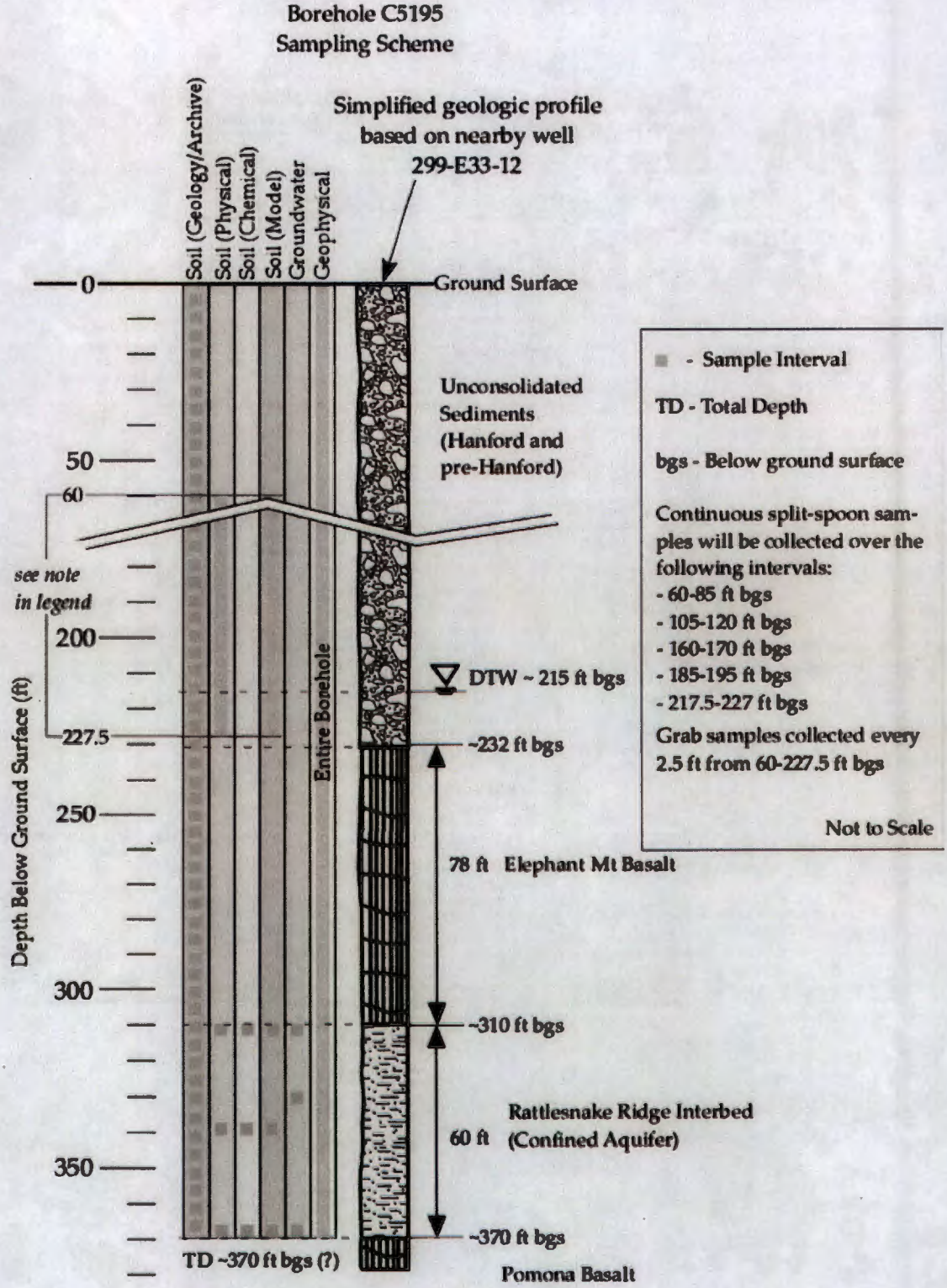


Figure 3-3. Borehole Sampling Scheme for Well C5195.



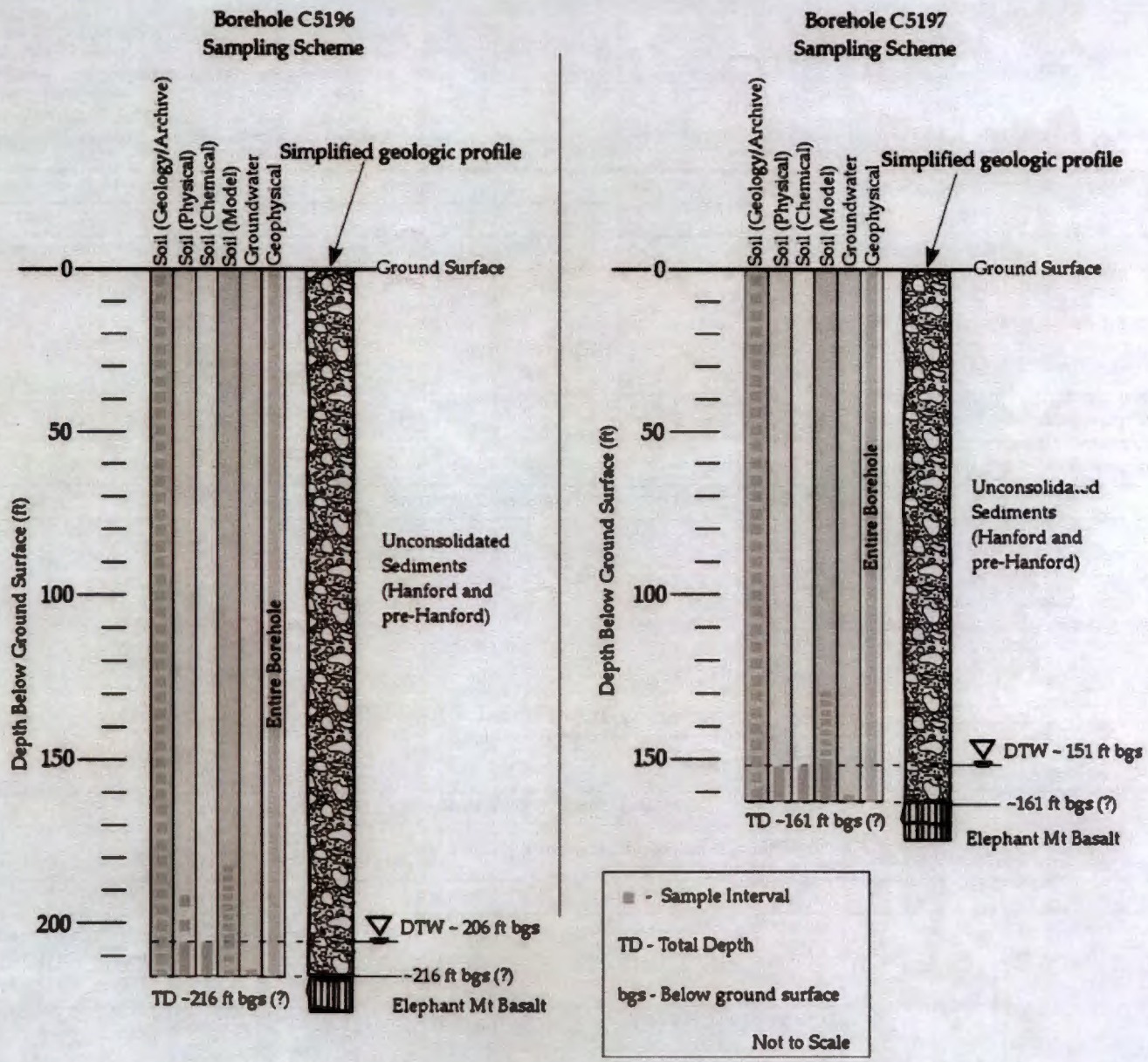


Figure 3-4. Borehole Sampling Scheme for Wells C5196 and C5197.

Table 3-1. Sediment Samples for Well C5195.

Sample Location	Sample Collection Method	Estimated Maximum Depth of Investigation	Sample Number and Type	Sample Interval	Analyte List
Lithologic Archive Samples					
Borehole C5195	Grab Pint Jar	376 ft bgs	74 samples (based on estimated depth)	Every 5 ft and at major changes in lithology	Samples for archive storage – no analysis required
Unsaturated Zone Sediment Samples					
Borehole C5195	Split-spoon	376 ft bgs	28 samples (5 for analysis)	Split-spoons collected continuously over intervals (ft bgs): 60-85, 105-120, 160-170, 185-195 and 217.5-227.5.	Physical Parameters - 2 samples (TBD) from the 28 split-spoons analyzed for Particle size distribution, cation exchange capacity, water retention or matric potential, distribution coefficient for U, Cr, and Tc-99, TOC, TIC, and bulk density.
Borehole C5195	Grab Quart Jar	376 ft bgs	67 samples (28 for analysis – 1 every 10 ft plus an estimated 7 based on observed chemical findings)	Every 2.5 ft over interval 60-227.5 ft bgs	Model Development parameters - analyzed for Tier 1 contaminant transport model development parameters – see Table 1-11. Unused samples to be retained by PNNL for potential future analyses.
Saturated Zone Sediment Samples					
Borehole C5195	Split-spoon	376 ft bgs	3 samples	At intervals 2.5-5, 25-27.5, and 47.5-50 ft below upper interbed/basalt contact (estimated contact at 310 ft bgs)	Physical parameters - particle size distribution, cation exchange capacity, water retention or matric potential, distribution coefficient for U, Cr, and Tc-99, TOC, TIC, and bulk density
					Radiological COCs – see Table 1-9
					Non-Radiological COCs – see Table 1-10
					Special – Cyanide extraction
Maximum number of collected samples (not including pint archive samples)[a]			98		
Approximate number of field quality control samples			0		
Approximate total number of samples			98		

Notes:

[a] = Note that the sample collection process is designed for comprehensive study of the unsaturated and saturated zone. Only a subset of these samples will be analyzed (as noted).

bgs = below ground surface
COC = contaminant of concern
PNNL = Pacific Northwest National Laboratory
TBD = to be determined
TIC = tentatively identified compound
TOC = total organic carbon

Table 3-2. Sediment Samples for Well C5196.

Sample Location	Sample Collection Method	Estimated Maximum Depth of Investigation	Sample Number and Type	Sample Interval	Analyte List
Archive Lithologic Samples					
Borehole C5196	Grab Pint Jar	217 ft bgs	43 samples (based on estimated depth)	Every 5 ft and at major changes in lithology	Samples for archive storage – no analysis required
Unsaturated Zone Sediment Samples					
Borehole C5196	Grab Quart Jar	217 ft bgs	8 samples	Every 2.5 ft over interval 20 ft above groundwater to groundwater surface (groundwater estimated at 206 ft bgs) – samples from 12.5 -2.5 ft above groundwater surface to be analyzed. PNNL to retain unused samples for potential future analyses.	5 samples - Model Development parameters - analyzed for Tier 1 contaminant transport model development parameters. Unused samples to be retained by PNNL for potential future analyses.
					5 samples (TBD) – Cyanide extraction
					Possible 3 samples (TBD) – Uranium isotopic signature
Borehole C5196	Split-spoon	217 ft bgs	2 samples	Samples collected from intervals 12.5-10 ft and 7.5-5 ft above groundwater surface.	Physical parameters - particle size distribution, cation exchange capacity, water retention or matric potential, distribution coefficient for U, Cr, and Tc-99, TOC, TIC, and bulk density.
Saturated Zone Sediment Samples					
Borehole C5196	Grab Quart Jar	217 ft bgs	3 samples (2 analyzed)	Every 2.5 ft in saturated interval	Model Development parameters - analyzed for Tier 1 contaminant transport model development parameters – see Table 1-11. Unused samples to be retained by PNNL for potential future analyses.
					Cyanide extraction
					Uranium isotopic signature
Borehole C5196	Split-spoon	217 ft bgs	3 Samples (only 2 analyzed – top and bottom of saturated zone), 1 field duplicate	At intervals 0-2.5 ft, 2.5-5 ft, and 5-7.5 ft below groundwater surface.	Physical parameters - particle size distribution, cation exchange capacity, water retention or matric potential, distribution coefficient for U, Cr, and Tc-99, TOC, TIC, and bulk density
					Radiological COCs – see Table 1-9
					Non-Radiological COCs – see Table 1-10
Maximum number of collected samples (not including pint archive samples)[a]				16	
Approximate number of field quality control samples				1	
Approximate total number of samples				17	

Notes:

[a] = Note that the sample collection process is designed for comprehensive study of the unsaturated and saturated zone. Only a subset of these samples will be analyzed (as noted).

bgs = below ground surface

COC = contaminant of concern

PNNL = Pacific Northwest National Laboratory

TBD = to be determined

TIC = total inorganic carbon

TOC = total organic carbon

Table 3-3. Sediment Samples for Well C5197.

Sample Location	Sample Collection Method	Estimated Maximum Depth of Investigation	Sample Number and Type	Sample Interval	Analyte List
Archive Lithologic Samples					
Borehole C5197	Grab Pint Jar	161 ft bgs	32 samples (based on estimated depth)	Every 5 ft and at major changes in lithology.	Samples for archive storage – no analysis required
Unsaturated Zone Sediment Samples					
Borehole C5197	Grab Quart Jar	161 ft bgs	8 samples (3 samples for analysis)	Every 2.5 ft over interval 20 ft above groundwater to groundwater surface (groundwater estimated at 151 ft bgs) – samples from 12.5, 7.5, and 2.5 ft above groundwater for analysis. PNNL to retain unused samples for potential future analyses.	Model Development parameters - analyzed for Tier 1 contaminant transport model development parameters. Unused samples to be retained by PNNL for potential future analyses.
					Cyanide extraction, uranium isotopic signature
Saturated Zone Sediment Samples					
Borehole C5197	Split-spoon	161 ft bgs	3 samples	At intervals 0-2.5 ft, 2.5-5 ft, and 5-7.5 ft below groundwater surface.	1 sample only (TBD) - Physical parameters - particle size distribution, cation exchange capacity, water retention or matric potential, distribution coefficient for U, Cr, and Tc-99, TOC, TIC, and bulk density
					Model Development parameters - 2 samples (TBD) analyzed for Tier 1 contaminant transport model development parameters. Unused samples to be retained by PNNL for potential future analyses.
					Radiological COCs – see Table 1-9
					Non-Radiological COCs – see Table 1-10
					Cyanide extraction, uranium isotopic signature
Maximum number of samples				6	
Approximate number of field quality control samples				0	
Approximate total number of samples				6	

Notes:

* = Note that the sample collection process is designed for comprehensive study of the unsaturated and saturated zone. Only a subset of these samples will be analyzed (as noted).
bgs = below ground surface
COC = contaminant of concern
PNNL = Pacific Northwest National Laboratory
TBD = to be determined
TIC = tentatively identified compound
TOC = total organic carbon

Table 3-4. Groundwater Samples for Wells C1595, C1596, C1597.

Sample Location	Sample Collection Method	Estimated Maximum Depth of Investigation	Sample Number and Type	Sample Interval	Analyte List
Borehole C5195	KABIS	376 ft bgs	3 samples, 1 field duplicate	Initial sample collected 2 ft below basalt/interbed contact, second sample 20 ft below first sample, third sample collected at bottom interbed/basalt contact.	Radiological COCs– see Table 1-9 Nonradiological COCs – see Table 1-10
Borehole C5195	Pumping	376 ft bgs	Samples collected at ~ 15-min intervals during well development	Field measurements during well development	pH, specific conductance, dissolved oxygen, temperature, turbidity –see Table 1-11
Borehole C5196	KABIS	217 ft bgs	1 sample, 1 field duplicate	At basalt surface (based on field observations during drilling)	Radiological COCs – see Table 1-9 Nonradiological COCs – see Table 1-10
Borehole C5196	Pumping	217 ft bgs	Samples collected at ~ 15-min intervals during well development	Field measurements during well development	pH, specific conductance, dissolved oxygen, temperature, turbidity –see Table 1-11
Borehole C5197	KABIS	175 ft bgs	1 sample	At basalt surface (based on field observations during drilling)	Radiological COCs – see Table 1-9 Nonradiological COCs – see Table 1-10
Borehole C5197	Pumping	175 ft bgs	Samples collected at ~ 15-min intervals during well development	Field measurements during well development	pH, specific conductance, dissolved oxygen, temperature, turbidity –see Table 1-11
Maximum number of samples – not including well development				5	
Approximate number of field quality control samples				2	
Approximate total number of samples				7	

Notes:
bgs = below ground surface
COC = contaminant of concern

3.3.1 Sampling Design Specific to Well C5195

As noted in Section 1.0, well C5195 will serve as a monitoring well for the Rattlesnake Ridge confined aquifer. Samples collected during drilling are designed to establish if recently observed Technetium-99 contamination in well 299-E33-12 is a result of vertical flow between the unconfined and confined aquifers or is from an upgradient source. Hydrogeologic and geochemical characterization of the Rattlesnake Ridge interbed is also a goal of the characterization effort.

Sediment Samples

Split-Spoon Samples: Continuous split-spoon samples will be collected from the unsaturated zone over the intervals 60 to 85 ft below ground surface (bgs), 105 to 120 ft bgs, 160 to 170 ft bgs, 185 to 195 ft bgs, and 217.5 to 227.5 ft bgs. The intervals were chosen to align with low permeability zones using stratigraphic information from nearby wells. Of the 28 samples collected, five physical property samples (at depths to be determined) are currently scheduled for analysis. The remaining unused samples will be retained for potential future analysis. A total of three split-spoon samples will be collected from the top, middle and bottom of the Rattlesnake Ridge interbed sediments. Based on the drillers log from well 299-E33-12, the thickness of the interbed is estimated at 60 ft. The samples will be collected at intervals 2.5 to 5 ft, 25 to 27.5 ft, and 47.5 ft below the upper Elephant Mountain member basalt and Rattlesnake Ridge interbed contact. The intervals were chosen to align with higher permeability zones based on well log information from well 299-E33-12. The split-spoon samplers will be equipped with four, 6-in. long lexan liners to allow segregation of the split-spoon sample after collection. The split-spoon sample liners will be capped, taped, and labeled according to internal FH procedures. A grab sample will be collected from any interval where minimal or no split-spoon recovery is obtained.

The five split spoon samples chosen for analysis from the 60 to 227.5 ft bgs interval will be analyzed for the physical and model development parameters listed in Table 1-11. The three split-spoon samples collected from the Rattlesnake Ridge interbed will be analyzed for the radiological and non radiological COCs and the physical parameters listed in Tables 1-9, 1-10, and 1-11, respectively. Analysis for the radiological and non radiological COCs will be performed at the Waste Sampling and Characterization Facility (WSCF) located on the Hanford site. Physical parameters testing and model development parameters will be performed by the PNNL in Richland, Washington.

Grab Samples: Grab samples will be collected from the drill cuttings in quart mason jars at 2.5 ft intervals between 60 and 227.5 ft bgs. These samples are in addition to the lithologic archive samples collected every 5 ft over the entire borehole. The quart-size grab samples will be analyzed by PNNL for a number of parameters used for verifying and developing geochemical transport models for the 200-BP-5 OU.

Groundwater Samples

KABIS Samples: Depth-discrete groundwater samples will be collected at corresponding intervals to the split-spoon samples near the top, middle, and bottom of the Rattlesnake Ridge interbed confined aquifer (see interbed split-spoon sample intervals in Table 3-1). The KABIS sample will be collected according to internal FH procedures. The KABIS sampler must be

lowered continuously to the target depth before stopping, in order to achieve a proper depth-discrete sample.

KABIS samples will be analyzed for the COCs listed in Tables 1-9 and 1-10. Analysis for the majority of radionuclide and non radionuclide COCs will be performed at WSCF.

3.3.2 Sampling Design Specific to Wells C5196 and C5197

As noted in Section 1.0, wells C5196 and C5197 are designed to provide northern definition of the uranium groundwater plume located north of the 200 East Area. The boreholes will also encounter the top of the basalt in order to obtain additional control on the basalt surface and for well C5197, to help identify an erosional channel in the basalt that could be the conduit between the unconfined and uppermost confined aquifers. These wells will also provide additional hydraulic data to help resolve the groundwater flow direction north of the 200 East Area. Other possible benefits from these wells include resolving possible differing uranium isotopic ratios in the deep vadose zone (past saturated zone), providing moisture content in various soil horizons, determining the concentrations of other radionuclide and chemical contaminants, and providing additional characterization data to augment risk assessment modeling of future contaminant migration.

Sediment Samples

Split-Spoon Samples: A total of two split-spoon samples will be collected from the intervals 12.5 to 10 ft and 7.5 to 5 ft above the water table (from well C5196 only). Split-spoon samples will be collected from intervals 0 to 2.5 ft and 4 to 6.5 ft below the water table at both well locations. The water table in the vicinity of the boreholes is estimated at 206 ft bgs at proposed well C5196 and 151 ft bgs at proposed well C5197. The thickness of the aquifer in the vicinity of the two proposed wells is thin due to the elevated basalt surface. Because of this, it should be noted that the lower-most sample interval may not be reached prior to encountering basalt. Every effort should be made to collect a split-spoon sample just above the basalt surface. A grab sample will be collected from any interval where minimal or no split-spoon recovery is obtained.

Split-spoon samples collected from the unsaturated zone in well C5196 will be analyzed for the physical parameters listed in Table 1-11. The split-spoon samples collected from the saturated zone at both well locations will be analyzed for the COCs listed in Tables 1-9 and 1-10 and for selected physical parameters (particle-size distribution, bulk density, and moisture content) listed in Table 1-11. Analysis of the sediments for the majority of radionclide and non radionuclide COCs will be performed at WSCF. Selected geochemical parameters will be performed by PNNL based on preliminary findings from WSCF results.

Grab Samples: Grab samples will be collected from the drill cuttings in quart mason jars at 2.5 ft intervals between 20 ft above the groundwater to groundwater in wells C5196 and C5197. Additional grab samples will be collected from the saturated zone in well C5196 every 2.5 ft. These samples are in addition to the lithologic archive samples collected every 5 ft over the entire borehole. Selected quart-size grab samples will be analyzed by PNNL for a number of parameters used for verifying and developing geochemical transport models for the 200-BP-5 OU (see Table 1-11).

Groundwater Samples

KABIS Samples: Depth-discrete groundwater samples using a KABIS sampler will be collected once the basalt surface is encountered in wells C5196 and C5197. A pumped sample may also be an option if 1) the aquifer thickness is sufficient to place a submersible pump, and 2) it is anticipated based on drilling observations that the aquifer will provide sufficient yield for a pumped sample.

KABIS (or pumped) samples will be analyzed for the COCs listed in Tables 1-9 and 1-10. Analysis for the majority of radionclide and non radionuclide COCs will be performed at WSCF. Selected parameters (need to specify) will be performed by PNNL. A sample aliquot from each sample will be analyzed for isotopic uranium at the Lawrence Berkeley National Laboratory.

3.3.3 Sampling Requirements for All Wells

The following sampling methodologies will be used at each well.

Geologic/Archive Samples

Cuttings will be collected every 5 ft or at major changes in lithology for purposes of geologic description and for archived storage. Cuttings will be collected in pint glass jars (one per interval). Geologic descriptions using FH internal procedures will be performed by the well-site geologist.

Geophysical Logging

Each borehole will be logged using S.M. Stoller Corporation's (Stoller's) spectral gamma logging system (SGLS) and neutron moisture logging system (NMLS). In general, borehole logging will be performed through a single string of casing (i.e., prior to telescoping) over the entire length of borehole. The SGLS uses a cryogenically cooled, high-purity germanium detector to detect, identify, and quantify gamma-emitting radionuclides in the subsurface. Identification of naturally occurring and man-made radionuclides is based on detection of characteristic gamma rays emitted during decay of specific radionuclides. The SGLS is calibrated annually by measuring detector response to gamma rays from potassium (K-40), thorium (Th-232), and uranium (U-238), resulting in a continuous detector response function over an energy range between 185 keV and 2.6 MeV. Verification of annual calibration prior to logging will ensure reliable detection and quantification of gamma-emitting radionuclides. The SGLS will be operated in move-stop-acquire mode with count times on the order of 100 to 200 seconds (s) per data point, at 1-ft depth increments. The logging data will be corrected for dead time, well-casing thickness, and the presence of water in the borehole.

The NMLS uses a 50-mCi americium/beryllium source and helium-3 detector. Neutrons emitted from the source bombard the surrounding formation and are scattered back to the detector. Neutron moisture logs are useful as an indication of in situ moisture content and for stratigraphic correlation. The NMLS will be calibrated to provide an indication of the volumetric moisture content up to about 20 percent in 6-in. and 8-in. diameter cased boreholes. For other borehole diameters, the NMLS data will be used qualitatively to identify differences in moisture content.

3.4 SAMPLING PROCEDURES

Table 3-5 lists the sampling related activities addressed by existing FH and DFSNW procedures. The appropriate procedure will be implemented by the field personnel during performance of the sampling activity.

Table 3-5. Sampling Activities Conducted Using Internal FH and DFSNW Procedures.

Sampling Activities Prior to Well Construction (FH Procedures)	Groundwater Sampling Activities Following Well Construction (DFSNW Procedures)
Sampling Equipment Decontamination	Chain of Custody/Sample Analysis Request
Geologic Logging	Project and Sample Identification for Sampling Services
Groundwater Sampling	Field Logbooks
Calibration of Field Equipment	Laboratory Cleaning of Sampling Equipment
Sample Packaging and Shipping	Calibration of Field Equipment
Sampling Documentation	Sample Packaging and Shipping
Soil and Sediment Sampling	Groundwater Sampling
Well Development and Testing	Control of Monitoring Instruments
Geophysical Logging (S.M. Stoller procedures)	Turbidity Measurements
	pH and Temperature Measurements
	Field Analysis of Conductivity

Notes:
FH = Fluor Hanford, Inc.
DFSNW = Duratek Federal Services Northwest

3.5 SAMPLE MANAGEMENT

Sample and data management activities will be performed in accordance with FH QA program plans.

Sample preservation, container, and holding-time requirements will be specified on sampling authorization forms and chain-of-custody forms in accordance with the requirements specified in RFS (1999) (or equivalent) and the specific analytical method prepared for specific sample events.

3.5.1 Sample Custody

All samples obtained during the project will be controlled from the point of origin to the analytical laboratory, as required by the Hanford Site internal laboratory QA requirements, and applicable FH and DFSNW procedures.

3.5.2 Sample Packaging and Shipping / Field Documentation

Field documentation shall be kept in accordance with the Hanford Site internal laboratory QA requirements, and FH and DFSNW procedures pertaining to the following:

- Chain of Custody/Sample Analysis Requests
- Logbooks
- Geologic Logging
- Sampling Documents.

3.6 MANAGEMENT OF INVESTIGATION-DERIVED WASTE

Investigation-derived waste from these sampling activities will be handled as CERCLA waste. The *Waste Control Plan for the 200-BP-5 Operable Unit* (DOE/RL-2003-30) establishes the management (e.g., designation, packaging and labeling, storage/transportation) and disposal of investigation-derived waste generated from groundwater well sampling, aquifer testing, groundwater well installation, water level, screening analysis, geophysical logging, and equipment decontamination for 200-BP-5 OU investigations. The anticipated waste streams associated with the activities included in this SAP include:

- Miscellaneous solid waste such as filters, wipes, gloves, and other personal protective equipment, cloth, sampling and measuring equipment, pumps, pipe, wire, plastic sheeting, tools, bentonite, sand, paper, wood, construction debris, stainless steel or carbon steel metal, and glass
- Purgewater generated during groundwater well installation, development, testing, monitoring, maintenance, and decommissioning
- Purgewater generated during decanting of soils and slurries
- Decontamination fluids
- Liquids generated during screening analysis
- Drill cuttings and associated wastes
- Materials generated from cleanup of unplanned releases
- Equipment and construction material (e.g., well casing, drill string, drive barrel, decommissioning materials, wooden pallets, etc.)

In addition to the Waste Control Plan referenced above, a DQO summary report is being prepared to support decision-making activities as they pertain to the handling, designation, and disposition of waste derived from the installation of three groundwater monitoring wells associated with this SAP. This waste DQO will be in place prior to initiation of drilling activities.

Unused samples and associated laboratory waste for the analysis will be dispositioned in accordance with the laboratory contract and agreements for return to the Hanford Site. In accordance with 40 CFR 300.440, FH technical project lead approval is required before returning unused samples or waste from offsite laboratories.

4.0 HEALTH AND SAFETY

All personnel working at the drilling sites addressed by this SAP will have completed, at a minimum:

- Occupational Safety and Health Administration Act 40-hour Hazardous Waste Site Worker training program (29 CFR 1910.120).
- Hanford General Employee Training (HGET).
- Hanford Radiation Worker II training.

Work will be performed in accordance with the following procedures:

- *PHMC Radiological Control Manual* (HNF-5173)
- Site-specific plans, as applicable:
  - Health and safety plans
  - Radiological Work Permit, as applicable
  - Activity hazard analysis/job safety analysis
  - Site-specific Waste Packaging Instruction
- HNF-IP procedures
- Central Plateau Radiological Control Procedures
- FH Environmental Procedures.

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5.0 REFERENCES

10 CFR 830, "Nuclear Safety Management," *Code of Federal Regulations,* as amended.

10 CFR 835, "Occupational Radiation Protection," *Code of Federal Regulations,* as amended.

29 CFR 1910, "Occupational Safety and Health," *Code of Federal Regulations,* as amended.

40 CFR 141, "National Preliminary Drinking Water Regulations," *Code of Federal Regulations,* as amended.

40 CFR 143, "National Secondary Drinking Water Regulations," *Code of Federal Regulations,* as amended.

40 CFR 300, "National Oil and Hazardous Substances Pollution Contingency Plan," *Code of Federal Regulations*, as amended.

Comprehensive Environmental Response, Compensation, and Liability Act of 1980, 42 U.S.C. 9601, et seq.

DOE Order 414.1A, *Quality Assurance,* U. S. Department of Energy, Office of Environment, Safety and Health, Washington, D. C.

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DOE/RL-92-24, 1995, *Hanford Site Background: Part 1, Soil Background for Nonradioactive Analytes,* DOE/RL-92-24, Rev. 3, U. S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE/RL-92-70, 1993, *Phase I Remedial Investigation Report for 200-BP-1 Operable Unit*, Rev. 0, U. S. Department of Energy, Richland Operations Office, Richland, Washington.

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APPENDIX A

Tiered Screening Rationale

A1.0 INTRODUCTION

The following describes the three-step tiered approach used to develop and screen groundwater constituents of potential concern (COPCs) associated with the 200-BP-5 OU. COPCs developed according to this process will be evaluated as COCs. Hanford site databases and a radionuclide inventory code were integral in researching well location, groundwater analytical data, waste site location and inventory, and radionuclide inventory. Each of these sources of information is described:

1) Waste Information Data System (WIDS) comprises the official summary of the history and status of the Hanford waste sites.
2) Hanford Environmental Information System (HEIS) database with the current analytical data for soil, biota, atmospheric, miscellaneous material, surface water and groundwater samples
3) Environmental Data Access (EDA) compiles analytical data from HEIS into groundwater quality well summary tables for the 200-BP-5 OU. The summary tables provide breakdown of the number of samples, detects, date first sampled and last sample date for various categories (e.g. radionuclides, volatiles, semi-volatiles, pesticides, metals, general chemistry [i.e. anions, cations, etc.], and physical properties).
4) Hanford Virtual Library provides laboratory reviewer comments and trend plots on individual analysis and various constituents, respectively.
5) Hanford Well Information System (HWIS) consists of information regarding the locations, as built diagrams and maintenance records for wells and boreholes for the Hanford Site.
6) The Hanford Geographic Information System (HGIS) contains detailed, accurate maps of the site and its main features, such as buildings, roads, aboveground and underground services, structures, piping, topography, geology, wells, and rivers and ponds.
7) Oak Ridge Isotope Generation and Depletion Code (ORIGIN2), contains the curie content per ton of uranium fuel for the highest inventories of actinides, fission products and activation products as well as the degradation of inventory over 5, 10, 25 and 50 years. The code was established for C and N reactor production.

The first step of the tiered approach involved development of a master list of contaminants. The master list was compiled from two primary sources:

- COPCs identified in source OU remedial investigation/feasibility study (RI/FS) work plans for waste sites contained within or contiguous to the boundaries of the 200-BP-5 OU. Contaminants considered not having the potential to impact groundwater were included in the master list for evaluation as a groundwater COPC
- Best basis inventories for tank farms located within the boundaries of the 200-BP-5 OU

The second step of the tiered approach involved comparing the master list of contaminants to groundwater analytical data from selected wells within the 200-BP-5 OU. Available database records indicate approximately 202 groundwater wells have been drilled within the 200-BP-5 OU. Each well was reviewed for use in the COPC screening process based on certain criteria including location, number of samples, active years of use, and maximum concentrations of contaminants of potential concern. Some of the 202 wells were removed from COPC screening process for a variety of reasons, such as limited sample results, distance from source sites, and date of well usage. Upon completion of the well review, 57 wells were selected for a detailed review as shown on Figure A-1. Forty-four of the wells selected were identified as Environmental Surveillance wells used by PNNL. These wells were retained due to their location and longevity near source waste sites. Besides the Environmental Surveillance wells, 13 additional wells were selected for COPC screening primarily based on their location relative to certain waste sites within the 200-BP-5 OU.

The following tables summarize the results of the detailed review which involved comparison of the master list of contaminants to groundwater analytical data from the 57 selected wells. Included in each table is the current total number of samples for the constituent from all 57 wells, date range of samples, number of wells sampled, total detects, total non-detects, maximum value reported, date of maximum value reported, regulatory standards for the constituent, background concentrations, retention decision, and comments.

The third step, and final step of the tiered approach involved evaluating the results of the detailed review to determine if a constituent should be excluded from further evaluation or retained as a COPC or COC. The decision on whether a constituent was excluded or retained as a groundwater COPC or COC for 200-BP-5 is included in the table. The basis for that determination is also included.

The criteria for retaining or excluding a constituent as a COPC or COC included:

- For all constituents (i.e., rad and non-rad), if analytical concentrations were below laboratory detection limits (i.e., all non detects), then the constituent was excluded as a COPC.
- For non-rad constituents, if the maximum reported value for a constituent is less than the Hanford site background concentration (DOE/RL-92-23 or DOE/RL-96-61) then the constituent was excluded as a COPC.
- For non-rad constituents, if the maximum value for a constituent exceeded background, but was less than EPA's primary or secondary drinking water standards and/or groundwater cleanup levels established according to the Model Toxics Control Act (WAC 173-340-720) Method B, then the constituent was excluded as a COPC. In some cases, if the maximum concentration was less than, but close to the regulatory thresholds or significantly higher than background, then the constituents was retained as a COPC for further evaluation.
- For non-rad constituents, if the maximum value for a constituent measured within the past 10 years exceeded EPA's primary or secondary drinking water standards

and/or groundwater cleanup levels established according to the Model Toxics Control Act (WAC 173-340-720) Method B, then the constituent was retained as a COC. If concentrations since the reported maximum have dropped below the regulatory thresholds mentioned above prior to the past three years, then the constituent was retained as a COPC rather than a COC. This was done for cadmium.

- For radionuclides, if the maximum value determined by analysis or ORIGIN2 modeling, is less than EPA's recommended 4 mrem per year ingestion dose limit (for beta and photon emitters) or less than 15 pCi/L for alpha emitters, then the constituent was excluded as a COPC.
- For radionuclides, if the maximum value for a constituent measured within the past 10 years determined by analysis or ORIGIN2 modeling, exceeds EPA's recommended 4 mrem per year ingestion dose limit (for beta and photon emitters) or more than or equal to 15 pCi/L for alpha emitters, then the constituent was retained as a COC.
- For all constituents, if groundwater analytical results or modeling results are inconclusive (i.e., not measured), then the constituent was retained as a COPC for further evaluation.

Note that metal constituents required further evaluation. Unfiltered samples were observed to have significantly higher concentrations for certain metals due to particle suspension in the water. Filtered results were generally used for comparison with regulatory standards and background concentrations. Thus, if the filtered results for a metal constituent were below regulatory standards or background concentrations then the constituent was excluded.

All radionuclide decay series were evaluated to determine key radionuclide indicators for radionuclide contaminants with no sample results or limited sample results. The key radionuclides were used for comparison from ORIGIN2 inventory calculations. Generally the radionuclides that were excluded were found to have insignificant ORIGIN2 inventories and were daughter products with low potential of in growth in the next 1000 years or more. Note that none of the radionuclides excluded have been determined (e.g. through draft waste site remedial investigation (RI) and feasibility study (FS) reports) to impact groundwater now or in the future.

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Figure A-1. 200-BP-5 Evaluated Historical Groundwater Monitoring Wells

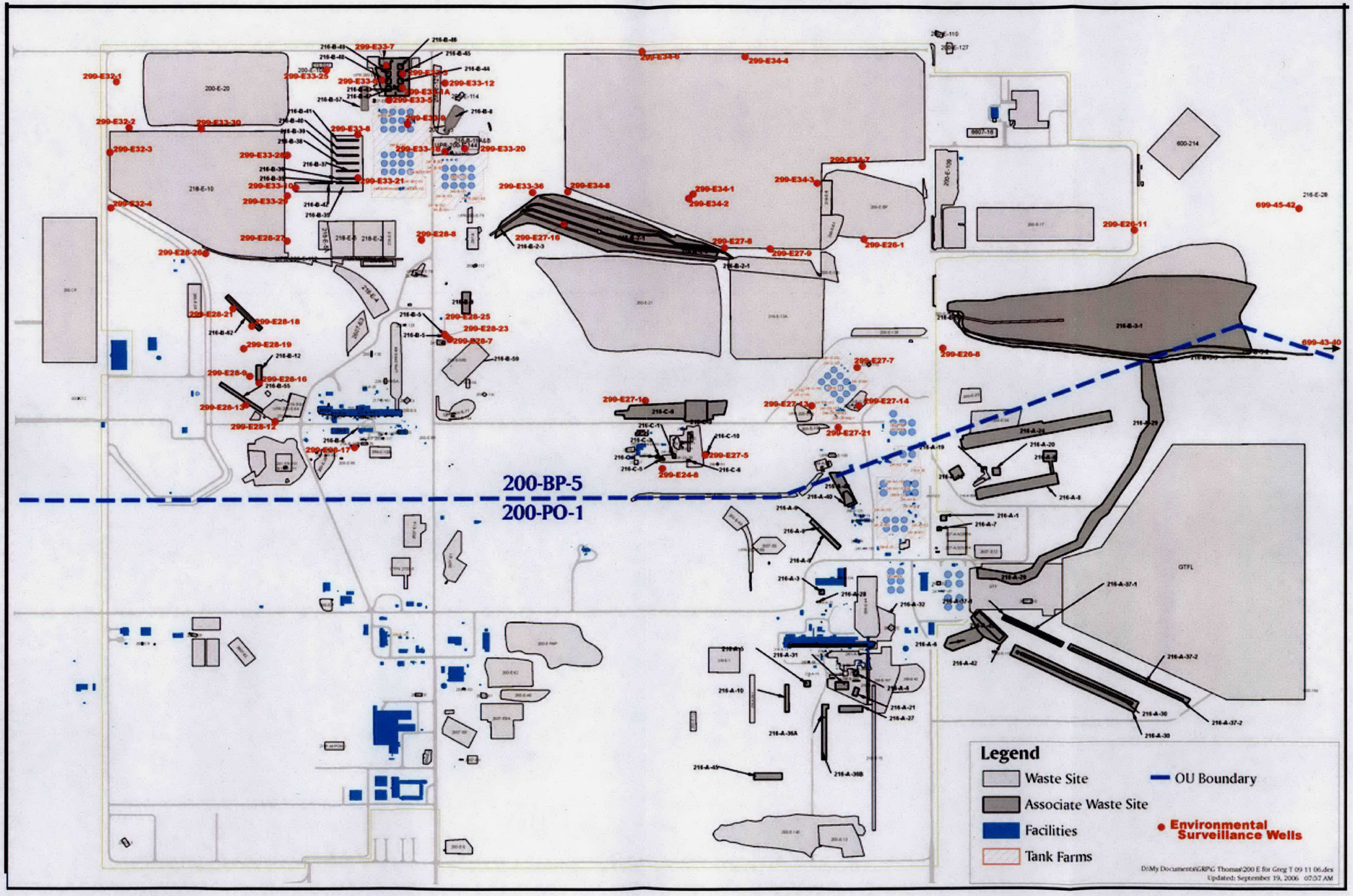

Table A-1. 200-BP-5 Radionuclide Contaminant Preliminary Screening Decision

Constituent	Total Samples	Sample Date Range	Number of Wells Sampled[c]	Total Detects	Total Non-Detects	Maximum Value Reported	Date of Maximum Detected	NPDWS	4 mrem standard dose.	Background	Retention Decision	Comments
Am-243	0	NA	0	0	0	NA	NA	15 pCi/L	NA	NA	Excluded	By length of decay rate for Cm-247 (16 million years) and Bk-247 (1400 years). Am-243 is associated with the Cf-251 and Bk-247 decay series. Based on the decay rate of Cm-247 and Bk-247 there would not be significant decay in growth for hundreds of years. In addition, in inventory comparisons based on ORIGIN2 Am-243 has nearly 4 orders of magnitude less inventory than Am-241 ten years after discharge. Am-243 has four orders less inventory 50 years after discharge.
Sb-125	365	1990-2006	34	45	320	116 pCi/L	9/3/92	NA	300 pCi/L	3.77 pCi/L[b(1)]	Excluded	No detected values above derived regulatory limits. All concentrations were significantly less than standards. According to ORIGIN2 values Sb-125 drops 5 orders of magnitude from 10 years to 50 years after reactor production. This constituent is representative of Sb-126 and Sb-126m due to higher initial inventory (5 orders of magnitude > inventory than Sb-126 and Sb-126m after 10 years removal from reactor). It also has the same mobility and that it is within an order of magnitude 50 years after removal from reactor.
Sb-126	0	NA	0	0	0	NA	NA	NA	537 pCi/L	NA	Excluded	By association with Sb-125 (see above).
Sb-126m	0	NA	0	0	0	NA	NA	NA	58,535 pCi/L	NA	Excluded	By association with Sb-125 (see above).
Ba-137m***	0	NA	0	0	0	NA	NA	NA	5,160 pCi/L	NA	COPC	By association with Cs-137. Ionic potential similar to Cs-137 thus similar mobility.
Be-7	351	1990-2006	32	19	332	7240 pCi/L	2/4/92	NA	42,926 pCi/L	9.4 pCi/L[b]	Excluded	All detected values reported were before 1992. Appears the analytical methodology was refined in 1992. Since 1992 all 256 results have been non-detect. In addition, half life is < 3 years. This constituent did not make the top 57 fission products and thus would be more than 23 orders of magnitude less than Cs-137 after 50 years.
Bi-210	0	NA	0	0	0	NA	NA	NA	856 pCi/L	NA	Excluded	By association with U-238. Bi-210 is associated with the U-238 natural decay series and Cm-250, Bk-250 and Cf-250 decay series. Based on Bateman equation, daughter products after U-234 would not generate equilibrium for approximately 1 million years. Thus, Bi-210 would have insignificant concentrations. According to ORIGIN2 derived inventory, values 50 years after removal from the reactor, Bi-210 is 5.5 orders of magnitude less than U-238.
Bi-211	0	NA	0	0	0	NA	NA	15 pCi/L	NA	NA	Excluded	By association with U-235. Bi-211 is associated with the U-235 natural decay series as well as the Cf-251, Bk-247, and Cm-243 decay series. Based on Bateman equation, daughter products after Pa-231 would not have significant in growth for thousands of years. According to ORIGIN2 derived inventory values 10 years after removal from the reactor Bi-211 is 4.5 orders of magnitude less than U-235. After 50 years Bi-211 is 3.5 orders of magnitude less than U-235. Based on ORIGIN2 and Bi-211 relationship to U-235 possible hot spots at B-5 reverse well would be 1.0E-3 pCi/L if in growth has occurred.

Table A-1. 200-BP-5 Radionuclide Contaminant Preliminary Screening Decision

Constituent	Total Samples	Sample Date Range	Number of Wells Sampled[c]	Total Detects	Total Non-Detects	Maximum Value Reported	Date of Maximum Detected	NPDWS	4 mrem standard dose.	Background	Retention Decision	Comments
Bi-212	0	NA	0	0	0	NA	NA	15 pCi/L	NA	NA	Excluded	By association with U-236 and Th-232. Bi-212 is associated with the Th-232 natural decay series and the Cm-244 and Cm-248 decay series. Based on long half life of U-236 and Th-232 (e.g. both over 23 million years) there would be insignificant inventory of Bi-212 for at least a million years. According to ORIGIN2 derived inventory values 10 years after removal from the reactor Bi-212 is 2 orders of magnitude less than U-236. After 50 years Bi-212 is still 2 orders of magnitude less than U-236.
Bi-213	0	NA	0	0	0	NA	NA	NA	7,595 pCi/L	NA	Excluded	By association with Am-241. Bi-213 is a decay product of Am-241 in the Cf-249 decay series. Based on Bateman equation, daughter products after Th-229 would not have significant in growth for thousands of years. Based on ORIGIN2 calculations Bi-213 did not make the top 60 actinide product inventories from reactor generated uranium fuel. Thus Bi-213 would be more than 10 orders of magnitude less than Am-241 reported values.
Bi-214	0	NA	0	0	0	NA	NA	NA	19,384 pCi/L	NA	Excluded	By association with U-238 and U-234. Bi-214 is associated with the U-238 natural decay series and Cm-250, Bk-250 and Cf-250 decay series. Based on Bateman equation, daughter products after U-234 would not generate equilibrium for approximately 1 million years. Thus, Bi-214 would have insignificant concentrations. According to ORIGIN2 derived inventory, values 50 years after removal from the reactor, Bi-214 is 5 orders of magnitude less than U-238.
C-14	2	1997-1998	2	0	2	NA	NA	NA	2,626 pCi/L	NA	COPC	Limited results and high activation product based on ORIGIN2.
Ce-144	64	1991-1994	13	0	64	NA	NA	NA	30 pCi/L	NA	Excluded	No detected values. 15 orders magnitude <Cs-137.
Cs-134	381	1991-2006	32	14	367	9.25 pCi/L	12/18/90	NA	80 pCi/L	0.747 pCi/L[b(1)]	Excluded	No detected values reported above derived regulatory standards. The highest concentration reported is at the B-5 reverse well. Cs-134 has seven orders of magnitude less inventory than Cs-137 after 50 years based on ORIGIN2 calculations.
Cs-135	0	NA	0	0	0	NA	NA	NA	900 pCi/L	NA	Excluded	By association with Cs-137 and Cs-134. 6 orders < Cs-137 after 50 years based on ORIGIN2 calculations.

Table A-1. 200-BP-5 Radionuclide Contaminant Preliminary Screening Decision

Constituent	Total Samples	Sample Date Range	Number of Wells Sampled[c]	Total Detects	Total Non-Detects	Maximum Value Reported	Date of Maximum Detected	NPDWS	4 mrem standard dose.	Background	Retention Decision	Comments
Cs-137	692	1988-2006	48	128	564	2310 pCi/L	3/29/94	200 pCi/L	200 pCi/L	2.26 pCi/L[b(1)]	COC	Only reported two wells above derived regulatory levels. The values were from 299-E28-23 and E28-25 located 3 and 20 feet from the B-5 reverse well, respectively. One other well had values approaching half of the derived regulatory limit. This well, 299-E28-7, is also located in the vicinity of B-5. Cs-137 is the most appropriate fission product contaminant for deriving other ORIGIN2 fission constituent concentrations which have no current analysis method available. This is due to the ranking of Cs-137 on the ORIGIN2 table. Cs-137 has the highest potential curies/metric ton of uranium fuel. In certain situations due to distribution coefficients other contaminants may be more appropriate. Those situations are identified in this table.
Cl-36	0	NA	0	0	0	NA	NA	NA	1,810 pCi/L	NA	Excluded	Based on ORIGIN2 calculations Cl-36 did not make the top 57 activation or fission product inventories from reactor generated uranium fuel. Thus, Cl-36 would be more than 13 orders of magnitude less than Cs-137 reported values. Therefore, Cl-36 is insignificant.
Co-60	865	1988-2006	48	206	659	228 pCi/L	10/24/88	100 pCi/L	100 pCi/L	1.09 µg/L[b(1)]	COPC	One detected value reported above NPDWS. However, the value is not consistent with the other sample results from the same well. The result was reported near the B-5 reverse well. The most consistent elevated concentrations of Co-60 are underlying and proximal the BY cribs (wells 299-E33-3, -7, -9, -38, and -44). Concentrations have ranged up to 78.4 pCi/L but appear to be trending down.
Cm-244	1	2004	1	0	1	NA	NA	15 pCi/L	NA	NA	Excluded	No detected values reported. Cm-244 is the initial radionuclide in the Cm-244 decay series. Main parent for Pu-240. Cm-244 has an 18 year half life. Not considered to have significant inventory based on ORIGIN2 calculations and relationship with Pu-240. Inventory concentrations are 1.5 orders of magnitude (20X) less at 10 years and 2.5 orders of magnitude less at 50 years. Potential hot spots at B-5 reverse well would be possibly 0.1 pCi/L if the Cm-244 was the only parent for Pu-239/240. Since Pu-239/240 was derived from the reactors, and is a daughter product of the Cf-251 and Cm-244 decay series any potential hot spots of Cm-244 are considered to be orders of magnitude less than .1pCi/L.
Cm-245	0	NA	0	0	0	NA	NA	15 pCi/L	NA	NA	Excluded	Cm-245 is a decay product of Cf-249 in the Cf-249 decay series. Not considered to have significant inventory based on ORIGIN2 calculations and relationship with Am-241. Inventory concentrations are 5.5 orders of magnitude less at 10 years and 6 orders of magnitude less at 50 years.
Eu-152	341	1992-2006	28	0	341	NA	NA	NA	200 pCi/L	12.9 µg/L[b(1)]	Excluded	No detected values reported.

Table A-1. 200-BP-5 Radionuclide Contaminant Preliminary Screening Decision

Constituent	Total Samples	Sample Date Range	Number of Wells Sampled[c]	Total Detects	Total Non-Detects	Maximum Value Reported	Date of Maximum Detected	NPDWS	4 mrem standard dose.	Background	Retention Decision	Comments
Eu-154	460	1988-2006	30	12	448	12.5 pCi/L	9/23/91	NA	60 pCi/L	8 μg/L[b(1)]	Excluded	All detected values reported were before 1992. Since 1992 all 431 results have been non-detect.
Eu-155	439	1990-2006	42	19	430	10.2 pCi/L	8/1/91	NA	600 pCi/L	2.33 μg/L[b]	Excluded	All detected values reported were before 1992. Since 1992 all 405 results have been non-detect.
Fr-221	0	NA	0	0	0	NA	NA	15 pCi/L	NA	NA	Excluded	By association with Am-241. Fr-221 is a decay product of Am-241 in the Cf-249 decay series. Based on Bateman equation, daughter products after U-233 would not generate significant in growth for thousands of years. Thus, Fr-221 would have insignificant concentrations. Based on ORIGIN2 calculations Fr-221 did not make the top 60 actinide product inventories from reactor generated uranium fuel. Thus Fr-221 would be more than 10 orders of magnitude less than Am-241 reported values. Possible hot spots may be present near the B-5 reverse well with concentrations < 5.61E-8 pCi/L..
Fr-223	0	NA	0	0	0	NA	NA	NA	636 pCi/L	NA	Excluded	By association with Pu-239 and U-235. Fr-223 is a decay product of the natural U-235 decay series as well as the Cf-251, Bk-247, and Cm-243 decay series. Based on Bateman equation, daughter products after Pa-231 would not have significant in growth for thousands of years. According to ORIGIN2 derived values Fr-223 has five orders of magnitude less inventory than U-235. Based on ORIGIN2 and Fr-223 relationship to U-235 possible hot spots of Fr-223 may be present near the B-5 reverse well with concentrations of 6.09E-5 pCi/L.
I-129	388	1988-2006	49	254	134	9.63 pCi/L	7/23/91	1 pCi/L	1pCi/L	0.95 μg/L[b]	COC	Exceeded regulatory limits throughout OU.
Pb-209	0	NA	0	0	0	NA	NA	NA	25,755 pCi/L	NA	Excluded	By association with Am-241 and U-233. Pb-209 is a decay product of Am-241, Np-237 and U-233 in the Cf-249 decay series. Based on Bateman equation, daughter products after U-233 would not generate significant in growth for thousands of years. Based on ORIGIN2 calculations Pb-209 did not make the top 60 actinide product inventories from reactor generated uranium fuel. Thus Pb-209 would be more than 10 orders of magnitude less than Am-241 reported values. Possible hot spots may be present near the B-5 reverse well with concentrations < 5.61E-8 pCi/L..
Pb210	0	NA	0	0	0	NA	NA	NA	1 pCi/L	NA	Excluded	By association with U-238 and U-234. Pb-210 is associated with the U-238 natural decay series and Cm-250, Bk-250 and Cf-250 decay series. Based on Bateman equation, daughter products after U-234 would not generate equilibrium for approximately 1 million years. According to ORIGIN2 derived inventory, values 50 years after removal from the reactor, Pb-210 is 5.5 orders of magnitude less than U-238.

Table A-1. 200-BP-5 Radionuclide Contaminant Preliminary Screening Decision

Constituent	Total Samples	Sample Date Range	Number of Wells Sampled[c]	Total Detects	Total Non-Detects	Maximum Value Reported	Date of Maximum Detected	NPDWS	4 mrem standard dose.	Background	Retention Decision	Comments
Pb-211	0	NA	0	0	0	NA	NA	NA	10,429 pCi/L	NA	Excluded	By association with Pu-239 and U-235. Pb-211 is a decay product of the natural U-235 decay series as well as the Cf-251, Bk-247, and Cm-243 decay series. Based on Bateman equation, daughter products after Pa-231 would not have significant in growth for thousands of years. According to ORIGIN2 derived values Pb-211 has 3.5 orders of magnitude less inventory than U-235. Based on ORIGIN2 and Pb-211 relationship to U-235 possible hot spots of Pb-211 may be present near the B-5 reverse well with concentrations of 1.09E-3 pCi/L.
Pb-212	1	1995	1	0	1	NA	NA	NA	120 pCi/L	NA	Excluded	No detected values reported. By association with U-236 and Th-232. Pb-212 is associated with the Th-232 natural decay series and the Cm-244 and Cm-248 decay series. Based on long half life of U-236 and Th-232 (e.g. both over 23 million years) there would be insignificant inventory of Pb-212 for at least a million years. According to ORIGIN2 derived inventory values 10 years after removal from the reactor Pb-212 is 2 orders of magnitude less than U-236. After 50 years Pb-212 is still 2 orders of magnitude less than U-236.
Pb-214	1	1995	1	0	1	NA	NA	NA	8,763 pCi/L	NA	Excluded	No detected values reported. By association with U-238 and U-234. Pb-214 is associated with the U-238 natural decay series and Cm-250, Bk-250 and Cf-250 decay series. Based on Bateman equation, daughter products after U-234 would not generate equilibrium for approximately 1 million years. Thus, Pb-214 would have insignificant concentrations. According to ORIGIN2 derived inventory, values 50 years after removal from the reactor, Pb-214 is 5 orders of magnitude less than U-238.
Nb-93m	0	NA	0	0	0	NA	NA	NA	10,500 pCi/L	NA	Excluded	By association with Cs-137. According to ORIGIN2 derived inventory values 10 years after removal from the reactor Nb-93m is 5 orders of magnitude less than Cs-137. After 50 years Nb-93m is 4 orders of magnitude less than Cs-137. This level would indicate a geometric average of 2.26E-3 pCi/L. Possible hot spots near B-5 may approach 1.16E-1 pCi/L. Based on obtained literatures niobium is not considered mobile and should accompany Cs-137.

Table A-1. 200-BP-5 Radionuclide Contaminant Preliminary Screening Decision

Constituent	Total Samples	Sample Date Range	Number of Wells Sampled[c]	Total Detects	Total Non-Detects	Maximum Value Reported	Date of Maximum Detected	NPDWS	4 mrem standard dose.	Background	Retention Decision	Comments
Np-237	8	2001-2005	2	0	8	NA	NA	15 pCi/L	NA	NA	COPC	No detected values reported. By association with Am-241. Np-237 is a decay product of Am-241 in the Cf-249 decay series. Few samples, mainly analyzed for at B-5 reverse well 299-E28-23 and 25. Other wells analyzed for include E28-5, E33-13 and E33-38. All reports are non-detect. By association with Am-241. According to ORIGIN2 derived inventory values 10 years after removal from the reactor Np-237 is 3.5 orders of magnitude less than Am-241. After 50 years Np-237 is 4 orders of magnitude less than Am-241. This level would indicate a geometric average of 7.32E-5 pCi/L. Possible hot spots near B-5 may approach 5.16E-2 pCi/L. Based on obtained literatures neptunium is considered mobile and should accompany uranium. Since it is considered mobile it will be retained and analyzed as a COPC.
NP-239	0	NA	0	0	0	NA	NA	NA	1,679 pCi/L	NA	Excluded	By association with Am-243. Np-239 is a decay product of the Cf-251 and Bk-247 decay series. Based on ORIGIN2 inventory Np-239 has the same inventory as Am-243. Due to the long half life for Cm-247, Bk-247 and Am-243 insignificant in growth.
Ni-63	0	NA	0	0	0	NA	NA	NA	9,493 pCi/L	NA	Excluded	By association with Cs-137. According to ORIGIN2 derived inventory values 10 years after removal from the reactor Ni-63 is 5 orders of magnitude less than Cs-137. After 50 years Ni-63m is 4 orders of magnitude less than Cs-137. This level would indicate a geometric average of 2.26E-3 pCi/L. Possible hot spots near B-5 may approach 1.16E-1 pCi/L.
Pu-238	356	1987-2005	45	69	287	11.6 pCi/L	8/24/94	15 pCi/L	NA	0.532 pCi/L[b]	COPC	Only concentrations reported above background were at the 299-E28-23 and E28-25 wells near the B-5 reverse well. Concentrations were reported twice above the site background at 299-E28-23 and once above at 299-E28-25. No value was reported above the derived regulatory standard. Pu-238 is a decay product of Cm-242 and Am-242M. According to ORIGIN2 calculations the inventory of Pu-238 should be almost an order of magnitude less than Pu-239/240. This comparison is to indicate the quantity of Pu-238 versus Pu-239/240 generated from reactor reactions.

Table A-1. 200-BP-5 Radionuclide Contaminant Preliminary Screening Decision

Constituent	Total Samples	Sample Date Range	Number of Wells Sampled[c]	Total Detects	Total Non-Detects	Maximum Value Reported	Date of Maximum Detected	NPDWS	4 mrem standard dose.	Background	Retention Decision	Comments
Pu-239/240	298	1987-2005	45	112	186	449 pCi/L	12/18/90	15 pCi/L	NA	0.398 pCi/L b(1)	COC	Only concentrations reported above background were at the 299-E28-23 and E28-25 wells near the B-5 reverse well and 299-E33-3 beneath BY cribs. Concentrations reported for 299-E28-23 have been above the derived regulatory limit every time except twice recently. Concentrations are trending down. Concentrations have only been reported 7 times above the derived regulatory limit in 299-E28-25. Concentrations are also trending down. Concentrations have not been reported at any other of the evaluated wells above regulatory limits.
Pu-241	0	NA	0	0	0	NA	NA	NA	80 pCi/L	NA	COPC	Pu-241 is a decay product of Cf-249 and Cm-245 in the Cf-249 decay series. Contributor to Am-241 concentration. Based on ORIGIN2 calculations and relationship with Am-241, Pu-241 has approximately the same inventory from reactor reactions.
Po-210	0	NA	0	0	0	NA	NA	15 pCi/L	NA	NA	Excluded	By association with U-238. Po-210 is associated with the U-238 natural decay series and Cm-250, Bk-250 and Cf-250 decay series. Based on Bateman equation, daughter products after U-234 would not generate equilibrium for approximately 1 million years. Thus, Po-210 would have insignificant concentrations. According to ORIGIN2 derived inventory, values 50 years after removal from the reactor, Po-210 is 5.5 orders of magnitude less than U-238.
Po-214	0	NA	0	0	0	NA	NA	15 pCi/L	NA	NA	Excluded	By association with U-238. Po-214 is associated with the U-238 natural decay series and Cm-250, Bk-250 and Cf-250 decay series. Based on Bateman equation, daughter products after U-234 would not generate equilibrium for approximately 1 million years. Thus, Po-214 would have insignificant concentrations. According to ORIGIN2 derived inventory, values 50 years after removal from the reactor, Po-214 is 5 orders of magnitude less than U-238.
Po-215	0	NA	0	0	0	NA	NA	15 pCi/L	NA	NA	Excluded	By association with U-235. Po-215 is associated with the U-235 natural decay series as well as the Cf-251, Bk-247, and Cm-243 decay series. Based on Bateman equation, daughter products after Pa-231 would not have significant in growth for thousands of years. According to ORIGIN2 derived inventory values 10 years after removal from the reactor Po-215 is 4.5 orders of magnitude less than U-235. After 50 years Po-215 is 3.5 orders of magnitude less than U-235. Based on ORIGIN2 and Po-215 relationship to U-235 possible hot spots at B-5 reverse well would be 1.0E-3 pCi/L if in growth has occurred.
Po-218	0	NA	0	0	0	NA	NA	15 pCi/L	NA	NA	Excluded	By association with U-238. Po-218 is associated with the U-238 natural decay series and Cm-250, Bk-250 and Cf-250 decay series. Based on Bateman equation, daughter products after U-234 would not generate equilibrium for approximately 1 million years. Thus, Po-218 would have insignificant concentrations. According to ORIGIN2 derived inventory, values 50 years after removal from the reactor, Po-218 is 5 orders of magnitude less than U-238.

Table A-2. 200-BP-5 Radionuclide Contaminant Preliminary Screening Decision

Constituent	Total Samples	Sample Date Range	Number of Wells Sampled[c]	Total Detects	Total Non-Detects	Maximum Value Reported	Date of Maximum Detected	NPDWS	4 mrem standard dose.	Background	Retention Decision	Comments
K-40	369	1990-2006	32	44	325	275 pCi/L	10/31/91	NA	295 pCi/L	77.3 pCi/L [b(1)]	Excluded	Most of the results with elevated concentrations are flagged as estimated. Several of the results have been rejected. The majority of results are non-detect.
Pm-147	0	NA	0	0	0	NA	NA	NA	5,233 pCi/L	NA	Excluded	By association with Cs-137. According to ORIGIN2 derived inventory values 10 years after removal from the reactor Pm-147 is approximately 1/3 the Cs-137 inventory. However, after 50 years Pm-147 is 5 orders of magnitude less than Cs-137. This level would indicate a geometric average of 2.26E-4 pCi/L. Possible hot spots near B-5 may approach 1.16E-2 pCi/L.
Pa-231	0	NA	0	0	0	NA	NA	15 pCi/L	NA	NA	Excluded	By association with U-235. Pa-231 is associated with the U-235 natural decay series as well as the Cf-251, Bk-247, and Cm-243 decay series. According to ORIGIN2 derived inventory values Pa-231 is 3 orders of magnitude less than U-235 50 years after being removed from the reactor. Based on ORIGIN2 and Pa-231 relationship to U-235 possible hot spots of Pa-231 may be present near the B-5 reverse well with concentrations of 6.09E-3 pCi/L.
Pa-234	0	NA	0	0	0	NA	NA	15 pCi/L	NA	NA	Excluded	By association with U-238 and Pa-234m. Pa-234 is associated with the U-238 natural decay series and Cm-250, Bk-250 and Cf-250 decay series. Based on decay rates Pa-234 is generated by less than 1% of the Pa-234m decay. According to ORIGIN2 derived inventory, Pa-234 values are approximately 3 orders of magnitude less than U-238 50 years after removal from the reactor.
Pa-234m	0	NA	0	0	0	NA	NA	NA	2,536 pCi/L*	NA	COPC	By association with U-238. Pa-234m is associated with the U-238 natural decay series and Cm-250, Bk-250 and Cf-250 decay series. According to ORIGIN2 derived inventory, Pa-234m values are the same as U-238 50 years after removal from the reactor. To be determined by calculation from U-238 reported analyses.
Ra-223	0	NA	0	0	0	NA	NA	15 pCi/L	NA	NA	Excluded	By association with Pu-239 and U-235. Ra-223 is a decay product of the natural U-235 decay series as well as the Cf-251, Bk-247, and Cm-243 decay series. Based on Bateman equation, daughter products after Pa-231 would not have significant in growth for thousands of years. According to ORIGIN2 derived values Ra-223 has 3.5 orders of magnitude less inventory than U-235. Based on ORIGIN2 and Ra-223 relationship to U-235 possible hot spots of Ra-223 may be present near the B-5 reverse well with concentrations of 1.09E-3 pCi/L.

Table A-1. 200-BP-5 Radionuclide Contaminant Preliminary Screening Decision

Constituent	Total Samples	Sample Date Range	Number of Wells Sampled[c]	Total Detects	Total Non-Detects	Maximum Value Reported	Date of Maximum Detected	NPDWS	4 mrem standard dose.	Background	Retention Decision	Comments
Ra-224	0	NA	0	0	0	NA	NA	15 pCi/L	NA	NA	Excluded	By association with U-236 and Th-232. Ra-224 is associated with the Th-232 natural decay series and the Cm-244 and Cm-248 decay series. Based on long half life of U-236 and Th-232 (e.g. both over 23 million years) and the short half life of Ra-224 (3.7 days) there would be insignificant inventory of Ra-224 for at least a million years. According to ORIGIN2 derived inventory values 10 years after removal from the reactor Ra-224 is 2 orders of magnitude less than U-236. After 50 years Ra-224 is still 2 orders of magnitude less than U-236.
Ra-225	0	NA	0	0	0	NA	NA	NA	14 pCi/L	NA	Excluded	By association with Am-241. Ra-225 is a decay product of Am-241 in the Cf-249 decay series. Based on Bateman equation, daughter products after U-233 would not generate significant in growth for thousands of years. Thus, Ra-225 would have insignificant concentrations. Based on ORIGIN2 calculations Ra-225 did not make the top 60 actinide product inventories from reactor generated uranium fuel. Thus Ra-221 would be more than 10 orders of magnitude less than Am-241 reported values. Possible hot spots may be present near the B-5 reverse well with concentrations < 5.61E-8 pCi/L.
Ra-226	87	1991-1995	14	2	85	0.37 pCi/L	3/27/91	5[e] pCi/L	NA	18.2 pCi/L [b(1)]	Excluded	No detected values reported. By association with U-238. Ra-226 is associated with the U-238 natural decay series and Cm-250, Bk-250 and Cf-250 decay series. Based on Bateman equation, daughter products after U-234 would not generate equilibrium for approximately 1 million years. Thus, Ra-226 would have insignificant concentrations. According to ORIGIN2 derived inventory, values 50 years after removal from the reactor, Ra-226 is 5 orders of magnitude less than U-238.
Ra-228	17	1991-1995	13	0	17	NA	NA	5[e] pCi/L	NA	32.3 pCi/L [b(1)]	Excluded	No detected values reported. By association with U-236 and Th-232. Ra-228 is associated with the Th-232 natural decay series and the Cm-244 and Cm-248 decay series. Based on long half life of U-236 and Th-232 (e.g. both over 23 million years) there would be insignificant inventory of Ra-228 for at least a million years. According to ORIGIN2 Ra-228 did not make the top constituent inventory for activation, fission or actinides.

Table A-1. 200-BP-5 Radionuclide Contaminant Preliminary Screening Decision

Constituent	Total Samples	Sample Date Range	Number of Wells Sampled[c]	Total Detects	Total Non-Detects	Maximum Value Reported	Date of Maximum Detected	NPDWS	4 mrem standard dose.	Background	Retention Decision	Comments
Rn-220	0	NA	0	0	0	NA	NA	15 pCi/L	NA	NA	Excluded	By association with U-236 and Th-232. Rn-220 is associated with the Th-232 natural decay series and the Cm-244 and Cm-248 decay series. Based on long half life of U-236 and Th-232 (e.g. both over 23 million years) there would be insignificant inventory of Rn-220 for at least a million years. According to ORIGIN2 derived inventory values 10 years after removal from the reactor Rn-220 is 2 orders of magnitude less than U-236. After 50 years Rn-220 is still 2 orders of magnitude less than U-236. Rn-220 is 6 orders of magnitude less than Am-241 initial inventory. This comparison is to indicate the low quantity of Rn-220 versus Am-241 generated from reactor reactions.
Rh-106	0	NA	0	0	0	NA	NA	NA	8,511 pCi/L	NA	Excluded	By association with Ru-106 (e.g. Half life < 3 years). Not a daughter product of uranium decay chain.
Ru-106	694	1991-2006	37	54	640	316 pCi/L	9/3/92	NA	30 pCi/L	1.63 pCi/L [b(1)]	Excluded	Since 1995 269 of the 270 results have been non-detect. The only detectable value reported was 17.1 pCi/L, which is below derived 4 mrem regulatory dose standard. Based on this information concentrations appear to have decayed to insignificant values. Not a daughter product of the uranium decay chain.
Sm-151	0	NA	0	0	0	NA	NA	NA	1,000 pCi/L	NA	Excluded	By association with Cs-137. According to ORIGIN2 derived inventory values 10 years after removal from the reactor Sm-151 is approximately 2 orders of magnitude less than the Cs-137 inventory. After 50 years Sm-151 is still approximately 2 orders of magnitude less than Cs-137. This level would indicate a geometric average of 2.26E-2 pCi/L. Possible hot spots near B-5 may approach 1.16E+1 pCi/L.
Se-79	0	NA	0	0	0	NA	NA	NA	630 pCi/L	NA	Excluded	By association with Cs-137. According to ORIGIN2 derived inventory values 10 years after removal from the reactor Se-79 is approximately 6.5 orders of magnitude less than the Cs-137 inventory. After 50 years Se-79 is approximately 5 orders of magnitude less than Cs-137. This level would indicate a geometric average of 2.26E-6 pCi/L. Possible hot spots near B-5 may approach 1.16E-3 pCi/L.
Sr-90	508	1988-2006	45	108	400	1200 pCi/L	4/5/01	8 pCi/L	8 pCi/L	1.03 pCi/L [b]	COC	Three wells reported values above derived regulatory levels. The values were from 299-E28-23, E28-25 and 299-E28-7 located 3, 20 and 61 feet from the B-5 reverse well, respectively.
Tc-99	972	1988-2006	50	863	109	16,100 pCi/L	5/15/06	900 pCi/L	900 pCi/L	0.83 pCi/L [b]	COC	Nine wells reported values above derived regulatory levels. The values were from the B and C complexes. The highest concentrations originate beneath the BY cribs. A new high concentration (42,900 pCi/L) has recently been reported at 299-E33-4 beneath BY cribs.

Table A-1. 200-BP-5 Radionuclide Contaminant Preliminary Screening Decision

Constituent	Total Samples	Sample Date Range	Number of Wells Sampled[c]	Total Detects	Total Non-Detects	Maximum Value Reported	Date of Maximum Detected	NPDWS	4 mrem standard dose.	Background	Retention Decision	Comments
Tl-207	0	NA	0	0	0	NA	NA	NA	1,631 pCi/L**	NA	Excluded	By association with Pu-239 and U-235. Tl-207 is a decay product of the natural U-235 decay series as well as the Cf-251, Bk-247, and Cm-243 decay series. Based on Bateman equation, daughter products after Pa-231 would not have significant in growth for thousands of years. According to ORIGIN2 derived values Tl-207 has 3.5 orders of magnitude less inventory than U-235. Based on ORIGIN2 and Tl-207 relationship to U-235 possible hot spots of Tl-207 may be present near the B-5 reverse well with concentrations of 1.09E-3 pCi/L.
Th-227	0	NA	0	0	0	NA	NA	15 pCi/L	NA	NA	Excluded	By association with Pu-239 and U-235. Th-227 is a decay product of the natural U-235 decay series as well as the Cf-251, Bk-247, and Cm-243 decay series. Based on Bateman equation, daughter products after Pa-231 would not have significant in growth for thousands of years. According to ORIGIN2 derived values Th-227 has 3.5 orders of magnitude less inventory than U-235. Based on ORIGIN2 and Th-227 relationship to U-235 possible hot spots of Th-227 may be present near the B-5 reverse well with concentrations of 1.09E-3 pCi/L.
Th-229	0	NA	0	0	0	NA	NA	15 pCi/L	NA	NA	Excluded	By association with Am-241. Th-229 is a decay product of Am-241 in the Cf-249 decay series. Based on Bateman equation, daughter products after U-233 would not generate significant in growth for thousands of years. Thus, Th-229 would have insignificant concentrations. Based on ORIGIN2 calculations Th-229 did not make the top 60 actinide product inventories from reactor generated uranium fuel. Thus Th-229 would be more than 10 orders of magnitude less than Am-241 reported values. Possible hot spots may be present near the B-5 reverse well with concentrations < 5.61E-8 pCi/L.
Th-230	0	NA	0	0	0	NA	NA	15 pCi/L	NA	NA	Excluded	By association with U-238. Th-230 is associated with the U-238 natural decay series and Cm-250, Bk-250 and Cf-250 decay series. Based on Bateman equation, daughter products after U-234 would not generate equilibrium for approximately 1 million years. Thus, Th-230 would have insignificant concentrations. According to ORIGIN2 derived inventory, values 50 years after removal from the reactor, Th-230 is 3 orders of magnitude less than U-238.
Th-231	0	NA	0	0	0	NA	NA	NA	4,057 pCi/L	NA	COPC	By association with Pu-239 and U-235. Th-231 is a decay product of the natural U-235 decay series as well as the Cf-251, Bk-247, and Cm-243 decay series. According to ORIGIN2 derived values Th-231 has approximately the same inventory as U-235. Th-231 will be calculated based on U-235 analytical analyses.
Th-232	27	1992-1994	14	1	26	50 pCi/L	10/13/94	15 pCi/L	NA	NA	COPC	One value reported above NPDWS. Limited amount of sample results. Th-232 is associated with the Cm-244 and Cm-248 decay series.

Table A-1. 200-BP-5 Radionuclide Contaminant Preliminary Screening Decision

Constituent	Total Samples	Sample Date Range	Number of Wells Sampled[c]	Total Detects	Total Non-Detects	Maximum Value Reported	Date of Maximum Detected	NPDWS	4 mrem standard dose.	Background	Retention Decision	Comments
Th-234	11	1992	10	0	11	NA	NA	NA	401 pCi/L	NA	COPC	No detected values reported. By association with U-238. Th-234 is associated with the U-238 natural decay series and Cm-250, Bk-250 and Cf-250 decay series. According to ORIGIN2 derived inventory, Th-234 is equivalent to U-238.
Tritium	1343	1988-2006	54	1261	82	4,820,000	7/26/88	20,000 pCi/L	20,000 pCi/L	0.83 pCi/L[b(1)]	COC	The highest concentration is significantly inconsistent with the other concentrations from this well. Most of the concentrations exceeding standards were along the western side of 200 East, beneath 216-B-62 crib and 218-E-10 burial ground. However, concentrations have declined since the mid 1990's and no longer exceed standards. One other area where concentrations slightly exceed standards is west of 216-B-50 and 216-B-57. Concentrations are rising in well 299-E33-26 and have recently exceeded standards.
U-233	1	1994	1	1	0	1.5 pCi/L	8/30/1994	NA	20 pCi/L	0.849 pCi/L[b]	COPC	By association with uranium metal concentrations.
U-234	1	1994	1	1	0	1.5 pCi/L	8/30/1994	NA	20 pCi/L	0.849 pCi/L[b]	COPC	By association with uranium metal concentrations.
U-235	34	1988-2004	10	21	13	6.09 pCi/L	4/5/01	NA	20 pCi/L	0.00 pCi/L[b]	COPC	By association with uranium metal concentrations.
U-238	33	1988-2004	9	32	1	73.1 pCi/L	4/5/01	NA	20 pCi/L	0.00 pCi/L[b]	COPC	By association with uranium metal concentrations.
Y-90	0	NA	0	0	0	NA	NA	NA	510 pCi/L	NA	COPC	By association with Sr-90. According to ORIGIN2 derived inventory values Y-90 has the same inventory as Sr-90. This constituent would be associated with the same areas as identified for Sr-90.
Zn-65	110	1990-1993	24	13	97	32.8 pCi/L	1/8/91	NA	300 pCi/L	NA	Excluded	No values reported above derived regulatory standards. Highest concentration not consistent with other sample results from same well. Next highest concentration 5.89 pCi/L.
Zr-93	0	NA	0	0	0	NA	NA	NA	NA	NA	Excluded	By association with Zr-95and Cs-137. According to ORIGIN2 derived inventory Zr-93 did not make the top 57 fission product inventories from reactor generated uranium fuel. Derived values 50 years after removal from the reactor Zr-93 is more than 20 orders of magnitude less than Cs-137.
Zr-95	58	1991-1993	12	0	58	NA	NA	NA	NA	NA	Excluded	No detected values reported.

[a] Hanford Site Groundwater Background (DOE/RL-92-23)
[b] Hanford Site Background: Part 3, Groundwater Background (DOE/RL-96-61)
b(1) Hanford Site Background: Part 3, Groundwater Background (DOE/RL-96-61) geometric mean used in place of 90th percentile.
[c] Wells sampled by PNNL for Groundwater Monitoring for Environmental Surveillance.
[d] MCL is 5 pCi/L for the combination of Ra-226 and Ra228.
[e] MCL is based on a combination of dose from these radium constituents.
NA - No Applicable/value not derived
NPDWS – National Primary Drinking Water Standard.
SDWS – Secondary Drinking Water Standard.
µg/L – micrograms per liter.

* - Calculated from Pa-234. An effective dose was not available for the metastable isotope.

** - Calculated from Tl-204. An effective dose was not available for the Tl-207.
*** - Calculated using the average effective dose equivalent from Ba-135m and Ba-139.

Table A-2. 200-BP-5 Anion Contaminant Preliminary Screening Decision

Constituent	Total Samples	Sample Date Range	Number of Wells Sampled[c]	Total Detects	Total Non-Detects	Maximum Value Reported	Date of Maximum Detected	NDWS	WAC 173-340-720 Method B	SDWS	Background	Retention Decision	Comments
Ammonium	290	1987-1994	32	57	233	1190 µg/L	12/27/88	NA	NA	NA	120 µg/L[a]	Excluded	3 wells significantly above background. These values were identified in wells 299-E28-18, E28-26 and E32-2 located near the 216-B-62 and 218-E-10 burial ground. The values were reported in the late 1980's and early 1990's. Concentration trended down after these high concentrations were reported. Although there is no current standard for ammonium, nitrogen concentrations from ammonium were evaluated against nitrate. The equivalent nitrogen for ammonium would be 2,307 µg/L.
Bromide	401	1989-1997	37	72	329	230 µg/L	11/6/95	NA	NA	NA	151 µg/L[b]	Excluded	Consistent with background.
Chloride	1442	1982-2006	53	1442	0	356,000 µg/L	10/7/02	NA	NA	250,000 µg/L	28,500 µg/L[a]	COPC	4 well were significantly above background. The wells were identified as 299-E28-8, E33-7 and E33-9 and E34-7. The well 299-E28-8 is not consistent with other results. The other three wells show trends. Wells 299-E33-7 is beneath the BY cribs, 299-E33-9 beneath the BY tank farm, and 299-E34-7 beneath the 218-E-8 burial ground. The concentrations at 299-E34-7 exceeded the SDWS in 2002 and 2003. Since that time the concentrations have trended down to 193,000 µg/L.
Cyanide	827	1987-2006	51	181	646	599 µg/L	11/16/05	200 µg/L	320 µg/L	NA	9.52 µg/L[b]	COC	2 wells reported above NPDWS. Both wells are beneath the BY cribs (299-E33-3 and 299-E33-7). Concentrations in 299-E33-7 are trending up.
Fluoride	1462	1982-2006	52	1267	195	1700 µg/L	4/3/91	NA	960 µg/L	2,000 µg/L	1298 µg/L[b]	Excluded	Only one report was significantly above background. That reported value was not consistent with the other results from that well. All other results were below background levels.

Table A-2. 200-BP-5 Anion Contaminant Preliminary Screening Decision

Constituent	Total Samples	Sample Date Range	Number of Wells Sampled[c]	Total Detects	Total Non-Detects	Maximum Value Reported	Date of Maximum Detected	NDWS	WAC 173-340-720 Method B	SDWS	Background	Retention Decision	Comments
Constituent	Total Samples	Sample Date Range	Number of Wells Sampled[c]	Total Detects	Total Non-Detects	Maximum Value Reported	Date of Maximum Detected	NDWS	WAC 173-340-720 Method B	SDWS	Background	Retention Decision	Comments
Nitrate	1607	1987-2006	54	1583	24	1,080,000 µg/L	5/15/06	10,000 µg/L	25,600 µg/L	NA	12,400 µg/L[a]	COC	All wells reported above NPDWS except those near 216-B-3 (B Pond).
Nitrite	1293	1987-2006	40	36	1257	4,270 µg/L	12/15/03	1,000 µg/L	1,600 µg/L	NA	130 µg/L[b]	COPC	3 wells reported above NPDWS. However, two wells considered suspect. The other well contained the analyte in the QC blank. The majority of the no flagged results were in the late 1990's near BY tank farm well 299-E33-9 and 299-E33-8.
Phosphate	599	1987-1997	38	4	595	250 µg/L	7/8/91	NA	NA	NA	184 µg/L[b]	Excluded	Only two results were reported above background. Both results were not consistent with the other nondetect results. In addition, both reported results were the nondetect values reported prior to and after. Finally the reported results were from the same day.
Silicon	163	1989-1995	28	163	0	28,000	5/9/95	NA	NA	NA	26,500 µg/L[a]	Excluded	Consistent with background.
Sulfate	1445	1982-2006	53	1444	1	671,000 µg/L	4/3/03	NA	NA	250,000 µg/L	54,950 µg/L[b]	COC	One well reported above SDWS. The well (299-E34-7) is located next to the 218-E-8 burial ground. Concentrations have remained high over the past 5 years. Other areas ranging from half to just below the SDWS are B Plant, 216-B-62, C Farm, BY Farm and BY cribs.
Sulfide	28	1988-1990	19	0	28	NA	NA	NA	NA	NA	2.35 µg/L[b]	Excluded	No reported values.

[a] Hanford Site Groundwater Background (DOE/RL-92-23)
[b] Hanford Site Background: Part 3, Groundwater Background (DOE/RL-96-61)
[c] Wells sampled by PNNL for Groundwater Monitoring for Environmental Surveillance.

NA - No Applicable/value not derived
NPDWS – National Primary Drinking Water Standard.
SDWS – Secondary Drinking Water Standard.

µg/L – micrograms per liter.

Table A-3. 200-BP-5 Metal Contaminant Preliminary Screening Decision

Constituent	Total Samples	Sample Date Range	Number of Wells Sampled[c]	Total Detects	Total Non-Detects	Maximum Value Reported	Date of Maximum Detected	NPDWS	WAC 173-340-720 Method B	SDWS	Background	Retention Decision	Comments
Aluminum	1439	1987-2005	51	476	963	2500 µg/L	9/12/94	NA	NA	50 – 200 µg/L	11.7 µg/L[b]	COPC	16 wells reported above SDWS. Elevated concentrations reported in 80's and early 90's. These past values do not reflect the more recent results which generally are non-detect or QC flagged with values below100 µg/L.
Antimony	1734	1987-2006	51	32	1702	88.3 µg/L	12/15/99	6 µg/L	6.4 µg/L	NA	69.8 µg/L[b]	COPC	13 wells reported above NPDWS. Most reported values were flagged as the concentration was reported below contract required detection limits, however, above MDL. Most of the elevated values are near the 216-E-10 and E-12 burial grounds.
Arsenic	798	1988-2006	48	267	531	18 µg/L	6/5/92	10 µg/L	.0583 µg/L	NA	11.8 µg/L[b]	COPC	Two wells (299-E27-16 and 299-E33-36) reported above NPDWS. The wells have not been sampled since 1994. The wells are located near the 216-B-63 trench.
Barium	1747	1987-2006	51	1745	30	149 µg/L	5/4/05	2,000 µg/L	3,200 µg/L	NA	68.5 µg/L[a]	Excluded	No reports above regulatory limits.
Beryllium	1734	1987-2006	51	183	1551	6 µg/L	3/14/89	4 µg/L	32 µg/L	NA	3.38 µg/L[b]	Excluded	One value was reported above the NPDWS. This value was flagged as suspect and is not consistent with the other sample results for this well. The next highest result was 3 µg/L. This result was flagged as the QC was outside the limits. The next highest value was 1.9 which although flagged is an acceptable value. The flag was that the reported value was below contract lab requirements but above the MDL.

Table A-3. 200-BP-5 Metal Contaminant Preliminary Screening Decision

Constituent	Total Samples	Sample Date Range	Number of Wells Sampled[c]	Total Detects	Total Non-Detects	Maximum Value Reported	Date of Maximum Detected	NPDWS	WAC 173-340-720 Method B	SDWS	Background	Retention Decision	Comments
Bismuth	0	NA	0	0	0	NA	NA	NA	NA	NA	<5 42 µg/L[a]	Excluded	No groundwater data. Mostly insoluble with a high sorption capacity. Only very slightly soluble as a mono sulfide and citrate. Bismuth subnitrate, subcarbonate and subsalicylate are used in medicine. Recommended Dietary Allowance / Intake (RDA / RDI) 2mcg - 30mcg. Therapeutic Range 50mcg - 525mg+.
Boron	148	1989-1991	30	146	2	185 µg/L	3/16/89	NA	1440 µg/L	NA	42.3 µg/L[b]	Excluded	No reports above regulatory limits.
Cadmium	1743	1987-2006	51	42	1701	9.2 µg/L	2/1/93	5 µg/L	8.0 µg/L	NA	1.29 µg/L[b]	COPC	Several wells reported with values above NPDWS. However, results were not consistent with other results from these same wells. All elevated concentrations were reported prior to mid 1990's except result at 299-E33-7 in 1999 (5.4 µg/L). Samples prior to 1995 were not always filtered. Concentrations in all wells have been <5 µg/L since 1999 and reported with a QC flags.

Table A-3. 200-BP-5 Metal Contaminant Preliminary Screening Decision

Constituent	Total Samples	Sample Date Range	Number of Wells Sampled[c]	Total Detects	Total Non-Detects	Maximum Value Reported	Date of Maximum Detected	NPDWS	WAC 173-340-720 Method B	SDWS	Background	Retention Decision	Comments
Calcium	1769	1987-2006	51	1765	4	341,000 µg/L	11/16/05	NA	NA	NA	58,389 µg/L[b]	Excluded	Several wells with concentrations over 2 time's background. Elevated concentrations reported mainly in wells 299-E33-3, E33-7, E33-9 and E34-7, beneath the By cribs and the 216-E-12 burial ground. Also reported values are trending up at C Farm, 299-E27-14. Calcium is required for the body. Supplement of 500 mg/day and more, depending on age, are recommended for today's diet.
Constituent	Total Samples	Sample Date Range	Number of Wells Sampled[c]	Total Detects	Total Non-Detects	Maximum Value Reported	Date of Maximum Detected	NPDWS	WAC 173-340-720 Method B	SDWS	Background	Retention Decision	Comments
Chromium	1747	1987-2006	51	909	838	420 µg/L	7/30/93	100 µg/L	24,000 µg/L	NA	3.17 µg/L[b]	COPC	20 wells reported above NPDWS. However, elevated concentrations were reported prior to 1995 and were unfiltered samples. The highest result of filtered samples is at 299-E33-18 (59.5 µg/L). This value may exceed the Chromium +6 limit. The only areas were chromium appears to be elevated is the north side of B tank farm and BY cribs.
Cobalt	1261	1989-2005	40	36	1225	20 µg/L	4/22/93	NA	320 µg/L	NA	1.29 µg/L[b]	Excluded	No reports above regulatory limits.
Copper	1747	1987-2005	40	252	1495	93 µg/L	2/11/97	1,300 µg/L	592 µg/L	NA	1.04 µg/L[b]	Excluded	No reports above regulatory limits.

Table A-3. 200-BP-5 Metal Contaminant Preliminary Screening Decision

Constituent	Total Samples	Sample Date Range	Number of Wells Sampled[c]	Total Detects	Total Non-Detects	Maximum Value Reported	Date of Maximum Detected	NPDWS	WAC 173-340-720 Method B	SDWS	Background	Retention Decision	Comments
Iron	1769	1982-2006	51	1297	472	23,000 µg/L	1/9/90	NA	NA	300 µg/L	1104 µg/L[b]	COPC	Several time SDWS. However, elevated concentrations were reported for unfiltered samples. When reviewing the filtered data only 6 wells have a maximum exceeding the SDWS. The wells are 299-E32-4, E33-3, E33-7, E33-8, E33-9 and E33-28. The highest is E32-4 at 1,160 µg/L.
Lanthanum								NA	NA	NA	NA	Excluded	No groundwater data. Lanthanum has various soluble compounds in cold water. Most likely compounds for associated Hanford waste would be Lanthanum chloride, chloride heptahydrate and nitrate. Lanthanum chloride is used for treatment of phosphate in swimming pool. Lanthanum is not absorbed orally. Lanthanum is also taken orally for digestive problems.
Constituent	Total Samples	Sample Date Range	Number of Wells Sampled[c]	Total Detects	Total Non-Detects	Maximum Value Reported	Date of Maximum Detected	NPDWS	WAC 173-340-720 Method B	SDWS	Background	Retention Decision	Comments
Lead	1219	1982-2005	69	1150	911	49 µg/L	5/19/82	15 µg/L	NA	NA	1.3 µg/L[b]	Excluded	7 wells reported above NPDWS, however, all values reported prior to 1995 and were either unfiltered or value was not consistent with duplicate. No values reported above regulatory values in past 10 years.
Lithium	138	1989-1990	25	0	138	NA	NA	NA	320 µg/L	NA	13,279 µg/L[b]	Excluded	No groundwater detected values.

Table A-3. 200-BP-5 Metal Contaminant Preliminary Screening Decision

Constituent	Total Samples	Sample Date Range	Number of Wells Sampled[c]	Total Detects	Total Non-Detects	Maximum Value Reported	Date of Maximum Detected	NPDWS	WAC 173-340-720 Method B	SDWS	Background	Retention Decision	Comments
Magnesium	1767	1982-2006	51	1653	114	48,100 µg/L	11/16/05	NA	NA	NA	31,051 µg/L[b]	Excluded	Significantly exceeds background at 299-E34-7. Exceeds background at BY cribs and BY Tank Farm. Magnesium is required for the body and supplement of 350 mg/day for various reasons are often recommended for today's diets.
Manganese	1765	1982-2006	51	1039	726	1430 µg/L	1/9/90	NA	2,240 µg/L	50 µg/L	163.5 µg/L[a]	Excluded	Three results significantly exceeded background and SDWS. However, these values were not filtered. All the filtered results were reported below background except one. The one result was not consistent with all the other samples from the sample well. Appears that the result may have been entered improperly.
Mercury	1321	1987-2005	44	65	1256	37.3 µg/L	10/2/92	2 µg/L	4.8 µg/L	NA	0.006 µg/L[b]	Excluded	Two reports exceeded the regulatory limits. However, duplicate results for both of these samples were non-detect. In addition, the elevated results were not consistent with any other sample results from the two wells. The next highest result was reported as 0.42 µg/L on 1/22/92 in well 299-E33-7. The result was below regulatory limits.
Constituent	Total Samples	Sample Date Range	Number of Wells Sampled[c]	Total Detects	Total Non-Detects	Maximum Value Reported	Date of Maximum Detected	NPDWS	WAC 173-340-720 Method B	SDWS	Background	Retention Decision	Comments
Nickel	1676	1982-2006	51	496	1180	710 µg/L	7/30/93	NA	320 µg/L	NA	1.98 µg/L[b]	Excluded	Two results above regulatory limits. However, the results were not filtered and not consistent with duplicates. The highest filtered result was 119 µg/L, which is below regulatory limits.

Table A-3. 200-BP-5 Metal Contaminant Preliminary Screening Decision

Constituent	Total Samples	Sample Date Range	Number of Wells Sampled[c]	Total Detects	Total Non-Detects	Maximum Value Reported	Date of Maximum Detected	NPDWS	WAC 173-340-720 Method B	SDWS	Background	Retention Decision	Comments
Potassium	1763	1982-2006	51	1752	11	19,200 µg/L	10/3/03	NA	NA	NA	11,089 µg/L[b]	Excluded	Consistent with background. No regulatory driver.
Phosphorous	0	NA	0	0	0	NA	NA	NA	NA	NA	NA	Excluded	Evaluated through phosphate a degradation product of phosphorous.
Selenium	891	1987-1996	45	160	731	82.3 µg/L	8/30/94	50 µg/L	80 µg/L	NA	<5 µg/L[a]	Excluded	Two values reported above NPDWS. However, duplicate values were not within control limits. In addition, another duplicates set from one of the wells were reported as non-detect. Both elevated results were analyzed on the same day. The next highest reported value was 8.6 µg/L at well 299-E34-2 on 5/13/96.
Silver	1716	1987-2006	51	70	1646	12.1 µg/L	8/24/92	NA	80 µg/L	100 µg/L	5.98 µg/L[b]	Excluded	No reports above regulatory limits.
Sodium	1762	1988-2006	50	1761	1	209,000 µg/L	4/28/06	NA	NA	NA	32,919 µg/L[b]	COPC	Significantly exceeds background at 3 wells located beneath the BY Tank Farm and BY cribs. Brackish water is equivalent to 250 mg/L based on seawater concentrations. See http://en.wikipedia.org/wiki/seawater.
Strontium	1011	1985-2006	49	984	27	1650 µg/L	4/8/02	NA	9,600 µg/L	NA	396 µg/L[b]	Excluded	No reports above regulatory limits.
Thallium	317	1988-1996	35	5	312	4.9 µg/L	5/13/96	2 µg/L	1.12 µg/L	NA	1.87 µg/L[b]	COPC	2 wells reported above NPDWS. However, one result the duplicate was reported as non-detect. The well identified with detected results is 299-E34-2.
Constituent	Total Samples	Sample Date Range	Number of Wells Sampled[c]	Total Detects	Total Non-Detects	Maximum Value Reported	Date of Maximum Detected	NPDWS	WAC 173-340-720 Method B	SDWS	Background	Retention Decision	Comments
Titanium	138	1989-1990	25	1	137	104 µg/L	9/6/89	NA	64,000 µg/L	NA	30 µg/L[b]	Excluded	No reports above regulatory limits.
Uranium	1135	1988-2006	51	1126	9	785 µg/L	3/15/06	30 µg/L	48 µg/L	NA	9.85 µg/L[b]	COC	Reported above limits.
Vanadium	1747	1985-2006	51	1369	378	75.4 µg/L	5/23/91	NA	112 µg/L	NA	19.3 µg/L[b]	Excluded	No reports above regulatory limits.

Table A-3. 200-BP-5 Metal Contaminant Preliminary Screening Decision

Constituent	Total Samples	Sample Date Range	Number of Wells Sampled[c]	Total Detects	Total Non-Detects	Maximum Value Reported	Date of Maximum Detected	NPDWS	WAC 173-340-720 Method B	SDWS	Background	Retention Decision	Comments
Zinc	1747	1982-2006	51	886	861	1,700 µg/L	10/1/93	NA	4,800 µg/L	5,000 µg/L	48.9 µg/L[b]	Excluded	No reports above regulatory limits.

[a] Hanford Site Groundwater Background (DOE/RL-92-23)
[b] Hanford Site Background: Part 3, Groundwater Background (DOE/RL-96-61)
[c] Wells sampled by PNNL for Groundwater Monitoring for Environmental Surveillance.

NA - No Applicable/value not derived
NPDWS – National Primary Drinking Water Standard.
SDWS – Secondary Drinking Water Standard.

µg/L – micrograms per liter.

Table A-4. 200-BP-5 VOA Contaminant Preliminary Screening Decision

Constituent	Total Samples	Sample Date Range	Number of Wells Sampled[a]	Total Detects	Total Non-Detects	Maximum Value Reported	Date of Maximum Detected	NPDWS	WAC 173-340-720 Method B	Retention Decision	Comments
Acetone	263	1988-2005	33	21	242	140 µg/L	6/22/88	NA	7,200 µg/L	Excluded	No detected values reported above regulatory limits. Maximum reported at 299-E28-7. Next highest without QC flag is 12 ug/L. Only 8 reported values without QC flags. All none flagged reports before 1994.
Benzene	361	1987-2006	38	0	361	NA	NA	5 µg/L	0.795 µg/L	Excluded	No detected values reported.
n-butyl benzene	0	NA	0	0	0	NA	NA	NA	320 µg/L	Excluded	By association with benzene and chlorobenzene.
Butylated hydroxyl toluene	0	NA	0	0	0	NA	NA	NA	NA	Excluded	By association with toluene and total petroleum hydrocarbons-kerosene.
1-butanol	129	1989-2006	18	0	129	NA	NA	NA	1,600 µg/L	Excluded	No detected values reported.
2-Butanone	329	1987-2006	40	2	327	10 µg/L	9/7/89	NA	4,800 µg/L	Excluded	No detected values reported above regulatory limits. Both reported values were on 9/7/89. No QC flags.
Carbon tetrachloride	392	1987-1994	40	3	389	1 µg/L	11/17/94	5 µg/L	.337 µg/L	Excluded	Three detected values reported. All three results were QC flagged. Two flagged results were qualified with "qualitative identification criteria not met/quality control results were outside limits". The other result the analyte was detected in both the associated QC blank and in the sample.
Chlorobenzene	100	1987-2005	38	0	100	NA	NA	100 µg/L	160 µg/L	Excluded	No detected values reported.
Chloroform	391	1987-2006	39	23	368	2.40 µg/L	3/6/92	NA	7.17 µg/L	COPC	No detected values reported above regulatory limits. All the reported values were QC flagged. The reported values were located in wells 299-E27-16 and E33-36 beneath and near 216-B-63 and 218-E-12B burial ground, and beneath the 218-E-10 burial ground in wells 299-E32-2, 299-E32-3 and 299-E34-8. These wells have not been sampled since mid 1990's for this analyte.
Cis-1,2-dichloroethylene	94	1990-2006	24	0	94	NA	NA	70 µg/L	80 µg/L	Excluded	No detected values reported.
Cyclohexanone	0	NA	0	0	0	NA	NA	NA	NA	Excluded	By association with acetone, 2-butanone, 4-methyl 2-pentanol, and kerosene.
Decane	144	1991-1996	18	0	144	NA	NA	NA	NA	Excluded	No detected values reported.
1,1-dichloroethane	360	1987-2006	38	0	360	NA	NA	NA	800 µg/L	Excluded	No detected values reported.
1,2-dichloroethane	360	1987-2006	38	0	360	NA	NA	5 µg/L	0.481 µg/L	Excluded	No detected values reported.
Diethyl ether	1	1991	1	1	0	9 µg/L	2/28/91	NA	1,600 µg/L	Excluded	No detected values reported above regulatory limits and association with acetone.
Ethanol	6	1989-1990	6	0	6	NA	NA	NA	NA	Excluded	No detected values reported.

Table A-4. 200-BP-5 VOA Contaminant Preliminary Screening Decision

Constituent	Total Samples	Sample Date Range	Number of Wells Sampled[a]	Total Detects	Total Non-Detects	Maximum Value Reported	Date of Maximum Detected	NPDWS	WAC 173-340-720 Method B	Retention Decision	Comments
Ethyelbenzene	100	1989-2006	32	3	97	.05 µg/L	4/27/94	700 µg/L	800 µg/L	Excluded	No detected values reported above regulatory limits. Reported values were QC flagged. One flag indicated that the analyte was reported in the blank and the sample. The other two were because the value was near the MDL.
Constituent	Total Samples	Sample Date Range	Number of Wells Sampled[a]	Total Detects	Total Non-Detects	Maximum Value Reported	Date of Maximum Detected	NPDWS	WAC 173-340-720 Method B	Retention Decision	Comments
Halogenated Hydrocarbons	0	NA	0	0	0	NA	NA	NA	NA	Excluded	By association with trichloroethene and tetrachloroethene.
4-methyl 2-pentanone	280	1987-2006	35	2	278	200 µg/L	4/10/91	NA	640 µg/L	COPC	No detected values reported above regulatory limits. No QC flag. Limited results near 216-B-8 crib, wells 299-E33-12 and E33-18.
Methylene Chloride	391	1987-2006	40	40	351	2900 µg/L	9/21/88	NA	5.83 µg/L	COPC	Exceeded regulatory limits, however, only 5 of the detects were reported without QC flags. The flag notified that the analyte was reported in the QC blank and sample. Most of the results were in the early 1990's and are not consistent with samples collected after the detections. The wells noted with results not flagged were 299-E32-2, 299-E33-28 and 299-E33-30.
Styrene	30	1989-2005	18	0	30	NA	NA	100 µg/L	1.46 µg/L	Excluded	No detected values reported and by association with benzene, ethylbenzene and toluene.
Tetrachloroethene	392	1987-2006	40	0	392	NA	NA	5 µg/L	0.858 µg/L	Excluded	No detected values reported.
Toluene	361	1986-2006	38	6	355	20 µg/L	6/22/88	1,000 µg/L	1,600 µg/L	Excluded	No detected values reported above regulatory limits. Only one result reported with no QC flag. That value was the max value. The others were either reported in the blank and the sample or estimated.
TPH-Kerosene	54	1987-1990	29	0	54	NA	NA	NA	500 µg/L	Excluded	No detected values reported.
Trans-1,2-dichloroethylene	218	1987-2006	37	0	216	NA	NA	100 µg/L	160 µg/L	Excluded	No detected values reported.
Trichloroethene	392	1986-2006	40	4	388	1 µg/L	4/9/91	5 µg/L	3.98 µg/L	COPC	No detected values reported above regulatory limits. All the reported values were QC flagged. The estimated values were reported in wells 299-E28-23 and 299-E28-27 near 216-B-5 and beneath the 218-E-10 burial ground in 299-E33-10. Wells have not been sampled since mid 1990's for this analyte.
1,1,1-trichloroethane	437	1987-2006	40	7	430	3 µg/L	4/7/92	200 µg/L	7,200 µg/L	Excluded	No detected values reported above regulatory limits. All the reported values were QC flagged. Only three reported values were not identified in the blank. The three were located in wells 299-E27-16 and E33-36 beneath and near 216-B-63 and 218-E-12B burial ground, and beneath the 218-E-10 burial ground in wells 299-E34-8. These wells have not been sampled since mid 1990's for this analyte. The reported values were near MDL.
1,1,2-trichloroethane	384	1986-2006	40	0	384	NA	NA	5 µg/L	0.768 µg/L	Excluded	No detected values reported.
Trichloromono-fluoromethane	60	1987-2005	31	0	60	NA	NA	NA	2,400 µg/L	Excluded	No detected values reported.

Table A-4. 200-BP-5 VOA Contaminant Preliminary Screening Decision

Constituent	Total Samples	Sample Date Range	Number of Wells Sampled[a]	Total Detects	Total Non-Detects	Maximum Value Reported	Date of Maximum Detected	NPDWS	WAC 173-340-720 Method B	Retention Decision	Comments
Xylene	86	1988-2006	6	0	86	NA	NA	NA	16,000 µg/L	Excluded	No detected values reported and by association with benzene, toluene, ethylbenzene, and total petroleum hydrocarbons-kerosene.

[a] Wells sampled by PNNL for Groundwater Monitoring for Environmental Surveillance.

µg/L – micrograms per liter.

NA - No Applicable/value not derived

NPDWS – National Primary Drinking Water Standard.

Table A-5. 200-BP-5 Semi VOA Contaminant Preliminary Screening Decision

Constituent	Total Samples	Sample Date Range	Number of Wells Sampled[a]	Total Detects	Total Non-Detects	Maximum Value Reported	Date of Maximum Detected	NPDWS	WAC 173-340-720 Method B	Retention Decision	Comments
Aldrin	220	1988-2005	31	0	220	NA	NA	NA	0.00515 µg/L	Excluded	No detected values reported.
Arolclor-1260	163	1986-2005	27	0	163	NA	NA	0.5 µg/L	0.0438 µg/L	Excluded	No detected values reported.
Benzo(a)anthracene	56	1985-2005	34	0	56	NA	NA	NA	0.12 µg/L	Excluded	No detected values reported.
Benzo(a)pyrene	56	1985-2005	34	0	56	NA	NA	NA	0.012 µg/L	Excluded	No detected values reported.
Benzo(b)fluoroanthene	56	1985-2005	34	0	56	NA	NA	NA	0.12 µg/L	Excluded	No detected values reported.
Bis(2-ethylhexyl)phthalate	109	1988-2005	34	9	100	22 µg/L	9/23/91	NA	6.25 µg/L	COPC	Reported above regulatory limit. However, several reported results were either estimated or detected in the QC blank and sample. The wells where detected as estimates or with no flag were 299-E28-27, 299-E32-2, 299-E33-18, 299-E34-1 and 299-E34-7. The detections are at random times from early 1990's through 2003.
Butylated phosphate	0	NA	0	0	0	NA	NA	NA	NA	Excluded	By association with TBP and total petroleum hydrocarbons.
3-chloro 4-menthylphenol	483	1988-2006	39	2	481	8.0 µg/L	8/25/92	NA	800 µg/L	Excluded	No detected values reports above regulatory limits. Results not consistent with the number of non-detects reported for the wells identified in (e.g. 299-E27-13 and 299-E28-27). The value reported at E28-27 was near the MDL.
2-chlorophenol	483	1988-2006	39	1	482	1.5 µg/L	10/5/93	NA	80 µg/L	Excluded	No reports above regulatory limits. Result not consistent with the number of non-detects reported for the well identified in (e.g. 299-E28-27). The value was reported near the MDL.
Chrysene	56	1985-2005	34	0	56	NA	NA	NA	12 µg/L	Excluded	No detected values reported.
4,4'-DDD	220	1988-1994	31	0	220	NA	NA	NA	0.365 µg/L	Excluded	No detected values reported.
4,4'-DDT	220	1988-1994	22	0	220	NA	NA	NA	0.257 µg/L	Excluded	No detected values reported.
Dibenz[a,h]anthracene	56	1985-2005	34	0	56	NA	NA	NA	0.012 µg/L	Excluded	No detected values reported.
Dibutyl phosphate	0	NA	0	0	0	NA	NA	NA	1,600 µg/L	Excluded	By association with TBP.
2,4-dichlorophenol	533	1988-2006	39	0	553	NA	NA	NA	48 µg/L	Excluded	No detected values reported.
Dieldrin	220	1988-2005	31	0	220	NA	NA	NA	0.00547 µg/L	Excluded	No detected values reported.
Dimethoate	31	1988-2005	25	0	31	NA	NA	NA	3.2 µg/L	Excluded	No detected values reported.
2,4-dimethylphenol	478	1988-2006	37	0	478	NA	NA	NA	320 µg/L	Excluded	No detected values reported.
2,4-dinitrophenol	459	1988-2006	39	15	444	2.6 µg/L	6/4/97	NA	32 µg/L	Excluded	No detected values reported above regulatory limits. All the reported values were QC flagged. The reported values were located in wells beneath and near 216-B-63 and 218-E-12B burial ground, and beneath the 218-E-10 burial ground. Each of these wells has only detected this analyte once in 1997, except wells 299-E28-26 and E32-2 in 1998. The 1998 detections (i.e. only one a piece) were the last reported detection.

Table A-5. 200-BP-5 Semi VOA Contaminant Preliminary Screening Decision

Constituent	Total Samples	Sample Date Range	Number of Wells Sampled[a]	Total Detects	Total Non-Detects	Maximum Value Reported	Date of Maximum Detected	NPDWS	WAC 173-340-720 Method B	Retention Decision	Comments
2,4-dinitrotoluene	57	1988-2005	34	0	57	NA	NA	NA	32 µg/L	Excluded	No detected values reported.
Constituent	Total Samples	Sample Date Range	Number of Wells Sampled[a]	Total Detects	Total Non-Detects	Maximum Value Reported	Date of Maximum Detected	NPDWS	WAC 173-340-720 Method B	Retention Decision	Comments
Endrin	300	1988-2005	36	0	300	NA	NA	2 µg/L	4.8 µg/L	Excluded	No detected values reported.
Endrin aldehyde	193	1991-2005	24	2	191	0.26 µg/L	6/5/92	NA	NA	Excluded	No detected values reported. Results not consistent with the number of non-detects reported for the wells identified in (e.g. 299-E27-16 and 299-E34-7).
Ethyl cyanide	78	1988-2006	23	0	78	NA	NA	NA	NA	Excluded	No detected values reported.
Ethylene glycol	19	1988-1990	18	0	19	NA	NA	NA	32,000 µg/L	Excluded	No detected values reported.
Heptachlor	246	1988-2005	31	0	246	NA	NA	0.4 µg/L	0.0194 µg/L	Excluded	No detected values reported.
Hydrazine	68	1987-1994	30	0	68	NA	NA	NA	0.0146 µg/L	Excluded	No detected values reported.
Indeno(1,2,3-cd)pyrene	56	1985-2005	34	0	56	NA	NA	NA	0.12 µg/L	Excluded	No detected values reported.
Lindane	300	1988-1994	36	0	300	NA	NA	0.2 µg/L	0.0763 µg/L	Excluded	No detected values reported.
3-Methylphenol	129	1991-1995	20	0	129	NA	NA	NA	800 µg/L	Excluded	No detected values reported.
4-Methylphenol	162	1991-2005	27	0	162	NA	NA	NA	80 µg/L	Excluded	No detected values reported.
Naphthalene	32	1988-2005	7	0	32	NA	NA	NA	1,600 µg/L	Excluded	No detected values reported and by association with benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoanthene, chrysene, dibenz[a,h]anthracene, indeno(1,2,3-cd)pyrene, and pyrene.
2-Nitrophenol	498	1989-2006	34	0	498	NA	NA	NA	NA	Excluded	No detected values reported.
Pentachlorophenol	628	1988-2006	39	6	622	4 µg/L	6/5/97	1 µg/L	0.729 µg/L	COC	Five reported values exceeded regulatory limits, however, several samples collected after were non-detect. All of the wells reporting detections were near the 218-E-10 burial ground.
Phenol	756	1987-2006	44	4	752	7.0 µg/L	6/15/93	NA	4,800 µg/L	Excluded	No detected values reported above regulatory limits. Reported values were QC flagged. One flag indicated that the analyte was reported in the blank and the sample. The other three were because the value was near the MDL. The reported values were in 1992 and 1993 and are not consistent with the multiple non-detect results since.
Phorate	6	1989-1990	6	0	6	NA	NA	NA	1.6 µg/L	Excluded	No detected values reported.
Pyrene	32	1989-2005	22	0	32	NA	NA	NA	480 µg/L	Excluded	No detected values reported and by association with benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoanthene, chrysene, dibenz[a,h]anthracene, and indeno(1,2,3-cd)pyrene.
2,3,4,6-tetrachlorophenol	251	1988-2006	36	0	251	NA	NA	NA	480 µg/L	Excluded	No detected values reported.
Tributyl phosphate	184	1987-2005	32	0	184	NA	NA	NA	NA	Excluded	No detected values reported.

[a] Wells sampled by PNNL for Groundwater Monitoring for Environmental Surveillance.
MDL – Method Detection Limit.
NA - No Applicable/value not derived.
NPDWS – National Primary Drinking Water Standard.
TBP – Tributyl Phosphate.
µg/L – micrograms per liter.

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