

Figure 4-1. Groundwater Monitoring Wells for the 300 Area Subregion of the 300-FF-5 Groundwater Operable Unit

Table 3-1. Summary of Federal and State Water Quality Criteria and Action Levels for the 300 Area Subregion of the 300-FF-5 Groundwater Operable Unit

CAS#	Analyte Name	Alternate Analyte Name	Units	Groundwater					Surface Water								Final Value	
				40 CFR 141 National Primary Drinking Water Regulations ^a		WAC 246-290-310 ^b	WAC 173-340-720 ^c		Clean Water Act National Recommended Water Quality Criteria ^d			WAC 173-201A ^e	40 CFR 131 Water Quality Standards ^f			WAC 173-340-730 ^g		
				Federal MCL	Federal MCLG	State MCL	Groundwater Method A Cleanup Levels	Groundwater Method B Unrestricted Land Use	Acute Freshwater CMC	Freshwater CCC	Human Health Water + Organism	Freshwater CCC	Freshwater CMC	Freshwater CCC	Human Health Water + Organism	Surface Water Method B Unrestricted Land Use		Final Action Level
630-20-6	1,1,1,2-Tetrachloroethane	--	µg/L	--	--	--	--	1.7	--	--	--	--	--	--	6.2	1.7	WAC 173-340-720(4)(b)(iii)(A) and (B)	
71-55-6	1,1,1-Trichloroethane	--	µg/L	200	200	--	--	16,000	--	--	--	--	--	--	925,926	200	40 CFR 141 - Federal MCL	
79-34-5	1,1,2,2-Tetrachloroethane	--	µg/L	--	--	--	--	0.22	--	--	--	0.17	--	--	6.5	0.17	Clean Water Act -- Human Health Water + Organism	
79-00-5	1,1,2-Trichloroethane	--	µg/L	5.0	3.0	--	--	0.77	--	--	--	0.59	--	--	25	0.59	Clean Water Act -- Human Health Water + Organism	
75-34-3	1,1-Dichloroethane	--	µg/L	--	--	--	--	1,600	--	--	--	--	--	--	73,549	1,600	WAC 173-340-720(4)(b)(iii)(A) and (B)	
75-35-4	1,1-Dichloroethene	1,1-Dichloroethylene	µg/L	7.0	7.0	--	--	400	--	--	--	330	--	--	23,148	0.057	40 CFR 131 -- Human Health Water + Organism	
96-18-4	1,2,3-Trichloropropane	--	µg/L	--	--	--	--	0.0015	--	--	--	--	--	--	0.017	0.0015	WAC 173-340-720(4)(b)(iii)(A) and (B)	
96-12-8	1,2-Dibromo-3-chloropropane	--	µg/L	0.20	--	--	--	0.055	--	--	--	--	--	--	0.70	0.055	WAC 173-340-720(4)(b)(iii)(A) and (B)	
106-93-4	1,2-Dibromoethane	--	µg/L	0.050	--	--	--	0.022	--	--	--	--	--	--	0.22	0.022	WAC 173-340-720(4)(b)(iii)(A) and (B)	
107-06-2	1,2-Dichloroethane	--	µg/L	5.0	--	--	--	0.48	--	--	--	0.38	--	--	59	0.38	Clean Water Act -- Human Health Water + Organism	
540-59-0	1,2-Dichloroethene (Total)	1,2-Dichloroethylene Mixed Isomers	µg/L	--	--	--	--	72	--	--	--	--	--	--	2,102	72	WAC 173-340-720(4)(b)(iii)(A) and (B)	
78-87-5	1,2-Dichloropropane	--	µg/L	5.0	--	--	--	1.2	--	--	--	0.50	--	--	44	0.50	Clean Water Act -- Human Health Water + Organism	
106-46-7	1,4-Dichlorobenzene	--	µg/L	75	75	--	--	8.1	--	--	--	63	--	--	22	8.1	WAC 173-340-720(4)(b)(iii)(A) and (B)	
123-91-1	1,4-Dioxane	--	µg/L	--	--	--	--	4.0	--	--	--	--	--	--	--	4.0	WAC 173-340-720(4)(b)(iii)(A) and (B)	
71-36-3	1-Butanol	N-Butanol	µg/L	--	--	--	--	800	--	--	--	--	--	--	82,044	800	WAC 173-340-720(4)(b)(iii)(A) and (B)	
78-93-3	2-Butanone	Methyl Ethyl Ketone	µg/L	--	--	--	--	4,800	--	--	--	--	--	--	492,264	4,800	WAC 173-340-720(4)(b)(iii)(A) and (B)	
591-78-6	2-Hexanone	--	µg/L	--	--	--	--	80	--	--	--	--	--	--	3,429	80	WAC 173-340-720(4)(b)(iii)(A) and (B)	
108-10-1	4-Methyl-2-pentanone	4-Methyl-2-Pentanone	µg/L	--	--	--	--	640	--	--	--	--	--	--	61,002	640	WAC 173-340-720(4)(b)(iii)(A) and (B)	
67-64-1	Acetone	--	µg/L	--	--	--	--	7,200	--	--	--	--	--	--	738,397	7,200	WAC 173-340-720(4)(b)(iii)(A) and (B)	
75-05-8	Acetonitrile	--	µg/L	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
107-02-8	Acrolein	--	µg/L	--	--	--	--	4.0	--	--	3.0	6.0	--	320	--	3.0	Clean Water Act -- Freshwater CCC	
107-05-1	Allyl chloride	--	µg/L	--	--	--	--	2.1	--	--	--	--	--	--	62	2.1	WAC 173-340-720(4)(b)(iii)(A) and (B)	
7429-90-5	Aluminum	--	µg/L	50	--	--	--	16,000	750	87	--	--	--	--	5,185	50	40 CFR 141 - Federal MCL	
7440-36-0	Antimony	Antimony (metallic)	µg/L	6.0	6.0	6.0	--	6.4	--	--	--	5.6	--	14	1,037	5.6	Clean Water Act -- Human Health Water + Organism	
7440-38-2	Arsenic	Arsenic, Inorganic	µg/L	10	--	10	--	0.058	340	150	0.018	--	190	0.018	0.098	0.018	Clean Water Act -- Human Health Water + Organism	
7440-39-3	Barium	--	µg/L	2,000	2,000	2,000	--	3,200	--	--	--	1,000	--	--	129,630	1,000	Clean Water Act -- Human Health Water + Organism	
71-43-2	Benzene	--	µg/L	5.0	--	--	--	0.80	--	--	--	2.2	--	--	23	0.80	WAC 173-340-720(4)(b)(iii)(A) and (B)	
7440-41-7	Beryllium	Beryllium and Compounds	µg/L	4.0	4.0	4.0	--	32	--	--	--	--	--	--	273	4.0	40 CFR 141 - Federal MCL	
7440-69-9	Bismuth	--	µg/L	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
7440-42-8	Boron	Boron And Borates Only	µg/L	--	--	--	--	3,200	--	--	--	--	--	--	--	3,200	WAC 173-340-720(4)(b)(iii)(A) and (B)	
24959-67-9	Bromide	--	µg/L	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
75-27-4	Bromodichloromethane	--	µg/L	--	--	--	--	0.71	--	--	--	0.55	--	0.27	28	0.27	40 CFR 131 -- Human Health Water + Organism	
75-25-2	Bromoform	--	µg/L	--	80	--	--	5.5	--	--	--	4.3	--	4.3	219	4.3	Clean Water Act -- Human Health Water + Organism	
74-83-9	Bromomethane	--	µg/L	--	--	--	--	11	--	--	--	47	--	48	968	11	WAC 173-340-720(4)(b)(iii)(A) and (B)	
7440-43-9	Cadmium	Cadmium (Water)	µg/L	5.0	5.0	5.0	--	8.0	2.0	0.25	--	0.91	3.9	1.0	20	0.25	Clean Water Act -- Freshwater CCC	
7440-70-2	Calcium	--	µg/L	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
75-15-0	Carbon disulfide	--	µg/L	--	--	--	--	800	--	--	--	--	--	--	13,295	800	WAC 173-340-720(4)(b)(iii)(A) and (B)	
56-23-5	Carbon tetrachloride	--	µg/L	5.0	--	--	--	0.34	--	--	--	0.23	--	0.25	2.7	0.23	Clean Water Act -- Human Health Water + Organism	
16887-00-6	Chloride	--	µg/L	250,000	--	250,000	--	--	860,000	230,000	--	230,000	--	--	230,000	--	Clean Water Act -- Freshwater CCC	
108-90-7	Chlorobenzene	--	µg/L	100	100	--	--	160	--	--	--	130	--	680	5,034	100	40 CFR 141 - Federal MCL	
75-00-3	Chloroethane	Ethylchloride	µg/L	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
67-66-3	Chloroform	--	µg/L	80	--	--	--	1.4	--	--	--	5.7	--	5.7	56	1.4	WAC 173-340-720(4)(b)(iii)(A) and (B)	
74-87-3	Chloromethane	--	µg/L	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
126-99-8	Chloroprene	2-Chloro-1,3-butadiene	µg/L	--	--	--	--	160	--	--	--	--	--	--	2,412	160	WAC 173-340-720(4)(b)(iii)(A) and (B)	
7440-47-3	Chromium	--	µg/L	100	100	100	--	24,000	570	65	--	156	550	180	19,444	65	Clean Water Act -- Freshwater CCC	
156-59-2	cis-1,2-Dichloroethylene	--	µg/L	70	70	--	--	80	--	--	--	--	--	--	2,336	70	40 CFR 141 - Federal MCL	
10061-01-5	cis-1,3-Dichloropropene	--	µg/L	--	--	--	--	0.44	--	--	--	0.34	--	--	34	0.34	Clean Water Act -- Human Health Water + Organism	
7440-48-4	Cobalt	--	µg/L	--	--	--	--	4.8	--	--	--	--	--	--	2.6	2.6	WAC 173-340-730(3)(b)(iii)(A) and (B)	
7440-50-8	Copper	--	µg/L	1,300	1,300	--	--	640	13	9.0	1,300	--	17	11	2,881	9.0	Clean Water Act -- Freshwater CCC	
57-12-5	Cyanide	--	µg/L	200	200	200	--	320	22	5.2	140	5.2	22	5.2	700	5.2	Clean Water Act -- Freshwater CCC	
124-48-1	Dibromochloromethane	--	µg/L	60	60	--	--	0.52	--	--	--	0.40	--	0.41	21	0.40	Clean Water Act -- Human Health Water + Organism	
74-95-3	Dibromomethane	Methylene Bromide	µg/L	--	--	--	--	80	--	--	--	--	--	--	4,216	80	WAC 173-340-720(4)(b)(iii)(A) and (B)	
75-71-8	Dichlorodifluoromethane	--	µg/L	--	--	--	--	1,600	--	--	--	--	--	--	84,312	1,600	WAC 173-340-720(4)(b)(iii)(A) and (B)	
107-12-0	Ethyl cyanide	--	µg/L	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
97-63-2	Ethyl methacrylate	--	µg/L	--	--	--	--	720	--	--	--	--	--	--	26,365	720	WAC 173-340-720(4)(b)(iii)(A) and (B)	
100-41-4	Ethylbenzene	--	µg/L	700	700	--	--	4.0	--	--	530	--	--	3,100	16	4.0	WAC 173-340-720(4)(b)(iii)(A) and (B)	
16984-48-8	Fluoride	--	µg/L	4,000	4,000	4,000	--	960	--	--	--	--	--	--	--	960	WAC 173-340-720(4)(b)(iii)(A) and (B)	
12587-46-1	Gross alpha	--	pCi/L	15	--	--	--	--	--	--	--	--	--	--	--	15	40 CFR 141 - Federal MCL	
12587-47-2	Gross beta	--	mrem/year	4.0	--	--	--	--	--	--	--	--	--	--	--	4.0	40 CFR 141 - Federal MCL	
74-88-4	Iodomethane	--	µg/L	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
7439-89-6	Iron	--	µg/L	300	--	300	--	11,200	--	1,000	300	--	--	--	9,074	300	40 CFR 141 - Federal MCL	
78-83-1	Isobutyl alcohol	--	µg/L	--	--	--	--	2,400	--	--	--	--	--	--	246,132	2,400	WAC 173-340-720(4)(b)(iii)(A) and (B)	
7439-92-1	Lead	Lead and Compounds	µg/L	15	--	--	15	--	65	2.5	--	2.1	65	2.5	--	2.1	WAC 173-201A	
7439-93-2	Lithium	--	µg/L	--	--	--	--	32	--	--	--	--	--	--	--	32	WAC 173-340-720(4)(b)(iii)(A) and (B)	
7439-95-4	Magnesium	--	µg/L	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
7439-96-5	Manganese	Manganese (Water)	µg/L	50	--	50	--	2,240	--	--	50	--	--	--	907	50	40 CFR 141 - Federal MCL	
7487-94-7	Mercury	Mercuric chloride	µg/L	2.0	2.0	2.0	--	4.8	1.4	0.77	--	0.012	2.1	0.012	0.14	0.78	0.012	40 CFR 131 -- Freshwater CCC
126-98-7	Methacrylonitrile	--	µg/L	--	--	--	--	0.80	--	--	--	--	--	--	82	0.80	WAC 173-340-720(4)(b)(iii)(A) and (B)	
80-62-6	Methyl methacrylate	--	µg/L	--	--	--	--	11,200	--	--	--	--	--	--	960,219	11,200	WAC 173-340-720(4)(b)(iii)(A) and (B)	
75-09-2	Methylene chloride	--	µg/L	5.0	--	--	--	5.8	--	--	4.6	--	--	4.7	960	4.6	Clean Water Act -- Human Health Water + Organism	
7439-98-7	Molybdenum	--	µg/L	--	--	--	--	80	--	--	--	--	--	--	1,296	80	WAC 173-340-720(4)(b)(iii)(A) and (B)	
7440-02-0	Nickel	Nickel Soluble Salts	µg/L	--	100	100	--	320	470	52	610	137	1,400	160	610	1,103	52	Clean Water Act -- Freshwater CCC
14797-55-8	Nitrate	--	µg/L	45,000	45,000	45,000	--	113,600	--	--	45,000	--	--	--	--	45,000	40 CFR 141 - Federal MCL	
14797-65-0	Nitrite	--	µg/L	3,300	3,300	3,300	--	5,280	--	--	--	--	--	--	--	3,300	40 CFR 141 - Federal MCL	
14265-44-2	Phosphate	--	µg/L	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
7440-09-7	Potassium	--	µg/L	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
7782-49-2	Selenium	--	µg/L	50	50	50	--	80	--	5.0	170	5.0	20	5.0	--	2,701	5.0	Clean Water Act -- Freshwater CCC
7440-21-3	Silicon	--	µg/L	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
7440-22-4	Silver	--	µg/L	100	--	100	--	80	3.2	--	--	2.6	3.4	--	25,926	2.6	WAC 173-201A	
7440-23-5	Sodium	--	µg/L	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
7440-24-6	Strontium	Strontium, Stable	µg/L	--	--	--	--	9,600	--	--	--	--	--	--	25,926	9,600	WAC 173-340-720(4)(b)(iii)(A) and (B)	
10098-97-2	Strontium-90	--	pCi/L	8.0	--	--	--	--	--	--	--	--	--	--	8.0	--	40 CFR 141 - Federal MCL	
100-42-5	Styrene	--	µg/L	100	100	--	--	1,600	--	--	--	--						

Table 3-1. Summary of Federal and State Water Quality Criteria and Action Levels for the 300 Area Subregion of the 300-FF-5 Groundwater Operable Unit

CAS#	Analyte Name	Alternate Analyte Name	Units	Groundwater					Surface Water							Final Value			
				40 CFR 141 National Primary Drinking Water Regulations ^a		WAC 246-290-310 ^b	WAC 173-340-720 ^c		Clean Water Act National Recommended Water Quality Criteria ^d			WAC 173-201A ^e	40 CFR 131 Water Quality Standards ^f				WAC 173-340-730 ^g		
				Federal MCL	Federal MCLG	State MCL	Groundwater Method A Cleanup Levels	Groundwater Method B Unrestricted Land Use	Acute Freshwater CMC	Freshwater CCC	Human Health Water + Organism	Freshwater CCC	Freshwater CMC	Freshwater CCC	Human Health Water + Organism		Surface Water Method B Unrestricted Land Use	Final Action Level	Final Action Level Basis
7440-28-0	Thallium	Thallium (Soluble Salts)	µg/L	2.0	0.50	2.0	--	--	--	--	--	0.24	--	--	--	1.7	--	0.24	Clean Water Act -- Human Health Water + Organism
7440-31-5	Tin	--	µg/L	--	--	--	--	9,600	--	--	--	--	--	--	--	--	519	519	WAC 173-340-730(3)(b)(iii)(A) and (B)
108-88-3	Toluene	--	µg/L	1,000	1,000	--	--	640	--	--	--	1,300	--	--	--	6,800	19,384	640	WAC 173-340-720(4)(b)(iii)(A) and (B)
156-60-5	trans-1,2-Dichloroethylene	--	µg/L	100	100	--	--	160	--	--	--	140	--	--	--	--	32,818	100	40 CFR 141 - Federal MCL
10061-02-6	trans-1,3-Dichloropropene	--	µg/L	--	--	--	--	0.44	--	--	--	0.34	--	--	--	--	34	0.34	Clean Water Act -- Human Health Water + Organism
110-57-6	trans-1,4-Dichloro-2-butene	--	µg/L	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
79-01-6	Trichloroethene	Trichloroethylene (TCE)	µg/L	5.0	--	--	--	0.49	--	--	--	2.5	--	--	--	2.7	6.6	0.49	WAC 173-340-720(4)(b)(iii)(A) and (B)
75-69-4	Trichloromonofluoromethane	Trichlorofluoromethane	µg/L	--	--	--	--	2,400	--	--	--	--	--	--	--	--	--	2,400	WAC 173-340-720(4)(b)(iii)(A) and (B)
10028-17-8	Tritium	--	pCi/L	20,000	--	--	--	--	--	--	--	--	--	--	--	--	--	20,000	40 CFR 141 - Federal MCL
7440-61-1	Uranium	Uranium (Soluble Salts)	µg/L	30	--	--	--	48	--	--	--	--	--	--	--	--	778	30	40 CFR 141 - Federal MCL
U-233/234	Uranium-233/234	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
13966-29-5	Uranium-234	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
15117-96-1	Uranium-235	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
U-238	Uranium-238	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
7440-62-2	Vanadium	Vanadium and Compounds	µg/L	--	--	--	--	80	--	--	--	--	--	--	--	--	--	80	WAC 173-340-720(4)(b)(iii)(A) and (B)
108-05-4	Vinyl acetate	--	µg/L	--	--	--	--	8,000	--	--	--	--	--	--	--	--	820,441	8,000	WAC 173-340-720(4)(b)(iii)(A) and (B)
75-01-4	Vinyl chloride	--	µg/L	2.0	--	--	--	0.061	--	--	--	0.025	--	--	--	2.0	7.7	0.025	Clean Water Act -- Human Health Water + Organism
1330-20-7	Xylenes (total)	Xylenes (mixture)	µg/L	10,000	10,000	--	--	1,600	--	--	--	--	--	--	--	--	--	1,600	WAC 173-340-720(4)(b)(iii)(A) and (B)
7440-66-6	Zinc	Zinc (Metallic)	µg/L	5,000	--	5,000	--	4,800	120	120	7,400	91	110	100	--	16,548	91	WAC 173-201A	

Notes:
a. 40 CFR 141 National Primary Drinking Water Regulations. <http://www.epa.gov/waterscience/criteria/wqtable/>
b. Washington Department of Ecology, 2008, *Group A Public Water Supplies 246-290-310 WAC*, Publication No. 08-03-061
c. WAC 173-340-720(4)(b)(iii)(A) and (B), Ground water cleanup standards, Method B ground water cleanup levels, Noncarcinogens and Carcinogens
d. Clean Water Act - National Recommended Water Quality Criteria
e. WAC 173-201A, "Water Quality Standards for Surface Waters of the State of Washington," *Washington Administrative Code*, Olympia, Washington. <http://apps.leg.wa.gov/wac/default.aspx?cite=173-201A>
f. 40 CFR 131 Water Quality Standards, <http://ecfr.gpoaccess.gov>
g. WAC 173-340-730(3)(b)(iii)(A) and (B), Surface water cleanup standards, Method B surface water cleanup levels, Noncarcinogens and Carcinogens
MCL - Maximum Contaminant Limit
MCLG - Maximum Contaminant Limit Goal
CCC - Criteria Continuous Concentration
CMC - Criteria Maximum Concentration
Ecology, 2007, The Model Toxics Control Act Cleanup Regulation Chapter 173-340 WAC, Publication No. 94-06, amended 1996, Washington State Department of Ecology, Olympia, Washington.

Table 4-1. Monitoring Wells for the 300 Area Subregion of the 300-FF-5 Groundwater Operable Unit

Well Name		
399-1-10A	399-2-1	399-3-9
399-1-12	399-2-2	399-4-1
399-1-17A	399-3-12	399-4-12
399-1-21A	399-3-20	399-4-14
399-1-6	399-3-6	399-4-9

Table 7-1. Summary of Groundwater Analytes That Meet Exclusion Criteria for the 300 Area Subregion of the 300-FF-5 Groundwater Operable Unit

Analyte Name	Analyte Class	Begin Sample Date	End Sample Date	Total Samples	Total Detects	Frequency of Detection	Units	Minimum Detection Limit	Maximum Detection Limit	Minimum Detected Result	Maximum Detected Result	Basis for Exclusion
Bromide	ANION	6/4/2010	12/14/2010	44	36	81.82%	µg/L	90	110	104	236	No Action Level/ No Toxicity Values
Phosphate	ANION	6/4/2010	12/14/2010	44	9	20.45%	µg/L	429	429	598	6,750	No Action Level/ No Toxicity Values
Bismuth	METAL	6/4/2010	12/14/2010	45	4	8.89%	µg/L	23	37	26	47	No Action Level/ No Toxicity Values
Calcium	METAL	6/4/2010	12/14/2010	45	45	100.00%	µg/L	--	--	27,600	67,000	Essential Nutrient
Magnesium	METAL	6/4/2010	12/14/2010	45	45	100.00%	µg/L	--	--	6,220	14,300	Essential Nutrient
Potassium	METAL	6/4/2010	12/14/2010	45	45	100.00%	µg/L	--	--	3,030	8,390	Essential Nutrient
Silicon	METAL	6/4/2010	12/14/2010	45	45	100.00%	µg/L	--	--	7,870	18,000	No Action Level/ No Toxicity Values
Sodium	METAL	6/4/2010	12/14/2010	45	45	100.00%	µg/L	--	--	13,500	27,000	Essential Nutrient
Gross beta	RAD	6/4/2010	12/14/2010	28	28	100.00%	pCi/L	--	--	2.7	49	No Action Level/ No Toxicity Values
Uranium-233/234	RAD	6/4/2010	12/14/2010	45	45	100.00%	pCi/L	--	--	2.5	72	No Action Level/ No Toxicity Values
Uranium-234	RAD	8/9/2010	8/9/2010	1	1	100.00%	pCi/L	--	--	32	32	No Action Level/ No Toxicity Values
Uranium-235	RAD	6/4/2010	12/14/2010	45	45	100.00%	pCi/L	--	--	0.11	5.5	No Action Level/ No Toxicity Values
Uranium-238	RAD	6/4/2010	12/14/2010	45	45	100.00%	pCi/L	--	--	2.1	69	No Action Level/ No Toxicity Values
Acetonitrile	VOC	6/4/2010	12/14/2010	45	0	0.00%	µg/L	2.0	2.0	--	--	No Action Level/ No Toxicity Values
Chloroethane	VOC	6/4/2010	12/14/2010	45	0	0.00%	µg/L	0.099	0.099	--	--	No Action Level/ No Toxicity Values
Chloromethane	VOC	6/4/2010	12/14/2010	45	4	8.89%	µg/L	0.077	0.077	0.10	0.21	No Action Level/ No Toxicity Values
Ethyl cyanide	VOC	6/4/2010	12/14/2010	45	0	0.00%	µg/L	1.4	1.4	--	--	No Action Level/ No Toxicity Values
Iodomethane	VOC	6/4/2010	12/14/2010	45	4	8.89%	µg/L	0.092	0.092	0.68	0.75	No Action Level/ No Toxicity Values
Tetrahydrofuran	VOC	6/4/2010	12/14/2010	45	0	0.00%	µg/L	1.1	1.1	--	--	No Action Level/ No Toxicity Values
trans-1,4-Dichloro-2-butene	VOC	6/4/2010	12/14/2010	45	0	0.00%	µg/L	0.29	0.29	--	--	No Action Level/ No Toxicity Values

Note:

Shading indicates analyte is listed as a groundwater contaminant of potential concern in DOE/RL-2009-45, 300 Area Remedial Investigation/ Feasibility Study Sampling and Analysis Plan for the 300-FF-1, 300-FF-2, and 300-FF-5 Operable Units.

Table 7-2. Summary of Groundwater Analytes That Were Not Detected for the 300 Area Subregion of the 300-FF-5 Groundwater Operable Unit

Analyte Name	Analyte Class	Begin Sample Date	End Sample Date	Total Samples	Total Detects	Frequency of Detection	Units	Minimum Detection Limit	Maximum Detection Limit	Action Level	Action Level Basis	Level of Exceedence
Nitrite	ANION	6/4/2010	12/14/2010	45	0	0.00%	µg/L	9.9	118	3,300	40 CFR 141 - Federal MCL	2.98E-03
Antimony	METAL	6/4/2010	12/14/2010	45	0	0.00%	µg/L	0.3	1.1	5.60E+00	Clean Water Act -- Human Health Water + Organism	5.36E-02
Beryllium	METAL	6/4/2010	12/14/2010	45	0	0.00%	µg/L	0.050	0.35	4.0	40 CFR 141 - Federal MCL	1.25E-02
Cadmium	METAL	6/4/2010	12/14/2010	45	0	0.00%	µg/L	0.055	0.20	0.25	Clean Water Act -- Freshwater CCC	2.20E-01
Mercury	METAL	6/4/2010	12/14/2010	45	0	0.00%	µg/L	0.05	0.1	1.20E-02	40 CFR 131 -- Freshwater CCC	4.17E+00
Strontium-90	RAD	6/4/2010	12/14/2010	45	0	0.00%	pCi/L	-1.10E+01	0.78	8.0	40 CFR 141 - Federal MCL	-1.38E+00
1,1,1,2-Tetrachloroethane	VOC	6/4/2010	12/14/2010	45	0	0.00%	µg/L	0.09	0.09	1.68E+00	WAC 173-340-720(4)(b)(iii)(A) and (B)	5.36E-02
1,1,1-Trichloroethane	VOC	6/4/2010	12/14/2010	45	0	0.00%	µg/L	0.069	0.069	200	40 CFR 141 - Federal MCL	3.45E-04
1,1,2,2-Tetrachloroethane	VOC	6/4/2010	12/14/2010	45	0	0.00%	µg/L	0.098	0.098	1.70E-01	Clean Water Act -- Human Health Water + Organism	5.76E-01
1,1,2-Trichloroethane	VOC	6/4/2010	12/14/2010	45	0	0.00%	µg/L	0.15	0.15	5.90E-01	Clean Water Act -- Human Health Water + Organism	2.54E-01
1,1-Dichloroethane	VOC	6/4/2010	12/14/2010	45	0	0.00%	µg/L	0.068	0.068	1,600	WAC 173-340-720(4)(b)(iii)(A) and (B)	4.25E-05
1,1-Dichloroethene	VOC	6/4/2010	12/14/2010	45	0	0.00%	µg/L	0.083	0.083	0.057	40 CFR 131 -- Human Health Water + Organism	1.46E+00
1,2,3-Trichloropropane	VOC	6/4/2010	12/14/2010	45	0	0.00%	µg/L	0.15	0.15	1.46E-03	WAC 173-340-720(4)(b)(iii)(A) and (B)	1.03E+02
1,2-Dibromo-3-chloropropane	VOC	6/4/2010	12/14/2010	45	0	0.00%	µg/L	0.41	0.41	5.47E-02	WAC 173-340-720(4)(b)(iii)(A) and (B)	7.50E+00
1,2-Dibromoethane	VOC	6/4/2010	12/14/2010	45	0	0.00%	µg/L	0.13	0.13	2.19E-02	WAC 173-340-720(4)(b)(iii)(A) and (B)	5.94E+00
1,2-Dichloroethane	VOC	6/4/2010	12/14/2010	45	0	0.00%	µg/L	0.1	0.1	3.80E-01	Clean Water Act -- Human Health Water + Organism	2.63E-01
1,2-Dichloropropane	VOC	6/4/2010	12/14/2010	45	0	0.00%	µg/L	0.097	0.097	5.00E-01	Clean Water Act -- Human Health Water + Organism	1.94E-01
1,4-Dichlorobenzene	VOC	6/4/2010	12/14/2010	45	0	0.00%	µg/L	0.12	0.12	8.1	WAC 173-340-720(4)(b)(iii)(A) and (B)	1.48E-02
1,4-Dioxane	VOC	6/4/2010	12/14/2010	45	0	0.00%	µg/L	7.6	7.6	3.98E+00	WAC 173-340-720(4)(b)(iii)(A) and (B)	1.91E+00
1-Butanol	VOC	6/4/2010	12/14/2010	45	0	0.00%	µg/L	12	12	8.00E+02	WAC 173-340-720(4)(b)(iii)(A) and (B)	1.50E-02
2-Butanone	VOC	6/4/2010	12/14/2010	45	0	0.00%	µg/L	0.52	0.52	4.80E+03	WAC 173-340-720(4)(b)(iii)(A) and (B)	1.08E-04
2-Hexanone	VOC	6/4/2010	12/14/2010	45	0	0.00%	µg/L	0.22	0.22	8.00E+01	WAC 173-340-720(4)(b)(iii)(A) and (B)	2.75E-03
4-Methyl-2-pentanone	VOC	6/4/2010	12/14/2010	45	0	0.00%	µg/L	0.12	0.12	6.40E+02	WAC 173-340-720(4)(b)(iii)(A) and (B)	1.88E-04
Allyl chloride	VOC	6/4/2010	12/14/2010	45	0	0.00%	µg/L	0.11	0.11	2.08E+00	WAC 173-340-720(4)(b)(iii)(A) and (B)	5.29E-02
Benzene	VOC	6/4/2010	12/14/2010	45	0	0.00%	µg/L	0.064	0.064	7.96E-01	WAC 173-340-720(4)(b)(iii)(A) and (B)	8.04E-02
Bromoform	VOC	6/4/2010	12/14/2010	45	0	0.00%	µg/L	0.17	0.17	4.30E+00	Clean Water Act -- Human Health Water + Organism	3.95E-02
Chlorobenzene	VOC	6/4/2010	12/14/2010	45	0	0.00%	µg/L	0.15	0.15	100	40 CFR 141 - Federal MCL	1.50E-03
Chloroprene	VOC	6/4/2010	12/14/2010	45	0	0.00%	µg/L	0.097	0.097	160	WAC 173-340-720(4)(b)(iii)(A) and (B)	6.06E-04
cis-1,3-Dichloropropene	VOC	6/4/2010	12/14/2010	45	0	0.00%	µg/L	0.073	0.073	0.34	Clean Water Act -- Human Health Water + Organism	2.15E-01
Dibromochloromethane	VOC	6/4/2010	12/14/2010	45	0	0.00%	µg/L	0.13	0.13	0.40	Clean Water Act -- Human Health Water + Organism	3.25E-01
Dibromomethane	VOC	6/4/2010	12/14/2010	45	0	0.00%	µg/L	0.21	0.21	80	WAC 173-340-720(4)(b)(iii)(A) and (B)	2.63E-03
Dichlorodifluoromethane	VOC	6/4/2010	12/14/2010	45	0	0.00%	µg/L	0.084	0.084	1,600	WAC 173-340-720(4)(b)(iii)(A) and (B)	5.25E-05
Ethyl methacrylate	VOC	6/4/2010	12/14/2010	45	0	0.00%	µg/L	0.11	0.11	720	WAC 173-340-720(4)(b)(iii)(A) and (B)	1.53E-04
Ethylbenzene	VOC	6/4/2010	12/14/2010	45	0	0.00%	µg/L	0.086	0.086	4.0	WAC 173-340-720(4)(b)(iii)(A) and (B)	2.16E-02
Isobutyl alcohol	VOC	6/4/2010	12/14/2010	45	0	0.00%	µg/L	8.7	8.7	2,400	WAC 173-340-720(4)(b)(iii)(A) and (B)	3.63E-03
Methacrylonitrile	VOC	6/4/2010	12/14/2010	45	0	0.00%	µg/L	0.50	0.50	0.80	WAC 173-340-720(4)(b)(iii)(A) and (B)	6.25E-01
Methyl methacrylate	VOC	6/4/2010	12/14/2010	45	0	0.00%	µg/L	0.26	0.26	11,200	WAC 173-340-720(4)(b)(iii)(A) and (B)	2.32E-05
Methylene chloride	VOC	6/4/2010	12/14/2010	45	0	0.00%	µg/L	0.11	0.11	4.6	Clean Water Act -- Human Health Water + Organism	2.39E-02
Styrene	VOC	6/4/2010	12/14/2010	45	0	0.00%	µg/L	0.074	0.074	100	40 CFR 141 - Federal MCL	7.40E-04
Toluene	VOC	6/4/2010	12/14/2010	45	0	0.00%	µg/L	0.072	0.072	640	WAC 173-340-720(4)(b)(iii)(A) and (B)	1.13E-04
trans-1,2-Dichloroethylene	VOC	6/4/2010	12/14/2010	45	0	0.00%	µg/L	0.083	0.083	100	40 CFR 141 - Federal MCL	8.30E-04
trans-1,3-Dichloropropene	VOC	6/4/2010	12/14/2010	45	0	0.00%	µg/L	0.083	0.083	0.34	Clean Water Act -- Human Health Water + Organism	2.44E-01
Trichloromonofluoromethane	VOC	6/4/2010	12/14/2010	45	0	0.00%	µg/L	0.11	0.11	2,400	WAC 173-340-720(4)(b)(iii)(A) and (B)	4.58E-05
Vinyl acetate	VOC	6/4/2010	12/14/2010	45	0	0.00%	µg/L	0.18	0.18	8,000	WAC 173-340-720(4)(b)(iii)(A) and (B)	2.25E-05
Vinyl chloride	VOC	6/4/2010	12/14/2010	45	0	0.00%	µg/L	0.084	0.084	0.025	Clean Water Act -- Human Health Water + Organism	3.36E+00
Xylenes (total)	VOC	6/4/2010	12/14/2010	45	0	0.00%	µg/L	0.20	0.20	1,600	WAC 173-340-720(4)(b)(iii)(A) and (B)	1.25E-04

Note:

Shading indicates analyte is listed as a groundwater contaminant of potential concern in DOE/RL-2009-45, 300 Area Remedial Investigation/ Feasibility Study Sampling and Analysis Plan for the 300-FF-1, 300-FF-2, and 300-FF-5 Operable Units.

Table 7-4. Summary of Groundwater Analytes That Do Not Exceed an Action Level for the 300 Area Subregion of the 300-FF-5 Groundwater Operable Unit

Analyte Name	Analyte Class	Begin Sample Date	End Sample Date	Total Samples	Total Detects	Frequency of Detection	Units	Minimum Detection Limit	Maximum Detection Limit	Minimum Detected Result	Maximum Detected Result	Action Level	Action Level Basis
Chloride	ANION	6/4/2010	12/14/2010	45	45	100.00%	µg/L	--	--	6,890	29,000	230,000	Clean Water Act -- Freshwater CCC
Cyanide	ANION	6/4/2010	12/14/2010	45	1	2.22%	µg/L	4.0	4.0	3.7	3.7	5.2	Clean Water Act -- Freshwater CCC
Fluoride	ANION	6/4/2010	12/14/2010	45	43	95.56%	µg/L	60	60	86	340	960	WAC 173-340-720(4)(b)(iii)(A) and (B)
Sulfate	ANION	6/4/2010	12/14/2010	45	45	100.00%	µg/L	--	--	25,700	59,500	250,000	40 CFR 141 - Federal MCL
Barium	METAL	6/4/2010	12/14/2010	45	45	100.00%	µg/L	--	--	37	83	1,000	Clean Water Act -- Human Health Water + Organism
Boron	METAL	6/4/2010	12/14/2010	45	12	26.67%	µg/L	19	41	19	118	3,200	WAC 173-340-720(4)(b)(iii)(A) and (B)
Chromium	METAL	6/4/2010	12/14/2010	45	44	97.78%	µg/L	1.0	1.0	1.4	17	65	Clean Water Act -- Freshwater CCC
Cobalt	METAL	6/4/2010	12/14/2010	45	3	6.67%	µg/L	0.050	0.22	0.14	0.16	2.6	WAC 173-340-730(3)(b)(iii)(A) and (B)
Manganese	METAL	6/4/2010	12/14/2010	45	3	6.67%	µg/L	4.0	6.0	6.0	12	50	40 CFR 141 - Federal MCL
Molybdenum	METAL	6/4/2010	12/14/2010	45	45	100.00%	µg/L	--	--	3.5	5.8	80	WAC 173-340-720(4)(b)(iii)(A) and (B)
Nickel	METAL	6/4/2010	12/14/2010	45	11	24.44%	µg/L	4.0	4.0	4.0	12	52	Clean Water Act -- Freshwater CCC
Silver	METAL	6/4/2010	12/14/2010	45	2	4.44%	µg/L	0.10	0.20	0.099	0.72	2.6	WAC 173-201A
Strontium	METAL	6/4/2010	12/14/2010	45	45	100.00%	µg/L	--	--	5.0	280	9,600	WAC 173-340-720(4)(b)(iii)(A) and (B)
Tin	METAL	6/4/2010	12/14/2010	45	3	6.67%	µg/L	0.050	0.10	0.10	0.20	519	WAC 173-340-730(3)(b)(iii)(A) and (B)
Vanadium	METAL	6/4/2010	12/14/2010	45	10	22.22%	µg/L	12	17	12	34	80	WAC 173-340-720(4)(b)(iii)(A) and (B)
Tritium	RAD	6/4/2010	12/14/2010	45	39	86.67%	pCi/L	2.7	130	180	7,700	20,000	40 CFR 141 - Federal MCL
1,2-Dichloroethene (Total)	VOC	6/4/2010	12/14/2010	45	10	22.22%	µg/L	0.15	0.15	0.18	0.69	72	WAC 173-340-720(4)(b)(iii)(A) and (B)
Acetone	VOC	6/4/2010	12/14/2010	45	8	17.78%	µg/L	0.34	0.34	0.71	31	7,200	WAC 173-340-720(4)(b)(iii)(A) and (B)
Bromomethane	VOC	6/4/2010	12/14/2010	45	3	6.67%	µg/L	0.13	0.25	0.44	0.77	11	WAC 173-340-720(4)(b)(iii)(A) and (B)
Carbon disulfide	VOC	6/4/2010	12/14/2010	45	4	8.89%	µg/L	0.051	0.051	0.056	0.075	800	WAC 173-340-720(4)(b)(iii)(A) and (B)
Chloroform	VOC	6/4/2010	12/14/2010	45	12	26.67%	µg/L	0.10	0.10	0.13	0.87	1.4	WAC 173-340-720(4)(b)(iii)(A) and (B)
cis-1,2-Dichloroethylene	VOC	6/4/2010	12/14/2010	45	11	24.44%	µg/L	0.087	0.087	0.12	0.69	70	40 CFR 141 - Federal MCL

Note:

Shading indicates analyte is listed as a groundwater contaminant of potential concern in DOE/RL-2009-45, 300 Area Remedial Investigation/ Feasibility Study Sampling and Analysis Plan for the 300-FF-1, 300-FF-2, and 300-FF-5 Operable Units.

Table 7-6. Summary of Groundwater Analytes That Exceed an Action Level for the 300 Area Subregion of the 300-FF-5 Groundwater Operable Unit

Analyte Name	Analyte Class	Begin Sample Date	End Sample Date	Total Samples	Total Detects	Frequency of Detection	Units	Minimum Detection Limit	Maximum Detection Limit	Minimum Detected Result	Maximum Detected Result	Action Level	Action Level Basis
Nitrate	ANION	6/4/2010	12/14/2010	45	45	100.00%	µg/L	--	--	7,080	62,000	45,000	40 CFR 141 - Federal MCL
Arsenic	METAL	6/4/2010	12/14/2010	45	43	95.56%	µg/L	0.80	0.80	0.93	6.5	0.018	Clean Water Act -- Human Health Water + Organism
Copper	METAL	6/4/2010	12/14/2010	45	23	51.11%	µg/L	0.10	0.45	0.21	31	9.0	Clean Water Act -- Freshwater CCC
Aluminum	METAL	6/4/2010	12/14/2010	45	4	8.89%	µg/L	5.0	10	9.3	100	50	40 CFR 141 - Federal MCL
Lead	METAL	6/4/2010	12/14/2010	45	3	6.67%	µg/L	0.10	0.20	0.29	3.5	2.1	WAC 173-201A
Selenium	METAL	6/4/2010	12/14/2010	45	45	100.00%	µg/L	--	--	0.48	5.8	5.0	Clean Water Act -- Freshwater CCC
Thallium	METAL	6/4/2010	12/14/2010	45	1	2.22%	µg/L	0.050	0.10	1.2	1.2	0.24	Clean Water Act -- Human Health Water + Organism
Uranium	METAL	6/4/2010	12/14/2010	45	45	100.00%	µg/L	--	--	6.4	177	30	40 CFR 141 - Federal MCL
Zinc	METAL	6/4/2010	12/14/2010	45	12	26.67%	µg/L	4.0	6.0	4.0	456	91	WAC 173-201A
Iron	METAL	6/4/2010	12/14/2010	45	19	42.22%	µg/L	18	38	18	647	300	40 CFR 141 - Federal MCL
Lithium	METAL	6/4/2010	12/14/2010	45	33	73.33%	µg/L	4.0	4.0	4.0	33	32	WAC 173-340-720(4)(b)(iii)(A) and (B)
Gross alpha	RAD	6/4/2010	12/14/2010	28	28	100.00%	pCi/L	--	--	3.4	77	15	40 CFR 141 - Federal MCL
Acrolein	VOC	6/4/2010	12/14/2010	45	1	2.22%	µg/L	2.8	2.8	3.8	3.8	3.0	Clean Water Act -- Freshwater CCC
Bromodichloromethane	VOC	6/4/2010	12/14/2010	45	3	6.67%	µg/L	0.088	0.088	0.68	0.69	0.27	40 CFR 131 -- Human Health Water + Organism
Carbon tetrachloride	VOC	6/4/2010	12/14/2010	45	3	6.67%	µg/L	0.12	0.12	0.13	0.59	0.23	Clean Water Act -- Human Health Water + Organism
Tetrachloroethene	VOC	6/4/2010	12/14/2010	45	3	6.67%	µg/L	0.18	0.18	0.19	0.38	0.081	WAC 173-340-720(4)(b)(iii)(A) and (B)
Trichloroethene	VOC	6/4/2010	12/14/2010	45	35	77.78%	µg/L	0.21	0.25	0.31	3.0	0.49	WAC 173-340-720(4)(b)(iii)(A) and (B)

Note:

Shading indicates analyte is listed as a groundwater contaminant of potential concern in DOE/RL-2009-45, 300 Area Remedial Investigation/ Feasibility Study Sampling and Analysis Plan for the 300-FF-1, 300-FF-2, and 300-FF-5 Operable Units.

Table 7-8. Exposure Point Concentration Summary for the 300 Area Subregion of the 300-FF-5 Groundwater Operable Unit

Analyte Name	Analyte Class	Total Samples	Total Detects	Frequency of Detection	Units	Minimum Detection Limit	Maximum Detection Limit	Minimum Detected Result	Maximum Detected Result	90 th Percentile	Action Level	Action Level Basis	90th Percentile > Action Level?	Level of Exceedence
Nitrate	ANION	45	45	100.00%	µg/L	--	--	7,080	62,000	31,250	45,000	40 CFR 141 - Federal MCL	No	6.94E-01
Aluminum	METAL	45	4	8.89%	µg/L	5.0	10	9.3	100	10	50	40 CFR 141 - Federal MCL	No	2.00E-01
Arsenic	METAL	45	43	95.56%	µg/L	0.80	0.80	0.93	6.5	5.2	0.018	Clean Water Act -- Human Health Water + Organism	Yes	2.90E+02
Copper	METAL	45	23	51.11%	µg/L	0.10	0.45	0.21	31	1.4	9.0	Clean Water Act -- Freshwater CCC	No	1.51E-01
Iron	METAL	45	19	42.22%	µg/L	18	38	18	647	106	300	40 CFR 141 - Federal MCL	No	3.52E-01
Lead	METAL	45	3	6.67%	µg/L	0.10	0.20	0.29	3.5	0.20	2.1	WAC 173-201A	No	9.48E-02
Lithium	METAL	45	33	73.33%	µg/L	4.0	4.0	4.0	33	25	32	WAC 173-340-720(4)(b)(iii)(A) and (B)	No	7.66E-01
Uranium	METAL	45	45	100.00%	µg/L	--	--	6.4	177	114	30	40 CFR 141 - Federal MCL	Yes	3.80E+00
Selenium	METAL	45	45	100.00%	µg/L	--	--	0.48	5.8	3.7	5.0	Clean Water Act -- Freshwater CCC	No	7.44E-01
Thallium	METAL	45	1	2.22%	µg/L	0.050	0.10	1.2	1.2	0.10	0.24	Clean Water Act -- Human Health Water + Organism	No	4.17E-01
Zinc	METAL	45	12	26.67%	µg/L	4.0	6.0	4.0	456	42	91	WAC 173-201A	No	4.56E-01
Gross alpha	RAD	28	28	100.00%	pCi/L	--	--	3.4	77	71	15	40 CFR 141 - Federal MCL	Yes	4.73E+00
Acrolein	VOC	45	1	2.22%	µg/L	2.8	2.8	3.8	3.8	2.8	3.0	Clean Water Act -- Freshwater CCC	No	9.33E-01
Bromodichloromethane	VOC	45	3	6.67%	µg/L	0.088	0.088	0.68	0.69	0.088	0.27	40 CFR 131 -- Human Health Water + Organism	No	3.26E-01
Carbon tetrachloride	VOC	45	3	6.67%	µg/L	0.12	0.12	0.13	0.59	0.12	0.23	Clean Water Act -- Human Health Water + Organism	No	5.22E-01
Tetrachloroethene ^a	VOC	45	3	6.67%	µg/L	0.18	0.18	0.19	0.38	0.18	0.081	WAC 173-340-720(4)(b)(iii)(A) and (B)	Yes	2.22E+00
Trichloroethene ^b	VOC	45	35	77.78%	µg/L	0.21	0.25	0.31	3.0	2.2	0.49	WAC 173-340-720(4)(b)(iii)(A) and (B)	Yes	4.47E+00

Note:

a. A quantitation limit of 5.0 µg/L is reported for tetrachloroethene in Table 2-7 of DOE/RL-2009-45.

b. A quantitation limit of 2.0 µg/L is reported for trichloroethene in Table 2-7 of DOE/RL-2009-45.

Table 7-14. Monitoring Well Locations Reported with Concentrations of COPCs Greater Than Action Level for the 300 Area Subregion of the 300-FF-5 Groundwater Operable Unit

Groundwater COPC Action Level	Gross alpha 15 pCi/L	Trichloroethene 0.49 µg/L	Uranium 30 µg/L	Zinc 91 µg/L
399-1-10A			X	
399-1-12	X			
399-1-17A			X	
399-1-21A	X	X	X	
399-1-6				
399-2-1	X	X	X	
399-2-2	X	X	X	
399-3-12	X	X	X	
399-3-20	X	X	X	X
399-3-6	X	X	X	
399-3-9	X	X	X	
399-4-1		X		
399-4-12		X		
399-4-14	X	X	X	
399-4-9	X	X	X	

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Draft A

Identification of Contaminants of Potential Concern for Groundwater Risk Assessment at the 600 Area Subregion of the 300-FF-5 Groundwater Operable Unit

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

Contractor for the U.S. Department of Energy
under Contract DE-AC06-08RL14788



P.O. Box 1600
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Identification of Contaminants of Potential Concern for Groundwater Risk Assessment at the 600 Area Subregion of the 300-FF-5 Groundwater Operable Unit

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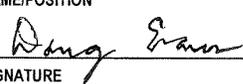
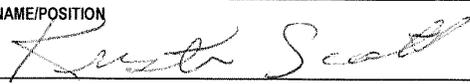
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Terms

ARAR	applicable or relevant and appropriate requirements
AWQC	Aquatic Water Quality Standards
BRA	Baseline Risk Assessment
COPC	contaminant of potential concern
DOE	U.S. Department of Energy
ECF	environmental calculation file
EPA	Environmental Protection Agency
EPC	Exposure Point Concentration
FS	Feasibility Study
HEIS	Hanford Environmental Information System
MCL	Maximum Contaminant Level
MCLG	Maximum Residual Disinfectant Levels
MDL	Method Detection Limit
OU	operable unit
QL	quantitation limit
RI/FS	Remedial Investigation/Feasibility Study
SDWA	Safe Drinking Water Act
SAP	Sampling and Analysis Plan
WAC	Washington Administrative Code

1 Purpose

This environmental calculation describes the identification of contaminants of potential concern (COPCs) for the groundwater risk assessment for the 600 Area subregion of the 300-FF-5 Groundwater Operable Unit (OU) (hereafter referred to simply as the 600 Area subregion). This evaluation supports DOE/RL-2010-99, *Remedial Investigation/Feasibility Study for the 300-FF-1, 300-FF-2, and 300-FF-5 Operable Units*.

This environmental calculation includes a description of the 600 Area subregion COPC identification process, and the COPC results.

2 Background

Groundwater COPCs are potentially site-related analytes that are detected in groundwater at levels that represent a potential threat to human health or the environment and that have analytical data of sufficient quality for use in a quantitative baseline risk assessment. COPCs are selected based on a multi-step screening process. COPCs that pose a potentially unacceptable risk are carried forward to be addressed by the feasibility study (FS).

1. In general, COPCs with exposure point concentrations (EPCs) above an action level [see Section 3.3 for a complete list of chemical-specific applicable or relevant and appropriate requirements (ARARs)] were retained as COPCs.
2. Exceptions to this general rule are made for analytes that have EPCs that *are not* above their action level (which are calculated for the subregion as a whole), but exist locally at concentrations above the action level (i.e., are localized contaminants that represent a potential threat to human health or the environment).

A preliminary COPC evaluation was conducted in 2008 to support DOE/RL-2009-30, *300 Area Remedial Investigation/Feasibility Study Work Plan for the 300-FF-1, 300-FF-2, and 300-FF-5 Operable Units* and DOE/RL-2009-45, *300 Area Remedial Investigation/Feasibility Study Sampling and Analysis Plan for the 300-FF-1, 300-FF-2 and 300-FF-5 Operable Units*. The work plan effort evaluated groundwater analytical data collected over a 17-year period (1992 to 2009) and resulted in the identification of historic COPCs that are reported in DOE/RL-2009-45, Table 1-5. The historic COPCs identified in DOE/RL-2009-45 for the 600 Area subregion are also listed in Table 2-1, below.

The groundwater data used in this calculation were collected specifically to address the data needs identified in DOE/RL-2009-30. The groundwater data set also addresses the chemical, spatial, and temporal uncertainties associated with the previous groundwater risk results.

This calculation focuses on:

1. Validating and updating the results of the DOE/RL-2009-30, using more recent and comprehensive groundwater analytical data, and
2. Evaluating the groundwater analytical data collected in accordance with DOE/RL-2009-45 to identify those analytes that qualify as COPCs.

This calculation uses a rigorous screening methodology that incorporates action levels derived from a comprehensive set of chemical-specific ARARs.

Table 2-1. List of Historic Contaminants of Potential Concern in the 600 Area Subregion of the 300-FF-5 Groundwater Operable Unit^a

Contaminants of Potential Concern			
Metals			
Antimony	Arsenic	Cadmium	Chromium
Copper	Lead	Manganese	Nickel
Uranium	Zinc		
Volatile Organic Compounds			
Carbon tetrachloride	Tetrachloroethene	Tributyl phosphate	Trichloroethene
Vinyl chloride			
Radiological			
Iodine-129	Strontium-90	Tritium	
Anions			
Fluoride	Nitrate (as N)	Nitrite (as N)	Sulfate

Notes:

a. DOE/RL-2009-45, Table 1-5.

3 Methodology

The COPC identification methodology is a sequence of three steps:

1. Extract (from the Hanford Environmental Information System) and process the 600 Area subregion-specific analytical data set.
2. Evaluate the data set to select analytes that qualify for the groundwater risk assessment.
3. Evaluate the analytes, to identify analytes that qualify as COPCs.

The COPCs will be carried forward into the supplemental groundwater risk evaluation, which will be conducted as part of the remedial investigation/feasibility study (RI/FS).

3.1 Verification of Data Set Completeness

A list of the analytical methods used is gathered from the dataset and compared against the methods specified in the sampling and analysis plan (DOE/RL-2009-45). The following steps are taken to verify that the data set is complete and contains only those records that will be used in the COPC identification process:

- Identify any records associated with an analytical method not called out in the SAP.
- Identify any records associated with an analytical method not equivalent to a method identified in the SAP.

- Identify each well, and independently verify that all results are reported in the data set, identifying any wells for which sample results are missing.

3.2 Analytical Data Processing

The data set obtained from HEIS included the following types of information:

- Analytical results from both unfiltered and filtered samples
- Data qualification and data validation flags, including rejected results
- Results for a given analyte reported by more than one analytical method
- Parent, field duplicate, and field split sample results

The analytical data were processed to eliminate unusable results and thus identify one set of results per sampling location and date of sample collection. The data processing steps and the numbers of records associated with each step are presented in Figure 3-1. Descriptions of the data processing steps follow.

3.2.1 Unfiltered Sample Results

Only analytical results from unfiltered samples are used in identifying COPCs; results from filtered samples are excluded. Unfiltered sample results represent total concentrations of the analytes, while filtered sample results represent only dissolved concentrations. Use of filtered sampling results might lead to underestimation of chemical and radiological concentrations (e.g., in water from an unfiltered tap).

The publication, EPA/541/1-89/002, *Risk Assessment Guidance for Superfund Volume I Human Health Evaluation Manual (Part A)*, addresses this issue in providing guidance on estimating exposure concentrations in groundwater:

“While filtration of ground-water samples provides useful information for understanding chemical transport within an aquifer, the use of filtered samples for estimating exposure is very controversial because these data may underestimate chemical concentrations in water from an unfiltered tap. Therefore, data from unfiltered samples should be used to estimate exposure concentrations.”

3.2.2 Laboratory and Data Validation Flags

Analytical data are received from the laboratory with data qualification flags. Validation qualifiers are assigned during the data validation process. The following rules determine how flagged and/or qualified sample results are used in identifying COPCs.

- Sample results flagged with a “U” qualifier, or combination of qualifiers that include a “U,” such as a “UJ,” are considered nondetected results.
- Sample results without a “U” qualifier are considered detected concentrations, including results with no qualifier or with a “J” qualifier.
- Sample results that are rejected and flagged with an “R” qualifier are not used in identifying COPCs.

3.2.3 Analytes Reported by Numerous Analytical Methods

Often analytes are reported by more than one analytical method, resulting in multiple results for the same analyte from the same location. When analytes are reported by more than one analytical method, the data are processed to select the method that provides the most reliable results. For example, the gamma

spectroscopy method provides concentration results for the uranium isotopes; however, uranium concentrations reported by a uranium-isotope-specific method are preferred.

3.2.4 Field Duplicate and Field Split Results

Field quality control samples (field duplicates and field splits) are collected in the field and analyzed by the laboratory as unique samples. The parent sample and quality control samples are collected from the same location (i.e., monitoring well) on the same date, resulting in more than one sample per location/date. The following criteria are used to reduce multiple sample results for an individual location/date to a single result:

- If two or more detections exist, the maximum concentration is used.
- If at least one detection and one or more nondetected results exist, the detected concentration is used.
- If only (two or more) nondetected results exist, the lowest detection limit is used.

3.3 Identify Action Levels

Action levels are derived from available sources of chemical-specific ARARs and default exposure assumptions. All sources of chemical-specific ARARs for each of the 227 analytes reported in the HEIS database for the 600 Area subregion are identified in Table 3-1.

For the COPC identification process, the action level is the lowest of the available values for protection of human health and aquatic receptors.

3.3.1 ARAR-Based Remediation Goals

The sources of the chemical-specific ARARs from federal regulations are:

- 40 CFR 141 National Primary Drinking Water Regulation, MCLs, secondary MCLs, and non-zero MCLGs established under the *Safe Drinking Water Act of 1974* (SDWA)
- National Recommended Water Quality Criteria, aquatic water quality criteria (AWQC) established under Section 304 of the *Clean Water Act of 1977*
- 40 CFR 131 water quality standards for states not complying with Section 303 of the *Clean Water Act of 1977*

The sources of the chemical-specific ARARs from Washington State regulations are:

- WAC 173-340-720, “Groundwater Cleanup Standards”
- WAC 173-340-730, “Surface Water Cleanup Standards”
- WAC 246-290-310, “Group A Public Water Supplies,” “Maximum Contaminant Levels (MCLs) and Maximum Residual Disinfectant Levels (MRDLs)”
- WAC 173-201A, “Water Quality Standards for Surface Waters of the State of Washington”

Derivation of State of Washington groundwater cleanup levels is provided in a separate calculation brief (ECF-100NPL-10-0462, *Calculation of Standard Method B Groundwater Cleanup Levels for Potable Groundwater for the 100 Areas and 300 Area Remedial Investigation/ Feasibility Study Report*).

Derivation of State of Washington surface water cleanup levels is provided in a separate calculation brief (ECF-100NPL-10-0463, *Calculation of Standard Method B Surface Water Cleanup Levels for the 100 Areas and 300 Area Remedial Investigation/ Feasibility Study Report*).

3.4 Groundwater COPC Identification Process: Part 1

After extracting and processing the 600 Area subregion groundwater analytical data set from HEIS, a multi-step screening process was used to identify COPCs. The COPC identification process steps, and the numbers of records and numbers of analytes associated with each step, are depicted in Figure 3-2. The steps are:

- Apply exclusion criteria
- Identify nondetected analytes
- Identify analytes with maximum detected concentrations less than their respective action levels;
- Identify analytes with maximum detected concentrations greater than their respective action levels.

3.4.1 Apply Exclusion Criteria

The first step in the groundwater COPC identification process is to apply certain exclusion criteria. Analytes that meet one or more of the exclusion criteria were eliminated as COPCs. Analytes that did not meet any of the exclusion criteria were carried forward into the next step. The exclusion criteria are:

- Naturally occurring radionuclides associated with background radiation
- Radionuclides that have half-lives of less than 3 years and are not significant daughter products
- Essential nutrients (minerals)
- Analytes without known toxicity information

3.4.2 Identify Nondetected Analytes

The next step in the groundwater COPC identification process was to identify nondetected analytes. Chemicals and radionuclides that have been analyzed for, but not detected in any sample (collected from appropriate locations, with adequate detection limits), are eliminated as COPCs. All analytes detected at least once were carried forward to the next step.

3.4.3 Identify Analytes with Maximum Detected Concentrations Less Than Action Levels

This step identifies analytes with maximum concentrations less than action levels. In this initial screening, the maximum concentration of each analyte detected in groundwater was compared to its action level, to identify analytes not likely to contribute significantly to overall risk. If the maximum detected concentration of an analyte was less than its action level, the analyte was eliminated as a COPC, unless the uncertainty analysis indicated otherwise.

Uncertainty Analysis. An additional evaluation was performed on those analytes that were detected at concentrations that were near but did not exceed their respective action level (i.e., the maximum detected concentration was at least greater than one-tenth the action level, or one order of magnitude). This evaluation also included the additional analytes identified as historic COPCs in DOE/RL-2009-45, Table 1-5 (see Table 2-1).

The purpose of this evaluation is to determine if there is a potential for underestimating cumulative effects when the concentrations of analytes only slightly less than their action levels. Additionally, method detection limits (MDLs) associated with these analytes were evaluated, to determine if the limits are adequate for confirming presence or absence of the analytes near their respective action levels.

3.4.4 Identify Analytes with Maximum Detected Concentrations Greater Than Action Levels

This step identifies analytes with maximum concentrations greater than their respective action levels. Such analytes are likely to contribute to overall risk. If the maximum detected concentration of an analyte is greater than its action level, the analyte is carried forward for EPC calculation, unless the uncertainty analysis indicates otherwise.

Uncertainty Analysis. An additional evaluation was performed to distinguish two types of analytes that were detected infrequently:

- Analytes detected once, or a very few times, with high concentrations that are not consistent with the remainder of the dataset (are not reproducible). Such results can lead to overestimation of actual groundwater concentrations. Analytes with limited, non-reproducible results are not retained.
- Analytes that were detected infrequently overall, but more frequently at one or more locations, and that are associated with a significant local trend or may be associated with a continuing vadose source. Such results indicate a potential risk, and these analytes are retained.

3.5 Groundwater COPC Identification Process: Part 2

After identifying the set of analytes with maximum concentrations above action levels for the 600 Area subregion, a multi-step screening process is applied to the analytical dataset to further evaluate the analytes that will be carried forward for evaluation in the 300-FF-5 OU RI/FS.

Groundwater COPCs are identified by comparing 90th percentile values to their respective action levels. The sequential steps in the COPC identification process are:

- Perform statistical calculations to estimate 90th percentile values for the analytes.
- Identify analytes with 90th percentile values less than their respective action levels.
- Identify analytes with 90th percentile values greater than their respective action levels.
- Perform analyte-specific evaluations.

A flow-chart depicting the COPC identification process and the number of analytes associated with each process step is provided in Figure 3-3. The steps in the sequence are described below.

3.5.1 Calculate 90th Percentile Values for Each Analyte

Groundwater COPCs are identified by comparing statistical EPC estimates (i.e., 90th percentile values) to action levels for each detected analyte. EPCs are estimated as the 90th percentile value for each analyte. In the 90th percentile value calculations, the MDL is used as the “detected” concentration for nondetect samples. A description of the methodology used to calculate the 90th percentile values is provided in ECF-300FF5-11-0131, *Calculation of Exposure Point Concentrations for the 600 Area Subregion of the 300-FF-5 Groundwater Operable Unit*.

3.5.2 Identify Analytes with 90th Percentile Values Less Than Action Levels

Groundwater analytes with 90th percentile values less than their respective action levels are identified. The 90th percentile values are compared to the lowest chemical-specific ARARs for protection of human health and aquatic receptors.

3.5.2.1 Analyte-Specific Evaluation

An analyte-specific evaluation step is conducted when the 90th percentile value for an analyte is less than its action level, but individual sample results indicate concentrations greater than the action level. A flow-chart depicting this analyte-specific evaluation is provided in Figure 3-4. This step is performed to confirm that the analyte has not been inappropriately eliminated as a COPC, and takes into consideration specific attributes of the groundwater contamination plume, as described below.

- Is the analyte co-located with one or more COPCs, with some sample concentrations above its action level?
- Is the analyte associated with a significant local trend or continuing vadose source?
- Is the analyte associated with a discrete local exposure point, with some concentrations above its action level?

3.5.3 Identify Analytes with 90th Percentile Values Greater Than Action Levels

Groundwater analytes with 90th percentile values greater than their respective action levels are identified. The 90th percentile values are compared to the lowest chemical-specific ARARs for protection of human health and aquatic receptors.

3.5.3.1 Analyte Specific Evaluation

An analyte-specific evaluation is performed on analytes with 90th percentile values greater than their respective action levels. A flow-chart depicting this analyte-specific evaluation is provided in Figure 3-5. This step is performed to confirm that the 90th percentile value has not inappropriately identified a COPC, and takes into consideration the effects that data quality, naturally occurring levels of metals, and action level selection have on COPC identification.

- Is the analyte at or below background levels and thus a naturally occurring substance?
- Is the ARAR-based action level (Table 3-1) only a secondary MCL that is not enforceable?
- Are there data quality issues associated with the analyte?

4 Assumptions and Inputs

4.1 Groundwater Data Set Used for COPC Identification

The groundwater data set used for COPC identification consists of sampling and analysis data collected from 17 monitoring wells within the boundaries of the 600 Area subregion. All are either monitoring wells or compliance wells. A list of the wells used in this evaluation is provided in Table 4-1. Figure 4-1 shows the location of each well.

The sampling and analysis data were collected over a 6-month period between June 10, 2010 and December 20, 2010. Three sampling events were used to capture the effects that temporal fluctuations of river stage have on groundwater conditions. Samples collected from June to early July 2010 represent the aquifer when the river stage is at its highest elevation. Samples collected from mid-November to mid-December 2010 represent the aquifer when the river is at its lowest elevation. Samples collected from August to mid-September 2010 represent the aquifer when the river is transitioning from high to low river stage. A total of 15,023 records were obtained from HEIS, and a total of 227 analytes were included in the data set prior to analytical data processing. After analytical data processing (as described in Section

3.2), the final data set used for the COPC identification process contained a total of 11,321 records, with 227 analytes included in the data set.

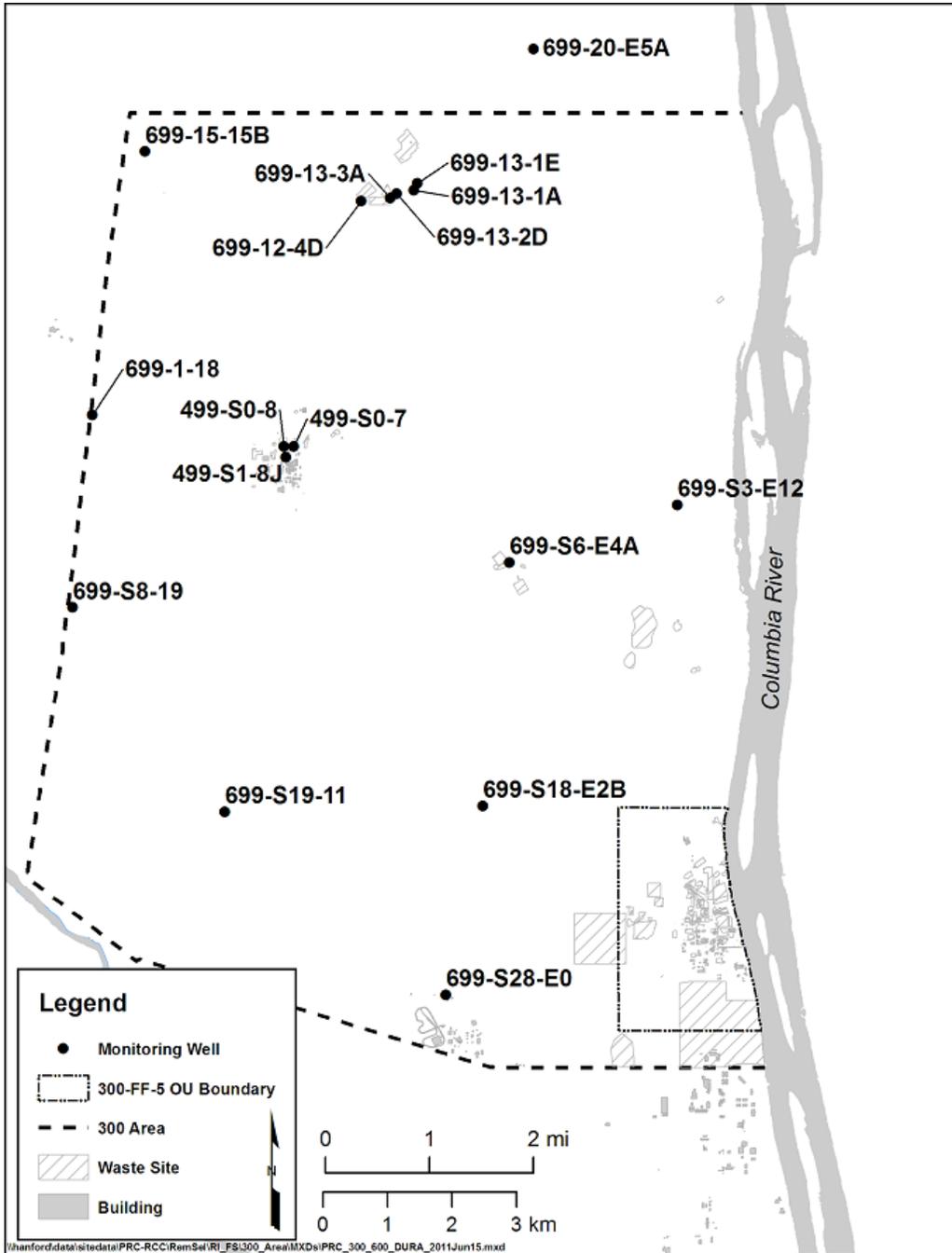


Figure 4-1. Groundwater Monitoring Wells for the 600 Area Subregion of the 300-FF-5 Groundwater Operable Unit

5 Software Applications

Software used for this analysis includes HEIS, Microsoft Access¹ database software, and Microsoft Excel². HEIS is a central repository for storing and maintaining access to environmental data collected for the Hanford Site. Microsoft Access is used to query and sort the data downloaded from HEIS. Microsoft Excel is used to present the groundwater data and other information in spreadsheets.

6 Calculation

Groundwater COPCs for the 600 Area subregion are identified using the methodology presented in Section 3 and the groundwater data set described in Section 4. Results for each step of the COPC identification process are summarized in the text and tables in Section 7.

The methodology used to calculate 90th percentile values and the results are provided in ECF-300FF5-11-0131.

7 Results/Conclusions

7.1 Groundwater COPC Identification Process: Part 1

This section summarizes the results of the COPC identification process.

7.1.1 Apply Exclusion Criteria

The following subsections summarize the results of the exclusion criteria screening step. A total of 41 analytes met the exclusion criteria; they are listed in Table 7-1. Sampling dates, minimum and maximum detected concentrations, minimum and maximum MDLs, and the bases for their exclusion are also provided in Table 7-1.

7.1.1.1 *Background Radiation*

No reported analytes in the 600 Area subregion were excluded based on being natural background radioisotopes.

7.1.1.2 *Radionuclides with Half-lives of Less than 3 Years*

No reported analytes in the 600 Area subregion were radioisotopes with half-lives of less than three years.

7.1.1.3 *Essential Nutrients*

Essential nutrients are those analytes considered essential for human nutrition. The essential nutrients calcium, magnesium, potassium, and sodium were detected in the groundwater in the 600 Area subregion but are excluded from further consideration as COPCs.

7.1.1.4 *Analytes without Action Levels or Toxicity Values*

Some analytes do not have an action level, because a promulgated chemical-specific ARAR is not available in any of the sources listed in Table 3-1. For some analytes without an action level, there is also no available toxicological information that could be considered in assessing any risks they may present. Thirty-seven analytes were eliminated from further consideration as COPCs because they do not have an action level and they do not have available toxicological information. The eliminated analytes are listed in Table 7-1.

¹ Access is a trademark of Microsoft Corporation, Redmond, Washington.

² Excel is a trademark of Microsoft Corporation, Redmond, Washington.

The MCL for gross beta is 4 mrem/yr annual dose and is used to indicate the presence of a group of beta-emitters. Although there is an MCL for gross beta, gross beta is reported by the laboratory in units of activity (pCi/L) and would require a conversion from activity to an annual dose rate (mrem/yr). Beta-emitting radioisotopes such as uranium and tritium are detected and are compared to their isotope specific standard, which is based on a 4 mrem/yr annual dose. This type of comparison is considered more protective than the overall standard for gross beta. For the purpose of this environmental calculation, gross beta is used to confirm the presence of beta-emitters.

7.1.2 Identify Nondetected Analytes

A total of 143 analytes were not detected in the 600 Area subregion groundwater samples. They are listed in Table 7-2, each with sampling dates, minimum and maximum MDLs, the action level, the basis of the action level, and the level of exceedance. The action levels in this table are the lowest of chemical-specific ARARs available for protection of human and aquatic receptors (Table 3-1). The level of exceedance in Table 7-2 is used to identify analytes with MDLs that did not meet the action level. The level of exceedance is calculated by dividing the minimum MDL by the action level.

Table 7-3 lists historic COPCs in DOE/RL-2009-45 not identified as groundwater COPCs for the 600 Area subregion because they were not detected.

Table 7-3. Summary of Historic COPCs from DOE/RL-2009-45 Not Identified as Groundwater COPCs for the 600 Area Subregion

COPC	Reason for Inclusion in the SAP (DOE/RL-2009-45)	Reason for Exclusion as COPC
Antimony	Max concentration and MDLs greater than action level	Not detected in data set; all MDLs less than action level.
Cadmium	Max concentration and MDLs greater than action level	Not detected in data set; all MDLs less than action level.
Nitrite	Max concentration and MDLs greater than action level	Not detected in data set; all MDLs less than action level.
Strontium-90	Max concentration greater than action level	Not detected in data set; all MDLs less than action level.
Tetrachloroethene	Max concentration and MDLs greater than action level	Not detected in data set; all MDLs less than the QL listed in DOE/RL-2009-45 ^a .
Trichloroethene	Max concentration greater than action level	Not detected in data set; all MDLs less than the QL listed in DOE/RL-2009-45 ^a .
Vinyl chloride	MDLs greater than action level	Not detected in data set; all MDLs less than the QL listed in DOE/RL-2009-45 ^a .

a. When action level is less than the quantitation limit (QL) reported in DOE/RL-2009-45, the action level defaults to the QL.

Antimony was identified as a historic COPC in DOE/RL-2009-45 because it was detected in groundwater samples between 1992 and 2008 at concentrations greater than the action level and most MDLs were greater than the action level. Antimony was not detected in the current 600 Area subregion samples and all MDLs are less than the action level of 5.6 µg/L. Therefore, antimony is not identified as a COPC; its elimination is not expected to lead to underestimation of cumulative health effects.

Cadmium was identified as a historic COPC in DOE/RL-2009-45 because it was detected in groundwater samples between 1992 and 2008 at concentrations greater than the action level and most MDLs were greater than the action level. Cadmium was not detected in the current 600 Area subregion samples and all MDLs are less than the action level of 0.25 µg/L. Therefore, cadmium is not identified as a COPC; its elimination is not expected to lead to underestimation of cumulative health effects.

Nitrite was identified as a historic COPC in DOE/RL-2009-45 because it was detected in groundwater samples between 1992 and 2008 at concentrations greater than the action level and most MDLs were greater than the action level. Nitrite was not detected in the current 600 Area subregion samples and all MDLs are less than the action level of 3,300 µg/L. Therefore, nitrite is not identified as a COPC; its elimination is not expected to lead to underestimation of cumulative health effects.

Strontium-90 was identified as a historic COPC in DOE/RL-2009-45 because it was detected in groundwater samples between 1992 and 2008 at concentrations greater than the action. Strontium-90 was not detected in the current 600 Area subregion samples and all MDLs are less than the action level of 8 pCi/L. Therefore, strontium-90 is not identified as a COPC; its elimination is not expected to lead to underestimation of cumulative health effects.

Tetrachloroethene was identified as a historic COPC in DOE/RL-2009-45 because it was detected between 1992 and 2008 at concentrations greater than the action level and most MDLs were greater than the action level. Tetrachloroethene was not detected in the current 600 Area subregion samples. All MDLs for tetrachloroethene are 0.18 µg/L. When the action level is less than the quantitation limit (QL) reported in DOE/RL-2009-45, the action level defaults to the QL. The QL of 5 µg/L reported in DOE/RL-2009-45 and all MDLs are greater than the action level of 0.081 µg/L. All MDLs are less than the QL listed in DOE/RL-2009-45.

Trichloroethene was identified as a historic COPC in DOE/RL-2009-45 because it was detected between 1992 and 2008 at concentrations greater than the action level. Trichloroethene was not detected in the current 600 Area subregion samples. All MDLs for trichloroethene ranged between 0.21 and 1.0 µg/L. When the action level is less than the QL reported in DOE/RL-2009-45, the action level defaults to the QL. The QL of 2 µg/L reported in DOE/RL-2009-45 and 1 of 51 MDLs are greater than the action level of 0.49 µg/L. All 51 MDLs are less than the QL listed in DOE/RL-2009-45.

Vinyl chloride was identified as a historic COPC in DOE/RL-2009-45 because all MDLs were greater than the action level. Vinyl chloride was not detected in the current 600 Area subregion samples. All MDLs for vinyl chloride are 0.084 µg/L. When the action level is less than the QL reported in DOE/RL-2009-45, the action level defaults to the QL. The QL of 5 µg/L reported in DOE/RL-2009-45 and all MDLs are greater than the action level of 0.025 µg/L. All MDLs are less than the QL listed in DOE/RL-2009-45.

7.1.2.1 Uncertainty Analysis

Fifty-one analytes were not detected and were reported with some or all MDLs greater than their respective action levels. This indicates that the analytical method selected is unable to detect the analyte at or below the action level. With the exceptions of tetrachloroethene, trichloroethene, and vinyl chloride, these 51 analytes that are not detected are not known or suspected to be associated with releases at the 300-FF-1 or 300-FF-2 source OUs.

7.1.3 Identify Analytes with Maximum Detected Concentrations Less than Action Levels

Thirty analytes were detected at least once and had maximum detected concentrations less than their respective action levels. A list of these analytes is presented in Table 7-4. Table 7-4 also provides

sampling dates, minimum and maximum MDLs, minimum and maximum detected concentrations, the action levels, and the bases of the action levels.

Table 7-5 lists the historic COPCs from DOE/RL-2009-45 that are not identified as groundwater COPC for the 600 Area subregion because their maximum concentrations are not greater than their respective action levels.

Table 7-5. Summary of Historic COPCs from DOE/RL-2009-45 Not Identified as Groundwater COPCs for the 600 Area Subregion

COPC	Reason for Inclusion in the SAP (DOE/RL-2009-45)	Reason for Exclusion as COPC
Carbon tetrachloride	Maximum concentration and MDLs greater than action level	All detects and MDLs less than action level
Chromium	Maximum concentration greater than action level	All detects and MDLs less than action level
Fluoride	Maximum concentration greater than action level	All detects and MDLs less than action level
Iodine-129	Maximum concentration and MDLs greater than action level	Single detection at well 699-1-18 and not detected in two other sample events; MDLs less than action level
Lead	Maximum concentration and MDLs greater than action level	All detects and MDLs less than action level
Nickel	Maximum concentration greater than action level	All detects and MDLs less than action level
Sulfate	Maximum concentration greater than action level	All detects less than action level
Tributyl phosphate	Maximum concentration greater than action level	Single detection at well 699-S6-E4A and not detected in two other sample events; MDLs less than action level
Uranium	Maximum concentration greater than action level	All detects and MDLs less than action level
Zinc	Maximum concentration greater than action level	All detects and MDLs less than action level

Carbon tetrachloride was detected in 2 of 51 water samples (3.9 percent frequency). Carbon tetrachloride concentrations ranged from 0.13 to 0.16 µg/L, all below the action level of 0.23 µg/L. In addition, all MDLs are less than the action level. Results of this evaluation indicate that carbon tetrachloride concentrations are consistently below the action level and that elimination of this analyte would not likely lead to underestimation of cumulative health effects.

Chromium was detected in 34 of 51 water samples (67 percent frequency). Chromium concentrations ranged from 1.1 to 5.9 µg/L, all below the action level of 65 µg/L. In addition, all MDLs are less than the action level. Results of this evaluation indicate that chromium concentrations are consistently below the action level and that elimination of this analyte would not likely lead to underestimation of cumulative health effects.

Fluoride was detected in 43 of 51 water samples (84 percent frequency). Fluoride concentrations ranged from 39 to 851 µg/L, all below the action level of 960 µg/L. In addition, all MDLs are less than the

action level. Results of this evaluation indicate that fluoride concentrations are consistently below the action level and that elimination of this analyte would not likely lead to underestimation of cumulative health effects.

Iodine-129 was detected in one of 51 water samples (2 percent frequency). Iodine-129 was detected as well 699-1-18 (B26MB5) at a concentration of 0.38 pCi/L, which is below the action level of 1.0 pCi/L. In addition, all MDLs are less than the action level. Results of this evaluation indicate that iodine-129 concentrations are consistently below the action level and that elimination of this analyte would not likely lead to underestimation of cumulative health effects.

Lead was detected in 15 of 51 water samples (29 percent frequency). Lead concentrations ranged from 0.24 to 1.4 µg/L, all below the action level of 2.1 µg/L. In addition, all MDLs are less than the action level. Results of this evaluation indicate that lead concentrations are consistently below the action level and that elimination of this analyte would not likely lead to underestimation of cumulative health effects.

Nickel was detected in four of 51 water samples (7.8 percent frequency). Nickel concentrations ranged from 4.0 to 8.0 µg/L, all below the action level of 52 µg/L. In addition, all MDLs are less than the action level. Results of this evaluation indicate that nickel concentrations are consistently below the action level and that elimination of this analyte would not likely lead to underestimation of cumulative health effects.

Sulfate was detected in all water samples (100 percent frequency). Sulfate concentrations ranged from 3,980 to 87,200 µg/L, all below the action level of 250,000 µg/L. Results of this evaluation indicate that nickel concentrations are consistently below the action level and that elimination of this analyte would not likely lead to underestimation of cumulative health effects.

Tributyl phosphate was detected in one of 51 water samples (2 percent frequency). Tributyl phosphate was detected at well 699-S6-E4A (B286K1) at a concentration of 6.7 µg/L, which is below the action level of 9.5 µg/L. In addition, all MDLs are less than the action level. Results of this evaluation indicate that tributyl phosphate concentrations are consistently below the action level and that elimination of this analyte would not likely lead to underestimation of cumulative health effects.

Uranium was detected in 49 of 51 water samples (96 percent frequency). Uranium concentrations ranged from 0.094 to 13 µg/L, all below the action level of 30 µg/L. In addition, all MDLs are less than the action level. Results of this evaluation indicate that uranium concentrations are consistently below the action level and that elimination of this analyte would not likely lead to underestimation of cumulative health effects.

Zinc was detected in 24 of 51 water samples (47 percent frequency). Zinc concentrations ranged from 4.0 to 71 µg/L, all below the action level of 91 µg/L. In addition, all MDLs are less than the action level. Results of this evaluation indicate that zinc concentrations are consistently below the action level and that elimination of this analyte would not likely lead to underestimation of cumulative health effects.

7.1.3.1 Uncertainty Analysis

The analytes detected at concentrations that are near but do not exceed their respective action levels (i.e., with maximum detected concentrations greater than one-tenth of their respective action level, or one order of magnitude) are barium, bromoform, butylbenzylphthalate, carbon tetrachloride, chloride, cobalt, iodine-129, lead, lithium, molybdenum, nickel, sulfate, tributyl phosphate, uranium, vanadium, and zinc. Among these, carbon tetrachloride, iodine-129, lead, nickel, sulfate, tributyl phosphate, uranium, and zinc were identified as historic COPCs in DOE/RL-2009-45 and are evaluated above.

Barium, bromoform, butylbenzylphthalate, chloride, cobalt, lithium, molybdenum, and vanadium were not identified as historic COPCs, but are considered below to determine if any have concentrations that

are only slightly less than their action levels and if there is thus a potential for underestimating cumulative effects by their elimination as COPCs. MDLs associated with these analytes are also evaluated, to determine if the limits are adequate for confirming presence or absence of the analytes near their respective action levels. None of these eight analytes was retained as a COPC.

Barium was detected in all water samples (100 percent frequency). Barium concentrations ranged from 15 to 118 µg/L, all below the action level of 1,000 µg/L. Results of this evaluation indicate that barium concentrations are consistently below the action level and that elimination of this analyte would not likely lead to underestimation of cumulative health effects.

Bromoform was detected in 6 of 51 water samples (12 percent frequency). Bromoform concentrations ranged from 1.6 to 2.9 µg/L, all below the action level of 4.3 µg/L. In addition, all MDLs were below the action level. Results of this evaluation indicate that bromoform concentrations are consistently below the action level and that elimination of this analyte would not likely lead to underestimation of cumulative health effects.

Butylbenzylphthalate was detected in one of 51 water samples (2.0 percent frequency). Butylbenzylphthalate was detected at well 699-20-E5A (B26MF8) at a concentration of 1.3 µg/L, which is below the action level of 8.2 µg/L. In addition, all MDLs are less than the action level. Results of this evaluation indicate that Butylbenzylphthalate concentrations are consistently below the action level and that elimination of this analyte would not likely lead to underestimation of cumulative health effects.

Chloride was detected in all water samples (100 percent frequency). Chloride concentrations ranged from 1,860 to 26,100 µg/L, all below the action level of 230,000 µg/L. Results of this evaluation indicate that chloride concentrations are consistently below the action level and that elimination of this analyte would not likely lead to underestimation of cumulative health effects.

Cobalt was detected in 10 of 51 water samples (20 percent frequency). Cobalt concentrations ranged from 0.13 to 1.0 µg/L, all below the action level of 2.6 µg/L. In addition, all MDLs were below the action level. Results of this evaluation indicate that cobalt concentrations are consistently below the action level and that elimination of this analyte would not likely lead to underestimation of cumulative health effects.

Lithium was detected in 36 of 50 water samples (72 percent frequency). Lithium concentrations ranged from 4.0 to 31 µg/L, all below the action level of 32 µg/L. In addition, all MDLs were below the action level. Results of this evaluation indicate that lithium concentrations are consistently below the action level and that elimination of this analyte would not likely lead to underestimation of cumulative health effects.

Molybdenum was detected in all water samples (100 percent frequency). Molybdenum concentrations ranged from 1.0 to 11 µg/L, all below the action level of 80 µg/L. Results of this evaluation indicate that molybdenum concentrations are consistently below the action level and that elimination of this analyte would not likely lead to underestimation of cumulative health effects.

Vanadium was detected in 19 of 51 water samples (37 percent frequency). Vanadium concentrations ranged from 12 to 33 µg/L, all below the action level of 80 µg/L. In addition, all MDLs were below the action level. Results of this evaluation indicate that vanadium concentrations are consistently below the action level and that elimination of this analyte would not likely lead to underestimation of cumulative health effects.

7.1.4 Identify Analytes with Maximum Detected Concentrations Greater than Action Levels

Thirteen analytes were detected at least once, with maximum detected concentrations greater than their respective action levels. Five of these analytes were identified as historic COPCs in DOE/RL-2009-45.

Table 7-6 provides a summary of the 13 analytes, providing for each, sampling dates, minimum and maximum MDLs, minimum and maximum detected concentrations, the action level, and the basis of the action level.

Table 7-7 lists the five historic COPCs from DOE/RL-2009-45 that are carried forward for EPC calculation for the 600 Area subregion because their maximum concentrations are greater than their respective action levels.

Table 7-7. Summary of Historic COPCs from DOE/RL-2009-45 Carried Forward for EPC Calculation

Arsenic	Copper	Manganese	Nitrate
Tritium			

In addition to the five analytes listed in Table 7-7, aluminum, bis(2-ethylhexyl) phthalate, bromodichloromethane, chloroform, dibromochloromethane, gross alpha, iron, and selenium are also carried forward for EPC calculation, because they have maximum concentrations greater than their action levels (13 total analytes).

7.2 Groundwater COPC Identification Process: Part 2

This section summarizes the COPC identification process.

7.2.1 Calculate 90th Percentile Values for Each Analyte

Groundwater COPCs are identified by comparing calculated EPC estimates (i.e., 90th percentile values) to action levels for each detected analyte. (The 90th percentile value is used as an estimate of the exposure point concentration.) The 90th percentile value is calculated for each analyte from the groundwater data set. In the calculations, the MDL is taken as the “detected” concentration for nondetect samples. Documentation of the calculations is provided in a separate environmental calculation (ECF-300FF5-11-0131). Results of the calculations are summarized in Table 7-8.

7.2.2 Identify Analytes with 90th Percentile Values Less Than the Action Levels

The 90th percentile values are compared to the lowest available chemical-specific ARARs for protection of human health and aquatic receptors (i.e., action levels). Analytes with 90th percentile values less than their respective action levels are listed in Table 7-9, and are discussed below in the analyte-specific evaluation.

Table 7-9. Summary of Analytes with 90th Percentile Values Less than Action Levels

Bis(2-ethylhexyl) phthalate	Chloroform	Copper
Gross alpha	Manganese	

7.2.2.1 Analyte Specific Evaluation

An analyte-specific evaluation step is conducted when the 90th percentile value for an analyte is less than its action level, but one or more individual sample results are greater than the action level. This step is

performed to confirm that the analyte has not been inappropriately eliminated COPC and takes into consideration specific attributes of the groundwater contamination plume, as described below.

- Is the analyte co-located with one or more COPCs, with some sample concentrations above its action level?
- Is the analyte associated with a significant local trend?
- Is the analyte associated with a discrete local exposure point, with some concentrations above its action level?

Five analytes have been detected at least once in groundwater and have 90th percentile values less than their respective action levels (Table 7-8). None of these are retained as COPCs.

Bis(2-ethylhexyl) phthalate's 90th percentile value is 1.0 µg/L, which is below the action level of 1.2 µg/L. Bis(2-ethylhexyl) phthalate was detected in 3 of 51 water samples (5.9 percent frequency) at concentrations ranging from 1.3 to 3.0 µg/L. Bis(2-ethylhexyl) phthalate was detected three times at a concentration above the action level, during a single sampling event at monitoring wells 699-13-2D (1.3 µg/L), 699-20-E5A (1.5 µg/L), and 699-S8-19 (3 µg/L). All three detections were flagged with a "J", indicating that the result is an estimated concentration. Bis(2-ethylhexyl) phthalate was not detected at these three wells during the other two sampling rounds. All MDLs are less than the action level. The results of this evaluation indicate that bis(2-ethylhexyl) phthalate is not associated with a local trend or a continuing local source; therefore, the 90th percentile value is considered a reasonable estimate of groundwater concentrations.

Chloroform's 90th percentile value is 0.62 µg/L, which is below the action level of 1.4 µg/L. When the action level is less than the QL reported in DOE/RL-2009-45, the action level defaults to the QL. The QL of 5.0 µg/L reported in DOE/RL-2009-45 is greater than the action level of 1.4 µg/L. All MDLs for chloroform are 0.10 µg/L. Chloroform was detected in 15 of 51 samples analyzed (29 percent frequency), with concentrations ranging from 0.11 µg/L to 7.1 µg/L. The results of this evaluation indicate that the 90th percentile value for chloroform is less than the QL reported in DOE/RL-2009-45; therefore, chloroform is not identified as a final COPC.

Copper's 90th percentile value is 3.3 µg/L, which is below the action level of 9.0 µg/L. Copper was detected in 31 of 51 water samples (61 percent frequency) at concentrations ranging from 0.24 to 12 µg/L. Copper was detected only once at a concentration above the action level. At monitoring well 499-S1-8J, copper was detected at a concentration of 12 µg/L. This detection was flagged with a "D", indicating that the analyte was reported at a secondary dilution factor. Other sampling rounds at this well reported detected concentrations less than the action level. All MDLs are less than the action level. The results of this evaluation indicate that copper is not associated with a local trend or a continuing local source; therefore, the 90th percentile value is considered a reasonable estimate of groundwater concentrations.

Gross alpha's 90th percentile value is 8.0 pCi/L, which is below the action level of 15 pCi/L. Gross alpha was detected in 14 of 22 water samples (64 percent frequency) at concentrations ranging from 2.3 to 40 pCi/L. Gross alpha was detected only once at a concentration above the action level. At monitoring well 699-13-3A, gross alpha was detected at a concentration of 40 pCi/L. Other sampling rounds at this well reported detected concentrations less than the action level (4.7 pCi/L and 4.2 pCi/L). All MDLs are less than the action level. The results of this evaluation indicate that gross alpha is not associated with a local trend or a continuing local source; therefore, the 90th percentile value is considered a reasonable estimate of groundwater concentrations.

Manganese's 90th percentile value is 40 µg/L, which is less than the action level of 50 µg/L. Manganese was detected in 27 of 51 water samples (53 percent frequency) at concentrations ranging from 5.0 to 261 µg/L. Manganese was detected at concentrations above the action level once at well 499-S0-7 (82 µg/L) and once at well 699-S18-E2B (261 µg/L). Other sampling rounds at these two wells reported detected concentrations less than the action level. All MDLs are less than the action level. The secondary MCL is the basis for the action level in this evaluation. This metal affects aesthetic water qualities relating to the public acceptance of drinking water. These regulations are not federally enforceable, but are intended as guidelines for the States. In addition, manganese is not associated with a long-term trend or a continuing local source; therefore, the 90th percentile value is considered a reasonable estimate of groundwater concentrations.

Conclusions from Analyte-Specific Evaluation

Table 7-10 provides a summary of the historic COPCs identified in DOE/RL-2009-45 that were eliminated in this evaluation as COPCs for the 600 Area subregion.

Table 7-10. Summary of Historic COPCs from DOE/RL-2009-45 Not Identified as Groundwater COPCs for the 600 Area Subregion

COPC	Reason for Inclusion in the SAP (DOE/RL-2009-45)	Reason for Exclusion as COPC
Copper	Max concentration greater than action level	90 th percentile less than action level; detected results not part of long-term trend or local exposure point.
Manganese	Max concentration greater than action level	90 th percentile less than action level; secondary MCL

7.2.3 Identify Analytes with 90th Percentile Values Greater Than Action Levels

Eight analytes have 90th percentile values that are greater than their respective action levels. Nitrate and tritium are retained as COPCs; they are discussed in Section 7.3. A summary is provided in Table 7-11.

Table 7-11. Summary of Analytes with 90th Percentile Values Greater than Action Levels

Aluminum	Arsenic	Bromodichloromethane
Dibromochloromethane	Iron	Nitrate
Selenium	Tritium	

7.2.3.1 Analyte-Specific Evaluation

An analyte-specific evaluation is performed on the analytes that have 90th percentile values greater than the action level. This evaluation considers the effects of data quality, naturally occurring levels of metals, long-term trends, and action levels on the identification of COPCs.

Aluminum's 90th percentile value is 87 µg/L, which is greater than the action level of 50 µg/L. Aluminum was detected in 15 of 51 water samples (29 percent frequency) at concentrations ranging from 12 to 539 µg/L. Five of the 15 detected concentrations were above the action level. The secondary MCL is the basis for the action level in this evaluation. The secondary MCL for aluminum is based on a range of concentrations between 50 and 200 µg/L, and the 90th percentile value is within this range of

concentrations. Aluminum affects the aesthetic qualities relating to the public acceptance of drinking water. These regulations are not federally enforceable but are intended as guidelines for the States. For these reasons, aluminum is not identified as a COPC.

Arsenic's 90th percentile value is 11 µg/L, which is greater than the action level of 0.018 µg/L. Arsenic was detected in 51 of 51 water samples (100 percent frequency), with concentrations ranging from 1.6 µg/L to 15 µg/L. Thus, all detected concentrations of arsenic are above the action level. In DOE/RL-96-61, background concentrations have been established for filtered (dissolved) concentrations of water constituents. Minimum, maximum, and 90th percentile concentrations for (filtered) background concentrations of arsenic are 0.5, 8.8, and 7.85 µg/L, respectively. All arsenic concentrations are within the range of the 90th percentile background (filtered) concentration and are considered to be naturally occurring; therefore, arsenic is not identified as a COPC.

Bromodichloromethane's 90th percentile value is 0.72 µg/L, which is greater than the action level of 0.27 µg/L. When the action level is less than the QL reported in DOE/RL-2009-45, the action level defaults to the QL. The QL of 5.0 µg/L reported in DOE/RL-2009-45 is greater than the action level of 0.27 µg/L. All MDLs for bromodichloromethane are 0.088 µg/L. Bromodichloromethane was detected in 10 of 51 water samples (20 percent frequency), with concentrations ranging from 0.17 to 2.1 µg/L. The results of this evaluation indicate that the 90th percentile value for bromodichloromethane is less than the QL reported in DOE/RL-2009-45; therefore, bromodichloromethane is not identified as a COPC.

Dibromochloromethane's 90th percentile value is 2.0 µg/L, which is greater than the action level of 0.4 µg/L. When the action level is less than the QL reported in DOE/RL-2009-45, the action level defaults to the QL. The QL of 5.0 µg/L reported in DOE/RL-2009-45 is greater than the action level of 0.4 µg/L. All MDLs for dibromochloromethane are 0.13 µg/L. Dibromochloromethane was detected in 7 of 51 samples analyzed (14 percent frequency), with concentrations ranging from 1.6 µg/L to 3.3 µg/L. The results of this evaluation indicate that the 90th percentile value for dibromochloromethane is less than the QL reported in DOE/RL-2009-45; therefore, dibromochloromethane is not identified as a COPC.

Iron's 90th percentile value is 477 µg/L, which is greater than the action level of 300 µg/L. The secondary MCL is the basis for the action level. Iron was detected in 40 of 51 samples (78 percent frequency), with concentrations ranging from 23 µg/L to 3,340 µg/L. In DOE/RL-96-61, background concentrations have been established for filtered (dissolved) concentrations of water constituents. Minimum, maximum, and 90th percentile concentrations for (filtered) background concentrations of iron are 6, 7,225, and 570 µg/L, respectively. All but two of the measured iron concentrations are below the 90th percentile background (filtered) concentration and are considered to be naturally occurring; therefore, iron is not identified as a COPC.

Selenium's 90th percentile value is 6.1 µg/L, which is greater than the action level of 5.0 µg/L. Selenium was detected at concentrations above the action level during all three sampling events at monitoring well 699-15-15B (10.1 µg/L, 10.6 µg/L, and 13.4 µg/L) and also during a single sampling event at wells 699-12-4D (6.8 µg/L) and 699-S6-E4A (6.1 µg/L). All five detections were flagged with a "D", indicating the analyte was reported at a secondary dilution factor. Other sampling rounds at wells 699-12-4D and 699-S6-E4A reported estimated concentrations less than the action level. In DOE/RL-96-61, background concentrations have been established for filtered (dissolved) concentrations of water constituents. Minimum, maximum, and 90th percentile concentrations for (filtered) background concentrations of selenium are 0.05, 11.6, and 10.5 µg/L, respectively. All selenium concentrations are within the range of the 90th percentile background (filtered) concentration and are considered to be naturally occurring; therefore, selenium is not identified as a COPC.

Conclusions from Analyte-Specific Evaluation

Table 7-12 lists the analytes that are excluded as COPCs for the 600 Area subregion.

Table 7-12. Summary of Analytes Excluded as Groundwater COPCs for the 600 Area Subregion

COPC	Reason for Inclusion in the SAP (DOE/RL-2009-45)	
		Reason for Exclusion as COPC
Arsenic	Maximum concentration and MLDs greater than action level	Naturally occurring

7.3 Summary of Groundwater COPCs

Seventeen monitoring wells were determined to be spatially representative of the groundwater conditions at the 600 Area subregion. Twenty-two historic COPCs were identified in DOE/RL-2009-45. The monitoring wells were analyzed for all 22 COPCs, using a method based analytical approach. Three sampling events are used to capture the effects that temporal fluctuations in river stage have on groundwater conditions. Samples collected from June to early July 2010 represent the aquifer when the river stage is at its highest elevation. Samples collected from mid-November to mid-December 2010 represent the aquifer when the river is at its lowest elevation. Samples collected from August to mid-September 2010 represent the aquifer when the river is transitioning from high to low river stage.

The COPCs are the contaminants most likely to contribute to overall risk.

1. In general, analytes with exposure point concentrations³ above an action level [see Section 3.3 for a complete list of chemical-specific applicable or relevant and appropriate requirements (ARARs)] were retained as COPCs.
2. Exceptions to this general rule are made for analytes that have exposure point concentrations that *are not* above their action level (which are calculated for the subregion as a whole), but exist locally at concentrations above the action level (i.e., are localized contaminants that represent a potential threat to human health or the environment).

Based on the results of the COPC identification process, two analytes are identified as COPCs for the 600 Area subregion.

A summary list is presented in Table 7-13. A list of the monitoring wells that reported concentrations greater than action levels is provided in Table 7-14.

Table 7-13. Summary of Groundwater COPCs Identified for the 600 Area Subregion

Metals	VOCs	Radionuclides	Non-Radioactive Anions
None	None	Tritium	Nitrate

Nitrate's 90th percentile value is 50,000 µg/L, which is greater than the action level of 45,000 µg/L. Nitrate was detected in 48 of 51 water samples (94 percent frequency), with concentrations ranging from

³ Exposure point concentrations are estimated as the 90th percentile value. See ECF-300FF5-11-0076.

227 to 136,000 µg/L. Nitrate was detected at concentrations greater than the action level in 3 of 17 monitoring wells.

Tritium's 90th percentile value is 290,000 pCi/L, which is greater than the action level of 20,000 pCi/L. Tritium was detected in 31 of 51 samples (61 percent frequency), with concentrations ranging from 290 pCi/L to 890,000 pCi/L. Tritium was detected at concentrations greater than the action level in 4 of 17 monitoring wells.

8 References

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- 41 CFR 143, "National Secondary Drinking Water Regulations," *Code of Federal Regulations*. Available at: http://www.access.gpo.gov/nara/cfr/waisidx_09/41cfr143_09.html.
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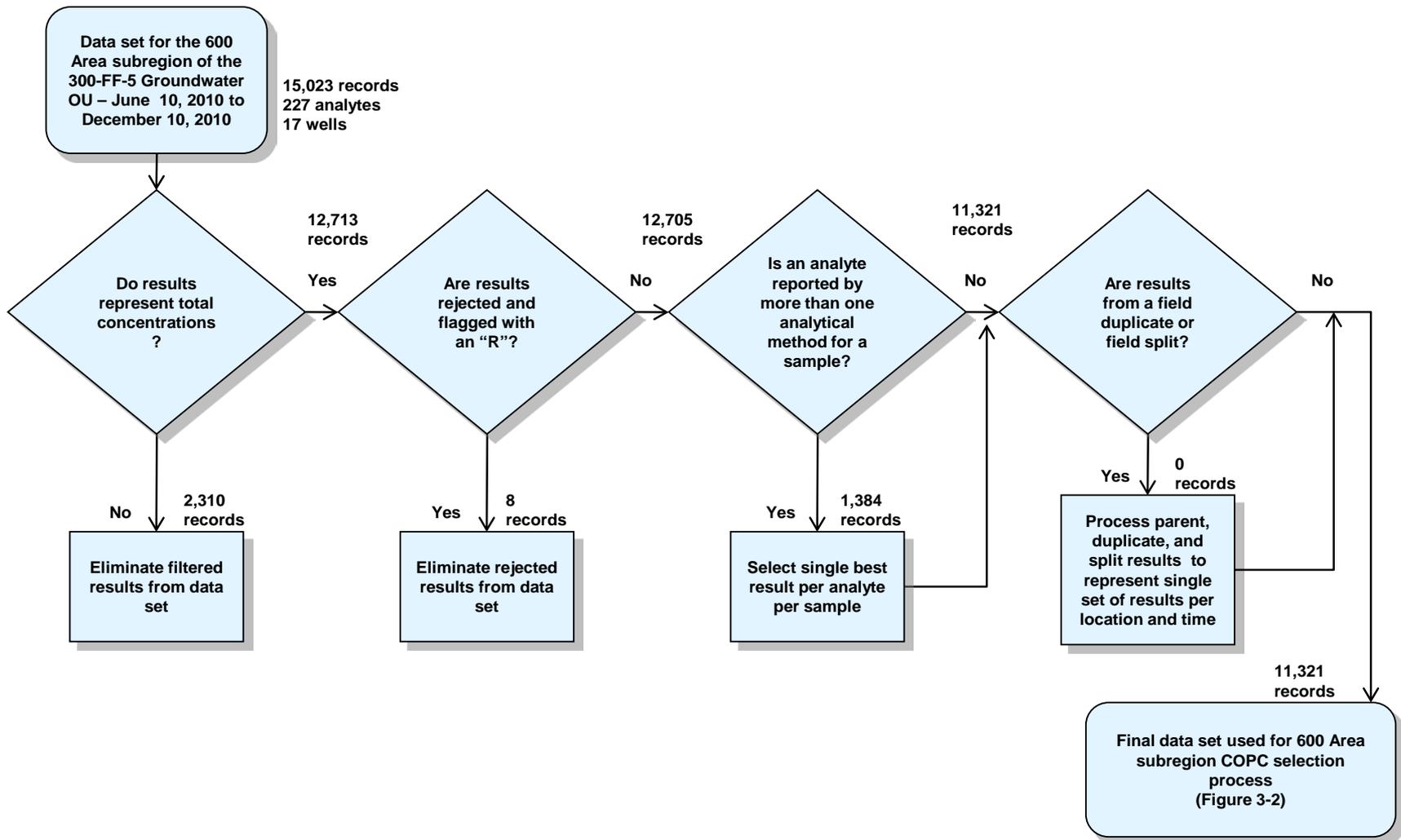


Figure 3-1. Data Processing and Reduction Steps for the 600 Area Subregion Data Set

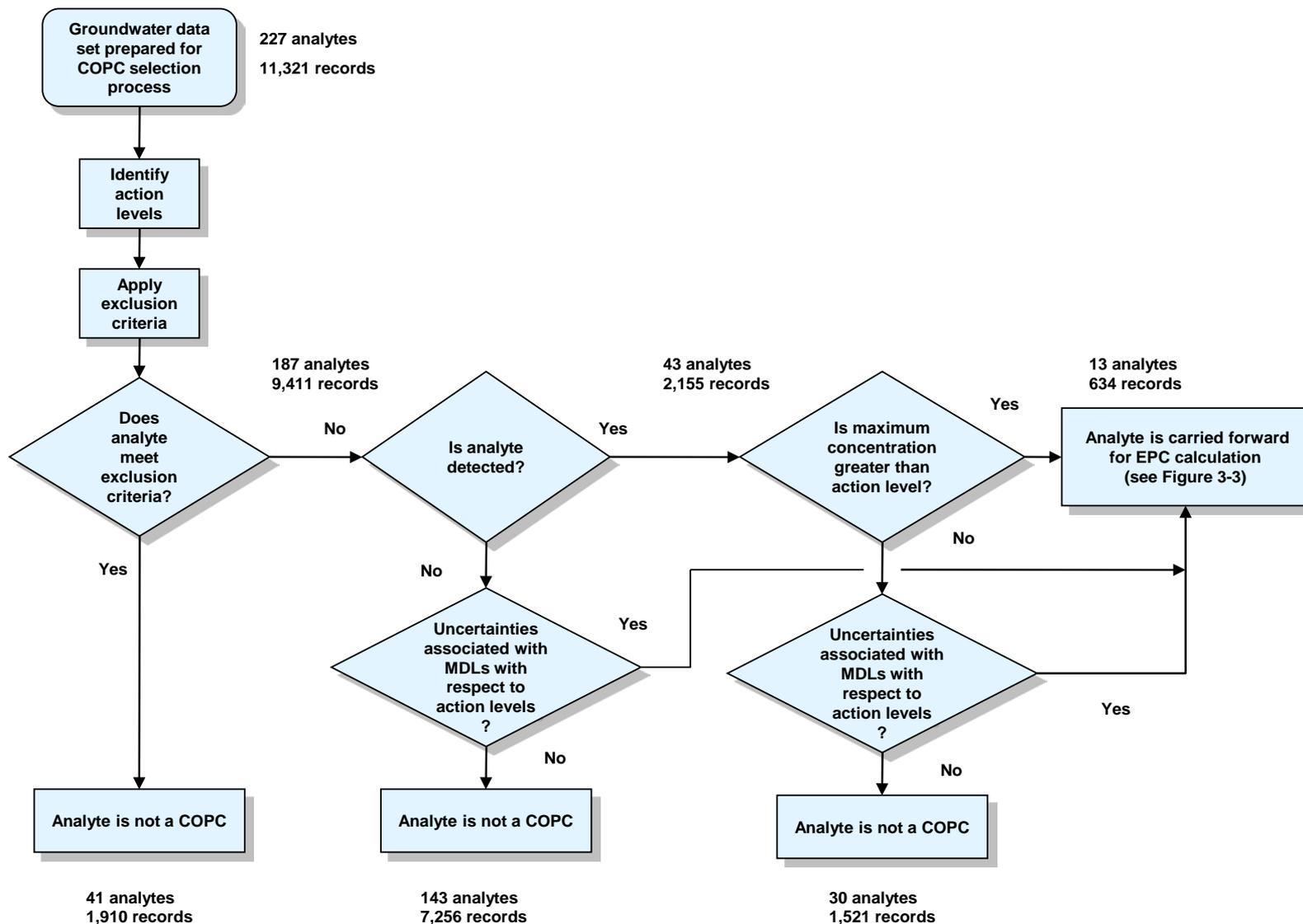


Figure 3-2. COPC Identification Process for the 600 Area Subregion of the 300-FF-5 Groundwater OU: Part 1

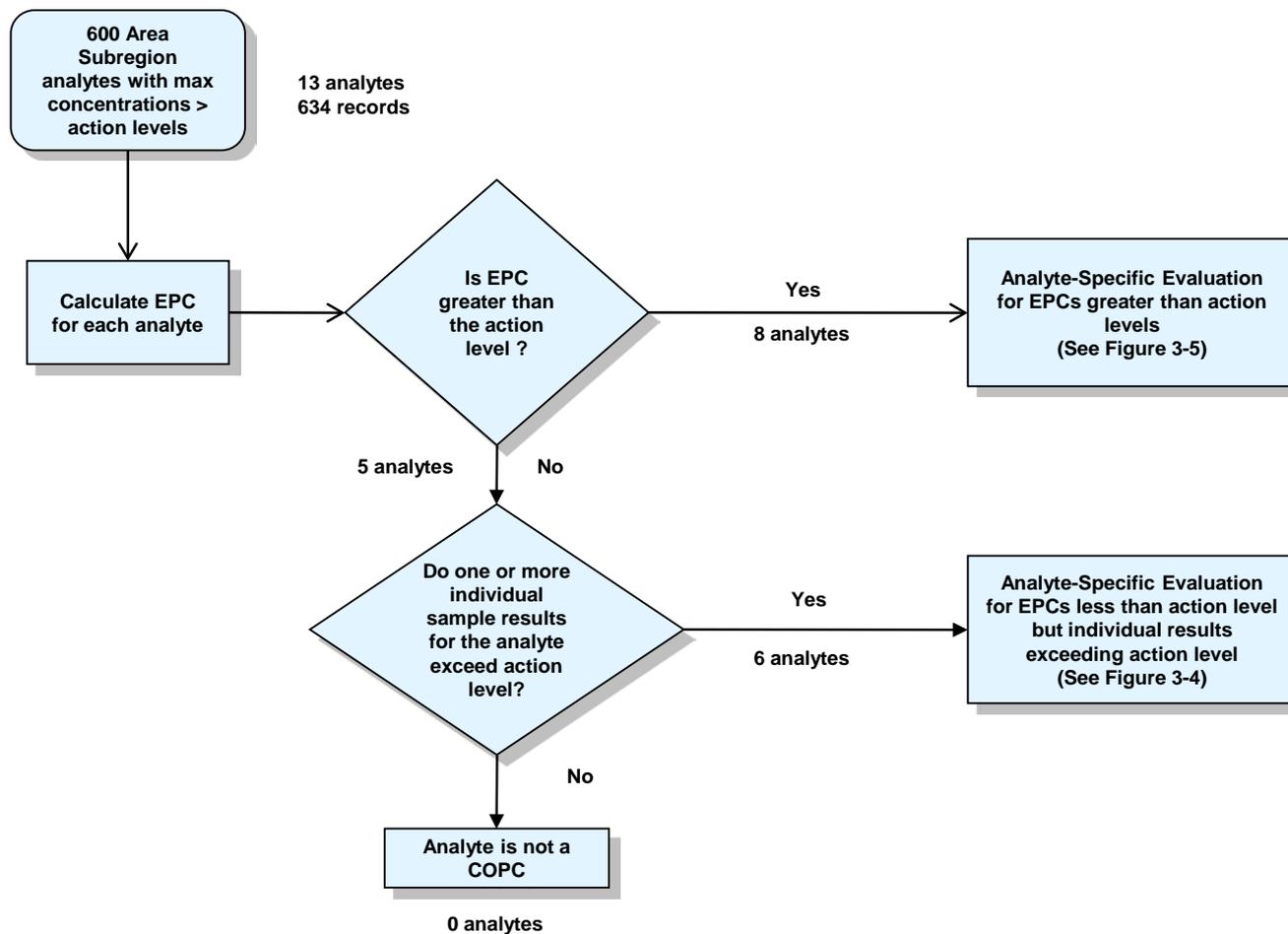


Figure 3-3. COPC Identification Process for the 600 Area Subregion of the 300-FF-5 Groundwater OU: Part 2

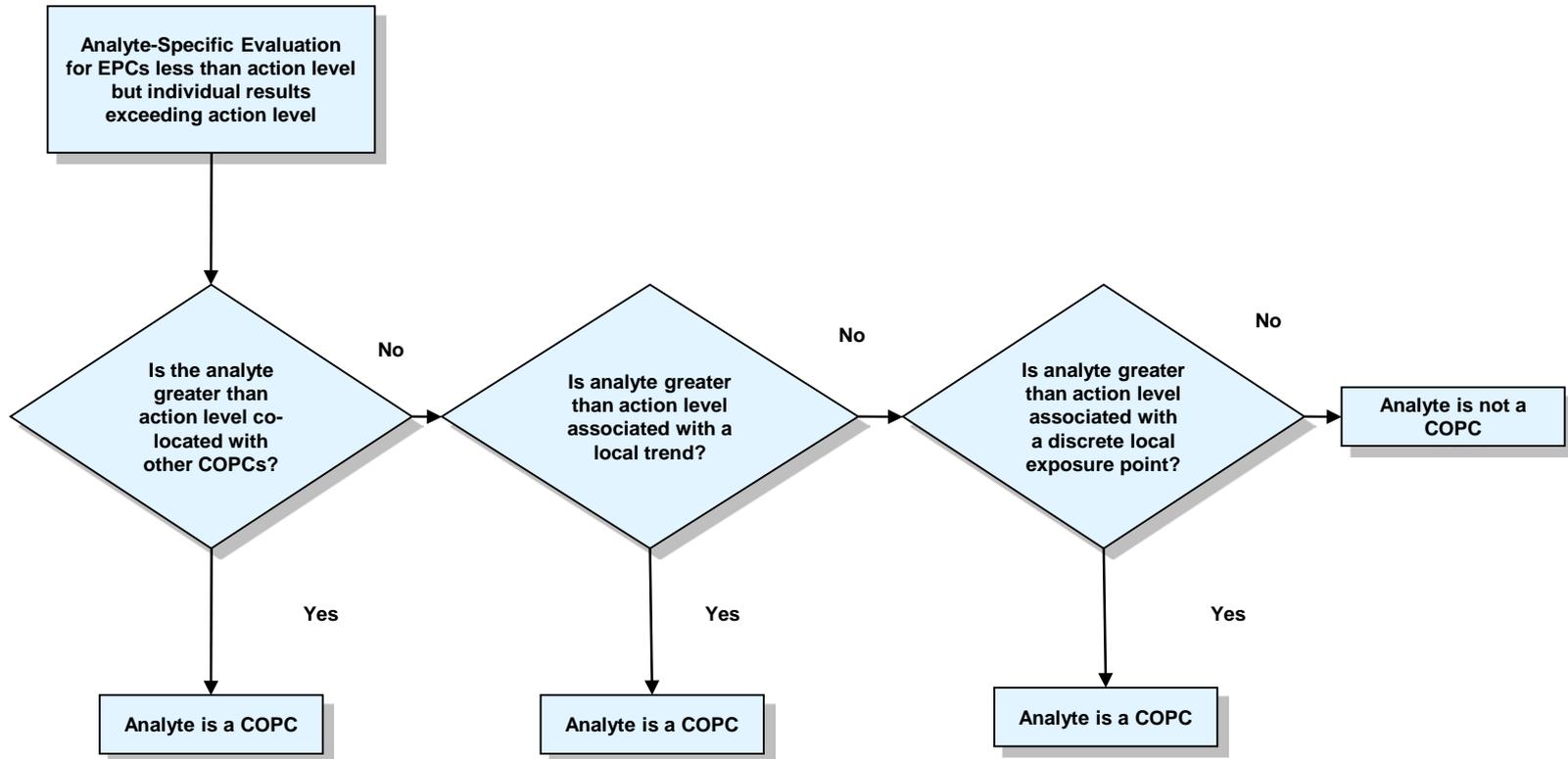


Figure 3-4. Analyte Specific Evaluation Process for EPCs Less Than Action Levels

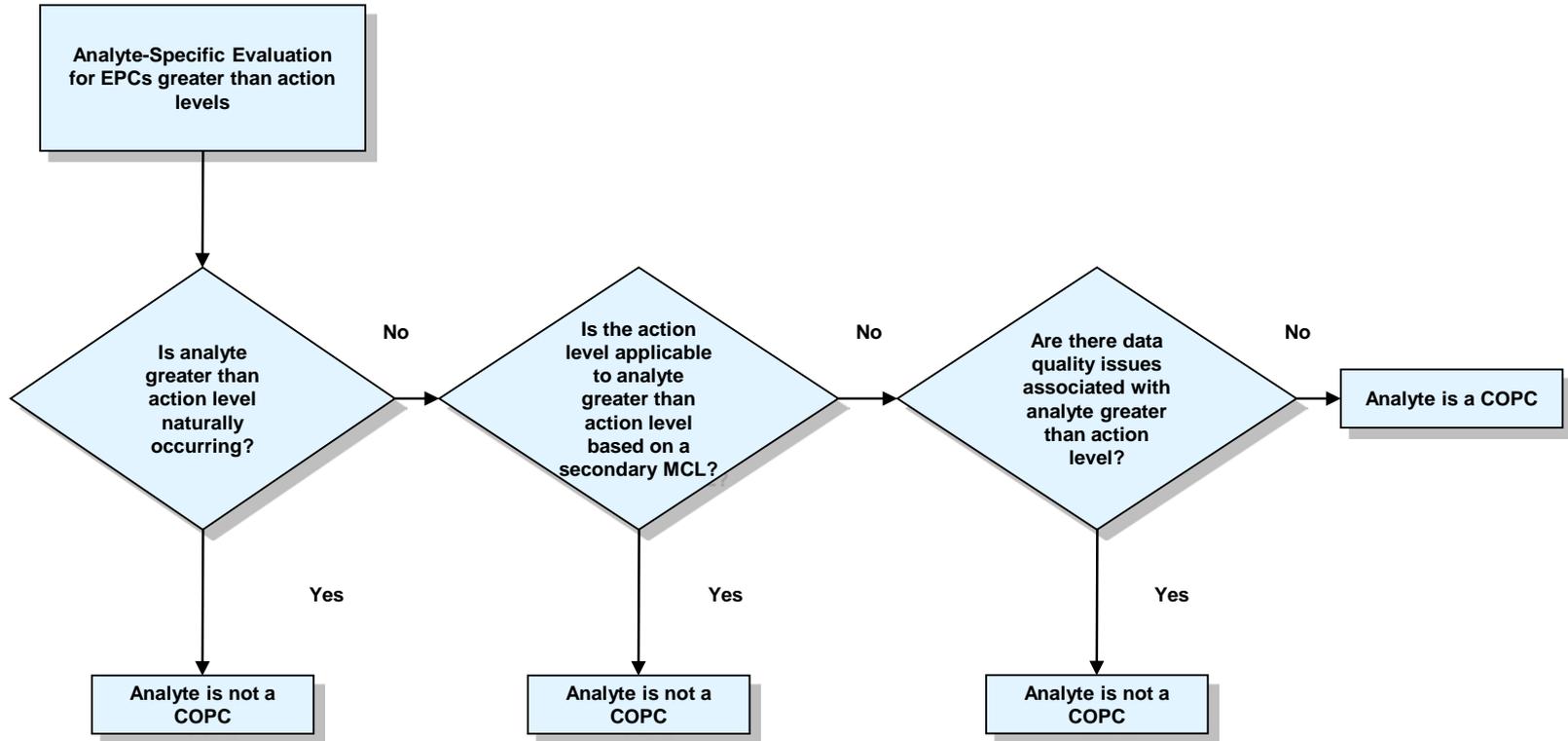


Figure 3-5. Analyte Specific Evaluation Process for EPCs Greater Than Action Levels

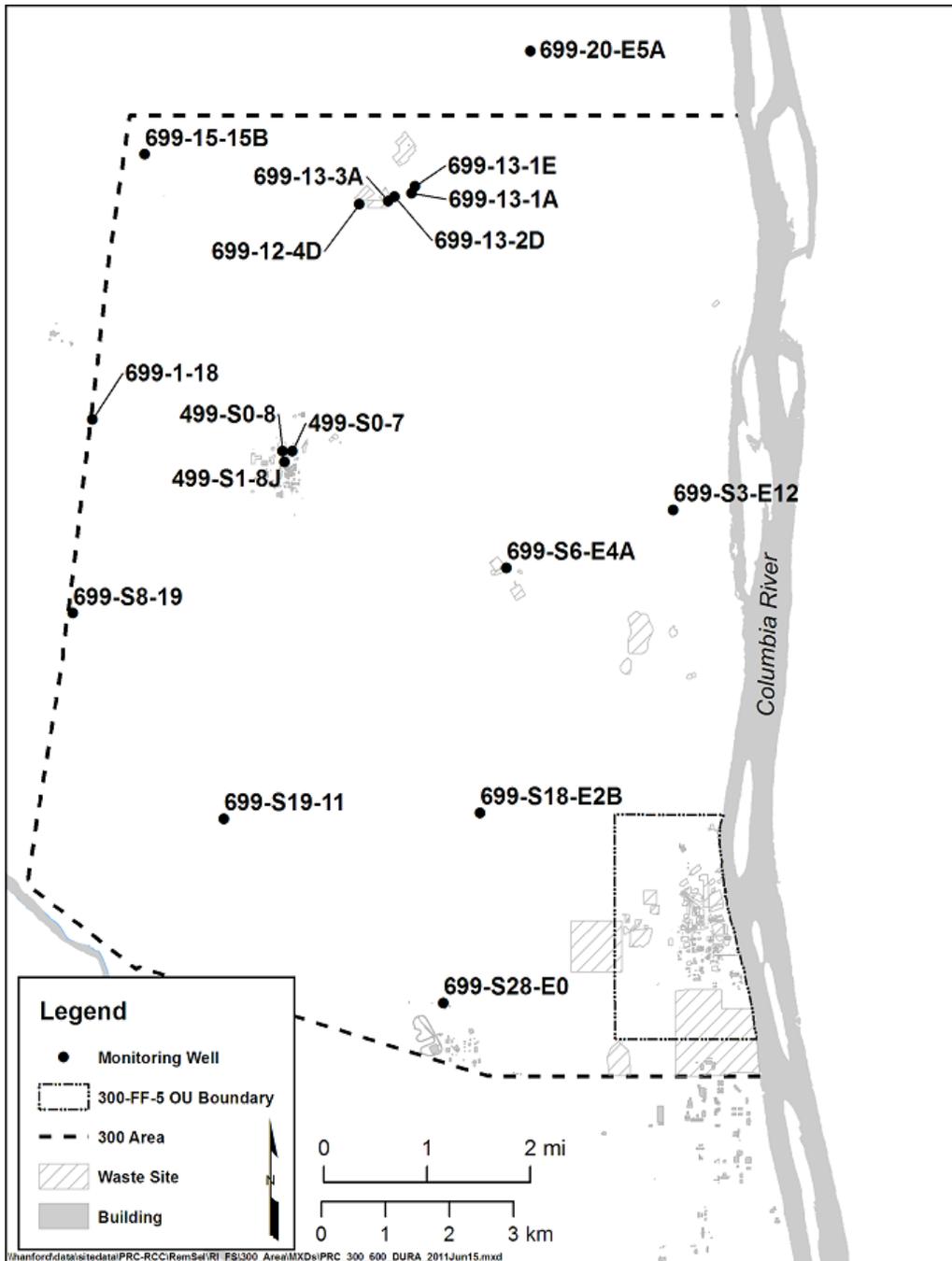


Figure 4-1. Groundwater Monitoring Wells for the 600 Area Subregion of the 300-FF-5 Groundwater Operable Unit

Table 3-1. Summary of Federal and State Water Quality Criteria and Action Levels for the 600 Area Subregion of the 300-FF-5 Groundwater Operable Unit

CAS#	Analyte Name	Alternate Analyte Name	Units	Groundwater					Surface Water							Final Value	
				40 CFR 141 National Primary Drinking Water Regulations ^a		WAC 246-290-310 ^b	WAC 173-340-720 ^c		Clean Water Act National Recommended Water Quality Criteria ^d			WAC 173-201A ^e	40 CFR 131 Water Quality Standards ^f				WAC 173-340-730 ^g
				Federal MCL	Federal MCLG		Groundwater Method A Cleanup Levels	Groundwater Method B Unrestricted Land Use	Acute Freshwater CMC	Freshwater CCC	Human Health Water + Organism		Freshwater CCC	Freshwater CMC	Freshwater CCC		
Final Action Level Basis																	
630-20-6	1,1,1,2-Tetrachloroethane	--	µg/L	--	--	--	--	1.7	--	--	--	--	--	--	6.2	1.7	WAC 173-340-720(4)(b)(iii)(A) and (B)
71-55-6	1,1,1-Trichloroethane	--	µg/L	200	200	--	--	16,000	--	--	--	--	--	--	925,926	200	40 CFR 141 - Federal MCL
79-34-5	1,1,2,2-Tetrachloroethane	--	µg/L	--	--	--	--	0.22	--	--	0.17	--	--	0.17	6.5	0.17	Clean Water Act -- Human Health Water + Organism
79-00-5	1,1,2-Trichloroethane	--	µg/L	5.0	3.0	--	--	0.77	--	--	0.59	--	--	0.60	25	0.59	Clean Water Act -- Human Health Water + Organism
75-34-3	1,1-Dichloroethane	--	µg/L	--	--	--	--	1,600	--	--	--	--	--	--	73,549	1,600	WAC 173-340-720(4)(b)(iii)(A) and (B)
75-35-4	1,1-Dichloroethene	1,1-Dichloroethylene	µg/L	7.0	7.0	--	--	400	--	--	330	--	--	0.057	23,148	0.057	40 CFR 131 -- Human Health Water + Organism
96-18-4	1,2,3-Trichloropropane	--	µg/L	--	--	--	--	0.0015	--	--	--	--	--	--	0.017	0.0015	WAC 173-340-720(4)(b)(iii)(A) and (B)
95-94-3	1,2,4,5-Tetrachlorobenzene	--	µg/L	--	--	--	--	4.8	--	--	0.97	--	--	--	0.28	0.28	WAC 173-340-730(3)(b)(iii)(A) and (B)
120-82-1	1,2,4-Trichlorobenzene	--	µg/L	70	70	--	--	1.5	--	--	35	--	--	--	--	1.5	WAC 173-340-720(4)(b)(iii)(A) and (B)
96-12-8	1,2-Dibromo-3-chloropropane	--	µg/L	0.20	--	--	--	0.055	--	--	--	--	--	--	0.70	0.055	WAC 173-340-720(4)(b)(iii)(A) and (B)
106-93-4	1,2-Dibromoethane	--	µg/L	0.050	--	--	--	0.022	--	--	--	--	--	--	0.22	0.022	WAC 173-340-720(4)(b)(iii)(A) and (B)
95-50-1	1,2-Dichlorobenzene	--	µg/L	600	600	--	--	720	--	--	420	--	--	--	2,700	420	Clean Water Act -- Human Health Water + Organism
107-06-2	1,2-Dichloroethane	--	µg/L	5.0	--	--	--	0.48	--	--	0.38	--	--	0.38	59	0.38	Clean Water Act -- Human Health Water + Organism
540-59-0	1,2-Dichloroethene (Total)	1,2-Dichloroethylene Mixed Isomers	µg/L	--	--	--	--	72	--	--	--	--	--	--	2,102	72	WAC 173-340-720(4)(b)(iii)(A) and (B)
78-87-5	1,2-Dichloropropane	--	µg/L	5.0	--	--	--	1.2	--	--	0.50	--	--	--	44	0.50	Clean Water Act -- Human Health Water + Organism
541-73-1	1,3-Dichlorobenzene	--	µg/L	--	--	--	--	320	--	--	320	--	--	--	400	320	Clean Water Act -- Human Health Water + Organism
106-46-7	1,4-Dichlorobenzene	--	µg/L	75	75	--	--	8.1	--	--	63	--	--	400	22	8.1	WAC 173-340-720(4)(b)(iii)(A) and (B)
123-91-1	1,4-Dioxane	--	µg/L	--	--	--	--	4.0	--	--	4.0	--	--	--	--	4.0	WAC 173-340-720(4)(b)(iii)(A) and (B)
130-15-4	1,4-Naphthoquinone	--	µg/L	--	--	--	--	--	--	--	--	--	--	--	--	--	--
71-36-3	1-Butanol	N-Butanol	µg/L	--	--	--	--	800	--	--	--	--	--	--	82,044	800	WAC 173-340-720(4)(b)(iii)(A) and (B)
134-32-7	1-Naphthylamine	--	µg/L	--	--	--	--	--	--	--	--	--	--	--	--	--	--
58-90-2	2,3,4,6-Tetrachlorophenol	--	µg/L	--	--	--	--	490	--	--	--	--	--	--	--	490	WAC 173-340-720(4)(b)(iii)(A) and (B)
95-95-4	2,4,5-Trichlorophenol	--	µg/L	--	--	--	--	800	--	--	1,800	--	--	--	--	800	WAC 173-340-720(4)(b)(iii)(A) and (B)
88-06-2	2,4,6-Trichlorophenol	--	µg/L	--	--	--	--	4.0	--	--	1.4	--	--	--	2.1	1.4	Clean Water Act -- Human Health Water + Organism
120-83-2	2,4-Dichlorophenol	--	µg/L	--	--	--	--	24	--	--	77	--	--	--	93	24	WAC 173-340-720(4)(b)(iii)(A) and (B)
105-67-9	2,4-Dimethylphenol	--	µg/L	--	--	--	--	160	--	--	380	--	--	--	--	160	WAC 173-340-720(4)(b)(iii)(A) and (B)
51-28-5	2,4-Dinitrophenol	--	µg/L	--	--	--	--	32	--	--	69	--	--	--	70	32	WAC 173-340-720(4)(b)(iii)(A) and (B)
121-14-2	2,4-Dinitrotoluene	--	µg/L	--	--	--	--	0.28	--	--	0.11	--	--	--	0.11	0.11	Clean Water Act -- Human Health Water + Organism
87-65-0	2,6-Dichlorophenol	--	µg/L	--	--	--	--	--	--	--	--	--	--	--	--	--	--
606-20-2	2,6-Dinitrotoluene	--	µg/L	--	--	--	--	16	--	--	--	--	--	--	--	16	WAC 173-340-720(4)(b)(iii)(A) and (B)
53-96-3	2-Acetylaminofluorene	--	µg/L	--	--	--	--	0.023	--	--	--	--	--	--	--	0.023	WAC 173-340-720(4)(b)(iii)(A) and (B)
78-93-3	2-Butanone	Methyl Ethyl Ketone	µg/L	--	--	--	--	4,800	--	--	--	--	--	--	492,264	4,800	WAC 173-340-720(4)(b)(iii)(A) and (B)
91-58-7	2-Chloronaphthalene	--	µg/L	--	--	--	--	640	--	--	1,000	--	--	--	--	640	WAC 173-340-720(4)(b)(iii)(A) and (B)
95-57-8	2-Chlorophenol	--	µg/L	--	--	--	--	40	--	--	81	--	--	--	--	40	WAC 173-340-720(4)(b)(iii)(A) and (B)
591-78-6	2-Hexanone	--	µg/L	--	--	--	--	80	--	--	--	--	--	3,429	80	WAC 173-340-720(4)(b)(iii)(A) and (B)	
91-57-6	2-Methylnaphthalene	--	µg/L	--	--	--	--	32	--	--	--	--	--	--	32	32	WAC 173-340-720(4)(b)(iii)(A) and (B)
95-48-7	2-Methylphenol (cresol, o-)	--	µg/L	--	--	--	--	400	--	--	--	--	--	--	400	400	WAC 173-340-720(4)(b)(iii)(A) and (B)
91-59-8	2-Naphthylamine	--	µg/L	--	--	--	--	0.049	--	--	--	--	--	--	0.049	0.049	WAC 173-340-720(4)(b)(iii)(A) and (B)
88-74-4	2-Nitroaniline	--	µg/L	--	--	--	--	160	--	--	--	--	--	--	160	160	WAC 173-340-720(4)(b)(iii)(A) and (B)
88-75-5	2-Nitrophenol	--	µg/L	--	--	--	--	--	--	--	--	--	--	--	--	--	--
109-06-8	2-Picoline	--	µg/L	--	--	--	--	--	--	--	--	--	--	--	--	--	--
91-94-1	3,3'-Dichlorobenzidine	--	µg/L	--	--	--	--	0.19	--	--	0.021	--	--	--	0.040	0.021	Clean Water Act -- Human Health Water + Organism
119-93-7	3,3'-Dimethylbenzidine	--	µg/L	--	--	--	--	0.0080	--	--	--	--	--	--	--	0.0080	WAC 173-340-720(4)(b)(iii)(A) and (B)
56-49-5	3-Methylcholanthrene	--	µg/L	--	--	--	--	0.0040	--	--	--	--	--	--	0.0040	0.0040	WAC 173-340-720(4)(b)(iii)(A) and (B)
99-09-2	3-Nitroaniline	--	µg/L	--	--	--	--	4.2	--	--	--	--	--	--	4.2	4.2	WAC 173-340-720(4)(b)(iii)(A) and (B)
534-52-1	4,6-Dinitro-2-methylphenol	--	µg/L	--	--	--	--	1.6	--	--	13	--	--	--	13	1.6	WAC 173-340-720(4)(b)(iii)(A) and (B)
92-67-1	4-Aminobiphenyl	--	µg/L	--	--	--	--	0.0042	--	--	--	--	--	--	0.0042	0.0042	WAC 173-340-720(4)(b)(iii)(A) and (B)
101-55-3	4-Bromophenyl ether	--	µg/L	--	--	--	--	--	--	--	--	--	--	--	--	--	--
59-50-7	4-Chloro-3-methylphenol	--	µg/L	--	--	--	--	1,600	--	--	--	--	--	--	1,600	1,600	WAC 173-340-720(4)(b)(iii)(A) and (B)
106-47-8	4-Chloroaniline	--	µg/L	--	--	--	--	0.22	--	--	--	--	--	--	0.22	0.22	WAC 173-340-720(4)(b)(iii)(A) and (B)
7005-72-3	4-Chlorophenyl ether	--	µg/L	--	--	--	--	--	--	--	--	--	--	--	--	--	--
108-10-1	4-Methyl-2-pentanone	4-Methyl-2-Pentanone	µg/L	--	--	--	--	640	--	--	--	--	--	61,002	640	640	WAC 173-340-720(4)(b)(iii)(A) and (B)
106-44-5	4-Methylphenol (cresol, p-)	--	µg/L	--	--	--	--	40	--	--	--	--	--	--	40	40	WAC 173-340-720(4)(b)(iii)(A) and (B)
100-01-6	4-Nitroaniline	--	µg/L	--	--	--	--	4.4	--	--	--	--	--	--	4.4	4.4	WAC 173-340-720(4)(b)(iii)(A) and (B)
100-02-7	4-Nitrophenol	--	µg/L	--	--	--	--	128	--	--	--	--	--	--	128	128	WAC 173-340-720(4)(b)(iii)(A) and (B)
56-57-5	4-Nitroquinoline-1-oxide	--	µg/L	--	--	--	--	--	--	--	--	--	--	--	--	--	--
99-55-8	5-Nitro-o-toluidine	--	µg/L	--	--	--	--	2.7	--	--	--	--	--	--	2.7	2.7	WAC 173-340-720(4)(b)(iii)(A) and (B)
57-97-6	7,12-Dimethylbenz[a]anthracene	--	µg/L	--	--	--	--	3.50E-04	--	--	--	--	--	--	3.50E-04	3.50E-04	WAC 173-340-720(4)(b)(iii)(A) and (B)
83-32-9	Acenaphthene	--	µg/L	--	--	--	--	960	--	--	670	--	--	--	670	670	Clean Water Act -- Human Health Water + Organism
208-96-8	Acenaphthylene	--	µg/L	--	--	--	--	--	--	--	--	--	--	--	--	--	--
67-64-1	Acetone	--	µg/L	--	--	--	--	7,200	--	--	--	--	--	738,397	7,200	7,200	WAC 173-340-720(4)(b)(iii)(A) and (B)
75-05-8	Acetonitrile	--	µg/L	--	--	--	--	--	--	--	--	--	--	--	--	--	--
98-86-2	Acetophenone	--	µg/L	--	--	--	--	800	--	--	--	--	--	--	800	800	WAC 173-340-720(4)(b)(iii)(A) and (B)
107-02-8	Acrolein	--	µg/L	--	--	--	--	4.0	--	3.0	6.0	--	--	320	3.0	3.0	Clean Water Act -- Freshwater CCC
107-05-1	Allyl chloride	--	µg/L	--	--	--	--	2.1	--	--	--	--	--	--	62	2.1	WAC 173-340-720(4)(b)(iii)(A) and (B)
122-09-8	alpha, alpha-Dimethylphenethylamine	--	µg/L	--	--	--	--	--	--	--	--	--	--	--	--	--	--
7429-90-5	Aluminum	--	µg/L	50	--	--	--	16,000	750	87	--	--	--	5,185	50	50	40 CFR 141 - Federal MCL
62-53-3	Aniline	--	µg/L	--	--	--	--	7.7	--	--	--	--	--	--	7.7	7.7	WAC 173-340-720(4)(b)(iii)(A) and (B)
120-12-7	Anthracene	--	µg/L	--	--	--	--	4,800	--	--	8,300	--	--	--	9,600	4,800	WAC 173-340-720(4)(b)(iii)(A) and (B)
7440-36-0	Antimony	Antimony (metallic)	µg/L	6.0	6.0	6.0	--	6.4	--	--	5.6	--	--	14	1,037	5.6	Clean Water Act -- Human Health Water + Organism
140-57-8	Aramite	--	µg/L	--	--	--	--	3.5	--	--	--	--	--	--	3.5	3.5	WAC 173-340-720(4)(b)(iii)(A) and (B)
7440-38-2	Arsenic	Arsenic, Inorganic	µg/L	10	--	10	--	0.058	340	150	0.018						

Table 3-1. Summary of Federal and State Water Quality Criteria and Action Levels for the 600 Area Subregion of the 300-FF-5 Groundwater Operable Unit

CAS#	Analyte Name	Alternate Analyte Name	Units	Groundwater					Surface Water								Final Value
				40 CFR 141 National Primary Drinking Water Regulations ^a		WAC 246-290-310 ^b	WAC 173-340-720 ^c		Clean Water Act National Recommended Water Quality Criteria ^d			WAC 173-201A ^e	40 CFR 131 Water Quality Standards ^f			WAC 173-340-730 ^g	
				Federal MCL	Federal MCLG	State MCL	Groundwater Method A Cleanup Levels	Groundwater Method B Unrestricted Land Use	Acute Freshwater CMC	Freshwater CCC	Human Health Water + Organism	Freshwater CCC	Freshwater CMC	Freshwater CCC	Human Health Water + Organism	Surface Water Method B Unrestricted Land Use	
108-60-1	Bis(2-chloro-1-methylethyl)ether	--	µg/L	--	--	--	--	0.63	--	--	1,400	--	--	--	1,400	0.63	WAC 173-340-720(4)(b)(iii)(A) and (B)
111-91-1	Bis(2-Chloroethoxy)methane	--	µg/L	--	--	--	--	48	--	--	--	--	--	--	--	48	WAC 173-340-720(4)(b)(iii)(A) and (B)
111-44-4	Bis(2-chloroethyl) ether	--	µg/L	--	--	--	--	0.040	--	--	0.030	--	--	--	0.031	0.030	Clean Water Act -- Human Health Water + Organism
117-81-7	Bis(2-ethylhexyl) phthalate	--	µg/L	6	--	--	--	6.3	--	--	1.2	--	--	--	1.8	1.2	Clean Water Act -- Human Health Water + Organism
7440-69-9	Bismuth	--	µg/L	--	--	--	--	--	--	--	--	--	--	--	--	--	--
7440-42-8	Boron	Boron And Borates Only	µg/L	--	--	--	--	3,200	--	--	--	--	--	--	--	3,200	WAC 173-340-720(4)(b)(iii)(A) and (B)
24959-67-9	Bromide	--	µg/L	--	--	--	--	--	--	--	--	--	--	--	--	--	--
75-27-4	Bromodichloromethane	--	µg/L	--	--	--	--	0.71	--	--	0.55	--	--	0.27	28	0.27	40 CFR 131 -- Human Health Water + Organism
75-25-2	Bromoform	--	µg/L	--	80	--	--	5.5	--	--	4.3	--	--	4.3	219	4.3	Clean Water Act -- Human Health Water + Organism
74-83-9	Bromomethane	--	µg/L	--	--	--	--	11	--	--	47	--	--	48	968	11	WAC 173-340-720(4)(b)(iii)(A) and (B)
85-68-7	Butylbenzylphthalate	--	µg/L	--	--	--	--	46	--	--	1,500	--	--	--	--	46	WAC 173-340-720(4)(b)(iii)(A) and (B)
7440-43-9	Cadmium	Cadmium (Water)	µg/L	5.0	5.0	5.0	--	8.0	2.0	0.25	--	0.91	3.9	1.0	20	0.25	Clean Water Act -- Freshwater CCC
7440-70-2	Calcium	--	µg/L	--	--	--	--	--	--	--	--	--	--	--	--	--	--
86-74-8	Carbazole	--	µg/L	--	--	--	--	4.4	--	--	--	--	--	--	--	4.4	WAC 173-340-720(4)(b)(iii)(A) and (B)
75-15-0	Carbon disulfide	--	µg/L	--	--	--	--	800	--	--	--	--	--	--	13,295	800	WAC 173-340-720(4)(b)(iii)(A) and (B)
56-23-5	Carbon tetrachloride	--	µg/L	5.0	--	--	--	0.34	--	--	0.23	--	--	0.25	2.7	0.23	Clean Water Act -- Human Health Water + Organism
16887-00-6	Chloride	--	µg/L	250,000	--	250,000	--	--	860,000	230,000	--	230,000	--	--	230,000	230,000	Clean Water Act -- Freshwater CCC
108-90-7	Chlorobenzene	--	µg/L	100	100	--	--	160	--	--	130	--	--	680	5,034	100	40 CFR 141 - Federal MCL
510-15-6	Chlorobenzilate	--	µg/L	--	--	--	--	0.80	--	--	--	--	--	--	--	0.80	WAC 173-340-720(4)(b)(iii)(A) and (B)
75-00-3	Chloroethane	Ethylchloride	µg/L	--	--	--	--	--	--	--	--	--	--	--	--	--	--
67-66-3	Chloroform	--	µg/L	80	--	80	--	1.4	--	--	5.7	--	--	5.7	56	1.4	WAC 173-340-720(4)(b)(iii)(A) and (B)
74-87-3	Chloromethane	--	µg/L	--	--	--	--	--	--	--	--	--	--	--	--	--	--
126-99-8	Chloroprene	2-Chloro-1,3-butadiene	µg/L	--	--	--	--	160	--	--	--	--	--	--	2,412	160	WAC 173-340-720(4)(b)(iii)(A) and (B)
7440-47-3	Chromium	--	µg/L	100	100	100	--	24,000	570	65	--	156	550	180	19,444	65	Clean Water Act -- Freshwater CCC
218-01-9	Chrysene	--	µg/L	--	--	--	--	1.2	--	--	0.0038	--	--	--	0.0028	0.0028	WAC 173-340-730(3)(b)(iii)(A) and (B)
156-59-2	cis-1,2-Dichloroethylene	--	µg/L	70	70	--	--	80	--	--	--	--	--	--	2,336	70	40 CFR 141 - Federal MCL
10061-01-5	cis-1,3-Dichloropropene	--	µg/L	--	--	--	--	0.44	--	--	0.34	--	--	--	34	0.34	Clean Water Act -- Human Health Water + Organism
7440-48-4	Cobalt	--	µg/L	--	--	--	--	4.8	--	--	--	--	--	--	2.6	2.6	WAC 173-340-730(3)(b)(iii)(A) and (B)
7440-50-8	Copper	--	µg/L	1,300	1,300	--	--	640	13	9.0	1,300	--	17	11	2,881	9.0	Clean Water Act -- Freshwater CCC
2303-16-4	Diallate	--	µg/L	--	--	--	--	1.4	--	--	--	--	--	--	1.4	1.4	WAC 173-340-720(4)(b)(iii)(A) and (B)
53-70-3	Dibenz[a,h]anthracene	--	µg/L	--	--	--	--	0.12	--	--	0.0038	--	--	--	0.0028	0.0028	WAC 173-340-730(3)(b)(iii)(A) and (B)
132-64-9	Dibenzofuran	--	µg/L	--	--	--	--	16	--	--	--	--	--	--	16	16	WAC 173-340-720(4)(b)(iii)(A) and (B)
124-48-1	Dibromochloromethane	--	µg/L	60	60	--	--	0.52	--	--	0.40	--	--	0.41	21	0.40	Clean Water Act -- Human Health Water + Organism
74-95-3	Dibromomethane	Methylene Bromide	µg/L	--	--	--	--	80	--	--	--	--	--	--	4,216	80	WAC 173-340-720(4)(b)(iii)(A) and (B)
75-71-8	Dichlorodifluoromethane	--	µg/L	--	--	--	--	1,600	--	--	--	--	--	--	84,312	1,600	WAC 173-340-720(4)(b)(iii)(A) and (B)
84-66-2	Diethylphthalate	--	µg/L	--	--	--	--	12,800	--	--	17,000	--	--	--	23,000	12,800	WAC 173-340-720(4)(b)(iii)(A) and (B)
60-51-5	Dimethoate	--	µg/L	--	--	--	--	3.2	--	--	--	--	--	--	3.2	3.2	WAC 173-340-720(4)(b)(iii)(A) and (B)
131-11-3	Dimethyl phthalate	--	µg/L	--	--	--	--	--	--	--	270,000	--	--	--	313,000	270,000	Clean Water Act -- Human Health Water + Organism
84-74-2	Di-n-butylphthalate	--	µg/L	--	--	--	--	1,600	--	--	2,000	--	--	--	2,700	1,600	WAC 173-340-720(4)(b)(iii)(A) and (B)
117-84-0	Di-n-octylphthalate	--	µg/L	--	--	--	--	--	--	--	--	--	--	--	--	--	--
88-85-7	Dinoseb(2-secButyl-4,6-dinitrophenol)	--	µg/L	7	7	--	--	16	--	--	--	--	--	--	7.0	7.0	40 CFR 141 - Federal MCL
298-04-4	Disulfoton	--	µg/L	--	--	--	--	0.64	--	--	--	--	--	--	--	0.64	WAC 173-340-720(4)(b)(iii)(A) and (B)
107-12-0	Ethyl cyanide	--	µg/L	--	--	--	--	--	--	--	--	--	--	--	--	--	--
97-63-2	Ethyl methacrylate	--	µg/L	--	--	--	--	720	--	--	--	--	--	--	26,365	720	WAC 173-340-720(4)(b)(iii)(A) and (B)
62-50-0	Ethyl methanesulfonate	--	µg/L	--	--	--	--	--	--	--	--	--	--	--	--	--	--
100-41-4	Ethylbenzene	--	µg/L	700	700	--	--	4.0	--	--	530	--	--	3,100	16	4.0	WAC 173-340-720(4)(b)(iii)(A) and (B)
52-85-7	Famphur	--	µg/L	--	--	--	--	--	--	--	--	--	--	--	--	--	--
206-44-0	Fluoranthene	--	µg/L	--	--	--	--	640	--	--	130	--	--	--	300	130	Clean Water Act -- Human Health Water + Organism
86-73-7	Fluorene	--	µg/L	--	--	--	--	640	--	--	1,100	--	--	--	1,300	640	WAC 173-340-720(4)(b)(iii)(A) and (B)
16984-48-8	Fluoride	--	µg/L	4,000	4,000	4,000	--	960	--	--	--	--	--	--	960	960	WAC 173-340-720(4)(b)(iii)(A) and (B)
12587-46-1	Gross alpha	--	µg/L	15	--	--	--	--	--	--	--	--	--	--	15	15	40 CFR 141 - Federal MCL
12587-47-2	Gross beta	--	µg/L	--	--	--	--	--	--	--	--	--	--	--	--	--	--
118-74-1	Hexachlorobenzene	--	µg/L	1	--	--	--	0.055	--	--	2.80E-04	--	--	--	7.50E-04	2.80E-04	Clean Water Act -- Human Health Water + Organism
87-68-3	Hexachlorobutadiene	--	µg/L	--	--	--	--	0.56	--	--	0.44	--	--	--	0.44	0.44	WAC 173-340-730(3)(b)(iii)(A) and (B)
77-47-4	Hexachlorocyclopentadiene	--	µg/L	50	50	--	--	48	--	--	40	--	--	--	40	40	Clean Water Act -- Human Health Water + Organism
67-72-1	Hexachloroethane	--	µg/L	--	--	--	--	3.1	--	--	1.4	--	--	--	1.9	1.4	Clean Water Act -- Human Health Water + Organism
70-30-4	Hexachlorophene	--	µg/L	--	--	--	--	4.8	--	--	--	--	--	--	4.8	4.8	WAC 173-340-720(4)(b)(iii)(A) and (B)
1888-71-7	Hexachloropropene	--	µg/L	--	--	--	--	--	--	--	--	--	--	--	--	--	--
193-39-5	Indeno(1,2,3-cd)pyrene	--	µg/L	--	--	--	--	0.12	--	--	0.0038	--	--	--	0.0028	0.0028	WAC 173-340-730(3)(b)(iii)(A) and (B)
15046-84-1	Iodine-129	--	µg/L	1	--	--	--	--	--	--	--	--	--	--	1.0	1.0	40 CFR 141 - Federal MCL
74-88-4	Iodomethane	--	µg/L	--	--	--	--	--	--	--	--	--	--	--	--	--	--
7439-89-6	Iron	--	µg/L	300	--	300	--	11,200	--	1,000	300	--	--	--	9,074	300	40 CFR 141 - Federal MCL
78-83-1	Isobutyl alcohol	--	µg/L	--	--	--	--	2,400	--	--	--	--	--	--	246,132	2,400	WAC 173-340-720(4)(b)(iii)(A) and (B)
465-73-6	Isodrin	--	µg/L	--	--	--	--	--	--	--	--	--	--	--	--	--	--
78-59-1	Isophorone	--	µg/L	--	--	--	--	46	--	--	35	--	--	--	8.4	8.4	WAC 173-340-730(3)(b)(iii)(A) and (B)
120-58-1	Isosafrole	--	µg/L	--	--	--	--	--	--	--	--	--	--	--	--	--	--
143-50-0	Kepone	--	µg/L	--	--	--	--	0.0088	--	--	--	--	--	--	0.0088	0.0088	WAC 173-340-720(4)(b)(iii)(A) and (B)
7439-92-1	Lead	Lead and Compounds	µg/L	15	--	--	15	--	65	2.5	--	2.1	65	2.5	--	2.1	WAC 173-201A
7439-93-2	Lithium	--	µg/L	--	--	--	--	32	--	--	--	--	--	--	32	32	WAC 173-340-720(4)(b)(iii)(A) and (B)
7439-95-4	Magnesium	--	µg/L	--	--	--	--	--	--	--	--	--	--	--	--	--	--
7439-96-5	Manganese	Manganese (Water)	µg/L	50	--	50	--	2,240	--	--	50	--	--	--	907	50	40 CFR 141 - Federal MCL
99-65-0	m-Dinitrobenzene	--	µg/L	--	--	--	--	1.6	--	--	--	--	--	--	1.6	1.6	WAC 173-340-720(4)(b)(iii)(A) and (B)
7487-94-7	Mercury	Mercuric chloride	µg/L	2.0	2.0	2.0	--	4.8	1.4	0.77	--	0.012	2.1	0.012	0.14	0.78	40 CFR 131 -- Freshwater CCC
126-98-7	Methacrylonitrile	--	µg/L	--	--	--	--	0.80									

Table 3-1. Summary of Federal and State Water Quality Criteria and Action Levels for the 600 Area Subregion of the 300-FF-5 Groundwater Operable Unit

CAS#	Analyte Name	Alternate Analyte Name	Units	Groundwater				Surface Water										Final Value
				40 CFR 141 National Primary Drinking Water Regulations ^a		WAC 246-290-310 ^b	WAC 173-340-720 ^c		Clean Water Act National Recommended Water Quality Criteria ^d			WAC 173-201A ^e	40 CFR 131 Water Quality Standards ^f			WAC 173-340-730 ^g		
				Federal MCL	Federal MCLG	State MCL	Groundwater Method A Cleanup Levels	Groundwater Method B Unrestricted Land Use	Acute Freshwater CMC	Freshwater CCC	Human Health Water + Organism	Freshwater CCC	Freshwater CMC	Freshwater CCC	Human Health Water + Organism	Surface Water Method B Unrestricted Land Use	Final Action Level	
14797-55-8	Nitrate	--	µg/L	45,000	45,000	45,000	--	113,600	--	--	45,000	--	--	--	--	45,000	40 CFR 141 - Federal MCL	
14797-65-0	Nitrite	--	µg/L	3,300	3,300	3,300	--	5,280	--	--	--	--	--	--	--	3,300	40 CFR 141 - Federal MCL	
98-95-3	Nitrobenzene	--	µg/L	--	--	--	--	16	--	--	17	--	--	--	17	--	WAC 173-340-720(4)(b)(iii)(A) and (B)	
930-55-2	Nitrosopyrrolidine	--	µg/L	--	--	--	--	0.021	--	--	0.016	--	--	--	--	0.016	Clean Water Act -- Human Health Water + Organism	
55-18-5	n-Nitrosodiethylamine	--	µg/L	--	--	--	--	2.92E-04	--	--	8.00E-04	--	--	--	--	2.92E-04	Clean Water Act -- Human Health Water + Organism	
62-75-9	n-Nitrosodimethylamine	--	µg/L	--	--	--	--	8.58E-04	--	--	6.90E-04	--	--	6.90E-04	6.90E-04	6.90E-04	Clean Water Act -- Human Health Water + Organism	
924-16-3	n-Nitrosodi-n-butylamine	--	µg/L	--	--	--	--	0.0081	--	--	0.0063	--	--	--	0.0063	0.0063	Clean Water Act -- Human Health Water + Organism	
621-64-7	n-Nitrosodi-n-dipropylamine	--	µg/L	--	--	--	--	0.013	--	--	0.0050	--	--	--	0.0050	0.0050	Clean Water Act -- Human Health Water + Organism	
86-30-6	n-Nitrosodiphenylamine	--	µg/L	--	--	--	--	18	--	--	3.3	--	--	5.0	3.3	3.3	Clean Water Act -- Human Health Water + Organism	
10595-95-6	n-Nitrosomethylethylamine	--	µg/L	--	--	--	--	0.0040	--	--	--	--	--	--	0.0040	0.0040	WAC 173-340-720(4)(b)(iii)(A) and (B)	
59-89-2	n-Nitrosomorpholine	--	µg/L	--	--	--	--	0.013	--	--	--	--	--	--	0.013	0.013	WAC 173-340-720(4)(b)(iii)(A) and (B)	
100-75-4	n-Nitrosopiperidine	--	µg/L	--	--	--	--	0.0093	--	--	--	--	--	--	0.0093	0.0093	WAC 173-340-720(4)(b)(iii)(A) and (B)	
126-68-1	O,O,O-Triethyl phosphorothioate	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
297-97-2	O,O-Diethyl O-2-pyrazinyl phosphorothioate	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
95-53-4	o-Toluidine	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
56-38-2	Parathion	--	µg/L	--	--	--	--	96	0.065	0.013	--	0.065	0.013	--	--	0.013	Clean Water Act -- Freshwater CCC	
60-11-7	p-Dimethylaminoazobenzene	--	µg/L	--	--	--	--	0.019	--	--	--	--	--	--	0.019	0.019	WAC 173-340-720(4)(b)(iii)(A) and (B)	
608-93-5	Pentachlorobenzene	--	µg/L	--	--	--	--	13	--	--	1.4	--	--	--	1.4	1.4	Clean Water Act -- Human Health Water + Organism	
76-01-7	Pentachloroethane	--	µg/L	--	--	--	--	0.97	--	--	--	--	--	--	0.97	0.97	WAC 173-340-720(4)(b)(iii)(A) and (B)	
82-68-8	Pentachloronitrobenzene (PCNB)	--	µg/L	--	--	--	--	0.34	--	--	--	--	--	--	0.34	0.34	WAC 173-340-720(4)(b)(iii)(A) and (B)	
87-86-5	Pentachlorophenol	--	µg/L	1	--	--	--	0.73	19	15	0.27	20.27	20	13	0.28	0.27	Clean Water Act -- Human Health Water + Organism	
62-44-2	Phenacetin	--	µg/L	--	--	--	--	40	--	--	--	--	--	--	40	40	WAC 173-340-720(4)(b)(iii)(A) and (B)	
85-01-8	Phenanthrene	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
108-95-2	Phenol	--	µg/L	--	--	--	--	2,400	--	--	10,000	--	--	21,000	2,400	2,400	WAC 173-340-720(4)(b)(iii)(A) and (B)	
298-02-2	Phorate	--	µg/L	--	--	--	--	3.2	--	--	--	--	--	--	3.2	3.2	WAC 173-340-720(4)(b)(iii)(A) and (B)	
14265-44-2	Phosphate	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
7440-09-7	Potassium	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
106-50-3	p-Phenylenediamine	--	µg/L	--	--	--	--	3,040	--	--	--	--	--	--	3,040	3,040	WAC 173-340-720(4)(b)(iii)(A) and (B)	
23950-58-5	Pronamide	--	µg/L	--	--	--	--	1,200	--	--	--	--	--	--	1,200	1,200	WAC 173-340-720(4)(b)(iii)(A) and (B)	
129-00-0	Pyrene	--	µg/L	--	--	--	--	480	--	--	830	--	--	960	480	480	WAC 173-340-720(4)(b)(iii)(A) and (B)	
110-86-1	Pyridine	--	µg/L	--	--	--	--	8.0	--	--	--	--	--	--	8.0	8.0	WAC 173-340-720(4)(b)(iii)(A) and (B)	
94-59-7	Safrol	--	µg/L	--	--	--	--	0.40	--	--	--	--	--	--	0.40	0.40	WAC 173-340-720(4)(b)(iii)(A) and (B)	
7782-49-2	Selenium	--	µg/L	50	50	50	--	80	--	5.0	170	5.0	20	5.0	2,701	5.0	Clean Water Act -- Freshwater CCC	
7440-21-3	Silicon	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
7440-22-4	Silver	--	µg/L	100	--	100	--	80	3.2	--	--	2.6	3.4	--	25,926	2.6	WAC 173-201A	
7440-23-5	Sodium	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
7440-24-6	Strontium	Strontium, Stable	µg/L	--	--	--	--	9,600	--	--	--	--	--	25,926	9,600	9,600	WAC 173-340-720(4)(b)(iii)(A) and (B)	
10098-97-2	Strontium-90	--	pCi/L	8.0	--	--	--	--	--	--	--	--	--	--	8.0	8.0	40 CFR 141 - Federal MCL	
100-42-5	Styrene	--	µg/L	100	100	--	--	1,600	--	--	--	--	--	38,409	100	100	40 CFR 141 - Federal MCL	
14808-79-8	Sulfate	--	µg/L	250,000	--	250,000	--	--	--	--	--	--	--	--	250,000	250,000	40 CFR 141 - Federal MCL	
99-35-4	sym-Tribromobenzene	--	µg/L	--	--	--	--	480	--	--	--	--	--	--	480	480	WAC 173-340-720(4)(b)(iii)(A) and (B)	
127-18-4	Tetrachloroethene	Perchloroethylene (PCE)	µg/L	5.0	--	--	--	0.081	--	--	0.69	--	--	0.80	0.39	0.081	WAC 173-340-720(4)(b)(iii)(A) and (B)	
3689-24-5	Tetraethyl dithiopyrophosphate (Sulfotep)	--	µg/L	--	--	--	--	8.0	--	--	--	--	--	--	8.0	8.0	WAC 173-340-720(4)(b)(iii)(A) and (B)	
109-99-9	Tetrahydrofuran	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
7440-28-0	Thallium	Thallium (Soluble Salts)	µg/L	2.0	0.50	2.0	--	--	--	--	0.24	--	--	1.7	--	0.24	Clean Water Act -- Human Health Water + Organism	
7440-31-5	Tin	--	µg/L	--	--	--	--	9,600	--	--	--	--	--	519	519	519	WAC 173-340-730(3)(b)(iii)(A) and (B)	
108-88-3	Toluene	--	µg/L	1,000	1,000	--	--	640	--	--	1,300	--	6,800	19,384	640	640	WAC 173-340-720(4)(b)(iii)(A) and (B)	
156-60-5	trans-1,2-Dichloroethylene	--	µg/L	100	100	--	--	160	--	--	140	--	--	32,818	100	100	40 CFR 141 - Federal MCL	
10061-02-6	trans-1,3-Dichloropropene	--	µg/L	--	--	--	--	0.44	--	--	0.34	--	--	34	0.34	0.34	Clean Water Act -- Human Health Water + Organism	
110-57-6	trans-1,4-Dichloro-2-butene	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
126-73-8	Tributyl phosphate	--	µg/L	--	--	--	--	9.5	--	--	--	--	--	--	9.5	9.5	WAC 173-340-720(4)(b)(iii)(A) and (B)	
79-01-6	Trichloroethene	Trichloroethylene (TCE)	µg/L	5.0	--	--	--	0.49	--	--	2.5	--	--	2.7	0.49	0.49	WAC 173-340-720(4)(b)(iii)(A) and (B)	
75-69-4	Trichloromonofluoromethane	Trichlorofluoromethane	µg/L	--	--	--	--	2,400	--	--	--	--	--	--	2,400	2,400	WAC 173-340-720(4)(b)(iii)(A) and (B)	
10028-17-8	Tritium	--	pCi/L	20,000	--	--	--	--	--	--	--	--	--	--	20,000	20,000	40 CFR 141 - Federal MCL	
7440-61-1	Uranium	Uranium (Soluble Salts)	µg/L	30	--	--	--	48	--	--	--	--	--	778	30	30	40 CFR 141 - Federal MCL	
13966-29-5	Uranium-234	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
15117-96-1	Uranium-235	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
U-238	Uranium-238	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
7440-62-2	Vanadium	Vanadium and Compounds	µg/L	--	--	--	--	80	--	--	--	--	--	--	80	80	WAC 173-340-720(4)(b)(iii)(A) and (B)	
108-05-4	Vinyl acetate	--	µg/L	--	--	--	--	8,000	--	--	--	--	--	820,441	8,000	8,000	WAC 173-340-720(4)(b)(iii)(A) and (B)	
75-01-4	Vinyl chloride	--	µg/L	2.0	--	--	--	0.061	--	--	0.025	--	2.0	7.7	0.025	0.025	Clean Water Act -- Human Health Water + Organism	
1330-20-7	Xylenes (total)	Xylenes (mixture)	µg/L	10,000	10,000	--	--	1,600	--	--	--	--	--	--	1,600	1,600	WAC 173-340-720(4)(b)(iii)(A) and (B)	
7440-66-6	Zinc	Zinc (Metallic)	µg/L	5,000	--	5,000	--	4,800	120	120	7,400	91	110	100	16,548	91	WAC 173-201A	

Notes:

- a. 40 CFR 141 National Primary Drinking Water Regulations. <http://www.epa.gov/waterscience/criteria/wqtable/>
 - b. Washington Department of Ecology, 2008, *Group A Public Water Supplies 246-290-310 WAC*, Publication No. 08-03-061
 - c. WAC 173-340-720(4)(b)(iii)(A) and (B), Ground water cleanup standards, Method B ground water cleanup levels, Noncarcinogens and Carcinogens
 - d. Clean Water Act - National Recommended Water Quality Criteria
 - e. WAC 173-201A, "Water Quality Standards for Surface Waters of the State of Washington," *Washington Administrative Code*, Olympia, Washington. <http://apps.leg.wa.gov/wac/default.aspx?cite=173-201A>
 - f. 40 CFR 131 Water Quality Standards, <http://ecfr.gpoaccess.gov>
 - g. WAC 173-340-730(3)(b)(iii)(A) and (B), Surface water cleanup standards, Method B surface water cleanup levels, Noncarcinogens and Carcinogens
- MCL - Maximum Contaminant Limit
MCLG - Maximum Contaminant Limit Goal
CCC - Criteria Continuous Concentration
CMC - Criteria Maximum Concentration
Ecology, 2007, The Model Toxics Control Act Cleanup Regulation Chapter 173-340 WAC, Publication No. 94-06, amended 1996, Washington State Department of Ecology, Olympia, Washington.

Table 4-1. Monitoring Wells for the 600 Area Subregion of the 300-FF-5 Groundwater Operable Unit

Well Name			
99-S0-7	699-13-1A	699-15-15B	699-S28-E0
499-S0-8	699-13-1E	699-20-E5A	699-S3-E12
499-S1-8J	699-13-2D	699-S18-E2B	699-S6-E4A
699-1-18	699-13-3A	699-S19-11	699-S8-19
699-12-4D			

Table 7-1. Summary of Groundwater Analytes That Meet Exclusion Criteria for the 600 Area Subregion of the 300-FF-5 Groundwater Operable Unit

Analyte Name	Analyte Class	Begin Sample Date	End Sample Date	Total Samples	Total Detects	Frequency of Detection	Units	Minimum Detection Limit	Maximum Detection Limit	Minimum Detected Result	Maximum Detected Result	Basis for Exclusion
Bromide	ANION	6/10/2010	12/20/2010	51	13	25.49%	ug/L	45	110	111	242	No Action Level/ No Toxicity Values
Phosphate	ANION	6/10/2010	12/20/2010	51	0	0.00%	ug/L	215	429	--	--	No Action Level/ No Toxicity Values
Bismuth	METAL	6/10/2010	12/20/2010	50	3	6.00%	ug/L	23	37	31	31	No Action Level/ No Toxicity Values
Calcium	METAL	6/10/2010	12/20/2010	51	51	100.00%	ug/L	--	--	19,400	80,500	Essential Nutrient
Magnesium	METAL	6/10/2010	12/20/2010	51	51	100.00%	ug/L	--	--	6,390	17,100	Essential Nutrient
Potassium	METAL	6/10/2010	12/20/2010	51	51	100.00%	ug/L	--	--	4,460	8,280	Essential Nutrient
Silicon	METAL	6/10/2010	12/20/2010	50	50	100.00%	ug/L	--	--	13,700	29,300	No Action Level/ No Toxicity Values
Sodium	METAL	6/10/2010	12/20/2010	51	51	100.00%	ug/L	--	--	11,900	41,500	Essential Nutrient
Gross beta	RAD	6/10/2010	12/20/2010	22	22	100.00%	pCi/L	--	--	3.6	61	No Action Level/ No Toxicity Values
Uranium-234	RAD	12/19/2010	12/19/2010	1	1	100.00%	pCi/L	--	--	3.8	3.8	No Action Level/ No Toxicity Values
Uranium-235	RAD	12/19/2010	12/19/2010	1	1	100.00%	pCi/L	--	--	0.20	0.20	No Action Level/ No Toxicity Values
Uranium-238	RAD	12/19/2010	12/19/2010	1	1	100.00%	pCi/L	--	--	4.4	4.4	No Action Level/ No Toxicity Values
1,4-Naphthoquinone	SVOC	6/10/2010	12/20/2010	51	0	0.00%	ug/L	1.0	1.0	--	--	No Action Level/ No Toxicity Values
1-Naphthylamine	SVOC	6/10/2010	12/20/2010	51	0	0.00%	ug/L	1.0	1.0	--	--	No Action Level/ No Toxicity Values
2,6-Dichlorophenol	SVOC	6/10/2010	12/20/2010	51	0	0.00%	ug/L	1.0	1.0	--	--	No Action Level/ No Toxicity Values
2-Nitrophenol	SVOC	6/10/2010	12/20/2010	51	0	0.00%	ug/L	1.0	1.0	--	--	No Action Level/ No Toxicity Values
2-Picoline	SVOC	6/10/2010	12/20/2010	51	0	0.00%	ug/L	2.0	2.0	--	--	No Action Level/ No Toxicity Values
4-Bromophenylphenyl ether	SVOC	6/10/2010	12/20/2010	51	0	0.00%	ug/L	1.0	1.0	--	--	No Action Level/ No Toxicity Values
4-Chlorophenylphenyl ether	SVOC	6/10/2010	12/20/2010	51	0	0.00%	ug/L	1.0	1.0	--	--	No Action Level/ No Toxicity Values
4-Nitroquinoline-1-oxide	SVOC	6/10/2010	12/20/2010	51	0	0.00%	ug/L	5.0	5.0	--	--	No Action Level/ No Toxicity Values
Acenaphthylene	SVOC	6/10/2010	12/20/2010	51	0	0.00%	ug/L	1.0	1.0	--	--	No Action Level/ No Toxicity Values
alpha, alpha-Dimethylphenethylamine	SVOC	6/10/2010	12/20/2010	51	0	0.00%	ug/L	22	22	--	--	No Action Level/ No Toxicity Values
Benzo(ghi)perylene	SVOC	6/10/2010	12/20/2010	51	0	0.00%	ug/L	1.0	1.0	--	--	No Action Level/ No Toxicity Values
Di-n-octylphthalate	SVOC	6/10/2010	12/20/2010	51	0	0.00%	ug/L	1.0	1.0	--	--	No Action Level/ No Toxicity Values
Ethyl methanesulfonate	SVOC	6/10/2010	12/20/2010	51	0	0.00%	ug/L	1.0	1.0	--	--	No Action Level/ No Toxicity Values
Famphur	SVOC	6/10/2010	12/20/2010	51	0	0.00%	ug/L	1.7	1.7	--	--	No Action Level/ No Toxicity Values
Hexachloropropene	SVOC	6/10/2010	12/20/2010	51	0	0.00%	ug/L	1.0	1.0	--	--	No Action Level/ No Toxicity Values
Isodrin	SVOC	6/10/2010	12/20/2010	51	0	0.00%	ug/L	1.0	1.0	--	--	No Action Level/ No Toxicity Values
Isosafrole	SVOC	6/10/2010	12/20/2010	51	0	0.00%	ug/L	1.3	1.3	--	--	No Action Level/ No Toxicity Values
Methapyrene	SVOC	6/10/2010	12/20/2010	51	0	0.00%	ug/L	1.3	1.3	--	--	No Action Level/ No Toxicity Values
O,O,O-Triethyl phosphorothioate	SVOC	6/10/2010	12/20/2010	51	0	0.00%	ug/L	1.0	1.0	--	--	No Action Level/ No Toxicity Values
O,O-Diethyl O-2-pyrazinyl phosphorothioate	SVOC	6/10/2010	12/20/2010	51	0	0.00%	ug/L	1.0	1.0	--	--	No Action Level/ No Toxicity Values
o-Toluidine	SVOC	6/10/2010	12/20/2010	51	0	0.00%	ug/L	1.0	1.0	--	--	No Action Level/ No Toxicity Values
Phenanthrene	SVOC	6/10/2010	12/20/2010	51	0	0.00%	ug/L	1.0	1.0	--	--	No Action Level/ No Toxicity Values
Acetonitrile	VOC	6/10/2010	12/20/2010	51	0	0.00%	ug/L	2.0	2.0	--	--	No Action Level/ No Toxicity Values
Chloroethane	VOC	6/10/2010	12/20/2010	51	0	0.00%	ug/L	0.099	0.099	--	--	No Action Level/ No Toxicity Values
Chloromethane	VOC	6/10/2010	12/20/2010	51	16	31.37%	ug/L	0.077	2.0	0.088	0.29	No Action Level/ No Toxicity Values
Ethyl cyanide	VOC	6/10/2010	12/20/2010	51	0	0.00%	ug/L	1.4	1.4	--	--	No Action Level/ No Toxicity Values
Iodomethane	VOC	6/10/2010	12/20/2010	51	2	3.92%	ug/L	0.092	0.092	0.83	0.88	No Action Level/ No Toxicity Values
Tetrahydrofuran	VOC	6/10/2010	12/20/2010	51	0	0.00%	ug/L	1.1	1.1	--	--	No Action Level/ No Toxicity Values
trans-1,4-Dichloro-2-butene	VOC	6/10/2010	12/20/2010	51	0	0.00%	ug/L	0.29	0.29	--	--	No Action Level/ No Toxicity Values

Table 7-2. Summary of Groundwater Analytes That Were Not Detected for the 600 Area Subregion of the 300-FF-5 Groundwater Operable Unit

Analyte Name	Analyte Class	Begin Sample Date	End Sample Date	Total Samples	Total Detects	Frequency of Detection	Units	Minimum Detection Limit	Maximum Detection Limit	Action Level	Action Level Basis	Level of Exceedence
Nitrite	ANION	6/10/2010	12/20/2010	51	0	0.00%	µg/L	59	118	3,300	40 CFR 141 - Federal MCL	1.79E-02
Antimony	METAL	6/10/2010	12/20/2010	51	0	0.00%	µg/L	0.60	0.60	5.6	Clean Water Act -- Human Health Water + Organism	1.07E-01
Cadmium	METAL	6/10/2010	12/20/2010	51	0	0.00%	µg/L	0.20	0.20	0.25	Clean Water Act -- Freshwater CCC	8.00E-01
Mercury	METAL	6/10/2010	12/5/2010	14	0	0.00%	µg/L	0.10	0.10	0.012	40 CFR 131 -- Freshwater CCC	8.33E+00
Silver	METAL	6/10/2010	12/20/2010	51	0	0.00%	µg/L	0.20	0.20	2.6	WAC 173-201A	7.66E-02
Thallium	METAL	6/10/2010	12/20/2010	51	0	0.00%	µg/L	0.10	0.10	0.24	Clean Water Act -- Human Health Water + Organism	4.17E-01
Strontium-90	RAD	6/10/2010	12/20/2010	51	0	0.00%	pCi/L	-1.20E+01	4.7	8.0	40 CFR 141 - Federal MCL	-1.50E+00
1,2,4,5-Tetrachlorobenzene	SVOC	6/10/2010	12/20/2010	51	0	0.00%	µg/L	1.0	1.0	0.28	WAC 173-340-730(3)(b)(iii)(A) and (B)	3.57E+00
1,2,4-Trichlorobenzene	SVOC	6/10/2010	12/20/2010	51	0	0.00%	µg/L	1.0	1.0	1.5	WAC 173-340-720(4)(b)(iii)(A) and (B)	6.62E-01
1,2-Dichlorobenzene	SVOC	6/10/2010	12/20/2010	51	0	0.00%	µg/L	1.0	1.0	420	Clean Water Act -- Human Health Water + Organism	2.38E-03
1,3-Dichlorobenzene	SVOC	6/10/2010	12/20/2010	51	0	0.00%	µg/L	1.0	1.0	320	Clean Water Act -- Human Health Water + Organism	3.13E-03
2,3,4,6-Tetrachlorophenol	SVOC	6/10/2010	12/20/2010	51	0	0.00%	µg/L	1.0	1.0	480	WAC 173-340-720(4)(b)(iii)(A) and (B)	2.08E-03
2,4,5-Trichlorophenol	SVOC	6/10/2010	12/20/2010	51	0	0.00%	µg/L	1.0	1.0	486	WAC 173-340-730(3)(b)(iii)(A) and (B)	2.06E-03
2,4,6-Trichlorophenol	SVOC	6/10/2010	12/20/2010	51	0	0.00%	µg/L	1.0	1.0	1.4	Clean Water Act -- Human Health Water + Organism	7.14E-01
2,4-Dichlorophenol	SVOC	6/10/2010	12/20/2010	51	0	0.00%	µg/L	1.0	1.0	24	WAC 173-340-720(4)(b)(iii)(A) and (B)	4.17E-02
2,4-Dimethylphenol	SVOC	6/10/2010	12/20/2010	51	0	0.00%	µg/L	1.0	1.0	160	WAC 173-340-720(4)(b)(iii)(A) and (B)	6.25E-03
2,4-Dinitrophenol	SVOC	6/10/2010	12/20/2010	51	0	0.00%	µg/L	2.0	2.0	32	WAC 173-340-720(4)(b)(iii)(A) and (B)	6.25E-02
2,4-Dinitrotoluene	SVOC	6/10/2010	12/20/2010	51	0	0.00%	µg/L	1.0	1.0	0.11	Clean Water Act -- Human Health Water + Organism	9.09E+00
2,6-Dinitrotoluene	SVOC	6/10/2010	12/20/2010	51	0	0.00%	µg/L	2.2	2.2	16	WAC 173-340-720(4)(b)(iii)(A) and (B)	1.38E-01
2-Acetylaminofluorene	SVOC	6/10/2010	12/20/2010	51	0	0.00%	µg/L	1.0	1.0	0.023	WAC 173-340-720(4)(b)(iii)(A) and (B)	4.35E+01
2-Chloronaphthalene	SVOC	6/10/2010	12/20/2010	51	0	0.00%	µg/L	1.0	1.0	640	WAC 173-340-720(4)(b)(iii)(A) and (B)	1.56E-03
2-Chlorophenol	SVOC	6/10/2010	12/20/2010	51	0	0.00%	µg/L	1.0	1.0	40	WAC 173-340-720(4)(b)(iii)(A) and (B)	2.50E-02
2-Methylnaphthalene	SVOC	6/10/2010	12/20/2010	51	0	0.00%	µg/L	1.0	1.0	32	WAC 173-340-720(4)(b)(iii)(A) and (B)	3.13E-02
2-Methylphenol (cresol, o-)	SVOC	6/10/2010	12/20/2010	51	0	0.00%	µg/L	1.0	1.0	400	WAC 173-340-720(4)(b)(iii)(A) and (B)	2.50E-03
2-Naphthylamine	SVOC	6/10/2010	12/20/2010	51	0	0.00%	µg/L	1.0	1.0	0.049	WAC 173-340-720(4)(b)(iii)(A) and (B)	2.06E+01
2-Nitroaniline	SVOC	6/10/2010	12/20/2010	51	0	0.00%	µg/L	1.0	1.0	160	WAC 173-340-720(4)(b)(iii)(A) and (B)	6.25E-03
3,3'-Dichlorobenzidine	SVOC	6/10/2010	12/20/2010	51	0	0.00%	µg/L	1.0	1.0	0.021	Clean Water Act -- Human Health Water + Organism	4.76E+01
3,3'-Dimethylbenzidine	SVOC	6/10/2010	12/20/2010	51	0	0.00%	µg/L	2.6	2.6	0.0080	WAC 173-340-720(4)(b)(iii)(A) and (B)	3.27E+02
3-Methylcholanthrene	SVOC	6/10/2010	12/20/2010	51	0	0.00%	µg/L	1.0	1.0	3.68E-05	WAC 173-340-730(3)(b)(iii)(A) and (B)	2.72E+04
3-Nitroaniline	SVOC	6/10/2010	12/20/2010	51	0	0.00%	µg/L	1.0	1.0	4.2	WAC 173-340-720(4)(b)(iii)(A) and (B)	2.40E-01
4,6-Dinitro-2-methylphenol	SVOC	6/10/2010	12/20/2010	51	0	0.00%	µg/L	1.0	1.0	1.6	WAC 173-340-720(4)(b)(iii)(A) and (B)	6.25E-01
4-Aminobiphenyl	SVOC	6/10/2010	12/20/2010	51	0	0.00%	µg/L	1.0	1.0	0.0042	WAC 173-340-720(4)(b)(iii)(A) and (B)	2.40E+02
4-Chloro-3-methylphenol	SVOC	6/10/2010	12/20/2010	51	0	0.00%	µg/L	1.0	1.0	1,600	WAC 173-340-720(4)(b)(iii)(A) and (B)	6.25E-04
4-Chloroaniline	SVOC	6/10/2010	12/20/2010	51	0	0.00%	µg/L	1.0	1.0	0.22	WAC 173-340-720(4)(b)(iii)(A) and (B)	4.57E+00
4-Methylphenol (cresol, p-)	SVOC	6/10/2010	12/20/2010	51	0	0.00%	µg/L	10	10	40	WAC 173-340-720(4)(b)(iii)(A) and (B)	2.50E-01
4-Nitroaniline	SVOC	6/10/2010	12/20/2010	51	0	0.00%	µg/L	1.0	1.0	4.4	WAC 173-340-720(4)(b)(iii)(A) and (B)	2.28E-01
4-Nitrophenol	SVOC	6/10/2010	12/20/2010	51	0	0.00%	µg/L	2.0	2.0	128	WAC 173-340-720(4)(b)(iii)(A) and (B)	1.56E-02
5-Nitro-o-tolidine	SVOC	6/10/2010	12/20/2010	51	0	0.00%	µg/L	1.0	1.0	2.7	WAC 173-340-720(4)(b)(iii)(A) and (B)	3.77E-01
7,12-Dimethylbenz[a]anthracene	SVOC	6/10/2010	12/20/2010	51	0	0.00%	µg/L	1.0	1.0	8.31E-06	WAC 173-340-730(3)(b)(iii)(A) and (B)	1.20E+05
Acenaphthene	SVOC	6/10/2010	12/20/2010	51	0	0.00%	µg/L	1.0	1.0	643	WAC 173-340-730(3)(b)(iii)(A) and (B)	1.56E-03
Acetophenone	SVOC	6/10/2010	12/20/2010	51	0	0.00%	µg/L	1.0	1.0	800	WAC 173-340-720(4)(b)(iii)(A) and (B)	1.25E-03
Aniline	SVOC	6/10/2010	12/20/2010	51	0	0.00%	µg/L	1.0	1.0	7.7	WAC 173-340-720(4)(b)(iii)(A) and (B)	1.30E-01
Anthracene	SVOC	6/10/2010	12/20/2010	51	0	0.00%	µg/L	1.0	1.0	4,800	WAC 173-340-720(4)(b)(iii)(A) and (B)	2.08E-04
Aramite	SVOC	6/10/2010	12/20/2010	51	0	0.00%	µg/L	20	20	0.37	WAC 173-340-730(3)(b)(iii)(A) and (B)	5.39E+01
Azobenzene	SVOC	6/10/2010	12/20/2010	51	0	0.00%	µg/L	1.0	1.0	0.80	WAC 173-340-720(4)(b)(iii)(A) and (B)	1.26E+00
Benzo(a)anthracene	SVOC	6/10/2010	12/20/2010	51	0	0.00%	µg/L	1.0	1.0	0.0028	40 CFR 131 -- Human Health Water + Organism	3.57E+02
Benzo(a)pyrene	SVOC	6/10/2010	12/20/2010	51	0	0.00%	µg/L	1.0	1.0	0.0028	40 CFR 131 -- Human Health Water + Organism	3.57E+02
Benzo(b)fluoranthene	SVOC	6/10/2010	12/20/2010	51	0	0.00%	µg/L	1.0	1.0	0.0028	40 CFR 131 -- Human Health Water + Organism	3.57E+02
Benzo(k)fluoranthene	SVOC	6/10/2010	12/20/2010	51	0	0.00%	µg/L	1.0	1.0	0.0028	40 CFR 131 -- Human Health Water + Organism	3.57E+02
Bis(2-chloro-1-methylethyl)ether	SVOC	6/10/2010	12/20/2010	51	0	0.00%	µg/L	1.0	1.0	0.63	WAC 173-340-720(4)(b)(iii)(A) and (B)	1.60E+00
Bis(2-Chloroethoxy)methane	SVOC	6/10/2010	12/20/2010	51	0	0.00%	µg/L	1.0	1.0	48	WAC 173-340-720(4)(b)(iii)(A) and (B)	2.08E-02
Bis(2-chloroethyl) ether	SVOC	6/10/2010	12/20/2010	51	0	0.00%	µg/L	1.0	1.0	0.030	Clean Water Act -- Human Health Water + Organism	3.33E+01
Carbazole	SVOC	6/10/2010	12/20/2010	51	0	0.00%	µg/L	1.0	1.0	1.9	WAC 173-340-730(3)(b)(iii)(A) and (B)	5.24E-01
Chlorobenzilate	SVOC	6/10/2010	12/20/2010	51	0	0.00%	µg/L	1.0	1.0	0.12	WAC 173-340-730(3)(b)(iii)(A) and (B)	8.20E+00
Chrysene	SVOC	6/10/2010	12/20/2010	51	0	0.00%	µg/L	1.0	1.0	0.0028	40 CFR 131 -- Human Health Water + Organism	3.57E+02
Diallate	SVOC	6/10/2010	12/20/2010	51	0	0.00%	µg/L	2.0	2.0	0.25	WAC 173-340-730(3)(b)(iii)(A) and (B)	8.03E+00
Dibenz[a,h]anthracene	SVOC	6/10/2010	12/20/2010	51	0	0.00%	µg/L	1.0	1.0	0.0028	40 CFR 131 -- Human Health Water + Organism	3.57E+02
Dibenzofuran	SVOC	6/10/2010	12/20/2010	51	0	0.00%	µg/L	1.0	1.0	1.7	WAC 173-340-730(3)(b)(iii)(A) and (B)	5.85E-01
Dimethoate	SVOC	6/10/2010	12/20/2010	51	0	0.00%	µg/L	1.0	1.0	3.2	WAC 173-340-720(4)(b)(iii)(A) and (B)	3.13E-01
Dimethyl phthalate	SVOC	6/10/2010	12/20/2010	51	0	0.00%	µg/L	1.0	1.0	270,000	Clean Water Act -- Human Health Water + Organism	3.70E-06
Dinoseb(2-secButyl-4,6-dinitrophenol)	SVOC	6/10/2010	12/20/2010	51	0	0.00%	µg/L	2.0	2.0	7.0	40 CFR 141 - Federal MCL	2.86E-01
Disulfoton	SVOC	6/10/2010	12/20/2010	51	0	0.00%	µg/L	1.0	1.0	0.48	WAC 173-340-730(3)(b)(iii)(A) and (B)	2.10E+00
Fluoranthene	SVOC	6/10/2010	12/20/2010	51	0	0.00%	µg/L	1.0	1.0	90	WAC 173-340-730(3)(b)(iii)(A) and (B)	1.11E-02
Fluorene	SVOC	6/10/2010	12/20/2010	51	0	0.00%	µg/L	1.0	1.0	640	WAC 173-340-720(4)(b)(iii)(A) and (B)	1.56E-03
Hexachlorobenzene	SVOC	6/10/2010	12/20/2010	51	0	0.00%	µg/L	1.0	1.0	2.80E-04	Clean Water Act -- Human Health Water + Organism	3.57E+03
Hexachlorobutadiene	SVOC	6/10/2010	12/20/2010	51	0	0.00%	µg/L	1.0	1.0	0.44	Clean Water Act -- Human Health Water + Organism	2.27E+00
Hexachlorocyclopentadiene	SVOC	6/10/2010	12/20/2010	51	0	0.00%	µg/L	1.0	1.0	40	Clean Water Act -- Human Health Water + Organism	2.50E-02
Hexachloroethane	SVOC	6/10/2010	12/20/2010	51	0	0.00%	µg/L	1.0	1.0	1.4	Clean Water Act -- Human Health Water + Organism	7.14E-01
Hexachlorophene	SVOC	6/10/2010	12/20/2010	51	0	0.00%	µg/L	10	10	4.8	WAC 173-340-720(4)(b)(iii)(A) and (B)	2.08E+00
Indeno(1,2,3-cd)pyrene	SVOC	6/10/2010	12/20/2010	51	0	0.00%	µg/L	1.0	1.0	0.0028	40 CFR 131 -- Human Health Water + Organism	3.57E+02
Isophorone	SVOC	6/10/2010	12/20/2010	51	0	0.00%	µg/L	1.0	1.0	8.4	40 CFR 131 -- Human Health Water + Organism	1.19E-01
Kepone	SVOC	6/10/2010	12/20/2010	51	0	0.00%	µg/L	20	20	4.18E-04	WAC 173-340-730(3)(b)(iii)(A) and (B)	4.78E+04
m-Dinitrobenzene	SVOC	6/10/2010	12/20/2010	51	0	0.00%	µg/L	1.0	1.0	1.6	WAC 173-340-720(4)(b)(iii)(A) and (B)	6.25E-01
Methyl methanesulfonate	SVOC	6/10/2010	12/20/2010	51	0	0.00%	µg/L	1.0	1.0	0.88	WAC 173-340-720(4)(b)(iii)(A) and (B)	1.13E+00
Methyl parathion	SVOC	6/10/2010	12/20/2010	51	0	0.00%	µg/L	1.0	1.0	4.0	WAC 173-340-720(4)(b)(iii)(A) and (B)	2.50E-01

Table 7-2. Summary of Groundwater Analytes That Were Not Detected for the 600 Area Subregion of the 300-FF-5 Groundwater Operable Unit

Analyte Name	Analyte Class	Begin Sample Date	End Sample Date	Total Samples	Total Detects	Frequency of Detection	Units	Minimum Detection Limit	Maximum Detection Limit	Action Level	Action Level Basis	Level of Exceedence
Naphthalene	SVOC	6/10/2010	12/20/2010	51	0	0.00%	µg/L	1.0	1.0	160	WAC 173-340-720(4)(b)(iii)(A) and (B)	6.25E-03
Nitrobenzene	SVOC	6/10/2010	12/20/2010	51	0	0.00%	µg/L	1.0	1.0	16	WAC 173-340-720(4)(b)(iii)(A) and (B)	6.25E-02
Nitrosopyrrolidine	SVOC	6/10/2010	12/20/2010	51	0	0.00%	µg/L	1.0	1.0	0.016	Clean Water Act -- Human Health Water + Organism	6.25E+01
n-Nitrosodiethylamine	SVOC	6/10/2010	12/20/2010	51	0	0.00%	µg/L	1.0	1.0	2.92E-04	WAC 173-340-720(4)(b)(iii)(A) and (B)	3.42E+03
n-Nitrosodimethylamine	SVOC	6/10/2010	12/20/2010	51	0	0.00%	µg/L	2.0	2.0	6.90E-04	Clean Water Act -- Human Health Water + Organism	2.90E+03
n-Nitrosodi-n-butylamine	SVOC	6/10/2010	12/20/2010	51	0	0.00%	µg/L	1.0	1.0	0.0063	Clean Water Act -- Human Health Water + Organism	1.59E+02
n-Nitrosodi-n-dipropylamine	SVOC	6/10/2010	12/20/2010	51	0	0.00%	µg/L	1.0	1.0	0.0050	Clean Water Act -- Human Health Water + Organism	2.00E+02
n-Nitrosodiphenylamine	SVOC	6/10/2010	12/20/2010	51	0	0.00%	µg/L	1.0	1.0	3.3	Clean Water Act -- Human Health Water + Organism	3.03E-01
n-Nitrosomethylethylamine	SVOC	6/10/2010	12/20/2010	51	0	0.00%	µg/L	1.0	1.0	0.0040	WAC 173-340-720(4)(b)(iii)(A) and (B)	2.51E+02
n-Nitrosomorpholine	SVOC	6/10/2010	12/20/2010	51	0	0.00%	µg/L	1.0	1.0	0.013	WAC 173-340-720(4)(b)(iii)(A) and (B)	7.63E+01
n-Nitrosopiperidine	SVOC	6/10/2010	12/20/2010	51	0	0.00%	µg/L	1.0	1.0	0.0093	WAC 173-340-720(4)(b)(iii)(A) and (B)	1.07E+02
Parathion	SVOC	6/10/2010	12/20/2010	51	0	0.00%	µg/L	1.0	1.0	0.013	Clean Water Act -- Freshwater CCC	7.69E+01
p-Dimethylaminoazobenzene	SVOC	6/10/2010	12/20/2010	51	0	0.00%	µg/L	1.0	1.0	0.019	WAC 173-340-720(4)(b)(iii)(A) and (B)	5.26E+01
Pentachlorobenzene	SVOC	6/10/2010	12/20/2010	51	0	0.00%	µg/L	1.0	1.0	1.4	Clean Water Act -- Human Health Water + Organism	7.14E-01
Pentachloroethane	SVOC	6/10/2010	12/20/2010	51	0	0.00%	µg/L	1.0	1.0	0.97	WAC 173-340-720(4)(b)(iii)(A) and (B)	1.03E+00
Pentachloronitrobenzene (PCNB)	SVOC	6/10/2010	12/20/2010	51	0	0.00%	µg/L	1.0	1.0	0.046	WAC 173-340-730(3)(b)(iii)(A) and (B)	2.19E+01
Pentachlorophenol	SVOC	6/10/2010	12/20/2010	51	0	0.00%	µg/L	1.3	1.3	0.27	Clean Water Act -- Human Health Water + Organism	4.81E+00
Phenacetin	SVOC	6/10/2010	12/20/2010	51	0	0.00%	µg/L	1.0	1.0	40	WAC 173-340-720(4)(b)(iii)(A) and (B)	2.51E-02
Phenol	SVOC	6/10/2010	12/20/2010	51	0	0.00%	µg/L	2.0	2.0	2,400	WAC 173-340-720(4)(b)(iii)(A) and (B)	8.33E-04
Phorate	SVOC	6/10/2010	12/20/2010	51	0	0.00%	µg/L	1.0	1.0	3.2	WAC 173-340-720(4)(b)(iii)(A) and (B)	3.13E-01
p-Phenylenediamine	SVOC	6/10/2010	12/20/2010	51	0	0.00%	µg/L	1.0	1.0	3,040	WAC 173-340-720(4)(b)(iii)(A) and (B)	3.29E-04
Pronamide	SVOC	6/10/2010	12/20/2010	51	0	0.00%	µg/L	1.0	1.0	1,200	WAC 173-340-720(4)(b)(iii)(A) and (B)	8.33E-04
Pyrene	SVOC	6/10/2010	12/20/2010	51	0	0.00%	µg/L	1.0	1.0	480	WAC 173-340-720(4)(b)(iii)(A) and (B)	2.08E-03
Pyridine	SVOC	6/10/2010	12/20/2010	51	0	0.00%	µg/L	2.0	2.0	8.0	WAC 173-340-720(4)(b)(iii)(A) and (B)	2.50E-01
Safrol	SVOC	6/10/2010	12/20/2010	51	0	0.00%	µg/L	1.0	1.0	0.34	WAC 173-340-730(3)(b)(iii)(A) and (B)	2.97E+00
sym-Trinitrobenzene	SVOC	6/10/2010	12/20/2010	51	0	0.00%	µg/L	1.0	1.0	480	WAC 173-340-720(4)(b)(iii)(A) and (B)	2.08E-03
Tetraethyl dithiopyrophosphate (Sulfotepp)	SVOC	6/10/2010	12/20/2010	51	0	0.00%	µg/L	1.0	1.0	6.5	WAC 173-340-730(3)(b)(iii)(A) and (B)	1.54E-01
1,1,1,2-Tetrachloroethane	VOC	6/10/2010	12/20/2010	51	0	0.00%	µg/L	0.090	0.090	1.7	WAC 173-340-720(4)(b)(iii)(A) and (B)	5.36E-02
1,1,1-Trichloroethane	VOC	6/10/2010	12/20/2010	51	0	0.00%	µg/L	0.069	0.069	200	40 CFR 141 - Federal MCL	3.45E-04
1,1,2,2-Tetrachloroethane	VOC	6/10/2010	12/20/2010	51	0	0.00%	µg/L	0.098	0.098	0.17	Clean Water Act -- Human Health Water + Organism	5.76E-01
1,1,2-Trichloroethane	VOC	6/10/2010	12/20/2010	51	0	0.00%	µg/L	0.15	0.15	0.59	Clean Water Act -- Human Health Water + Organism	2.54E-01
1,1-Dichloroethane	VOC	6/10/2010	12/20/2010	51	0	0.00%	µg/L	0.083	0.083	0.057	40 CFR 131 -- Human Health Water + Organism	1.46E+00
1,2,3-Trichloropropane	VOC	6/10/2010	12/20/2010	51	0	0.00%	µg/L	0.15	0.15	0.0015	WAC 173-340-720(4)(b)(iii)(A) and (B)	1.03E+02
1,2-Dibromo-3-chloropropane	VOC	6/10/2010	12/20/2010	51	0	0.00%	µg/L	0.41	0.41	0.055	WAC 173-340-720(4)(b)(iii)(A) and (B)	7.50E+00
1,2-Dibromoethane	VOC	6/10/2010	12/20/2010	51	0	0.00%	µg/L	0.13	0.13	0.022	WAC 173-340-720(4)(b)(iii)(A) and (B)	5.94E+00
1,2-Dichloroethane	VOC	6/10/2010	12/20/2010	51	0	0.00%	µg/L	0.10	0.10	0.38	Clean Water Act -- Human Health Water + Organism	2.63E-01
1,2-Dichloroethene (Total)	VOC	6/10/2010	12/20/2010	51	0	0.00%	µg/L	0.15	0.15	72	WAC 173-340-720(4)(b)(iii)(A) and (B)	2.08E-03
1,2-Dichloropropane	VOC	6/10/2010	12/20/2010	51	0	0.00%	µg/L	0.097	0.097	0.50	Clean Water Act -- Human Health Water + Organism	1.94E-01
1,4-Dichlorobenzene	VOC	6/10/2010	12/20/2010	51	0	0.00%	µg/L	0.12	0.12	8.1	WAC 173-340-720(4)(b)(iii)(A) and (B)	1.48E-02
1,4-Dioxane	VOC	6/10/2010	12/20/2010	51	0	0.00%	µg/L	7.6	7.6	4.0	WAC 173-340-720(4)(b)(iii)(A) and (B)	1.91E+00
1-Butanol	VOC	6/10/2010	12/20/2010	51	0	0.00%	µg/L	12	12	800	WAC 173-340-720(4)(b)(iii)(A) and (B)	1.50E-02
2-Butanone	VOC	6/10/2010	12/20/2010	51	0	0.00%	µg/L	0.52	0.52	4,800	WAC 173-340-720(4)(b)(iii)(A) and (B)	1.08E-04
2-Hexanone	VOC	6/10/2010	12/20/2010	51	0	0.00%	µg/L	0.22	0.22	80	WAC 173-340-720(4)(b)(iii)(A) and (B)	2.75E-03
4-Methyl-2-pentanone	VOC	6/10/2010	12/20/2010	51	0	0.00%	µg/L	0.12	0.12	640	WAC 173-340-720(4)(b)(iii)(A) and (B)	1.88E-04
Acrolein	VOC	6/10/2010	12/20/2010	51	0	0.00%	µg/L	2.8	2.8	3.0	Clean Water Act -- Freshwater CCC	9.33E-01
Allyl chloride	VOC	6/10/2010	12/20/2010	51	0	0.00%	µg/L	0.11	0.11	2.1	WAC 173-340-720(4)(b)(iii)(A) and (B)	5.29E-02
Benzene	VOC	6/10/2010	12/20/2010	51	0	0.00%	µg/L	0.064	0.064	0.80	WAC 173-340-720(4)(b)(iii)(A) and (B)	8.04E-02
Chlorobenzene	VOC	6/10/2010	12/20/2010	51	0	0.00%	µg/L	0.15	0.15	100	40 CFR 141 - Federal MCL	1.50E-03
Chloroprene	VOC	6/10/2010	12/20/2010	51	0	0.00%	µg/L	0.097	0.097	160	WAC 173-340-720(4)(b)(iii)(A) and (B)	6.06E-04
cis-1,2-Dichloroethylene	VOC	6/10/2010	12/20/2010	51	0	0.00%	µg/L	0.087	0.087	70	40 CFR 141 - Federal MCL	1.24E-03
cis-1,3-Dichloropropene	VOC	6/10/2010	12/20/2010	51	0	0.00%	µg/L	0.073	0.073	0.34	Clean Water Act -- Human Health Water + Organism	2.15E-01
Dibromomethane	VOC	6/10/2010	12/20/2010	51	0	0.00%	µg/L	0.21	0.21	80	WAC 173-340-720(4)(b)(iii)(A) and (B)	2.63E-03
Dichlorodifluoromethane	VOC	6/10/2010	12/20/2010	51	0	0.00%	µg/L	0.084	0.084	1,600	WAC 173-340-720(4)(b)(iii)(A) and (B)	5.25E-05
Ethyl methacrylate	VOC	6/10/2010	12/20/2010	51	0	0.00%	µg/L	0.11	0.11	720	WAC 173-340-720(4)(b)(iii)(A) and (B)	1.53E-04
Ethylbenzene	VOC	6/10/2010	12/20/2010	51	0	0.00%	µg/L	0.086	0.086	4.0	WAC 173-340-720(4)(b)(iii)(A) and (B)	2.16E-02
Isobutyl alcohol	VOC	6/10/2010	12/20/2010	51	0	0.00%	µg/L	8.7	8.7	2,400	WAC 173-340-720(4)(b)(iii)(A) and (B)	3.63E-03
Methacrylonitrile	VOC	6/10/2010	12/20/2010	51	0	0.00%	µg/L	0.50	0.50	0.80	WAC 173-340-720(4)(b)(iii)(A) and (B)	6.25E-01
Methyl methacrylate	VOC	6/10/2010	12/20/2010	51	0	0.00%	µg/L	0.26	0.26	11,200	WAC 173-340-720(4)(b)(iii)(A) and (B)	2.32E-05
Methylene chloride	VOC	6/10/2010	12/20/2010	51	0	0.00%	µg/L	0.11	0.11	4.6	Clean Water Act -- Human Health Water + Organism	2.39E-02
Styrene	VOC	6/10/2010	12/20/2010	51	0	0.00%	µg/L	0.074	0.074	100	40 CFR 141 - Federal MCL	7.40E-04
Tetrachloroethene	VOC	6/10/2010	12/20/2010	51	0	0.00%	µg/L	0.18	0.18	0.081	WAC 173-340-720(4)(b)(iii)(A) and (B)	2.22E+00
trans-1,2-Dichloroethylene	VOC	6/10/2010	12/20/2010	51	0	0.00%	µg/L	0.083	0.083	100	40 CFR 141 - Federal MCL	8.30E-04
trans-1,3-Dichloropropene	VOC	6/10/2010	12/20/2010	51	0	0.00%	µg/L	0.083	0.083	0.34	Clean Water Act -- Human Health Water + Organism	2.44E-01
Trichloroethene	VOC	6/10/2010	12/20/2010	51	0	0.00%	µg/L	0.21	1.0	0.49	WAC 173-340-720(4)(b)(iii)(A) and (B)	4.27E-01
Trichloromonofluoromethane	VOC	6/10/2010	12/20/2010	51	0	0.00%	µg/L	0.11	0.11	2,400	WAC 173-340-720(4)(b)(iii)(A) and (B)	4.58E-05
Vinyl acetate	VOC	6/10/2010	12/20/2010	51	0	0.00%	µg/L	0.18	0.18	8,000	WAC 173-340-720(4)(b)(iii)(A) and (B)	2.25E-05
Vinyl chloride	VOC	6/10/2010	12/20/2010	51	0	0.00%	µg/L	0.084	0.084	0.025	Clean Water Act -- Human Health Water + Organism	3.36E+00
Xylenes (total)	VOC	6/10/2010	12/20/2010	51	0	0.00%	µg/L	0.20	0.20	1,600	WAC 173-340-720(4)(b)(iii)(A) and (B)	1.25E-04

Note:

Shading indicates analyte is listed as a groundwater contaminant of potential concern in DOE/RL-2009-45, 300 Area Remedial Investigation/ Feasibility Study Sampling and Analysis Plan for the 300-FF-1, 300-FF-2, and 300-FF-5 Operable Units.

Table 7-4. Summary of Groundwater Analytes That Do Not Exceed an Action Level for the 600 Area Subregion of the 300-FF-5 Groundwater Operable Unit

Analyte Name	Analyte Class	Begin Sample Date	End Sample Date	Total Samples	Total Detects	Frequency of Detection	Units	Minimum Detection Limit	Maximum Detection Limit	Minimum Detected Result	Maximum Detected Result	Action Level	Action Level Basis
Chloride	ANION	6/10/2010	12/20/2010	51	51	100.00%	ug/L	--	--	1,860	26,100	230,000	Clean Water Act -- Freshwater CCC
Fluoride	ANION	6/10/2010	12/20/2010	51	43	84.31%	µg/L	60	60	39	851	960	WAC 173-340-720(4)(b)(iii)(A) and (B)
Sulfate	ANION	6/10/2010	12/20/2010	51	51	100.00%	ug/L	--	--	3,980	87,200	250,000	40 CFR 141 - Federal MCL
Barium	METAL	6/10/2010	12/20/2010	51	51	100.00%	ug/L	--	--	15	118	1,000	Clean Water Act -- Human Health Water + Organism
Beryllium	METAL	6/10/2010	12/20/2010	51	1	1.96%	ug/L	0.10	0.10	0.19	0.19	4.0	40 CFR 141 - Federal MCL
Boron	METAL	6/10/2010	12/20/2010	50	14	28.00%	ug/L	19	41	20	107	3,200	WAC 173-340-720(4)(b)(iii)(A) and (B)
Chromium	METAL	6/10/2010	12/20/2010	51	34	66.67%	ug/L	1.0	1.0	1.1	5.9	65	Clean Water Act -- Freshwater CCC
Cobalt	METAL	6/10/2010	12/20/2010	51	10	19.61%	ug/L	0.10	0.10	0.13	1.0	2.6	WAC 173-340-730(3)(b)(iii)(A) and (B)
Lead	METAL	6/10/2010	12/20/2010	51	15	29.41%	ug/L	0.20	0.20	0.24	1.4	2.1	WAC 173-201A
Lithium	METAL	6/10/2010	12/20/2010	50	36	72.00%	ug/L	4.0	4.0	4.0	31	32	WAC 173-340-720(4)(b)(iii)(A) and (B)
Molybdenum	METAL	6/10/2010	12/20/2010	51	51	100.00%	ug/L	--	--	1.0	11	80	WAC 173-340-720(4)(b)(iii)(A) and (B)
Nickel	METAL	6/10/2010	12/20/2010	51	4	7.84%	ug/L	4.0	4.0	4.0	8.0	52	Clean Water Act -- Freshwater CCC
Strontium	METAL	6/10/2010	12/20/2010	51	51	100.00%	ug/L	--	--	115	407	9,600	WAC 173-340-720(4)(b)(iii)(A) and (B)
Tin	METAL	6/10/2010	12/20/2010	51	4	7.84%	ug/L	0.10	0.10	0.12	0.26	519	WAC 173-340-730(3)(b)(iii)(A) and (B)
Uranium	METAL	6/10/2010	12/20/2010	51	49	96.08%	ug/L	0.10	0.10	0.094	13	30	40 CFR 141 - Federal MCL
Vanadium	METAL	6/10/2010	12/20/2010	51	19	37.25%	ug/L	12	17	12	33	80	WAC 173-340-720(4)(b)(iii)(A) and (B)
Zinc	METAL	6/10/2010	12/20/2010	51	24	47.06%	ug/L	4.0	6.0	4.0	71	91	WAC 173-201A
Iodine-129	RAD	6/10/2010	12/20/2010	51	1	1.96%	pCi/L	-9.83E-02	0.24	0.38	0.38	1.0	40 CFR 141.66
Benzyl alcohol	SVOC	6/10/2010	12/20/2010	51	1	1.96%	ug/L	1.0	1.0	1.1	1.1	800	WAC 173-340-720(4)(b)(iii)(A) and (B)
Butylbenzylphthalate	SVOC	6/10/2010	12/20/2010	51	1	1.96%	ug/L	1.0	1.0	1.3	1.3	8.2	WAC 173-340-730(3)(b)(iii)(A) and (B)
Diethylphthalate	SVOC	6/10/2010	12/20/2010	51	2	3.92%	ug/L	1.0	1.0	1.7	42	12,800	WAC 173-340-720(4)(b)(iii)(A) and (B)
Di-n-butylphthalate	SVOC	6/10/2010	12/20/2010	51	1	1.96%	ug/L	1.0	1.0	1.0	1.0	1,600	WAC 173-340-720(4)(b)(iii)(A) and (B)
Tributyl phosphate	SVOC	6/10/2010	12/20/2010	51	1	1.96%	ug/L	1.0	1.0	6.7	6.7	9.5	WAC 173-340-720(4)(b)(iii)(A) and (B)
1,1-Dichloroethane	VOC	6/10/2010	12/20/2010	51	3	5.88%	ug/L	0.068	0.068	0.15	0.20	1,600	WAC 173-340-720(4)(b)(iii)(A) and (B)
Acetone	VOC	6/10/2010	12/20/2010	44	5	11.36%	ug/L	0.34	0.34	0.40	2.5	7,200	WAC 173-340-720(4)(b)(iii)(A) and (B)
Bromoform	VOC	6/10/2010	12/20/2010	51	6	11.76%	ug/L	0.17	0.17	1.6	2.9	4.3	Clean Water Act -- Human Health Water + Organism
Bromomethane	VOC	6/10/2010	12/20/2010	51	9	17.65%	ug/L	0.13	2.0	0.31	0.95	11	WAC 173-340-720(4)(b)(iii)(A) and (B)
Carbon disulfide	VOC	6/10/2010	12/20/2010	51	3	5.88%	ug/L	0.051	0.051	0.060	0.11	800	WAC 173-340-720(4)(b)(iii)(A) and (B)
Carbon tetrachloride	VOC	6/10/2010	12/20/2010	51	2	3.92%	ug/L	0.12	0.12	0.13	0.16	0.23	Clean Water Act -- Human Health Water + Organism
Toluene	VOC	6/10/2010	12/20/2010	51	2	3.92%	ug/L	0.072	0.072	0.083	0.14	640	WAC 173-340-720(4)(b)(iii)(A) and (B)

Note:
Shading indicates analyte is listed as a groundwater contaminant of potential concern in DOE/RL-2009-45, 300 Area Remedial Investigation/ Feasibility Study Sampling and Analysis Plan for the 300-FF-1, 300-FF-2, and 300-FF-5 Operable Units.

Table 7-6. Summary of Groundwater Analytes That Exceed an Action Level for the 600 Area Subregion of the 300-FF-5 Groundwater Operable Unit

Analyte Name	Analyte Class	Begin Sample Date	End Sample Date	Total Samples	Total Detects	Frequency of Detection	Units	Minimum Detection Limit	Maximum Detection Limit	Minimum Detected Result	Maximum Detected Result	Action Level	Action Level Basis
Nitrate	ANION	6/10/2010	12/20/2010	51	48	94.12%	µg/L	84	274	227	136,000	45,000	40 CFR 141 - Federal MCL
Aluminum	METAL	6/10/2010	12/20/2010	51	15	29.41%	µg/L	10	10	12	539	50	40 CFR 141 - Federal MCL
Arsenic	METAL	6/10/2010	12/20/2010	51	51	100.00%	µg/L	--	--	1.6	15	0.018	Clean Water Act -- Human Health Water + Organism
Copper	METAL	6/10/2010	12/20/2010	51	31	60.78%	µg/L	0.20	0.20	0.24	12	9.0	Clean Water Act -- Freshwater CCC
Iron	METAL	6/10/2010	12/20/2010	51	40	78.43%	µg/L	18	38	23	3,340	300	40 CFR 141 - Federal MCL
Manganese	METAL	6/10/2010	12/20/2010	51	27	52.94%	µg/L	4.0	6.0	5.0	261	50	40 CFR 141 - Federal MCL
Selenium	METAL	6/10/2010	12/20/2010	51	33	64.71%	µg/L	0.60	6.0	0.63	13	5.0	Clean Water Act -- Freshwater CCC
Gross alpha	RAD	6/10/2010	12/20/2010	22	14	63.64%	pCi/L	-1.30E+00	1.2	2.3	40	15	40 CFR 141 - Federal MCL
Tritium	RAD	6/10/2010	12/20/2010	51	31	60.78%	pCi/L	-5.70E+01	180	290	890,000	20,000	40 CFR 141 - Federal MCL
Bis(2-ethylhexyl) phthalate	VOC	6/10/2010	12/20/2010	51	3	5.88%	µg/L	1.0	1.0	1.3	3.0	1.2	Clean Water Act -- Human Health Water + Organism
Bromodichloromethane	VOC	6/10/2010	12/20/2010	51	10	19.61%	µg/L	0.088	0.088	0.17	2.1	0.27	40 CFR 131 -- Human Health Water + Organism
Chloroform	VOC	6/10/2010	12/20/2010	51	15	29.41%	µg/L	0.10	0.10	0.11	7.1	1.4	WAC 173-340-720(4)(b)(iii)(A) and (B)
Dibromochloromethane	VOC	6/10/2010	12/20/2010	51	7	13.73%	µg/L	0.13	0.13	1.6	3.3	0.40	Clean Water Act -- Human Health Water + Organism

Note:

Shading indicates analyte is listed as a groundwater contaminant of potential concern in DOE/RL-2009-45, 300 Area Remedial Investigation/ Feasibility Study Sampling and Analysis Plan for the 300-FF-1, 300-FF-2, and 300-FF-5 Operable Units.

Table 7-8. Exposure Point Concentration Summary for the 600 Area Subregion of the 300-FF-5 Groundwater Operable Unit

Analyte Name	Analyte Class	Total Number of Samples	Number of Detects	Frequency of Detection	Units	Minimum Detection Limit	Maximum Detection Limit	Minimum Detected Result	Maximum Detected Result	90th Percentile	Action Level	Action Level Basis	90th Percentile > Action Level?	Level of Exceedence
Nitrate	ANION	51	48	94.12%	µg/L	84	274	227	136,000	50,000	45,000	40 CFR 141 - Federal MCL	Yes	1.11E+00
Aluminum	METAL	51	15	29.41%	µg/L	10	10	12	539	87	50	40 CFR 141 - Federal MCL	Yes	1.73E+00
Arsenic	METAL	51	51	100.00%	µg/L	--	--	1.6	15	11	0.018	Clean Water Act -- Human Health Water + Organism	Yes	6.01E+02
Copper	METAL	51	31	60.78%	µg/L	0.20	0.20	0.24	12	3.3	9.0	Clean Water Act -- Freshwater CCC	No	3.69E-01
Iron	METAL	51	40	78.43%	µg/L	18	38	23	3,340	477	300	40 CFR 141 - Federal MCL	Yes	1.59E+00
Manganese	METAL	51	27	52.94%	µg/L	4.0	6.0	5.0	261	40	50	40 CFR 141 - Federal MCL	No	7.90E-01
Selenium	METAL	51	33	64.71%	µg/L	0.60	6.0	0.63	13	6.1	5.0	Clean Water Act -- Freshwater CCC	Yes	1.21E+00
Gross alpha	RAD	22	14	63.64%	pCi/L	-1.30E+00	1.2	2.3	40	8.0	15	40 CFR 141 - Federal MCL	No	5.33E-01
Tritium	RAD	51	31	60.78%	pCi/L	-5.70E+01	180	290	890,000	290,000	20,000	40 CFR 141 - Federal MCL	Yes	1.45E+01
Bis(2-ethylhexyl) phthalate	SVOC	51	3	5.88%	µg/L	1.0	1.0	1.3	3.0	1.0	1.2	Clean Water Act -- Human Health Water + Organism	No	8.33E-01
Bromodichloromethane ^a	VOC	51	10	19.61%	µg/L	0.088	0.088	0.17	2.1	0.72	0.27	40 CFR 131 -- Human Health Water + Organism	Yes	2.67E+00
Chloroform	VOC	51	15	29.41%	µg/L	0.10	0.10	0.11	7.1	0.62	1.4	WAC 173-340-720(4)(b)(iii)(A) and (B)	No	4.36E-01
Dibromochloromethane ^b	VOC	51	7	13.73%	µg/L	0.13	0.13	1.6	3.3	2.0	0.40	Clean Water Act -- Human Health Water + Organism	Yes	5.00E+00

Note:

a. A quantitation limit of 5.0 µg/L is reported for bromotrichloromethane in Table A-6 of DOE/RL-2009-45.

b. A quantitation limit of 5.0 µg/L is reported for dibromochloromethane in Table A-6 of DOE/RL-2009-45.

Table 7-14. Monitoring Well Locations Reported with Concentrations of Final COPCs Greater Than Action Level for the 600 Area Subregion of the 300-FF-5 Groundwater Operable Unit

Final COPC	Nitrate	Tritium
Action Level	45,000 µg/L	20,000 pCi/L
99-S0-7		
499-S0-8		
499-S1-8J		
699-1-18		
699-12-4D		
699-13-1A		
699-13-1E	X	X
699-13-2D	X	X
699-13-3A	X	X
699-15-15B		
699-20-E5A		X
699-S18-E2B		
699-S19-11		
699-S28-E0		
699-S3-E12		
699-S6-E4A		
699-S8-19		

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Draft A

Calculation of Exposure Point Concentrations for the 300 Area Subregion of the 300-FF-5 Groundwater Operable Unit

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

Contractor for the U.S. Department of Energy
under Contract DE-AC06-08RL14788



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Calculation of Exposure Point Concentrations for the 300 Area Subregion of the 300-FF-5 Groundwater Operable Unit

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Environmental Calculation Cover Page

Part 1: Completed by the Responsible Manager

Project: 300-FF-5 OU

Date: December 8, 2011

Calculation Title & Description: Calculation of Exposure Point Concentrations for the 300 Area Subregion of the 300-FF-5 Groundwater Operable Unit

This calculation brief describes the calculation of exposure point concentrations for the detected constituents/contaminants of potential concern identified for the 300 Area subregion of the 300-FF-5 Groundwater Operable Unit.

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Calculation No.: ECF-300FF5-11-0130

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Terms

95UCL	95% upper confidence limit
BDL	Below detection limit
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
COPC	Contaminant of potential concern
CV	Coefficient of variation
ECF	Environmental Calculation File
EPC	Exposure point concentration
HEIS	Hanford Environmental Information System
MAD	Median absolute deviation
OU	Operable unit
RI	Remedial investigation
RI/FS	Remedial investigation/feasibility study
RME	Reasonable maximum exposure
RSD	Relative standard deviation
SD	Standard deviation
UCL	Upper confidence limit

1 Purpose

This environmental calculation describes the calculation of exposure point concentrations (EPCs) for analytes in groundwater at the 300 Area subregion of the 300-FF-5 Groundwater Operable Unit (OU) (hereafter referred to simply as the 300 Area subregion). This calculation brief details the statistical methodology used to calculate the EPCs and supports a separate calculation brief addressing the identification of groundwater contaminants of potential concern (COPCs) for the 300 Area subregion (ECF-300FF5-11-0128, *Identification of Contaminants of Potential Concern for the 300 Area Subregion of the 300-FF-5 Groundwater Operable Unit*). EPCs are calculated herein for a set of 49 analytes consisting of:

1. Analytes identified in ECF-300FF5-11-0128 as COPCs for the 300 Area subregion based on maximum detected concentrations in groundwater that exceed an applicable action level;
2. Analytes identified as groundwater COPCs in Table 1-4 of DOE/RL-2009-45, *300 Area Remedial Investigation/Feasibility Study Sampling and Analysis Plan for the 300-FF-1, 300-FF-2, and 300-FF-5 Operable Units*; and
3. Analytes detected at least once during the groundwater sampling and analysis activities described in DOE/RL-2009-45.

This calculation brief supports the remedial investigation/feasibility study (RI/FS) process being conducted for the 300-FF-5 OU under the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) as documented in DOE/RL-2010-99, *Remedial Investigation/Feasibility Study for the 300-FF-1, 300-FF-2, and 300-FF-5 Operable Units*.

2 Background

This calculation brief addresses a key element of the risk assessment process for hazardous waste sites: estimation of the concentration of a chemical in the environment. The following section provides a brief definition of the EPC.

2.1 Exposure Point Concentration

An EPC is a conservative estimate of the contaminant concentration at an exposure point or in an exposure area where an exposed receptor may reasonably be assumed to move at random and where contact with an environmental medium (e.g., water) is equally likely at all locations within the exposure area. The rationale for use of exposure concentrations is explained in EPA/540/1-89/002, *Risk Assessment Guidance for Superfund Volume I Human Health Evaluation Manual (Part A): Interim Final*:

“Although this concentration does not reflect the maximum concentration that could be contacted at any one time, it is regarded as a reasonable estimate of the concentration likely to be contacted over time. This is because in most situations, assuming long-term contact with the maximum concentration is not reasonable.”

3 Methodology

The following subsections discuss the methodology and equations used to calculate EPC values for the 300 Area subregion.

3.1 Exposure Point Concentration Methodology

The methodology involves using the 300 Area subregion groundwater analytical data set to calculate an EPC for each of the detected analytes/COPCs. Calculated 90th percentile values are taken as estimates of the EPCs. The 90th percentile value is the concentration that corresponds to the position in an ordered data set that has 90% of the data points below it, and 10% above it. The rationale for use of the 90th percentile value as the estimated EPC is discussed in Section 4.2. The steps taken to calculate the 90th percentile values are:

1. Obtain the dataset for each detected analyte/COPC.
2. Place the sample results for each detected analyte/COPC in order from the lowest concentration to the highest concentration.
3. Assign each sample result a ranked number (rank), starting with the number 1 for the lowest concentration result and continuing to the highest concentration, which is given the number equal to the total number of samples.
4. Calculate the 90th percentile value using the equations presented in Section 3.2.

3.2 Equations Used for Calculating the 90th Percentile Value

The position corresponding to the 90th percentile (k) is determined using the following equation (Hogg and Tanis, 2001, *Probability and Statistical Inference*):

$$k = \frac{p(n+1)}{100} \quad \text{where } p = 90 \text{ for a 90th percentile calculation}$$

$$n = \text{total number of samples}$$

If the number corresponding to the calculated value, k , is an integer, the sample result with rank corresponding to k is the 90th percentile value as indicated by the following equation.

$$90\text{th percentile value} = k\text{th value} \quad \text{where } k \text{ is an integer}$$

If k is not an integer, then the average or mean of the values on either side of k (the values in the positions $k_{\text{rounddown}}$ and k_{roundup}) is calculated using the following equation to determine the 90th percentile value:

$$90\text{th percentile value} = \frac{k_{\text{rounddown}}\text{value} + k_{\text{roundup}}\text{value}}{2}$$

where k is not an integer

If k is greater than n for smaller data sets ($n < 10$), the 90th percentile value defaults to the maximum concentration reported (i.e., the n^{th} value).

4 Assumptions and Inputs

4.1 Sample Analysis Data

The groundwater data set used for the EPC calculations consists of sample analysis data for samples collected from groundwater wells located in the 300 Area subregion. All of these wells are either monitoring wells or compliance wells. The data set is composed of analytical results from the groundwater sampling and analysis activities performed per the requirements documented in DOE/RL-2009-45. The analytical data set is extracted from the Hanford Environmental Information System (HEIS) database. After extraction from HEIS, the analytical data are processed to obtain a single set of results per sampling location and date of collection. Analytical data set processing is described in ECF-300FF5-11-0128. The input data used for the 90th percentile calculations are provided in Appendix A.

4.2 Determination of Statistical Calculation Method for EPC Values

In general, EPA Superfund guidance recommends using a 95% Upper Confidence Limit (95UCL) on the mean for estimating EPCs. However, experience at the Hanford Site indicates that averages and UCLs cannot be reliably calculated for Hanford groundwater data sets, such as the 300 Area subregion data, where multiple groundwater contaminants are present in overlapping plumes, and the highest concentrations for different analytes often have different locations within the plumes.

Use of the 90th percentile value from a distribution of groundwater concentration data as an estimate of the EPC is a different approach for estimating EPCs than that provided in some Superfund guidance (OSWER 9285.6-10, *Calculating Upper Confidence Limits for Exposure Point Concentrations at Hazardous Waste Sites*). However as described below, the 90th percentile exposure concentration is identified in other EPA risk assessment guidance as appropriate for describing and characterizing health risks; its use yields risk estimates that correspond to a reasonable maximum exposure (RME).

According to EPA/100/B-04/001, *An Examination of EPA Risk Assessment Principles and Practices*, the RME is an appropriate exposure scenario for risk calculations, within the realistic range of exposure, since the goal of the Superfund program is to protect against high-end, not average, exposures. The “high end” is defined as that part of the exposure distribution that is above the 90th percentile, but below the 99.9th percentile. The approach is consistent with the peer reviewed EPA/600/Z-92/001, *Guidelines for Exposure Assessment*. Groundwater concentrations directly reflect potential exposures and risks; so, a 90th percentile concentration reflects an RME scenario.

Groundwater data sets at the Hanford site are highly skewed, with a large proportion of below-detection-limit (BDL) values. The EPA data analysis guidance (EPA/240/B-06/003, *Data Quality Assessment: Statistical Methods for Practitioners*) provides different guidance for estimating statistical parameters (whether means or upper percentiles) depending on the variability of the data set. The variability of the data set is assessed in terms of the coefficient of variation (CV) and the proportion of analytical results that are BDL. For data sets with CVs > 0.5, and with 50% or more analytical results that are BDL, EPA recommends using upper percentiles, as opposed to means, to develop summary statistics.

Therefore, the rationale for using the 90th percentile value as an estimate of the EPC is consistent with the definition of an RME scenario, and is an appropriate statistic for groundwater data sets at the Hanford Site. Additional statistical evaluation of the 300 Area subregion data sets that supports selection of the 90th percentile value as the estimate of the EPC is provided in Appendix B. The Appendix B evaluation includes an estimation of the 95UCL value for each detected analyte/COPC along with an analysis of data set variability to assess the reliability of the 95UCL estimates. Results of the evaluation indicate that, for

all but nine of detected analytes/COPCs, a reliable and meaningful 95UCL estimate cannot be calculated, because of 1) an insufficient number of samples, 2) an insufficient frequency of detections, or 3) a high variance of the data. For those nine detected analytes/COPCs, the calculated 95UCL is less conservative than its corresponding 90th percentile value. Therefore, the 90th percentile value is adopted as the estimated EPC for all detected analytes/COPCs. A comparison of the 90th percentile and 95UCL values is provided in Section 7.2.

5 Software Applications

Software programs used for this analysis were the HEIS database, Microsoft Access¹ database software, ProUCL statistical software², and Microsoft Excel³. The HEIS is a central repository for storing and maintaining access to environmental data for the Hanford Site. Microsoft Access was used to query and sort the data downloaded from HEIS. Microsoft Excel was used to calculate the 90th percentile concentrations and to present the groundwater data and information in spreadsheets. ProUCL was used to perform statistical calculations on the analytical data sets. The ProUCL-generated calculations are presented in Appendix B and summarized in Section 7.2.

6 Calculation

Calculate the 90th percentile value using the methodology presented in Section 3. The 90th percentile calculations are validated by comparison with a hand calculation. The hand calculation is provided in Figure 6-1.

¹ Access is a trademark of Microsoft Corporation, Redmond, Washington.

² ProUCL is a statistical software package developed by the U.S. Environmental Protection Agency, distributed free of charge, and made available for download at http://www.epa.gov/nerlesd1/tsc/TSC_form.htm.

³ Excel is a trademark of Microsoft Corporation, Redmond, Washington.

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Arsenic

$$K = \frac{p(n+1)}{100}$$

$$n = 45$$

$$p = 90$$

$$K = \frac{90(45+1)}{100} = 41.4 \checkmark$$

$$\begin{aligned} 90\text{th Percentile} &= \frac{K_{\text{round down}} + K_{\text{round up}}}{2} \\ &= \frac{4\text{st Value} + 4\text{2nd Value}}{2} \\ &= \frac{5.15 + 5.28}{2} \\ &= 5.215 \checkmark \end{aligned}$$

Figure 6-1. Hand Calculation of the 90th Percentile Value

7 Results/Conclusions

7.1 90th Percentile Exposure Point Concentrations

The calculated 90th percentile values are presented in Table 7-1.

Table 7-1. 90th Percentile Calculation Results

Detected Analyte/COPC	Detects	Nondetects	Number of values (n)	Percentile (p)	Position in Sequence (k)	Mean 90 th Percentile (µg/L or pCi/L)
1,2-Dichloroethene (Total) ^a	10	35	45	90	41.4	0.22
Acetone	8	37	45	90	41.4	1.0
Acrolein	1	44	45	90	41.4	2.8
Aluminum	4	41	45	90	41.4	10
Antimony ^a	No detectable results reported					
Arsenic ^a	43	2	45	90	41.4	5.2
Barium	45	0	45	90	41.4	71
Boron	12	33	45	90	41.4	45
Bromodichloromethane	3	42	45	90	41.4	0.088
Bromomethane	3	42	45	90	41.4	0.25
Cadmium ^a	No detectable results reported					
Carbon disulfide	4	41	45	90	41.4	0.054
Carbon tetrachloride ^a	3	42	45	90	41.4	0.12
Chloride	45	0	45	90	41.4	25,950
Chloroform ^a	12	33	45	90	41.4	0.47
Chromium ^a	44	1	45	90	41.4	7.1
cis-1,2-Dichloroethylene ^a	11	34	45	90	41.4	0.22
Cobalt ^a	3	42	45	90	41.4	0.12
Copper ^a	23	22	45	90	41.4	1.4
Cyanide ^a	1	44	45	90	41.4	4.0
Fluoride ^a	43	2	45	90	41.4	280
Gross alpha	28	0	28	90	26.1	71
Gross beta	28	0	28	90	26.1	42
Iron	19	26	45	90	41.4	106
Lead ^a	3	42	45	90	41.4	0.20
Lithium	33	12	45	90	41.4	25

Table 7-1. 90th Percentile Calculation Results

Detected Analyte/COPC	Detects	Nondetects	Number of values (n)	Percentile (p)	Position in Sequence (k)	Mean 90 th Percentile (µg/L or pCi/L)
Manganese ^a	3	42	45	90	41.4	6.0
Mercury ^a	No detectable results reported					
Molybdenum	45	0	45	90	41.4	5.7
Nickel ^a	11	34	45	90	41.4	6.0
Nitrate ^a	45	0	45	90	41.4	31,250
Nitrite ^a	No detectable results reported					
Selenium ^a	45	0	45	90	41.4	3.7
Silver ^a	2	43	45	90	41.4	0.20
Strontium	45	0	45	90	41.4	248
Strontium-90 ^a	No detectable results reported					
Sulfate ^a	45	0	45	90	41.4	58,500
Tetrachloroethene ^a	3	42	45	90	41.4	0.18
Thallium ^a	1	44	45	90	41.4	0.10
Tin	3	42	45	90	41.4	0.10
Trichloroethene ^a	35	10	45	90	41.4	2.2
Tritium ^a	39	6	45	90	41.4	6,150
Uranium ^a	45	0	45	90	41.4	114
Uranium-233/234 ^a	No detectable results reported					
Uranium-235 ^a	No detectable results reported					
Uranium-238 ^a	No detectable results reported					
Vanadium	10	35	45	90	41.4	21
Vinyl Chloride ^a	No detectable results reported					
Zinc ^a	12	33	45	90	41.4	42

Notes:

a. Identified as a groundwater COPC in Table 1-4 of DOE/RL-2009-45.

COPC = contaminant of potential concern.

DOE/RL-2009-45, 300 Area Remedial Investigation/Feasibility Study Sampling and Analysis Plan for the 300-FF-1, 300-FF-2, and 300-FF-5 Operable Units

7.2 Uncertainties Associated with Exposure Point Concentrations

The EPCs for groundwater are estimated by the 90th percentile concentration. The RI/FS protectiveness and risk evaluation methodology uses RME concentrations for the exposure area as a whole, rather than performing the evaluation on a specific well or location. As discussed in Section 4.2, EPA Superfund guidance generally recommends using a 95 percent UCL on the mean for estimating EPCs. However, experience at the Hanford Site indicates that averages and UCLs cannot be reliably calculated for groundwater data sets using this approach. Using the present example, the 300 Area subregion has multiple groundwater contaminants present in overlapping plumes, and the highest concentrations of the different analytes often have different locations within the plumes.

Taking the 90th percentile from a distribution of groundwater concentration data as an estimate of the EPC is a different approach from Superfund guidance for estimating EPCs in risk assessments (OSWER 9285.6-10). However, as discussed in Section 4.2, the 90th percentile concentration is identified in other EPA risk assessment guidance as usable for describing and characterizing health risks. Risk estimates based on the 90th percentile value correspond to an RME.

Table 7-2 shows the 90th percentile concentrations used for the RI/FS protectiveness and risk evaluations, as well as the maximum, average, and 95UCL concentrations for the 300 Area subregion.

A groundwater data set is considered robust when the 90th percentile value is greater than the 95UCL value. The 90th percentile concentration is greater than the 95UCL value for 21 detected analytes/COPCs but less than the 95UCL for 15 detected analytes/COPCs (1,2-dichloroethene (total), acetone, aluminum, bromodichloromethane, bromomethane, carbon disulfide, carbon tetrachloride, cis-1,2-dichloroethylene, cobalt, copper, lead, manganese, tetrachloroethene, tin, and zinc). As discussed in Section 4.2 and Appendix B, the 95UCL values calculated from the 300 Area subregion data sets have low reliability. Four detected analytes/COPCs (acrolein, cyanide, silver, and thallium) lack a 95UCL value altogether because their data sets contain only one or two detected values and could not be processed by the ProUCL software. Of the 36 detected analytes/COPCs where ProUCL was able to calculate a 95UCL, the data set for 27 failed to meet one or more of the criteria used for evaluating whether the data set can provide a reliable and meaningful 95UCL value. For the nine detected analytes/COPCs where a meaningful 95UCL could be calculated (arsenic, barium, chloride, fluoride, molybdenum, nitrate, selenium, strontium, and sulfate) the calculated 95UCL is less conservative than its corresponding 90th percentile value. Generally, when data sets are large, the 95UCL will approach the mean concentration. For example, for nitrate, the 95UCL is 27,800 µg/L and the mean is 25,900 µg/L; in contrast, the 90th percentile is 31,300 µg/L. Therefore, 90th percentile values are reasonable upper bounds of exposure area concentrations, for the purposes of the RI/FS risk assessment.

However, risks could be significantly underestimated for a detected analyte/COPC whose maximum concentration is considerably larger than the 90th percentile value. This is true of five of the detected analytes/COPCs (acetone, copper, lead, thallium, and zinc), for which the maximum concentrations are more than an order of magnitude greater than the 90th percentile values. If a future drinking water well were drilled at the location of one of these maximum concentrations, the health risk would be greater than calculated using the 90th percentile value as the estimated EPC. However, because only 10 percent of the data exceed the 90th percentile value, such very high concentrations are few, and they represent only limited areas.

Table 7-2. Percentile Concentrations and Summary Statistics for the 300 Area Subregion Data Set

Detected Analyte/COPC	Units	Number of Measurements	90 th Percentile	Maximum	Mean	95% UCL ^a
1,2-Dichloroethene (Total)	µg/L	45	0.22	0.69	0.30	0.24
Acetone	µg/L	45	1.0	31	4.8	3.5
Acrolein	µg/L	45	2.8	3.8	3.8	--
Aluminum	µg/L	45	10	100	34	15
Arsenic	µg/L	45	5.2	6.5	3.8	4.0
Barium	µg/L	45	71	83	57	59
Boron	µg/L	45	45	118	41	31
Bromodichloromethane	µg/L	45	0.088	0.69	0.68	0.68
Bromomethane	µg/L	45	0.25	0.77	0.59	0.77
Carbon disulfide	µg/L	45	0.054	0.075	0.065	0.073
Carbon tetrachloride	µg/L	45	0.12	0.59	0.33	0.59
Chloride	µg/L	45	25,950	29,000	20,405	21,552
Chloroform	µg/L	45	0.47	0.87	0.40	0.27
Chromium	µg/L	45	7.1	17	4.4	5.0
cis-1,2-Dichloroethylene	µg/L	45	0.22	0.69	0.28	0.23
Cobalt	µg/L	45	0.12	0.16	0.15	0.14
Copper	µg/L	45	1.4	31	2.2	4.3
Cyanide	µg/L	45	4.0	3.7	3.7	--
Fluoride	µg/L	45	280	340	209	218
Gross alpha	pCi/L	28	71	77	23	31
Gross beta	pCi/L	28	42	49	21	25
Iron	µg/L	45	106	647	129	102
Lead	µg/L	45	0.20	3.5	1.5	3.5
Lithium	µg/L	45	25	33	13	13
Manganese	µg/L	45	6.0	12	8.3	12
Molybdenum	µg/L	45	5.7	5.8	4.9	5.0
Nickel	µg/L	45	6.0	12	5.9	4.8
Nitrate	µg/L	45	31,250	62,000	25,871	27,805
Selenium	µg/L	45	3.7	5.8	2.5	2.8

Table 7-2. Percentile Concentrations and Summary Statistics for the 300 Area Subregion Data Set

Detected Analyte/COPC	Units	Number of Measurements	90 th Percentile	Maximum	Mean	95% UCL ^a
Silver	µg/L	45	0.20	0.72	0.41	--
Strontium	µg/L	45	248	280	218	246
Sulfate	µg/L	45	58,500	59,500	48,396	50,661
Tetrachloroethene	µg/L	45	0.18	0.38	0.29	0.38
Thallium	µg/L	45	0.10	1.2	1.2	--
Tin	µg/L	45	0.10	0.20	0.13	0.11
Trichloroethene	µg/L	45	2.2	3.0	1.3	1.3
Tritium	pCi/L	45	6,150	7,700	3,319	3,473
Uranium	µg/L	45	114	177	55	66
Vanadium	µg/L	45	21	34	19	16
Zinc	µg/L	45	42	456	105	95

Notes:

a. -- Indicates number of detected results is insufficient for ProUCL to process the data set.

COPC = contaminant of potential concern.

UCL = upper confidence limit.

8 References

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APPENDIX A

Data Spreadsheets

The input data used for the 90th percentile calculations for the 300 Area subregion are provided in Table A-1. This table is provided as an electronic attachment (formatted for on-screen viewing) in the Excel workbook “ECF-300FF5-11-0130 300 Area Subregion EPC Calculation Worksheet.xlsx” that accompanies this environmental calculation.

APPENDIX B

Summary Statistics and Supporting Information

B.1 Summary Statistics for the 300 Area Subregion Data Set

Statistical calculations were performed for each of the detected analytes/COPCs in groundwater in the 300 Area subregion. The results of the statistical calculations are provided in Table B-1. The raw statistics were calculated by the ProUCL software. This table is provided as an electronic attachment (formatted for on-screen viewing) in the Excel workbook “ECF-300FF5-11-0130 300 Area Subregion EPC Calculation Worksheet.xlsx” that accompanies this environmental calculation. The following statistical definitions are provided for assistance in interpreting the information provided by ProUCL.

- **Mean:** The sum of all the values of a set of measurements divided by the number of values in the set; a measure of central tendency.
- **Median:** The middle value for an ordered set of n values. Represented by the central value when n is odd or by the average of the two most central values when n is even. The median is the 50th percentile.
- **Standard Deviation (SD):** A measure of variation (or spread) from an average value of the sample data values.
- **Median Absolute Deviation (MAD):** For observations x_1, x_2, \dots, x_n , with median m , the median absolute deviation is the median of the differences $|x_1 - m|, |x_2 - m|, \dots, |x_n - m|$.
- **MAD/0.675** = Robust measure of variation (standard deviation) where MAD = Median Absolute Deviation
- **Skewness:** A measure of the asymmetry of the distribution of the characteristic under study (e.g., lead concentrations). It can also be measured in terms of the standard deviation of log-transformed data. The higher the standard deviation, the higher the skewness. Coefficient of Skewness = $CV^3 + 3CV$ where CV is the coefficient of variation.
- **Coefficient of Variation (CV):** A dimensionless quantity used to measure the spread of data relative to the size of the numbers. For a normal distribution, the CV is given by the standard deviation divided by the mean. Also known as the relative standard deviation (RSD).

B.2 ProUCL Generated 95 Percent Upper Confidence Limits

The ProUCL 4.0 statistical software package (EPA/600/R-07/038, *ProUCL Version 4.00.05 User Guide (Draft)*) was used to generate an estimate of the 95% upper confidence limit (95UCL) on the mean concentration for each detected analyte/COPC. ProUCL 4.0 contains statistical methods to address data sets both with and without nondetects and computes the UCL for a given data set by a variety of alternative statistical approaches (including several approaches that do not require the assumption of normality or log-normality). ProUCL 4.0 then recommends specific UCL values as being the most appropriate for that particular data set. The input data files used to calculate the 95UCL values are the same as those used for the 90th percentile calculations and are provided in Appendix A. The ProUCL output generated for the 300 Area subregion is provided at the end of this appendix. A summary table with the ProUCL comments, recommended UCL calculation methods, and warnings regarding the adequacy of the data to provide meaningful results for each detected analyte/COPC is provided in Table B-2.

Table B-2. Summary of ProUCL Comments and UCL Calculation Methods

Detected Analyte/COPC	ProUCL Comment	UCL Calculation Method
1,2-Dichloroethene (Total)	Data not Normal at 5% Significance Level Data not Lognormal at 5% Significance Level Data not Gamma Distributed at 5% Significance Level Data do not follow a Discernable Distribution (0.05)	95% KM (% Bootstrap) UCL
Acetone	Warning: There are only 8 Detected Values in this data Note: It should be noted that even though bootstrap may be performed on this data set the resulting calculations may not be reliable enough to draw conclusions It is recommended to have 10-15 or more distinct observations for accurate and meaningful results. Data not Normal at 5% Significance Level Data not Lognormal at 5% Significance Level Data do not follow a Discernable Distribution (0.05)	95% KM (BCA) UCL
Acrolein	Warning: Only one distinct data value was detected! ProUCL (or any other software) should not be used on such a data set! It is suggested to use alternative site specific values determined by the Project Team to estimate environmental parameters (e.g., EPC, BTV). The data set for variable Acrolein was not processed!	Not Processed
Aluminum	Warning: There are only 4 Distinct Detected Values in this data Note: It should be noted that even though bootstrap may be performed on this data set the resulting calculations may not be reliable enough to draw conclusions It is recommended to have 10-15 or more distinct observations for accurate and meaningful results. Data not Normal at 5% Significance Level Data appear Lognormal at 5% Significance Level Data follow Appr. Gamma Distribution at 5% Significance Level	95% KM (t) UCL
Arsenic	Data appear Normal at 5% Significance Level Data not Lognormal at 5% Significance Level Data appear Gamma Distributed at 5% Significance Level	95% KM (Percentile Bootstrap) UCL
Barium	Data appear Normal at 5% Significance Level Data appear Lognormal at 5% Significance Level Data appear Gamma Distributed at 5% Significance Level	Use 95% Student's-t UCL
Boron	Data not Normal at 5% Significance Level Data appear Lognormal at 5% Significance Level Data appear Gamma Distributed at 5% Significance Level	95% KM (t) UCL

Table B-2. Summary of ProUCL Comments and UCL Calculation Methods

Detected Analyte/COPC	ProUCL Comment	UCL Calculation Method
Bromodichloromethane	<p>Warning: Data set has only 2 Distinct Detected Values.</p> <p>This may not be adequate enough to compute meaningful and reliable test statistics and estimates.</p> <p>The Project Team may decide to use alternative site specific values to estimate environmental parameters (e.g., EPC, BTV).</p> <p>Unless Data Quality Objectives (DQOs) have been met, it is suggested to collect additional observations.</p> <p>The number of detected data may not be adequate enough to perform GOF tests, bootstrap, and ROS methods.</p> <p>Those methods will return a 'N/A' value on your output display!</p> <p>It is necessary to have 4 or more Distinct Values for bootstrap methods.</p> <p>However, results obtained using 4 to 9 distinct values may not be reliable.</p> <p>It is recommended to have 10 to 15 or more observations for accurate and meaningful results and estimates.</p> <p>Data not Normal at 5% Significance Level</p> <p>Data not Lognormal at 5% Significance Level</p> <p>Data not Gamma Distributed at 5% Significance Level</p> <p>Data do not follow a Discernable Distribution (0.05)</p>	95% KM (t) UCL
Bromomethane	<p>Warning: There are only 3 Distinct Detected Values in this data set</p> <p>The number of detected data may not be adequate enough to perform GOF tests, bootstrap, and ROS methods.</p> <p>Those methods will return a 'N/A' value on your output display!</p> <p>It is necessary to have 4 or more Distinct Values for bootstrap methods.</p> <p>However, results obtained using 4 to 9 distinct values may not be reliable.</p> <p>It is recommended to have 10 to 15 or more observations for accurate and meaningful results and estimates.</p> <p>Data appear Normal at 5% Significance Level</p> <p>Data appear Lognormal at 5% Significance Level</p> <p>Data not Gamma Distributed at 5% Significance Level</p>	95% KM (Percentile Bootstrap) UCL
Carbon disulfide	<p>Warning: There are only 4 Distinct Detected Values in this data set</p> <p>Note: It should be noted that even though bootstrap may be performed on this data set the resulting calculations may not be reliable enough to draw conclusions</p> <p>It is recommended to have 10-15 or more distinct observations for accurate and meaningful results.</p> <p>Data appear Normal at 5% Significance Level</p> <p>Data appear Lognormal at 5% Significance Level</p>	95% KM (Percentile Bootstrap) UCL

Table B-2. Summary of ProUCL Comments and UCL Calculation Methods

Detected Analyte/COPC	ProUCL Comment	UCL Calculation Method
	Data appear Gamma Distributed at 5% Significance Level	
Carbon tetrachloride	<p>Warning: There are only 3 Distinct Detected Values in this data set</p> <p>The number of detected data may not be adequate enough to perform GOF tests, bootstrap, and ROS methods.</p> <p>Those methods will return a 'N/A' value on your output display!</p> <p>It is necessary to have 4 or more Distinct Values for bootstrap methods.</p> <p>However, results obtained using 4 to 9 distinct values may not be reliable.</p> <p>It is recommended to have 10 to 15 or more observations for accurate and meaningful results and estimates.</p> <p>Data appear Normal at 5% Significance Level</p> <p>Data appear Lognormal at 5% Significance Level</p> <p>Data not Gamma Distributed at 5% Significance Level</p>	95% KM (Percentile Bootstrap) UCL
Chloride	<p>Data not Normal at 5% Significance Level</p> <p>Data not Lognormal at 5% Significance Level</p> <p>Data not Gamma Distributed at 5% Significance Level</p> <p>Data do not follow a Discernable Distribution (0.05)</p>	Use 95% Student's-t UCL
Chloroform	<p>Data appear Normal at 5% Significance Level</p> <p>Data appear Lognormal at 5% Significance Level</p> <p>Data appear Gamma Distributed at 5% Significance Level</p>	95% KM (Percentile Bootstrap) UCL
Chromium	<p>Data not Normal at 5% Significance Level</p> <p>Data appear Lognormal at 5% Significance Level</p> <p>Data follow Appr. Gamma Distribution at 5% Significance Level</p>	95% KM (BCA) UCL
cis-1,2-Dichloroethylene	<p>Data not Normal at 5% Significance Level</p> <p>Data not Lognormal at 5% Significance Level</p> <p>Data not Gamma Distributed at 5% Significance Level</p> <p>Data do not follow a Discernable Distribution (0.05)</p>	95% KM (% Bootstrap) UCL
Cobalt	<p>Warning: There are only 3 Distinct Detected Values in this data set</p> <p>The number of detected data may not be adequate enough to perform GOF tests, bootstrap, and ROS methods.</p> <p>Those methods will return a 'N/A' value on your output display!</p> <p>It is necessary to have 4 or more Distinct Values for bootstrap methods.</p> <p>However, results obtained using 4 to 9 distinct values may not be reliable.</p> <p>It is recommended to have 10 to 15 or more observations for accurate and meaningful results and estimates.</p> <p>Data appear Normal at 5% Significance Level</p>	95% KM (t) UCL

Table B-2. Summary of ProUCL Comments and UCL Calculation Methods

Detected Analyte/COPC	ProUCL Comment	UCL Calculation Method
	Data appear Lognormal at 5% Significance Level Data not Gamma Distributed at 5% Significance Level	
Copper	Data not Normal at 5% Significance Level Data not Lognormal at 5% Significance Level Data not Gamma Distributed at 5% Significance Level	95% KM (Chebyshev) UCL
Cyanide	Warning: Only one distinct data value was detected! ProUCL (or any other software) should not be used on such a data set! It is suggested to use alternative site specific values determined by the Project Team to estimate environmental parameters (e.g., EPC, BTV). The data set for variable Cyanide was not processed!	Not Processed
Fluoride	Data appear Normal at 5% Significance Level Data appear Lognormal at 5% Significance Level Data appear Gamma Distributed at 5% Significance Level	95% KM (Percentile Bootstrap) UCL
Gross alpha	Data not Normal at 5% Significance Level Data appear Lognormal at 5% Significance Level Data appear Gamma Distributed at 5% Significance Level	Use 95% Approximate Gamma UCL
Gross beta	Data appear Normal at 5% Significance Level Data appear Lognormal at 5% Significance Level Data appear Gamma Distributed at 5% Significance Level	Use 95% Student's-t UCL
Iron	Data not Normal at 5% Significance Level Data not Lognormal at 5% Significance Level Data not Gamma Distributed at 5% Significance Level Data do not follow a Discernable Distribution (0.05)	95% KM (% Bootstrap) UCL
Lead	Warning: There are only 3 Distinct Detected Values in this data set The number of detected data may not be adequate enough to perform GOF tests, bootstrap, and ROS methods. Those methods will return a 'N/A' value on your output display! It is necessary to have 4 or more Distinct Values for bootstrap methods. However, results obtained using 4 to 9 distinct values may not be reliable. It is recommended to have 10 to 15 or more observations for accurate and meaningful results and estimates. Data appear Normal at 5% Significance Level Data appear Lognormal at 5% Significance Level Data not Gamma Distributed at 5% Significance Level	95% KM (Percentile Bootstrap) UCL

Table B-2. Summary of ProUCL Comments and UCL Calculation Methods

Detected Analyte/COPC	ProUCL Comment	UCL Calculation Method
Lithium	Data not Normal at 5% Significance Level Data not Lognormal at 5% Significance Level Data not Gamma Distributed at 5% Significance Level Data do not follow a Discernable Distribution (0.05)	95% KM (BCA) UCL
Manganese	Warning: There are only 3 Distinct Detected Values in this data set The number of detected data may not be adequate enough to perform GOF tests, bootstrap, and ROS methods. Those methods will return a 'N/A' value on your output display! It is necessary to have 4 or more Distinct Values for bootstrap methods. However, results obtained using 4 to 9 distinct values may not be reliable. It is recommended to have 10 to 15 or more observations for accurate and meaningful results and estimates. Data appear Normal at 5% Significance Level Data appear Lognormal at 5% Significance Level Data not Gamma Distributed at 5% Significance Level	95% KM (Percentile Bootstrap) UCL
Molybdenum	Data appear Normal at 5% Significance Level Data not Lognormal at 5% Significance Level Data appear Gamma Distributed at 5% Significance Level	Use 95% Student's-t UCL
Nickel	Data not Normal at 5% Significance Level Data appear Lognormal at 5% Significance Level Data appear Gamma Distributed at 5% Significance Level	95% KM (t) UCL
Nitrate	Data not Normal at 5% Significance Level Data not Lognormal at 5% Significance Level Data not Gamma Distributed at 5% Significance Level Data do not follow a Discernable Distribution (0.05)	95% Modified-t UCL
Selenium	Data appear Normal at 5% Significance Level Data not Lognormal at 5% Significance Level Data appear Gamma Distributed at 5% Significance Level	Use 95% Student's-t UCL
Silver	Warning: Data set has only 2 Distinct Detected Values. This may not be adequate enough to compute meaningful and reliable test statistics and estimates. The Project Team may decide to use alternative site specific values to estimate environmental parameters (e.g., EPC, BTV). Unless Data Quality Objectives (DQOs) have been met, it is suggested to collect additional observations. The number of detected data may not be adequate enough to	95% KM (BCA) UCL

Table B-2. Summary of ProUCL Comments and UCL Calculation Methods

Detected Analyte/COPC	ProUCL Comment	UCL Calculation Method
	<p>perform GOF tests, bootstrap, and ROS methods.</p> <p>Those methods will return a 'N/A' value on your output display!</p> <p>It is necessary to have 4 or more Distinct Values for bootstrap methods.</p> <p>However, results obtained using 4 to 9 distinct values may not be reliable.</p> <p>It is recommended to have 10 to 15 or more observations for accurate and meaningful results and estimates.</p> <p>Data not Normal at 5% Significance Level</p> <p>Data not Lognormal at 5% Significance Level</p> <p>Data not Gamma Distributed at 5% Significance Level</p> <p>Data do not follow a Discernable Distribution (0.05)</p>	
Strontium	<p>Data not Normal at 5% Significance Level</p> <p>Data not Lognormal at 5% Significance Level</p> <p>Data not Gamma Distributed at 5% Significance Level</p> <p>Data do not follow a Discernable Distribution (0.05)</p>	Use 95% Chebyshev (Mean, Sd) UCL
Sulfate	<p>Data not Normal at 5% Significance Level</p> <p>Data not Lognormal at 5% Significance Level</p> <p>Data follow Appr. Gamma Distribution at 5% Significance Level</p>	Use 95% Approximate Gamma UCL
Tetrachloroethene	<p>Warning: There are only 3 Distinct Detected Values in this data set</p> <p>The number of detected data may not be adequate enough to perform GOF tests, bootstrap, and ROS methods.</p> <p>Those methods will return a 'N/A' value on your output display!</p> <p>It is necessary to have 4 or more Distinct Values for bootstrap methods.</p> <p>However, results obtained using 4 to 9 distinct values may not be reliable.</p> <p>It is recommended to have 10 to 15 or more observations for accurate and meaningful results and estimates.</p> <p>Data appear Normal at 5% Significance Level</p> <p>Data appear Lognormal at 5% Significance Level</p> <p>Data not Gamma Distributed at 5% Significance Level</p>	95% KM (Percentile Bootstrap) UCL
Thallium	<p>Warning: Only one distinct data value was detected! ProUCL (or any other software) should not be used on such a data set!</p> <p>It is suggested to use alternative site specific values determined by the Project Team to estimate environmental parameters (e.g., EPC, BTV).</p> <p>The data set for variable Thallium was not processed!</p>	Not Processed
Tin	<p>Warning: There are only 3 Distinct Detected Values in this data set</p> <p>The number of detected data may not be adequate enough to</p>	95% KM (t) UCL

Table B-2. Summary of ProUCL Comments and UCL Calculation Methods

Detected Analyte/COPC	ProUCL Comment	UCL Calculation Method
	perform GOF tests, bootstrap, and ROS methods. Those methods will return a 'N/A' value on your output display! It is necessary to have 4 or more Distinct Values for bootstrap methods. However, results obtained using 4 to 9 distinct values may not be reliable. It is recommended to have 10 to 15 or more observations for accurate and meaningful results and estimates. Data not Normal at 5% Significance Level Data not Lognormal at 5% Significance Level Data not Gamma Distributed at 5% Significance Level Data do not follow a Discernable Distribution (0.05)	
Trichloroethene	Data appear Normal at 5% Significance Level Data appear Lognormal at 5% Significance Level Data appear Gamma Distributed at 5% Significance Level	95% KM (t) UCL
Tritium	Data appear Normal at 5% Significance Level Data not Lognormal at 5% Significance Level Data follow Appr. Gamma Distribution at 5% Significance Level	95% KM (Percentile Bootstrap) UCL
Uranium	Data not Normal at 5% Significance Level Data appear Lognormal at 5% Significance Level Data appear Gamma Distributed at 5% Significance Level	Use 95% Approximate Gamma UCL
Vanadium	Data appear Normal at 5% Significance Level Data appear Lognormal at 5% Significance Level Data appear Gamma Distributed at 5% Significance Level	95% KM (Percentile Bootstrap) UCL
Zinc	Data not Normal at 5% Significance Level Data not Lognormal at 5% Significance Level Data not Gamma Distributed at 5% Significance Level Data do not follow a Discernable Distribution (0.05)	95% KM (Chebyshev) UCL

Notes:

KM (BCA) UCL: UCL based upon Kaplan-Meier Estimates using the Bias Corrected Accelerated Percentile Bootstrap Method

KM (t) UCL: UCL based upon Kaplan-Meier Estimates using Student's t-Distribution Critical Value

KM (% Bootstrap) UCL: UCL based upon Kaplan-Meier Estimates using the Percentile Bootstrap Method.

KM (Chebyshev) UCL: UCL based upon Kaplan-Meier Estimates using the Chebyshev Inequality

The 300 Area subregion groundwater data set is highly skewed or left-censored (i.e., they contain a significant number of results reported below detection limits). Determination of the distribution of left-censored data sets, especially when a large percentage (> 40% -50%) of observations are censored, because they are nondetected, is very difficult (EPA/600/R-07/038). The 300 Area subregion data set

generally does not fit either normal or lognormal distributions as demonstrated by the comments generated in the ProUCL output.

Skewed or highly censored data sets present problems in calculating the UCL as well. Reviewing the ProUCL output, the majority (69%) of the recommended calculation methods utilize Kaplan–Meier estimates. Estimation methods such as the Kaplan–Meier estimates yield reasonably good 95UCLs (providing adequate coverage for the population mean) for symmetric or mildly skewed distributions but may not perform well on a data set obtained from moderately or highly skewed distributions such as the 300 Area subregion data set (EPA/600/R-06/022, *On the Computation of 95% Upper Confidence Limit of the Unknown Population Mean Based Upon Data Sets with Below Detection Limit Observations*).

In evaluating the reliability of the 95UCL values generated by the ProUCL software, the following subsections summarize the characteristics of the 300 Area subregion data set with respect to 1) left-censoring or skewness, 2) adequate number of detected results, and 3) variance of the data.

B.3 Number of Less than Detectable Results Reported for the 300 Area Subregion Data Set

As previously mentioned, the 300 Area subregion data set contained results reported at less than the detection limits and is considered left-censored. A summary of the number of less than detectable results reported for the 300 Area subregion data set is provided in Table B-3.

B.4 Number of Detectable Results for the 300 Area Subregion Data Set

Several detected analytes/COPCs had insufficient detectable results to enable the ProUCL software to calculate reliable and meaningful results. A summary of the number of detectable results for the 300 Area subregion data set is provided in Table B-3.

B.5 Coefficient of Variation for the 300 Area Subregion Data Set

A large sample variance indicates that the data are not clustered close to the mean. A small sample variance (relative to the mean) indicates that most of the data are near the mean. The sample variance is affected by extreme values and by a large number of non-detects. Guidelines in EPA/240/B-06/003, *Data Quality Assessment: Statistical Methods for Practitioners* provide recommendations regarding statistical parameters to use for different values of CV, when censoring is present in data sets. Coefficients of variation greater than 0.5 is the threshold value used in EPA/240/B-06/003 for using an upper percentile value, instead of a mean-based value, for a statistical parameter. The CVs for the 300 Area subregion data set are provided in Table B-3.

Table B-3. Data Set Summary by Detected Analyte/COPC for 300 Area Subregion Data Set

Detected Analyte/COPC	Number of Detects	Number of Nondetects	Frequency of Nondetects	Sufficient Percentage of Detects ^a	Coefficient of Variation	Coefficient of Variation >0.5 ^b
1,2-Dichloroethene (Total)	10	35	78%	No	0.66	Yes
Acetone ^c	8	37	82%	No	2.2	Yes
Acrolein ^c	1	44	98%	No	N/A	--
Aluminum ^c	4	41	91%	No	1.3	Yes

Table B-3. Data Set Summary by Detected Analyte/COPC for 300 Area Subregion Data Set

Detected Analyte/COPC	Number of Detects	Number of Nondetects	Frequency of Nondetects	Sufficient Percentage of Detects ^a	Coefficient of Variation	Coefficient of Variation >0.5 ^b
Arsenic	43	2	4%	Yes	0.30	No
Barium	45	0	0%	Yes	0.17	No
Boron	12	33	73%	No	0.65	Yes
Bromodichloromethane ^c	3	42	93%	No	0.0085	No
Bromomethane ^c	3	42	93%	No	0.28	No
Carbon disulfide ^c	4	41	91%	No	0.16	No
Carbon tetrachloride ^c	3	42	93%	No	0.73	Yes
Chloride	45	0	0%	Yes	0.22	No
Chloroform	12	33	73%	No	0.57	Yes
Chromium	44	1	2%	Yes	0.57	Yes
cis-1,2-Dichloroethylene	11	34	76%	No	0.69	Yes
Cobalt ^c	3	42	93%	No	0.087	No
Copper	23	22	49%	Yes	2.9	Yes
Cyanide ^c	1	44	98%	No	N/A	--
Fluoride	43	2	4%	Yes	0.27	No
Gross alpha	28	0	0%	Yes	0.90	Yes
Gross beta	28	0	0%	Yes	0.53	Yes
Iron	19	26	58%	No	1.4	Yes
Lead ^c	3	42	93%	No	1.2	Yes
Lithium	33	12	27%	Yes	0.68	Yes
Manganese ^c	3	42	93%	No	0.39	No
Molybdenum	45	0	0%	Yes	0.13	No
Nickel	11	34	76%	No	0.41	No
Nitrate	45	0	0%	Yes	0.29	No

Table B-3. Data Set Summary by Detected Analyte/COPC for 300 Area Subregion Data Set

Detected Analyte/COPC	Number of Detects	Number of Nondetects	Frequency of Nondetects	Sufficient Percentage of Detects ^a	Coefficient of Variation	Coefficient of Variation >0.5 ^b
Selenium	45	0	0%	Yes	0.41	No
Silver ^c	2	43	96%	No	1.1	Yes
Strontium	45	0	0%	Yes	0.20	No
Sulfate	45	0	0%	Yes	0.17	No
Tetrachloroethene ^c	3	42	93%	No	0.33	No
Thallium ^c	1	44	98%	No	N/A	--
Tin ^c	3	42	93%	No	0.43	No
Trichloroethene	35	10	22%	Yes	0.54	Yes
Tritium	39	6	13%	Yes	0.64	Yes
Uranium	45	0	0%	Yes	0.70	Yes
Vanadium	10	35	78%	No	0.33	No
Zinc	12	33	73%	No	1.6	Yes

Notes:

- Sufficient percentage of detections is considered to be 50% or greater.
- Coefficient of Variation = Standard Deviation / Mean. Data is considered variable if greater than 0.5.
- Number of detected results is insufficient for ProUCL to calculate meaningful and reliable results.

COPC = contaminant of potential concern.

Shading indicates those COPCs that have a sufficient number of results, a sufficient number of detects, and a coefficient of variation less than 0.5.

B.6 Statistical Summary Results Reported for the 300 Area Subregion Data Set

Table B-3 summarizes the detected analytes/COPCs with respect to sufficient number of detectable results, the percentage of detected results (left-censored indicator), and the CV. Those detected analytes/COPCs that had a sufficient number of results above detection limits and a coefficient of variation less than 0.5 are shaded, for clarity. The detected analytes/COPCs that have data sets that could provide generally reliable 95UCL values are arsenic, barium, chloride, fluoride, molybdenum, nitrate, selenium, strontium, and sulfate. The percentage values associated with this information are provided in Table B-4.

Table B-4. General Summary of the Data Set for the 300 Area Subregion

Exposure Area	Number of Detected Results Sufficient			% Detected Sufficient			Coefficient of Variation>0.5		
	No	Yes	%No	No	Yes	%No	No	Yes	%Yes
300 Area Subregion	15	25	38%	23	17	58%	18	19	51%

B.7 ProUCL Output

ProUCL output generated for the 300 Area subregion data set is provided in Table B-5. This table is provided as an electronic attachment (formatted for on-screen viewing) in the Excel workbook “ECF-300FF5-11-0130 300 Area Subregion EPC Calculation Worksheet.xlsx” that accompanies this environmental calculation.

Table A-1. 300 Area Subregion Analytical Data Used for 90th Percentile Calculation

1,2-Dichloroethene (Total)

D_1,2-Dichloroethene (Total)

detects	10
nondetects	35
n (number of values)	45
p (percentile)	90
k (position in sequence)	41.4
mean 90th percentile	0.22

Rank	$\mu\text{g/L}$	Det. = 1 Nondet. = 0	Rank	$\mu\text{g/L}$	Det. = 1 Nondet. = 0	
	1	0.15	0	32	0.15	0
	2	0.15	0	33	0.15	0
	3	0.15	0	34	0.15	0
	4	0.15	0	35	0.15	0
	5	0.15	0	36	0.18	1
	6	0.15	0	37	0.19	1
	7	0.15	0	38	0.19	1
	8	0.15	0	39	0.2	1
	9	0.15	0	40	0.2	1
	10	0.15	0	41	0.21	1
	11	0.15	0	42	0.23	1
	12	0.15	0	43	0.23	1
	13	0.15	0	44	0.64	1
	14	0.15	0	45	0.69	1
	15	0.15	0			
	16	0.15	0			
	17	0.15	0			
	18	0.15	0			
	19	0.15	0			
	20	0.15	0			
	21	0.15	0			
	22	0.15	0			
	23	0.15	0			
	24	0.15	0			
	25	0.15	0			
	26	0.15	0			
	27	0.15	0			
	28	0.15	0			
	29	0.15	0			
	30	0.15	0			
	31	0.15	0			

Acetone

D_Acetone

Table A-1. 300 Area Subregion Analytical Data Used for 90th Percentile Calculation

detects	8
nondetects	37
n (number of values)	45
p (percentile)	90
k (position in sequence)	41.4
mean 90th percentile	1.045

Rank	$\mu\text{g/L}$	Det. = 1 Nondet. = 0	Rank	$\mu\text{g/L}$	Det. = 1 Nondet. = 0
1	0.34	0	32	0.34	0
2	0.34	0	33	0.34	0
3	0.34	0	34	0.34	0
4	0.34	0	35	0.34	0
5	0.34	0	36	0.34	0
6	0.34	0	37	0.34	0
7	0.34	0	38	0.71	1
8	0.34	0	39	0.75	1
9	0.34	0	40	0.82	1
10	0.34	0	41	0.99	1
11	0.34	0	42	1.1	1
12	0.34	0	43	1.2	1
13	0.34	0	44	1.6	1
14	0.34	0	45	31	1
15	0.34	0			
16	0.34	0			
17	0.34	0			
18	0.34	0			
19	0.34	0			
20	0.34	0			
21	0.34	0			
22	0.34	0			
23	0.34	0			
24	0.34	0			
25	0.34	0			
26	0.34	0			
27	0.34	0			
28	0.34	0			
29	0.34	0			
30	0.34	0			
31	0.34	0			

Table A-1. 300 Area Subregion Analytical Data Used for 90th Percentile Calculation

Acrolein

D_Acrolein

detects	1
nondetects	44
n (number of values)	45
p (percentile)	90
k (position in sequence)	41.4
mean 90th percentile	2.8

Rank	$\mu\text{g/L}$	Det. = 1 Nondet. = 0	Rank	$\mu\text{g/L}$	Det. = 1 Nondet. = 0
1	2.8	0	32	2.8	0
2	2.8	0	33	2.8	0
3	2.8	0	34	2.8	0
4	2.8	0	35	2.8	0
5	2.8	0	36	2.8	0
6	2.8	0	37	2.8	0
7	2.8	0	38	2.8	0
8	2.8	0	39	2.8	0
9	2.8	0	40	2.8	0
10	2.8	0	41	2.8	0
11	2.8	0	42	2.8	0
12	2.8	0	43	2.8	0
13	2.8	0	44	2.8	0
14	2.8	0	45	3.8	1
15	2.8	0			
16	2.8	0			
17	2.8	0			
18	2.8	0			
19	2.8	0			
20	2.8	0			
21	2.8	0			
22	2.8	0			
23	2.8	0			
24	2.8	0			
25	2.8	0			
26	2.8	0			
27	2.8	0			
28	2.8	0			
29	2.8	0			
30	2.8	0			
31	2.8	0			

Table A-1. 300 Area Subregion Analytical Data Used for 90th Percentile Calculation

Aluminum

D_Aluminum

detects	4
nondetects	41
n (number of values)	45
p (percentile)	90
k (position in sequence)	41.4
mean 90th percentile	10

Rank	µg/L	Det. = 1 Nondet. = 0	Rank	µg/L	Det. = 1 Nondet. = 0
1	5	0	32	10	0
2	5	0	33	10	0
3	5	0	34	10	0
4	5	0	35	10	0
5	8.3	0	36	10	0
6	9.34	1	37	10	0
7	10	0	38	10	0
8	10	0	39	10	0
9	10	0	40	10	0
10	10	0	41	10	0
11	10	0	42	10	0
12	10	0	43	11.1	1
13	10	0	44	15.6	1
14	10	0	45	99.5	1
15	10	0			
16	10	0			
17	10	0			
18	10	0			
19	10	0			
20	10	0			
21	10	0			
22	10	0			
23	10	0			
24	10	0			
25	10	0			
26	10	0			
27	10	0			
28	10	0			
29	10	0			
30	10	0			
31	10	0			

Table A-1. 300 Area Subregion Analytical Data Used for 90th Percentile Calculation

Arsenic

D_Arsenic

detects	43
nondetects	2
n (number of values)	45
p (percentile)	90
k (position in sequence)	41.4
mean 90th percentile	5.215

Rank	$\mu\text{g/L}$	Det. = 1 Nondet. = 0	Rank	$\mu\text{g/L}$	Det. = 1 Nondet. = 0
1	0.8	0	32	4.4	1
2	0.8	0	33	4.4	1
3	0.932	1	34	4.42	1
4	2.09	1	35	4.46	1
5	2.34	1	36	4.51	1
6	2.4	1	37	4.54	1
7	2.43	1	38	4.56	1
8	2.51	1	39	4.71	1
9	2.69	1	40	5	1
10	2.75	1	41	5.15	1
11	2.81	1	42	5.28	1
12	2.97	1	43	5.82	1
13	2.98	1	44	6.39	1
14	3.04	1	45	6.45	1
15	3.12	1			
16	3.13	1			
17	3.28	1			
18	3.32	1			
19	3.45	1			
20	3.45	1			
21	3.46	1			
22	3.49	1			
23	3.69	1			
24	3.69	1			
25	3.76	1			
26	3.79	1			
27	3.93	1			
28	4	1			
29	4.3	1			
30	4.31	1			
31	4.32	1			

Table A-1. 300 Area Subregion Analytical Data Used for 90th Percentile Calculation

Barium	D_Barium
detects	45
nondetects	0
n (number of values)	45
p (percentile)	90
k (position in sequence)	41.4
mean 90th percentile	71.45

Rank	$\mu\text{g/L}$	Det. = 1 Nondet. = 0	Rank	$\mu\text{g/L}$	Det. = 1 Nondet. = 0
1	37.4	1	32	59.4	1
2	42.2	1	33	60.2	1
3	45.2	1	34	61.2	1
4	46	1	35	62.1	1
5	46.2	1	36	63.9	1
6	46.3	1	37	64.4	1
7	47.8	1	38	66.1	1
8	47.9	1	39	69.1	1
9	49.5	1	40	69.1	1
10	49.6	1	41	71.1	1
11	50.4	1	42	71.8	1
12	50.5	1	43	71.9	1
13	50.7	1	44	76.5	1
14	51.2	1	45	82.7	1
15	51.2	1			
16	51.6	1			
17	52.6	1			
18	52.9	1			
19	53.9	1			
20	54.2	1			
21	54.9	1			
22	56	1			
23	56.1	1			
24	56.3	1			
25	56.4	1			
26	56.5	1			
27	57.6	1			
28	57.7	1			
29	57.9	1			
30	58.7	1			
31	59.2	1			

Table A-1. 300 Area Subregion Analytical Data Used for 90th Percentile Calculation

Boron

D_Boron

detects	12
nondetects	33
n (number of values)	45
p (percentile)	90
k (position in sequence)	41.4
mean 90th percentile	44.5

Rank	$\mu\text{g/L}$	Det. = 1 Nondet. = 0	Rank	$\mu\text{g/L}$	Det. = 1 Nondet. = 0
1	19	0	32	41	0
2	19	0	33	41	0
3	19	0	34	41	0
4	19	1	35	41	0
5	19	0	36	41	1
6	19	0	37	41	0
7	19	0	38	41	0
8	19	0	39	41	0
9	19	0	40	41	0
10	19	0	41	41	0
11	19	0	42	48	1
12	21	1	43	49	1
13	24	1	44	55	1
14	28	1	45	118	1
15	30	1			
16	30.3	1			
17	33	1			
18	41	0			
19	41	0			
20	41	0			
21	41	0			
22	41	0			
23	41	0			
24	41	0			
25	41	0			
26	41	0			
27	41	0			
28	41	0			
29	41	0			
30	41	0			
31	41	0			

Table A-1. 300 Area Subregion Analytical Data Used for 90th Percentile Calculation

Bromodichloromethane

D_Bromodichloromethane

detects	3
nondetects	42
n (number of values)	45
p (percentile)	90
k (position in sequence)	41.4
mean 90th percentile	0.088

Rank	$\mu\text{g/L}$	Det. = 1 Nondet. = 0	Rank	$\mu\text{g/L}$	Det. = 1 Nondet. = 0
1	0.088	0	32	0.088	0
2	0.088	0	33	0.088	0
3	0.088	0	34	0.088	0
4	0.088	0	35	0.088	0
5	0.088	0	36	0.088	0
6	0.088	0	37	0.088	0
7	0.088	0	38	0.088	0
8	0.088	0	39	0.088	0
9	0.088	0	40	0.088	0
10	0.088	0	41	0.088	0
11	0.088	0	42	0.088	0
12	0.088	0	43	0.68	1
13	0.088	0	44	0.68	1
14	0.088	0	45	0.69	1
15	0.088	0			
16	0.088	0			
17	0.088	0			
18	0.088	0			
19	0.088	0			
20	0.088	0			
21	0.088	0			
22	0.088	0			
23	0.088	0			
24	0.088	0			
25	0.088	0			
26	0.088	0			
27	0.088	0			
28	0.088	0			
29	0.088	0			
30	0.088	0			
31	0.088	0			

Table A-1. 300 Area Subregion Analytical Data Used for 90th Percentile Calculation

Bromomethane

D_Bromomethane

detects	3
nondetects	42
n (number of values)	45
p (percentile)	90
k (position in sequence)	41.4
mean 90th percentile	0.25

Rank	$\mu\text{g/L}$	Det. = 1 Nondet. = 0	Rank	$\mu\text{g/L}$	Det. = 1 Nondet. = 0
1	0.13	0	32	0.25	0
2	0.13	0	33	0.25	0
3	0.13	0	34	0.25	0
4	0.13	0	35	0.25	0
5	0.13	0	36	0.25	0
6	0.13	0	37	0.25	0
7	0.13	0	38	0.25	0
8	0.13	0	39	0.25	0
9	0.13	0	40	0.25	0
10	0.13	0	41	0.25	0
11	0.13	0	42	0.25	0
12	0.13	0	43	0.44	1
13	0.13	0	44	0.56	1
14	0.13	0	45	0.77	1
15	0.13	0			
16	0.25	0			
17	0.25	0			
18	0.25	0			
19	0.25	0			
20	0.25	0			
21	0.25	0			
22	0.25	0			
23	0.25	0			
24	0.25	0			
25	0.25	0			
26	0.25	0			
27	0.25	0			
28	0.25	0			
29	0.25	0			
30	0.25	0			
31	0.25	0			

Table A-1. 300 Area Subregion Analytical Data Used for 90th Percentile Calculation

Carbon disulfide

D_Carbon disulfide

detects	4
nondetects	41
n (number of values)	45
p (percentile)	90
k (position in sequence)	41.4
mean 90th percentile	0.0535

Rank	$\mu\text{g/L}$	Det. = 1 Nondet. = 0	Rank	$\mu\text{g/L}$	Det. = 1 Nondet. = 0
1	0.051	0	32	0.051	0
2	0.051	0	33	0.051	0
3	0.051	0	34	0.051	0
4	0.051	0	35	0.051	0
5	0.051	0	36	0.051	0
6	0.051	0	37	0.051	0
7	0.051	0	38	0.051	0
8	0.051	0	39	0.051	0
9	0.051	0	40	0.051	0
10	0.051	0	41	0.051	0
11	0.051	0	42	0.056	1
12	0.051	0	43	0.057	1
13	0.051	0	44	0.073	1
14	0.051	0	45	0.075	1
15	0.051	0			
16	0.051	0			
17	0.051	0			
18	0.051	0			
19	0.051	0			
20	0.051	0			
21	0.051	0			
22	0.051	0			
23	0.051	0			
24	0.051	0			
25	0.051	0			
26	0.051	0			
27	0.051	0			
28	0.051	0			
29	0.051	0			
30	0.051	0			
31	0.051	0			

Table A-1. 300 Area Subregion Analytical Data Used for 90th Percentile Calculation

Carbon tetrachloride

D_Carbon tetrachloride

detects	3
nondetects	42
n (number of values)	45
p (percentile)	90
k (position in sequence)	41.4
mean 90th percentile	0.12

Rank	$\mu\text{g/L}$	Det. = 1 Nondet. = 0	Rank	$\mu\text{g/L}$	Det. = 1 Nondet. = 0
1	0.12	0	32	0.12	0
2	0.12	0	33	0.12	0
3	0.12	0	34	0.12	0
4	0.12	0	35	0.12	0
5	0.12	0	36	0.12	0
6	0.12	0	37	0.12	0
7	0.12	0	38	0.12	0
8	0.12	0	39	0.12	0
9	0.12	0	40	0.12	0
10	0.12	0	41	0.12	0
11	0.12	0	42	0.12	0
12	0.12	0	43	0.13	1
13	0.12	0	44	0.26	1
14	0.12	0	45	0.59	1
15	0.12	0			
16	0.12	0			
17	0.12	0			
18	0.12	0			
19	0.12	0			
20	0.12	0			
21	0.12	0			
22	0.12	0			
23	0.12	0			
24	0.12	0			
25	0.12	0			
26	0.12	0			
27	0.12	0			
28	0.12	0			
29	0.12	0			
30	0.12	0			
31	0.12	0			

Table A-1. 300 Area Subregion Analytical Data Used for 90th Percentile Calculation

Chloride

D_Chloride

detects	45
nondetects	0
n (number of values)	45
p (percentile)	90
k (position in sequence)	41.4
mean 90th percentile	25950

Rank	$\mu\text{g/L}$	Det. = 1 Nondet. = 0	Rank	$\mu\text{g/L}$	Det. = 1 Nondet. = 0
1	6890	1	32	22300	1
2	7540	1	33	22500	1
3	10300	1	34	22500	1
4	11700	1	35	22600	1
5	15800	1	36	23100	1
6	16500	1	37	23600	1
7	17500	1	38	23900	1
8	17900	1	39	24100	1
9	18200	1	40	25400	1
10	18700	1	41	25600	1
11	18700	1	42	26300	1
12	18800	1	43	27000	1
13	18800	1	44	27100	1
14	19200	1	45	29000	1
15	19500	1			
16	19600	1			
17	19900	1			
18	20200	1			
19	20300	1			
20	20400	1			
21	20500	1			
22	20700	1			
23	21100	1			
24	21500	1			
25	21600	1			
26	21700	1			
27	21700	1			
28	21900	1			
29	22000	1			
30	22000	1			
31	22100	1			

Table A-1. 300 Area Subregion Analytical Data Used for 90th Percentile Calculation

Chloroform

D_Chloroform

detects	12
nondetects	33
n (number of values)	45
p (percentile)	90
k (position in sequence)	41.4
mean 90th percentile	0.47

Rank	$\mu\text{g/L}$	Det. = 1 Nondet. = 0	Rank	$\mu\text{g/L}$	Det. = 1 Nondet. = 0
1	0.1	0	32	0.1	0
2	0.1	0	33	0.1	0
3	0.1	0	34	0.13	1
4	0.1	0	35	0.14	1
5	0.1	0	36	0.14	1
6	0.1	0	37	0.25	1
7	0.1	0	38	0.32	1
8	0.1	0	39	0.36	1
9	0.1	0	40	0.41	1
10	0.1	0	41	0.45	1
11	0.1	0	42	0.49	1
12	0.1	0	43	0.6	1
13	0.1	0	44	0.63	1
14	0.1	0	45	0.87	1
15	0.1	0			
16	0.1	0			
17	0.1	0			
18	0.1	0			
19	0.1	0			
20	0.1	0			
21	0.1	0			
22	0.1	0			
23	0.1	0			
24	0.1	0			
25	0.1	0			
26	0.1	0			
27	0.1	0			
28	0.1	0			
29	0.1	0			
30	0.1	0			
31	0.1	0			

Table A-1. 300 Area Subregion Analytical Data Used for 90th Percentile Calculation

Chromium

D_Chromium

detects	44
nondetects	1
n (number of values)	45
p (percentile)	90
k (position in sequence)	41.4
mean 90th percentile	7.125

Rank	$\mu\text{g/L}$	Det. = 1 Nondet. = 0	Rank	$\mu\text{g/L}$	Det. = 1 Nondet. = 0
1	1	0	32	4.84	1
2	1.37	1	33	4.91	1
3	1.8	1	34	4.97	1
4	2.13	1	35	5.02	1
5	2.47	1	36	5.45	1
6	2.52	1	37	5.51	1
7	2.58	1	38	5.66	1
8	2.58	1	39	5.8	1
9	2.6	1	40	5.88	1
10	2.71	1	41	6.65	1
11	2.77	1	42	7.6	1
12	2.98	1	43	8.13	1
13	3.05	1	44	8.99	1
14	3.1	1	45	16.5	1
15	3.14	1			
16	3.22	1			
17	3.26	1			
18	3.26	1			
19	3.3	1			
20	3.32	1			
21	3.39	1			
22	3.55	1			
23	3.71	1			
24	3.92	1			
25	4.08	1			
26	4.1	1			
27	4.19	1			
28	4.36	1			
29	4.36	1			
30	4.49	1			
31	4.6	1			

Table A-1. 300 Area Subregion Analytical Data Used for 90th Percentile Calculation

cis-1,2-Dichloroethylene

D_cis-1,2-Dichloroethylene

detects	11
nondetects	34
n (number of values)	45
p (percentile)	90
k (position in sequence)	41.4
mean 90th percentile	0.22

Rank	$\mu\text{g/L}$	Det. = 1 Nondet. = 0	Rank	$\mu\text{g/L}$	Det. = 1 Nondet. = 0
1	0.087	0	32	0.087	0
2	0.087	0	33	0.087	0
3	0.087	0	34	0.087	0
4	0.087	0	35	0.12	1
5	0.087	0	36	0.18	1
6	0.087	0	37	0.19	1
7	0.087	0	38	0.19	1
8	0.087	0	39	0.2	1
9	0.087	0	40	0.2	1
10	0.087	0	41	0.21	1
11	0.087	0	42	0.23	1
12	0.087	0	43	0.23	1
13	0.087	0	44	0.64	1
14	0.087	0	45	0.69	1
15	0.087	0			
16	0.087	0			
17	0.087	0			
18	0.087	0			
19	0.087	0			
20	0.087	0			
21	0.087	0			
22	0.087	0			
23	0.087	0			
24	0.087	0			
25	0.087	0			
26	0.087	0			
27	0.087	0			
28	0.087	0			
29	0.087	0			
30	0.087	0			
31	0.087	0			

Table A-1. 300 Area Subregion Analytical Data Used for 90th Percentile Calculation

Cobalt	D_Cobalt
detects	3
nondetects	42
n (number of values)	45
p (percentile)	90
k (position in sequence)	41.4
mean 90th percentile	0.118

Rank	$\mu\text{g/L}$	Det. = 1 Nondet. = 0	Rank	$\mu\text{g/L}$	Det. = 1 Nondet. = 0
1	0.05	0	32	0.1	0
2	0.05	0	33	0.1	0
3	0.05	0	34	0.1	0
4	0.05	0	35	0.1	0
5	0.05	0	36	0.1	0
6	0.1	0	37	0.1	0
7	0.1	0	38	0.1	0
8	0.1	0	39	0.1	0
9	0.1	0	40	0.1	0
10	0.1	0	41	0.1	0
11	0.1	0	42	0.136	1
12	0.1	0	43	0.15	1
13	0.1	0	44	0.162	1
14	0.1	0	45	0.22	0
15	0.1	0			
16	0.1	0			
17	0.1	0			
18	0.1	0			
19	0.1	0			
20	0.1	0			
21	0.1	0			
22	0.1	0			
23	0.1	0			
24	0.1	0			
25	0.1	0			
26	0.1	0			
27	0.1	0			
28	0.1	0			
29	0.1	0			
30	0.1	0			
31	0.1	0			

Table A-1. 300 Area Subregion Analytical Data Used for 90th Percentile Calculation

Copper

D_Copper

detects	23
nondetects	22
n (number of values)	45
p (percentile)	90
k (position in sequence)	41.4
mean 90th percentile	1.355

Rank	µg/L	Det. = 1 Nondet. = 0	Rank	µg/L	Det. = 1 Nondet. = 0
1	0.1	0	32	0.384	1
2	0.1	0	33	0.411	1
3	0.2	0	34	0.425	1
4	0.2	0	35	0.45	0
5	0.2	0	36	0.53	1
6	0.2	0	37	0.571	1
7	0.2	0	38	0.578	1
8	0.2	0	39	0.626	1
9	0.2	0	40	1.06	1
10	0.2	0	41	1.08	1
11	0.2	0	42	1.63	1
12	0.2	0	43	1.96	1
13	0.2	0	44	8.89	1
14	0.2	0	45	30.7	1
15	0.2	0			
16	0.2	0			
17	0.2	0			
18	0.2	0			
19	0.2	0			
20	0.2	0			
21	0.2	0			
22	0.205	1			
23	0.22	1			
24	0.249	1			
25	0.262	1			
26	0.271	1			
27	0.293	1			
28	0.304	1			
29	0.319	1			
30	0.34	1			
31	0.362	1			

Table A-1. 300 Area Subregion Analytical Data Used for 90th Percentile Calculation

Cyanide

D_Cyanide

detects	1
nondetects	44
n (number of values)	45
p (percentile)	90
k (position in sequence)	41.4
mean 90th percentile	4

Rank	$\mu\text{g/L}$	Det. = 1 Nondet. = 0	Rank	$\mu\text{g/L}$	Det. = 1 Nondet. = 0
1	3.7	1	32	4	0
2	4	0	33	4	0
3	4	0	34	4	0
4	4	0	35	4	0
5	4	0	36	4	0
6	4	0	37	4	0
7	4	0	38	4	0
8	4	0	39	4	0
9	4	0	40	4	0
10	4	0	41	4	0
11	4	0	42	4	0
12	4	0	43	4	0
13	4	0	44	4	0
14	4	0	45	4	0
15	4	0			
16	4	0			
17	4	0			
18	4	0			
19	4	0			
20	4	0			
21	4	0			
22	4	0			
23	4	0			
24	4	0			
25	4	0			
26	4	0			
27	4	0			
28	4	0			
29	4	0			
30	4	0			
31	4	0			

Table A-1. 300 Area Subregion Analytical Data Used for 90th Percentile Calculation

Fluoride

D_Fluoride

detects	43
nondetects	2
n (number of values)	45
p (percentile)	90
k (position in sequence)	41.4
mean 90th percentile	280

Rank	$\mu\text{g/L}$	Det. = 1 Nondet. = 0	Rank	$\mu\text{g/L}$	Det. = 1 Nondet. = 0
1	60	0	32	242	1
2	60	0	33	242	1
3	85.7	1	34	242	1
4	116	1	35	257	1
5	116	1	36	259	1
6	138	1	37	262	1
7	150	1	38	267	1
8	154	1	39	274	1
9	155	1	40	275	1
10	157	1	41	277	1
11	164	1	42	283	1
12	165	1	43	298	1
13	167	1	44	304	1
14	175	1	45	340	1
15	178	1			
16	178	1			
17	181	1			
18	183	1			
19	188	1			
20	188	1			
21	190	1			
22	193	1			
23	198	1			
24	200	1			
25	201	1			
26	206	1			
27	209	1			
28	217	1			
29	228	1			
30	228	1			
31	233	1			

Table A-1. 300 Area Subregion Analytical Data Used for 90th Percentile Calculation

Gross alpha	D_Gross alpha
detects	28
nondetects	0
n (number of values)	28
p (percentile)	90
k (position in sequence)	26.1
mean 90th percentile	71

Rank	$\mu\text{g/L}$	Det. = 1 Nondet. = 0	Rank	$\mu\text{g/L}$	Det. = 1 Nondet. = 0
1	3.4	1	32	0	0
2	5.6	1	33	0	0
3	5.6	1	34	0	0
4	6	1	35	0	0
5	6.6	1	36	0	0
6	7	1	37	0	0
7	9.9	1	38	0	0
8	9.9	1	39	0	0
9	11	1	40	0	0
10	11	1	41	0	0
11	13	1	42	0	0
12	13	1	43	0	0
13	14	1	44	0	0
14	14	1	45	0	0
15	18	1			
16	18	1			
17	19	1			
18	20	1			
19	21	1			
20	24	1			
21	25	1			
22	31	1			
23	35	1			
24	41	1			
25	54	1			
26	68	1			
27	74	1			
28	77	1			
29	0	0			
30	0	0			
31	0	0			

Table A-1. 300 Area Subregion Analytical Data Used for 90th Percentile Calculation

Gross beta	D_Gross beta
detects	28
nondetects	0
n (number of values)	28
p (percentile)	90
k (position in sequence)	26.1
mean 90th percentile	41.5

Rank	$\mu\text{g/L}$	Det. = 1 Nondet. = 0	Rank	$\mu\text{g/L}$	Det. = 1 Nondet. = 0
1	2.7	1	32	0	0
2	5.7	1	33	0	0
3	8.6	1	34	0	0
4	8.9	1	35	0	0
5	9.2	1	36	0	0
6	11	1	37	0	0
7	14	1	38	0	0
8	15	1	39	0	0
9	16	1	40	0	0
10	16	1	41	0	0
11	16	1	42	0	0
12	17	1	43	0	0
13	20	1	44	0	0
14	20	1	45	0	0
15	20	1			
16	22	1			
17	22	1			
18	22	1			
19	24	1			
20	25	1			
21	25	1			
22	29	1			
23	30	1			
24	31	1			
25	39	1			
26	41	1			
27	42	1			
28	49	1			
29	0	0			
30	0	0			
31	0	0			

Table A-1. 300 Area Subregion Analytical Data Used for 90th Percentile Calculation

Iron	D_Iron
detects	19
nondetects	26
n (number of values)	45
p (percentile)	90
k (position in sequence)	41.4
mean 90th percentile	105.5

Rank	$\mu\text{g/L}$	Det. = 1 Nondet. = 0	Rank	$\mu\text{g/L}$	Det. = 1 Nondet. = 0
1	18	0	32	45	1
2	18	0	33	47	1
3	18	1	34	48	1
4	18	0	35	52	1
5	18	0	36	67	1
6	18	0	37	71	1
7	18	0	38	71	1
8	18	0	39	73	1
9	18	0	40	80	1
10	18	0	41	92	1
11	18	0	42	119	1
12	19	1	43	372	1
13	37	1	44	508	1
14	38	0	45	647	1
15	38	0			
16	38	0			
17	38	0			
18	38	0			
19	38	0			
20	38	0			
21	38	0			
22	38	0			
23	38	0			
24	38	0			
25	38	0			
26	38	0			
27	38	0			
28	38	0			
29	38	0			
30	40	1			
31	41	1			

Table A-1. 300 Area Subregion Analytical Data Used for 90th Percentile Calculation

Lead	D_Lead
detects	3
nondetects	42
n (number of values)	45
p (percentile)	90
k (position in sequence)	41.4
mean 90th percentile	0.2

Rank	$\mu\text{g/L}$	Det. = 1 Nondet. = 0	Rank	$\mu\text{g/L}$	Det. = 1 Nondet. = 0
1	0.1	0	32	0.2	0
2	0.1	0	33	0.2	0
3	0.1	0	34	0.2	0
4	0.1	0	35	0.2	0
5	0.17	0	36	0.2	0
6	0.2	0	37	0.2	0
7	0.2	0	38	0.2	0
8	0.2	0	39	0.2	0
9	0.2	0	40	0.2	0
10	0.2	0	41	0.2	0
11	0.2	0	42	0.2	0
12	0.2	0	43	0.292	1
13	0.2	0	44	0.687	1
14	0.2	0	45	3.53	1
15	0.2	0			
16	0.2	0			
17	0.2	0			
18	0.2	0			
19	0.2	0			
20	0.2	0			
21	0.2	0			
22	0.2	0			
23	0.2	0			
24	0.2	0			
25	0.2	0			
26	0.2	0			
27	0.2	0			
28	0.2	0			
29	0.2	0			
30	0.2	0			
31	0.2	0			

Table A-1. 300 Area Subregion Analytical Data Used for 90th Percentile Calculation

Lithium

D_Lithium

detects	33
nondetects	12
n (number of values)	45
p (percentile)	90
k (position in sequence)	41.4
mean 90th percentile	24.5

Rank	$\mu\text{g/L}$	Det. = 1 Nondet. = 0	Rank	$\mu\text{g/L}$	Det. = 1 Nondet. = 0
1	4	0	32	12	1
2	4	0	33	13	1
3	4	0	34	15	1
4	4	1	35	16	1
5	4	0	36	20	1
6	4	1	37	22	1
7	4	1	38	22	1
8	4	0	39	23	1
9	4	0	40	23	1
10	4	0	41	24	1
11	4	0	42	25	1
12	4	1	43	25	1
13	4	0	44	28	1
14	4	0	45	33	1
15	4	1			
16	4	1			
17	4	0			
18	4	1			
19	4	0			
20	5	1			
21	5	1			
22	6	1			
23	6	1			
24	6	1			
25	6	1			
26	7	1			
27	9	1			
28	11	1			
29	11	1			
30	11	1			
31	12	1			

Table A-1. 300 Area Subregion Analytical Data Used for 90th Percentile Calculation

Manganese

D_Manganese

detects	3
nondetects	42
n (number of values)	45
p (percentile)	90
k (position in sequence)	41.4
mean 90th percentile	6

Rank	µg/L	Det. = 1 Nondet. = 0	Rank	µg/L	Det. = 1 Nondet. = 0
1	4	0	32	6	0
2	4	0	33	6	0
3	4	0	34	6	0
4	4	0	35	6	0
5	4	0	36	6	0
6	4	0	37	6	0
7	4	0	38	6	0
8	4	0	39	6	0
9	4	0	40	6	0
10	4	0	41	6	0
11	4	0	42	6	0
12	4	0	43	6	0
13	4	0	44	7	1
14	4	0	45	12	1
15	4	0			
16	4	0			
17	6	0			
18	6	0			
19	6	0			
20	6	0			
21	6	0			
22	6	0			
23	6	1			
24	6	0			
25	6	0			
26	6	0			
27	6	0			
28	6	0			
29	6	0			
30	6	0			
31	6	0			

Table A-1. 300 Area Subregion Analytical Data Used for 90th Percentile Calculation

Molybdenum

D_Molybdenum

detects	45
nondetects	0
n (number of values)	45
p (percentile)	90
k (position in sequence)	41.4
mean 90th percentile	5.65

Rank	µg/L	Det. = 1 Nondet. = 0	Rank	µg/L	Det. = 1 Nondet. = 0
1	3.52	1	32	5.16	1
2	3.53	1	33	5.34	1
3	3.68	1	34	5.34	1
4	3.7	1	35	5.38	1
5	3.94	1	36	5.42	1
6	4	1	37	5.43	1
7	4.26	1	38	5.44	1
8	4.27	1	39	5.48	1
9	4.34	1	40	5.55	1
10	4.46	1	41	5.64	1
11	4.5	1	42	5.66	1
12	4.51	1	43	5.68	1
13	4.53	1	44	5.78	1
14	4.65	1	45	5.81	1
15	4.69	1			
16	4.7	1			
17	4.74	1			
18	4.75	1			
19	4.78	1			
20	4.79	1			
21	4.87	1			
22	4.88	1			
23	4.91	1			
24	4.94	1			
25	4.95	1			
26	4.97	1			
27	5.02	1			
28	5.06	1			
29	5.11	1			
30	5.12	1			
31	5.14	1			

Table A-1. 300 Area Subregion Analytical Data Used for 90th Percentile Calculation

Nickel	D_Nickel
detects	11
nondetects	34
n (number of values)	45
p (percentile)	90
k (position in sequence)	41.4
mean 90th percentile	6

Rank	$\mu\text{g/L}$	Det. = 1 Nondet. = 0	Rank	$\mu\text{g/L}$	Det. = 1 Nondet. = 0
1	4	0	32	4	0
2	4	0	33	4	0
3	4	0	34	4	0
4	4	0	35	4	0
5	4	0	36	4	0
6	4	0	37	4	0
7	4	0	38	4	0
8	4	0	39	5	1
9	4	0	40	5	1
10	4	0	41	6	1
11	4	0	42	6	1
12	4	0	43	7	1
13	4	0	44	8	1
14	4	0	45	12	1
15	4	0			
16	4	0			
17	4	0			
18	4	0			
19	4	0			
20	4	1			
21	4	0			
22	4	0			
23	4	1			
24	4	0			
25	4	0			
26	4	0			
27	4	1			
28	4	0			
29	4	0			
30	4	1			
31	4	0			

Table A-1. 300 Area Subregion Analytical Data Used for 90th Percentile Calculation

Nitrate	D_Nitrate
detects	45
nondetects	0
n (number of values)	45
p (percentile)	90
k (position in sequence)	41.4
mean 90th percentile	31250

Rank	$\mu\text{g/L}$	Det. = 1 Nondet. = 0	Rank	$\mu\text{g/L}$	Det. = 1 Nondet. = 0
1	7080	1	32	27100	1
2	13200	1	33	27200	1
3	14600	1	34	27400	1
4	19700	1	35	27800	1
5	19800	1	36	27800	1
6	21500	1	37	28600	1
7	21900	1	38	29000	1
8	22200	1	39	29000	1
9	23000	1	40	29700	1
10	23200	1	41	31100	1
11	23200	1	42	31400	1
12	23200	1	43	36200	1
13	23400	1	44	36500	1
14	23600	1	45	62000	1
15	23900	1			
16	24300	1			
17	24400	1			
18	24500	1			
19	24700	1			
20	24700	1			
21	25100	1			
22	25200	1			
23	25400	1			
24	25800	1			
25	26200	1			
26	26400	1			
27	26500	1			
28	26600	1			
29	26600	1			
30	26700	1			
31	26800	1			

Table A-1. 300 Area Subregion Analytical Data Used for 90th Percentile Calculation

Selenium

D_Selenium

detects	45
nondetects	0
n (number of values)	45
p (percentile)	90
k (position in sequence)	41.4
mean 90th percentile	3.72

Rank	µg/L	Det. = 1 Nondet. = 0	Rank	µg/L	Det. = 1 Nondet. = 0
1	0.48	1	32	3.07	1
2	0.68	1	33	3.07	1
3	1.03	1	34	3.1	1
4	1.09	1	35	3.28	1
5	1.15	1	36	3.31	1
6	1.36	1	37	3.37	1
7	1.41	1	38	3.4	1
8	1.56	1	39	3.43	1
9	1.65	1	40	3.51	1
10	1.84	1	41	3.54	1
11	1.84	1	42	3.9	1
12	2.02	1	43	4.11	1
13	2.09	1	44	4.24	1
14	2.12	1	45	5.8	1
15	2.14	1			
16	2.14	1			
17	2.15	1			
18	2.16	1			
19	2.19	1			
20	2.19	1			
21	2.21	1			
22	2.34	1			
23	2.35	1			
24	2.46	1			
25	2.57	1			
26	2.68	1			
27	2.78	1			
28	2.8	1			
29	2.94	1			
30	2.95	1			
31	3.02	1			

Table A-1. 300 Area Subregion Analytical Data Used for 90th Percentile Calculation

Silver	D_Silver
detects	2
nondetects	43
n (number of values)	45
p (percentile)	90
k (position in sequence)	41.4
mean 90th percentile	0.2

Rank	$\mu\text{g/L}$	Det. = 1 Nondet. = 0	Rank	$\mu\text{g/L}$	Det. = 1 Nondet. = 0
1	0.099	1	32	0.2	0
2	0.1	0	33	0.2	0
3	0.1	0	34	0.2	0
4	0.1	0	35	0.2	0
5	0.1	0	36	0.2	0
6	0.1	0	37	0.2	0
7	0.1	0	38	0.2	0
8	0.2	0	39	0.2	0
9	0.2	0	40	0.2	0
10	0.2	0	41	0.2	0
11	0.2	0	42	0.2	0
12	0.2	0	43	0.2	0
13	0.2	0	44	0.2	0
14	0.2	0	45	0.719	1
15	0.2	0			
16	0.2	0			
17	0.2	0			
18	0.2	0			
19	0.2	0			
20	0.2	0			
21	0.2	0			
22	0.2	0			
23	0.2	0			
24	0.2	0			
25	0.2	0			
26	0.2	0			
27	0.2	0			
28	0.2	0			
29	0.2	0			
30	0.2	0			
31	0.2	0			

Table A-1. 300 Area Subregion Analytical Data Used for 90th Percentile Calculation

Strontium

D_Strontium

detects	45
nondetects	0
n (number of values)	45
p (percentile)	90
k (position in sequence)	41.4
mean 90th percentile	248

Rank	$\mu\text{g/L}$	Det. = 1 Nondet. = 0	Rank	$\mu\text{g/L}$	Det. = 1 Nondet. = 0
1	5	1	32	235	1
2	127	1	33	236	1
3	139	1	34	236	1
4	174	1	35	240	1
5	183	1	36	240	1
6	197	1	37	240	1
7	200	1	38	241	1
8	208	1	39	241	1
9	209	1	40	243	1
10	212	1	41	248	1
11	214	1	42	248	1
12	214	1	43	257	1
13	214	1	44	279	1
14	216	1	45	280	1
15	216	1			
16	216	1			
17	217	1			
18	219	1			
19	220	1			
20	221	1			
21	222	1			
22	223	1			
23	223	1			
24	224	1			
25	225	1			
26	229	1			
27	233	1			
28	233	1			
29	234	1			
30	234	1			
31	234	1			

Table A-1. 300 Area Subregion Analytical Data Used for 90th Percentile Calculation

Sulfate	D_Sulfate
detects	45
nondetects	0
n (number of values)	45
p (percentile)	90
k (position in sequence)	41.4
mean 90th percentile	58500

Rank	$\mu\text{g/L}$	Det. = 1 Nondet. = 0	Rank	$\mu\text{g/L}$	Det. = 1 Nondet. = 0
1	25700	1	32	53400	1
2	26100	1	33	54800	1
3	37600	1	34	55300	1
4	39800	1	35	55300	1
5	40300	1	36	56000	1
6	40600	1	37	57200	1
7	40800	1	38	57300	1
8	41300	1	39	57600	1
9	41500	1	40	57900	1
10	42200	1	41	58500	1
11	42300	1	42	58500	1
12	42500	1	43	58700	1
13	42600	1	44	59400	1
14	42700	1	45	59500	1
15	43200	1			
16	44900	1			
17	45200	1			
18	46200	1			
19	47500	1			
20	47700	1			
21	48100	1			
22	48500	1			
23	49200	1			
24	50100	1			
25	50400	1			
26	50600	1			
27	50900	1			
28	51300	1			
29	52300	1			
30	53000	1			
31	53300	1			

Table A-1. 300 Area Subregion Analytical Data Used for 90th Percentile Calculation

Tetrachloroethene

D_Tetrachloroethene

detects	3
nondetects	42
n (number of values)	45
p (percentile)	90
k (position in sequence)	41.4
mean 90th percentile	0.18

Rank	$\mu\text{g/L}$	Det. = 1 Nondet. = 0	Rank	$\mu\text{g/L}$	Det. = 1 Nondet. = 0
1	0.18	0	32	0.18	0
2	0.18	0	33	0.18	0
3	0.18	0	34	0.18	0
4	0.18	0	35	0.18	0
5	0.18	0	36	0.18	0
6	0.18	0	37	0.18	0
7	0.18	0	38	0.18	0
8	0.18	0	39	0.18	0
9	0.18	0	40	0.18	0
10	0.18	0	41	0.18	0
11	0.18	0	42	0.18	0
12	0.18	0	43	0.19	1
13	0.18	0	44	0.29	1
14	0.18	0	45	0.38	1
15	0.18	0			
16	0.18	0			
17	0.18	0			
18	0.18	0			
19	0.18	0			
20	0.18	0			
21	0.18	0			
22	0.18	0			
23	0.18	0			
24	0.18	0			
25	0.18	0			
26	0.18	0			
27	0.18	0			
28	0.18	0			
29	0.18	0			
30	0.18	0			
31	0.18	0			

Table A-1. 300 Area Subregion Analytical Data Used for 90th Percentile Calculation

Thallium	D_Thallium
detects	1
nondetects	44
n (number of values)	45
p (percentile)	90
k (position in sequence)	41.4
mean 90th percentile	0.1

Rank	$\mu\text{g/L}$	Det. = 1 Nondet. = 0	Rank	$\mu\text{g/L}$	Det. = 1 Nondet. = 0
1	0.05	0	32	0.1	0
2	0.05	0	33	0.1	0
3	0.05	0	34	0.1	0
4	0.05	0	35	0.1	0
5	0.05	0	36	0.1	0
6	0.05	0	37	0.1	0
7	0.1	0	38	0.1	0
8	0.1	0	39	0.1	0
9	0.1	0	40	0.1	0
10	0.1	0	41	0.1	0
11	0.1	0	42	0.1	0
12	0.1	0	43	0.1	0
13	0.1	0	44	0.1	0
14	0.1	0	45	1.2	1
15	0.1	0			
16	0.1	0			
17	0.1	0			
18	0.1	0			
19	0.1	0			
20	0.1	0			
21	0.1	0			
22	0.1	0			
23	0.1	0			
24	0.1	0			
25	0.1	0			
26	0.1	0			
27	0.1	0			
28	0.1	0			
29	0.1	0			
30	0.1	0			
31	0.1	0			

Table A-1. 300 Area Subregion Analytical Data Used for 90th Percentile Calculation

Tin	D_Tin
detects	3
nondetects	42
n (number of values)	45
p (percentile)	90
k (position in sequence)	41.4
mean 90th percentile	0.1

Rank	$\mu\text{g/L}$	Det. = 1 Nondet. = 0	Rank	$\mu\text{g/L}$	Det. = 1 Nondet. = 0
1	0.05	0	32	0.1	0
2	0.05	0	33	0.1	0
3	0.05	0	34	0.1	0
4	0.05	0	35	0.1	0
5	0.05	0	36	0.1	0
6	0.05	0	37	0.1	0
7	0.1	0	38	0.1	0
8	0.1	0	39	0.1	0
9	0.1	0	40	0.1	0
10	0.1	0	41	0.1	0
11	0.1	0	42	0.1	0
12	0.1	0	43	0.1	0
13	0.1	0	44	0.101	1
14	0.1	0	45	0.2	1
15	0.1	0			
16	0.1	0			
17	0.1	0			
18	0.1	0			
19	0.1	0			
20	0.1	0			
21	0.1	1			
22	0.1	0			
23	0.1	0			
24	0.1	0			
25	0.1	0			
26	0.1	0			
27	0.1	0			
28	0.1	0			
29	0.1	0			
30	0.1	0			
31	0.1	0			

Table A-1. 300 Area Subregion Analytical Data Used for 90th Percentile Calculation

Trichloroethene

D_Trichloroethene

detects	35
nondetects	10
n (number of values)	45
p (percentile)	90
k (position in sequence)	41.4
mean 90th percentile	2.2

Rank	$\mu\text{g/L}$	Det. = 1 Nondet. = 0	Rank	$\mu\text{g/L}$	Det. = 1 Nondet. = 0
1	0.21	0	32	1.4	1
2	0.21	0	33	1.5	1
3	0.21	0	34	1.5	1
4	0.21	0	35	1.7	1
5	0.25	0	36	1.7	1
6	0.25	0	37	2	1
7	0.25	0	38	2	1
8	0.25	0	39	2.1	1
9	0.25	0	40	2.1	1
10	0.25	0	41	2.2	1
11	0.31	1	42	2.2	1
12	0.34	1	43	2.3	1
13	0.41	1	44	2.3	1
14	0.42	1	45	3	1
15	0.48	1			
16	0.58	1			
17	0.59	1			
18	0.63	1			
19	0.71	1			
20	0.72	1			
21	0.75	1			
22	0.84	1			
23	0.92	1			
24	1	1			
25	1.1	1			
26	1.1	1			
27	1.2	1			
28	1.2	1			
29	1.3	1			
30	1.3	1			
31	1.4	1			

Table A-1. 300 Area Subregion Analytical Data Used for 90th Percentile Calculation

Tritium	D_Tritium
detects	39
nondetects	6
n (number of values)	45
p (percentile)	90
k (position in sequence)	41.4
mean 90th percentile	6150

Rank	$\mu\text{g/L}$	Det. = 1 Nondet. = 0	Rank	$\mu\text{g/L}$	Det. = 1 Nondet. = 0
1	2.7	0	32	4600	1
2	58	0	33	4700	1
3	84	0	34	4800	1
4	97	0	35	4800	1
5	120	0	36	4800	1
6	130	0	37	5100	1
7	180	1	38	5200	1
8	200	1	39	5300	1
9	220	1	40	5510	1
10	270	1	41	5900	1
11	500	1	42	6400	1
12	820	1	43	6800	1
13	930	1	44	7200	1
14	1100	1	45	7700	1
15	1400	1			
16	1400	1			
17	1700	1			
18	1800	1			
19	2100	1			
20	2100	1			
21	2200	1			
22	2400	1			
23	2500	1			
24	2600	1			
25	3100	1			
26	3400	1			
27	3500	1			
28	3700	1			
29	3900	1			
30	4300	1			
31	4300	1			

Table A-1. 300 Area Subregion Analytical Data Used for 90th Percentile Calculation

Uranium

D_Uranium

detects	45
nondetects	0
n (number of values)	45
p (percentile)	90
k (position in sequence)	41.4
mean 90th percentile	114

Rank	$\mu\text{g/L}$	Det. = 1 Nondet. = 0	Rank	$\mu\text{g/L}$	Det. = 1 Nondet. = 0
1	6.35	1	32	68.7	1
2	7.21	1	33	69.8	1
3	7.93	1	34	80.4	1
4	16.8	1	35	87.8	1
5	17.1	1	36	88.4	1
6	20.6	1	37	89	1
7	21.5	1	38	94.8	1
8	22.9	1	39	98.6	1
9	24.5	1	40	111	1
10	24.5	1	41	114	1
11	25.1	1	42	114	1
12	26.3	1	43	124	1
13	27.9	1	44	135	1
14	28.4	1	45	177	1
15	29.4	1			
16	29.7	1			
17	30.3	1			
18	33.6	1			
19	36.2	1			
20	36.8	1			
21	43.2	1			
22	44.9	1			
23	45.8	1			
24	48	1			
25	48.4	1			
26	50.1	1			
27	51.6	1			
28	54.6	1			
29	56.3	1			
30	56.4	1			
31	62.6	1			

Table A-1. 300 Area Subregion Analytical Data Used for 90th Percentile Calculation

Vanadium

D_Vanadium

detects	10
nondetects	35
n (number of values)	45
p (percentile)	90
k (position in sequence)	41.4
mean 90th percentile	20.5

Rank	$\mu\text{g/L}$	Det. = 1 Nondet. = 0	Rank	$\mu\text{g/L}$	Det. = 1 Nondet. = 0
1	12	1	32	17	0
2	12	0	33	17	0
3	12	0	34	17	0
4	12	0	35	17	0
5	12	0	36	17	0
6	12	0	37	17	0
7	12	0	38	17	0
8	12	0	39	17	0
9	12	0	40	18	1
10	12	0	41	20	1
11	13	1	42	21	1
12	14	1	43	22	1
13	17	1	44	23	1
14	17	0	45	34	1
15	17	0			
16	17	0			
17	17	0			
18	17	0			
19	17	0			
20	17	0			
21	17	0			
22	17	0			
23	17	0			
24	17	0			
25	17	0			
26	17	0			
27	17	0			
28	17	0			
29	17	0			
30	17	0			
31	17	0			

Table A-1. 300 Area Subregion Analytical Data Used for 90th Percentile Calculation

Zinc

D_Zinc

detects	12
nondetects	33
n (number of values)	45
p (percentile)	90
k (position in sequence)	41.4
mean 90th percentile	41.5

Rank	$\mu\text{g/L}$	Det. = 1 Nondet. = 0	Rank	$\mu\text{g/L}$	Det. = 1 Nondet. = 0
1	4	1	32	6	0
2	4	0	33	6	0
3	4	0	34	6	0
4	4	0	35	6	0
5	4	0	36	6	0
6	4	0	37	6	0
7	4	0	38	8	1
8	4	0	39	8	1
9	4	0	40	11	1
10	4	1	41	25	1
11	4	0	42	58	1
12	4	0	43	334	1
13	4	1	44	347	1
14	4	0	45	456	1
15	4	0			
16	4	0			
17	4	0			
18	4	0			
19	4	0			
20	4	0			
21	4	0			
22	4	0			
23	5	1			
24	6	0			
25	6	0			
26	6	0			
27	6	0			
28	6	0			
29	6	0			
30	6	0			
31	6	0			

Table B-1. 300 Area Subregion Summary Statistics for Raw Data Sets with NDs using Detected Data Only

Variable	Num Ds	NumNDs	% NDs	Raw Statistics using Detected Observations							
				Minimum	Maximum	Mean	Median	SD	MAD/0.675	Skewness	CV
1,2-Dichloroethene (Total)	10	35	77.78%	0.18	0.69	0.296	0.205	0.196	0.0297	1.764	0.661
Acetone	8	37	82.22%	0.71	31	4.771	1.045	10.6	0.385	2.824	2.222
Acrolein	1	44	97.78%	3.8	3.8	3.8	3.8	N/A	0	N/A	N/A
Aluminum	4	41	91.11%	9.34	99.5	33.89	13.35	43.82	4.64	1.979	1.293
Arsenic	43	2	4.44%	0.932	6.45	3.78	3.69	1.134	1.067	0.223	0.3
Barium	45	0	0.00%	37.4	82.7	56.76	56.1	9.392	8.302	0.623	0.165
Boron	12	33	73.33%	19	118	41.36	31.65	26.76	14.83	2.407	0.647
Bromodichloromethane	3	42	93.33%	0.68	0.69	0.683	0.68	0.00577	0	1.732	0.00845
Bromomethane	3	42	93.33%	0.44	0.77	0.59	0.56	0.167	0.178	0.782	0.283
Carbon disulfide	4	41	91.11%	0.056	0.075	0.0653	0.065	0.0101	0.0126	0.0251	0.155
Carbon tetrachloride	3	42	93.33%	0.13	0.59	0.327	0.26	0.237	0.193	1.165	0.726
Chloride	45	0	0.00%	6890	29000	20405	21100	4579	2965	-1.145	0.224
Chloroform	12	33	73.33%	0.13	0.87	0.399	0.385	0.226	0.259	0.635	0.567
Chromium	44	1	2.22%	1.37	16.5	4.382	3.815	2.487	1.586	2.968	0.567
cis-1,2-Dichloroethylene	11	34	75.56%	0.12	0.69	0.28	0.2	0.193	0.0297	1.828	0.689
Cobalt	3	42	93.33%	0.136	0.162	0.149	0.15	0.013	0.0178	-0.23	0.0871
Copper	23	22	48.89%	0.205	30.7	2.247	0.411	6.456	0.237	4.295	2.874
Cyanide	1	44	97.78%	3.7	3.7	3.7	3.7	N/A	0	N/A	N/A
Fluoride	43	2	4.44%	85.7	340	208.5	200	55.65	62.27	0.158	0.267
Gross alpha	28	0	0.00%	3.4	77	23.39	16	21	12.6	1.557	0.898
Gross beta	28	0	0.00%	2.7	49	21.47	20	11.42	8.154	0.683	0.532
Iron	19	26	57.78%	18	647	128.8	67	176.9	37.06	2.244	1.374
Lead	3	42	93.33%	0.292	3.53	1.503	0.687	1.767	0.586	1.635	1.175
Lithium	33	12	26.67%	4	33	12.85	11	8.686	10.38	0.675	0.676
Manganese	3	42	93.33%	6	12	8.333	7	3.215	1.483	1.545	0.386
Molybdenum	45	0	0.00%	3.52	5.81	4.854	4.91	0.606	0.638	-0.545	0.125
Nickel	11	34	75.56%	4	12	5.909	5	2.427	1.483	1.77	0.411
Nitrate	45	0	0.00%	7080	62000	25871	25400	7478	3262	2.222	0.289
Selenium	45	0	0.00%	0.48	5.8	2.523	2.35	1.02	1.038	0.522	0.405
Silver	2	43	95.56%	0.099	0.719	0.409	0.409	0.438	0.46	N/A	1.072
Strontium	45	0	0.00%	5	280	217.8	223	42.79	17.79	-3.13	0.196
Sulfate	45	0	0.00%	25700	59500	48396	49200	8132	9785	-0.768	0.168
Tetrachloroethene	3	42	93.33%	0.19	0.38	0.287	0.29	0.095	0.133	-0.158	0.332
Thallium	1	44	97.78%	1.2	1.2	1.2	1.2	N/A	0	N/A	N/A
Tin	3	42	93.33%	0.1	0.2	0.134	0.101	0.0574	0.00148	1.731	0.43
Trichloroethene	35	10	22.22%	0.31	3	1.294	1.2	0.693	0.741	0.461	0.536
Tritium	39	6	13.33%	180	7700	3319	3400	2130	2520	0.195	0.642
Uranium	45	0	0.00%	6.35	177	55.28	45.8	38.64	31.58	1.112	0.699
Vanadium	10	35	77.78%	12	34	19.4	19	6.398	5.189	1.241	0.33
Zinc	12	33	73.33%	4	456	105.3	9.5	168.2	8.154	1.417	1.596

Table B-5. 300 Area Subregion General UCL Statistics for Data Sets with Non-Detects

Minimum	0.0593	95% KM (bootstrap t) UCL	0.396
Maximum	0.91	95% KM (BCA) UCL	0.244
Mean	0.531	95% KM (Percentile Bootstrap) UCL	0.236
Median	0.579	95% KM (Chebyshev) UCL	0.274
SD	0.256	97.5% KM (Chebyshev) UCL	0.304
k star	3.043	99% KM (Chebyshev) UCL	0.362
Theta star	0.175		
Nu star	273.9	Potential UCLs to Use	
AppChi2	236.5	95% KM (t) UCL	0.232
95% Gamma Approximate UCL	0.615	95% KM (% Bootstrap) UCL	0.236
95% Adjusted Gamma UCL	0.618		

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006). For additional insight, the user may want to consult a statistician.

Acetone

General Statistics			
Number of Valid Data	45	Number of Detected Data	8
Number of Distinct Detected Data	8	Number of Non-Detect Data	37
		Percent Non-Detects	82.22%
Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.71	Minimum Detected	-0.342
Maximum Detected	31	Maximum Detected	3.434
Mean of Detected	4.771	Mean of Detected	0.418
SD of Detected	10.6	SD of Detected	1.248
Minimum Non-Detect	0.34	Minimum Non-Detect	-1.079
Maximum Non-Detect	0.34	Maximum Non-Detect	-1.079

Warning: There are only 8 Detected Values in this data

Note: It should be noted that even though bootstrap may be performed on this data set the resulting calculations may not be reliable enough to draw conclusions

It is recommended to have 10-15 or more distinct observations for accurate and meaningful results.

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic	0.443	Shapiro Wilk Test Statistic	0.619
5% Shapiro Wilk Critical Value	0.818	5% Shapiro Wilk Critical Value	0.818
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	
Assuming Normal Distribution		Assuming Lognormal Distribution	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	0.988	Mean	-1.383
SD	4.588	SD	0.982
95% DL/2 (t) UCL	2.137	95% H-Stat (DL/2) UCL	0.576
Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
MLE yields a negative mean		Mean in Log Scale	-3.777
		SD in Log Scale	2.834
		Mean in Original Scale	0.883

Table B-5. 300 Area Subregion General UCL Statistics for Data Sets with Non-Detects

		SD in Original Scale	4.607
		95% t UCL	2.037
		95% Percentile Bootstrap UCL	2.243
		95% BCA Bootstrap UCL	3.535
Gamma Distribution Test with Detected Values Only		Data Distribution Test with Detected Values Only	
	k star (bias corrected)	Data do not follow a Discernable Distribution (0.05)	
	Theta Star		
	nu star		
	A-D Test Statistic	Nonparametric Statistics	
	5% A-D Critical Value	Kaplan-Meier (KM) Method	
	K-S Test Statistic	Mean	1.432
	5% K-S Critical Value	SD	4.46
		SE of Mean	0.711
		95% KM (t) UCL	2.626
		95% KM (z) UCL	2.601
		95% KM (jackknife) UCL	2.532
		95% KM (bootstrap t) UCL	32.57
		95% KM (BCA) UCL	3.474
		95% KM (Percentile Bootstrap) UCL	2.787
		95% KM (Chebyshev) UCL	4.53
		97.5% KM (Chebyshev) UCL	5.871
		99% KM (Chebyshev) UCL	8.505
Data not Gamma Distributed at 5% Significance Level			
Assuming Gamma Distribution			
	Gamma ROS Statistics using Extrapolated Data	Potential UCLs to Use	
	Minimum	95% KM (BCA) UCL	3.474
	Maximum		
	Mean		
	Median		
	SD		
	k star		
	Theta star		
	Nu star		
	AppChi2		
	95% Gamma Approximate UCL		
	95% Adjusted Gamma UCL		

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006). For additional insight, the user may want to consult a statistician.

Acrolein

General Statistics			
Number of Valid Data	45	Number of Detected Data	1
Number of Distinct Detected Data	1	Number of Non-Detect Data	44
		Percent Non-Detects	97.78%

Warning: Only one distinct data value was detected! ProUCL (or any other software) should not be used on such a data set! It is suggested to use alternative site specific values determined by the Project Team to estimate environmental parameters (e.g., EPC, BTV).

The data set for variable Acrolein was not processed!

Aluminum

General Statistics			
Number of Valid Data	45	Number of Detected Data	4
Number of Distinct Detected Data	4	Number of Non-Detect Data	41
		Percent Non-Detects	91.11%

Table B-5. 300 Area Subregion General UCL Statistics for Data Sets with Non-Detects

Raw Statistics		Log-transformed Statistics	
Minimum Detected	9.34	Minimum Detected	2.234
Maximum Detected	99.5	Maximum Detected	4.6
Mean of Detected	33.89	Mean of Detected	2.997
SD of Detected	43.82	SD of Detected	1.09
Minimum Non-Detect	5	Minimum Non-Detect	1.609
Maximum Non-Detect	10	Maximum Non-Detect	2.303
		Number treated as Non-Detect	42
		Number treated as Detected	3
		Single DL Non-Detect Percentage	93.33%

Note: Data have multiple DLs - Use of KM Method is recommended
For all methods (except KM, DL/2, and ROS Methods),
Observations < Largest ND are treated as NDs

Warning: There are only 4 Distinct Detected Values in this data

**Note: It should be noted that even though bootstrap may be performed on this data set
the resulting calculations may not be reliable enough to draw conclusions**

It is recommended to have 10-15 or more distinct observations for accurate and meaningful results.

UCL Statistics		UCL Statistics	
Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic	0.683	Shapiro Wilk Test Statistic	0.795
5% Shapiro Wilk Critical Value	0.748	5% Shapiro Wilk Critical Value	0.748
Data not Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	
Assuming Normal Distribution		Assuming Lognormal Distribution	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	7.326	Mean	1.667
SD	14.21	SD	0.545
95% DL/2 (t) UCL	10.88	95% H-Stat (DL/2) UCL	7.206
Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
MLE yields a negative mean		Mean in Log Scale	-0.191
		SD in Log Scale	1.796
		Mean in Original Scale	4.452
		SD in Original Scale	14.91
		95% t UCL	8.186
		95% Percentile Bootstrap UCL	8.643
		95% BCA Bootstrap UCL	11.37
Gamma Distribution Test with Detected Values Only		Data Distribution Test with Detected Values Only	
k star (bias corrected)	0.438	Data Follow Appr. Gamma Distribution at 5% Significance Level	
Theta Star	77.28		
nu star	3.508		
A-D Test Statistic	0.674	Nonparametric Statistics	
5% A-D Critical Value	0.666	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.666	Mean	11.52
5% K-S Critical Value	0.402	SD	13.3
Data follow Appr. Gamma Distribution at 5% Significance Level		SE of Mean	2.289
Assuming Gamma Distribution		95% KM (t) UCL	15.37
Gamma ROS Statistics using Extrapolated Data		95% KM (z) UCL	15.29
Minimum	1E-12	95% KM (jackknife) UCL	14.28
Maximum	216.1	95% KM (bootstrap t) UCL	40.96
Mean	58.41	95% KM (BCA) UCL	99.5
Median	32.57	95% KM (Percentile Bootstrap) UCL	19.33
		95% KM (Chebyshev) UCL	21.5

Table B-5. 300 Area Subregion General UCL Statistics for Data Sets with Non-Detects

SD	63.72	97.5% KM (Chebyshev) UCL	25.82
k star	0.127	99% KM (Chebyshev) UCL	34.3
Theta star	459.5		
Nu star	11.44	Potential UCLs to Use	
AppChi2	4.862	95% KM (t) UCL	15.37
95% Gamma Approximate UCL	137.5		
95% Adjusted Gamma UCL	N/A		

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006). For additional insight, the user may want to consult a statistician.

Arsenic

General Statistics			
Number of Valid Data	45	Number of Detected Data	43
Number of Distinct Detected Data	40	Number of Non-Detect Data	2
		Percent Non-Detects	4.44%
Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.932	Minimum Detected	-0.0704
Maximum Detected	6.45	Maximum Detected	1.864
Mean of Detected	3.78	Mean of Detected	1.279
SD of Detected	1.134	SD of Detected	0.343
Minimum Non-Detect	0.8	Minimum Non-Detect	-0.223
Maximum Non-Detect	0.8	Maximum Non-Detect	-0.223
Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic	0.982	Shapiro Wilk Test Statistic	0.922
5% Shapiro Wilk Critical Value	0.943	5% Shapiro Wilk Critical Value	0.943
Data appear Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	
Assuming Normal Distribution		Assuming Lognormal Distribution	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	3.629	Mean	1.181
SD	1.313	SD	0.567
95% DL/2 (t) UCL	3.958	95% H-Stat (DL/2) UCL	4.524
Maximum Likelihood Estimate(MLE) Method		Log ROS Method	
Mean	3.626	Mean in Log Scale	1.244
SD	1.309	SD in Log Scale	0.373
95% MLE (t) UCL	3.954	Mean in Original Scale	3.685
95% MLE (Tiku) UCL	3.959	SD in Original Scale	1.194
		95% t UCL	3.984
		95% Percentile Bootstrap UCL	3.974
		95% BCA Bootstrap UCL	3.986
Gamma Distribution Test with Detected Values Only		Data Distribution Test with Detected Values Only	
k star (bias corrected)	9.331	Data appear Normal at 5% Significance Level	
Theta Star	0.405		
nu star	802.5		
A-D Test Statistic	0.344	Nonparametric Statistics	

Table B-5. 300 Area Subregion General UCL Statistics for Data Sets with Non-Detects

5% A-D Critical Value	0.748	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.748	Mean	3.653
5% K-S Critical Value	0.135	SD	1.243
Data appear Gamma Distributed at 5% Significance Level		SE of Mean	0.187
Assuming Gamma Distribution		95% KM (t) UCL	3.968
Gamma ROS Statistics using Extrapolated Data		95% KM (z) UCL	3.961
Minimum	0.715	95% KM (jackknife) UCL	3.954
Maximum	6.45	95% KM (bootstrap t) UCL	3.959
Mean	3.654	95% KM (BCA) UCL	4.009
Median	3.69	95% KM (Percentile Bootstrap) UCL	3.992
SD	1.255	95% KM (Chebyshev) UCL	4.47
k star	6.218	97.5% KM (Chebyshev) UCL	4.824
Theta star	0.588	99% KM (Chebyshev) UCL	5.518
Nu star	559.6	Potential UCLs to Use	
AppChi2	505.7	95% KM (t) UCL	3.968
95% Gamma Approximate UCL	4.044	95% KM (Percentile Bootstrap) UCL	3.992
95% Adjusted Gamma UCL	4.057		

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006). For additional insight, the user may want to consult a statistician.

Barium

General Statistics

Number of Valid Observations 45

Number of Distinct Observations 43

Raw Statistics

Minimum 37.4
Maximum 82.7
Mean 56.76
Median 56.1
SD 9.392
Coefficient of Variation 0.165
Skewness 0.623

Log-transformed Statistics

Minimum of Log Data 3.622
Maximum of Log Data 4.415
Mean of log Data 4.026
SD of log Data 0.163

Relevant UCL Statistics

Normal Distribution Test

Shapiro Wilk Test Statistic 0.969
Shapiro Wilk Critical Value 0.945

Data appear Normal at 5% Significance Level

Lognormal Distribution Test

Shapiro Wilk Test Statistic 0.989
Shapiro Wilk Critical Value 0.945

Data appear Lognormal at 5% Significance Level

Assuming Normal Distribution

95% Student's-t UCL 59.11

95% UCLs (Adjusted for Skewness)

95% Adjusted-CLT UCL (Chen-1995) 59.2
95% Modified-t UCL (Johnson-1978) 59.13

Assuming Lognormal Distribution

95% H-UCL 59.16
95% Chebyshev (MVUE) UCL 62.78
97.5% Chebyshev (MVUE) UCL 65.39
99% Chebyshev (MVUE) UCL 70.52

Gamma Distribution Test

k star (bias corrected) 35.99
Theta Star 1.577
MLE of Mean 56.76
MLE of Standard Deviation 9.46
nu star 3239

Data Distribution

Data appear Normal at 5% Significance Level

Table B-5. 300 Area Subregion General UCL Statistics for Data Sets with Non-Detects

Approximate Chi Square Value (.05) 3108	Nonparametric Statistics
Adjusted Level of Significance 0.0447	95% CLT UCL 59.06
Adjusted Chi Square Value 3104	95% Jackknife UCL 59.11
Anderson-Darling Test Statistic 0.304	95% Standard Bootstrap UCL 59.1
Anderson-Darling 5% Critical Value 0.748	95% Bootstrap-t UCL 59.34
Kolmogorov-Smirnov Test Statistic 0.0787	95% Hall's Bootstrap UCL 59.3
Kolmogorov-Smirnov 5% Critical Value 0.131	95% Percentile Bootstrap UCL 59.15
Data appear Gamma Distributed at 5% Significance Level	95% BCA Bootstrap UCL 59.11
Assuming Gamma Distribution	95% Chebyshev(Mean, Sd) UCL 62.86
95% Approximate Gamma UCL 59.15	97.5% Chebyshev(Mean, Sd) UCL 65.5
95% Adjusted Gamma UCL 59.24	99% Chebyshev(Mean, Sd) UCL 70.69
Potential UCL to Use	Use 95% Student's-t UCL 59.11

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Boron

General Statistics			
Number of Valid Data	45	Number of Detected Data	12
Number of Distinct Detected Data	12	Number of Non-Detect Data	33
		Percent Non-Detects	73.33%
Raw Statistics		Log-transformed Statistics	
Minimum Detected	19	Minimum Detected	2.944
Maximum Detected	118	Maximum Detected	4.771
Mean of Detected	41.36	Mean of Detected	3.589
SD of Detected	26.76	SD of Detected	0.503
Minimum Non-Detect	19	Minimum Non-Detect	2.944
Maximum Non-Detect	41	Maximum Non-Detect	3.714
		Number treated as Non-Detect	40
		Number treated as Detected	5
		Single DL Non-Detect Percentage	88.89%

**Note: Data have multiple DLs - Use of KM Method is recommended
For all methods (except KM, DL/2, and ROS Methods),
Observations < Largest ND are treated as NDs**

UCL Statistics		Lognormal Distribution Test with Detected Values Only	
Normal Distribution Test with Detected Values Only		Shapiro Wilk Test Statistic	0.926
Shapiro Wilk Test Statistic	0.726	5% Shapiro Wilk Critical Value	0.859
5% Shapiro Wilk Critical Value	0.859	Data appear Lognormal at 5% Significance Level	
Data not Normal at 5% Significance Level			
Assuming Normal Distribution		Assuming Lognormal Distribution	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	23.62	Mean	3.001
SD	17.76	SD	0.534
95% DL/2 (t) UCL	28.07	95% H-Stat (DL/2) UCL	27.09
Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
MLE yields a negative mean		Mean in Log Scale	2.817
		SD in Log Scale	0.719
		Mean in Original Scale	21.82
		SD in Original Scale	19.29

Table B-5. 300 Area Subregion General UCL Statistics for Data Sets with Non-Detects

		95% t UCL	26.66
		95% Percentile Bootstrap UCL	26.84
		95% BCA Bootstrap UCL	28.35
Gamma Distribution Test with Detected Values Only		Data Distribution Test with Detected Values Only	
	k star (bias corrected)	Data appear Gamma Distributed at 5% Significance Level	
	Theta Star		
	nu star		
	A-D Test Statistic	Nonparametric Statistics	
	5% A-D Critical Value	Kaplan-Meier (KM) Method	
	K-S Test Statistic	Mean	26.53
	5% K-S Critical Value	SD	16.38
Data appear Gamma Distributed at 5% Significance Level		SE of Mean	2.679
Assuming Gamma Distribution		95% KM (t) UCL	31.04
Gamma ROS Statistics using Extrapolated Data		95% KM (z) UCL	30.94
	Minimum	95% KM (jackknife) UCL	30.37
	Maximum	95% KM (bootstrap t) UCL	33.39
	Mean	95% KM (BCA) UCL	34.42
	Median	95% KM (Percentile Bootstrap) UCL	32.91
	SD	95% KM (Chebyshev) UCL	38.21
	k star	97.5% KM (Chebyshev) UCL	43.27
	Theta star	99% KM (Chebyshev) UCL	53.19
	Nu star	Potential UCLs to Use	
	AppChi2	95% KM (t) UCL	31.04
	95% Gamma Approximate UCL		
	95% Adjusted Gamma UCL		

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006). For additional insight, the user may want to consult a statistician.

Bromodichloromethane

General Statistics			
Number of Valid Data	45	Number of Detected Data	3
Number of Distinct Detected Data	2	Number of Non-Detect Data	42
		Percent Non-Detects	93.33%
Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.68	Minimum Detected	-0.386
Maximum Detected	0.69	Maximum Detected	-0.371
Mean of Detected	0.683	Mean of Detected	-0.381
SD of Detected	0.00577	SD of Detected	0.00843
Minimum Non-Detect	0.088	Minimum Non-Detect	-2.43
Maximum Non-Detect	0.088	Maximum Non-Detect	-2.43

Warning: Data set has only 2 Distinct Detected Values.

This may not be adequate enough to compute meaningful and reliable test statistics and estimates.

The Project Team may decide to use alternative site specific values to estimate environmental parameters (e.g., EPC, BTV).

Unless Data Quality Objectives (DQOs) have been met, it is suggested to collect additional observations.

Table B-5. 300 Area Subregion General UCL Statistics for Data Sets with Non-Detects
The number of detected data may not be adequate enough to perform GOF tests, bootstrap, and ROS methods.
Those methods will return a 'N/A' value on your output display!

It is necessary to have 4 or more Distinct Values for bootstrap methods.
However, results obtained using 4 to 9 distinct values may not be reliable.
It is recommended to have 10 to 15 or more observations for accurate and meaningful results and estimates.

		UCL Statistics			
Normal Distribution Test with Detected Values Only				Lognormal Distribution Test with Detected Values Only	
	Shapiro Wilk Test Statistic	0.75			Shapiro Wilk Test Statistic
	5% Shapiro Wilk Critical Value	0.767			5% Shapiro Wilk Critical Value
Data not Normal at 5% Significance Level				Data not Lognormal at 5% Significance Level	
Assuming Normal Distribution			Assuming Lognormal Distribution		
	DL/2 Substitution Method				DL/2 Substitution Method
	Mean	0.0866			Mean
	SD	0.161			SD
	95% DL/2 (t) UCL	0.127			95% H-Stat (DL/2) UCL
	Maximum Likelihood Estimate(MLE) Method	N/A			Log ROS Method
MLE method failed to converge properly					Mean in Log Scale
					SD in Log Scale
					Mean in Original Scale
					SD in Original Scale
					95% t UCL
					95% Percentile Bootstrap UCL
					95% BCA Bootstrap UCL
Gamma Distribution Test with Detected Values Only				Data Distribution Test with Detected Values Only	
	k star (bias corrected)	N/A		Data do not follow a Discernable Distribution (0.05)	
	Theta Star	N/A			
	nu star	N/A			
	A-D Test Statistic	N/A		Nonparametric Statistics	
	5% A-D Critical Value	N/A		Kaplan-Meier (KM) Method	
	K-S Test Statistic	N/A			Mean
	5% K-S Critical Value	N/A			SD
Data not Gamma Distributed at 5% Significance Level					SE of Mean
Assuming Gamma Distribution					
	Gamma ROS Statistics using Extrapolated Data				95% KM (t) UCL
	Minimum	N/A			95% KM (z) UCL
	Maximum	N/A			95% KM (jackknife) UCL
	Mean	N/A			95% KM (bootstrap t) UCL
	Median	N/A			95% KM (BCA) UCL
	SD	N/A			95% KM (Percentile Bootstrap) UCL
	k star	N/A			95% KM (Chebyshev) UCL
	Theta star	N/A			97.5% KM (Chebyshev) UCL
	Nu star	N/A			99% KM (Chebyshev) UCL
	AppChi2	N/A		Potential UCLs to Use	
	95% Gamma Approximate UCL	N/A			95% KM (t) UCL
	95% Adjusted Gamma UCL	N/A			95% KM (% Bootstrap) UCL

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).

Table B-5. 300 Area Subregion General UCL Statistics for Data Sets with Non-Detects
For additional insight, the user may want to consult a statistician.

Bromomethane

General Statistics			
Number of Valid Data	45	Number of Detected Data	3
Number of Distinct Detected Data	3	Number of Non-Detect Data	42
		Percent Non-Detects	93.33%
Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.44	Minimum Detected	-0.821
Maximum Detected	0.77	Maximum Detected	-0.261
Mean of Detected	0.59	Mean of Detected	-0.554
SD of Detected	0.167	SD of Detected	0.281
Minimum Non-Detect	0.13	Minimum Non-Detect	-2.04
Maximum Non-Detect	0.25	Maximum Non-Detect	-1.386

Note: Data have multiple DLs - Use of KM Method is recommended
For all methods (except KM, DL/2, and ROS Methods),
Observations < Largest ND are treated as NDs

Number treated as Non-Detect	42
Number treated as Detected	3
Single DL Non-Detect Percentage	93.33%

Warning: There are only 3 Distinct Detected Values in this data set
The number of detected data may not be adequate enough to perform GOF tests, bootstrap, and ROS methods.
Those methods will return a 'N/A' value on your output display!

It is necessary to have 4 or more Distinct Values for bootstrap methods.
However, results obtained using 4 to 9 distinct values may not be reliable.
It is recommended to have 10 to 15 or more observations for accurate and meaningful results and estimates.

UCL Statistics			
Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic	0.976	Shapiro Wilk Test Statistic	0.994
5% Shapiro Wilk Critical Value	0.767	5% Shapiro Wilk Critical Value	0.767
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	
Assuming Normal Distribution		Assuming Lognormal Distribution	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	0.136	Mean	-2.196
SD	0.131	SD	0.542
95% DL/2 (t) UCL	0.169	95% H-Stat (DL/2) UCL	0.151
Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
MLE yields a negative mean		Mean in Log Scale	-2.693
		SD in Log Scale	1.061
		Mean in Original Scale	0.118
		SD in Original Scale	0.149
		95% t UCL	0.155
		95% Percentile Bootstrap UCL	0.155
		95% BCA Bootstrap UCL	0.169
Gamma Distribution Test with Detected Values Only		Data Distribution Test with Detected Values Only	
k star (bias corrected)	N/A	Data appear Normal at 5% Significance Level	
Theta Star	N/A		
nu star	N/A		

Table B-5. 300 Area Subregion General UCL Statistics for Data Sets with Non-Detects

A-D Test Statistic	N/A	Nonparametric Statistics	
5% A-D Critical Value	N/A	Kaplan-Meier (KM) Method	
K-S Test Statistic	N/A	Mean	0.45
5% K-S Critical Value	N/A	SD	0.0514
Data not Gamma Distributed at 5% Significance Level		SE of Mean	0.00938
Assuming Gamma Distribution		95% KM (t) UCL	0.466
Gamma ROS Statistics using Extrapolated Data		95% KM (z) UCL	0.465
Minimum	N/A	95% KM (jackknife) UCL	0.527
Maximum	N/A	95% KM (bootstrap t) UCL	0.461
Mean	N/A	95% KM (BCA) UCL	0.77
Median	N/A	95% KM (Percentile Bootstrap) UCL	0.77
SD	N/A	95% KM (Chebyshev) UCL	0.491
k star	N/A	97.5% KM (Chebyshev) UCL	0.509
Theta star	N/A	99% KM (Chebyshev) UCL	0.543
Nu star	N/A	Potential UCLs to Use	
AppChi2	N/A	95% KM (t) UCL	0.466
95% Gamma Approximate UCL	N/A	95% KM (Percentile Bootstrap) UCL	0.77
95% Adjusted Gamma UCL	N/A		

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006). For additional insight, the user may want to consult a statistician.

Carbon disulfide

General Statistics			
Number of Valid Data	45	Number of Detected Data	4
Number of Distinct Detected Data	4	Number of Non-Detect Data	41
		Percent Non-Detects	91.11%
Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.056	Minimum Detected	-2.882
Maximum Detected	0.075	Maximum Detected	-2.59
Mean of Detected	0.0653	Mean of Detected	-2.739
SD of Detected	0.0101	SD of Detected	0.156
Minimum Non-Detect	0.051	Minimum Non-Detect	-2.976
Maximum Non-Detect	0.051	Maximum Non-Detect	-2.976

Warning: There are only 4 Distinct Detected Values in this data

Note: It should be noted that even though bootstrap may be performed on this data set the resulting calculations may not be reliable enough to draw conclusions

It is recommended to have 10-15 or more distinct observations for accurate and meaningful results.

UCL Statistics		UCL Statistics	
Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic	0.802	Shapiro Wilk Test Statistic	0.801
5% Shapiro Wilk Critical Value	0.748	5% Shapiro Wilk Critical Value	0.748
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	
Assuming Normal Distribution		Assuming Lognormal Distribution	
DL/2 Substitution Method		DL/2 Substitution Method	

Table B-5. 300 Area Subregion General UCL Statistics for Data Sets with Non-Detects

Mean	0.029	Mean	-3.586
SD	0.0117	SD	0.271
95% DL/2 (t) UCL	0.032	95% H-Stat (DL/2) UCL	0.0309
Maximum Likelihood Estimate(MLE) Method		Log ROS Method	
Mean	0.0124	Mean in Log Scale	-3.641
SD	0.0288	SD in Log Scale	0.494
95% MLE (t) UCL	0.0196	Mean in Original Scale	0.0296
95% MLE (Tiku) UCL	0.0457	SD in Original Scale	0.0152
		95% t UCL	0.0334
		95% Percentile Bootstrap UCL	0.0334
		95% BCA Bootstrap UCL	0.0336
Gamma Distribution Test with Detected Values Only		Data Distribution Test with Detected Values Only	
k star (bias corrected)	13.89	Data appear Normal at 5% Significance Level	
Theta Star	0.0047		
nu star	111.1		
A-D Test Statistic	0.577	Nonparametric Statistics	
5% A-D Critical Value	0.656	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.656	Mean	0.0568
5% K-S Critical Value	0.394	SD	0.00371
		SE of Mean	0.00063923
		95% KM (t) UCL	0.0579
		95% KM (z) UCL	0.0579
		95% KM (jackknife) UCL	0.0577
		95% KM (bootstrap t) UCL	0.0574
		95% KM (BCA) UCL	0.0732
		95% KM (Percentile Bootstrap) UCL	0.0731
		95% KM (Chebyshev) UCL	0.0596
		97.5% KM (Chebyshev) UCL	0.0608
		99% KM (Chebyshev) UCL	0.0632
Data appear Gamma Distributed at 5% Significance Level		Potential UCLs to Use	
Assuming Gamma Distribution		95% KM (t) UCL 0.0579	
Gamma ROS Statistics using Extrapolated Data		95% KM (Percentile Bootstrap) UCL 0.0731	
Minimum	0.0534		
Maximum	0.125		
Mean	0.0998		
Median	0.105		
SD	0.0204		
k star	19.67		
Theta star	0.00507		
Nu star	1771		
AppChi2	1674		
95% Gamma Approximate UCL	0.106		
95% Adjusted Gamma UCL	N/A		

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.

These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).

For additional insight, the user may want to consult a statistician.

Carbon tetrachloride

General Statistics			
Number of Valid Data	45	Number of Detected Data	3
Number of Distinct Detected Data	3	Number of Non-Detect Data	42
		Percent Non-Detects	93.33%
Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.13	Minimum Detected	-2.04
Maximum Detected	0.59	Maximum Detected	-0.528
Mean of Detected	0.327	Mean of Detected	-1.305
SD of Detected	0.237	SD of Detected	0.757
Minimum Non-Detect	0.12	Minimum Non-Detect	-2.12

Table B-5. 300 Area Subregion General UCL Statistics for Data Sets with Non-Detects

Maximum Non-Detect	0.12	Maximum Non-Detect	-2.12
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Warning: There are only 3 Distinct Detected Values in this data set
The number of detected data may not be adequate enough to perform GOF tests, bootstrap, and ROS methods.
Those methods will return a 'N/A' value on your output display!

It is necessary to have 4 or more Distinct Values for bootstrap methods.
However, results obtained using 4 to 9 distinct values may not be reliable.
It is recommended to have 10 to 15 or more observations for accurate and meaningful results and estimates.

		UCL Statistics				
Normal Distribution Test with Detected Values Only				Lognormal Distribution Test with Detected Values Only		
	Shapiro Wilk Test Statistic	0.941			Shapiro Wilk Test Statistic	0.998
	5% Shapiro Wilk Critical Value	0.767			5% Shapiro Wilk Critical Value	0.767
				Data appear Lognormal at 5% Significance Level		
Data appear Normal at 5% Significance Level						
Assuming Normal Distribution				Assuming Lognormal Distribution		
	DL/2 Substitution Method				DL/2 Substitution Method	
	Mean	0.0778			Mean	-2.713
	SD	0.0842			SD	0.413
	95% DL/2 (t) UCL	0.0989			95% H-Stat (DL/2) UCL	0.0811
	Maximum Likelihood Estimate(MLE) Method	N/A			Log ROS Method	
MLE yields a negative mean					Mean in Log Scale	-7.082
					SD in Log Scale	2.953
					Mean in Original Scale	0.0266
					SD in Original Scale	0.0962
					95% t UCL	0.0507
					95% Percentile Bootstrap UCL	0.0525
					95% BCA Bootstrap UCL	0.0678
Gamma Distribution Test with Detected Values Only				Data Distribution Test with Detected Values Only		
	k star (bias corrected)	N/A		Data appear Normal at 5% Significance Level		
	Theta Star	N/A				
	nu star	N/A				
	A-D Test Statistic	N/A		Nonparametric Statistics		
	5% A-D Critical Value	N/A			Kaplan-Meier (KM) Method	
	K-S Test Statistic	N/A			Mean	0.143
	5% K-S Critical Value	N/A			SD	0.07
Data not Gamma Distributed at 5% Significance Level					SE of Mean	0.0128
Assuming Gamma Distribution					95% KM (t) UCL	0.165
	Gamma ROS Statistics using Extrapolated Data				95% KM (z) UCL	0.164
	Minimum	N/A			95% KM (jackknife) UCL	0.227
	Maximum	N/A			95% KM (bootstrap t) UCL	0.164
	Mean	N/A			95% KM (BCA) UCL	0.59
	Median	N/A			95% KM (Percentile Bootstrap) UCL	0.59
	SD	N/A			95% KM (Chebyshev) UCL	0.199
	k star	N/A			97.5% KM (Chebyshev) UCL	0.223
	Theta star	N/A			99% KM (Chebyshev) UCL	0.27
	Nu star	N/A		Potential UCLs to Use		
	AppChi2	N/A			95% KM (t) UCL	0.165
	95% Gamma Approximate UCL	N/A			95% KM (Percentile Bootstrap) UCL	0.59
	95% Adjusted Gamma UCL	N/A				

Table B-5. 300 Area Subregion General UCL Statistics for Data Sets with Non-Detects

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.

These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).

For additional insight, the user may want to consult a statistician.

Chloride

General Statistics

Number of Valid Observations 45

Number of Distinct Observations 40

Raw Statistics

Minimum 6890
Maximum 29000
Mean 20405
Median 21100
SD 4579
Coefficient of Variation 0.224
Skewness -1.145

Log-transformed Statistics

Minimum of Log Data 8.838
Maximum of Log Data 10.28
Mean of log Data 9.889
SD of log Data 0.29

Relevant UCL Statistics

Normal Distribution Test

Shapiro Wilk Test Statistic 0.906
Shapiro Wilk Critical Value 0.945

Data not Normal at 5% Significance Level

Lognormal Distribution Test

Shapiro Wilk Test Statistic 0.768
Shapiro Wilk Critical Value 0.945

Data not Lognormal at 5% Significance Level

Assuming Normal Distribution

95% Student's-t UCL 21552

95% UCLs (Adjusted for Skewness)

95% Adjusted-CLT UCL (Chen-1995) 21403
95% Modified-t UCL (Johnson-1978) 21533

Assuming Lognormal Distribution

95% H-UCL 22223

95% Chebyshev (MVUE) UCL 24492
97.5% Chebyshev (MVUE) UCL 26198
99% Chebyshev (MVUE) UCL 29548

Gamma Distribution Test

k star (bias corrected) 13.87
Theta Star 1471
MLE of Mean 20405
MLE of Standard Deviation 5479
nu star 1248
Approximate Chi Square Value (.05) 1167
Adjusted Level of Significance 0.0447
Adjusted Chi Square Value 1165

Data not Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

95% Approximate Gamma UCL 21822
95% Adjusted Gamma UCL 21870

Potential UCL to Use

Data Distribution

Data do not follow a Discernable Distribution (0.05)

Nonparametric Statistics

95% CLT UCL 21528
95% Jackknife UCL 21552
95% Standard Bootstrap UCL 21520
95% Bootstrap-t UCL 21411
95% Hall's Bootstrap UCL 21419
95% Percentile Bootstrap UCL 21465
95% BCA Bootstrap UCL 21442
95% Chebyshev(Mean, Sd) UCL 23380
97.5% Chebyshev(Mean, Sd) UCL 24668
99% Chebyshev(Mean, Sd) UCL 27196

Use 95% Student's-t UCL 21552
or 95% Modified-t UCL 21533

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.

Table B-5. 300 Area Subregion General UCL Statistics for Data Sets with Non-Detects
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Chloroform

General Statistics			
Number of Valid Data	45	Number of Detected Data	12
Number of Distinct Detected Data	11	Number of Non-Detect Data	33
		Percent Non-Detects	73.33%
Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.13	Minimum Detected	-2.04
Maximum Detected	0.87	Maximum Detected	-0.139
Mean of Detected	0.399	Mean of Detected	-1.086
SD of Detected	0.226	SD of Detected	0.635
Minimum Non-Detect	0.1	Minimum Non-Detect	-2.303
Maximum Non-Detect	0.1	Maximum Non-Detect	-2.303
UCL Statistics			
Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic	0.94	Shapiro Wilk Test Statistic	0.925
5% Shapiro Wilk Critical Value	0.859	5% Shapiro Wilk Critical Value	0.859
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	
Assuming Normal Distribution		Assuming Lognormal Distribution	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	0.143	Mean	-2.487
SD	0.193	SD	0.911
95% DL/2 (t) UCL	0.191	95% H-Stat (DL/2) UCL	0.172
Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
MLE yields a negative mean		Mean in Log Scale	-2.772
		SD in Log Scale	1.349
		Mean in Original Scale	0.142
		SD in Original Scale	0.196
		95% t UCL	0.191
		95% Percentile Bootstrap UCL	0.192
		95% BCA Bootstrap UCL	0.199
Gamma Distribution Test with Detected Values Only		Data Distribution Test with Detected Values Only	
k star (bias corrected)	2.407	Data appear Normal at 5% Significance Level	
Theta Star	0.166		
nu star	57.76		
A-D Test Statistic	0.297	Nonparametric Statistics	
5% A-D Critical Value	0.739	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.739	Mean	0.202
5% K-S Critical Value	0.247	SD	0.163
Data appear Gamma Distributed at 5% Significance Level		SE of Mean	0.0254
Assuming Gamma Distribution		95% KM (t) UCL	0.245
Gamma ROS Statistics using Extrapolated Data		95% KM (z) UCL	0.244
Minimum	0.00308	95% KM (jackknife) UCL	0.238
Maximum	1.254	95% KM (bootstrap t) UCL	0.252
Mean	0.68	95% KM (BCA) UCL	0.296
		95% KM (Percentile Bootstrap) UCL	0.271

Table B-5. 300 Area Subregion General UCL Statistics for Data Sets with Non-Detects

Median	0.672	95% KM (Chebyshev) UCL	0.313
SD	0.359	97.5% KM (Chebyshev) UCL	0.361
k star	1.899	99% KM (Chebyshev) UCL	0.455
Theta star	0.358		
Nu star	170.9	Potential UCLs to Use	
AppChi2	141.7	95% KM (t) UCL	0.245
95% Gamma Approximate UCL	0.821	95% KM (Percentile Bootstrap) UCL	0.271
95% Adjusted Gamma UCL	0.826		

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006). For additional insight, the user may want to consult a statistician.

Chromium

General Statistics			
Number of Valid Data	45	Number of Detected Data	44
Number of Distinct Detected Data	41	Number of Non-Detect Data	1
		Percent Non-Detects	2.22%
Raw Statistics		Log-transformed Statistics	
Minimum Detected	1.37	Minimum Detected	0.315
Maximum Detected	16.5	Maximum Detected	2.803
Mean of Detected	4.382	Mean of Detected	1.369
SD of Detected	2.487	SD of Detected	0.449
Minimum Non-Detect	1	Minimum Non-Detect	0
Maximum Non-Detect	1	Maximum Non-Detect	0
UCL Statistics		Lognormal Distribution Test with Detected Values Only	
Normal Distribution Test with Detected Values Only		Shapiro Wilk Test Statistic	0.977
Shapiro Wilk Test Statistic	0.751	5% Shapiro Wilk Critical Value	0.944
5% Shapiro Wilk Critical Value	0.944		
Data not Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	
Assuming Normal Distribution		Assuming Lognormal Distribution	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	4.296	Mean	1.323
SD	2.525	SD	0.54
95% DL/2 (t) UCL	4.929	95% H-Stat (DL/2) UCL	5.084
Maximum Likelihood Estimate(MLE) Method		Log ROS Method	
Mean	4.281	Mean in Log Scale	1.343
SD	2.527	SD in Log Scale	0.476
95% MLE (t) UCL	4.914	Mean in Original Scale	4.313
95% MLE (Tiku) UCL	4.895	SD in Original Scale	2.502
		95% t UCL	4.939
		95% Percentile Bootstrap UCL	4.971
		95% BCA Bootstrap UCL	5.146
Gamma Distribution Test with Detected Values Only		Data Distribution Test with Detected Values Only	
k star (bias corrected)	4.441	Data Follow Appr. Gamma Distribution at 5% Significance Level	
Theta Star	0.987		
nu star	390.8		

Table B-5. 300 Area Subregion General UCL Statistics for Data Sets with Non-Detects

A-D Test Statistic	0.789	Nonparametric Statistics	
5% A-D Critical Value	0.753	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.753	Mean	4.315
5% K-S Critical Value	0.134	SD	2.471
Data follow Appr. Gamma Distribution at 5% Significance Level		SE of Mean	0.373
Assuming Gamma Distribution		95% KM (t) UCL	4.941
Gamma ROS Statistics using Extrapolated Data		95% KM (z) UCL	4.928
Minimum	1E-12	95% KM (jackknife) UCL	4.935
Maximum	16.5	95% KM (bootstrap t) UCL	5.225
Mean	4.285	95% KM (BCA) UCL	4.998
Median	3.71	95% KM (Percentile Bootstrap) UCL	4.979
SD	2.543	95% KM (Chebyshev) UCL	5.939
k star	0.771	97.5% KM (Chebyshev) UCL	6.642
Theta star	5.555	99% KM (Chebyshev) UCL	8.023
Nu star	69.42	Potential UCLs to Use	
AppChi2	51.24	95% KM (BCA) UCL	4.998
95% Gamma Approximate UCL	5.805		
95% Adjusted Gamma UCL	5.864		

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006). For additional insight, the user may want to consult a statistician.

cis-1,2-Dichloroethylene

General Statistics			
Number of Valid Data	45	Number of Detected Data	11
Number of Distinct Detected Data	8	Number of Non-Detect Data	34
		Percent Non-Detects	75.56%
Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.12	Minimum Detected	-2.12
Maximum Detected	0.69	Maximum Detected	-0.371
Mean of Detected	0.28	Mean of Detected	-1.427
SD of Detected	0.193	SD of Detected	0.533
Minimum Non-Detect	0.087	Minimum Non-Detect	-2.442
Maximum Non-Detect	0.087	Maximum Non-Detect	-2.442
UCL Statistics		Lognormal Distribution Test with Detected Values Only	
Normal Distribution Test with Detected Values Only		Shapiro Wilk Test Statistic	0.766
Shapiro Wilk Test Statistic	0.638	5% Shapiro Wilk Critical Value	0.85
5% Shapiro Wilk Critical Value	0.85	Data not Lognormal at 5% Significance Level	
Data not Normal at 5% Significance Level		Assuming Lognormal Distribution	
Assuming Normal Distribution		DL/2 Substitution Method	
DL/2 Substitution Method		Mean	-2.717
Mean	0.101	SD	0.785
SD	0.138	95% H-Stat (DL/2) UCL	0.116
95% DL/2 (t) UCL	0.136		
Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
MLE yields a negative mean		Mean in Log Scale	-2.912
		SD in Log Scale	1.141

Table B-5. 300 Area Subregion General UCL Statistics for Data Sets with Non-Detects

			Mean in Original Scale	0.102
			SD in Original Scale	0.14
			95% t UCL	0.137
			95% Percentile Bootstrap UCL	0.138
			95% BCA Bootstrap UCL	0.147
Gamma Distribution Test with Detected Values Only		Data Distribution Test with Detected Values Only		
	k star (bias corrected)	2.542	Data do not follow a Discernable Distribution (0.05)	
	Theta Star	0.11		
	nu star	55.92		
	A-D Test Statistic	1.614	Nonparametric Statistics	
	5% A-D Critical Value	0.733	Kaplan-Meier (KM) Method	
	K-S Test Statistic	0.733		Mean
	5% K-S Critical Value	0.257		SD
Data not Gamma Distributed at 5% Significance Level				SE of Mean
Assuming Gamma Distribution				95% KM (t) UCL
	Gamma ROS Statistics using Extrapolated Data			95% KM (z) UCL
	Minimum	0.033		95% KM (jackknife) UCL
	Maximum	0.863		95% KM (bootstrap t) UCL
	Mean	0.487		95% KM (BCA) UCL
	Median	0.521		95% KM (Percentile Bootstrap) UCL
	SD	0.248		95% KM (Chebyshev) UCL
	k star	2.652		97.5% KM (Chebyshev) UCL
	Theta star	0.184		99% KM (Chebyshev) UCL
	Nu star	238.7		
	AppChi2	203.9		Potential UCLs to Use
	95% Gamma Approximate UCL	0.57		95% KM (t) UCL
	95% Adjusted Gamma UCL	0.573		95% KM (% Bootstrap) UCL

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006). For additional insight, the user may want to consult a statistician.

Cobalt

General Statistics			
Number of Valid Data	45	Number of Detected Data	3
Number of Distinct Detected Data	3	Number of Non-Detect Data	42
		Percent Non-Detects	93.33%
Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.136	Minimum Detected	-1.995
Maximum Detected	0.162	Maximum Detected	-1.82
Mean of Detected	0.149	Mean of Detected	-1.904
SD of Detected	0.013	SD of Detected	0.0877
Minimum Non-Detect	0.05	Minimum Non-Detect	-2.996
Maximum Non-Detect	0.22	Maximum Non-Detect	-1.514
		Number treated as Non-Detect	45
		Number treated as Detected	0
		Single DL Non-Detect Percentage	100.00%

Note: Data have multiple DLs - Use of KM Method is recommended
For all methods (except KM, DL/2, and ROS Methods),
Observations < Largest ND are treated as NDs

Warning: There are only 3 Distinct Detected Values in this data set

Table B-5. 300 Area Subregion General UCL Statistics for Data Sets with Non-Detects
The number of detected data may not be adequate enough to perform GOF tests, bootstrap, and ROS methods.
Those methods will return a 'N/A' value on your output display!

It is necessary to have 4 or more Distinct Values for bootstrap methods.
However, results obtained using 4 to 9 distinct values may not be reliable.
It is recommended to have 10 to 15 or more observations for accurate and meaningful results and estimates.

		UCL Statistics			
Normal Distribution Test with Detected Values Only				Lognormal Distribution Test with Detected Values Only	
	Shapiro Wilk Test Statistic	0.998			Shapiro Wilk Test Statistic 0.995
	5% Shapiro Wilk Critical Value	0.767			5% Shapiro Wilk Critical Value 0.767
Data appear Normal at 5% Significance Level				Data appear Lognormal at 5% Significance Level	
Assuming Normal Distribution			Assuming Lognormal Distribution		
	DL/2 Substitution Method				DL/2 Substitution Method
	Mean	0.0552			Mean -2.982
	SD	0.0284			SD 0.387
	95% DL/2 (t) UCL	0.0623			95% H-Stat (DL/2) UCL 0.0608
	Maximum Likelihood Estimate(MLE) Method	N/A			Log ROS Method
MLE method failed to converge properly					Mean in Log Scale -2.555
					SD in Log Scale 0.323
					Mean in Original Scale 0.0818
					SD in Original Scale 0.0274
					95% t UCL 0.0886
					95% Percentile Bootstrap UCL 0.0884
					95% BCA Bootstrap UCL 0.0894
Gamma Distribution Test with Detected Values Only				Data Distribution Test with Detected Values Only	
	k star (bias corrected)	N/A		Data appear Normal at 5% Significance Level	
	Theta Star	N/A			
	nu star	N/A			
	A-D Test Statistic	N/A		Nonparametric Statistics	
	5% A-D Critical Value	N/A			Kaplan-Meier (KM) Method
	K-S Test Statistic	N/A			Mean 0.137
	5% K-S Critical Value	N/A			SD 0.00436
Data not Gamma Distributed at 5% Significance Level					SE of Mean 0.00080464
					95% KM (t) UCL 0.138
					95% KM (z) UCL 0.138
					95% KM (jackknife) UCL 0.146
					95% KM (bootstrap t) UCL 0.137
					95% KM (BCA) UCL 0.162
					95% KM (Percentile Bootstrap) UCL N/A
					95% KM (Chebyshev) UCL 0.14
					97.5% KM (Chebyshev) UCL 0.142
					99% KM (Chebyshev) UCL 0.145
				Potential UCLs to Use	
					95% KM (t) UCL 0.138
					95% KM (Percentile Bootstrap) UCL N/A
	Assuming Gamma Distribution				
	Gamma ROS Statistics using Extrapolated Data				
	Minimum	N/A			
	Maximum	N/A			
	Mean	N/A			
	Median	N/A			
	SD	N/A			
	k star	N/A			
	Theta star	N/A			
	Nu star	N/A			
	AppChi2	N/A			
	95% Gamma Approximate UCL	N/A			
	95% Adjusted Gamma UCL	N/A			

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).

Table B-5. 300 Area Subregion General UCL Statistics for Data Sets with Non-Detects
For additional insight, the user may want to consult a statistician.

Copper

General Statistics			
Number of Valid Data	45	Number of Detected Data	23
Number of Distinct Detected Data	23	Number of Non-Detect Data	22
		Percent Non-Detects	48.89%
Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.205	Minimum Detected	-1.585
Maximum Detected	30.7	Maximum Detected	3.424
Mean of Detected	2.247	Mean of Detected	-0.469
SD of Detected	6.456	SD of Detected	1.215
Minimum Non-Detect	0.1	Minimum Non-Detect	-2.303
Maximum Non-Detect	0.45	Maximum Non-Detect	-0.799
		Number treated as Non-Detect	35
		Number treated as Detected	10
		Single DL Non-Detect Percentage	77.78%
UCL Statistics		Lognormal Distribution Test with Detected Values Only	
Normal Distribution Test with Detected Values Only			
Shapiro Wilk Test Statistic	0.339	Shapiro Wilk Test Statistic	0.766
5% Shapiro Wilk Critical Value	0.914	5% Shapiro Wilk Critical Value	0.914
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	
Assuming Normal Distribution		Assuming Lognormal Distribution	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	1.198	Mean	-1.378
SD	4.692	SD	1.288
95% DL/2 (t) UCL	2.373	95% H-Stat (DL/2) UCL	0.978
Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
MLE yields a negative mean		Mean in Log Scale	-1.941
		SD in Log Scale	1.88
		Mean in Original Scale	1.17
		SD in Original Scale	4.699
		95% t UCL	2.347
		95% Percentile Bootstrap UCL	2.543
		95% BCA Bootstrap UCL	3.383
Gamma Distribution Test with Detected Values Only		Data Distribution Test with Detected Values Only	
k star (bias corrected)	0.461	Data do not follow a Discernable Distribution (0.05)	
Theta Star	4.87		
nu star	21.22		
A-D Test Statistic	3.909	Nonparametric Statistics	
5% A-D Critical Value	0.806	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.806	Mean	1.249
5% K-S Critical Value	0.192	SD	4.628
Data not Gamma Distributed at 5% Significance Level		SE of Mean	0.705
Assuming Gamma Distribution		95% KM (t) UCL	2.434
Gamma ROS Statistics using Extrapolated Data		95% KM (z) UCL	2.41
Minimum	1E-12	95% KM (jackknife) UCL	2.415
		95% KM (bootstrap t) UCL	13.24

Table B-5. 300 Area Subregion General UCL Statistics for Data Sets with Non-Detects

Maximum	30.7	95% KM (BCA) UCL	2.586
Mean	2.205	95% KM (Percentile Bootstrap) UCL	2.587
Median	0.425	95% KM (Chebyshev) UCL	4.324
SD	4.928	97.5% KM (Chebyshev) UCL	5.654
k star	0.123	99% KM (Chebyshev) UCL	8.267
Theta star	17.92		
Nu star	11.07	Potential UCLs to Use	
AppChi2	4.623	95% KM (Chebyshev) UCL	4.324
95% Gamma Approximate UCL	5.282		
95% Adjusted Gamma UCL	5.445		

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006). For additional insight, the user may want to consult a statistician.

Cyanide

General Statistics			
Number of Valid Data	45	Number of Detected Data	1
Number of Distinct Detected Data	1	Number of Non-Detect Data	44
		Percent Non-Detects	97.78%

Warning: Only one distinct data value was detected! ProUCL (or any other software) should not be used on such a data set! It is suggested to use alternative site specific values determined by the Project Team to estimate environmental parameters (e.g., EPC, BTV).

The data set for variable Cyanide was not processed!

Fluoride

General Statistics			
Number of Valid Data	45	Number of Detected Data	43
Number of Distinct Detected Data	37	Number of Non-Detect Data	2
		Percent Non-Detects	4.44%
Raw Statistics		Log-transformed Statistics	
Minimum Detected	85.7	Minimum Detected	4.451
Maximum Detected	340	Maximum Detected	5.829
Mean of Detected	208.5	Mean of Detected	5.302
SD of Detected	55.65	SD of Detected	0.285
Minimum Non-Detect	60	Minimum Non-Detect	4.094
Maximum Non-Detect	60	Maximum Non-Detect	4.094
UCL Statistics		UCL Statistics	
Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic	0.987	Shapiro Wilk Test Statistic	0.97
5% Shapiro Wilk Critical Value	0.943	5% Shapiro Wilk Critical Value	0.943
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	
Assuming Normal Distribution		Assuming Lognormal Distribution	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	200.5	Mean	5.218
SD	65.88	SD	0.484

Table B-5. 300 Area Subregion General UCL Statistics for Data Sets with Non-Detects

95% DL/2 (t) UCL	217	95% H-Stat (DL/2) UCL	238.2
Maximum Likelihood Estimate(MLE) Method		Log ROS Method	
Mean	200.8	Mean in Log Scale	5.272
SD	64.46	SD in Log Scale	0.312
95% MLE (t) UCL	217	Mean in Original Scale	203.7
95% MLE (Tiku) UCL	217.3	SD in Original Scale	58.73
		95% t UCL	218.4
		95% Percentile Bootstrap UCL	218
		95% BCA Bootstrap UCL	218.3
Gamma Distribution Test with Detected Values Only		Data Distribution Test with Detected Values Only	
k star (bias corrected)	12.57	Data appear Normal at 5% Significance Level	
Theta Star	16.59		
nu star	1081		
A-D Test Statistic	0.238	Nonparametric Statistics	
5% A-D Critical Value	0.748	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.748	Mean	203
5% K-S Critical Value	0.135	SD	59.42
		SE of Mean	8.963
		95% KM (t) UCL	218.1
		95% KM (z) UCL	217.7
		95% KM (jackknife) UCL	217.5
		95% KM (bootstrap t) UCL	218
		95% KM (BCA) UCL	219
		95% KM (Percentile Bootstrap) UCL	218.2
		95% KM (Chebyshev) UCL	242.1
		97.5% KM (Chebyshev) UCL	259
		99% KM (Chebyshev) UCL	292.2
		Potential UCLs to Use	
		95% KM (t) UCL	218.1
		95% KM (Percentile Bootstrap) UCL	218.2
Data appear Gamma Distributed at 5% Significance Level			
Assuming Gamma Distribution			
Gamma ROS Statistics using Extrapolated Data			
Minimum	54.36		
Maximum	340		
Mean	202.2		
Median	198		
SD	61.89		
k star	8.444		
Theta star	23.94		
Nu star	760		
AppChi2	697		
95% Gamma Approximate UCL	220.4		
95% Adjusted Gamma UCL	221.1		

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006). For additional insight, the user may want to consult a statistician.

Gross alpha

General Statistics		Log-transformed Statistics	
Number of Valid Observations	28	Number of Distinct Observations	22
Raw Statistics		Log-transformed Statistics	
Minimum	3.4	Minimum of Log Data	1.224
Maximum	77	Maximum of Log Data	4.344
Mean	23.39	Mean of log Data	2.814
Median	16	SD of log Data	0.833
SD	21		
Coefficient of Variation	0.898		
Skewness	1.557		
Relevant UCL Statistics			

Table B-5. 300 Area Subregion General UCL Statistics for Data Sets with Non-Detects

<p>Normal Distribution Test</p> <p>Shapiro Wilk Test Statistic 0.784 Shapiro Wilk Critical Value 0.924</p> <p>Data not Normal at 5% Significance Level</p> <p>Assuming Normal Distribution</p> <p>95% Student's-t UCL 30.15</p> <p>95% UCLs (Adjusted for Skewness)</p> <p>95% Adjusted-CLT UCL (Chen-1995) 31.17 95% Modified-t UCL (Johnson-1978) 30.35</p> <p>Gamma Distribution Test</p> <p>k star (bias corrected) 1.476 Theta Star 15.85 MLE of Mean 23.39 MLE of Standard Deviation 19.26 nu star 82.64 Approximate Chi Square Value (.05) 62.69 Adjusted Level of Significance 0.0404 Adjusted Chi Square Value 61.61</p> <p>Anderson-Darling Test Statistic 0.643 Anderson-Darling 5% Critical Value 0.761 Kolmogorov-Smirnov Test Statistic 0.129 Kolmogorov-Smirnov 5% Critical Value 0.168</p> <p>Data appear Gamma Distributed at 5% Significance Level</p> <p>Assuming Gamma Distribution</p> <p>95% Approximate Gamma UCL 30.84 95% Adjusted Gamma UCL 31.38</p> <p>Potential UCL to Use</p>	<p>Lognormal Distribution Test</p> <p>Shapiro Wilk Test Statistic 0.969 Shapiro Wilk Critical Value 0.924</p> <p>Data appear Lognormal at 5% Significance Level</p> <p>Assuming Lognormal Distribution</p> <p>95% H-UCL 33.89 95% Chebyshev (MVUE) UCL 40.85 97.5% Chebyshev (MVUE) UCL 48.47 99% Chebyshev (MVUE) UCL 63.46</p> <p>Data Distribution</p> <p>Data appear Gamma Distributed at 5% Significance Level</p> <p>Nonparametric Statistics</p> <p>95% CLT UCL 29.92 95% Jackknife UCL 30.15 95% Standard Bootstrap UCL 29.85 95% Bootstrap-t UCL 32.41 95% Hall's Bootstrap UCL 30.54 95% Percentile Bootstrap UCL 29.84 95% BCA Bootstrap UCL 31.11 95% Chebyshev(Mean, Sd) UCL 40.69 97.5% Chebyshev(Mean, Sd) UCL 48.18 99% Chebyshev(Mean, Sd) UCL 62.89</p> <p>Use 95% Approximate Gamma UCL 30.84</p>
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Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Gross beta

General Statistics	
Number of Valid Observations 28	Number of Distinct Observations 21
<p>Raw Statistics</p> <p>Minimum 2.7 Maximum 49 Mean 21.47 Median 20 SD 11.42 Coefficient of Variation 0.532 Skewness 0.683</p>	<p>Log-transformed Statistics</p> <p>Minimum of Log Data 0.993 Maximum of Log Data 3.892 Mean of log Data 2.903 SD of log Data 0.639</p>
Relevant UCL Statistics	
<p>Normal Distribution Test</p> <p>Shapiro Wilk Test Statistic 0.954 Shapiro Wilk Critical Value 0.924</p> <p>Data appear Normal at 5% Significance Level</p>	<p>Lognormal Distribution Test</p> <p>Shapiro Wilk Test Statistic 0.937 Shapiro Wilk Critical Value 0.924</p> <p>Data appear Lognormal at 5% Significance Level</p>

Table B-5. 300 Area Subregion General UCL Statistics for Data Sets with Non-Detects

<p>Assuming Normal Distribution</p> <p style="padding-left: 40px;">95% Student's-t UCL 25.14</p> <p>95% UCLs (Adjusted for Skewness)</p> <p style="padding-left: 40px;">95% Adjusted-CLT UCL (Chen-1995) 25.31</p> <p style="padding-left: 40px;">95% Modified-t UCL (Johnson-1978) 25.19</p> <p>Gamma Distribution Test</p> <p style="padding-left: 40px;">k star (bias corrected) 2.886</p> <p style="padding-left: 80px;">Theta Star 7.438</p> <p style="padding-left: 80px;">MLE of Mean 21.47</p> <p style="padding-left: 40px;">MLE of Standard Deviation 12.64</p> <p style="padding-left: 80px;">nu star 161.6</p> <p style="padding-left: 40px;">Approximate Chi Square Value (.05) 133.2</p> <p style="padding-left: 40px;">Adjusted Level of Significance 0.0404</p> <p style="padding-left: 40px;">Adjusted Chi Square Value 131.6</p> <p style="padding-left: 40px;">Anderson-Darling Test Statistic 0.243</p> <p style="padding-left: 40px;">Anderson-Darling 5% Critical Value 0.753</p> <p style="padding-left: 40px;">Kolmogorov-Smirnov Test Statistic 0.0966</p> <p style="padding-left: 40px;">Kolmogorov-Smirnov 5% Critical Value 0.166</p> <p>Data appear Gamma Distributed at 5% Significance Level</p> <p>Assuming Gamma Distribution</p> <p style="padding-left: 40px;">95% Approximate Gamma UCL 26.04</p> <p style="padding-left: 40px;">95% Adjusted Gamma UCL 26.36</p> <p>Potential UCL to Use</p>	<p>Assuming Lognormal Distribution</p> <p style="padding-left: 40px;">95% H-UCL 28.8</p> <p style="padding-left: 40px;">95% Chebyshev (MVUE) UCL 34.61</p> <p style="padding-left: 40px;">97.5% Chebyshev (MVUE) UCL 39.99</p> <p style="padding-left: 40px;">99% Chebyshev (MVUE) UCL 50.58</p> <p>Data Distribution</p> <p>Data appear Normal at 5% Significance Level</p> <p>Nonparametric Statistics</p> <p style="padding-left: 40px;">95% CLT UCL 25.02</p> <p style="padding-left: 40px;">95% Jackknife UCL 25.14</p> <p style="padding-left: 40px;">95% Standard Bootstrap UCL 24.99</p> <p style="padding-left: 40px;">95% Bootstrap-t UCL 25.39</p> <p style="padding-left: 40px;">95% Hall's Bootstrap UCL 25.45</p> <p style="padding-left: 40px;">95% Percentile Bootstrap UCL 25.03</p> <p style="padding-left: 40px;">95% BCA Bootstrap UCL 25</p> <p style="padding-left: 40px;">95% Chebyshev(Mean, Sd) UCL 30.87</p> <p style="padding-left: 40px;">97.5% Chebyshev(Mean, Sd) UCL 34.94</p> <p style="padding-left: 40px;">99% Chebyshev(Mean, Sd) UCL 42.94</p> <p style="text-align: right; padding-right: 40px;">Use 95% Student's-t UCL 25.14</p>
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Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Iron

General Statistics			
Number of Valid Data	45	Number of Detected Data	19
Number of Distinct Detected Data	18	Number of Non-Detect Data	26
		Percent Non-Detects	57.78%
Raw Statistics		Log-transformed Statistics	
Minimum Detected	18	Minimum Detected	2.89
Maximum Detected	647	Maximum Detected	6.472
Mean of Detected	128.8	Mean of Detected	4.298
SD of Detected	176.9	SD of Detected	0.976
Minimum Non-Detect	18	Minimum Non-Detect	2.89
Maximum Non-Detect	38	Maximum Non-Detect	3.638

Note: Data have multiple DLs - Use of KM Method is recommended
For all methods (except KM, DL/2, and ROS Methods),
Observations < Largest ND are treated as NDs

Number treated as Non-Detect	29
Number treated as Detected	16
Single DL Non-Detect Percentage	64.44%

UCL Statistics			
Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic	0.597	Shapiro Wilk Test Statistic	0.879
5% Shapiro Wilk Critical Value	0.901	5% Shapiro Wilk Critical Value	0.901

Table B-5. 300 Area Subregion General UCL Statistics for Data Sets with Non-Detects

Data not Normal at 5% Significance Level

Data not Lognormal at 5% Significance Level

Assuming Normal Distribution

DL/2 Substitution Method	
Mean	63.13
SD	126.7
95% DL/2 (t) UCL	94.86
Maximum Likelihood Estimate(MLE) Method	N/A
MLE yields a negative mean	

Assuming Lognormal Distribution

DL/2 Substitution Method	
Mean	3.35
SD	1.067
95% H-Stat (DL/2) UCL	74.66
Log ROS Method	
Mean in Log Scale	2.756
SD in Log Scale	1.651
Mean in Original Scale	58.78
SD in Original Scale	128.4
95% t UCL	90.94
95% Percentile Bootstrap UCL	92.87
95% BCA Bootstrap UCL	100.8

Gamma Distribution Test with Detected Values Only

k star (bias corrected)	0.899
Theta Star	143.2
nu star	34.18
A-D Test Statistic	1.873
5% A-D Critical Value	0.769
K-S Test Statistic	0.769
5% K-S Critical Value	0.204

Data Distribution Test with Detected Values Only

Data do not follow a Discernable Distribution (0.05)

Nonparametric Statistics

Kaplan-Meier (KM) Method	
Mean	65.32
SD	124.4
SE of Mean	19.06
95% KM (t) UCL	97.36
95% KM (z) UCL	96.68
95% KM (jackknife) UCL	96.4
95% KM (bootstrap t) UCL	130.5
95% KM (BCA) UCL	112.2
95% KM (Percentile Bootstrap) UCL	101.5
95% KM (Chebyshev) UCL	148.4
97.5% KM (Chebyshev) UCL	184.4
99% KM (Chebyshev) UCL	255

Data not Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

Gamma ROS Statistics using Extrapolated Data	
Minimum	18
Maximum	647
Mean	126.3
Median	109.1
SD	114.5
k star	2.043
Theta star	61.84
Nu star	183.9
AppChi2	153.5
95% Gamma Approximate UCL	151.3
95% Adjusted Gamma UCL	152.2

Potential UCLs to Use

95% KM (t) UCL	97.36
95% KM (% Bootstrap) UCL	101.5

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.

These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).

For additional insight, the user may want to consult a statistician.

Lead

General Statistics

Number of Valid Data	45
Number of Distinct Detected Data	3

Number of Detected Data	3
Number of Non-Detect Data	42
Percent Non-Detects	93.33%

Raw Statistics

Minimum Detected	0.292
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Log-transformed Statistics

Minimum Detected	-1.231
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Table B-5. 300 Area Subregion General UCL Statistics for Data Sets with Non-Detects

Maximum Detected	3.53	Maximum Detected	1.261
Mean of Detected	1.503	Mean of Detected	-0.115
SD of Detected	1.767	SD of Detected	1.266
Minimum Non-Detect	0.1	Minimum Non-Detect	-2.303
Maximum Non-Detect	0.2	Maximum Non-Detect	-1.609

Note: Data have multiple DLs - Use of KM Method is recommended
For all methods (except KM, DL/2, and ROS Methods),
Observations < Largest ND are treated as NDs

Number treated as Non-Detect	42
Number treated as Detected	3
Single DL Non-Detect Percentage	93.33%

Warning: There are only 3 Distinct Detected Values in this data set
The number of detected data may not be adequate enough to perform GOF tests, bootstrap, and ROS methods.
Those methods will return a 'N/A' value on your output display!

It is necessary to have 4 or more Distinct Values for bootstrap methods.
However, results obtained using 4 to 9 distinct values may not be reliable.
It is recommended to have 10 to 15 or more observations for accurate and meaningful results and estimates.

UCL Statistics			
Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic	0.84	Shapiro Wilk Test Statistic	0.968
5% Shapiro Wilk Critical Value	0.767	5% Shapiro Wilk Critical Value	0.767
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	
Assuming Normal Distribution		Assuming Lognormal Distribution	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	0.189	Mean	-2.222
SD	0.518	SD	0.661
95% DL/2 (t) UCL	0.318	95% H-Stat (DL/2) UCL	0.165
Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
MLE yields a negative mean		Mean in Log Scale	-9.769
		SD in Log Scale	4.79
		Mean in Original Scale	0.103
		SD in Original Scale	0.534
		95% t UCL	0.237
		95% Percentile Bootstrap UCL	0.259
		95% BCA Bootstrap UCL	0.353
Gamma Distribution Test with Detected Values Only		Data Distribution Test with Detected Values Only	
k star (bias corrected)	N/A	Data appear Normal at 5% Significance Level	
Theta Star	N/A		
nu star	N/A		
A-D Test Statistic	N/A	Nonparametric Statistics	
5% A-D Critical Value	N/A	Kaplan-Meier (KM) Method	
K-S Test Statistic	N/A	Mean	0.373
5% K-S Critical Value	N/A	SD	0.48
Data not Gamma Distributed at 5% Significance Level		SE of Mean	0.0875
Assuming Gamma Distribution		95% KM (t) UCL	0.52
Gamma ROS Statistics using Extrapolated Data		95% KM (z) UCL	0.517
Minimum	N/A	95% KM (jackknife) UCL	0.638
Maximum	N/A	95% KM (bootstrap t) UCL	0.78
Mean	N/A	95% KM (BCA) UCL	N/A
Median	N/A	95% KM (Percentile Bootstrap) UCL	3.53
		95% KM (Chebyshev) UCL	0.754

Table B-5. 300 Area Subregion General UCL Statistics for Data Sets with Non-Detects

SD	N/A	97.5% KM (Chebyshev) UCL	0.919
k star	N/A	99% KM (Chebyshev) UCL	1.244
Theta star	N/A		
Nu star	N/A	Potential UCLs to Use	
AppChi2	N/A	95% KM (t) UCL	0.52
95% Gamma Approximate UCL	N/A	95% KM (Percentile Bootstrap) UCL	3.53
95% Adjusted Gamma UCL	N/A		

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006). For additional insight, the user may want to consult a statistician.

Lithium

General Statistics			
Number of Valid Data	45	Number of Detected Data	33
Number of Distinct Detected Data	17	Number of Non-Detect Data	12
		Percent Non-Detects	26.67%
Raw Statistics		Log-transformed Statistics	
Minimum Detected	4	Minimum Detected	1.386
Maximum Detected	33	Maximum Detected	3.497
Mean of Detected	12.85	Mean of Detected	2.313
SD of Detected	8.686	SD of Detected	0.72
Minimum Non-Detect	4	Minimum Non-Detect	1.386
Maximum Non-Detect	4	Maximum Non-Detect	1.386
UCL Statistics		Lognormal Distribution Test with Detected Values Only	
Normal Distribution Test with Detected Values Only		Shapiro Wilk Test Statistic	0.889
Shapiro Wilk Test Statistic	0.868	5% Shapiro Wilk Critical Value	0.931
5% Shapiro Wilk Critical Value	0.931	Data not Lognormal at 5% Significance Level	
Data not Normal at 5% Significance Level		Assuming Lognormal Distribution	
Assuming Normal Distribution		DL/2 Substitution Method	
DL/2 Substitution Method		Mean	1.881
Mean	9.956	SD	0.95
SD	8.855	95% H-Stat (DL/2) UCL	14.36
95% DL/2 (t) UCL	12.17		
Maximum Likelihood Estimate(MLE) Method		Log ROS Method	
Mean	8.649	Mean in Log Scale	1.867
SD	10.5	SD in Log Scale	0.992
95% MLE (t) UCL	11.28	Mean in Original Scale	9.968
95% MLE (Tiku) UCL	11.37	SD in Original Scale	8.852
		95% t UCL	12.18
		95% Percentile Bootstrap UCL	12.13
		95% BCA Bootstrap UCL	12.39
Gamma Distribution Test with Detected Values Only		Data Distribution Test with Detected Values Only	
k star (bias corrected)	2.053	Data do not follow a Discernable Distribution (0.05)	
Theta Star	6.26		
nu star	135.5		
A-D Test Statistic	1.167	Nonparametric Statistics	

Table B-5. 300 Area Subregion General UCL Statistics for Data Sets with Non-Detects

5% A-D Critical Value	0.758	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.758	Mean	10.49
5% K-S Critical Value	0.155	SD	8.304
Data not Gamma Distributed at 5% Significance Level		SE of Mean	1.257
Assuming Gamma Distribution		95% KM (t) UCL	12.6
Gamma ROS Statistics using Extrapolated Data		95% KM (z) UCL	12.56
Minimum	1E-12	95% KM (jackknife) UCL	12.59
Maximum	33	95% KM (bootstrap t) UCL	12.86
Mean	10.62	95% KM (BCA) UCL	12.62
Median	7.122	95% KM (Percentile Bootstrap) UCL	12.58
SD	8.485	95% KM (Chebyshev) UCL	15.97
k star	0.397	97.5% KM (Chebyshev) UCL	18.34
Theta star	26.77	99% KM (Chebyshev) UCL	23
Nu star	35.7	Potential UCLs to Use	
AppChi2	23.03	95% KM (BCA) UCL	12.62
95% Gamma Approximate UCL	16.46		
95% Adjusted Gamma UCL	16.71		

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006). For additional insight, the user may want to consult a statistician.

Manganese

General Statistics			
Number of Valid Data	45	Number of Detected Data	3
Number of Distinct Detected Data	3	Number of Non-Detect Data	42
		Percent Non-Detects	93.33%
Raw Statistics		Log-transformed Statistics	
Minimum Detected	6	Minimum Detected	1.792
Maximum Detected	12	Maximum Detected	2.485
Mean of Detected	8.333	Mean of Detected	2.074
SD of Detected	3.215	SD of Detected	0.364
Minimum Non-Detect	4	Minimum Non-Detect	1.386
Maximum Non-Detect	6	Maximum Non-Detect	1.792

Note: Data have multiple DLs - Use of KM Method is recommended
For all methods (except KM, DL/2, and ROS Methods),
Observations < Largest ND are treated as NDs

Number treated as Non-Detect	42
Number treated as Detected	3
Single DL Non-Detect Percentage	93.33%

Warning: There are only 3 Distinct Detected Values in this data set
The number of detected data may not be adequate enough to perform GOF tests, bootstrap, and ROS methods.
Those methods will return a 'N/A' value on your output display!

It is necessary to have 4 or more Distinct Values for bootstrap methods.
However, results obtained using 4 to 9 distinct values may not be reliable.
It is recommended to have 10 to 15 or more observations for accurate and meaningful results and estimates.

UCL Statistics			
Normal Distribution Test with Detected Values Only	Lognormal Distribution Test with Detected Values Only		
Shapiro Wilk Test Statistic	0.871	Shapiro Wilk Test Statistic	0.907
5% Shapiro Wilk Critical Value	0.767	5% Shapiro Wilk Critical Value	0.767

Table B-5. 300 Area Subregion General UCL Statistics for Data Sets with Non-Detects

Data appear Normal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Assuming Normal Distribution

DL/2 Substitution Method	
Mean	3
SD	1.665
95% DL/2 (t) UCL	3.417
Maximum Likelihood Estimate(MLE) Method	
	N/A
MLE yields a negative mean	

Assuming Lognormal Distribution

DL/2 Substitution Method	
Mean	1.019
SD	0.353
95% H-Stat (DL/2) UCL	3.248
Log ROS Method	
Mean in Log Scale	-0.655
SD in Log Scale	1.353
Mean in Original Scale	1.268
SD in Original Scale	2.175
95% t UCL	1.813
95% Percentile Bootstrap UCL	1.837
95% BCA Bootstrap UCL	2.012

Gamma Distribution Test with Detected Values Only

k star (bias corrected)	N/A
Theta Star	N/A
nu star	N/A

Data Distribution Test with Detected Values Only

Data appear Normal at 5% Significance Level

A-D Test Statistic	N/A
5% A-D Critical Value	N/A
K-S Test Statistic	N/A
5% K-S Critical Value	N/A

Nonparametric Statistics

Kaplan-Meier (KM) Method	
Mean	6.156
SD	0.893
SE of Mean	0.163
95% KM (t) UCL	6.43
95% KM (z) UCL	6.424
95% KM (jackknife) UCL	6.813
95% KM (bootstrap t) UCL	6.683
95% KM (BCA) UCL	12
95% KM (Percentile Bootstrap) UCL	12
95% KM (Chebyshev) UCL	6.866
97.5% KM (Chebyshev) UCL	7.174
99% KM (Chebyshev) UCL	7.778

Data not Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

Gamma ROS Statistics using Extrapolated Data	
Minimum	N/A
Maximum	N/A
Mean	N/A
Median	N/A
SD	N/A
k star	N/A
Theta star	N/A
Nu star	N/A
AppChi2	N/A
95% Gamma Approximate UCL	N/A
95% Adjusted Gamma UCL	N/A

Potential UCLs to Use

95% KM (t) UCL	6.43
95% KM (Percentile Bootstrap) UCL	12

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006). For additional insight, the user may want to consult a statistician.

Molybdenum

General Statistics

Number of Valid Observations 45

Number of Distinct Observations 44

Raw Statistics

Minimum	3.52
Maximum	5.81
Mean	4.854

Log-transformed Statistics

Minimum of Log Data	1.258
Maximum of Log Data	1.76
Mean of log Data	1.572

Table B-5. 300 Area Subregion General UCL Statistics for Data Sets with Non-Detects

Median 4.91	SD of log Data 0.131
SD 0.606	
Coefficient of Variation 0.125	
Skewness -0.545	
Relevant UCL Statistics	
Normal Distribution Test	Lognormal Distribution Test
Shapiro Wilk Test Statistic 0.948	Shapiro Wilk Test Statistic 0.924
Shapiro Wilk Critical Value 0.945	Shapiro Wilk Critical Value 0.945
Data appear Normal at 5% Significance Level	Data not Lognormal at 5% Significance Level
Assuming Normal Distribution	Assuming Lognormal Distribution
95% Student's-t UCL 5.006	95% H-UCL 5.02
95% UCLs (Adjusted for Skewness)	95% Chebyshev (MVUE) UCL 5.271
95% Adjusted-CLT UCL (Chen-1995) 4.995	97.5% Chebyshev (MVUE) UCL 5.45
95% Modified-t UCL (Johnson-1978) 5.004	99% Chebyshev (MVUE) UCL 5.803
Gamma Distribution Test	Data Distribution
k star (bias corrected) 57.6	Data appear Normal at 5% Significance Level
Theta Star 0.0843	
MLE of Mean 4.854	
MLE of Standard Deviation 0.64	
nu star 5184	
Approximate Chi Square Value (.05) 5018	Nonparametric Statistics
Adjusted Level of Significance 0.0447	95% CLT UCL 5.002
Adjusted Chi Square Value 5012	95% Jackknife UCL 5.006
Anderson-Darling Test Statistic 0.703	95% Standard Bootstrap UCL 5.003
Anderson-Darling 5% Critical Value 0.747	95% Bootstrap-t UCL 4.997
Kolmogorov-Smirnov Test Statistic 0.0997	95% Hall's Bootstrap UCL 4.995
Kolmogorov-Smirnov 5% Critical Value 0.131	95% Percentile Bootstrap UCL 5.001
Data appear Gamma Distributed at 5% Significance Level	95% BCA Bootstrap UCL 4.999
Assuming Gamma Distribution	95% Chebyshev(Mean, Sd) UCL 5.247
95% Approximate Gamma UCL 5.015	97.5% Chebyshev(Mean, Sd) UCL 5.418
95% Adjusted Gamma UCL 5.02	99% Chebyshev(Mean, Sd) UCL 5.752
Potential UCL to Use	Use 95% Student's-t UCL 5.006

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Nickel

General Statistics			
Number of Valid Data	45	Number of Detected Data	11
Number of Distinct Detected Data	6	Number of Non-Detect Data	34
		Percent Non-Detects	75.56%
Raw Statistics		Log-transformed Statistics	
Minimum Detected	4	Minimum Detected	1.386
Maximum Detected	12	Maximum Detected	2.485
Mean of Detected	5.909	Mean of Detected	1.714
SD of Detected	2.427	SD of Detected	0.353
Minimum Non-Detect	4	Minimum Non-Detect	1.386

Table B-5. 300 Area Subregion General UCL Statistics for Data Sets with Non-Detects

Maximum Non-Detect	4	Maximum Non-Detect	1.386
UCL Statistics			
Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic	0.794	Shapiro Wilk Test Statistic	0.872
5% Shapiro Wilk Critical Value	0.85	5% Shapiro Wilk Critical Value	0.85
Data not Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	
Assuming Normal Distribution		Assuming Lognormal Distribution	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	2.956	Mean	0.943
SD	2.056	SD	0.475
95% DL/2 (t) UCL	3.47	95% H-Stat (DL/2) UCL	3.289
Maximum Likelihood Estimate(MLE) Method		Log ROS Method	
Mean	1.252	Mean in Log Scale	0.649
SD	3.774	SD in Log Scale	0.816
95% MLE (t) UCL	2.197	Mean in Original Scale	2.636
95% MLE (Tiku) UCL	3.211	SD in Original Scale	2.32
		95% t UCL	3.217
		95% Percentile Bootstrap UCL	3.234
		95% BCA Bootstrap UCL	3.343
Gamma Distribution Test with Detected Values Only		Data Distribution Test with Detected Values Only	
k star (bias corrected)	6.031	Data appear Gamma Distributed at 5% Significance Level	
Theta Star	0.98		
nu star	132.7		
A-D Test Statistic	0.618	Nonparametric Statistics	
5% A-D Critical Value	0.73	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.73	Mean	4.467
5% K-S Critical Value	0.256	SD	1.408
Data appear Gamma Distributed at 5% Significance Level		SE of Mean	0.22
Assuming Gamma Distribution		95% KM (t) UCL	4.837
Gamma ROS Statistics using Extrapolated Data		95% KM (z) UCL	4.829
Minimum	2.244	95% KM (jackknife) UCL	4.823
Maximum	12.45	95% KM (bootstrap t) UCL	5.168
Mean	8.34	95% KM (BCA) UCL	4.889
Median	8.682	95% KM (Percentile Bootstrap) UCL	4.911
SD	2.943	95% KM (Chebyshev) UCL	5.426
k star	6.324	97.5% KM (Chebyshev) UCL	5.841
Theta star	1.319	99% KM (Chebyshev) UCL	6.657
Nu star	569.2	Potential UCLs to Use	
AppChi2	514.9	95% KM (t) UCL	4.837
95% Gamma Approximate UCL	9.22		
95% Adjusted Gamma UCL	9.251		

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006). For additional insight, the user may want to consult a statistician.

Nitrate

Table B-5. 300 Area Subregion General UCL Statistics for Data Sets with Non-Detects

General Statistics	
Number of Valid Observations 45	Number of Distinct Observations 39
Raw Statistics	Log-transformed Statistics
Minimum 7080	Minimum of Log Data 8.865
Maximum 62000	Maximum of Log Data 11.03
Mean 25871	Mean of log Data 10.12
Median 25400	SD of log Data 0.296
SD 7478	
Coefficient of Variation 0.289	
Skewness 2.222	
Relevant UCL Statistics	
Normal Distribution Test	Lognormal Distribution Test
Shapiro Wilk Test Statistic 0.776	Shapiro Wilk Test Statistic 0.808
Shapiro Wilk Critical Value 0.945	Shapiro Wilk Critical Value 0.945
Data not Normal at 5% Significance Level	Data not Lognormal at 5% Significance Level
Assuming Normal Distribution	Assuming Lognormal Distribution
95% Student's-t UCL 27744	95% H-UCL 28127
95% UCLs (Adjusted for Skewness)	95% Chebyshev (MVUE) UCL 31043
95% Adjusted-CLT UCL (Chen-1995) 28099	97.5% Chebyshev (MVUE) UCL 33243
95% Modified-t UCL (Johnson-1978) 27805	99% Chebyshev (MVUE) UCL 37563
Gamma Distribution Test	Data Distribution
k star (bias corrected) 12.02	Data do not follow a Discernable Distribution (0.05)
Theta Star 2152	
MLE of Mean 25871	
MLE of Standard Deviation 7461	
nu star 1082	
Approximate Chi Square Value (.05) 1007	Nonparametric Statistics
Adjusted Level of Significance 0.0447	95% CLT UCL 27704
Adjusted Chi Square Value 1004	95% Jackknife UCL 27744
Anderson-Darling Test Statistic 2.806	95% Standard Bootstrap UCL 27711
Anderson-Darling 5% Critical Value 0.748	95% Bootstrap-t UCL 28178
Kolmogorov-Smirnov Test Statistic 0.197	95% Hall's Bootstrap UCL 30176
Kolmogorov-Smirnov 5% Critical Value 0.132	95% Percentile Bootstrap UCL 27824
Data not Gamma Distributed at 5% Significance Level	95% BCA Bootstrap UCL 28113
Assuming Gamma Distribution	95% Chebyshev(Mean, Sd) UCL 30730
95% Approximate Gamma UCL 27807	97.5% Chebyshev(Mean, Sd) UCL 32832
95% Adjusted Gamma UCL 27874	99% Chebyshev(Mean, Sd) UCL 36962
Potential UCL to Use	Use 95% Student's-t UCL 27744 or 95% Modified-t UCL 27805

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Selenium

General Statistics	
Number of Valid Observations 45	Number of Distinct Observations 41

Table B-5. 300 Area Subregion General UCL Statistics for Data Sets with Non-Detects

Raw Statistics		Log-transformed Statistics	
	Minimum 0.48		Minimum of Log Data -0.734
	Maximum 5.8		Maximum of Log Data 1.758
	Mean 2.523		Mean of log Data 0.83
	Median 2.35		SD of log Data 0.478
	SD 1.02		
	Coefficient of Variation 0.405		
	Skewness 0.522		
Relevant UCL Statistics			
Normal Distribution Test		Lognormal Distribution Test	
	Shapiro Wilk Test Statistic 0.975		Shapiro Wilk Test Statistic 0.928
	Shapiro Wilk Critical Value 0.945		Shapiro Wilk Critical Value 0.945
Data appear Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	
Assuming Normal Distribution		Assuming Lognormal Distribution	
	95% Student's-t UCL 2.778		95% H-UCL 2.945
95% UCLs (Adjusted for Skewness)			95% Chebyshev (MVUE) UCL 3.395
	95% Adjusted-CLT UCL (Chen-1995) 2.786		97.5% Chebyshev (MVUE) UCL 3.755
	95% Modified-t UCL (Johnson-1978) 2.78		99% Chebyshev (MVUE) UCL 4.462
Gamma Distribution Test		Data Distribution	
	k star (bias corrected) 5.051	Data appear Normal at 5% Significance Level	
	Theta Star 0.499		
	MLE of Mean 2.523		
	MLE of Standard Deviation 1.122		
	nu star 454.6		
	Approximate Chi Square Value (.05) 406.1	Nonparametric Statistics	
	Adjusted Level of Significance 0.0447		95% CLT UCL 2.773
	Adjusted Chi Square Value 404.6		95% Jackknife UCL 2.778
	Anderson-Darling Test Statistic 0.572		95% Standard Bootstrap UCL 2.767
	Anderson-Darling 5% Critical Value 0.753		95% Bootstrap-t UCL 2.776
	Kolmogorov-Smirnov Test Statistic 0.124		95% Hall's Bootstrap UCL 2.792
	Kolmogorov-Smirnov 5% Critical Value 0.132		95% Percentile Bootstrap UCL 2.781
Data appear Gamma Distributed at 5% Significance Level			95% BCA Bootstrap UCL 2.785
			95% Chebyshev(Mean, Sd) UCL 3.186
Assuming Gamma Distribution			97.5% Chebyshev(Mean, Sd) UCL 3.473
	95% Approximate Gamma UCL 2.823		99% Chebyshev(Mean, Sd) UCL 4.036
	95% Adjusted Gamma UCL 2.834		
Potential UCL to Use		Use 95% Student's-t UCL 2.778	

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and IacI (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Silver

General Statistics				
	Number of Valid Data	45	Number of Detected Data	2
	Number of Distinct Detected Data	2	Number of Non-Detect Data	43
			Percent Non-Detects	95.56%
Raw Statistics		Log-transformed Statistics		
	Minimum Detected	0.099	Minimum Detected	-2.313

Table B-5. 300 Area Subregion General UCL Statistics for Data Sets with Non-Detects

Maximum Detected	0.719	Maximum Detected	-0.33
Mean of Detected	0.409	Mean of Detected	-1.321
SD of Detected	0.438	SD of Detected	1.402
Minimum Non-Detect	0.1	Minimum Non-Detect	-2.303
Maximum Non-Detect	0.2	Maximum Non-Detect	-1.609

Note: Data have multiple DLs - Use of KM Method is recommended
For all methods (except KM, DL/2, and ROS Methods),
Observations < Largest ND are treated as NDs

Number treated as Non-Detect	44
Number treated as Detected	1
Single DL Non-Detect Percentage	97.78%

Warning: Data set has only 2 Distinct Detected Values.

This may not be adequate enough to compute meaningful and reliable test statistics and estimates.

The Project Team may decide to use alternative site specific values to estimate environmental parameters (e.g., EPC, BTV).

Unless Data Quality Objectives (DQOs) have been met, it is suggested to collect additional observations.

The number of detected data may not be adequate enough to perform GOF tests, bootstrap, and ROS methods.

Those methods will return a 'N/A' value on your output display!

It is necessary to have 4 or more Distinct Values for bootstrap methods.

However, results obtained using 4 to 9 distinct values may not be reliable.

It is recommended to have 10 to 15 or more observations for accurate and meaningful results and estimates.

		UCL Statistics			
Normal Distribution Test with Detected Values Only				Lognormal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic	N/A	Shapiro Wilk Test Statistic	N/A	Shapiro Wilk Test Statistic	N/A
5% Shapiro Wilk Critical Value	N/A	5% Shapiro Wilk Critical Value	N/A	5% Shapiro Wilk Critical Value	N/A
Data not Normal at 5% Significance Level				Data not Lognormal at 5% Significance Level	
Assuming Normal Distribution				Assuming Lognormal Distribution	
DL/2 Substitution Method		DL/2 Substitution Method		DL/2 Substitution Method	
Mean	0.107	Mean	-2.351	Mean	-2.351
SD	0.0949	SD	0.389	SD	0.389
95% DL/2 (t) UCL	0.131	95% H-Stat (DL/2) UCL	0.114	95% H-Stat (DL/2) UCL	0.114
Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method		Log ROS Method	
MLE method failed to converge properly		Mean in Log Scale	N/A	Mean in Log Scale	N/A
		SD in Log Scale	N/A	SD in Log Scale	N/A
		Mean in Original Scale	N/A	Mean in Original Scale	N/A
		SD in Original Scale	N/A	SD in Original Scale	N/A
		95% t UCL	N/A	95% t UCL	N/A
		95% Percentile Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
		95% BCA Bootstrap UCL	N/A	95% BCA Bootstrap UCL	N/A
Gamma Distribution Test with Detected Values Only				Data Distribution Test with Detected Values Only	
k star (bias corrected)	N/A	Data do not follow a Discernable Distribution (0.05)			
Theta Star	N/A				
nu star	N/A				
A-D Test Statistic	N/A	Nonparametric Statistics			
5% A-D Critical Value	N/A	Kaplan-Meier (KM) Method			
K-S Test Statistic	N/A	Mean			
5% K-S Critical Value	N/A	SD			
Data not Gamma Distributed at 5% Significance Level		SE of Mean			
Assuming Gamma Distribution		95% KM (t) UCL			
		95% KM (z) UCL			

Table B-5. 300 Area Subregion General UCL Statistics for Data Sets with Non-Detects

Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	0.517
Minimum	N/A	95% KM (bootstrap t) UCL	N/A
Maximum	N/A	95% KM (BCA) UCL	N/A
Mean	N/A	95% KM (Percentile Bootstrap) UCL	0.719
Median	N/A	95% KM (Chebyshev) UCL	0.197
SD	N/A	97.5% KM (Chebyshev) UCL	0.233
k star	N/A	99% KM (Chebyshev) UCL	0.304
Theta star	N/A		
Nu star	N/A	Potential UCLs to Use	
AppChi2	N/A	95% KM (BCA) UCL	N/A
95% Gamma Approximate UCL	N/A		
95% Adjusted Gamma UCL	N/A		

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006). For additional insight, the user may want to consult a statistician.

Strontium

General Statistics

Number of Valid Observations 45

Number of Distinct Observations 32

Raw Statistics

Minimum 5
Maximum 280
Mean 217.8
Median 223
SD 42.79
Coefficient of Variation 0.196
Skewness -3.13

Log-transformed Statistics

Minimum of Log Data 1.609
Maximum of Log Data 5.635
Mean of log Data 5.312
SD of log Data 0.582

Relevant UCL Statistics

Normal Distribution Test

Shapiro Wilk Test Statistic 0.712
Shapiro Wilk Critical Value 0.945

Data not Normal at 5% Significance Level

Lognormal Distribution Test

Shapiro Wilk Test Statistic 0.326
Shapiro Wilk Critical Value 0.945

Data not Lognormal at 5% Significance Level

Assuming Normal Distribution

95% Student's-t UCL 228.5

95% UCLs (Adjusted for Skewness)

95% Adjusted-CLT UCL (Chen-1995) 225.1
95% Modified-t UCL (Johnson-1978) 228

Assuming Lognormal Distribution

95% H-UCL 285.4
95% Chebyshev (MVUE) UCL 335.5
97.5% Chebyshev (MVUE) UCL 377.2
99% Chebyshev (MVUE) UCL 459.1

Gamma Distribution Test

k star (bias corrected) 6.704
Theta Star 32.48
MLE of Mean 217.8
MLE of Standard Deviation 84.1
nu star 603.3
Approximate Chi Square Value (.05) 547.4
Adjusted Level of Significance 0.0447
Adjusted Chi Square Value 545.6

Anderson-Darling Test Statistic 8.254
Anderson-Darling 5% Critical Value 0.751

Data Distribution

Data do not follow a Discernable Distribution (0.05)

Nonparametric Statistics

95% CLT UCL 228.2
95% Jackknife UCL 228.5
95% Standard Bootstrap UCL 228.2
95% Bootstrap-t UCL 226.6
95% Hall's Bootstrap UCL 226

Table B-5. 300 Area Subregion General UCL Statistics for Data Sets with Non-Detects

Assuming Gamma Distribution

99% Chebyshev(Mean, Sd) UCL 60458

95% Approximate Gamma UCL 50661

95% Adjusted Gamma UCL 50737

Potential UCL to Use

Use 95% Approximate Gamma UCL 50661

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Tetrachloroethene

General Statistics			
Number of Valid Data	45	Number of Detected Data	3
Number of Distinct Detected Data	3	Number of Non-Detect Data	42
		Percent Non-Detects	93.33%
Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.19	Minimum Detected	-1.661
Maximum Detected	0.38	Maximum Detected	-0.968
Mean of Detected	0.287	Mean of Detected	-1.289
SD of Detected	0.095	SD of Detected	0.349
Minimum Non-Detect	0.18	Minimum Non-Detect	-1.715
Maximum Non-Detect	0.18	Maximum Non-Detect	-1.715

Warning: There are only 3 Distinct Detected Values in this data set. The number of detected data may not be adequate enough to perform GOF tests, bootstrap, and ROS methods. Those methods will return a 'N/A' value on your output display!

It is necessary to have 4 or more Distinct Values for bootstrap methods. However, results obtained using 4 to 9 distinct values may not be reliable. It is recommended to have 10 to 15 or more observations for accurate and meaningful results and estimates.

Normal Distribution Test with Detected Values Only		UCL Statistics		Lognormal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic	0.999			Shapiro Wilk Test Statistic	0.984
5% Shapiro Wilk Critical Value	0.767			5% Shapiro Wilk Critical Value	0.767
Data appear Normal at 5% Significance Level				Data appear Lognormal at 5% Significance Level	
Assuming Normal Distribution				Assuming Lognormal Distribution	
DL/2 Substitution Method				DL/2 Substitution Method	
Mean	0.103			Mean	-2.333
SD	0.0536			SD	0.292
95% DL/2 (t) UCL	0.117			95% H-Stat (DL/2) UCL	0.109
Maximum Likelihood Estimate(MLE) Method	N/A			Log ROS Method	
MLE yields a negative mean				Mean in Log Scale	-3.878
				SD in Log Scale	1.324
				Mean in Original Scale	0.0474
				SD in Original Scale	0.0744
				95% t UCL	0.066
				95% Percentile Bootstrap UCL	0.0664
				95% BCA Bootstrap UCL	0.0729

Table B-5. 300 Area Subregion General UCL Statistics for Data Sets with Non-Detects

Gamma Distribution Test with Detected Values Only		Data Distribution Test with Detected Values Only	
		Data appear Normal at 5% Significance Level	
k star (bias corrected)	N/A		
Theta Star	N/A		
nu star	N/A		
A-D Test Statistic	N/A	Nonparametric Statistics	
5% A-D Critical Value	N/A	Kaplan-Meier (KM) Method	
K-S Test Statistic	N/A	Mean	0.196
5% K-S Critical Value	N/A	SD	0.0314
		SE of Mean	0.00572
		95% KM (t) UCL	0.206
		95% KM (z) UCL	0.206
		95% KM (jackknife) UCL	0.26
		95% KM (bootstrap t) UCL	0.2
		95% KM (BCA) UCL	0.38
		95% KM (Percentile Bootstrap) UCL	0.38
		95% KM (Chebyshev) UCL	0.221
		97.5% KM (Chebyshev) UCL	0.232
		99% KM (Chebyshev) UCL	0.253
		Potential UCLs to Use	
		95% KM (t) UCL	0.206
		95% KM (Percentile Bootstrap) UCL	0.38
Data not Gamma Distributed at 5% Significance Level			
Assuming Gamma Distribution			
Gamma ROS Statistics using Extrapolated Data			
Minimum	N/A		
Maximum	N/A		
Mean	N/A		
Median	N/A		
SD	N/A		
k star	N/A		
Theta star	N/A		
Nu star	N/A		
AppChi2	N/A		
95% Gamma Approximate UCL	N/A		
95% Adjusted Gamma UCL	N/A		

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006). For additional insight, the user may want to consult a statistician.

Thallium

General Statistics			
Number of Valid Data	45	Number of Detected Data	1
Number of Distinct Detected Data	1	Number of Non-Detect Data	44
		Percent Non-Detects	97.78%

Warning: Only one distinct data value was detected! ProUCL (or any other software) should not be used on such a data set! It is suggested to use alternative site specific values determined by the Project Team to estimate environmental parameters (e.g., EPC, BTV).

The data set for variable Thallium was not processed!

Tin

General Statistics			
Number of Valid Data	45	Number of Detected Data	3
Number of Distinct Detected Data	3	Number of Non-Detect Data	42
		Percent Non-Detects	93.33%
Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.1	Minimum Detected	-2.303
Maximum Detected	0.2	Maximum Detected	-1.609
Mean of Detected	0.134	Mean of Detected	-2.068
SD of Detected	0.0574	SD of Detected	0.397

Table B-5. 300 Area Subregion General UCL Statistics for Data Sets with Non-Detects

Minimum Non-Detect	0.05	Minimum Non-Detect	-2.996
Maximum Non-Detect	0.1	Maximum Non-Detect	-2.303

Note: Data have multiple DLs - Use of KM Method is recommended
For all methods (except KM, DL/2, and ROS Methods),
Observations < Largest ND are treated as NDs

Number treated as Non-Detect	42
Number treated as Detected	3
Single DL Non-Detect Percentage	93.33%

Warning: There are only 3 Distinct Detected Values in this data set
The number of detected data may not be adequate enough to perform GOF tests, bootstrap, and ROS methods.
Those methods will return a 'N/A' value on your output display!

It is necessary to have 4 or more Distinct Values for bootstrap methods.
However, results obtained using 4 to 9 distinct values may not be reliable.
It is recommended to have 10 to 15 or more observations for accurate and meaningful results and estimates.

		UCL Statistics				
Normal Distribution Test with Detected Values Only				Lognormal Distribution Test with Detected Values Only		
	Shapiro Wilk Test Statistic	0.757			Shapiro Wilk Test Statistic	0.761
	5% Shapiro Wilk Critical Value	0.767			5% Shapiro Wilk Critical Value	0.767
Data not Normal at 5% Significance Level				Data not Lognormal at 5% Significance Level		
Assuming Normal Distribution				Assuming Lognormal Distribution		
	DL/2 Substitution Method				DL/2 Substitution Method	
	Mean	0.0522			Mean	-3.026
	SD	0.0266			SD	0.361
	95% DL/2 (t) UCL	0.0589			95% H-Stat (DL/2) UCL	0.0571
	Maximum Likelihood Estimate(MLE) Method	N/A			Log ROS Method	
MLE yields a negative mean					Mean in Log Scale	-4.879
					SD in Log Scale	1.403
					Mean in Original Scale	0.0197
					SD in Original Scale	0.0354
					95% t UCL	0.0286
					95% Percentile Bootstrap UCL	0.0295
					95% BCA Bootstrap UCL	0.0324
Gamma Distribution Test with Detected Values Only				Data Distribution Test with Detected Values Only		
	k star (bias corrected)	N/A		Data do not follow a Discernable Distribution (0.05)		
	Theta Star	N/A				
	nu star	N/A				
	A-D Test Statistic	N/A		Nonparametric Statistics		
	5% A-D Critical Value	N/A		Kaplan-Meier (KM) Method		
	K-S Test Statistic	N/A			Mean	0.102
	5% K-S Critical Value	N/A			SD	0.0147
Data not Gamma Distributed at 5% Significance Level					SE of Mean	0.00269
Assuming Gamma Distribution					95% KM (t) UCL	0.107
Gamma ROS Statistics using Extrapolated Data					95% KM (z) UCL	0.107
	Minimum	N/A			95% KM (jackknife) UCL	0.105
	Maximum	N/A			95% KM (bootstrap t) UCL	0.278
	Mean	N/A			95% KM (BCA) UCL	N/A
	Median	N/A			95% KM (Percentile Bootstrap) UCL	N/A
	SD	N/A			95% KM (Chebyshev) UCL	0.114
	k star	N/A			97.5% KM (Chebyshev) UCL	0.119
	Theta star	N/A			99% KM (Chebyshev) UCL	0.129

Table B-5. 300 Area Subregion General UCL Statistics for Data Sets with Non-Detects

Nu star	N/A	Potential UCLs to Use	
AppChi2	N/A	95% KM (t) UCL	0.107
95% Gamma Approximate UCL	N/A	95% KM (% Bootstrap) UCL	N/A
95% Adjusted Gamma UCL	N/A		

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006). For additional insight, the user may want to consult a statistician.

Trichloroethene

General Statistics			
Number of Valid Data	45	Number of Detected Data	35
Number of Distinct Detected Data	25	Number of Non-Detect Data	10
		Percent Non-Detects	22.22%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.31	Minimum Detected	-1.171
Maximum Detected	3	Maximum Detected	1.099
Mean of Detected	1.294	Mean of Detected	0.0955
SD of Detected	0.693	SD of Detected	0.611
Minimum Non-Detect	0.21	Minimum Non-Detect	-1.561
Maximum Non-Detect	0.25	Maximum Non-Detect	-1.386

Note: Data have multiple DLs - Use of KM Method is recommended
For all methods (except KM, DL/2, and ROS Methods),
Observations < Largest ND are treated as NDs

Number treated as Non-Detect	10
Number treated as Detected	35
Single DL Non-Detect Percentage	22.22%

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic	0.946	Shapiro Wilk Test Statistic	0.948
5% Shapiro Wilk Critical Value	0.934	5% Shapiro Wilk Critical Value	0.934
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	1.033	Mean	-0.403
SD	0.785	SD	1.086
95% DL/2 (t) UCL	1.229	95% H-Stat (DL/2) UCL	1.807
Maximum Likelihood Estimate(MLE) Method		Log ROS Method	
Mean	0.946	Mean in Log Scale	-0.207
SD	0.911	SD in Log Scale	0.795
95% MLE (t) UCL	1.174	Mean in Original Scale	1.071
95% MLE (Tiku) UCL	1.182	SD in Original Scale	0.742
		95% t UCL	1.257
		95% Percentile Bootstrap UCL	1.254
		95% BCA Bootstrap UCL	1.27

Gamma Distribution Test with Detected Values Only		Data Distribution Test with Detected Values Only	
k star (bias corrected)	2.977	Data appear Normal at 5% Significance Level	
Theta Star	0.435		
nu star	208.4		
A-D Test Statistic	0.377	Nonparametric Statistics	

Table B-5. 300 Area Subregion General UCL Statistics for Data Sets with Non-Detects

5% A-D Critical Value	0.753	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.753	Mean	1.076
5% K-S Critical Value	0.15	SD	0.728
Data appear Gamma Distributed at 5% Significance Level		SE of Mean	0.11
Assuming Gamma Distribution		95% KM (t) UCL	1.261
Gamma ROS Statistics using Extrapolated Data		95% KM (z) UCL	1.257
Minimum	1E-12	95% KM (jackknife) UCL	1.255
Maximum	3	95% KM (bootstrap t) UCL	1.276
Mean	1.106	95% KM (BCA) UCL	1.282
Median	0.92	95% KM (Percentile Bootstrap) UCL	1.261
SD	0.719	95% KM (Chebyshev) UCL	1.556
k star	0.689	97.5% KM (Chebyshev) UCL	1.763
Theta star	1.605	99% KM (Chebyshev) UCL	2.172
Nu star	62.03	Potential UCLs to Use	
AppChi2	44.92	95% KM (t) UCL	1.261
95% Gamma Approximate UCL	1.527	95% KM (Percentile Bootstrap) UCL	1.261
95% Adjusted Gamma UCL	1.544		

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006). For additional insight, the user may want to consult a statistician.

Tritium

General Statistics			
Number of Valid Data	45	Number of Detected Data	39
Number of Distinct Detected Data	34	Number of Non-Detect Data	6
		Percent Non-Detects	13.33%
Raw Statistics		Log-transformed Statistics	
Minimum Detected	180	Minimum Detected	5.193
Maximum Detected	7700	Maximum Detected	8.949
Mean of Detected	3319	Mean of Detected	7.753
SD of Detected	2130	SD of Detected	1.038
Minimum Non-Detect	2.7	Minimum Non-Detect	0.993
Maximum Non-Detect	130	Maximum Non-Detect	4.868

Note: Data have multiple DLs - Use of KM Method is recommended
For all methods (except KM, DL/2, and ROS Methods),
Observations < Largest ND are treated as NDs

Number treated as Non-Detect	6
Number treated as Detected	39
Single DL Non-Detect Percentage	13.33%

UCL Statistics		Lognormal Distribution Test with Detected Values Only	
Normal Distribution Test with Detected Values Only		Shapiro Wilk Test Statistic	0.849
Shapiro Wilk Test Statistic	0.949	5% Shapiro Wilk Critical Value	0.939
5% Shapiro Wilk Critical Value	0.939	Data not Lognormal at 5% Significance Level	
Data appear Normal at 5% Significance Level			

Assuming Normal Distribution		Assuming Lognormal Distribution	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	2882	Mean	7.154
SD	2278	SD	1.888
95% DL/2 (t) UCL	3452	95% H-Stat (DL/2) UCL	20770
Maximum Likelihood Estimate(MLE) Method		Log ROS Method	

Table B-5. 300 Area Subregion General UCL Statistics for Data Sets with Non-Detects

Mean	2719	Mean in Log Scale	7.478
SD	2517	SD in Log Scale	1.198
95% MLE (t) UCL	3350	Mean in Original Scale	2916
95% MLE (Tiku) UCL	3355	SD in Original Scale	2236
		95% t UCL	3476
		95% Percentile Bootstrap UCL	3488
		95% BCA Bootstrap UCL	3465
Gamma Distribution Test with Detected Values Only		Data Distribution Test with Detected Values Only	
k star (bias corrected)	1.456	Data appear Normal at 5% Significance Level	
Theta Star	2279		
nu star	113.6		
A-D Test Statistic	0.998	Nonparametric Statistics	
5% A-D Critical Value	0.765	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.765	Mean	2900
5% K-S Critical Value	0.144	SD	2229
		SE of Mean	336.7
		95% KM (t) UCL	3466
		95% KM (z) UCL	3454
		95% KM (jackknife) UCL	3463
		95% KM (bootstrap t) UCL	3477
		95% KM (BCA) UCL	3450
		95% KM (Percentile Bootstrap) UCL	3473
		95% KM (Chebyshev) UCL	4368
		97.5% KM (Chebyshev) UCL	5003
		99% KM (Chebyshev) UCL	6250
Data follow Appr. Gamma Distribution at 5% Significance Level			
Assuming Gamma Distribution			
Gamma ROS Statistics using Extrapolated Data			
Minimum	1E-12	Potential UCLs to Use	
Maximum	7700	95% KM (t) UCL	3466
Mean	2876	95% KM (Percentile Bootstrap) UCL	3473
Median	2500		
SD	2285		
k star	0.16		
Theta star	18017		
Nu star	14.37		
AppChi2	6.824		
95% Gamma Approximate UCL	6056		
95% Adjusted Gamma UCL	6213		

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006). For additional insight, the user may want to consult a statistician.

Uranium

General Statistics	
Number of Valid Observations	45
Number of Distinct Observations	43
Raw Statistics	Log-transformed Statistics
Minimum	6.35
Maximum	177
Mean	55.28
Median	45.8
SD	38.64
Coefficient of Variation	0.699
Skewness	1.112
Relevant UCL Statistics	
Normal Distribution Test	Lognormal Distribution Test
Shapiro Wilk Test Statistic	0.9
Shapiro Wilk Critical Value	0.945
Shapiro Wilk Test Statistic	0.962
Shapiro Wilk Critical Value	0.945

Table B-5. 300 Area Subregion General UCL Statistics for Data Sets with Non-Detects

<p>5% Shapiro Wilk Critical Value 0.842</p> <p>Data appear Normal at 5% Significance Level</p> <p>Assuming Normal Distribution</p> <p>DL/2 Substitution Method</p> <p style="padding-left: 40px;">Mean 10.42</p> <p style="padding-left: 40px;">SD 5.734</p> <p style="padding-left: 40px;">95% DL/2 (t) UCL 11.86</p> <p>Maximum Likelihood Estimate(MLE) Method</p> <p style="padding-left: 40px;">Mean 6.349</p> <p style="padding-left: 40px;">SD 10.42</p> <p style="padding-left: 40px;">95% MLE (t) UCL 8.958</p> <p style="padding-left: 40px;">95% MLE (Tiku) UCL 14.09</p> <p>Gamma Distribution Test with Detected Values Only</p> <p style="padding-left: 40px;">k star (bias corrected) 8.01</p> <p style="padding-left: 40px;">Theta Star 2.422</p> <p style="padding-left: 40px;">nu star 160.2</p> <p style="padding-left: 40px;">A-D Test Statistic 0.261</p> <p style="padding-left: 40px;">5% A-D Critical Value 0.725</p> <p style="padding-left: 40px;">K-S Test Statistic 0.725</p> <p style="padding-left: 40px;">5% K-S Critical Value 0.267</p> <p>Data appear Gamma Distributed at 5% Significance Level</p> <p>Assuming Gamma Distribution</p> <p>Gamma ROS Statistics using Extrapolated Data</p> <p style="padding-left: 40px;">Minimum 4.949</p> <p style="padding-left: 40px;">Maximum 34</p> <p style="padding-left: 40px;">Mean 19.96</p> <p style="padding-left: 40px;">Median 21</p> <p style="padding-left: 40px;">SD 6.092</p> <p style="padding-left: 40px;">k star 8.226</p> <p style="padding-left: 40px;">Theta star 2.426</p> <p style="padding-left: 40px;">Nu star 740.3</p> <p style="padding-left: 40px;">AppChi2 678.2</p> <p style="padding-left: 40px;">95% Gamma Approximate UCL 21.79</p> <p style="padding-left: 40px;">95% Adjusted Gamma UCL 21.85</p>	<p>5% Shapiro Wilk Critical Value 0.842</p> <p>Data appear Lognormal at 5% Significance Level</p> <p>Assuming Lognormal Distribution</p> <p>DL/2 Substitution Method</p> <p style="padding-left: 40px;">Mean 2.244</p> <p style="padding-left: 40px;">SD 0.415</p> <p style="padding-left: 40px;">95% H-Stat (DL/2) UCL 11.53</p> <p>Log ROS Method</p> <p style="padding-left: 40px;">Mean in Log Scale 2.17</p> <p style="padding-left: 40px;">SD in Log Scale 0.572</p> <p style="padding-left: 40px;">Mean in Original Scale 10.31</p> <p style="padding-left: 40px;">SD in Original Scale 6.349</p> <p style="padding-left: 40px;">95% t UCL 11.9</p> <p style="padding-left: 40px;">95% Percentile Bootstrap UCL 11.96</p> <p style="padding-left: 40px;">95% BCA Bootstrap UCL 12.17</p> <p>Data Distribution Test with Detected Values Only</p> <p>Data appear Normal at 5% Significance Level</p> <p>Nonparametric Statistics</p> <p>Kaplan-Meier (KM) Method</p> <p style="padding-left: 40px;">Mean 13.79</p> <p style="padding-left: 40px;">SD 4.171</p> <p style="padding-left: 40px;">SE of Mean 0.667</p> <p style="padding-left: 40px;">95% KM (t) UCL 14.91</p> <p style="padding-left: 40px;">95% KM (z) UCL 14.89</p> <p style="padding-left: 40px;">95% KM (jackknife) UCL 14.74</p> <p style="padding-left: 40px;">95% KM (bootstrap t) UCL 15.27</p> <p style="padding-left: 40px;">95% KM (BCA) UCL 18.49</p> <p style="padding-left: 40px;">95% KM (Percentile Bootstrap) UCL 16.42</p> <p style="padding-left: 40px;">95% KM (Chebyshev) UCL 16.7</p> <p style="padding-left: 40px;">97.5% KM (Chebyshev) UCL 17.96</p> <p style="padding-left: 40px;">99% KM (Chebyshev) UCL 20.43</p> <p>Potential UCLs to Use</p> <p style="padding-left: 40px;">95% KM (t) UCL 14.91</p> <p style="padding-left: 40px;">95% KM (Percentile Bootstrap) UCL 16.42</p>
---	---

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006). For additional insight, the user may want to consult a statistician.

Zinc

General Statistics			
	Number of Valid Data	45	
	Number of Distinct Detected Data	9	
			Number of Detected Data 12
			Number of Non-Detect Data 33
			Percent Non-Detects 73.33%
Raw Statistics			Log-transformed Statistics

Table B-5. 300 Area Subregion General UCL Statistics for Data Sets with Non-Detects

Minimum Detected	4	Minimum Detected	1.386
Maximum Detected	456	Maximum Detected	6.122
Mean of Detected	105.3	Mean of Detected	3.116
SD of Detected	168.2	SD of Detected	1.873
Minimum Non-Detect	4	Minimum Non-Detect	1.386
Maximum Non-Detect	6	Maximum Non-Detect	1.792

Note: Data have multiple DLs - Use of KM Method is recommended
For all methods (except KM, DL/2, and ROS Methods),
Observations < Largest ND are treated as NDs

Number treated as Non-Detect	37
Number treated as Detected	8
Single DL Non-Detect Percentage	82.22%

UCL Statistics

Normal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.648
5% Shapiro Wilk Critical Value	0.859

Data not Normal at 5% Significance Level

Assuming Normal Distribution

DL/2 Substitution Method	
Mean	29.87
SD	95.85
95% DL/2 (t) UCL	53.88

Maximum Likelihood Estimate(MLE) Method N/A

MLE yields a negative mean

Lognormal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.818
5% Shapiro Wilk Critical Value	0.859

Data not Lognormal at 5% Significance Level

Assuming Lognormal Distribution

DL/2 Substitution Method	
Mean	1.465
SD	1.386
95% H-Stat (DL/2) UCL	20.46

Log ROS Method

Mean in Log Scale -1.307

SD in Log Scale 3.556

Mean in Original Scale 28.38

SD in Original Scale 96.3

95% t UCL 52.5

95% Percentile Bootstrap UCL 54.13

95% BCA Bootstrap UCL 63.63

Gamma Distribution Test with Detected Values Only

k star (bias corrected)	0.373
Theta Star	282.5
nu star	8.948

A-D Test Statistic 1.289

5% A-D Critical Value 0.8

K-S Test Statistic 0.8

5% K-S Critical Value 0.261

Data not Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

Gamma ROS Statistics using Extrapolated Data	
Minimum	1E-12
Maximum	2516
Mean	449.6
Median	174.4
SD	614.9
k star	0.134
Theta star	3357
Nu star	12.05
AppChi2	5.261
95% Gamma Approximate UCL	1030
95% Adjusted Gamma UCL	1060

Data Distribution Test with Detected Values Only

Data do not follow a Discernable Distribution (0.05)

Nonparametric Statistics

Kaplan-Meier (KM) Method	
Mean	31.04
SD	94.45
SE of Mean	14.71
95% KM (t) UCL	55.74
95% KM (z) UCL	55.22
95% KM (jackknife) UCL	54.96
95% KM (bootstrap t) UCL	183.1
95% KM (BCA) UCL	58.22
95% KM (Percentile Bootstrap) UCL	57.44
95% KM (Chebyshev) UCL	95.13
97.5% KM (Chebyshev) UCL	122.9
99% KM (Chebyshev) UCL	177.4

Potential UCLs to Use

95% KM (Chebyshev) UCL 95.13

Note: DL/2 is not a recommended method.

Table B-5. 300 Area Subregion General UCL Statistics for Data Sets with Non-Detects

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006). For additional insight, the user may want to consult a statistician.

ECF-300FF5-11-0131
Draft A

Calculation of Exposure Point Concentrations for the 600 Area Subregion of the 300-FF-5 Groundwater Operable Unit

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

Contractor for the U.S. Department of Energy
under Contract DE-AC06-08RL14788



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Calculation of Exposure Point Concentrations for the 600 Area Subregion of the 300-FF-5 Groundwater Operable Unit

Document Type: RPT Program/Project: EP & SP

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Assistant Secretary for Environmental Management

Contractor for the U.S. Department of Energy
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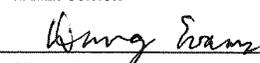
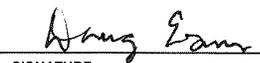
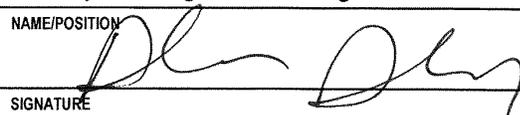
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Draft A

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		<h2>Environmental Calculation Cover Page</h2>													
Part 1: Completed by the Responsible Manager Project: 300-FF-5 OU Date: December 8, 2011															
Calculation Title & Description: Calculation of Exposure Point Concentrations for the 600 Area Subregion of the 300-FF-5 Groundwater Operable Unit This calculation brief describes the calculation of exposure point concentrations for the detected constituents/contaminants of potential concern identified for the 600 Area subregion of the 300-FF-5 Groundwater Operable Unit.															
Preparer: Ian Ross		Basis of Qualification: Education and Experience													
Checker: Doug Evans		Basis of Qualification: Education and Experience													
Senior Reviewer: Doug Evans		Basis of Qualification: Education and Experience													
Part 2: Completed by Preparer Calculation No.: ECF-300FF5-11-0131		Revision No.: Draft A													
Revision History: <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 15%;">Revision No.</th> <th style="width: 45%;">Description</th> <th style="width: 20%;">Date</th> <th style="width: 20%;">Affected Pages</th> </tr> </thead> <tbody> <tr> <td>Draft A</td> <td>Enhanced discussion of 95 UCL uncertainties</td> <td>11/22/2011</td> <td>All</td> </tr> <tr> <td> </td> <td> </td> <td> </td> <td> </td> </tr> </tbody> </table>				Revision No.	Description	Date	Affected Pages	Draft A	Enhanced discussion of 95 UCL uncertainties	11/22/2011	All				
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Draft A	Enhanced discussion of 95 UCL uncertainties	11/22/2011	All												
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Terms

95UCL	95% upper confidence limit
BDL	Below detection limit
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
COPC	Contaminant of potential concern
CV	Coefficient of variation
ECF	Environmental Calculation File
EPC	Exposure point concentration
HEIS	Hanford Environmental Information System
MAD	Median absolute deviation
OU	Operable unit
RI	Remedial investigation
RI/FS	Remedial investigation/feasibility study
RME	Reasonable maximum exposure
RSD	Relative standard deviation
SD	Standard deviation
UCL	Upper confidence limit

1 Purpose

This environmental calculation describes the calculation of exposure point concentrations (EPCs) for analytes in groundwater at the 600 Area subregion of the 300-FF-5 Groundwater Operable Unit (hereafter referred to simply as the 600 Area subregion). This calculation brief details the statistical methodology used to calculate the EPCs and supports a separate calculation brief addressing the identification of groundwater contaminants of potential concern (COPCs) for the 600 Area subregion (ECF-300FF5-11-0129, *Identification of Contaminants of Potential Concern for the 600 Area Subregion of the 300-FF-5 Groundwater Operable Unit*). EPCs are calculated herein for a set of 51 analytes consisting of:

1. Analytes identified in ECF-300FF5-11-0129 as COPCs for the 600 Area subregion based on maximum detected concentrations in groundwater that exceed an applicable action level;
2. Analytes identified as groundwater COPCs in Table 1-5 of DOE/RL-2009-45, *300 Area Remedial Investigation/Feasibility Study Sampling and Analysis Plan for the 300-FF-1, 300-FF-2, and 300-FF-5 Operable Units*; and
3. Analytes detected at least once during the groundwater sampling and analysis activities described in DOE/RL-2009-45.

This calculation brief supports the remedial investigation/feasibility study (RI/FS) process being conducted for the 600 Area subregion under the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) as documented in DOE/RL-2010-99, *Remedial Investigation/Feasibility Study for the 300-FF-1, 300-FF-2, and 300-FF-5 Operable Units*.

2 Background

This calculation brief addresses a key element of the risk assessment process for hazardous waste sites: estimation of the concentration of a chemical in the environment. The following section provides a brief definition of the EPC.

2.1 Exposure Point Concentration

An EPC is a conservative estimate of the contaminant concentration at an exposure point or in an exposure area where an exposed receptor may reasonably be assumed to move at random and where contact with an environmental medium (e.g., water) is equally likely at all locations within the exposure area. The rationale for use of exposure concentrations is explained in EPA/540/1-89/002, *Risk Assessment Guidance for Superfund Volume I Human Health Evaluation Manual (Part A): Interim Final*:

“Although this concentration does not reflect the maximum concentration that could be contacted at any one time, it is regarded as a reasonable estimate of the concentration likely to be contacted over time. This is because in most situations, assuming long-term contact with the maximum concentration is not reasonable.”

3 Methodology

The following subsections discuss the methodology and equations used to calculate EPC values for the 600 Area subregion.

3.1 Exposure Point Concentration Methodology

The methodology involves using the 600 Area subregion groundwater analytical data set to calculate an EPC for each of the detected analytes/COPCs. Calculated 90th percentile values are taken as estimates of the EPCs. The 90th percentile value is the concentration that corresponds to the position in an ordered data set that has 90% of the data points below it, and 10% above it. The rationale for use of the 90th percentile value as the estimated EPC is discussed in Section 4.2. The steps taken to calculate the 90th percentile values are:

1. Obtain the dataset for each detected analyte/COPC.
2. Place the sample results for each detected analyte/COPC in order from the lowest concentration to the highest concentration.
3. Assign each sample result a ranked number (rank), starting with the number 1 for the lowest concentration result and continuing to the highest concentration, which is given the number equal to the total number of samples.
4. Calculate the 90th percentile value using the equations presented in Section 3.2.

3.2 Equations Used for Calculating the 90th Percentile Value

The position corresponding to the 90th percentile (k) is determined using the following equation (Hogg and Tanis, 2001, *Probability and Statistical Inference*):

$$k = \frac{p(n+1)}{100} \quad \text{where } p = 90 \text{ for a 90th percentile calculation}$$

$$n = \text{total number of samples}$$

If the number corresponding to the calculated value, k , is an integer, the sample result with rank corresponding to k is the 90th percentile value as indicated by the following equation.

$$90\text{th percentile value} = k\text{th value} \quad \text{where } k \text{ is an integer}$$

If k is not an integer, then the average or mean of the values on either side of k (the values in the positions $k_{\text{rounddown}}$ and k_{roundup}) is calculated using the following equation to determine the 90th percentile value:

$$90\text{th percentile value} = \frac{k_{\text{rounddown}}\text{value} + k_{\text{roundup}}\text{value}}{2}$$

where k is not an integer

If k is greater than n for smaller data sets ($n < 10$), the 90th percentile value defaults to the maximum concentration reported (i.e., the n^{th} value).

4 Assumptions and Inputs

4.1 Sample Analysis Data

The groundwater data set used for the EPC calculations consists of sample analysis data for samples collected from groundwater wells located in the 600 Area subregion. All of these wells are either monitoring wells or compliance wells. The data set is composed of analytical results from the groundwater sampling and analysis activities performed per the requirements documented in DOE/RL-2009-45. The analytical data set is extracted from the Hanford Environmental Information System (HEIS) database. After extraction from HEIS, the analytical data are processed to obtain a single set of results per sampling location and date of collection. Analytical data set processing is described in ECF-300FF5-11-0129. The input data used for the 90th percentile calculations are provided in Appendix A.

4.2 Determination of Statistical Calculation Method for EPC Values

In general, EPA Superfund guidance recommends using a 95% Upper Confidence Limit (95UCL) on the mean for estimating EPCs. However, experience at the Hanford Site indicates that averages and UCLs cannot be reliably calculated for Hanford groundwater data sets, such as the 600 Area subregion data, where multiple groundwater contaminants are present in overlapping plumes, and the highest concentrations for different analytes often have different locations within the plumes.

Use of the 90th percentile value from a distribution of groundwater concentration data as an estimate of the EPC is a different approach for estimating EPCs than that provided in some Superfund guidance (OSWER 9285.6-10, *Calculating Upper Confidence Limits for Exposure Point Concentrations at Hazardous Waste Sites*). However as described below, the 90th percentile exposure concentration is identified in other EPA risk assessment guidance as appropriate for describing and characterizing health risks; its use yields risk estimates that correspond to a reasonable maximum exposure (RME).

According to EPA/100/B-04/001, *An Examination of EPA Risk Assessment Principles and Practices*, the RME is an appropriate exposure scenario for risk calculations, within the realistic range of exposure, since the goal of the Superfund program is to protect against high-end, not average, exposures. The “high end” is defined as that part of the exposure distribution that is above the 90th percentile, but below the 99.9th percentile. The approach is consistent with the peer reviewed EPA/600/Z-92/001, *Guidelines for Exposure Assessment*. Groundwater concentrations directly reflect potential exposures and risks; so, a 90th percentile concentration reflects an RME scenario.

Groundwater data sets at the Hanford site are highly skewed, with a large proportion of below-detection-limit (BDL) values. The EPA data analysis guidance (EPA/240/B-06/003, *Data Quality Assessment: Statistical Methods for Practitioners*) provides different guidance for estimating statistical parameters (whether means or upper percentiles) depending on the variability of the data set. The variability of the data set is assessed in terms of the coefficient of variation (CV) and the proportion of analytical results that are BDL. For data sets with CVs > 0.5, and with 50% or more analytical results that are BDL, EPA recommends using upper percentiles, as opposed to means, to develop summary statistics.

Therefore, the rationale for using the 90th percentile value as an estimate of the EPC is consistent with the definition of an RME scenario, and is an appropriate statistic for groundwater data sets at the Hanford Site. Additional statistical evaluation of the 600 Area subregion data sets that supports selection of the 90th percentile value as the estimate of the EPC is provided in Appendix B. The Appendix B evaluation includes an estimation of the 95UCL value for each detected analyte/COPC along with an analysis of data set variability to assess the reliability of the 95UCL estimates. Results of the evaluation indicate that, for

all but five of detected analytes/COPCs, a reliable and meaningful 95UCL estimate cannot be calculated, because of 1) an insufficient number of samples, 2) an insufficient frequency of detections, or 3) a high variance of the data. For those five detected analytes/COPCs, the calculated 95UCL is less conservative than its corresponding 90th percentile value. Therefore, the 90th percentile value is adopted as the estimated EPC for all detected analytes/COPCs. A comparison of the 90th percentile and 95UCL values is provided in Section 7.2.

5 Software Applications

Software programs used for this analysis were the HEIS database, Microsoft Access¹ database software, ProUCL statistical software², and Microsoft Excel³. The HEIS is a central repository for storing and maintaining access to environmental data for the Hanford Site. Microsoft Access was used to query and sort the data downloaded from HEIS. Microsoft Excel was used to calculate the 90th percentile concentrations and to present the groundwater data and information in spreadsheets. ProUCL was used to perform statistical calculations on the analytical data sets. The ProUCL-generated calculations are presented in Appendix B and summarized in Section 7.2.

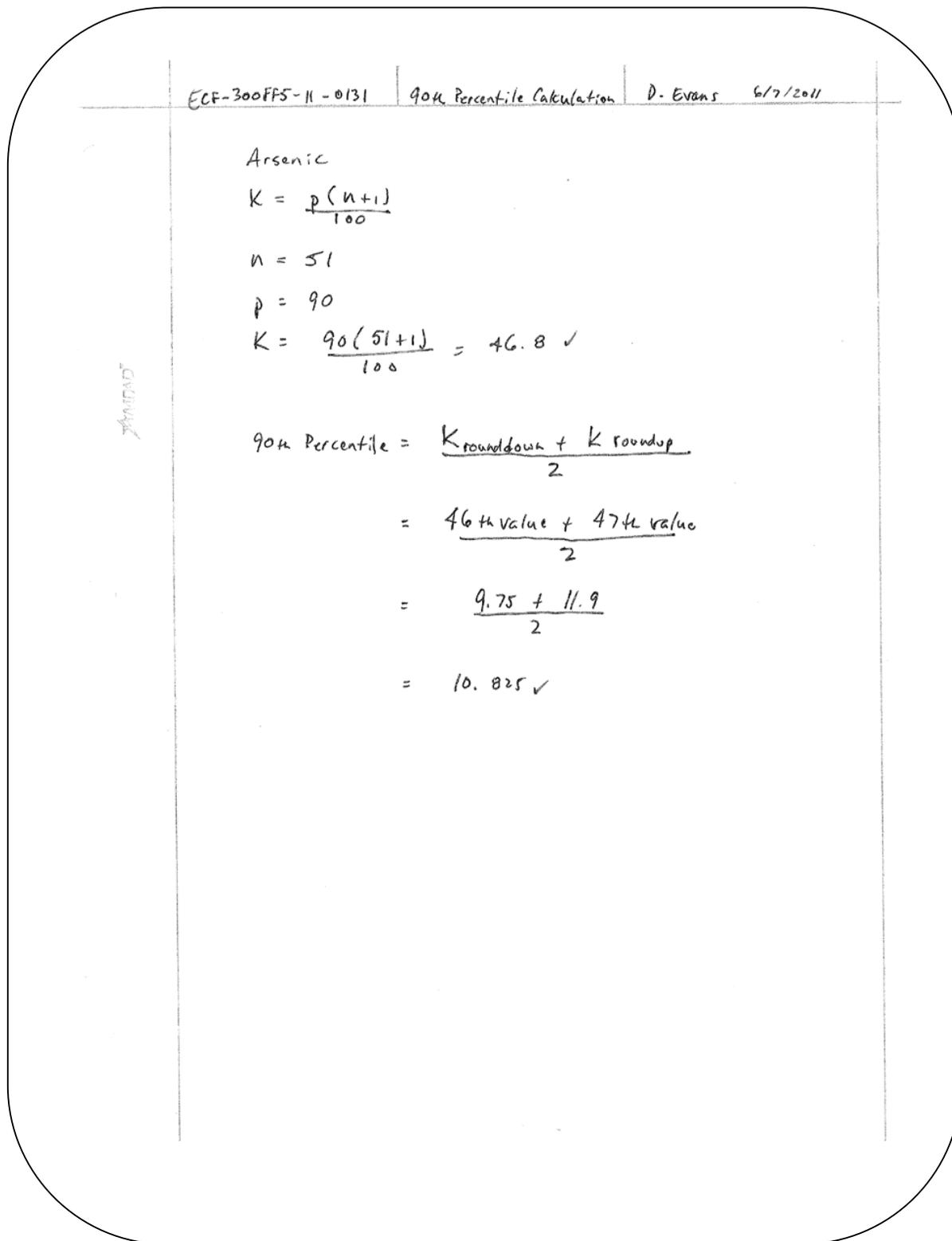
6 Calculation

Calculate the 90th percentile value using the methodology presented in Section 3. The 90th percentile calculations are validated by comparison with a hand calculation. The hand calculation is provided in Figure 6-1.

¹ Access is a trademark of Microsoft Corporation, Redmond, Washington.

² ProUCL is a statistical software package developed by the U.S. Environmental Protection Agency, distributed free of charge, and made available for download at http://www.epa.gov/nerlesd1/tsc/TSC_form.htm.

³ Excel is a trademark of Microsoft Corporation, Redmond, Washington.

Figure 6-1. Hand Calculation of the 90th Percentile Value

7 Results/Conclusions

7.1 90th Percentile Exposure Point Concentrations

The calculated 90th percentile values are presented in Table 7-1.

Table 7-1. 90th Percentile Calculation Results

Detected Analyte/COPC	Detects	Nondetects	Number of values (n)	Percentile (p)	Position in Sequence (k)	Mean 90 th Percentile (µg/L or pCi/L)
1,1-Dichloroethane	3	48	51	90	46.8	0.068
Acetone	5	39	44	90	40.5	1.0
Aluminum	15	36	51	90	46.8	87
Antimony ^a	No detectable results reported					
Arsenic ^a	51	0	51	90	46.8	11
Barium	51	0	51	90	46.8	69
Benzyl alcohol	1	50	51	90	46.8	1.0
Beryllium	1	50	51	90	46.8	0.10
Bis(2-ethylhexyl) phthalate	3	48	51	90	46.8	1.0
Boron	14	36	50	90	45.9	43
Bromodichloromethane	10	41	51	90	46.8	0.72
Bromoform	6	45	51	90	46.8	1.8
Bromomethane	9	42	51	90	46.8	2.0
Butylbenzylphthalate	1	50	51	90	46.8	1.0
Cadmium ^a	No detectable results reported					
Carbon disulfide	3	48	51	90	46.8	0.051
Carbon tetrachloride ^a	2	49	51	90	46.8	0.12
Chloride	51	0	51	90	46.8	16,600
Chloroform	15	36	51	90	46.8	0.62
Chromium ^a	34	17	51	90	46.8	4.9
Cobalt	10	41	51	90	46.8	0.36
Copper ^a	31	20	51	90	46.8	3.3
Dibromochloromethane	7	44	51	90	46.8	2.0
Diethylphthalate	2	49	51	90	46.8	1.0
Di-n-butylphthalate	1	50	51	90	46.8	1.0
Fluoride ^a	43	8	51	90	46.8	333

Table 7-1. 90th Percentile Calculation Results

Detected Analyte/COPC	Detects	Nondetects	Number of values (n)	Percentile (p)	Position in Sequence (k)	Mean 90 th Percentile (µg/L or pCi/L)
Gross alpha	14	8	22	90	20.7	8.0
Gross beta	22	0	22	90	20.7	57
Iodine-129 ^a	1	50	51	90	46.8	0.12
Iron	40	11	51	90	46.8	477
Lead ^a	15	36	51	90	46.8	0.61
Lithium	36	14	50	90	45.9	23
Manganese ^a	27	24	51	90	46.8	40
Molybdenum	51	0	51	90	46.8	8.7
Nickel ^a	4	47	51	90	46.8	4.0
Nitrate ^a	48	3	51	90	46.8	50,000
Nitrite ^a	No detectable results reported					
Selenium	33	18	51	90	46.8	6.1
Strontium	51	0	51	90	46.8	298
Strontium-90 ^a	No detectable results reported					
Sulfate ^a	51	0	51	90	46.8	64,600
Tetrachloroethene ^a	No detectable results reported					
Tin	4	47	51	90	46.8	0.10
Toluene	2	49	51	90	46.8	0.072
Tributyl phosphate ^a	1	50	51	90	46.8	1.0
Trichloroethene ^a	No detectable results reported					
Tritium ^a	31	20	51	90	46.8	290,000
Uranium ^a	49	2	51	90	46.8	9.2
Vanadium	19	32	51	90	46.8	21
Vinyl Chloride ^a	No detectable results reported					
Zinc ^a	24	27	51	90	46.8	38

Notes:

a. Identified as a groundwater COPC in Table 1-5 of DOE/RL-2009-45.

COPC = contaminant of potential concern.

DOE/RL-2009-45, 300 Area Remedial Investigation/Feasibility Study Sampling and Analysis Plan for the 300-FF-1, 300-FF-2, and 300-FF-5 Operable Units

7.2 Uncertainties Associated with Exposure Point Concentrations

The EPCs for groundwater are estimated by the 90th percentile concentration. The RI/FS protectiveness and risk evaluation methodology uses RME concentrations for the exposure area as a whole, rather than performing the evaluation on a specific well or location. As discussed in Section 4.2, EPA Superfund guidance generally recommends using a 95 percent UCL on the mean for estimating EPCs. However, experience at the Hanford Site indicates that averages and UCLs cannot be reliably calculated for groundwater data sets using this approach. Using the present example, the 600 Area subregion has multiple groundwater contaminants present in overlapping plumes, and the highest concentrations of the different analytes often have different locations within the plumes.

Taking the 90th percentile from a distribution of groundwater concentration data as an estimate of the EPC is a different approach from Superfund guidance for estimating EPCs in risk assessments (OSWER 9285.6-10). However, as discussed in Section 4.2, the 90th percentile concentration is identified in other EPA risk assessment guidance as usable for describing and characterizing health risks. Risk estimates based on the 90th percentile value correspond to an RME.

Table 7-2 shows the 90th percentile concentrations used for the RI/FS protectiveness and risk evaluations, as well as the maximum, average, and 95UCL concentrations for the 600 Area subregion.

A groundwater data set is considered robust when the 90th percentile value is greater than the 95UCL value. The 90th percentile concentration is greater than the 95UCL value for 22 detected analytes/COPCs but less than the 95UCL for 16 detected analytes/COPCs (1,1-dichloroethane, acetone, bis(2-ethylhexyl) phthalate, bromoform, carbon disulfide, carbon tetrachloride, chloroform, dibromochloromethane, diethylphthalate, gross alpha, iron, nickel, nitrate, tin, toluene, and tritium). As discussed in Section 4.2 and Appendix B, the 95UCL values calculated from the 600 Area subregion data sets have low reliability. Six detected analytes/COPCs (benzyl alcohol, beryllium, butylbenzylphthalate, di-n-butylphthalate, iodine-129, and tributyl phosphate) lack a 95UCL value altogether because their data sets contain only one detected value and could not be processed by the ProUCL software. Of the 38 detected analytes/COPCs where ProUCL was able to calculate a 95UCL, the data set for 33 failed to meet one or more of the criteria used for evaluating whether the data set can provide a reliable and meaningful 95UCL value. For five detected analytes/COPCs where a meaningful 95UCL could be calculated (barium, chloride, chromium, strontium, and sulfate) the calculated 95UCL is less conservative than its corresponding 90th percentile value. Generally, when data sets are large, the 95UCL will approach the mean concentration. For example, for arsenic, the 95UCL is 6.7 µg/L and the mean is 5.8 µg/L; in contrast, the 90th percentile is 10.8 µg/L. Therefore, 90th percentile values are reasonable upper bounds of exposure area concentrations, for the purposes of the RI/FS risk assessment.

However, risks could be significantly underestimated for a detected analyte/COPC whose maximum concentration is considerably larger than the 90th percentile value. This is true of two of the detected analytes/COPCs (chloroform and diethylphthalate), for which the maximum concentrations are more than an order of magnitude greater than the 90th percentile values. If a future drinking water well were drilled at the location of one of these maximum concentrations, the health risk would be greater than calculated using the 90th percentile value as the estimated EPC. However, because only 10 percent of the data exceed the 90th percentile value, such very high concentrations are few, and they represent only limited areas.

Table 7-2. Percentile Concentrations and Summary Statistics for the 600 Area Subregion Data Set

Detected Analyte/COPC	Units	Number of Measurements	90 th Percentile	Maximum	Mean	95% UCL ^a
1,1-Dichloroethane	µg/L	51	0.068	0.20	0.17	0.20
Acetone	µg/L	44	1.0	2.5	1.8	2.1
Aluminum	µg/L	51	87	539	106	66
Arsenic	µg/L	51	11	15	5.8	6.7
Barium	µg/L	51	69	118	45	50
Benzyl alcohol	µg/L	51	1.0	1.1	1.1	--
Beryllium	µg/L	51	0.10	0.19	0.19	--
Bis(2-ethylhexyl) phthalate	µg/L	51	1.0	3.0	1.9	3.0
Boron	µg/L	50	43	107	50	39
Bromodichloromethane	µg/L	51	0.72	2.1	0.89	0.64
Bromoform	µg/L	51	1.8	2.9	2.3	2.5
Bromomethane	µg/L	51	2.0	0.95	0.45	0.37
Butylbenzylphthalate	µg/L	51	1.0	1.3	1.3	--
Carbon disulfide	µg/L	51	0.051	0.11	0.081	0.11
Carbon tetrachloride	µg/L	51	0.12	0.16	0.15	0.13
Chloride	µg/L	51	16,600	26,100	11,591	12,864
Chloroform	µg/L	51	0.62	7.1	1.1	0.75
Chromium	µg/L	51	4.9	5.9	3.1	2.9
Cobalt	µg/L	51	0.36	1.0	0.46	0.26
Copper	µg/L	51	3.3	12	1.8	1.7
Dibromochloromethane	µg/L	51	2.0	3.3	2.4	2.3
Diethylphthalate	µg/L	51	1.0	42	22	14
Di-n-butylphthalate	µg/L	51	1.0	1.0	1.0	--
Fluoride	µg/L	51	333	851	242	322
Gross alpha	pCi/L	22	8.0	40	6.7	22
Gross beta	pCi/L	22	57	61	27	38
Iodine-129	pCi/L	51	0.12	0.38	0.38	--
Iron	µg/L	51	477	3,340	306	541
Lead	µg/L	51	0.61	1.4	0.56	0.39

Table 7-2. Percentile Concentrations and Summary Statistics for the 600 Area Subregion Data Set

Detected Analyte/COPC	Units	Number of Measurements	90 th Percentile	Maximum	Mean	95% UCL ^a
Lithium	µg/L	50	23	31	14	13
Manganese	µg/L	51	40	261	34	30
Molybdenum	µg/L	51	8.7	11	4.9	5.6
Nickel	µg/L	51	4.0	8.0	5.3	4.3
Nitrate	µg/L	51	50,000	136,000	26,630	50,530
Selenium	µg/L	51	6.1	13	3.4	3.2
Strontium	µg/L	51	298	407	226	241
Sulfate	µg/L	51	64,600	87,200	41,436	46,048
Tin	µg/L	51	0.10	0.26	0.18	0.19
Toluene	µg/L	51	0.072	0.14	0.11	0.087
Tributyl phosphate	µg/L	51	1.0	6.7	6.7	--
Tritium	pCi/L	51	290,000	890,000	128,200	365,852
Uranium	µg/L	51	9.2	13	4.9	6.9
Vanadium	µg/L	51	21	33	19	17
Zinc	µg/L	51	38	71	21	16

Notes:

a. -- Indicates number of detected results is insufficient for ProUCL to process the data set.

COPC = contaminant of potential concern.

UCL = upper confidence limit.

8 References

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APPENDIX A

Data Spreadsheets

The input data used for the 90th percentile calculations for the 600 Area subregion are provided in Table A-1. This table is provided as an electronic attachment (formatted for on-screen viewing) in the Excel workbook “ECF-300FF5-11-0131 600 Area Subregion EPC Calculation Worksheet.xlsx” that accompanies this environmental calculation.

APPENDIX B

Summary Statistics and Supporting Information

B.1 Summary Statistics for the 600 Area Subregion Data Set

Statistical calculations were performed for each of the detected analytes/COPCs in groundwater in the 600 Area subregion. The results of the statistical calculations are provided in Table B-1. The raw statistics were calculated by the ProUCL software. This table is provided as an electronic attachment (formatted for on-screen viewing) in the Excel workbook “ECF-300FF5-11-0131 600 Area Subregion EPC Calculation Worksheet.xlsx” that accompanies this environmental calculation. The following statistical definitions are provided for assistance in interpreting the information provided by ProUCL.

- **Mean:** The sum of all the values of a set of measurements divided by the number of values in the set; a measure of central tendency.
- **Median:** The middle value for an ordered set of n values. Represented by the central value when n is odd or by the average of the two most central values when n is even. The median is the 50th percentile.
- **Standard Deviation (SD):** A measure of variation (or spread) from an average value of the sample data values.
- **Median Absolute Deviation (MAD):** For observations x_1, x_2, \dots, x_n , with median m , the median absolute deviation is the median of the differences $|x_1 - m|, |x_2 - m|, \dots, |x_n - m|$.
- **MAD/0.675 = Robust measure of variation (standard deviation)** where MAD = Median Absolute Deviation
- **Skewness:** A measure of the asymmetry of the distribution of the characteristic under study (e.g., lead concentrations). It can also be measured in terms of the standard deviation of log-transformed data. The higher the standard deviation, the higher the skewness. Coefficient of Skewness = $CV^3 + 3CV$ where CV is the coefficient of variation.
- **Coefficient of Variation (CV):** A dimensionless quantity used to measure the spread of data relative to the size of the numbers. For a normal distribution, the CV is given by the standard deviation divided by the mean. Also known as the relative standard deviation (RSD).

B.2 ProUCL Generated 95 Percent Upper Confidence Limits

The ProUCL 4.0 statistical software package (EPA/600/R-07/038, *ProUCL Version 4.00.05 User Guide (Draft)*) was used to generate an estimate of the 95% upper confidence limit (95UCL) on the mean concentration for each detected analyte/COPC. ProUCL 4.0 contains statistical methods to address data sets both with and without nondetects and computes the UCL for a given data set by a variety of alternative statistical approaches (including several approaches that do not require the assumption of normality or log-normality). ProUCL 4.0 then recommends specific UCL values as being the most appropriate for that particular data set. The input data files used to calculate the 95UCL values are the same as those used for the 90th percentile calculations and are provided in Appendix A. The ProUCL output generated for the 600 Area subregion is provided at the end of this appendix. A summary table with the ProUCL comments, recommended UCL calculation methods, and warnings regarding the adequacy of the data to provide meaningful results for each detected analyte/COPC is provided in Table B-2.

Table B-2. Summary of ProUCL Comments and UCL Calculation Methods

Detected Analyte/COPC	ProUCL Comment	UCL Calculation Method
1,1-Dichloroethane	<p>Warning: There are only 3 Distinct Detected Values in this data set</p> <p>The number of detected data may not be adequate enough to perform GOF tests, bootstrap, and ROS methods.</p> <p>Those methods will return a 'N/A' value on your output display!</p> <p>It is necessary to have 4 or more Distinct Values for bootstrap methods.</p> <p>However, results obtained using 4 to 9 distinct values may not be reliable.</p> <p>It is recommended to have 10 to 15 or more observations for accurate and meaningful results and estimates.</p> <p>Data appear Normal at 5% Significance Level</p> <p>Data appear Lognormal at 5% Significance Level</p> <p>Data not Gamma Distributed at 5% Significance Level</p>	95% KM (Percentile Bootstrap) UCL
Acetone	<p>Warning: There are only 5 Detected Values in this data</p> <p>Note: It should be noted that even though bootstrap may be performed on this data set</p> <p>the resulting calculations may not be reliable enough to draw conclusions</p> <p>It is recommended to have 10-15 or more distinct observations for accurate and meaningful results.</p> <p>Data appear Normal at 5% Significance Level</p> <p>Data not Lognormal at 5% Significance Level</p> <p>Data appear Gamma Distributed at 5% Significance Level</p>	95% KM (Percentile Bootstrap) UCL
Aluminum	<p>Data not Normal at 5% Significance Level</p> <p>Data not Lognormal at 5% Significance Level</p> <p>Data not Gamma Distributed at 5% Significance Level</p> <p>Data do not follow a Discernable Distribution (0.05)</p>	95% KM (BCA) UCL
Arsenic	<p>Data not Normal at 5% Significance Level</p> <p>Data not Lognormal at 5% Significance Level</p> <p>Data follow Appr. Gamma Distribution at 5% Significance Level</p>	Use 95% Approximate Gamma UCL
Barium	<p>Data appear Normal at 5% Significance Level</p> <p>Data not Lognormal at 5% Significance Level</p> <p>Data appear Gamma Distributed at 5% Significance Level</p>	Use 95% Student's-t UCL
Benzyl alcohol	<p>Warning: Only one distinct data value was detected! ProUCL (or any other software) should not be used on such a data set!</p> <p>It is suggested to use alternative site specific values determined by the Project Team to estimate environmental parameters (e.g., EPC, BTV).</p> <p>The data set for variable Benzyl alcohol was not processed!</p>	Not Processed

Table B-2. Summary of ProUCL Comments and UCL Calculation Methods

Detected Analyte/COPC	ProUCL Comment	UCL Calculation Method
Beryllium	<p>Warning: Only one distinct data value was detected! ProUCL (or any other software) should not be used on such a data set!</p> <p>It is suggested to use alternative site specific values determined by the Project Team to estimate environmental parameters (e.g., EPC, BTV).</p> <p>The data set for variable Beryllium was not processed!</p>	Not Processed
Bis(2-ethylhexyl) phthalate	<p>Warning: There are only 3 Distinct Detected Values in this data set</p> <p>The number of detected data may not be adequate enough to perform GOF tests, bootstrap, and ROS methods.</p> <p>Those methods will return a 'N/A' value on your output display!</p> <p>It is necessary to have 4 or more Distinct Values for bootstrap methods.</p> <p>However, results obtained using 4 to 9 distinct values may not be reliable.</p> <p>It is recommended to have 10 to 15 or more observations for accurate and meaningful results and estimates.</p> <p>Data appear Normal at 5% Significance Level</p> <p>Data appear Lognormal at 5% Significance Level</p> <p>Data not Gamma Distributed at 5% Significance Level</p>	95% KM (Percentile Bootstrap) UCL
Boron	<p>Data not Normal at 5% Significance Level</p> <p>Data not Lognormal at 5% Significance Level</p> <p>Data not Gamma Distributed at 5% Significance Level</p> <p>Data do not follow a Discernable Distribution (0.05)</p>	95% KM (% Bootstrap) UCL
Bromodichloromethane	<p>Data appear Normal at 5% Significance Level</p> <p>Data appear Lognormal at 5% Significance Level</p> <p>Data appear Gamma Distributed at 5% Significance Level</p>	95% KM (Percentile Bootstrap) UCL
Bromoform	<p>Warning: There are only 6 Detected Values in this data</p> <p>Note: It should be noted that even though bootstrap may be performed on this data set the resulting calculations may not be reliable enough to draw conclusions</p> <p>It is recommended to have 10-15 or more distinct observations for accurate and meaningful results.</p> <p>Data appear Normal at 5% Significance Level</p> <p>Data appear Lognormal at 5% Significance Level</p> <p>Data appear Gamma Distributed at 5% Significance Level</p>	95% KM (Percentile Bootstrap) UCL
Bromomethane	<p>Warning: There are only 9 Detected Values in this data</p> <p>Note: It should be noted that even though bootstrap may be performed on this data set the resulting calculations may not be reliable enough to draw conclusions</p>	95% KM (t) UCL

Table B-2. Summary of ProUCL Comments and UCL Calculation Methods

Detected Analyte/COPC	ProUCL Comment	UCL Calculation Method
	<p>It is recommended to have 10-15 or more distinct observations for accurate and meaningful results.</p> <p>Data not Normal at 5% Significance Level</p> <p>Data not Lognormal at 5% Significance Level</p> <p>Data follow Appr. Gamma Distribution at 5% Significance Level</p>	
Butylbenzylphthalate	<p>Warning: Only one distinct data value was detected! ProUCL (or any other software) should not be used on such a data set!</p> <p>It is suggested to use alternative site specific values determined by the Project Team to estimate environmental parameters (e.g., EPC, BTV).</p> <p>The data set for variable Butylbenzylphthalate was not processed!</p>	Not Processed
Carbon disulfide	<p>Warning: There are only 3 Distinct Detected Values in this data set</p> <p>The number of detected data may not be adequate enough to perform GOF tests, bootstrap, and ROS methods.</p> <p>Those methods will return a 'N/A' value on your output display!</p> <p>It is necessary to have 4 or more Distinct Values for bootstrap methods.</p> <p>However, results obtained using 4 to 9 distinct values may not be reliable.</p> <p>It is recommended to have 10 to 15 or more observations for accurate and meaningful results and estimates.</p> <p>Data appear Normal at 5% Significance Level</p> <p>Data appear Lognormal at 5% Significance Level</p> <p>Data not Gamma Distributed at 5% Significance Level</p>	95% KM (Percentile Bootstrap) UCL
Carbon tetrachloride	<p>Warning: Data set has only 2 Distinct Detected Values.</p> <p>This may not be adequate enough to compute meaningful and reliable test statistics and estimates.</p> <p>The Project Team may decide to use alternative site specific values to estimate environmental parameters (e.g., EPC, BTV).</p> <p>Unless Data Quality Objectives (DQOs) have been met, it is suggested to collect additional observations.</p> <p>The number of detected data may not be adequate enough to perform GOF tests, bootstrap, and ROS methods.</p> <p>Those methods will return a 'N/A' value on your output display!</p> <p>It is necessary to have 4 or more Distinct Values for bootstrap methods.</p> <p>However, results obtained using 4 to 9 distinct values may not be reliable.</p> <p>It is recommended to have 10 to 15 or more observations for accurate and meaningful results and estimates.</p> <p>Data not Normal at 5% Significance Level</p> <p>Data not Lognormal at 5% Significance Level</p>	95% KM (t) UCL

Table B-2. Summary of ProUCL Comments and UCL Calculation Methods

Detected Analyte/COPC	ProUCL Comment	UCL Calculation Method
	Data not Gamma Distributed at 5% Significance Level Data do not follow a Discernable Distribution (0.05)	
Chloride	Data appear Normal at 5% Significance Level Data not Lognormal at 5% Significance Level Data follow Appr. Gamma Distribution at 5% Significance Level	Use 95% Student's-t UCL
Chloroform	Data not Normal at 5% Significance Level Data appear Lognormal at 5% Significance Level Data not Gamma Distributed at 5% Significance Level	95% KM (BCA) UCL
Chromium	Data not Normal at 5% Significance Level Data appear Lognormal at 5% Significance Level Data appear Gamma Distributed at 5% Significance Level	95% KM (Percentile Bootstrap) UCL
Cobalt	Data appear Normal at 5% Significance Level Data appear Lognormal at 5% Significance Level Data appear Gamma Distributed at 5% Significance Level	95% KM (Percentile Bootstrap) UCL
Copper	Data not Normal at 5% Significance Level Data appear Lognormal at 5% Significance Level Data follow Appr. Gamma Distribution at 5% Significance Level	95% KM (BCA) UCL
Dibromochloromethane	Warning: There are only 7 Detected Values in this data Note: It should be noted that even though bootstrap may be performed on this data set the resulting calculations may not be reliable enough to draw conclusions It is recommended to have 10-15 or more distinct observations for accurate and meaningful results. Data appear Normal at 5% Significance Level Data appear Lognormal at 5% Significance Level Data appear Gamma Distributed at 5% Significance Level	95% KM (Percentile Bootstrap) UCL
Diethylphthalate	Warning: Data set has only 2 Distinct Detected Values. This may not be adequate enough to compute meaningful and reliable test statistics and estimates. The Project Team may decide to use alternative site specific values to estimate environmental parameters (e.g., EPC, BTV). Unless Data Quality Objectives (DQOs) have been met, it is suggested to collect additional observations. The number of detected data may not be adequate enough to perform GOF tests, bootstrap, and ROS methods. Those methods will return a 'N/A' value on your output display! It is necessary to have 4 or more Distinct Values for bootstrap	99% KM (Chebyshev) UCL

Table B-2. Summary of ProUCL Comments and UCL Calculation Methods

Detected Analyte/COPC	ProUCL Comment	UCL Calculation Method
	<p>methods.</p> <p>However, results obtained using 4 to 9 distinct values may not be reliable.</p> <p>It is recommended to have 10 to 15 or more observations for accurate and meaningful results and estimates.</p> <p>Data not Normal at 5% Significance Level</p> <p>Data not Lognormal at 5% Significance Level</p> <p>Data not Gamma Distributed at 5% Significance Level</p> <p>Data do not follow a Discernable Distribution (0.05)</p>	
Di-n-butylphthalate	<p>Warning: Only one distinct data value was detected! ProUCL (or any other software) should not be used on such a data set!</p> <p>It is suggested to use alternative site specific values determined by the Project Team to estimate environmental parameters (e.g., EPC, BTV).</p> <p>The data set for variable Di-n-butylphthalate was not processed!</p>	Not Processed
Fluoride	<p>Data not Normal at 5% Significance Level</p> <p>Data not Lognormal at 5% Significance Level</p> <p>Data not Gamma Distributed at 5% Significance Level</p> <p>Data do not follow a Discernable Distribution (0.05)</p>	95% KM (Chebyshev) UCL
Gross alpha	Data not Normal at 5% Significance Level	99% KM (Chebyshev) UCL
Gross beta	<p>Data not Normal at 5% Significance Level</p> <p>Data appear Lognormal at 5% Significance Level</p> <p>Data appear Gamma Distributed at 5% Significance Level</p>	Use 95% Approximate Gamma UCL
Iodine-129	<p>Warning: Only one distinct data value was detected! ProUCL (or any other software) should not be used on such a data set!</p> <p>It is suggested to use alternative site specific values determined by the Project Team to estimate environmental parameters (e.g., EPC, BTV).</p> <p>The data set for variable Iodine-129 was not processed!</p>	Not Processed
Iron	<p>Data not Normal at 5% Significance Level</p> <p>Data appear Lognormal at 5% Significance Level</p> <p>Data follow Appr. Gamma Distribution at 5% Significance Level</p>	95% KM (Chebyshev) UCL
Lead	<p>Data not Normal at 5% Significance Level</p> <p>Data appear Lognormal at 5% Significance Level</p> <p>Data appear Gamma Distributed at 5% Significance Level</p>	95% KM (t) UCL
Lithium	<p>Data not Normal at 5% Significance Level</p> <p>Data not Lognormal at 5% Significance Level</p> <p>Data not Gamma Distributed at 5% Significance Level</p> <p>Data do not follow a Discernable Distribution (0.05)</p>	95% KM (BCA) UCL

Table B-2. Summary of ProUCL Comments and UCL Calculation Methods

Detected Analyte/COPC	ProUCL Comment	UCL Calculation Method
Manganese	Data not Normal at 5% Significance Level Data appear Lognormal at 5% Significance Level Data not Gamma Distributed at 5% Significance Level	95% KM (% Bootstrap) UCL
Molybdenum	Data not Normal at 5% Significance Level Data appear Lognormal at 5% Significance Level Data appear Gamma Distributed at 5% Significance Level	Use 95% Approximate Gamma UCL
Nickel	Warning: There are only 3 Distinct Detected Values in this data set The number of detected data may not be adequate enough to perform GOF tests, bootstrap, and ROS methods. Those methods will return a 'N/A' value on your output display! It is necessary to have 4 or more Distinct Values for bootstrap methods. However, results obtained using 4 to 9 distinct values may not be reliable. It is recommended to have 10 to 15 or more observations for accurate and meaningful results and estimates. Data appear Normal at 5% Significance Level Data appear Lognormal at 5% Significance Level Data appear Gamma Distributed at 5% Significance Level	95% KM (t) UCL
Nitrate	Data not Normal at 5% Significance Level Data not Lognormal at 5% Significance Level Data not Gamma Distributed at 5% Significance Level Data do not follow a Discernable Distribution (0.05)	97.5% KM (Chebyshev) UCL
Selenium	Data not Normal at 5% Significance Level Data appear Lognormal at 5% Significance Level Data not Gamma Distributed at 5% Significance Level	95% KM (BCA) UCL
Strontium	Data appear Normal at 5% Significance Level Data appear Lognormal at 5% Significance Level Data appear Gamma Distributed at 5% Significance Level	Use 95% Student's-t UCL
Sulfate	Data appear Normal at 5% Significance Level Data not Lognormal at 5% Significance Level Data not Gamma Distributed at 5% Significance Level	Use 95% Student's-t UCL
Tin	Warning: There are only 4 Distinct Detected Values in this data set Note: It should be noted that even though bootstrap may be performed on this data set the resulting calculations may not be reliable enough to draw conclusions It is recommended to have 10-15 or more distinct observations for accurate and meaningful results.	95% KM (Percentile Bootstrap) UCL

Table B-2. Summary of ProUCL Comments and UCL Calculation Methods

Detected Analyte/COPC	ProUCL Comment	UCL Calculation Method
	Data appear Normal at 5% Significance Level Data appear Lognormal at 5% Significance Level Data appear Gamma Distributed at 5% Significance Level	
Toluene	Warning: Data set has only 2 Distinct Detected Values. This may not be adequate enough to compute meaningful and reliable test statistics and estimates. The Project Team may decide to use alternative site specific values to estimate environmental parameters (e.g., EPC, BTV). Unless Data Quality Objectives (DQOs) have been met, it is suggested to collect additional observations. The number of detected data may not be adequate enough to perform GOF tests, bootstrap, and ROS methods. Those methods will return a 'N/A' value on your output display! It is necessary to have 4 or more Distinct Values for bootstrap methods. However, results obtained using 4 to 9 distinct values may not be reliable. It is recommended to have 10 to 15 or more observations for accurate and meaningful results and estimates. Data not Normal at 5% Significance Level Data not Lognormal at 5% Significance Level Data not Gamma Distributed at 5% Significance Level Data do not follow a Discernable Distribution (0.05)	95% KM (t) UCL
Tributyl phosphate	Warning: Only one distinct data value was detected! ProUCL (or any other software) should not be used on such a data set! It is suggested to use alternative site specific values determined by the Project Team to estimate environmental parameters (e.g., EPC, BTV). The data set for variable Tributyl phosphate was not processed!	Not Processed
Tritium	Data not Normal at 5% Significance Level	99% KM (Chebyshev) UCL
Uranium	Data not Normal at 5% Significance Level Data not Lognormal at 5% Significance Level Data not Gamma Distributed at 5% Significance Level Data do not follow a Discernable Distribution (0.05)	95% KM (Chebyshev) UCL
Vanadium	Data not Normal at 5% Significance Level Data appear Lognormal at 5% Significance Level Data not Gamma Distributed at 5% Significance Level	95% KM (% Bootstrap) UCL
Zinc	Data not Normal at 5% Significance Level Data not Lognormal at 5% Significance Level Data follow Appr. Gamma Distribution at 5% Significance Level	95% KM (t) UCL

Table B-2. Summary of ProUCL Comments and UCL Calculation Methods

Detected Analyte/COPC	ProUCL Comment	UCL Calculation Method
Notes:		
KM (BCA) UCL: UCL based upon Kaplan-Meier Estimates using the Bias Corrected Accelerated Percentile Bootstrap Method		
KM (t) UCL: UCL based upon Kaplan-Meier Estimates using Student's t-Distribution Critical Value		
KM (% Bootstrap) UCL: UCL based upon Kaplan-Meier Estimates using the Percentile Bootstrap Method.		
KM (Chebyshev) UCL: UCL based upon Kaplan-Meier Estimates using the Chebyshev Inequality		

The 600 Area subregion groundwater data set is highly skewed or left-censored (i.e., they contain a significant number of results reported below detection limits). Determination of the distribution of left-censored data sets, especially when a large percentage (> 40% -50%) of observations are censored, because they are nondetected, is very difficult (EPA/600/R-07/038). The 600 Area subregion data set generally does not fit either normal or lognormal distributions as demonstrated by the comments generated in the ProUCL output.

Skewed or highly censored data sets present problems in calculating the UCL as well. Reviewing the ProUCL output, the majority (71%) of the recommended calculation methods utilize Kaplan–Meier estimates. Estimation methods such as the Kaplan-Meier estimates yield reasonably good 95UCLs (providing adequate coverage for the population mean) for symmetric or mildly skewed distributions but may not perform well on a data set obtained from moderately or highly skewed distributions such as the 600 Area subregion data set (EPA/600/R-06/022, *On the Computation of 95% Upper Confidence Limit of the Unknown Population Mean Based Upon Data Sets with Below Detection Limit Observations*).

In evaluating the reliability of the 95UCL values generated by the ProUCL software, the following subsections summarize the characteristics of the 600 Area subregion data set with respect to 1) left-censoring or skewness, 2) adequate number of detected results, and 3) variance of the data.

B.3 Number of Less than Detectable Results Reported for the 600 Area Subregion Data Set

As previously mentioned, the 600 Area subregion data set contained results reported at less than the detection limits and is considered left-censored. A summary of the number of less than detectable results reported for the 600 Area subregion data set is provided in Table B-3.

B.4 Number of Detectable Results for the 600 Area Subregion Data Set

Several detected analytes/COPCs had insufficient detectable results to enable the ProUCL software to calculate reliable and meaningful results. A summary of the number of detectable results for the 600 Area subregion data set is provided in Table B-3.

B.5 Coefficient of Variation for the 600 Area Subregion Data Set

A large sample variance indicates that the data are not clustered close to the mean. A small sample variance (relative to the mean) indicates that most of the data are near the mean. The sample variance is affected by extreme values and by a large number of non-detects. Guidelines in EPA/240/B-06/003, *Data Quality Assessment: Statistical Methods for Practitioners* provide recommendations regarding statistical

parameters to use for different values of CV, when censoring is present in data sets. Coefficients of variation greater than 0.5 is the threshold value used in EPA/240/B-06/003 for using an upper percentile value, instead of a mean-based value, for a statistical parameter. The CVs for the 600 Area subregion data set are provided in Table B-3.

Table B-3. Data Set Summary by Detected Analyte/COPC for 600 Area Subregion Data Set

Detected Analyte/COPC	Number of Detects	Number of Nondetects	Frequency of Nondetects	Sufficient Percentage of Detects ^a	Coefficient of Variation	Coefficient of Variation >0.5 ^b
1,1-Dichloroethane ^c	3	48	94%	No	0.15	No
Acetone ^c	5	39	89%	No	0.47	No
Aluminum	15	36	71%	No	1.5	Yes
Arsenic	51	0	0%	Yes	0.57	Yes
Barium	51	0	0%	Yes	0.49	No
Benzyl alcohol ^c	1	50	98%	No	N/A	--
Beryllium ^c	1	50	98%	No	N/A	--
Bis(2-ethylhexyl) phthalate ^c	3	48	94%	No	0.48	No
Boron	14	36	72%	No	0.62	Yes
Bromodichloromethane	10	41	80%	No	0.68	Yes
Bromoform ^c	6	45	88%	No	0.20	No
Bromomethane ^c	9	42	82%	No	0.47	No
Butylbenzylphthalate ^c	1	50	98%	No	N/A	--
Carbon disulfide ^c	3	48	94%	No	0.32	No
Carbon tetrachloride ^c	2	49	96%	No	0.15	No
Chloride	51	0	0%	Yes	0.47	No
Chloroform	15	36	71%	No	1.7	Yes
Chromium	34	17	33%	Yes	0.45	No
Cobalt	10	41	80%	No	0.71	Yes
Copper	31	20	39%	Yes	1.4	Yes
Dibromochloromethane ^c	7	44	86%	No	0.25	No
Diethylphthalate ^c	2	49	96%	No	1.3	Yes
Di-n-butylphthalate ^c	1	50	98%	No	N/A	--
Fluoride	43	8	16%	Yes	0.76	Yes

Table B-3. Data Set Summary by Detected Analyte/COPC for 600 Area Subregion Data Set

Detected Analyte/COPC	Number of Detects	Number of Nondetects	Frequency of Nondetects	Sufficient Percentage of Detects ^a	Coefficient of Variation	Coefficient of Variation >0.5 ^b
Gross alpha	14	8	36%	Yes	1.5	Yes
Gross beta	22	0	0%	Yes	0.72	Yes
Iodine-129 ^c	1	50	98%	No	N/A	--
Iron	40	11	22%	Yes	1.7	Yes
Lead	15	36	71%	No	0.56	Yes
Lithium	36	14	28%	Yes	0.53	Yes
Manganese	27	24	47%	Yes	1.4	Yes
Molybdenum	51	0	0%	Yes	0.54	Yes
Nickel ^c	4	47	92%	No	0.36	No
Nitrate	48	3	6%	Yes	1.1	Yes
Selenium	33	18	35%	Yes	0.88	Yes
Strontium	51	0	0%	Yes	0.29	No
Sulfate	51	0	0%	Yes	0.47	No
Tinc	4	47	92%	No	0.33	No
Toluene ^c	2	49	96%	No	0.36	No
Tributyl phosphate ^c	1	50	98%	No	N/A	--
Tritium	31	20	39%	Yes	2.0	Yes
Uranium	49	2	4%	Yes	0.70	Yes
Vanadium	19	32	63%	No	0.27	No
Zinc	24	27	53%	No	1.0	Yes

Notes:

- Sufficient percentage of detections is consider to be 50% or greater.
- Coefficient of Variation = Standard Deviation / Mean. Data is considered variable if greater than 0.5.
- Number of detected results is insufficient for ProUCL to calculate meaningful and reliable results.

COPC = contaminant of potential concern.

Shading indicates those COPCs that have a sufficient number of results, a sufficient number of detects, and a coefficient of variation less than 0.5.

B.6 Statistical Summary Results Reported for the 600 Area Subregion Data Set

Table B-3 summarizes the detected analytes/COPCs with respect to sufficient number of detectable results, the percentage of detected results (left-censored indicator), and the CV. Those detected analytes/COPCs that had a sufficient number of results above detection limits and a coefficient of variation less than 0.5 are shaded, for clarity. The detected analytes/COPCs that have data sets that could

provide generally reliable 95UCL values are barium, chloride, chloroform, strontium, and sulfate. The percentage values associated with this information are provided in Table B-4.

Table B-4. General Summary of the Data Set for 600 Area Subregion

Exposure Area	Number of Detected Results Sufficient			% Detected Sufficient			Coefficient of Variation>0.5		
	No	Yes	%No	No	Yes	%No	No	Yes	%Yes
600 Area Subregion	17	26	41%	26	18	59%	17	21	55%

B.7 ProUCL Output

ProUCL output generated for the 600 Area subregion data set is provided in Table B-5. This table is provided as an electronic attachment (formatted for on-screen viewing) in the Excel workbook “ECF-300FF5-11-0131 600 Area Subregion EPC Calculation Worksheet.xlsx” that accompanies this environmental calculation.

Table A-1. 600 Area Subregion Analytical Data Used for 90th Percentile Calculation

1,1-Dichloroethane

D_1,1-Dichloroethane

detects	3
nondetects	48
n (number of values)	51
p (percentile)	90
k (position in sequence)	46.8
mean 90th percentile	0.068

Rank	µg/L	Det. = 1 Nondet. = 0	Rank	µg/L	Det. = 1 Nondet. = 0
1	0.068	0	32	0.068	0
2	0.068	0	33	0.068	0
3	0.068	0	34	0.068	0
4	0.068	0	35	0.068	0
5	0.068	0	36	0.068	0
6	0.068	0	37	0.068	0
7	0.068	0	38	0.068	0
8	0.068	0	39	0.068	0
9	0.068	0	40	0.068	0
10	0.068	0	41	0.068	0
11	0.068	0	42	0.068	0
12	0.068	0	43	0.068	0
13	0.068	0	44	0.068	0
14	0.068	0	45	0.068	0
15	0.068	0	46	0.068	0
16	0.068	0	47	0.068	0
17	0.068	0	48	0.068	0
18	0.068	0	49	0.15	1
19	0.068	0	50	0.17	1
20	0.068	0	51	0.2	1
21	0.068	0			
22	0.068	0			
23	0.068	0			
24	0.068	0			
25	0.068	0			
26	0.068	0			
27	0.068	0			
28	0.068	0			
29	0.068	0			
30	0.068	0			
31	0.068	0			

Table A-1. 600 Area Subregion Analytical Data Used for 90th Percentile Calculation
Acetone D_Acetone

detects	5
nondetects	39
n (number of values)	44
p (percentile)	90
k (position in sequence)	40.5
mean 90th percentile	1

Rank	µg/L	Det. = 1 Nondet. = 0	Rank	µg/L	Det. = 1 Nondet. = 0
1	0.34	0	32	0.34	0
2	0.34	0	33	0.34	0
3	0.34	0	34	0.34	0
4	0.34	0	35	0.34	0
5	0.34	0	36	0.34	0
6	0.34	0	37	0.34	0
7	0.34	0	38	0.34	0
8	0.34	0	39	0.34	0
9	0.34	0	40	0.4	1
10	0.34	0	41	1.6	1
11	0.34	0	42	2.1	1
12	0.34	0	43	2.2	1
13	0.34	0	44	2.5	1
14	0.34	0	45	0	0
15	0.34	0	46	0	0
16	0.34	0	47	0	0
17	0.34	0	48	0	0
18	0.34	0	49	0	0
19	0.34	0	50	0	0
20	0.34	0	51	0	0
21	0.34	0			
22	0.34	0			
23	0.34	0			
24	0.34	0			
25	0.34	0			
26	0.34	0			
27	0.34	0			
28	0.34	0			
29	0.34	0			
30	0.34	0			
31	0.34	0			

Table A-1. 600 Area Subregion Analytical Data Used for 90th Percentile Calculation

Aluminum

D_Aluminum

detects	15
nondetects	36
n (number of values)	51
p (percentile)	90
k (position in sequence)	46.8
mean 90th percentile	86.55

Rank	µg/L	Det. = 1 Nondet. = 0	Rank	µg/L	Det. = 1 Nondet. = 0
1	10	0	32	10	0
2	10	0	33	10	0
3	10	0	34	10	0
4	10	0	35	10	0
5	10	0	36	10	0
6	10	0	37	11.5	1
7	10	0	38	13.3	1
8	10	0	39	13.4	1
9	10	0	40	14.6	1
10	10	0	41	17.4	1
11	10	0	42	20.3	1
12	10	0	43	24.8	1
13	10	0	44	25.1	1
14	10	0	45	26.7	1
15	10	0	46	48.1	1
16	10	0	47	125	1
17	10	0	48	128	1
18	10	0	49	160	1
19	10	0	50	417	1
20	10	0	51	539	1
21	10	0			
22	10	0			
23	10	0			
24	10	0			
25	10	0			
26	10	0			
27	10	0			
28	10	0			
29	10	0			
30	10	0			
31	10	0			

Table A-1. 600 Area Subregion Analytical Data Used for 90th Percentile Calculation

Arsenic

D_Arsenic

detects	51
nondetects	0
n (number of values)	51
p (percentile)	90
k (position in sequence)	46.8
mean 90th percentile	10.825

Rank	µg/L	Det. = 1 Nondet. = 0	Rank	µg/L	Det. = 1 Nondet. = 0
1	1.58	1	32	6.32	1
2	1.59	1	33	6.38	1
3	1.73	1	34	6.4	1
4	1.76	1	35	6.5	1
5	1.8	1	36	6.65	1
6	1.91	1	37	6.81	1
7	2.18	1	38	6.89	1
8	2.24	1	39	6.95	1
9	2.27	1	40	6.96	1
10	2.41	1	41	7.2	1
11	2.55	1	42	7.35	1
12	2.58	1	43	8.17	1
13	2.62	1	44	8.62	1
14	2.76	1	45	8.66	1
15	3.68	1	46	9.75	1
16	4.32	1	47	11.9	1
17	4.34	1	48	12.7	1
18	4.59	1	49	13.8	1
19	4.81	1	50	13.9	1
20	4.81	1	51	14.9	1
21	5.18	1			
22	5.22	1			
23	5.49	1			
24	5.53	1			
25	5.54	1			
26	5.7	1			
27	5.93	1			
28	5.97	1			
29	6.19	1			
30	6.21	1			
31	6.25	1			

Barium

D_Barium

Table A-1. 600 Area Subregion Analytical Data Used for 90th Percentile Calculation

detects	51
nondetects	0
n (number of values)	51
p (percentile)	90
k (position in sequence)	46.8
mean 90th percentile	68.65

Rank	µg/L	Det. = 1 Nondet. = 0	Rank	µg/L	Det. = 1 Nondet. = 0
1	15.4	1	32	51.6	1
2	15.7	1	33	51.7	1
3	15.9	1	34	52.4	1
4	17	1	35	53.2	1
5	17	1	36	54.8	1
6	17.4	1	37	56.5	1
7	22.2	1	38	56.8	1
8	22.3	1	39	57.6	1
9	22.5	1	40	58.1	1
10	22.9	1	41	59	1
11	23.1	1	42	59.2	1
12	23.3	1	43	60.8	1
13	23.5	1	44	61.8	1
14	25.1	1	45	62.6	1
15	27.8	1	46	66.8	1
16	29.7	1	47	70.5	1
17	31.2	1	48	81.9	1
18	31.8	1	49	85.6	1
19	33.6	1	50	91.1	1
20	38	1	51	118	1
21	40.4	1			
22	40.4	1			
23	41.2	1			
24	41.3	1			
25	43.4	1			
26	44.1	1			
27	44.4	1			
28	49.2	1			
29	49.5	1			
30	49.8	1			
31	51.2	1			

Table A-1. 600 Area Subregion Analytical Data Used for 90th Percentile Calculation

Benzyl alcohol

D_Benzyl alcohol

detects	1
nondetects	50
n (number of values)	51
p (percentile)	90
k (position in sequence)	46.8
mean 90th percentile	1

Rank	µg/L	Det. = 1 Nondet. = 0	Rank	µg/L	Det. = 1 Nondet. = 0
1		1 0	32	1	0
2		1 0	33	1	0
3		1 0	34	1	0
4		1 0	35	1	0
5		1 0	36	1	0
6		1 0	37	1	0
7		1 0	38	1	0
8		1 0	39	1	0
9		1 0	40	1	0
10		1 0	41	1	0
11		1 0	42	1	0
12		1 0	43	1	0
13		1 0	44	1	0
14		1 0	45	1	0
15		1 0	46	1	0
16		1 0	47	1	0
17		1 0	48	1	0
18		1 0	49	1	0
19		1 0	50	1	0
20		1 0	51	1.1	1
21		1 0			
22		1 0			
23		1 0			
24		1 0			
25		1 0			
26		1 0			
27		1 0			
28		1 0			
29		1 0			
30		1 0			
31		1 0			

Beryllium

D_Beryllium

Table A-1. 600 Area Subregion Analytical Data Used for 90th Percentile Calculation

detects	1
nondetects	50
n (number of values)	51
p (percentile)	90
k (position in sequence)	46.8
mean 90th percentile	0.1

Rank	µg/L	Det. = 1 Nondet. = 0	Rank	µg/L	Det. = 1 Nondet. = 0
1	0.1	0	32	0.1	0
2	0.1	0	33	0.1	0
3	0.1	0	34	0.1	0
4	0.1	0	35	0.1	0
5	0.1	0	36	0.1	0
6	0.1	0	37	0.1	0
7	0.1	0	38	0.1	0
8	0.1	0	39	0.1	0
9	0.1	0	40	0.1	0
10	0.1	0	41	0.1	0
11	0.1	0	42	0.1	0
12	0.1	0	43	0.1	0
13	0.1	0	44	0.1	0
14	0.1	0	45	0.1	0
15	0.1	0	46	0.1	0
16	0.1	0	47	0.1	0
17	0.1	0	48	0.1	0
18	0.1	0	49	0.1	0
19	0.1	0	50	0.1	0
20	0.1	0	51	0.188	1
21	0.1	0			
22	0.1	0			
23	0.1	0			
24	0.1	0			
25	0.1	0			
26	0.1	0			
27	0.1	0			
28	0.1	0			
29	0.1	0			
30	0.1	0			
31	0.1	0			

Bis(2-ethylhexyl) phthalate D_Bis(2-ethylhexyl) phthalate

Table A-1. 600 Area Subregion Analytical Data Used for 90th Percentile Calculation

detects	3
nondetects	48
n (number of values)	51
p (percentile)	90
k (position in sequence)	46.8
mean 90th percentile	1

Rank	µg/L	Det. = 1 Nondet. = 0	Rank	µg/L	Det. = 1 Nondet. = 0
1		1 0	32	1	0
2		1 0	33	1	0
3		1 0	34	1	0
4		1 0	35	1	0
5		1 0	36	1	0
6		1 0	37	1	0
7		1 0	38	1	0
8		1 0	39	1	0
9		1 0	40	1	0
10		1 0	41	1	0
11		1 0	42	1	0
12		1 0	43	1	0
13		1 0	44	1	0
14		1 0	45	1	0
15		1 0	46	1	0
16		1 0	47	1	0
17		1 0	48	1	0
18		1 0	49	1.3	1
19		1 0	50	1.5	1
20		1 0	51	3	1
21		1 0			
22		1 0			
23		1 0			
24		1 0			
25		1 0			
26		1 0			
27		1 0			
28		1 0			
29		1 0			
30		1 0			
31		1 0			

Boron

D_Boron

detects

14

Table A-1. 600 Area Subregion Analytical Data Used for 90th Percentile Calculation

nondetects	36
n (number of values)	50
p (percentile)	90
k (position in sequence)	45.9
mean 90th percentile	42.5

Rank	$\mu\text{g/L}$	Det. = 1 Nondet. = 0	Rank	$\mu\text{g/L}$	Det. = 1 Nondet. = 0
1	19	0	32	41	0
2	19	0	33	41	0
3	19	0	34	41	0
4	19	0	35	41	0
5	19	0	36	41	0
6	19	0	37	41	0
7	19	0	38	41	0
8	19	0	39	41	0
9	19	0	40	41	0
10	19	0	41	41	0
11	19	0	42	41	0
12	20	1	43	41	0
13	25	1	44	41	0
14	30	1	45	42	1
15	32	1	46	43	1
16	34	1	47	52	1
17	34	1	48	102	1
18	34	1	49	106	1
19	35	1	50	107	1
20	41	0	51	0	0
21	41	0			
22	41	0			
23	41	0			
24	41	0			
25	41	0			
26	41	0			
27	41	0			
28	41	0			
29	41	0			
30	41	0			
31	41	0			

Bromodichloromethane D_Bromodichloromethane

detects	10
nondetects	41

Table A-1. 600 Area Subregion Analytical Data Used for 90th Percentile Calculation

n (number of values)	51
p (percentile)	90
k (position in sequence)	46.8
mean 90th percentile	0.72

Rank	µg/L	Det. = 1 Nondet. = 0	Rank	µg/L	Det. = 1 Nondet. = 0
1	0.088	0	32	0.088	0
2	0.088	0	33	0.088	0
3	0.088	0	34	0.088	0
4	0.088	0	35	0.088	0
5	0.088	0	36	0.088	0
6	0.088	0	37	0.088	0
7	0.088	0	38	0.088	0
8	0.088	0	39	0.088	0
9	0.088	0	40	0.088	0
10	0.088	0	41	0.088	0
11	0.088	0	42	0.17	1
12	0.088	0	43	0.3	1
13	0.088	0	44	0.51	1
14	0.088	0	45	0.56	1
15	0.088	0	46	0.71	1
16	0.088	0	47	0.73	1
17	0.088	0	48	1	1
18	0.088	0	49	1.2	1
19	0.088	0	50	1.6	1
20	0.088	0	51	2.1	1
21	0.088	0			
22	0.088	0			
23	0.088	0			
24	0.088	0			
25	0.088	0			
26	0.088	0			
27	0.088	0			
28	0.088	0			
29	0.088	0			
30	0.088	0			
31	0.088	0			

Bromoform

D_Bromoform

detects	6
nondetects	45
n (number of values)	51

Table A-1. 600 Area Subregion Analytical Data Used for 90th Percentile Calculation

p (percentile)	90
k (position in sequence)	46.8
mean 90th percentile	1.8

Rank	µg/L	Det. = 1 Nondet. = 0	Rank	µg/L	Det. = 1 Nondet. = 0
1	0.17	0	32	0.17	0
2	0.17	0	33	0.17	0
3	0.17	0	34	0.17	0
4	0.17	0	35	0.17	0
5	0.17	0	36	0.17	0
6	0.17	0	37	0.17	0
7	0.17	0	38	0.17	0
8	0.17	0	39	0.17	0
9	0.17	0	40	0.17	0
10	0.17	0	41	0.17	0
11	0.17	0	42	0.17	0
12	0.17	0	43	0.17	0
13	0.17	0	44	0.17	0
14	0.17	0	45	0.17	0
15	0.17	0	46	1.6	1
16	0.17	0	47	2	1
17	0.17	0	48	2.3	1
18	0.17	0	49	2.5	1
19	0.17	0	50	2.5	1
20	0.17	0	51	2.9	1
21	0.17	0			
22	0.17	0			
23	0.17	0			
24	0.17	0			
25	0.17	0			
26	0.17	0			
27	0.17	0			
28	0.17	0			
29	0.17	0			
30	0.17	0			
31	0.17	0			

Bromomethane

D_Bromomethane

detects	9
nondetects	42
n (number of values)	51
p (percentile)	90

Table A-1. 600 Area Subregion Analytical Data Used for 90th Percentile Calculation

k (position in sequence)	46.8
mean 90th percentile	2

Rank	µg/L	Det. = 1 Nondet. = 0	Rank	µg/L	Det. = 1 Nondet. = 0
1	0.13	0	32	0.25	0
2	0.13	0	33	0.25	0
3	0.13	0	34	0.31	1
4	0.13	0	35	0.33	1
5	0.13	0	36	0.33	1
6	0.13	0	37	0.34	1
7	0.13	0	38	0.34	1
8	0.13	0	39	0.41	1
9	0.13	0	40	0.43	1
10	0.13	0	41	0.62	1
11	0.13	0	42	0.95	1
12	0.13	0	43	2	0
13	0.13	0	44	2	0
14	0.13	0	45	2	0
15	0.13	0	46	2	0
16	0.25	0	47	2	0
17	0.25	0	48	2	0
18	0.25	0	49	2	0
19	0.25	0	50	2	0
20	0.25	0	51	2	0
21	0.25	0			
22	0.25	0			
23	0.25	0			
24	0.25	0			
25	0.25	0			
26	0.25	0			
27	0.25	0			
28	0.25	0			
29	0.25	0			
30	0.25	0			
31	0.25	0			

Butylbenzylphthalate

D_Butylbenzylphthalate

detects	1
nondetects	50
n (number of values)	51
p (percentile)	90
k (position in sequence)	46.8

Table A-1. 600 Area Subregion Analytical Data Used for 90th Percentile Calculation

mean 90th percentile				1			
Rank	µg/L	Det. = 1 Nondet. = 0	Rank	µg/L	Det. = 1 Nondet. = 0		
1		1 0	32	1	0		
2		1 0	33	1	0		
3		1 0	34	1	0		
4		1 0	35	1	0		
5		1 0	36	1	0		
6		1 0	37	1	0		
7		1 0	38	1	0		
8		1 0	39	1	0		
9		1 0	40	1	0		
10		1 0	41	1	0		
11		1 0	42	1	0		
12		1 0	43	1	0		
13		1 0	44	1	0		
14		1 0	45	1	0		
15		1 0	46	1	0		
16		1 0	47	1	0		
17		1 0	48	1	0		
18		1 0	49	1	0		
19		1 0	50	1	0		
20		1 0	51	1.3	1		
21		1 0					
22		1 0					
23		1 0					
24		1 0					
25		1 0					
26		1 0					
27		1 0					
28		1 0					
29		1 0					
30		1 0					
31		1 0					

Carbon disulfide

D_Carbon disulfide

detects	3
nondetects	48
n (number of values)	51
p (percentile)	90
k (position in sequence)	46.8
mean 90th percentile	0.051

Table A-1. 600 Area Subregion Analytical Data Used for 90th Percentile Calculation

Rank	µg/L	Det. = 1 Nondet. = 0	Rank	µg/L	Det. = 1 Nondet. = 0
1	0.051	0	32	0.051	0
2	0.051	0	33	0.051	0
3	0.051	0	34	0.051	0
4	0.051	0	35	0.051	0
5	0.051	0	36	0.051	0
6	0.051	0	37	0.051	0
7	0.051	0	38	0.051	0
8	0.051	0	39	0.051	0
9	0.051	0	40	0.051	0
10	0.051	0	41	0.051	0
11	0.051	0	42	0.051	0
12	0.051	0	43	0.051	0
13	0.051	0	44	0.051	0
14	0.051	0	45	0.051	0
15	0.051	0	46	0.051	0
16	0.051	0	47	0.051	0
17	0.051	0	48	0.051	0
18	0.051	0	49	0.06	1
19	0.051	0	50	0.074	1
20	0.051	0	51	0.11	1
21	0.051	0			
22	0.051	0			
23	0.051	0			
24	0.051	0			
25	0.051	0			
26	0.051	0			
27	0.051	0			
28	0.051	0			
29	0.051	0			
30	0.051	0			
31	0.051	0			

Carbon tetrachloride

D_Carbon tetrachloride

detects	2
nondetects	49
n (number of values)	51
p (percentile)	90
k (position in sequence)	46.8
mean 90th percentile	0.12

Table A-1. 600 Area Subregion Analytical Data Used for 90th Percentile Calculation

Rank	µg/L	Det. = 1 Nondet. = 0	Rank	µg/L	Det. = 1 Nondet. = 0
1	0.12	0	32	0.12	0
2	0.12	0	33	0.12	0
3	0.12	0	34	0.12	0
4	0.12	0	35	0.12	0
5	0.12	0	36	0.12	0
6	0.12	0	37	0.12	0
7	0.12	0	38	0.12	0
8	0.12	0	39	0.12	0
9	0.12	0	40	0.12	0
10	0.12	0	41	0.12	0
11	0.12	0	42	0.12	0
12	0.12	0	43	0.12	0
13	0.12	0	44	0.12	0
14	0.12	0	45	0.12	0
15	0.12	0	46	0.12	0
16	0.12	0	47	0.12	0
17	0.12	0	48	0.12	0
18	0.12	0	49	0.12	0
19	0.12	0	50	0.13	1
20	0.12	0	51	0.16	1
21	0.12	0			
22	0.12	0			
23	0.12	0			
24	0.12	0			
25	0.12	0			
26	0.12	0			
27	0.12	0			
28	0.12	0			
29	0.12	0			
30	0.12	0			
31	0.12	0			

Chloride

D_Chloride

detects	51
nondetects	0
n (number of values)	51
p (percentile)	90
k (position in sequence)	46.8
mean 90th percentile	16600

Table A-1. 600 Area Subregion Analytical Data Used for 90th Percentile Calculation

Rank	µg/L	Det. = 1 Nondet. = 0	Rank	µg/L	Det. = 1 Nondet. = 0
1	1860	1	32	12400	1
2	2440	1	33	12800	1
3	2910	1	34	13000	1
4	4070	1	35	13200	1
5	4230	1	36	13200	1
6	4260	1	37	13400	1
7	5010	1	38	13500	1
8	7490	1	39	14100	1
9	7610	1	40	14500	1
10	7810	1	41	15900	1
11	7870	1	42	16200	1
12	8390	1	43	16300	1
13	8430	1	44	16400	1
14	8580	1	45	16400	1
15	8820	1	46	16400	1
16	8920	1	47	16800	1
17	9760	1	48	20600	1
18	9780	1	49	25600	1
19	9820	1	50	25900	1
20	10200	1	51	26100	1
21	10200	1			
22	10200	1			
23	10300	1			
24	10400	1			
25	10500	1			
26	10700	1			
27	10800	1			
28	11100	1			
29	11800	1			
30	12000	1			
31	12200	1			

Chloroform

D_Chloroform

detects	15
nondetects	36
n (number of values)	51
p (percentile)	90
k (position in sequence)	46.8
mean 90th percentile	0.615

Table A-1. 600 Area Subregion Analytical Data Used for 90th Percentile Calculation

Rank	µg/L	Det. = 1 Nondet. = 0	Rank	µg/L	Det. = 1 Nondet. = 0
1	0.1	0	32	0.1	0
2	0.1	0	33	0.1	0
3	0.1	0	34	0.1	0
4	0.1	0	35	0.1	0
5	0.1	0	36	0.1	0
6	0.1	0	37	0.11	1
7	0.1	0	38	0.11	1
8	0.1	0	39	0.17	1
9	0.1	0	40	0.21	1
10	0.1	0	41	0.28	1
11	0.1	0	42	0.32	1
12	0.1	0	43	0.41	1
13	0.1	0	44	0.44	1
14	0.1	0	45	0.45	1
15	0.1	0	46	0.47	1
16	0.1	0	47	0.76	1
17	0.1	0	48	0.94	1
18	0.1	0	49	1.1	1
19	0.1	0	50	4.3	1
20	0.1	0	51	7.1	1
21	0.1	0			
22	0.1	0			
23	0.1	0			
24	0.1	0			
25	0.1	0			
26	0.1	0			
27	0.1	0			
28	0.1	0			
29	0.1	0			
30	0.1	0			
31	0.1	0			

Chromium

D_Chromium

detects	34
nondetects	17
n (number of values)	51
p (percentile)	90
k (position in sequence)	46.8
mean 90th percentile	4.925

Rank	µg/L	Det. = 1 Nondet. = 0	Rank	µg/L	Det. = 1 Nondet. = 0
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Table A-1. 600 Area Subregion Analytical Data Used for 90th Percentile Calculation

1	1	0	32	2.66	1
2	1	0	33	2.73	1
3	1	0	34	2.76	1
4	1	0	35	2.81	1
5	1	0	36	3.06	1
6	1	0	37	3.09	1
7	1	0	38	3.18	1
8	1	0	39	3.2	1
9	1	0	40	3.41	1
10	1	0	41	3.59	1
11	1	0	42	3.94	1
12	1	0	43	4.59	1
13	1	0	44	4.59	1
14	1	0	45	4.79	1
15	1	0	46	4.92	1
16	1	0	47	4.93	1
17	1	0	48	5.13	1
18	1.07	1	49	5.52	1
19	1.08	1	50	5.84	1
20	1.65	1	51	5.9	1
21	1.65	1			
22	1.73	1			
23	1.76	1			
24	1.79	1			
25	1.83	1			
26	1.85	1			
27	2	1			
28	2.36	1			
29	2.42	1			
30	2.49	1			
31	2.61	1			

Cobalt

D_Cobalt

detects	10
nondetects	41
n (number of values)	51
p (percentile)	90
k (position in sequence)	46.8
mean 90th percentile	0.362

Table A-1. 600 Area Subregion Analytical Data Used for 90th Percentile Calculation

Rank	µg/L	Det. = 1 Nondet. = 0	Rank	µg/L	Det. = 1 Nondet. = 0
1	0.1	0	32	0.1	0
2	0.1	0	33	0.1	0
3	0.1	0	34	0.1	0
4	0.1	0	35	0.1	0
5	0.1	0	36	0.1	0
6	0.1	0	37	0.1	0
7	0.1	0	38	0.1	0
8	0.1	0	39	0.1	0
9	0.1	0	40	0.1	0
10	0.1	0	41	0.1	0
11	0.1	0	42	0.128	1
12	0.1	0	43	0.135	1
13	0.1	0	44	0.19	1
14	0.1	0	45	0.198	1
15	0.1	0	46	0.25	1
16	0.1	0	47	0.474	1
17	0.1	0	48	0.647	1
18	0.1	0	49	0.649	1
19	0.1	0	50	0.899	1
20	0.1	0	51	1	1
21	0.1	0			
22	0.1	0			
23	0.1	0			
24	0.1	0			
25	0.1	0			
26	0.1	0			
27	0.1	0			
28	0.1	0			
29	0.1	0			
30	0.1	0			
31	0.1	0			

Copper

D_Copper

detects	31
nondetects	20
n (number of values)	51
p (percentile)	90
k (position in sequence)	46.8
mean 90th percentile	3.325

Rank	µg/L	Det. = 1 Nondet. = 0	Rank	µg/L	Det. = 1 Nondet. = 0
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Table A-1. 600 Area Subregion Analytical Data Used for 90th Percentile Calculation

1	0.2	0	32	0.625	1
2	0.2	0	33	0.709	1
3	0.2	0	34	0.723	1
4	0.2	0	35	0.73	1
5	0.2	0	36	0.879	1
6	0.2	0	37	0.924	1
7	0.2	0	38	0.999	1
8	0.2	0	39	1.53	1
9	0.2	0	40	1.58	1
10	0.2	0	41	1.59	1
11	0.2	0	42	1.59	1
12	0.2	0	43	1.87	1
13	0.2	0	44	1.99	1
14	0.2	0	45	2.24	1
15	0.2	0	46	3.23	1
16	0.2	0	47	3.42	1
17	0.2	0	48	4.11	1
18	0.2	0	49	4.23	1
19	0.2	0	50	8.06	1
20	0.2	0	51	12	1
21	0.237	1			
22	0.249	1			
23	0.252	1			
24	0.253	1			
25	0.271	1			
26	0.29	1			
27	0.432	1			
28	0.441	1			
29	0.535	1			
30	0.541	1			
31	0.571	1			

Dibromochloromethane D_Dibromochloromethane

detects	7
nondetects	44
n (number of values)	51
p (percentile)	90
k (position in sequence)	46.8
mean 90th percentile	2

Rank	µg/L	Det. = 1 Nondet. = 0	Rank	µg/L	Det. = 1 Nondet. = 0
1	0.13	0	32	0.13	0

Table A-1. 600 Area Subregion Analytical Data Used for 90th Percentile Calculation

2	0.13	0	33	0.13	0
3	0.13	0	34	0.13	0
4	0.13	0	35	0.13	0
5	0.13	0	36	0.13	0
6	0.13	0	37	0.13	0
7	0.13	0	38	0.13	0
8	0.13	0	39	0.13	0
9	0.13	0	40	0.13	0
10	0.13	0	41	0.13	0
11	0.13	0	42	0.13	0
12	0.13	0	43	0.13	0
13	0.13	0	44	0.13	0
14	0.13	0	45	1.6	1
15	0.13	0	46	1.8	1
16	0.13	0	47	2.2	1
17	0.13	0	48	2.5	1
18	0.13	0	49	2.8	1
19	0.13	0	50	2.9	1
20	0.13	0	51	3.3	1
21	0.13	0			
22	0.13	0			
23	0.13	0			
24	0.13	0			
25	0.13	0			
26	0.13	0			
27	0.13	0			
28	0.13	0			
29	0.13	0			
30	0.13	0			
31	0.13	0			

Diethylphthalate

D_Diethylphthalate

detects	2
nondetects	49
n (number of values)	51
p (percentile)	90
k (position in sequence)	46.8
mean 90th percentile	1

Rank	µg/L	Det. = 1 Nondet. = 0	Rank	µg/L	Det. = 1 Nondet. = 0
1		1 0	32	1	0
2		1 0	33	1	0

Table A-1. 600 Area Subregion Analytical Data Used for 90th Percentile Calculation

3	1	0	34	1	0
4	1	0	35	1	0
5	1	0	36	1	0
6	1	0	37	1	0
7	1	0	38	1	0
8	1	0	39	1	0
9	1	0	40	1	0
10	1	0	41	1	0
11	1	0	42	1	0
12	1	0	43	1	0
13	1	0	44	1	0
14	1	0	45	1	0
15	1	0	46	1	0
16	1	0	47	1	0
17	1	0	48	1	0
18	1	0	49	1	0
19	1	0	50	1.7	1
20	1	0	51	42	1
21	1	0			
22	1	0			
23	1	0			
24	1	0			
25	1	0			
26	1	0			
27	1	0			
28	1	0			
29	1	0			
30	1	0			
31	1	0			

Di-n-butylphthalate

D_Di-n-butylphthalate

detects	1
nondetects	50
n (number of values)	51
p (percentile)	90
k (position in sequence)	46.8
mean 90th percentile	1

Rank	µg/L	Det. = 1 Nondet. = 0	Rank	µg/L	Det. = 1 Nondet. = 0
1		1 0	32	1	0
2		1 0	33	1	0
3		1 0	34	1	0

Table A-1. 600 Area Subregion Analytical Data Used for 90th Percentile Calculation

4	1	0	35	1	0
5	1	0	36	1	0
6	1	0	37	1	0
7	1	0	38	1	0
8	1	0	39	1	0
9	1	0	40	1	0
10	1	0	41	1	0
11	1	0	42	1	0
12	1	0	43	1	0
13	1	0	44	1	0
14	1	0	45	1	0
15	1	0	46	1	0
16	1	0	47	1	0
17	1	0	48	1	0
18	1	0	49	1	0
19	1	0	50	1	0
20	1	0	51	1	0
21	1	0			
22	1	0			
23	1	0			
24	1	0			
25	1	0			
26	1	0			
27	1	1			
28	1	0			
29	1	0			
30	1	0			
31	1	0			

Fluoride

D_Fluoride

detects	43
nondetects	8
n (number of values)	51
p (percentile)	90
k (position in sequence)	46.8
mean 90th percentile	332.5

Rank	µg/L	Det. = 1 Nondet. = 0	Rank	µg/L	Det. = 1 Nondet. = 0
1	39.4	1	32	206	1
2	60	0	33	213	1
3	60	0	34	213	1
4	60	0	35	214	1

Table A-1. 600 Area Subregion Analytical Data Used for 90th Percentile Calculation

5	60	0	36	226	1
6	60	0	37	226	1
7	60	0	38	228	1
8	60	0	39	230	1
9	60	0	40	232	1
10	92.7	1	41	233	1
11	110	1	42	242	1
12	110	1	43	256	1
13	116	1	44	278	1
14	120	1	45	279	1
15	131	1	46	286	1
16	131	1	47	379	1
17	131	1	48	575	1
18	135	1	49	789	1
19	143	1	50	849	1
20	151	1	51	851	1
21	160	1			
22	167	1			
23	170	1			
24	172	1			
25	173	1			
26	175	1			
27	185	1			
28	187	1			
29	188	1			
30	194	1			
31	199	1			

Gross alpha

D_Gross alpha

detects	14
nondetects	8
n (number of values)	22
p (percentile)	90
k (position in sequence)	20.7
mean 90th percentile	8

Rank	$\mu\text{g/L}$	Det. = 1 Nondet. = 0	Rank	$\mu\text{g/L}$	Det. = 1 Nondet. = 0
1	-1.3	0	32	0	0
2	-0.37	0	33	0	0
3	-0.24	0	34	0	0
4	0.28	0	35	0	0
5	0.36	0	36	0	0

Table A-1. 600 Area Subregion Analytical Data Used for 90th Percentile Calculation

6	1.1	0	37	0	0
7	1.1	0	38	0	0
8	1.2	0	39	0	0
9	2.3	1	40	0	0
10	2.4	1	41	0	0
11	2.6	1	42	0	0
12	2.7	1	43	0	0
13	3	1	44	0	0
14	3	1	45	0	0
15	3.3	1	46	0	0
16	3.5	1	47	0	0
17	4.2	1	48	0	0
18	4.7	1	49	0	0
19	5.5	1	50	0	0
20	6.2	1	51	0	0
21	9.8	1			
22	40	1			
23	0	0			
24	0	0			
25	0	0			
26	0	0			
27	0	0			
28	0	0			
29	0	0			
30	0	0			
31	0	0			

Gross beta

D_Gross beta

detects	22
nondetects	0
n (number of values)	22
p (percentile)	90
k (position in sequence)	20.7
mean 90th percentile	56.5

Rank	µg/L	Det. = 1 Nondet. = 0	Rank	µg/L	Det. = 1 Nondet. = 0
1	3.6	1	32	0	0
2	4.7	1	33	0	0
3	6	1	34	0	0
4	8.2	1	35	0	0
5	8.5	1	36	0	0
6	8.8	1	37	0	0

Table A-1. 600 Area Subregion Analytical Data Used for 90th Percentile Calculation

7	9.7	1	38	0	0
8	11	1	39	0	0
9	12	1	40	0	0
10	23	1	41	0	0
11	25	1	42	0	0
12	26	1	43	0	0
13	27	1	44	0	0
14	28	1	45	0	0
15	35	1	46	0	0
16	45	1	47	0	0
17	46	1	48	0	0
18	49	1	49	0	0
19	53	1	50	0	0
20	56	1	51	0	0
21	57	1			
22	61	1			
23	0	0			
24	0	0			
25	0	0			
26	0	0			
27	0	0			
28	0	0			
29	0	0			
30	0	0			
31	0	0			

Iodine-129

D_Iodine-129

detects	1
nondetects	50
n (number of values)	51
p (percentile)	90
k (position in sequence)	46.8
mean 90th percentile	0.1175

Rank	$\mu\text{g/L}$	Det. = 1 Nondet. = 0	Rank	$\mu\text{g/L}$	Det. = 1 Nondet. = 0
1	-0.0983	0	32	0.0425	0
2	-0.0819	0	33	0.048	0
3	-0.0609	0	34	0.0549	0
4	-0.0593	0	35	0.0557	0
5	-0.0521	0	36	0.056	0
6	-0.0519	0	37	0.0562	0
7	-0.0462	0	38	0.0663	0

Table A-1. 600 Area Subregion Analytical Data Used for 90th Percentile Calculation

8	-0.0452	0	39	0.068	0
9	-0.0426	0	40	0.0703	0
10	-0.0424	0	41	0.0761	0
11	-0.0385	0	42	0.0823	0
12	-0.0357	0	43	0.0826	0
13	-0.0339	0	44	0.0927	0
14	-0.0298	0	45	0.104	0
15	-0.0208	0	46	0.114	0
16	-0.0134	0	47	0.121	0
17	-0.0101	0	48	0.158	0
18	-0.0096	0	49	0.166	0
19	-0.00568	0	50	0.242	0
20	0.00219	0	51	0.377	1
21	0.0026	0			
22	0.00366	0			
23	0.00957	0			
24	0.0111	0			
25	0.0211	0			
26	0.0242	0			
27	0.0249	0			
28	0.0301	0			
29	0.0307	0			
30	0.0317	0			
31	0.037	0			

Iron

D_Iron

detects	40
nondetects	11
n (number of values)	51
p (percentile)	90
k (position in sequence)	46.8
mean 90th percentile	476.5

Rank	$\mu\text{g/L}$	Det. = 1 Nondet. = 0	Rank	$\mu\text{g/L}$	Det. = 1 Nondet. = 0
1	18	0	32	178	1
2	18	0	33	179	1
3	23	1	34	181	1
4	35	1	35	194	1
5	38	0	36	223	1
6	38	0	37	225	1
7	38	0	38	252	1
8	38	0	39	259	1
9	38	0	40	285	1

Table A-1. 600 Area Subregion Analytical Data Used for 90th Percentile Calculation

10	38	0	41	290	1
11	38	0	42	360	1
12	38	0	43	394	1
13	38	0	44	430	1
14	44	1	45	441	1
15	56	1	46	467	1
16	57	1	47	486	1
17	61	1	48	524	1
18	67	1	49	546	1
19	70	1	50	1020	1
20	74	1	51	3340	1
21	78	1			
22	79	1			
23	112	1			
24	114	1			
25	120	1			
26	148	1			
27	165	1			
28	169	1			
29	170	1			
30	170	1			
31	171	1			

Lead

D_Lead

detects	15
nondetects	36
n (number of values)	51
p (percentile)	90
k (position in sequence)	46.8
mean 90th percentile	0.6105

Rank	µg/L	Det. = 1 Nondet. = 0	Rank	µg/L	Det. = 1 Nondet. = 0
1	0.2	0	32	0.2	0
2	0.2	0	33	0.2	0
3	0.2	0	34	0.2	0
4	0.2	0	35	0.2	0
5	0.2	0	36	0.2	0
6	0.2	0	37	0.24	1
7	0.2	0	38	0.266	1
8	0.2	0	39	0.289	1
9	0.2	0	40	0.355	1
10	0.2	0	41	0.369	1

Table A-1. 600 Area Subregion Analytical Data Used for 90th Percentile Calculation

11	0.2	0	42	0.412	1
12	0.2	0	43	0.416	1
13	0.2	0	44	0.423	1
14	0.2	0	45	0.467	1
15	0.2	0	46	0.569	1
16	0.2	0	47	0.652	1
17	0.2	0	48	0.862	1
18	0.2	0	49	0.87	1
19	0.2	0	50	0.886	1
20	0.2	0	51	1.37	1
21	0.2	0			
22	0.2	0			
23	0.2	0			
24	0.2	0			
25	0.2	0			
26	0.2	0			
27	0.2	0			
28	0.2	0			
29	0.2	0			
30	0.2	0			
31	0.2	0			

Lithium

D_Lithium

detects	36
nondetects	14
n (number of values)	50
p (percentile)	90
k (position in sequence)	45.9
mean 90th percentile	23

Rank	µg/L	Det. = 1 Nondet. = 0	Rank	µg/L	Det. = 1 Nondet. = 0
1		4 0	32	13	1
2		4 1	33	14	1
3		4 0	34	15	1
4		4 0	35	15	1
5		4 0	36	15	1
6		4 0	37	17	1
7		4 0	38	20	1
8		4 0	39	20	1
9		4 0	40	21	1
10		4 1	41	21	1
11		4 0	42	22	1
12		4 0	43	22	1

Table A-1. 600 Area Subregion Analytical Data Used for 90th Percentile Calculation

13	4	0	44	23	1
14	4	0	45	23	1
15	4	0	46	23	1
16	4	0	47	24	1
17	5	1	48	25	1
18	5	1	49	25	1
19	6	1	50	31	1
20	7	1	51	0	0
21	7	1			
22	7	1			
23	7	1			
24	7	1			
25	7	1			
26	8	1			
27	9	1			
28	10	1			
29	11	1			
30	12	1			
31	12	1			

Table A-1. 600 Area Subregion Analytical Data Used for 90th Percentile Calculation
Manganese D_Manganese

detects	27
nondetects	24
n (number of values)	51
p (percentile)	90
k (position in sequence)	46.8
mean 90th percentile	39.5

Rank	µg/L	Det. = 1 Nondet. = 0	Rank	µg/L	Det. = 1 Nondet. = 0
1		4 0	32	12	1
2		4 0	33	14	1
3		4 0	34	15	1
4		4 0	35	16	1
5		4 0	36	20	1
6		4 0	37	21	1
7		4 0	38	22	1
8		4 0	39	27	1
9		4 0	40	28	1
10		5 1	41	28	1
11		6 0	42	31	1
12		6 0	43	35	1
13		6 0	44	36	1
14		6 0	45	37	1
15		6 0	46	39	1
16		6 0	47	40	1
17		6 0	48	42	1
18		6 0	49	46	1
19		6 0	50	82	1
20		6 0	51	261	1
21		6 0			
22		6 0			
23		6 0			
24		6 0			
25		6 0			
26		7 1			
27		8 1			
28		8 1			
29		9 1			
30		10 1			
31		10 1			

Table A-1. 600 Area Subregion Analytical Data Used for 90th Percentile Calculation

Molybdenum

D_Molybdenum

detects	51
nondetects	0
n (number of values)	51
p (percentile)	90
k (position in sequence)	46.8
mean 90th percentile	8.705

Rank	µg/L	Det. = 1 Nondet. = 0	Rank	µg/L	Det. = 1 Nondet. = 0
1	1.01	1	32	5.53	1
2	1.02	1	33	5.6	1
3	1.16	1	34	5.65	1
4	1.56	1	35	5.87	1
5	1.96	1	36	5.88	1
6	1.98	1	37	5.99	1
7	2.12	1	38	6	1
8	2.28	1	39	6.11	1
9	2.43	1	40	7.49	1
10	2.5	1	41	7.65	1
11	2.65	1	42	7.83	1
12	2.69	1	43	7.99	1
13	2.83	1	44	8.18	1
14	3.19	1	45	8.48	1
15	3.21	1	46	8.58	1
16	3.23	1	47	8.83	1
17	3.34	1	48	8.9	1
18	3.55	1	49	10.4	1
19	3.55	1	50	10.7	1
20	3.6	1	51	10.8	1
21	3.62	1			
22	3.64	1			
23	3.67	1			
24	3.71	1			
25	4.11	1			
26	4.28	1			
27	4.46	1			
28	4.86	1			
29	5.05	1			
30	5.12	1			
31	5.43	1			

Table A-1. 600 Area Subregion Analytical Data Used for 90th Percentile Calculation

Nickel

D_Nickel

detects	4
nondetects	47
n (number of values)	51
p (percentile)	90
k (position in sequence)	46.8
mean 90th percentile	4

Rank	µg/L	Det. = 1 Nondet. = 0	Rank	µg/L	Det. = 1 Nondet. = 0
1		4 0	32	4	0
2		4 0	33	4	0
3		4 0	34	4	0
4		4 0	35	4	0
5		4 0	36	4	0
6		4 0	37	4	0
7		4 0	38	4	0
8		4 0	39	4	0
9		4 0	40	4	0
10		4 0	41	4	0
11		4 0	42	4	0
12		4 0	43	4	0
13		4 0	44	4	0
14		4 0	45	4	0
15		4 0	46	4	1
16		4 0	47	4	0
17		4 0	48	4	0
18		4 0	49	4	0
19		4 0	50	5	1
20		4 0	51	8	1
21		4 0			
22		4 0			
23		4 0			
24		4 1			
25		4 0			
26		4 0			
27		4 0			
28		4 0			
29		4 0			
30		4 0			
31		4 0			

Nitrate

D_Nitrate

Table A-1. 600 Area Subregion Analytical Data Used for 90th Percentile Calculation

detects	48
nondetects	3
n (number of values)	51
p (percentile)	90
k (position in sequence)	46.8
mean 90th percentile	50000

Rank	µg/L	Det. = 1 Nondet. = 0	Rank	µg/L	Det. = 1 Nondet. = 0
1	84.1	0	32	26800	1
2	227	1	33	27200	1
3	274	0	34	27600	1
4	274	0	35	28100	1
5	339	1	36	28800	1
6	392	1	37	29800	1
7	397	1	38	30200	1
8	544	1	39	30300	1
9	664	1	40	34300	1
10	682	1	41	37700	1
11	695	1	42	38700	1
12	1980	1	43	44700	1
13	2500	1	44	46500	1
14	2730	1	45	46900	1
15	3890	1	46	50000	1
16	11600	1	47	50000	1
17	12000	1	48	53100	1
18	12300	1	49	113000	1
19	12800	1	50	116000	1
20	14300	1	51	136000	1
21	14600	1			
22	15400	1			
23	15500	1			
24	16000	1			
25	16200	1			
26	16400	1			
27	17200	1			
28	17400	1			
29	25000	1			
30	25000	1			
31	25800	1			

Selenium

D_Selenium

Table A-1. 600 Area Subregion Analytical Data Used for 90th Percentile Calculation

detects	33
nondetects	18
n (number of values)	51
p (percentile)	90
k (position in sequence)	46.8
mean 90th percentile	6.06

Rank	µg/L	Det. = 1 Nondet. = 0	Rank	µg/L	Det. = 1 Nondet. = 0
1	0.6	0	32	2.36	1
2	0.6	0	33	2.37	1
3	0.6	0	34	2.37	1
4	0.6	0	35	2.41	1
5	0.6	0	36	2.61	1
6	0.6	0	37	2.62	1
7	0.6	0	38	2.87	1
8	0.6	0	39	3.03	1
9	0.6	0	40	3.06	1
10	0.6	0	41	3.12	1
11	0.6	0	42	3.66	1
12	0.6	0	43	4.09	1
13	0.6	0	44	4.18	1
14	0.6	0	45	4.2	1
15	0.6	0	46	6	0
16	0.6	0	47	6.12	1
17	0.6	0	48	6.77	1
18	0.633	1	49	10.1	1
19	0.898	1	50	10.6	1
20	0.934	1	51	13.4	1
21	1	1			
22	1.25	1			
23	1.28	1			
24	1.48	1			
25	1.59	1			
26	1.6	1			
27	1.73	1			
28	2.01	1			
29	2.13	1			
30	2.22	1			
31	2.24	1			

Strontium

D_Strontium

detects	51
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Table A-1. 600 Area Subregion Analytical Data Used for 90th Percentile Calculation

nondetects	0
n (number of values)	51
p (percentile)	90
k (position in sequence)	46.8
mean 90th percentile	298

Rank	µg/L	Det. = 1 Nondet. = 0	Rank	µg/L	Det. = 1 Nondet. = 0
1	115	1	32	246	1
2	116	1	33	249	1
3	124	1	34	258	1
4	160	1	35	261	1
5	164	1	36	261	1
6	164	1	37	265	1
7	164	1	38	270	1
8	165	1	39	272	1
9	165	1	40	281	1
10	167	1	41	285	1
11	167	1	42	286	1
12	169	1	43	287	1
13	170	1	44	292	1
14	170	1	45	294	1
15	171	1	46	294	1
16	174	1	47	302	1
17	176	1	48	307	1
18	182	1	49	341	1
19	188	1	50	387	1
20	190	1	51	407	1
21	202	1			
22	206	1			
23	208	1			
24	213	1			
25	214	1			
26	218	1			
27	226	1			
28	227	1			
29	232	1			
30	233	1			
31	240	1			

Sulfate

D_Sulfate

detects	51
nondetects	0

Table A-1. 600 Area Subregion Analytical Data Used for 90th Percentile Calculation

n (number of values)	51
p (percentile)	90
k (position in sequence)	46.8
mean 90th percentile	64600

Rank	µg/L	Det. = 1 Nondet. = 0	Rank	µg/L	Det. = 1 Nondet. = 0
1	3980	1	32	46400	1
2	4250	1	33	47100	1
3	4350	1	34	47600	1
4	5360	1	35	48100	1
5	18400	1	36	48200	1
6	19000	1	37	52500	1
7	21100	1	38	53100	1
8	23000	1	39	53500	1
9	28500	1	40	57300	1
10	28600	1	41	59800	1
11	28900	1	42	60800	1
12	31000	1	43	61600	1
13	31600	1	44	61600	1
14	32000	1	45	63400	1
15	32500	1	46	64300	1
16	32900	1	47	64900	1
17	33000	1	48	66500	1
18	33100	1	49	85300	1
19	33500	1	50	86500	1
20	34100	1	51	87200	1
21	34200	1			
22	34400	1			
23	34500	1			
24	34900	1			
25	35100	1			
26	37100	1			
27	38600	1			
28	41000	1			
29	41500	1			
30	42800	1			
31	44300	1			

Tin

D_Tin

detects	4
nondetects	47
n (number of values)	51

Table A-1. 600 Area Subregion Analytical Data Used for 90th Percentile Calculation

p (percentile)	90
k (position in sequence)	46.8
mean 90th percentile	0.1

Rank	µg/L	Det. = 1 Nondet. = 0	Rank	µg/L	Det. = 1 Nondet. = 0
1	0.1	0	32	0.1	0
2	0.1	0	33	0.1	0
3	0.1	0	34	0.1	0
4	0.1	0	35	0.1	0
5	0.1	0	36	0.1	0
6	0.1	0	37	0.1	0
7	0.1	0	38	0.1	0
8	0.1	0	39	0.1	0
9	0.1	0	40	0.1	0
10	0.1	0	41	0.1	0
11	0.1	0	42	0.1	0
12	0.1	0	43	0.1	0
13	0.1	0	44	0.1	0
14	0.1	0	45	0.1	0
15	0.1	0	46	0.1	0
16	0.1	0	47	0.1	0
17	0.1	0	48	0.118	1
18	0.1	0	49	0.149	1
19	0.1	0	50	0.183	1
20	0.1	0	51	0.255	1
21	0.1	0			
22	0.1	0			
23	0.1	0			
24	0.1	0			
25	0.1	0			
26	0.1	0			
27	0.1	0			
28	0.1	0			
29	0.1	0			
30	0.1	0			
31	0.1	0			

Toluene

D_Toluene

detects	2
nondetects	49
n (number of values)	51
p (percentile)	90

Table A-1. 600 Area Subregion Analytical Data Used for 90th Percentile Calculation

k (position in sequence)	46.8
mean 90th percentile	0.072

Rank	µg/L	Det. = 1 Nondet. = 0	Rank	µg/L	Det. = 1 Nondet. = 0
1	0.072	0	32	0.072	0
2	0.072	0	33	0.072	0
3	0.072	0	34	0.072	0
4	0.072	0	35	0.072	0
5	0.072	0	36	0.072	0
6	0.072	0	37	0.072	0
7	0.072	0	38	0.072	0
8	0.072	0	39	0.072	0
9	0.072	0	40	0.072	0
10	0.072	0	41	0.072	0
11	0.072	0	42	0.072	0
12	0.072	0	43	0.072	0
13	0.072	0	44	0.072	0
14	0.072	0	45	0.072	0
15	0.072	0	46	0.072	0
16	0.072	0	47	0.072	0
17	0.072	0	48	0.072	0
18	0.072	0	49	0.072	0
19	0.072	0	50	0.083	1
20	0.072	0	51	0.14	1
21	0.072	0			
22	0.072	0			
23	0.072	0			
24	0.072	0			
25	0.072	0			
26	0.072	0			
27	0.072	0			
28	0.072	0			
29	0.072	0			
30	0.072	0			
31	0.072	0			

Tributyl phosphate

D_Tributyl phosphate

detects	1
nondetects	50
n (number of values)	51
p (percentile)	90
k (position in sequence)	46.8

Table A-1. 600 Area Subregion Analytical Data Used for 90th Percentile Calculation

mean 90th percentile				1			
Rank	µg/L	Det. = 1 Nondet. = 0	Rank	µg/L	Det. = 1 Nondet. = 0		
1		1 0	32	1	0		
2		1 0	33	1	0		
3		1 0	34	1	0		
4		1 0	35	1	0		
5		1 0	36	1	0		
6		1 0	37	1	0		
7		1 0	38	1	0		
8		1 0	39	1	0		
9		1 0	40	1	0		
10		1 0	41	1	0		
11		1 0	42	1	0		
12		1 0	43	1	0		
13		1 0	44	1	0		
14		1 0	45	1	0		
15		1 0	46	1	0		
16		1 0	47	1	0		
17		1 0	48	1	0		
18		1 0	49	1	0		
19		1 0	50	1	0		
20		1 0	51	6.7	1		
21		1 0					
22		1 0					
23		1 0					
24		1 0					
25		1 0					
26		1 0					
27		1 0					
28		1 0					
29		1 0					
30		1 0					
31		1 0					

Tritium

D_Tritium

detects	31
nondetects	20
n (number of values)	51
p (percentile)	90
k (position in sequence)	46.8
mean 90th percentile	290000

Table A-1. 600 Area Subregion Analytical Data Used for 90th Percentile Calculation

Rank	µg/L	Det. = 1 Nondet. = 0	Rank	µg/L	Det. = 1 Nondet. = 0
1	-57	0	32	3100	1
2	-39	0	33	4400	1
3	-35	0	34	4700	1
4	10	0	35	4800	1
5	20	0	36	6900	1
6	24	0	37	9400	1
7	28	0	38	9400	1
8	30	0	39	9600	1
9	34	0	40	38000	1
10	42	0	41	38000	1
11	54	0	42	39000	1
12	79	0	43	120000	1
13	84	0	44	130000	1
14	98	0	45	160000	1
15	100	0	46	280000	1
16	110	0	47	300000	1
17	120	0	48	300000	1
18	170	0	49	740000	1
19	170	0	50	870000	1
20	180	0	51	890000	1
21	290	1			
22	1200	1			
23	1300	1			
24	1300	1			
25	1700	1			
26	1700	1			
27	1800	1			
28	1800	1			
29	1900	1			
30	1900	1			
31	2000	1			

Uranium

D_Uranium

detects	49
nondetects	2
n (number of values)	51
p (percentile)	90
k (position in sequence)	46.8
mean 90th percentile	9.205

Table A-1. 600 Area Subregion Analytical Data Used for 90th Percentile Calculation

Rank	µg/L	Det. = 1 Nondet. = 0	Rank	µg/L	Det. = 1 Nondet. = 0
1	0.0938	1	32	4.91	1
2	0.1	0	33	6.09	1
3	0.1	0	34	6.33	1
4	0.104	1	35	6.6	1
5	0.138	1	36	6.68	1
6	0.139	1	37	7.54	1
7	0.151	1	38	7.99	1
8	0.165	1	39	8.21	1
9	0.211	1	40	8.34	1
10	0.699	1	41	8.42	1
11	0.748	1	42	8.49	1
12	0.899	1	43	8.79	1
13	1.32	1	44	8.86	1
14	1.88	1	45	8.94	1
15	2.13	1	46	9.05	1
16	2.52	1	47	9.36	1
17	2.58	1	48	9.93	1
18	3.55	1	49	10.1	1
19	3.77	1	50	11	1
20	3.85	1	51	12.5	1
21	4.05	1			
22	4.1	1			
23	4.16	1			
24	4.29	1			
25	4.3	1			
26	4.31	1			
27	4.4	1			
28	4.48	1			
29	4.48	1			
30	4.55	1			
31	4.61	1			

Vanadium

D_Vanadium

detects	19
nondetects	32
n (number of values)	51
p (percentile)	90
k (position in sequence)	46.8
mean 90th percentile	20.5

Table A-1. 600 Area Subregion Analytical Data Used for 90th Percentile Calculation

Rank	µg/L	Det. = 1 Nondet. = 0	Rank	µg/L	Det. = 1 Nondet. = 0
1	12	0	32	17	0
2	12	0	33	17	0
3	12	1	34	17	1
4	12	1	35	17	0
5	12	1	36	17	0
6	12	0	37	17	0
7	12	0	38	17	0
8	12	0	39	19	1
9	12	0	40	19	1
10	12	0	41	19	1
11	12	0	42	19	1
12	12	0	43	19	1
13	12	0	44	19	1
14	15	1	45	20	1
15	17	0	46	20	1
16	17	1	47	21	1
17	17	0	48	21	1
18	17	0	49	23	1
19	17	0	50	28	1
20	17	0	51	33	1
21	17	0			
22	17	0			
23	17	0			
24	17	0			
25	17	0			
26	17	0			
27	17	0			
28	17	0			
29	17	0			
30	17	0			
31	17	0			

Zinc

D_Zinc

detects	24
nondetects	27
n (number of values)	51
p (percentile)	90
k (position in sequence)	46.8
mean 90th percentile	37.5

Table A-1. 600 Area Subregion Analytical Data Used for 90th Percentile Calculation

Rank	µg/L	Det. = 1 Nondet. = 0	Rank	µg/L	Det. = 1 Nondet. = 0
1		4	32	6	0
2		4	33	6	1
3		4	34	6	0
4		4	35	6	0
5		4	36	7	1
6		4	37	8	1
7		4	38	9	1
8		4	39	9	1
9		4	40	11	1
10		4	41	12	1
11		4	42	14	1
12		4	43	16	1
13		4	44	18	1
14		4	45	35	1
15		4	46	36	1
16		4	47	39	1
17		4	48	50	1
18		4	49	62	1
19		4	50	66	1
20		5	51	71	1
21		5			1
22		6			0
23		6			0
24		6			0
25		6			0
26		6			0
27		6			1
28		6			0
29		6			0
30		6			0
31		6			0

Table B-1. 600 Area Subregion Summary Statistics for Raw Data Sets with NDs using Detected Data Only

Variable	Num Ds	NumNDs	% NDs	Raw Statistics using Detected Observations							
				Minimum	Maximum	Mean	Median	SD	MAD/0.675	Skewness	CV
1,1-Dichloroethane 3	48	48	94.12%	0.15	0.2	0.173	0.17	0.0252	0.0297	0.586	0.145
Acetone 5	39	39	88.64%	0.4	2.5	1.76	2.1	0.826	0.593	-1.469	0.47
Aluminum 15	36	36	70.59%	11.5	539	105.6	25.1	160.4	17.49	2.107	1.519
Arsenic 51	0	0	0.00%	1.58	14.9	5.815	5.7	3.315	2.224	0.991	0.57
Barium 51	0	0	0.00%	15.4	118	44.71	44.1	21.79	22.09	0.888	0.487
Benzyl alcohol 1	50	50	98.04%	1.1	1.1	1.1	1.1	N/A	0	N/A	N/A
Beryllium 1	50	50	98.04%	0.188	0.188	0.188	0.188	N/A	0	N/A	N/A
Bis(2-ethylhexyl) phthalate 3	48	48	94.12%	1.3	3	1.933	1.5	0.929	0.297	1.642	0.481
Boron 14	36	36	72.00%	20	107	49.71	34.5	30.94	11.86	1.33	0.622
Bromodichloromethane 10	41	41	80.39%	0.17	2.1	0.888	0.72	0.601	0.519	0.959	0.677
Bromoform 6	45	45	88.24%	1.6	2.9	2.3	2.4	0.452	0.371	-0.449	0.196
Bromomethane 9	42	42	82.35%	0.31	0.95	0.451	0.34	0.21	0.0445	2.073	0.466
Butylbenzylphthalate 1	50	50	98.04%	1.3	1.3	1.3	1.3	N/A	0	N/A	N/A
Carbon disulfide 3	48	48	94.12%	0.06	0.11	0.0813	0.074	0.0258	0.0208	1.176	0.317
Carbon tetrachloride 2	49	49	96.08%	0.13	0.16	0.145	0.145	0.0212	0.0222	N/A	0.146
Chloride 51	0	0	0.00%	1860	26100	11591	10700	5424	4003	0.788	0.468
Chloroform 15	36	36	70.59%	0.11	7.1	1.145	0.44	1.945	0.4	2.642	1.699
Chromium 34	17	17	33.33%	1.07	5.9	3.145	2.785	1.399	1.446	0.519	0.445
Cobalt 10	41	41	80.39%	0.128	1	0.457	0.362	0.326	0.342	0.586	0.713
Copper 31	20	20	39.22%	0.237	12	1.842	0.879	2.512	0.93	2.868	1.364
Dibromochloromethane 7	44	44	86.27%	1.6	3.3	2.443	2.5	0.613	0.593	-0.109	0.251
Diethylphthalate 2	49	49	96.08%	1.7	42	21.85	21.85	28.5	29.87	N/A	1.304
Di-n-butylphthalate 1	50	50	98.04%	1	1	1	1	N/A	0	N/A	N/A
Fluoride 43	8	8	15.69%	39.4	851	241.5	194	183.8	63.75	2.514	0.761
Gross alpha 14	8	8	36.36%	2.3	40	6.657	3.4	9.807	1.334	3.485	1.473
Gross beta 22	0	0	0.00%	3.6	61	27.43	25.5	19.66	25.43	0.391	0.717
Iodine-129 1	50	50	98.04%	0.377	0.377	0.377	0.377	N/A	0	N/A	N/A
Iron 40	11	11	21.57%	23	3340	306.4	174.5	528.8	152	5.128	1.726
Lead 15	36	36	70.59%	0.24	1.37	0.563	0.423	0.313	0.216	1.37	0.555
Lithium 36	14	14	28.00%	4	31	14.36	13.5	7.549	9.637	0.302	0.526
Manganese 27	24	24	47.06%	5	261	33.67	22	48.45	19.27	4.278	1.439
Molybdenum 51	0	0	0.00%	1.01	10.8	4.907	4.28	2.623	2.417	0.605	0.535
Nickel 4	47	47	92.16%	4	8	5.25	4.5	1.893	0.741	1.659	0.361
Nitrate 48	3	3	5.88%	227	136000	26630	17300	29296	19577	2.221	1.1
Selenium 33	18	18	35.29%	0.633	13.4	3.362	2.37	2.944	1.156	2.142	0.876
Strontium 51	0	0	0.00%	115	407	226	218	64.99	72.65	0.6	0.288
Sulfate 51	0	0	0.00%	3980	87200	41436	37100	19654	15567	0.297	0.474
Tin 4	47	47	92.16%	0.118	0.255	0.176	0.166	0.0588	0.0482	0.887	0.334
Toluene 2	49	49	96.08%	0.083	0.14	0.112	0.112	0.0403	0.0423	N/A	0.361
Tributyl phosphate 1	50	50	98.04%	6.7	6.7	6.7	6.7	N/A	0	N/A	N/A
Tritium 31	20	20	39.22%	290	890000	128200	6900	252140	8302	2.343	1.967
Uranium 49	2	2	3.92%	0.0938	12.5	4.914	4.4	3.427	4.655	0.213	0.697
Vanadium 19	32	32	62.75%	12	33	19.21	19	5.127	2.965	0.989	0.267
Zinc 24	27	27	52.94%	4	71	20.88	10	21.7	8.895	1.301	1.039

Table B-5. 600 Area Subregion General UCL Statistics for Data Sets with Non-Detects

User Selected Options
 From File Sheet4.wst
 Full Precision OFF
 Confidence Coefficient 95%
 Number of Bootstrap Operations 2000

1,1-Dichloroethane

General Statistics			
Number of Valid Data	51	Number of Detected Data	3
Number of Distinct Detected Data	3	Number of Non-Detect Data	48
		Percent Non-Detects	94.12%
Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.15	Minimum Detected	-1.897
Maximum Detected	0.2	Maximum Detected	-1.609
Mean of Detected	0.173	Mean of Detected	-1.76
SD of Detected	0.0252	SD of Detected	0.144
Minimum Non-Detect	0.068	Minimum Non-Detect	-2.688
Maximum Non-Detect	0.068	Maximum Non-Detect	-2.688

Warning: There are only 3 Distinct Detected Values in this data set
The number of detected data may not be adequate enough to perform GOF tests, bootstrap, and ROS methods.
Those methods will return a 'N/A' value on your output display!

It is necessary to have 4 or more Distinct Values for bootstrap methods.
However, results obtained using 4 to 9 distinct values may not be reliable.
It is recommended to have 10 to 15 or more observations for accurate and meaningful results and estimates.

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic	0.987	Shapiro Wilk Test Statistic	0.994
5% Shapiro Wilk Critical Value	0.767	5% Shapiro Wilk Critical Value	0.767
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	
Assuming Normal Distribution		Assuming Lognormal Distribution	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	0.0422	Mean	-3.286
SD	0.0335	SD	0.386
95% DL/2 (t) UCL	0.0501	95% H-Stat (DL/2) UCL	0.0445
Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
MLE method failed to converge properly		Mean in Log Scale	-2.919
		SD in Log Scale	0.578
		Mean in Original Scale	0.0636
		SD in Original Scale	0.0389
		95% t UCL	0.0727
		95% Percentile Bootstrap UCL	0.0725
		95% BCA Bootstrap UCL	0.0737
Gamma Distribution Test with Detected Values Only		Data Distribution Test with Detected Values Only	
k star (bias corrected)	N/A	Data appear Normal at 5% Significance Level	

Table B-5. 600 Area Subregion General UCL Statistics for Data Sets with Non-Detects

Theta Star	N/A		
nu star	N/A		
A-D Test Statistic	N/A	Nonparametric Statistics	
5% A-D Critical Value	N/A	Kaplan-Meier (KM) Method	
K-S Test Statistic	N/A	Mean	0.151
5% K-S Critical Value	N/A	SD	0.00741
		SE of Mean	0.00127
		95% KM (t) UCL	0.154
		95% KM (z) UCL	0.153
		95% KM (jackknife) UCL	0.164
		95% KM (bootstrap t) UCL	0.153
		95% KM (BCA) UCL	0.2
		95% KM (Percentile Bootstrap) UCL	0.2
		95% KM (Chebyshev) UCL	0.157
		97.5% KM (Chebyshev) UCL	0.159
		99% KM (Chebyshev) UCL	0.164
		Potential UCLs to Use	
		95% KM (t) UCL	0.154
		95% KM (Percentile Bootstrap) UCL	0.2
Data not Gamma Distributed at 5% Significance Level			
Assuming Gamma Distribution			
Gamma ROS Statistics using Extrapolated Data			
Minimum	N/A		
Maximum	N/A		
Mean	N/A		
Median	N/A		
SD	N/A		
k star	N/A		
Theta star	N/A		
Nu star	N/A		
AppChi2	N/A		
95% Gamma Approximate UCL	N/A		
95% Adjusted Gamma UCL	N/A		

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006). For additional insight, the user may want to consult a statistician.

Acetone

	General Statistics			
Number of Valid Data	44	Number of Detected Data	5	
Number of Distinct Detected Data	5	Number of Non-Detect Data	39	
		Percent Non-Detects	88.64%	
Raw Statistics		Log-transformed Statistics		
Minimum Detected	0.4	Minimum Detected	-0.916	
Maximum Detected	2.5	Maximum Detected	0.916	
Mean of Detected	1.76	Mean of Detected	0.4	
SD of Detected	0.826	SD of Detected	0.754	
Minimum Non-Detect	0.34	Minimum Non-Detect	-1.079	
Maximum Non-Detect	0.34	Maximum Non-Detect	-1.079	

Warning: There are only 5 Detected Values in this data

Note: It should be noted that even though bootstrap may be performed on this data set the resulting calculations may not be reliable enough to draw conclusions

It is recommended to have 10-15 or more distinct observations for accurate and meaningful results.

	UCL Statistics		
Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic	0.869	Shapiro Wilk Test Statistic	0.738

Table B-5. 600 Area Subregion General UCL Statistics for Data Sets with Non-Detects

5% Shapiro Wilk Critical Value	0.762	5% Shapiro Wilk Critical Value	0.762
Data appear Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	
Assuming Normal Distribution		Assuming Lognormal Distribution	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	0.351	Mean	-1.525
SD	0.569	SD	0.734
95% DL/2 (t) UCL	0.495	95% H-Stat (DL/2) UCL	0.36
Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
MLE yields a negative mean		Mean in Log Scale	-2.643
		SD in Log Scale	1.782
		Mean in Original Scale	0.298
		SD in Original Scale	0.6
		95% t UCL	0.45
		95% Percentile Bootstrap UCL	0.459
		95% BCA Bootstrap UCL	0.5
Gamma Distribution Test with Detected Values Only		Data Distribution Test with Detected Values Only	
k star (bias corrected)	1.407	Data appear Normal at 5% Significance Level	
Theta Star	1.251		
nu star	14.07		
A-D Test Statistic	0.668	Nonparametric Statistics	
5% A-D Critical Value	0.682	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.682	Mean	0.555
5% K-S Critical Value	0.359	SD	0.498
Data appear Gamma Distributed at 5% Significance Level		SE of Mean	0.084
Assuming Gamma Distribution		95% KM (t) UCL	0.696
Gamma ROS Statistics using Extrapolated Data		95% KM (z) UCL	0.693
Minimum	0.4	95% KM (jackknife) UCL	1.29
Maximum	12.54	95% KM (bootstrap t) UCL	0.642
Mean	6.709	95% KM (BCA) UCL	2.2
Median	6.914	95% KM (Percentile Bootstrap) UCL	2.123
SD	3.681	95% KM (Chebyshev) UCL	0.921
k star	2.143	97.5% KM (Chebyshev) UCL	1.079
Theta star	3.13	99% KM (Chebyshev) UCL	1.39
Nu star	188.6	Potential UCLs to Use	
AppChi2	157.9	95% KM (t) UCL	0.696
95% Gamma Approximate UCL	8.016	95% KM (Percentile Bootstrap) UCL	2.123
95% Adjusted Gamma UCL	8.065		

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006). For additional insight, the user may want to consult a statistician.

Aluminum

General Statistics			
Number of Valid Data	51	Number of Detected Data	15
Number of Distinct Detected Data	15	Number of Non-Detect Data	36
		Percent Non-Detects	70.59%

Table B-5. 600 Area Subregion General UCL Statistics for Data Sets with Non-Detects

Raw Statistics		Log-transformed Statistics	
Minimum Detected	11.5	Minimum Detected	2.442
Maximum Detected	539	Maximum Detected	6.29
Mean of Detected	105.6	Mean of Detected	3.79
SD of Detected	160.4	SD of Detected	1.294
Minimum Non-Detect	10	Minimum Non-Detect	2.303
Maximum Non-Detect	10	Maximum Non-Detect	2.303
UCL Statistics		UCL Statistics	
Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic	0.64	Shapiro Wilk Test Statistic	0.861
5% Shapiro Wilk Critical Value	0.881	5% Shapiro Wilk Critical Value	0.881
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	
Assuming Normal Distribution		Assuming Lognormal Distribution	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	34.59	Mean	2.251
SD	96.7	SD	1.215
95% DL/2 (t) UCL	57.29	95% H-Stat (DL/2) UCL	30.71
Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
MLE yields a negative mean		Mean in Log Scale	0.514
		SD in Log Scale	2.752
		Mean in Original Scale	32.03
		SD in Original Scale	97.53
		95% t UCL	54.92
		95% Percentile Bootstrap UCL	55.57
		95% BCA Bootstrap UCL	67.3
Gamma Distribution Test with Detected Values Only		Data Distribution Test with Detected Values Only	
k star (bias corrected)	0.601	Data do not follow a Discernable Distribution (0.05)	
Theta Star	175.9		
nu star	18.02		
A-D Test Statistic	1.278	Nonparametric Statistics	
5% A-D Critical Value	0.779	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.779	Mean	39.18
5% K-S Critical Value	0.231	SD	94.37
Data not Gamma Distributed at 5% Significance Level		SE of Mean	13.68
Assuming Gamma Distribution		95% KM (t) UCL	62.1
Gamma ROS Statistics using Extrapolated Data		95% KM (z) UCL	61.68
Minimum	1E-12	95% KM (jackknife) UCL	60.46
Maximum	1727	95% KM (bootstrap t) UCL	107.4
Mean	480.7	95% KM (BCA) UCL	65.92
Median	263.6	95% KM (Percentile Bootstrap) UCL	65.01
SD	528.1	95% KM (Chebyshev) UCL	98.8
k star	0.213	97.5% KM (Chebyshev) UCL	124.6
Theta star	2262	99% KM (Chebyshev) UCL	175.3
Nu star	21.68	Potential UCLs to Use	
AppChi2	12.1	95% KM (BCA) UCL	65.92
95% Gamma Approximate UCL	861.4		
95% Adjusted Gamma UCL	876.5		

Table B-5. 600 Area Subregion General UCL Statistics for Data Sets with Non-Detects

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006). For additional insight, the user may want to consult a statistician.

Arsenic

General Statistics

Number of Valid Observations 51

Number of Distinct Observations 50

Raw Statistics

Minimum 1.58
Maximum 14.9
Mean 5.815
Median 5.7
SD 3.315
Coefficient of Variation 0.57
Skewness 0.991

Log-transformed Statistics

Minimum of Log Data 0.457
Maximum of Log Data 2.701
Mean of log Data 1.592
SD of log Data 0.609

Relevant UCL Statistics

Normal Distribution Test

Lilliefors Test Statistic 0.149
Lilliefors Critical Value 0.124

Data not Normal at 5% Significance Level

Lognormal Distribution Test

Lilliefors Test Statistic 0.142
Lilliefors Critical Value 0.124

Data not Lognormal at 5% Significance Level

Assuming Normal Distribution

95% Student's-t UCL 6.593

95% UCLs (Adjusted for Skewness)

95% Adjusted-CLT UCL (Chen-1995) 6.647
95% Modified-t UCL (Johnson-1978) 6.603

Assuming Lognormal Distribution

95% H-UCL 7.002

95% Chebyshev (MVUE) UCL 8.244
97.5% Chebyshev (MVUE) UCL 9.262
99% Chebyshev (MVUE) UCL 11.26

Gamma Distribution Test

k star (bias corrected) 2.961
Theta Star 1.964
MLE of Mean 5.815
MLE of Standard Deviation 3.379
nu star 302
Approximate Chi Square Value (.05) 262.8
Adjusted Level of Significance 0.0453
Adjusted Chi Square Value 261.7

Anderson-Darling Test Statistic 0.954
Anderson-Darling 5% Critical Value 0.757
Kolmogorov-Smirnov Test Statistic 0.11
Kolmogorov-Smirnov 5% Critical Value 0.125

Data follow Appr. Gamma Distribution at 5% Significance Level

Assuming Gamma Distribution

95% Approximate Gamma UCL 6.683
95% Adjusted Gamma UCL 6.711

Potential UCL to Use

Data Distribution

Data Follow Appr. Gamma Distribution at 5% Significance Level

Nonparametric Statistics

95% CLT UCL 6.578
95% Jackknife UCL 6.593
95% Standard Bootstrap UCL 6.567
95% Bootstrap-t UCL 6.707
95% Hall's Bootstrap UCL 6.589
95% Percentile Bootstrap UCL 6.584
95% BCA Bootstrap UCL 6.662
95% Chebyshev(Mean, Sd) UCL 7.838
97.5% Chebyshev(Mean, Sd) UCL 8.713
99% Chebyshev(Mean, Sd) UCL 10.43

Use 95% Approximate Gamma UCL 6.683

Table B-5. 600 Area Subregion General UCL Statistics for Data Sets with Non-Detects

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Barium**General Statistics**

Number of Valid Observations 51

Number of Distinct Observations 49

Raw Statistics

Minimum 15.4

Maximum 118

Mean 44.71

Median 44.1

SD 21.79

Coefficient of Variation 0.487

Skewness 0.888

Log-transformed Statistics

Minimum of Log Data 2.734

Maximum of Log Data 4.771

Mean of log Data 3.679

SD of log Data 0.512

Relevant UCL Statistics**Normal Distribution Test**

Lilliefors Test Statistic 0.0905

Lilliefors Critical Value 0.124

Data appear Normal at 5% Significance Level**Assuming Normal Distribution**

95% Student's-t UCL 49.82

95% UCLs (Adjusted for Skewness)

95% Adjusted-CLT UCL (Chen-1995) 50.13

95% Modified-t UCL (Johnson-1978) 49.89

Gamma Distribution Test

k star (bias corrected) 4.045

Theta Star 11.05

MLE of Mean 44.71

MLE of Standard Deviation 22.23

nu star 412.6

Approximate Chi Square Value (.05) 366.5

Adjusted Level of Significance 0.0453

Adjusted Chi Square Value 365.2

Anderson-Darling Test Statistic 0.703

Anderson-Darling 5% Critical Value 0.754

Kolmogorov-Smirnov Test Statistic 0.112

Kolmogorov-Smirnov 5% Critical Value 0.125

Data appear Gamma Distributed at 5% Significance Level**Assuming Gamma Distribution**

95% Approximate Gamma UCL 50.33

95% Adjusted Gamma UCL 50.51

Potential UCL to Use**Lognormal Distribution Test**

Lilliefors Test Statistic 0.135

Lilliefors Critical Value 0.124

Data not Lognormal at 5% Significance Level**Assuming Lognormal Distribution**

95% H-UCL 51.75

95% Chebyshev (MVUE) UCL 59.83

97.5% Chebyshev (MVUE) UCL 66.24

99% Chebyshev (MVUE) UCL 78.82

Data Distribution**Data appear Normal at 5% Significance Level****Nonparametric Statistics**

95% CLT UCL 49.73

95% Jackknife UCL 49.82

95% Standard Bootstrap UCL 49.63

95% Bootstrap-t UCL 50.63

95% Hall's Bootstrap UCL 50.57

95% Percentile Bootstrap UCL 49.88

95% BCA Bootstrap UCL 50.18

95% Chebyshev(Mean, Sd) UCL 58.01

97.5% Chebyshev(Mean, Sd) UCL 63.76

99% Chebyshev(Mean, Sd) UCL 75.06

Use 95% Student's-t UCL 49.82

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)

Table B-5. 600 Area Subregion General UCL Statistics for Data Sets with Non-Detects and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Benzyl alcohol

General Statistics			
Number of Valid Data	51	Number of Detected Data	1
Number of Distinct Detected Data	1	Number of Non-Detect Data	50
		Percent Non-Detects	98.04%

**Warning: Only one distinct data value was detected! ProUCL (or any other software) should not be used on such a data set!
It is suggested to use alternative site specific values determined by the Project Team to estimate environmental parameters (e.g., EPC, BTV).**

The data set for variable Benzyl alcohol was not processed!

Beryllium

General Statistics			
Number of Valid Data	51	Number of Detected Data	1
Number of Distinct Detected Data	1	Number of Non-Detect Data	50
		Percent Non-Detects	98.04%

**Warning: Only one distinct data value was detected! ProUCL (or any other software) should not be used on such a data set!
It is suggested to use alternative site specific values determined by the Project Team to estimate environmental parameters (e.g., EPC, BTV).**

The data set for variable Beryllium was not processed!

Bis(2-ethylhexyl) phthalate

General Statistics			
Number of Valid Data	51	Number of Detected Data	3
Number of Distinct Detected Data	3	Number of Non-Detect Data	48
		Percent Non-Detects	94.12%
Raw Statistics		Log-transformed Statistics	
Minimum Detected	1.3	Minimum Detected	0.262
Maximum Detected	3	Maximum Detected	1.099
Mean of Detected	1.933	Mean of Detected	0.589
SD of Detected	0.929	SD of Detected	0.447
Minimum Non-Detect	1	Minimum Non-Detect	0
Maximum Non-Detect	1	Maximum Non-Detect	0

**Warning: There are only 3 Distinct Detected Values in this data set
The number of detected data may not be adequate enough to perform GOF tests, bootstrap, and ROS methods.
Those methods will return a 'N/A' value on your output display!**

**It is necessary to have 4 or more Distinct Values for bootstrap methods.
However, results obtained using 4 to 9 distinct values may not be reliable.
It is recommended to have 10 to 15 or more observations for accurate and meaningful results and estimates.**

Table B-5. 600 Area Subregion General UCL Statistics for Data Sets with Non-Detects

		UCL Statistics				
Normal Distribution Test with Detected Values Only				Lognormal Distribution Test with Detected Values Only		
	Shapiro Wilk Test Statistic	0.837			Shapiro Wilk Test Statistic	0.874
	5% Shapiro Wilk Critical Value	0.767			5% Shapiro Wilk Critical Value	0.767
Data appear Normal at 5% Significance Level				Data appear Lognormal at 5% Significance Level		
Assuming Normal Distribution				Assuming Lognormal Distribution		
	DL/2 Substitution Method				DL/2 Substitution Method	
	Mean	0.584			Mean	-0.618
	SD	0.388			SD	0.318
	95% DL/2 (t) UCL	0.675			95% H-Stat (DL/2) UCL	0.613
	Maximum Likelihood Estimate(MLE) Method	N/A			Log ROS Method	
MLE yields a negative mean					Mean in Log Scale	-2.91
					SD in Log Scale	1.744
					Mean in Original Scale	0.221
					SD in Original Scale	0.495
					95% t UCL	0.337
					95% Percentile Bootstrap UCL	0.343
					95% BCA Bootstrap UCL	0.393
Gamma Distribution Test with Detected Values Only				Data Distribution Test with Detected Values Only		
	k star (bias corrected)	N/A		Data appear Normal at 5% Significance Level		
	Theta Star	N/A				
	nu star	N/A				
	A-D Test Statistic	N/A		Nonparametric Statistics		
	5% A-D Critical Value	N/A			Kaplan-Meier (KM) Method	
	K-S Test Statistic	N/A			Mean	1.337
	5% K-S Critical Value	N/A			SD	0.237
Data not Gamma Distributed at 5% Significance Level					SE of Mean	0.0406
					95% KM (t) UCL	1.405
					95% KM (z) UCL	1.404
					95% KM (jackknife) UCL	1.471
					95% KM (bootstrap t) UCL	1.534
					95% KM (BCA) UCL	3
					95% KM (Percentile Bootstrap) UCL	3
					95% KM (Chebyshev) UCL	1.514
					97.5% KM (Chebyshev) UCL	1.591
					99% KM (Chebyshev) UCL	1.741
				Potential UCLs to Use		
					95% KM (t) UCL	1.405
					95% KM (Percentile Bootstrap) UCL	3
	Gamma ROS Statistics using Extrapolated Data					
	Minimum	N/A				
	Maximum	N/A				
	Mean	N/A				
	Median	N/A				
	SD	N/A				
	k star	N/A				
	Theta star	N/A				
	Nu star	N/A				
	AppChi2	N/A				
	95% Gamma Approximate UCL	N/A				
	95% Adjusted Gamma UCL	N/A				

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006). For additional insight, the user may want to consult a statistician.

Boron

Table B-5. 600 Area Subregion General UCL Statistics for Data Sets with Non-Detects

General Statistics			
Number of Valid Data	50	Number of Detected Data	14
Number of Distinct Detected Data	12	Number of Non-Detect Data	36
		Percent Non-Detects	72.00%
Raw Statistics		Log-transformed Statistics	
Minimum Detected	20	Minimum Detected	2.996
Maximum Detected	107	Maximum Detected	4.673
Mean of Detected	49.71	Mean of Detected	3.759
SD of Detected	30.94	SD of Detected	0.536
Minimum Non-Detect	19	Minimum Non-Detect	2.944
Maximum Non-Detect	41	Maximum Non-Detect	3.714
		Number treated as Non-Detect	44
		Number treated as Detected	6
		Single DL Non-Detect Percentage	88.00%
UCL Statistics			
Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic	0.734	Shapiro Wilk Test Statistic	0.862
5% Shapiro Wilk Critical Value	0.874	5% Shapiro Wilk Critical Value	0.874
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	
Assuming Normal Distribution		Assuming Lognormal Distribution	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	26.26	Mean	3.058
SD	22.16	SD	0.603
95% DL/2 (t) UCL	31.51	95% H-Stat (DL/2) UCL	30.24
Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
MLE yields a negative mean		Mean in Log Scale	2.979
		SD in Log Scale	0.748
		Mean in Original Scale	26.2
		SD in Original Scale	23.33
		95% t UCL	31.73
		95% Percentile Bootstrap UCL	31.65
		95% BCA Bootstrap UCL	32.66
Gamma Distribution Test with Detected Values Only		Data Distribution Test with Detected Values Only	
k star (bias corrected)	2.841	Data do not follow a Discernable Distribution (0.05)	
Theta Star	17.5		
nu star	79.54		
A-D Test Statistic	1.208	Nonparametric Statistics	
5% A-D Critical Value	0.741	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.741	Mean	30.53
5% K-S Critical Value	0.23	SD	20.34
Data not Gamma Distributed at 5% Significance Level		SE of Mean	3.138
Assuming Gamma Distribution		95% KM (t) UCL	35.79
Gamma ROS Statistics using Extrapolated Data		95% KM (z) UCL	35.69
Minimum	1E-12	95% KM (jackknife) UCL	35.04
Maximum	107	95% KM (bootstrap t) UCL	37.24
Mean	53.6	95% KM (BCA) UCL	40.85
Median	51.03	95% KM (Percentile Bootstrap) UCL	38.8
		95% KM (Chebyshev) UCL	44.21

Table B-5. 600 Area Subregion General UCL Statistics for Data Sets with Non-Detects

SD	28.4	97.5% KM (Chebyshev) UCL	50.12
k star	0.72	99% KM (Chebyshev) UCL	61.75
Theta star	74.43		
Nu star	72.02	Potential UCLs to Use	
AppChi2	53.48	95% KM (t) UCL	35.79
95% Gamma Approximate UCL	72.18	95% KM (% Bootstrap) UCL	38.8
95% Adjusted Gamma UCL	72.83		

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006). For additional insight, the user may want to consult a statistician.

Bromodichloromethane

General Statistics			
Number of Valid Data	51	Number of Detected Data	10
Number of Distinct Detected Data	10	Number of Non-Detect Data	41
		Percent Non-Detects	80.39%
Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.17	Minimum Detected	-1.772
Maximum Detected	2.1	Maximum Detected	0.742
Mean of Detected	0.888	Mean of Detected	-0.349
SD of Detected	0.601	SD of Detected	0.759
Minimum Non-Detect	0.088	Minimum Non-Detect	-2.43
Maximum Non-Detect	0.088	Maximum Non-Detect	-2.43
Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic	0.928	Shapiro Wilk Test Statistic	0.976
5% Shapiro Wilk Critical Value	0.842	5% Shapiro Wilk Critical Value	0.842
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	
Assuming Normal Distribution		Assuming Lognormal Distribution	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	0.209	Mean	-2.58
SD	0.424	SD	1.158
95% DL/2 (t) UCL	0.309	95% H-Stat (DL/2) UCL	0.222
Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
MLE yields a negative mean		Mean in Log Scale	-2.918
		SD in Log Scale	1.798
		Mean in Original Scale	0.221
		SD in Original Scale	0.423
		95% t UCL	0.32
		95% Percentile Bootstrap UCL	0.327
		95% BCA Bootstrap UCL	0.348
Gamma Distribution Test with Detected Values Only		Data Distribution Test with Detected Values Only	
k star (bias corrected)	1.693	Data appear Normal at 5% Significance Level	
Theta Star	0.525		
nu star	33.85		

Table B-5. 600 Area Subregion General UCL Statistics for Data Sets with Non-Detects

<table border="0"> <tr><td>A-D Test Statistic</td><td>0.133</td></tr> <tr><td>5% A-D Critical Value</td><td>0.734</td></tr> <tr><td>K-S Test Statistic</td><td>0.734</td></tr> <tr><td>5% K-S Critical Value</td><td>0.269</td></tr> </table> <p>Data appear Gamma Distributed at 5% Significance Level</p> <p>Assuming Gamma Distribution</p> <table border="0"> <tr><td>Gamma ROS Statistics using Extrapolated Data</td><td></td></tr> <tr><td> Minimum</td><td>1E-12</td></tr> <tr><td> Maximum</td><td>4.694</td></tr> <tr><td> Mean</td><td>2.379</td></tr> <tr><td> Median</td><td>2.369</td></tr> <tr><td> SD</td><td>1.428</td></tr> <tr><td> k star</td><td>0.723</td></tr> <tr><td> Theta star</td><td>3.291</td></tr> <tr><td> Nu star</td><td>73.75</td></tr> <tr><td> AppChi2</td><td>54.97</td></tr> <tr><td>95% Gamma Approximate UCL</td><td>3.192</td></tr> <tr><td>95% Adjusted Gamma UCL</td><td>3.22</td></tr> </table>	A-D Test Statistic	0.133	5% A-D Critical Value	0.734	K-S Test Statistic	0.734	5% K-S Critical Value	0.269	Gamma ROS Statistics using Extrapolated Data		Minimum	1E-12	Maximum	4.694	Mean	2.379	Median	2.369	SD	1.428	k star	0.723	Theta star	3.291	Nu star	73.75	AppChi2	54.97	95% Gamma Approximate UCL	3.192	95% Adjusted Gamma UCL	3.22	<p>Nonparametric Statistics</p> <table border="0"> <tr><td>Kaplan-Meier (KM) Method</td><td></td></tr> <tr><td> Mean</td><td>0.311</td></tr> <tr><td> SD</td><td>0.381</td></tr> <tr><td> SE of Mean</td><td>0.0562</td></tr> <tr><td>95% KM (t) UCL</td><td>0.405</td></tr> <tr><td>95% KM (z) UCL</td><td>0.403</td></tr> <tr><td>95% KM (jackknife) UCL</td><td>0.407</td></tr> <tr><td>95% KM (bootstrap t) UCL</td><td>0.435</td></tr> <tr><td>95% KM (BCA) UCL</td><td>0.682</td></tr> <tr><td>95% KM (Percentile Bootstrap) UCL</td><td>0.635</td></tr> <tr><td>95% KM (Chebyshev) UCL</td><td>0.556</td></tr> <tr><td>97.5% KM (Chebyshev) UCL</td><td>0.662</td></tr> <tr><td>99% KM (Chebyshev) UCL</td><td>0.87</td></tr> </table> <p>Potential UCLs to Use</p> <table border="0"> <tr><td>95% KM (t) UCL</td><td>0.405</td></tr> <tr><td>95% KM (Percentile Bootstrap) UCL</td><td>0.635</td></tr> </table>	Kaplan-Meier (KM) Method		Mean	0.311	SD	0.381	SE of Mean	0.0562	95% KM (t) UCL	0.405	95% KM (z) UCL	0.403	95% KM (jackknife) UCL	0.407	95% KM (bootstrap t) UCL	0.435	95% KM (BCA) UCL	0.682	95% KM (Percentile Bootstrap) UCL	0.635	95% KM (Chebyshev) UCL	0.556	97.5% KM (Chebyshev) UCL	0.662	99% KM (Chebyshev) UCL	0.87	95% KM (t) UCL	0.405	95% KM (Percentile Bootstrap) UCL	0.635
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SE of Mean	0.0562																																																														
95% KM (t) UCL	0.405																																																														
95% KM (z) UCL	0.403																																																														
95% KM (jackknife) UCL	0.407																																																														
95% KM (bootstrap t) UCL	0.435																																																														
95% KM (BCA) UCL	0.682																																																														
95% KM (Percentile Bootstrap) UCL	0.635																																																														
95% KM (Chebyshev) UCL	0.556																																																														
97.5% KM (Chebyshev) UCL	0.662																																																														
99% KM (Chebyshev) UCL	0.87																																																														
95% KM (t) UCL	0.405																																																														
95% KM (Percentile Bootstrap) UCL	0.635																																																														

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006). For additional insight, the user may want to consult a statistician.

Bromoform

General Statistics			
Number of Valid Data	51	Number of Detected Data	6
Number of Distinct Detected Data	5	Number of Non-Detect Data	45
		Percent Non-Detects	88.24%
Raw Statistics		Log-transformed Statistics	
Minimum Detected	1.6	Minimum Detected	0.47
Maximum Detected	2.9	Maximum Detected	1.065
Mean of Detected	2.3	Mean of Detected	0.816
SD of Detected	0.452	SD of Detected	0.208
Minimum Non-Detect	0.17	Minimum Non-Detect	-1.772
Maximum Non-Detect	0.17	Maximum Non-Detect	-1.772

Warning: There are only 6 Detected Values in this data

Note: It should be noted that even though bootstrap may be performed on this data set the resulting calculations may not be reliable enough to draw conclusions

It is recommended to have 10-15 or more distinct observations for accurate and meaningful results.

UCL Statistics	
Normal Distribution Test with Detected Values Only	Lognormal Distribution Test with Detected Values Only
Shapiro Wilk Test Statistic	0.968
5% Shapiro Wilk Critical Value	0.788
Data appear Normal at 5% Significance Level	Data appear Lognormal at 5% Significance Level

Table B-5. 600 Area Subregion General UCL Statistics for Data Sets with Non-Detects

Assuming Normal Distribution		Assuming Lognormal Distribution	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	0.346	Mean	-2.079
SD	0.735	SD	1.07
95% DL/2 (t) UCL	0.518	95% H-Stat (DL/2) UCL	0.317
Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
MLE yields a negative mean		Mean in Log Scale	-0.159
		SD in Log Scale	0.576
		Mean in Original Scale	1.003
		SD in Original Scale	0.605
		95% t UCL	1.145
		95% Percentile Bootstrap UCL	1.152
		95% BCA Bootstrap UCL	1.165
Gamma Distribution Test with Detected Values Only		Data Distribution Test with Detected Values Only	
k star (bias corrected)	14.6	Data appear Normal at 5% Significance Level	
Theta Star	0.158		
nu star	175.2		
A-D Test Statistic	0.275	Nonparametric Statistics	
5% A-D Critical Value	0.697	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.697	Mean	1.682
5% K-S Critical Value	0.332	SD	0.266
		SE of Mean	0.0408
		95% KM (t) UCL	1.751
		95% KM (z) UCL	1.75
		95% KM (jackknife) UCL	1.927
		95% KM (bootstrap t) UCL	1.748
		95% KM (BCA) UCL	2.508
		95% KM (Percentile Bootstrap) UCL	2.5
		95% KM (Chebyshev) UCL	1.86
		97.5% KM (Chebyshev) UCL	1.937
		99% KM (Chebyshev) UCL	2.089
		Potential UCLs to Use	
		95% KM (t) UCL	1.751
		95% KM (Percentile Bootstrap) UCL	2.5
Data appear Gamma Distributed at 5% Significance Level			
Assuming Gamma Distribution			
Gamma ROS Statistics using Extrapolated Data			
Minimum	1.587		
Maximum	4.682		
Mean	3.597		
Median	3.826		
SD	0.872		
k star	13.57		
Theta star	0.265		
Nu star	1384		
AppChi2	1299		
95% Gamma Approximate UCL	3.833		
95% Adjusted Gamma UCL	3.84		

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006). For additional insight, the user may want to consult a statistician.

Bromomethane

General Statistics			
Number of Valid Data	51	Number of Detected Data	9
Number of Distinct Detected Data	7	Number of Non-Detect Data	42
		Percent Non-Detects	82.35%
Raw Statistics		Log-transformed Statistics	

Table B-5. 600 Area Subregion General UCL Statistics for Data Sets with Non-Detects

Minimum Detected	0.31	Minimum Detected	-1.171
Maximum Detected	0.95	Maximum Detected	-0.0513
Mean of Detected	0.451	Mean of Detected	-0.868
SD of Detected	0.21	SD of Detected	0.374
Minimum Non-Detect	0.13	Minimum Non-Detect	-2.04
Maximum Non-Detect	2	Maximum Non-Detect	0.693

Note: Data have multiple DLs - Use of KM Method is recommended
For all methods (except KM, DL/2, and ROS Methods),
Observations < Largest ND are treated as NDs

Number treated as Non-Detect	51
Number treated as Detected	0
Single DL Non-Detect Percentage	100.00%

Warning: There are only 9 Detected Values in this data

**Note: It should be noted that even though bootstrap may be performed on this data set
the resulting calculations may not be reliable enough to draw conclusions**

It is recommended to have 10-15 or more distinct observations for accurate and meaningful results.

		UCL Statistics			
Normal Distribution Test with Detected Values Only				Lognormal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic	0.7	Shapiro Wilk Test Statistic	0.781	Shapiro Wilk Test Statistic	0.781
5% Shapiro Wilk Critical Value	0.829	5% Shapiro Wilk Critical Value	0.829	5% Shapiro Wilk Critical Value	0.829
Data not Normal at 5% Significance Level				Data not Lognormal at 5% Significance Level	
Assuming Normal Distribution				Assuming Lognormal Distribution	
DL/2 Substitution Method		DL/2 Substitution Method		DL/2 Substitution Method	
Mean	0.319	Mean	-1.691	Mean	-1.691
SD	0.356	SD	1.019	SD	1.019
95% DL/2 (t) UCL	0.403	95% H-Stat (DL/2) UCL	0.433	95% H-Stat (DL/2) UCL	0.433
Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method		Log ROS Method	
MLE method failed to converge properly		Mean in Log Scale	-2.089	Mean in Log Scale	-2.089
		SD in Log Scale	0.84	SD in Log Scale	0.84
		Mean in Original Scale	0.176	Mean in Original Scale	0.176
		SD in Original Scale	0.169	SD in Original Scale	0.169
		95% t UCL	0.215	95% t UCL	0.215
		95% Percentile Bootstrap UCL	0.216	95% Percentile Bootstrap UCL	0.216
		95% BCA Bootstrap UCL	0.222	95% BCA Bootstrap UCL	0.222
Gamma Distribution Test with Detected Values Only				Data Distribution Test with Detected Values Only	
k star (bias corrected)	4.822	Data Follow Appr. Gamma Distribution at 5% Significance Level			
Theta Star	0.0936				
nu star	86.79				
A-D Test Statistic	1.023	Nonparametric Statistics			
5% A-D Critical Value	0.722	Kaplan-Meier (KM) Method			
K-S Test Statistic	0.722	Mean	0.34	Mean	0.34
5% K-S Critical Value	0.28	SD	0.108	SD	0.108
Data follow Appr. Gamma Distribution at 5% Significance Level		SE of Mean	0.0178	SE of Mean	0.0178
Assuming Gamma Distribution		95% KM (t) UCL	0.37	95% KM (t) UCL	0.37
Gamma ROS Statistics using Extrapolated Data		95% KM (z) UCL	0.369	95% KM (z) UCL	0.369
Minimum	0.159	95% KM (jackknife) UCL	0.364	95% KM (jackknife) UCL	0.364
Maximum	0.95	95% KM (bootstrap t) UCL	0.436	95% KM (bootstrap t) UCL	0.436
Mean	0.551	95% KM (BCA) UCL	0.391	95% KM (BCA) UCL	0.391
		95% KM (Percentile Bootstrap) UCL	0.381	95% KM (Percentile Bootstrap) UCL	0.381

Table B-5. 600 Area Subregion General UCL Statistics for Data Sets with Non-Detects

Median	0.581	95% KM (Chebyshev) UCL	0.418
SD	0.187	97.5% KM (Chebyshev) UCL	0.451
k star	7.007	99% KM (Chebyshev) UCL	0.517
Theta star	0.0787		
Nu star	714.7	Potential UCLs to Use	
AppChi2	653.7	95% KM (t) UCL	0.37
95% Gamma Approximate UCL	0.603		
95% Adjusted Gamma UCL	0.604		

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.

These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).

For additional insight, the user may want to consult a statistician.

Butylbenzylphthalate

General Statistics			
Number of Valid Data	51	Number of Detected Data	1
Number of Distinct Detected Data	1	Number of Non-Detect Data	50
		Percent Non-Detects	98.04%

Warning: Only one distinct data value was detected! ProUCL (or any other software) should not be used on such a data set!

It is suggested to use alternative site specific values determined by the Project Team to estimate environmental parameters (e.g., EPC, BTV).

The data set for variable Butylbenzylphthalate was not processed!

Carbon disulfide

General Statistics			
Number of Valid Data	51	Number of Detected Data	3
Number of Distinct Detected Data	3	Number of Non-Detect Data	48
		Percent Non-Detects	94.12%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.06	Minimum Detected	-2.813
Maximum Detected	0.11	Maximum Detected	-2.207
Mean of Detected	0.0813	Mean of Detected	-2.541
SD of Detected	0.0258	SD of Detected	0.308
Minimum Non-Detect	0.051	Minimum Non-Detect	-2.976
Maximum Non-Detect	0.051	Maximum Non-Detect	-2.976

Warning: There are only 3 Distinct Detected Values in this data set

The number of detected data may not be adequate enough to perform GOF tests, bootstrap, and ROS methods.

Those methods will return a 'N/A' value on your output display!

It is necessary to have 4 or more Distinct Values for bootstrap methods.

However, results obtained using 4 to 9 distinct values may not be reliable.

It is recommended to have 10 to 15 or more observations for accurate and meaningful results and estimates.

UCL Statistics

Table B-5. 600 Area Subregion General UCL Statistics for Data Sets with Non-Detects

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic	0.939	Shapiro Wilk Test Statistic	0.969
5% Shapiro Wilk Critical Value	0.767	5% Shapiro Wilk Critical Value	0.767
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	
Assuming Normal Distribution		Assuming Lognormal Distribution	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	0.0288	Mean	-3.603
SD	0.0142	SD	0.275
95% DL/2 (t) UCL	0.0321	95% H-Stat (DL/2) UCL	0.0303
Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
MLE method failed to converge properly		Mean in Log Scale	-5.015
		SD in Log Scale	1.233
		Mean in Original Scale	0.0137
		SD in Original Scale	0.0201
		95% t UCL	0.0184
		95% Percentile Bootstrap UCL	0.0185
		95% BCA Bootstrap UCL	0.0203
Gamma Distribution Test with Detected Values Only		Data Distribution Test with Detected Values Only	
k star (bias corrected)	N/A	Data appear Normal at 5% Significance Level	
Theta Star	N/A		
nu star	N/A		
A-D Test Statistic	N/A	Nonparametric Statistics	
5% A-D Critical Value	N/A	Kaplan-Meier (KM) Method	
K-S Test Statistic	N/A	Mean	0.0613
5% K-S Critical Value	N/A	SD	0.00716
Data not Gamma Distributed at 5% Significance Level		SE of Mean	0.00123
Assuming Gamma Distribution		95% KM (t) UCL	0.0633
Gamma ROS Statistics using Extrapolated Data		95% KM (z) UCL	0.0633
Minimum	N/A	95% KM (jackknife) UCL	0.0703
Maximum	N/A	95% KM (bootstrap t) UCL	0.0632
Mean	N/A	95% KM (BCA) UCL	0.11
Median	N/A	95% KM (Percentile Bootstrap) UCL	0.11
SD	N/A	95% KM (Chebyshev) UCL	0.0666
k star	N/A	97.5% KM (Chebyshev) UCL	0.0689
Theta star	N/A	99% KM (Chebyshev) UCL	0.0735
Nu star	N/A	Potential UCLs to Use	
AppChi2	N/A	95% KM (t) UCL	0.0633
95% Gamma Approximate UCL	N/A	95% KM (Percentile Bootstrap) UCL	0.11
95% Adjusted Gamma UCL	N/A		

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006). For additional insight, the user may want to consult a statistician.

Carbon tetrachloride

General Statistics			
Number of Valid Data	51	Number of Detected Data	2

Table B-5. 600 Area Subregion General UCL Statistics for Data Sets with Non-Detects

Number of Distinct Detected Data	2	Number of Non-Detect Data	49
		Percent Non-Detects	96.08%

Raw Statistics

Minimum Detected	0.13
Maximum Detected	0.16
Mean of Detected	0.145
SD of Detected	0.0212
Minimum Non-Detect	0.12
Maximum Non-Detect	0.12

Log-transformed Statistics

Minimum Detected	-2.04
Maximum Detected	-1.833
Mean of Detected	-1.936
SD of Detected	0.147
Minimum Non-Detect	-2.12
Maximum Non-Detect	-2.12

Warning: Data set has only 2 Distinct Detected Values.

This may not be adequate enough to compute meaningful and reliable test statistics and estimates.

The Project Team may decide to use alternative site specific values to estimate environmental parameters (e.g., EPC, BTV).

Unless Data Quality Objectives (DQOs) have been met, it is suggested to collect additional observations.

The number of detected data may not be adequate enough to perform GOF tests, bootstrap, and ROS methods.

Those methods will return a 'N/A' value on your output display!

It is necessary to have 4 or more Distinct Values for bootstrap methods.

However, results obtained using 4 to 9 distinct values may not be reliable.

It is recommended to have 10 to 15 or more observations for accurate and meaningful results and estimates.

		UCL Statistics			
Normal Distribution Test with Detected Values Only				Lognormal Distribution Test with Detected Values Only	
	Shapiro Wilk Test Statistic	N/A		Shapiro Wilk Test Statistic	N/A
	5% Shapiro Wilk Critical Value	N/A		5% Shapiro Wilk Critical Value	N/A
Data not Normal at 5% Significance Level				Data not Lognormal at 5% Significance Level	
Assuming Normal Distribution				Assuming Lognormal Distribution	
	DL/2 Substitution Method			DL/2 Substitution Method	
	Mean	0.0633		Mean	-2.779
	SD	0.0169		SD	0.173
	95% DL/2 (t) UCL	0.0673		95% H-Stat (DL/2) UCL	0.0657
	Maximum Likelihood Estimate(MLE) Method	N/A		Log ROS Method	
MLE method failed to converge properly				Mean in Log Scale	N/A
				SD in Log Scale	N/A
				Mean in Original Scale	N/A
				SD in Original Scale	N/A
				95% t UCL	N/A
				95% Percentile Bootstrap UCL	N/A
				95% BCA Bootstrap UCL	N/A
Gamma Distribution Test with Detected Values Only				Data Distribution Test with Detected Values Only	
	k star (bias corrected)	N/A		Data do not follow a Discernable Distribution (0.05)	
	Theta Star	N/A			
	nu star	N/A			
	A-D Test Statistic	N/A		Nonparametric Statistics	
	5% A-D Critical Value	N/A		Kaplan-Meier (KM) Method	
	K-S Test Statistic	N/A		Mean	0.131

Table B-5. 600 Area Subregion General UCL Statistics for Data Sets with Non-Detects

5% K-S Critical Value	N/A	SD	0.00416
Data not Gamma Distributed at 5% Significance Level		SE of Mean	0.00082369
Assuming Gamma Distribution		95% KM (t) UCL	0.132
Gamma ROS Statistics using Extrapolated Data		95% KM (z) UCL	0.132
Minimum	N/A	95% KM (jackknife) UCL	N/A
Maximum	N/A	95% KM (bootstrap t) UCL	N/A
Mean	N/A	95% KM (BCA) UCL	N/A
Median	N/A	95% KM (Percentile Bootstrap) UCL	N/A
SD	N/A	95% KM (Chebyshev) UCL	0.134
k star	N/A	97.5% KM (Chebyshev) UCL	0.136
Theta star	N/A	99% KM (Chebyshev) UCL	0.139
Nu star	N/A	Potential UCLs to Use	
AppChi2	N/A	95% KM (t) UCL	0.132
95% Gamma Approximate UCL	N/A	95% KM (% Bootstrap) UCL	N/A
95% Adjusted Gamma UCL	N/A		

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006). For additional insight, the user may want to consult a statistician.

Chloride

General Statistics

Number of Valid Observations 51

Number of Distinct Observations 46

Raw Statistics

Minimum 1860
Maximum 26100
Mean 11591
Median 10700
SD 5424
Coefficient of Variation 0.468
Skewness 0.788

Log-transformed Statistics

Minimum of Log Data 7.528
Maximum of Log Data 10.17
Mean of log Data 9.232
SD of log Data 0.553

Relevant UCL Statistics

Normal Distribution Test

Lilliefors Test Statistic 0.108
Lilliefors Critical Value 0.124

Data appear Normal at 5% Significance Level

Lognormal Distribution Test

Lilliefors Test Statistic 0.153
Lilliefors Critical Value 0.124

Data not Lognormal at 5% Significance Level

Assuming Normal Distribution

95% Student's-t UCL 12864

95% UCLs (Adjusted for Skewness)

95% Adjusted-CLT UCL (Chen-1995) 12930
95% Modified-t UCL (Johnson-1978) 12878

Assuming Lognormal Distribution

95% H-UCL 13820
95% Chebyshev (MVUE) UCL 16107
97.5% Chebyshev (MVUE) UCL 17944
99% Chebyshev (MVUE) UCL 21553

Gamma Distribution Test

k star (bias corrected) 3.888
Theta Star 2982
MLE of Mean 11591
MLE of Standard Deviation 5879
nu star 396.5

Data Distribution

Data appear Normal at 5% Significance Level

Table B-5. 600 Area Subregion General UCL Statistics for Data Sets with Non-Detects

Approximate Chi Square Value (.05)	351.4	Nonparametric Statistics	95% CLT UCL	12841
Adjusted Level of Significance	0.0453		95% Jackknife UCL	12864
Adjusted Chi Square Value	350.1		95% Standard Bootstrap UCL	12851
Anderson-Darling Test Statistic	0.883		95% Bootstrap-t UCL	12935
Anderson-Darling 5% Critical Value	0.754		95% Hall's Bootstrap UCL	13030
Kolmogorov-Smirnov Test Statistic	0.119		95% Percentile Bootstrap UCL	12902
Kolmogorov-Smirnov 5% Critical Value	0.125		95% BCA Bootstrap UCL	12999
			95% Chebyshev(Mean, Sd) UCL	14902
			97.5% Chebyshev(Mean, Sd) UCL	16334
			99% Chebyshev(Mean, Sd) UCL	19148

Data follow Appr. Gamma Distribution at 5% Significance Level

Assuming Gamma Distribution

95% Approximate Gamma UCL	13081
95% Adjusted Gamma UCL	13127

Potential UCL to Use

Use 95% Student's-t UCL 12864

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Chloroform

General Statistics			
Number of Valid Data	51	Number of Detected Data	15
Number of Distinct Detected Data	14	Number of Non-Detect Data	36
		Percent Non-Detects	70.59%
Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.11	Minimum Detected	-2.207
Maximum Detected	7.1	Maximum Detected	1.96
Mean of Detected	1.145	Mean of Detected	-0.683
SD of Detected	1.945	SD of Detected	1.194
Minimum Non-Detect	0.1	Minimum Non-Detect	-2.303
Maximum Non-Detect	0.1	Maximum Non-Detect	-2.303
UCL Statistics		Lognormal Distribution Test with Detected Values Only	
Normal Distribution Test with Detected Values Only		Shapiro Wilk Test Statistic	0.917
Shapiro Wilk Test Statistic	0.557	5% Shapiro Wilk Critical Value	0.881
5% Shapiro Wilk Critical Value	0.881		
Data not Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	
Assuming Normal Distribution		Assuming Lognormal Distribution	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	0.372	Mean	-2.316
SD	1.146	SD	1.238
95% DL/2 (t) UCL	0.641	95% H-Stat (DL/2) UCL	0.333
Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
MLE yields a negative mean		Mean in Log Scale	-3.71
		SD in Log Scale	2.542
		Mean in Original Scale	0.35
		SD in Original Scale	1.152
		95% t UCL	0.621

Table B-5. 600 Area Subregion General UCL Statistics for Data Sets with Non-Detects

		95% Percentile Bootstrap UCL	0.641
		95% BCA Bootstrap UCL	0.803
Gamma Distribution Test with Detected Values Only		Data Distribution Test with Detected Values Only	
	k star (bias corrected)	Data appear Lognormal at 5% Significance Level	
	Theta Star		
	nu star		
	A-D Test Statistic	Nonparametric Statistics	
	5% A-D Critical Value	Kaplan-Meier (KM) Method	
	K-S Test Statistic	Mean	0.414
	5% K-S Critical Value	SD	1.123
		SE of Mean	0.163
		95% KM (t) UCL	0.687
		95% KM (z) UCL	0.682
		95% KM (jackknife) UCL	0.68
		95% KM (bootstrap t) UCL	1.756
		95% KM (BCA) UCL	0.747
		95% KM (Percentile Bootstrap) UCL	0.715
		95% KM (Chebyshev) UCL	1.124
		97.5% KM (Chebyshev) UCL	1.431
		99% KM (Chebyshev) UCL	2.034
Data not Gamma Distributed at 5% Significance Level			
Assuming Gamma Distribution			
Gamma ROS Statistics using Extrapolated Data			
	Minimum	1E-12	
	Maximum	17.42	
	Mean	4.98	
	Median	2.855	
	SD	5.386	
	k star	0.235	
	Theta star	21.16	
	Nu star	24.01	
	AppChi2	13.86	
	95% Gamma Approximate UCL	8.63	
	95% Adjusted Gamma UCL	8.773	
		Potential UCLs to Use	
		95% KM (BCA) UCL	0.747

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006). For additional insight, the user may want to consult a statistician.

Chromium

General Statistics				
	Number of Valid Data	51	Number of Detected Data	34
	Number of Distinct Detected Data	32	Number of Non-Detect Data	17
			Percent Non-Detects	33.33%
Raw Statistics		Log-transformed Statistics		
	Minimum Detected	1.07	Minimum Detected	0.0677
	Maximum Detected	5.9	Maximum Detected	1.775
	Mean of Detected	3.145	Mean of Detected	1.045
	SD of Detected	1.399	SD of Detected	0.466
	Minimum Non-Detect	1	Minimum Non-Detect	0
	Maximum Non-Detect	1	Maximum Non-Detect	0
UCL Statistics				
Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only		
	Shapiro Wilk Test Statistic	0.925	Shapiro Wilk Test Statistic	0.954
	5% Shapiro Wilk Critical Value	0.933	5% Shapiro Wilk Critical Value	0.933
Data not Normal at 5% Significance Level				
Data appear Lognormal at 5% Significance Level				

Table B-5. 600 Area Subregion General UCL Statistics for Data Sets with Non-Detects

Assuming Normal Distribution		Assuming Lognormal Distribution	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	2.263	Mean	0.466
SD	1.696	SD	0.91
95% DL/2 (t) UCL	2.661	95% H-Stat (DL/2) UCL	3.206
Maximum Likelihood Estimate(MLE) Method		Log ROS Method	
Mean	1.974	Mean in Log Scale	0.674
SD	2.1	SD in Log Scale	0.677
95% MLE (t) UCL	2.467	Mean in Original Scale	2.423
95% MLE (Tiku) UCL	2.51	SD in Original Scale	1.544
		95% t UCL	2.785
		95% Percentile Bootstrap UCL	2.79
		95% BCA Bootstrap UCL	2.8
Gamma Distribution Test with Detected Values Only		Data Distribution Test with Detected Values Only	
k star (bias corrected)	4.686	Data appear Gamma Distributed at 5% Significance Level	
Theta Star	0.671		
nu star	318.7		
A-D Test Statistic	0.439	Nonparametric Statistics	
5% A-D Critical Value	0.749	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.749	Mean	2.453
5% K-S Critical Value	0.151	SD	1.491
		SE of Mean	0.212
		95% KM (t) UCL	2.809
		95% KM (z) UCL	2.802
		95% KM (jackknife) UCL	2.804
		95% KM (bootstrap t) UCL	2.836
		95% KM (BCA) UCL	2.913
		95% KM (Percentile Bootstrap) UCL	2.862
		95% KM (Chebyshev) UCL	3.377
		97.5% KM (Chebyshev) UCL	3.777
		99% KM (Chebyshev) UCL	4.562
		Potential UCLs to Use	
		95% KM (Percentile Bootstrap) UCL	2.862
Data appear Gamma Distributed at 5% Significance Level			
Assuming Gamma Distribution			
Gamma ROS Statistics using Extrapolated Data			
Minimum	1E-12		
Maximum	5.9		
Mean	2.803		
Median	2.66		
SD	1.354		
k star	0.86		
Theta star	3.258		
Nu star	87.74		
AppChi2	67.15		
95% Gamma Approximate UCL	3.662		
95% Adjusted Gamma UCL	3.691		

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006). For additional insight, the user may want to consult a statistician.

Cobalt

General Statistics		Log-transformed Statistics	
Number of Valid Data	51	Number of Detected Data	10
Number of Distinct Detected Data	10	Number of Non-Detect Data	41
		Percent Non-Detects	80.39%
Raw Statistics			

Table B-5. 600 Area Subregion General UCL Statistics for Data Sets with Non-Detects

Minimum Detected	0.128	Minimum Detected	-2.056
Maximum Detected	1	Maximum Detected	0
Mean of Detected	0.457	Mean of Detected	-1.045
SD of Detected	0.326	SD of Detected	0.787
Minimum Non-Detect	0.1	Minimum Non-Detect	-2.303
Maximum Non-Detect	0.1	Maximum Non-Detect	-2.303

UCL Statistics

Normal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.873
5% Shapiro Wilk Critical Value	0.842

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

DL/2 Substitution Method	
Mean	0.13
SD	0.214
95% DL/2 (t) UCL	0.18

Maximum Likelihood Estimate(MLE) Method N/A

MLE yields a negative mean

Lognormal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.898
5% Shapiro Wilk Critical Value	0.842

Data appear Lognormal at 5% Significance Level

Assuming Lognormal Distribution

DL/2 Substitution Method	
Mean	-2.613
SD	0.851
95% H-Stat (DL/2) UCL	0.136
Log ROS Method	
Mean in Log Scale	-3.738
SD in Log Scale	1.885
Mean in Original Scale	0.111
SD in Original Scale	0.223
95% t UCL	0.163
95% Percentile Bootstrap UCL	0.168
95% BCA Bootstrap UCL	0.176

Gamma Distribution Test with Detected Values Only

k star (bias corrected)	1.511
Theta Star	0.302
nu star	30.22

A-D Test Statistic	0.495
5% A-D Critical Value	0.735
K-S Test Statistic	0.735
5% K-S Critical Value	0.27

Data appear Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

Gamma ROS Statistics using Extrapolated Data	
Minimum	1E-12
Maximum	2.742
Mean	1.336
Median	1.307
SD	0.845
k star	0.702
Theta star	1.902
Nu star	71.64
AppChi2	53.15
95% Gamma Approximate UCL	1.801
95% Adjusted Gamma UCL	1.817

Data Distribution Test with Detected Values Only

Data appear Normal at 5% Significance Level

Nonparametric Statistics

Kaplan-Meier (KM) Method	
Mean	0.193
SD	0.189
SE of Mean	0.0279
95% KM (t) UCL	0.239
95% KM (z) UCL	0.238
95% KM (jackknife) UCL	0.233
95% KM (bootstrap t) UCL	0.255
95% KM (BCA) UCL	0.292
95% KM (Percentile Bootstrap) UCL	0.264
95% KM (Chebyshev) UCL	0.314
97.5% KM (Chebyshev) UCL	0.367
99% KM (Chebyshev) UCL	0.47

Potential UCLs to Use

95% KM (t) UCL	0.239
95% KM (Percentile Bootstrap) UCL	0.264

Note: DL/2 is not a recommended method.

Table B-5. 600 Area Subregion General UCL Statistics for Data Sets with Non-Detects

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006). For additional insight, the user may want to consult a statistician.

Copper

General Statistics			
Number of Valid Data	51	Number of Detected Data	31
Number of Distinct Detected Data	30	Number of Non-Detect Data	20
		Percent Non-Detects	39.22%
Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.237	Minimum Detected	-1.44
Maximum Detected	12	Maximum Detected	2.485
Mean of Detected	1.842	Mean of Detected	0.0166
SD of Detected	2.512	SD of Detected	1.063
Minimum Non-Detect	0.2	Minimum Non-Detect	-1.609
Maximum Non-Detect	0.2	Maximum Non-Detect	-1.609
UCL Statistics			
Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic	0.639	Shapiro Wilk Test Statistic	0.948
5% Shapiro Wilk Critical Value	0.929	5% Shapiro Wilk Critical Value	0.929
Data not Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	
Assuming Normal Distribution		Assuming Lognormal Distribution	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	1.159	Mean	-0.893
SD	2.127	SD	1.409
95% DL/2 (t) UCL	1.658	95% H-Stat (DL/2) UCL	1.918
Maximum Likelihood Estimate(MLE) Method		Log ROS Method	
Mean	0.29	Mean in Log Scale	-1.053
SD	2.942	SD in Log Scale	1.664
95% MLE (t) UCL	0.981	Mean in Original Scale	1.154
95% MLE (Tiku) UCL	1.061	SD in Original Scale	2.13
		95% t UCL	1.654
		95% Percentile Bootstrap UCL	1.689
		95% BCA Bootstrap UCL	1.816
Gamma Distribution Test with Detected Values Only		Data Distribution Test with Detected Values Only	
k star (bias corrected)	0.902	Data Follow Appr. Gamma Distribution at 5% Significance Level	
Theta Star	2.043		
nu star	55.89		
A-D Test Statistic	1.055	Nonparametric Statistics	
5% A-D Critical Value	0.777	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.777	Mean	1.213
5% K-S Critical Value	0.163	SD	2.08
Data follow Appr. Gamma Distribution at 5% Significance Level		SE of Mean	0.296
Assuming Gamma Distribution		95% KM (t) UCL	1.709
Gamma ROS Statistics using Extrapolated Data		95% KM (z) UCL	1.7
		95% KM (jackknife) UCL	1.701

Table B-5. 600 Area Subregion General UCL Statistics for Data Sets with Non-Detects

Minimum	1E-12	95% KM (bootstrap t) UCL	2.17
Maximum	12	95% KM (BCA) UCL	1.705
Mean	1.454	95% KM (Percentile Bootstrap) UCL	1.708
Median	0.73	95% KM (Chebyshev) UCL	2.503
SD	2.079	97.5% KM (Chebyshev) UCL	3.062
k star	0.183	99% KM (Chebyshev) UCL	4.158
Theta star	7.957		
Nu star	18.64	Potential UCLs to Use	
AppChi2	9.853	95% KM (BCA) UCL	1.705
95% Gamma Approximate UCL	2.75		
95% Adjusted Gamma UCL	2.803		

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006). For additional insight, the user may want to consult a statistician.

Dibromochloromethane

General Statistics			
Number of Valid Data	51	Number of Detected Data	7
Number of Distinct Detected Data	7	Number of Non-Detect Data	44
		Percent Non-Detects	86.27%
Raw Statistics		Log-transformed Statistics	
Minimum Detected	1.6	Minimum Detected	0.47
Maximum Detected	3.3	Maximum Detected	1.194
Mean of Detected	2.443	Mean of Detected	0.864
SD of Detected	0.613	SD of Detected	0.263
Minimum Non-Detect	0.13	Minimum Non-Detect	-2.04
Maximum Non-Detect	0.13	Maximum Non-Detect	-2.04

Warning: There are only 7 Detected Values in this data

Note: It should be noted that even though bootstrap may be performed on this data set the resulting calculations may not be reliable enough to draw conclusions

It is recommended to have 10-15 or more distinct observations for accurate and meaningful results.

UCL Statistics			
Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic	0.967	Shapiro Wilk Test Statistic	0.952
5% Shapiro Wilk Critical Value	0.803	5% Shapiro Wilk Critical Value	0.803
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	
Assuming Normal Distribution		Assuming Lognormal Distribution	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	0.391	Mean	-2.24
SD	0.853	SD	1.254
95% DL/2 (t) UCL	0.592	95% H-Stat (DL/2) UCL	0.37
Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
MLE yields a negative mean		Mean in Log Scale	-0.287

Table B-5. 600 Area Subregion General UCL Statistics for Data Sets with Non-Detects

			SD in Log Scale	0.712
			Mean in Original Scale	0.96
			SD in Original Scale	0.724
			95% t UCL	1.13
			95% Percentile Bootstrap UCL	1.133
			95% BCA Bootstrap UCL	1.134
Gamma Distribution Test with Detected Values Only		Data Distribution Test with Detected Values Only		
	k star (bias corrected)	10.12	Data appear Normal at 5% Significance Level	
	Theta Star	0.241		
	nu star	141.7		
	A-D Test Statistic	0.235	Nonparametric Statistics	
	5% A-D Critical Value	0.707	Kaplan-Meier (KM) Method	
	K-S Test Statistic	0.707	Mean	1.716
	5% K-S Critical Value	0.312	SD	0.358
Data appear Gamma Distributed at 5% Significance Level			SE of Mean	0.0542
Assuming Gamma Distribution			95% KM (t) UCL	1.807
Gamma ROS Statistics using Extrapolated Data			95% KM (z) UCL	1.805
	Minimum	1.42	95% KM (jackknife) UCL	1.848
	Maximum	5.465	95% KM (bootstrap t) UCL	1.811
	Mean	3.997	95% KM (BCA) UCL	2.545
	Median	4.271	95% KM (Percentile Bootstrap) UCL	2.3
	SD	1.145	95% KM (Chebyshev) UCL	1.952
	k star	9.421	97.5% KM (Chebyshev) UCL	2.054
	Theta star	0.424	99% KM (Chebyshev) UCL	2.255
	Nu star	960.9	Potential UCLs to Use	
	AppChi2	890	95% KM (t) UCL	1.807
	95% Gamma Approximate UCL	4.316	95% KM (Percentile Bootstrap) UCL	2.3
	95% Adjusted Gamma UCL	4.325		

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006). For additional insight, the user may want to consult a statistician.

Diethylphthalate

General Statistics			
Number of Valid Data	51	Number of Detected Data	2
Number of Distinct Detected Data	2	Number of Non-Detect Data	49
		Percent Non-Detects	96.08%
Raw Statistics		Log-transformed Statistics	
Minimum Detected	1.7	Minimum Detected	0.531
Maximum Detected	42	Maximum Detected	3.738
Mean of Detected	21.85	Mean of Detected	2.134
SD of Detected	28.5	SD of Detected	2.268
Minimum Non-Detect	1	Minimum Non-Detect	0
Maximum Non-Detect	1	Maximum Non-Detect	0

Warning: Data set has only 2 Distinct Detected Values.

Table B-5. 600 Area Subregion General UCL Statistics for Data Sets with Non-Detects

This may not be adequate enough to compute meaningful and reliable test statistics and estimates.

The Project Team may decide to use alternative site specific values to estimate environmental parameters (e.g., EPC, BTV).

Unless Data Quality Objectives (DQOs) have been met, it is suggested to collect additional observations.

The number of detected data may not be adequate enough to perform GOF tests, bootstrap, and ROS methods.

Those methods will return a 'N/A' value on your output display!

It is necessary to have 4 or more Distinct Values for bootstrap methods.

However, results obtained using 4 to 9 distinct values may not be reliable.

It is recommended to have 10 to 15 or more observations for accurate and meaningful results and estimates.

		UCL Statistics			
Normal Distribution Test with Detected Values Only				Lognormal Distribution Test with Detected Values Only	
	Shapiro Wilk Test Statistic	N/A		Shapiro Wilk Test Statistic	N/A
	5% Shapiro Wilk Critical Value	N/A		5% Shapiro Wilk Critical Value	N/A
Data not Normal at 5% Significance Level				Data not Lognormal at 5% Significance Level	
Assuming Normal Distribution				Assuming Lognormal Distribution	
	DL/2 Substitution Method			DL/2 Substitution Method	
	Mean	1.337		Mean	-0.582
	SD	5.81		SD	0.64
	95% DL/2 (t) UCL	2.701		95% H-Stat (DL/2) UCL	0.82
	Maximum Likelihood Estimate(MLE) Method	N/A		Log ROS Method	
MLE method failed to converge properly				Mean in Log Scale	N/A
				SD in Log Scale	N/A
				Mean in Original Scale	N/A
				SD in Original Scale	N/A
				95% t UCL	N/A
				95% Percentile Bootstrap UCL	N/A
				95% BCA Bootstrap UCL	N/A
Gamma Distribution Test with Detected Values Only				Data Distribution Test with Detected Values Only	
	k star (bias corrected)	N/A		Data do not follow a Discernable Distribution (0.05)	
	Theta Star	N/A			
	nu star	N/A			
	A-D Test Statistic	N/A		Nonparametric Statistics	
	5% A-D Critical Value	N/A		Kaplan-Meier (KM) Method	
	K-S Test Statistic	N/A		Mean	2.49
	5% K-S Critical Value	N/A		SD	5.588
Data not Gamma Distributed at 5% Significance Level				SE of Mean	1.106
				95% KM (t) UCL	4.345
				95% KM (z) UCL	4.31
				95% KM (jackknife) UCL	N/A
				95% KM (bootstrap t) UCL	N/A
				95% KM (BCA) UCL	N/A
				95% KM (Percentile Bootstrap) UCL	N/A
				95% KM (Chebyshev) UCL	7.313
				97.5% KM (Chebyshev) UCL	9.4
				99% KM (Chebyshev) UCL	13.5
Assuming Gamma Distribution				Potential UCLs to Use	
Gamma ROS Statistics using Extrapolated Data					
	Minimum	N/A			
	Maximum	N/A			
	Mean	N/A			
	Median	N/A			
	SD	N/A			
	k star	N/A			
	Theta star	N/A			
	Nu star	N/A			

Table B-5. 600 Area Subregion General UCL Statistics for Data Sets with Non-Detects

AppChi2	N/A	99% KM (Chebyshev) UCL	13.5
95% Gamma Approximate UCL	N/A		
95% Adjusted Gamma UCL	N/A		

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006). For additional insight, the user may want to consult a statistician.

Di-n-butylphthalate

General Statistics			
Number of Valid Data	51	Number of Detected Data	1
Number of Distinct Detected Data	1	Number of Non-Detect Data	50
		Percent Non-Detects	98.04%

Warning: Only one distinct data value was detected! ProUCL (or any other software) should not be used on such a data set! It is suggested to use alternative site specific values determined by the Project Team to estimate environmental parameters (e.g., EPC, BTV).

The data set for variable Di-n-butylphthalate was not processed!

Fluoride

General Statistics			
Number of Valid Data	51	Number of Detected Data	43
Number of Distinct Detected Data	38	Number of Non-Detect Data	8
		Percent Non-Detects	15.69%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	39.4	Minimum Detected	3.674
Maximum Detected	851	Maximum Detected	6.746
Mean of Detected	241.5	Mean of Detected	5.305
SD of Detected	183.8	SD of Detected	0.572
Minimum Non-Detect	60	Minimum Non-Detect	4.094
Maximum Non-Detect	60	Maximum Non-Detect	4.094

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic	0.651	Shapiro Wilk Test Statistic	0.91
5% Shapiro Wilk Critical Value	0.943	5% Shapiro Wilk Critical Value	0.943

Data not Normal at 5% Significance Level

Data not Lognormal at 5% Significance Level

Assuming Normal Distribution		Assuming Lognormal Distribution	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	208.3	Mean	5.007
SD	185.5	SD	0.874
95% DL/2 (t) UCL	251.9	95% H-Stat (DL/2) UCL	286.6
Maximum Likelihood Estimate(MLE) Method		Log ROS Method	
Mean	191.2	Mean in Log Scale	5.119
SD	207.5	SD in Log Scale	0.688

Table B-5. 600 Area Subregion General UCL Statistics for Data Sets with Non-Detects

95% MLE (t) UCL	239.9	Mean in Original Scale	213.6
95% MLE (Tiku) UCL	239.6	SD in Original Scale	180.8
		95% t UCL	256
		95% Percentile Bootstrap UCL	259.5
		95% BCA Bootstrap UCL	267.7
Gamma Distribution Test with Detected Values Only		Data Distribution Test with Detected Values Only	
k star (bias corrected)	2.72	Data do not follow a Discernable Distribution (0.05)	
Theta Star	88.78		
nu star	233.9		
A-D Test Statistic	2.532	Nonparametric Statistics	
5% A-D Critical Value	0.756	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.756	Mean	209.8
5% K-S Critical Value	0.136	SD	182.2
		SE of Mean	25.82
		95% KM (t) UCL	253.1
		95% KM (z) UCL	252.3
		95% KM (jackknife) UCL	248.6
		95% KM (bootstrap t) UCL	266.6
		95% KM (BCA) UCL	267.3
		95% KM (Percentile Bootstrap) UCL	258.7
		95% KM (Chebyshev) UCL	322.4
		97.5% KM (Chebyshev) UCL	371.1
		99% KM (Chebyshev) UCL	466.7
		Potential UCLs to Use	
		95% KM (Chebyshev) UCL	322.4
Data not Gamma Distributed at 5% Significance Level			
Assuming Gamma Distribution			
Gamma ROS Statistics using Extrapolated Data			
Minimum	1E-12		
Maximum	851		
Mean	212.8		
Median	175		
SD	182.2		
k star	0.427		
Theta star	497.7		
Nu star	43.6		
AppChi2	29.46		
95% Gamma Approximate UCL	314.9		
95% Adjusted Gamma UCL	318.6		

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006). For additional insight, the user may want to consult a statistician.

Gross alpha

General Statistics			
Number of Valid Data	22	Number of Detected Data	14
Number of Distinct Detected Data	13	Number of Non-Detect Data	8
		Percent Non-Detects	36.36%
Raw Statistics		Log-transformed Statistics	
Minimum Detected	2.3	Log Statistics Not Available	
Maximum Detected	40		
Mean of Detected	6.657		
Mean of Detected	6.657		
Mean of Detected	6.657		
Maximum Non-Detect	1.2		

Note: Data have multiple DLs - Use of KM Method is recommended for all methods (except KM, DL/2, and ROS Methods), Observations < Largest ND are treated as NDs

Number treated as Non-Detect	8
Number treated as Detected	14
Single DL Non-Detect Percentage	36.36%

Table B-5. 600 Area Subregion General UCL Statistics for Data Sets with Non-Detects

UCL Statistics			
Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic	0.459	Not Available	
5% Shapiro Wilk Critical Value	0.874		
Data not Normal at 5% Significance Level			
Assuming Normal Distribution		Assuming Lognormal Distribution	
DL/2 Substitution Method		DL/2 Substitution Method	N/A
Mean	4.285		
SD	8.362		
95% DL/2 (t) UCL	7.352		
Maximum Likelihood Estimate(MLE) Method		Log ROS Method	N/A
Mean	1.585		
SD	10.82		
95% MLE (t) UCL	5.553		
95% MLE (Tiku) UCL	5.913		
Gamma Distribution Test with Detected Values Only		Data Distribution Test with Detected Values Only	
Gamma Statistics Not Available		Data do not follow a Discernable Distribution (0.05)	
Potential UCLs to Use		Nonparametric Statistics	
99% KM (Chebyshev) UCL	22.3	Kaplan-Meier (KM) Method	
		Mean	5.073
		SD	7.825
		SE of Mean	1.731
		95% KM (t) UCL	8.052
		95% KM (z) UCL	7.92
		95% KM (jackknife) UCL	7.98
		95% KM (bootstrap t) UCL	20.6
		95% KM (BCA) UCL	8.523
		95% KM (Percentile Bootstrap) UCL	8.345
		95% KM (Chebyshev) UCL	12.62
		97.5% KM (Chebyshev) UCL	15.88
		99% KM (Chebyshev) UCL	22.3

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006). For additional insight, the user may want to consult a statistician.

Gross beta

General Statistics			
Number of Valid Observations	22	Number of Distinct Observations	22
Raw Statistics		Log-transformed Statistics	
Minimum	3.6	Minimum of Log Data	1.281
Maximum	61	Maximum of Log Data	4.111
Mean	27.43	Mean of log Data	2.985
Median	25.5	SD of log Data	0.899
SD	19.66		
Coefficient of Variation	0.717		

Table B-5. 600 Area Subregion General UCL Statistics for Data Sets with Non-Detects

Skewness 0.391

Relevant UCL Statistics

Normal Distribution Test

Shapiro Wilk Test Statistic 0.892
Shapiro Wilk Critical Value 0.911

Data not Normal at 5% Significance Level

Assuming Normal Distribution

95% Student's-t UCL 34.64

95% UCLs (Adjusted for Skewness)

95% Adjusted-CLT UCL (Chen-1995) 34.7
95% Modified-t UCL (Johnson-1978) 34.7

Gamma Distribution Test

k star (bias corrected) 1.479
Theta Star 18.55
MLE of Mean 27.43
MLE of Standard Deviation 22.56
nu star 65.06
Approximate Chi Square Value (.05) 47.5
Adjusted Level of Significance 0.0386
Adjusted Chi Square Value 46.38

Anderson-Darling Test Statistic 0.675
Anderson-Darling 5% Critical Value 0.758
Kolmogorov-Smirnov Test Statistic 0.157
Kolmogorov-Smirnov 5% Critical Value 0.188

Data appear Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

95% Approximate Gamma UCL 37.57
95% Adjusted Gamma UCL 38.48

Potential UCL to Use

Lognormal Distribution Test

Shapiro Wilk Test Statistic 0.915
Shapiro Wilk Critical Value 0.911

Data appear Lognormal at 5% Significance Level

Assuming Lognormal Distribution

95% H-UCL 47.93
95% Chebyshev (MVUE) UCL 55.7
97.5% Chebyshev (MVUE) UCL 67.29
99% Chebyshev (MVUE) UCL 90.05

Data Distribution

Data appear Gamma Distributed at 5% Significance Level

Nonparametric Statistics

95% CLT UCL 34.33
95% Jackknife UCL 34.64
95% Standard Bootstrap UCL 34.1
95% Bootstrap-t UCL 34.91
95% Hall's Bootstrap UCL 34.06
95% Percentile Bootstrap UCL 34.19
95% BCA Bootstrap UCL 34.8
95% Chebyshev(Mean, Sd) UCL 45.7
97.5% Chebyshev(Mean, Sd) UCL 53.61
99% Chebyshev(Mean, Sd) UCL 69.14

Use 95% Approximate Gamma UCL 37.57

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Iodine-129

General Statistics

Number of Valid Data	51	Number of Detected Data	1
Number of Distinct Detected Data	1	Number of Non-Detect Data	50
		Percent Non-Detects	98.04%

Warning: Only one distinct data value was detected! ProUCL (or any other software) should not be used on such a data set! It is suggested to use alternative site specific values determined by the Project Team to estimate environmental parameters (e.g., EPC, BTV).

The data set for variable Iodine-129 was not processed!

Table B-5. 600 Area Subregion General UCL Statistics for Data Sets with Non-Detects

Iron

General Statistics			
Number of Valid Data	51	Number of Detected Data	40
Number of Distinct Detected Data	39	Number of Non-Detect Data	11
		Percent Non-Detects	21.57%
Raw Statistics		Log-transformed Statistics	
Minimum Detected	23	Minimum Detected	3.135
Maximum Detected	3340	Maximum Detected	8.114
Mean of Detected	306.4	Mean of Detected	5.176
SD of Detected	528.8	SD of Detected	0.97
Minimum Non-Detect	18	Minimum Non-Detect	2.89
Maximum Non-Detect	38	Maximum Non-Detect	3.638
		Number treated as Non-Detect	13
		Number treated as Detected	38
		Single DL Non-Detect Percentage	25.49%
UCL Statistics			
Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic	0.44	Shapiro Wilk Test Statistic	0.977
5% Shapiro Wilk Critical Value	0.94	5% Shapiro Wilk Critical Value	0.94
Data not Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	
Assuming Normal Distribution		Assuming Lognormal Distribution	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	244	Mean	4.666
SD	482.3	SD	1.311
95% DL/2 (t) UCL	357.2	95% H-Stat (DL/2) UCL	410.2
Maximum Likelihood Estimate(MLE) Method		Log ROS Method	
Mean	140.4	Mean in Log Scale	4.718
SD	577.8	SD in Log Scale	1.251
95% MLE (t) UCL	276	Mean in Original Scale	245.4
95% MLE (Tiku) UCL	277.2	SD in Original Scale	481.6
		95% t UCL	358.4
		95% Percentile Bootstrap UCL	371.8
		95% BCA Bootstrap UCL	451.9
Gamma Distribution Test with Detected Values Only		Data Distribution Test with Detected Values Only	
k star (bias corrected)	0.984	Data Follow Appr. Gamma Distribution at 5% Significance Level	
Theta Star	311.3		
nu star	78.76		
A-D Test Statistic	1.36	Nonparametric Statistics	
5% A-D Critical Value	0.778	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.778	Mean	245.8
5% K-S Critical Value	0.144	SD	476.7
Data follow Appr. Gamma Distribution at 5% Significance Level		SE of Mean	67.6
Assuming Gamma Distribution		95% KM (t) UCL	359.1
Gamma ROS Statistics using Extrapolated Data		95% KM (z) UCL	357
Minimum	1E-12	95% KM (jackknife) UCL	357.2
Maximum	3340	95% KM (bootstrap t) UCL	530.7
		95% KM (BCA) UCL	390.3

Table B-5. 600 Area Subregion General UCL Statistics for Data Sets with Non-Detects

Mean	243.9	95% KM (Percentile Bootstrap) UCL	370.4
Median	148	95% KM (Chebyshev) UCL	540.5
SD	482.6	97.5% KM (Chebyshev) UCL	668
k star	0.145	99% KM (Chebyshev) UCL	918.5
Theta star	1682		
Nu star	14.79	Potential UCLs to Use	
AppChi2	7.116	95% KM (Chebyshev) UCL	540.5
95% Gamma Approximate UCL	506.9		
95% Adjusted Gamma UCL	518.2		

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.

These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).

For additional insight, the user may want to consult a statistician.

Lead

General Statistics			
Number of Valid Data	51	Number of Detected Data	15
Number of Distinct Detected Data	15	Number of Non-Detect Data	36
		Percent Non-Detects	70.59%
Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.24	Minimum Detected	-1.427
Maximum Detected	1.37	Maximum Detected	0.315
Mean of Detected	0.563	Mean of Detected	-0.7
SD of Detected	0.313	SD of Detected	0.506
Minimum Non-Detect	0.2	Minimum Non-Detect	-1.609
Maximum Non-Detect	0.2	Maximum Non-Detect	-1.609
UCL Statistics		Lognormal Distribution Test with Detected Values Only	
Normal Distribution Test with Detected Values Only		Shapiro Wilk Test Statistic	0.952
Shapiro Wilk Test Statistic	0.854	5% Shapiro Wilk Critical Value	0.881
5% Shapiro Wilk Critical Value	0.881	Data appear Lognormal at 5% Significance Level	
Data not Normal at 5% Significance Level		Assuming Lognormal Distribution	
Assuming Normal Distribution		DL/2 Substitution Method	
DL/2 Substitution Method		Mean	-1.831
Mean	0.236	SD	0.785
SD	0.27	95% H-Stat (DL/2) UCL	0.275
95% DL/2 (t) UCL	0.3		
Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
MLE yields a negative mean		Mean in Log Scale	-1.985
		SD in Log Scale	1.079
		Mean in Original Scale	0.237
		SD in Original Scale	0.274
		95% t UCL	0.302
		95% Percentile Bootstrap UCL	0.301
		95% BCA Bootstrap UCL	0.311
Gamma Distribution Test with Detected Values Only		Data Distribution Test with Detected Values Only	
k star (bias corrected)	3.362	Data appear Gamma Distributed at 5% Significance Level	

Table B-5. 600 Area Subregion General UCL Statistics for Data Sets with Non-Detects

Theta Star	0.168		
nu star	100.8		
A-D Test Statistic	0.471	Nonparametric Statistics	
5% A-D Critical Value	0.74	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.74	Mean	0.335
5% K-S Critical Value	0.222	SD	0.22
		SE of Mean	0.0319
		95% KM (t) UCL	0.389
		95% KM (z) UCL	0.388
		95% KM (jackknife) UCL	0.379
		95% KM (bootstrap t) UCL	0.403
		95% KM (BCA) UCL	0.451
		95% KM (Percentile Bootstrap) UCL	0.414
		95% KM (Chebyshev) UCL	0.474
		97.5% KM (Chebyshev) UCL	0.534
		99% KM (Chebyshev) UCL	0.653
		Potential UCLs to Use	
		95% KM (t) UCL	0.389

Data appear Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution			
Gamma ROS Statistics using Extrapolated Data			
Minimum	0.0273		
Maximum	1.405		
Mean	0.818		
Median	0.862		
SD	0.387		
k star	2.886		
Theta star	0.284		
Nu star	294.3		
AppChi2	255.6		
95% Gamma Approximate UCL	0.942		
95% Adjusted Gamma UCL	0.946		

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006). For additional insight, the user may want to consult a statistician.

Lithium

General Statistics			
Number of Valid Data	50	Number of Detected Data	36
Number of Distinct Detected Data	20	Number of Non-Detect Data	14
		Percent Non-Detects	28.00%
Raw Statistics		Log-transformed Statistics	
Minimum Detected	4	Minimum Detected	1.386
Maximum Detected	31	Maximum Detected	3.434
Mean of Detected	14.36	Mean of Detected	2.508
SD of Detected	7.549	SD of Detected	0.594
Minimum Non-Detect	4	Minimum Non-Detect	1.386
Maximum Non-Detect	4	Maximum Non-Detect	1.386
UCL Statistics			
Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic	0.919	Shapiro Wilk Test Statistic	0.921
5% Shapiro Wilk Critical Value	0.935	5% Shapiro Wilk Critical Value	0.935
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	
Assuming Normal Distribution		Assuming Lognormal Distribution	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	10.9	Mean	2
SD	8.493	SD	0.964

Table B-5. 600 Area Subregion General UCL Statistics for Data Sets with Non-Detects

95% DL/2 (t) UCL	12.91	95% H-Stat (DL/2) UCL	16.15
Maximum Likelihood Estimate(MLE) Method		Log ROS Method	
Mean	9.672	Mean in Log Scale	2.128
SD	10.2	SD in Log Scale	0.816
95% MLE (t) UCL	12.09	Mean in Original Scale	11.28
95% MLE (Tiku) UCL	12.22	SD in Original Scale	8.123
		95% t UCL	13.2
		95% Percentile Bootstrap UCL	13.16
		95% BCA Bootstrap UCL	13.29
Gamma Distribution Test with Detected Values Only		Data Distribution Test with Detected Values Only	
k star (bias corrected)	3.09	Data do not follow a Discernable Distribution (0.05)	
Theta Star	4.648		
nu star	222.5		
A-D Test Statistic	0.888	Nonparametric Statistics	
5% A-D Critical Value	0.753	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.753	Mean	11.46
5% K-S Critical Value	0.148	SD	7.844
		SE of Mean	1.125
		95% KM (t) UCL	13.35
		95% KM (z) UCL	13.31
		95% KM (jackknife) UCL	13.34
		95% KM (bootstrap t) UCL	13.46
		95% KM (BCA) UCL	13.46
		95% KM (Percentile Bootstrap) UCL	13.32
		95% KM (Chebyshev) UCL	16.36
		97.5% KM (Chebyshev) UCL	18.49
		99% KM (Chebyshev) UCL	22.65
		Potential UCLs to Use	
		95% KM (BCA) UCL	13.46
Data not Gamma Distributed at 5% Significance Level			
Assuming Gamma Distribution			
Gamma ROS Statistics using Extrapolated Data			
Minimum	1E-12		
Maximum	31		
Mean	12.31		
Median	10.8		
SD	7.517		
k star	0.717		
Theta star	17.16		
Nu star	71.71		
AppChi2	53.22		
95% Gamma Approximate UCL	16.59		
95% Adjusted Gamma UCL	16.74		

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006). For additional insight, the user may want to consult a statistician.

Manganese

General Statistics			
Number of Valid Data	51	Number of Detected Data	27
Number of Distinct Detected Data	24	Number of Non-Detect Data	24
		Percent Non-Detects	47.06%
Raw Statistics		Log-transformed Statistics	
Minimum Detected	5	Minimum Detected	1.609
Maximum Detected	261	Maximum Detected	5.565
Mean of Detected	33.67	Mean of Detected	3.085
SD of Detected	48.45	SD of Detected	0.853
Minimum Non-Detect	4	Minimum Non-Detect	1.386

Table B-5. 600 Area Subregion General UCL Statistics for Data Sets with Non-Detects

Maximum Non-Detect	6	Maximum Non-Detect	1.792
Note: Data have multiple DLs - Use of KM Method is recommended		Number treated as Non-Detect	25
For all methods (except KM, DL/2, and ROS Methods),		Number treated as Detected	26
Observations < Largest ND are treated as NDs		Single DL Non-Detect Percentage	49.02%

UCL Statistics

Normal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.485
5% Shapiro Wilk Critical Value	0.923

Data not Normal at 5% Significance Level

Assuming Normal Distribution

DL/2 Substitution Method	
Mean	19.06
SD	38.28
95% DL/2 (t) UCL	28.04

Maximum Likelihood Estimate(MLE) Method

MLE yields a negative mean

N/A

Lognormal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.951
5% Shapiro Wilk Critical Value	0.923

Data appear Lognormal at 5% Significance Level

Assuming Lognormal Distribution

DL/2 Substitution Method	
Mean	2.079
SD	1.248
95% H-Stat (DL/2) UCL	27.47
Log ROS Method	
Mean in Log Scale	2.034
SD in Log Scale	1.373
Mean in Original Scale	19.19
SD in Original Scale	38.24
95% t UCL	28.16
95% Percentile Bootstrap UCL	29.08
95% BCA Bootstrap UCL	32.23

Gamma Distribution Test with Detected Values Only

k star (bias corrected)	1.18
Theta Star	28.54
nu star	63.7

A-D Test Statistic	1.091
5% A-D Critical Value	0.767
K-S Test Statistic	0.767
5% K-S Critical Value	0.172

Data not Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

Gamma ROS Statistics using Extrapolated Data	
Minimum	1E-12
Maximum	261
Mean	31.73
Median	27
SD	37.74
k star	0.319
Theta star	99.53
Nu star	32.52
AppChi2	20.49
95% Gamma Approximate UCL	50.38
95% Adjusted Gamma UCL	51.07

Data Distribution Test with Detected Values Only

Data appear Lognormal at 5% Significance Level

Nonparametric Statistics

Kaplan-Meier (KM) Method	
Mean	20.18
SD	37.43
SE of Mean	5.341
95% KM (t) UCL	29.13
95% KM (z) UCL	28.96
95% KM (jackknife) UCL	28.33
95% KM (bootstrap t) UCL	40.19
95% KM (BCA) UCL	29.92
95% KM (Percentile Bootstrap) UCL	30.35
95% KM (Chebyshev) UCL	43.46
97.5% KM (Chebyshev) UCL	53.53
99% KM (Chebyshev) UCL	73.32

Potential UCLs to Use

95% KM (t) UCL	29.13
95% KM (% Bootstrap) UCL	30.35

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).

Table B-5. 600 Area Subregion General UCL Statistics for Data Sets with Non-Detects
For additional insight, the user may want to consult a statistician.

Molybdenum

General Statistics

Number of Valid Observations 51

Number of Distinct Observations 50

Raw Statistics

Minimum 1.01
Maximum 10.8
Mean 4.907
Median 4.28
SD 2.623
Coefficient of Variation 0.535
Skewness 0.605

Log-transformed Statistics

Minimum of Log Data 0.00995
Maximum of Log Data 2.38
Mean of log Data 1.433
SD of log Data 0.598

Relevant UCL Statistics

Normal Distribution Test

Lilliefors Test Statistic 0.147
Lilliefors Critical Value 0.124

Data not Normal at 5% Significance Level

Lognormal Distribution Test

Lilliefors Test Statistic 0.0791
Lilliefors Critical Value 0.124

Data appear Lognormal at 5% Significance Level

Assuming Normal Distribution

95% Student's-t UCL 5.523

95% UCLs (Adjusted for Skewness)

95% Adjusted-CLT UCL (Chen-1995) 5.545
95% Modified-t UCL (Johnson-1978) 5.528

Assuming Lognormal Distribution

95% H-UCL 5.91

95% Chebyshev (MVUE) UCL 6.945
97.5% Chebyshev (MVUE) UCL 7.79
99% Chebyshev (MVUE) UCL 9.449

Gamma Distribution Test

k star (bias corrected) 3.147
Theta Star 1.56
MLE of Mean 4.907
MLE of Standard Deviation 2.766
nu star 321
Approximate Chi Square Value (.05) 280.4
Adjusted Level of Significance 0.0453
Adjusted Chi Square Value 279.3

Anderson-Darling Test Statistic 0.306

Anderson-Darling 5% Critical Value 0.756

Kolmogorov-Smirnov Test Statistic 0.0885

Kolmogorov-Smirnov 5% Critical Value 0.125

Data appear Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

95% Approximate Gamma UCL 5.616

95% Adjusted Gamma UCL 5.638

Potential UCL to Use

Data Distribution

Data appear Gamma Distributed at 5% Significance Level

Nonparametric Statistics

95% CLT UCL 5.511

95% Jackknife UCL 5.523

95% Standard Bootstrap UCL 5.5

95% Bootstrap-t UCL 5.564

95% Hall's Bootstrap UCL 5.565

95% Percentile Bootstrap UCL 5.473

95% BCA Bootstrap UCL 5.571

95% Chebyshev(Mean, Sd) UCL 6.508

97.5% Chebyshev(Mean, Sd) UCL 7.201

99% Chebyshev(Mean, Sd) UCL 8.562

Use 95% Approximate Gamma UCL 5.616

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Table B-5. 600 Area Subregion General UCL Statistics for Data Sets with Non-Detects

Nickel

General Statistics			
Number of Valid Data	51	Number of Detected Data	4
Number of Distinct Detected Data	3	Number of Non-Detect Data	47
		Percent Non-Detects	92.16%
Raw Statistics		Log-transformed Statistics	
Minimum Detected	4	Minimum Detected	1.386
Maximum Detected	8	Maximum Detected	2.079
Mean of Detected	5.25	Mean of Detected	1.615
SD of Detected	1.893	SD of Detected	0.327
Minimum Non-Detect	4	Minimum Non-Detect	1.386
Maximum Non-Detect	4	Maximum Non-Detect	1.386

Warning: There are only 3 Distinct Detected Values in this data set
The number of detected data may not be adequate enough to perform GOF tests, bootstrap, and ROS methods.
Those methods will return a 'N/A' value on your output display!

It is necessary to have 4 or more Distinct Values for bootstrap methods.
However, results obtained using 4 to 9 distinct values may not be reliable.
It is recommended to have 10 to 15 or more observations for accurate and meaningful results and estimates.

UCL Statistics			
Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic	0.791	Shapiro Wilk Test Statistic	0.824
5% Shapiro Wilk Critical Value	0.748	5% Shapiro Wilk Critical Value	0.748
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	
Assuming Normal Distribution		Assuming Lognormal Distribution	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	2.255	Mean	0.765
SD	0.997	SD	0.263
95% DL/2 (t) UCL	2.489	95% H-Stat (DL/2) UCL	2.373
Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
MLE yields a negative mean		Mean in Log Scale	-0.502
		SD in Log Scale	1.125
		Mean in Original Scale	1.111
		SD in Original Scale	1.453
		95% t UCL	1.452
		95% Percentile Bootstrap UCL	1.446
		95% BCA Bootstrap UCL	1.571
Gamma Distribution Test with Detected Values Only		Data Distribution Test with Detected Values Only	
k star (bias corrected)	3.124	Data appear Normal at 5% Significance Level	
Theta Star	1.68		
nu star	24.99		
A-D Test Statistic	0.523	Nonparametric Statistics	
5% A-D Critical Value	0.657	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.657	Mean	4.098

Table B-5. 600 Area Subregion General UCL Statistics for Data Sets with Non-Detects

Mean	23699	Mean in Log Scale	9.147
SD	30613	SD in Log Scale	1.855
95% MLE (t) UCL	30883	Mean in Original Scale	25083
95% MLE (Tiku) UCL	30545	SD in Original Scale	29083
		95% t UCL	31908
		95% Percentile Bootstrap UCL	32388
		95% BCA Bootstrap UCL	33209
Gamma Distribution Test with Detected Values Only		Data Distribution Test with Detected Values Only	
k star (bias corrected)	0.692	Data do not follow a Discernable Distribution (0.05)	
Theta Star	38457		
nu star	66.48		
A-D Test Statistic	1.282	Nonparametric Statistics	
5% A-D Critical Value	0.794	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.794	Mean	25077
5% K-S Critical Value	0.133	SD	28802
		SE of Mean	4076
		95% KM (t) UCL	31907
		95% KM (z) UCL	31781
		95% KM (jackknife) UCL	31898
		95% KM (bootstrap t) UCL	33765
		95% KM (BCA) UCL	32352
		95% KM (Percentile Bootstrap) UCL	31905
		95% KM (Chebyshev) UCL	42843
		97.5% KM (Chebyshev) UCL	50530
		99% KM (Chebyshev) UCL	65630
Data not Gamma Distributed at 5% Significance Level		Potential UCLs to Use	
		97.5% KM (Chebyshev) UCL	50530
Assuming Gamma Distribution			
Gamma ROS Statistics using Extrapolated Data			
Minimum	1E-12		
Maximum	136000		
Mean	25064		
Median	16400		
SD	29100		
k star	0.241		
Theta star	103949		
Nu star	24.59		
AppChi2	14.3		
95% Gamma Approximate UCL	43102		
95% Adjusted Gamma UCL	43804		

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006). For additional insight, the user may want to consult a statistician.

Selenium

General Statistics			
Number of Valid Data	51	Number of Detected Data	33
Number of Distinct Detected Data	32	Number of Non-Detect Data	18
		Percent Non-Detects	35.29%
Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.633	Minimum Detected	-0.457
Maximum Detected	13.4	Maximum Detected	2.595
Mean of Detected	3.362	Mean of Detected	0.944
SD of Detected	2.944	SD of Detected	0.714
Minimum Non-Detect	0.6	Minimum Non-Detect	-0.511
Maximum Non-Detect	6	Maximum Non-Detect	1.792
		Number treated as Non-Detect	46

Note: Data have multiple DLs - Use of KM Method is recommended

Table B-5. 600 Area Subregion General UCL Statistics for Data Sets with Non-Detects

For all methods (except KM, DL/2, and ROS Methods),
Observations < Largest ND are treated as NDs

Number treated as Detected 5
Single DL Non-Detect Percentage 90.20%

		UCL Statistics			
Normal Distribution Test with Detected Values Only				Lognormal Distribution Test with Detected Values Only	
	Shapiro Wilk Test Statistic	0.733			Shapiro Wilk Test Statistic 0.967
	5% Shapiro Wilk Critical Value	0.931			5% Shapiro Wilk Critical Value 0.931
Data not Normal at 5% Significance Level				Data appear Lognormal at 5% Significance Level	
Assuming Normal Distribution				Assuming Lognormal Distribution	
	DL/2 Substitution Method				DL/2 Substitution Method
	Mean	2.334			Mean 0.231
	SD	2.768			SD 1.173
	95% DL/2 (t) UCL	2.984			95% H-Stat (DL/2) UCL 3.79
	Maximum Likelihood Estimate(MLE) Method	N/A			Log ROS Method
MLE yields a negative mean					Mean in Log Scale 0.361
					SD in Log Scale 1.029
					Mean in Original Scale 2.372
					SD in Original Scale 2.721
					95% t UCL 3.011
					95% Percentile Bootstrap UCL 3.021
					95% BCA Bootstrap UCL 3.111
Gamma Distribution Test with Detected Values Only				Data Distribution Test with Detected Values Only	
	k star (bias corrected)	1.848		Data appear Lognormal at 5% Significance Level	
	Theta Star	1.819			
	nu star	122			
	A-D Test Statistic	1.037		Nonparametric Statistics	
	5% A-D Critical Value	0.759		Kaplan-Meier (KM) Method	
	K-S Test Statistic	0.759			Mean 2.419
	5% K-S Critical Value	0.155			SD 2.667
Data not Gamma Distributed at 5% Significance Level					SE of Mean 0.38
Assuming Gamma Distribution					95% KM (t) UCL 3.055
	Gamma ROS Statistics using Extrapolated Data				95% KM (z) UCL 3.044
	Minimum	1E-12			95% KM (jackknife) UCL 2.993
	Maximum	13.4			95% KM (bootstrap t) UCL 3.235
	Mean	2.832			95% KM (BCA) UCL 3.181
	Median	2.36			95% KM (Percentile Bootstrap) UCL 3.134
	SD	2.599			95% KM (Chebyshev) UCL 4.075
	k star	0.348			97.5% KM (Chebyshev) UCL 4.791
	Theta star	8.134			99% KM (Chebyshev) UCL 6.199
	Nu star	35.52		Potential UCLs to Use	
	AppChi2	22.88		95% KM (BCA) UCL 3.181	
	95% Gamma Approximate UCL	4.397			
	95% Adjusted Gamma UCL	4.454			

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006). For additional insight, the user may want to consult a statistician.

Table B-5. 600 Area Subregion General UCL Statistics for Data Sets with Non-Detects

Strontium

General Statistics

Number of Valid Observations 51

Number of Distinct Observations 44

Raw Statistics

Minimum 115
Maximum 407
Mean 226
Median 218
SD 64.99
Coefficient of Variation 0.288
Skewness 0.6

Log-transformed Statistics

Minimum of Log Data 4.745
Maximum of Log Data 6.009
Mean of log Data 5.38
SD of log Data 0.288

Relevant UCL Statistics

Normal Distribution Test

Lilliefors Test Statistic 0.112
Lilliefors Critical Value 0.124

Data appear Normal at 5% Significance Level

Lognormal Distribution Test

Lilliefors Test Statistic 0.0996
Lilliefors Critical Value 0.124

Data appear Lognormal at 5% Significance Level

Assuming Normal Distribution

95% Student's-t UCL 241.2

95% UCLs (Adjusted for Skewness)

95% Adjusted-CLT UCL (Chen-1995) 241.8
95% Modified-t UCL (Johnson-1978) 241.4

Assuming Lognormal Distribution

95% H-UCL 242.7
95% Chebyshev (MVUE) UCL 266.6
97.5% Chebyshev (MVUE) UCL 284.1
99% Chebyshev (MVUE) UCL 318.5

Gamma Distribution Test

k star (bias corrected) 11.84
Theta Star 19.09
MLE of Mean 226
MLE of Standard Deviation 65.68
nu star 1207
Approximate Chi Square Value (.05) 1128
Adjusted Level of Significance 0.0453
Adjusted Chi Square Value 1126

Anderson-Darling Test Statistic 0.607
Anderson-Darling 5% Critical Value 0.749
Kolmogorov-Smirnov Test Statistic 0.108
Kolmogorov-Smirnov 5% Critical Value 0.124

Data appear Gamma Distributed at 5% Significance Level

Data Distribution

Data appear Normal at 5% Significance Level

Nonparametric Statistics

95% CLT UCL 240.9
95% Jackknife UCL 241.2
95% Standard Bootstrap UCL 240
95% Bootstrap-t UCL 242.7
95% Hall's Bootstrap UCL 242.6
95% Percentile Bootstrap UCL 240.5
95% BCA Bootstrap UCL 240.1
95% Chebyshev(Mean, Sd) UCL 265.6
97.5% Chebyshev(Mean, Sd) UCL 282.8
99% Chebyshev(Mean, Sd) UCL 316.5

Assuming Gamma Distribution

95% Approximate Gamma UCL 241.9
95% Adjusted Gamma UCL 242.4

Potential UCL to Use

Use 95% Student's-t UCL 241.2

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Sulfate

Table B-5. 600 Area Subregion General UCL Statistics for Data Sets with Non-Detects

General Statistics	
Number of Valid Observations	51
Number of Distinct Observations 50	
Raw Statistics	Log-transformed Statistics
Minimum	3980
Maximum	87200
Mean	41436
Median	37100
SD	19654
Coefficient of Variation	0.474
Skewness	0.297
Normal Distribution Test	Lognormal Distribution Test
Lilliefors Test Statistic	0.117
Lilliefors Critical Value	0.124
Assuming Normal Distribution	Assuming Lognormal Distribution
95% Student's-t UCL	46048
95% UCLs (Adjusted for Skewness)	95% H-UCL
95% Adjusted-CLT UCL (Chen-1995)	46085
95% Modified-t UCL (Johnson-1978)	46067
95% Chebyshev (MVUE) UCL	65649
	97.5% Chebyshev (MVUE) UCL
	74776
	99% Chebyshev (MVUE) UCL
	92704
Gamma Distribution Test	Data Distribution
k star (bias corrected)	2.905
Theta Star	14266
MLE of Mean	41436
MLE of Standard Deviation	24313
nu star	296.3
Approximate Chi Square Value (.05)	257.4
Adjusted Level of Significance	0.0453
Adjusted Chi Square Value	256.3
Anderson-Darling Test Statistic	1.715
Anderson-Darling 5% Critical Value	0.757
Kolmogorov-Smirnov Test Statistic	0.18
Kolmogorov-Smirnov 5% Critical Value	0.125
Assuming Gamma Distribution	Nonparametric Statistics
95% Approximate Gamma UCL	47694
95% Adjusted Gamma UCL	47889
95% CLT UCL	45963
95% Jackknife UCL	46048
95% Standard Bootstrap UCL	45879
95% Bootstrap-t UCL	45807
95% Hall's Bootstrap UCL	46126
95% Percentile Bootstrap UCL	46177
95% BCA Bootstrap UCL	46424
95% Chebyshev(Mean, Sd) UCL	53432
97.5% Chebyshev(Mean, Sd) UCL	58623
99% Chebyshev(Mean, Sd) UCL	68819
Potential UCL to Use	Use 95% Student's-t UCL
	46048

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Tin

General Statistics			
Number of Valid Data	51	Number of Detected Data	4

Table B-5. 600 Area Subregion General UCL Statistics for Data Sets with Non-Detects

Number of Distinct Detected Data	4	Number of Non-Detect Data	47
		Percent Non-Detects	92.16%

Raw Statistics

Minimum Detected	0.118
Maximum Detected	0.255
Mean of Detected	0.176
SD of Detected	0.0588
Minimum Non-Detect	0.1
Maximum Non-Detect	0.1

Log-transformed Statistics

Minimum Detected	-2.137
Maximum Detected	-1.366
Mean of Detected	-1.776
SD of Detected	0.327
Minimum Non-Detect	-2.303
Maximum Non-Detect	-2.303

Warning: There are only 4 Distinct Detected Values in this data

Note: It should be noted that even though bootstrap may be performed on this data set the resulting calculations may not be reliable enough to draw conclusions

It is recommended to have 10-15 or more distinct observations for accurate and meaningful results.

UCL Statistics

Normal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.96
5% Shapiro Wilk Critical Value	0.748

Data appear Normal at 5% Significance Level

Lognormal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.993
5% Shapiro Wilk Critical Value	0.748

Data appear Lognormal at 5% Significance Level

Assuming Normal Distribution

DL/2 Substitution Method	
Mean	0.0599
SD	0.0372
95% DL/2 (t) UCL	0.0686

Maximum Likelihood Estimate(MLE) Method

Mean	0.19
SD	0.0509
95% MLE (t) UCL	0.202
95% MLE (Tiku) UCL	0.232

Assuming Lognormal Distribution

DL/2 Substitution Method	
Mean	-2.9
SD	0.341
95% H-Stat (DL/2) UCL	0.0634

Log ROS Method

Mean in Log Scale	-3.965
SD in Log Scale	1.163
Mean in Original Scale	0.0362
SD in Original Scale	0.0485
95% t UCL	0.0476
95% Percentile Bootstrap UCL	0.0481
95% BCA Bootstrap UCL	0.0501

Gamma Distribution Test with Detected Values Only

k star (bias corrected)	3.29
Theta Star	0.0536
nu star	26.32

A-D Test Statistic	0.217
5% A-D Critical Value	0.657
K-S Test Statistic	0.657
5% K-S Critical Value	0.395

Data appear Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

Gamma ROS Statistics using Extrapolated Data	
Minimum	0.106
Maximum	0.701

Data Distribution Test with Detected Values Only

Data appear Normal at 5% Significance Level

Nonparametric Statistics

Kaplan-Meier (KM) Method	
Mean	0.123
SD	0.0212
SE of Mean	0.00343
95% KM (t) UCL	0.128
95% KM (z) UCL	0.128
95% KM (jackknife) UCL	0.142
95% KM (bootstrap t) UCL	0.128
95% KM (BCA) UCL	0.187

Table B-5. 600 Area Subregion General UCL Statistics for Data Sets with Non-Detects

Mean	0.472	95% KM (Percentile Bootstrap) UCL	0.186
Median	0.509	95% KM (Chebyshev) UCL	0.138
SD	0.173	97.5% KM (Chebyshev) UCL	0.144
k star	5.151	99% KM (Chebyshev) UCL	0.157
Theta star	0.0916		
Nu star	525.4	Potential UCLs to Use	
AppChi2	473.2	95% KM (t) UCL	0.128
95% Gamma Approximate UCL	0.524	95% KM (Percentile Bootstrap) UCL	0.186
95% Adjusted Gamma UCL	N/A		

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006). For additional insight, the user may want to consult a statistician.

Toluene

General Statistics			
Number of Valid Data	51	Number of Detected Data	2
Number of Distinct Detected Data	2	Number of Non-Detect Data	49
		Percent Non-Detects	96.08%
Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.083	Minimum Detected	-2.489
Maximum Detected	0.14	Maximum Detected	-1.966
Mean of Detected	0.112	Mean of Detected	-2.228
SD of Detected	0.0403	SD of Detected	0.37
Minimum Non-Detect	0.072	Minimum Non-Detect	-2.631
Maximum Non-Detect	0.072	Maximum Non-Detect	-2.631

Warning: Data set has only 2 Distinct Detected Values.

This may not be adequate enough to compute meaningful and reliable test statistics and estimates.

The Project Team may decide to use alternative site specific values to estimate environmental parameters (e.g., EPC, BTV).

Unless Data Quality Objectives (DQOs) have been met, it is suggested to collect additional observations.

The number of detected data may not be adequate enough to perform GOF tests, bootstrap, and ROS methods.

Those methods will return a 'N/A' value on your output display!

It is necessary to have 4 or more Distinct Values for bootstrap methods.

However, results obtained using 4 to 9 distinct values may not be reliable.

It is recommended to have 10 to 15 or more observations for accurate and meaningful results and estimates.

UCL Statistics		UCL Statistics	
Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic	N/A	Shapiro Wilk Test Statistic	N/A
5% Shapiro Wilk Critical Value	N/A	5% Shapiro Wilk Critical Value	N/A
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	
Assuming Normal Distribution		Assuming Lognormal Distribution	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	0.039	Mean	-3.281

Table B-5. 600 Area Subregion General UCL Statistics for Data Sets with Non-Detects

	SD	0.0159		SD	0.221
	95% DL/2 (t) UCL	0.0427		95% H-Stat (DL/2) UCL	0.0406
Maximum Likelihood Estimate(MLE) Method			N/A	Log ROS Method	
MLE method failed to converge properly				Mean in Log Scale	N/A
				SD in Log Scale	N/A
				Mean in Original Scale	N/A
				SD in Original Scale	N/A
				95% t UCL	N/A
				95% Percentile Bootstrap UCL	N/A
				95% BCA Bootstrap UCL	N/A
Gamma Distribution Test with Detected Values Only			Data Distribution Test with Detected Values Only		
	k star (bias corrected)	N/A	Data do not follow a Discernable Distribution (0.05)		
	Theta Star	N/A			
	nu star	N/A			
	A-D Test Statistic	N/A	Nonparametric Statistics		
	5% A-D Critical Value	N/A	Kaplan-Meier (KM) Method		
	K-S Test Statistic	N/A		Mean	0.0841
	5% K-S Critical Value	N/A		SD	0.0079
Data not Gamma Distributed at 5% Significance Level				SE of Mean	0.00157
Assuming Gamma Distribution				95% KM (t) UCL	0.0867
Gamma ROS Statistics using Extrapolated Data				95% KM (z) UCL	0.0867
	Minimum	N/A		95% KM (jackknife) UCL	N/A
	Maximum	N/A		95% KM (bootstrap t) UCL	N/A
	Mean	N/A		95% KM (BCA) UCL	N/A
	Median	N/A		95% KM (Percentile Bootstrap) UCL	N/A
	SD	N/A		95% KM (Chebyshev) UCL	0.0909
	k star	N/A		97.5% KM (Chebyshev) UCL	0.0939
	Theta star	N/A		99% KM (Chebyshev) UCL	0.0997
	Nu star	N/A	Potential UCLs to Use		
	AppChi2	N/A		95% KM (t) UCL	0.0867
	95% Gamma Approximate UCL	N/A		95% KM (% Bootstrap) UCL	N/A
	95% Adjusted Gamma UCL	N/A			

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006). For additional insight, the user may want to consult a statistician.

Tributyl phosphate

General Statistics			
Number of Valid Data	51	Number of Detected Data	1
Number of Distinct Detected Data	1	Number of Non-Detect Data	50
		Percent Non-Detects	98.04%

Warning: Only one distinct data value was detected! ProUCL (or any other software) should not be used on such a data set! It is suggested to use alternative site specific values determined by the Project Team to estimate environmental parameters (e.g., EPC, BTV).

The data set for variable Tributyl phosphate was not processed!

Table B-5. 600 Area Subregion General UCL Statistics for Data Sets with Non-Detects

Tritium

General Statistics			
Number of Valid Data	51	Number of Detected Data	31
Number of Distinct Detected Data	24	Number of Non-Detect Data	20
		Percent Non-Detects	39.22%
Raw Statistics		Log-transformed Statistics	
Minimum Detected	290	Log Statistics Not Available	
Maximum Detected	890000		
Mean of Detected	128200		
Mean of Detected	128200		
Mean of Detected	128200		
Maximum Non-Detect	180		
UCL Statistics		Lognormal Distribution Test with Detected Values Only	
Normal Distribution Test with Detected Values Only			
Shapiro Wilk Test Statistic	0.564	Not Available	
5% Shapiro Wilk Critical Value	0.929		
Data not Normal at 5% Significance Level			
Assuming Normal Distribution		Assuming Lognormal Distribution	
DL/2 Substitution Method		DL/2 Substitution Method	N/A
Mean	77937		
SD	205278		
95% DL/2 (t) UCL	126110		
Maximum Likelihood Estimate(MLE) Method		Log ROS Method	N/A
Mean	-11962		
SD	281899		
95% MLE (t) UCL	54192		
95% MLE (Tiku) UCL	62080		
Gamma Distribution Test with Detected Values Only			
Gamma Statistics Not Available		Data Distribution Test with Detected Values Only	
		Data do not follow a Discernable Distribution (0.05)	
Potential UCLs to Use		Nonparametric Statistics	
99% KM (Chebyshev) UCL	365852	Kaplan-Meier (KM) Method	
		Mean	78039
		SD	203216
		SE of Mean	28926
		95% KM (t) UCL	126517
		95% KM (z) UCL	125619
		95% KM (jackknife) UCL	125882
		95% KM (bootstrap t) UCL	160594
		95% KM (BCA) UCL	134118
		95% KM (Percentile Bootstrap) UCL	129506
		95% KM (Chebyshev) UCL	204126
		97.5% KM (Chebyshev) UCL	258684

Table B-5. 600 Area Subregion General UCL Statistics for Data Sets with Non-Detects

99% KM (Chebyshev) UCL 365852

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006). For additional insight, the user may want to consult a statistician.

Uranium

General Statistics			
Number of Valid Data	51	Number of Detected Data	49
Number of Distinct Detected Data	48	Number of Non-Detect Data	2
		Percent Non-Detects	3.92%
Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.0938	Minimum Detected	-2.367
Maximum Detected	12.5	Maximum Detected	2.526
Mean of Detected	4.914	Mean of Detected	1.044
SD of Detected	3.427	SD of Detected	1.414
Minimum Non-Detect	0.1	Minimum Non-Detect	-2.303
Maximum Non-Detect	0.1	Maximum Non-Detect	-2.303
UCL Statistics			
Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic	0.932	Shapiro Wilk Test Statistic	0.782
5% Shapiro Wilk Critical Value	0.947	5% Shapiro Wilk Critical Value	0.947
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	
Assuming Normal Distribution		Assuming Lognormal Distribution	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	4.724	Mean	0.886
SD	3.49	SD	1.596
95% DL/2 (t) UCL	5.543	95% H-Stat (DL/2) UCL	17.05
Maximum Likelihood Estimate(MLE) Method		Log ROS Method	
Mean	4.623	Mean in Log Scale	0.935
SD	3.629	SD in Log Scale	1.489
95% MLE (t) UCL	5.475	Mean in Original Scale	4.729
95% MLE (Tiku) UCL	5.462	SD in Original Scale	3.483
		95% t UCL	5.546
		95% Percentile Bootstrap UCL	5.504
		95% BCA Bootstrap UCL	5.551
Gamma Distribution Test with Detected Values Only		Data Distribution Test with Detected Values Only	
k star (bias corrected)	0.997	Data do not follow a Discernable Distribution (0.05)	
Theta Star	4.928		
nu star	97.73		
A-D Test Statistic	2.299	Nonparametric Statistics	
5% A-D Critical Value	0.778	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.778	Mean	4.725
5% K-S Critical Value	0.13	SD	3.454
		SE of Mean	0.489
Data not Gamma Distributed at 5% Significance Level			

Table B-5. 600 Area Subregion General UCL Statistics for Data Sets with Non-Detects

Assuming Gamma Distribution				95% KM (t) UCL	5.544
Gamma ROS Statistics using Extrapolated Data				95% KM (z) UCL	5.529
	Minimum	1E-12		95% KM (jackknife) UCL	5.544
	Maximum	12.5		95% KM (bootstrap t) UCL	5.567
	Mean	4.722		95% KM (BCA) UCL	5.544
	Median	4.31		95% KM (Percentile Bootstrap) UCL	5.562
	SD	3.493		95% KM (Chebyshev) UCL	6.855
	k star	0.392		97.5% KM (Chebyshev) UCL	7.777
	Theta star	12.04		99% KM (Chebyshev) UCL	9.587
	Nu star	39.99			
	AppChi2	26.5		Potential UCLs to Use	
	95% Gamma Approximate UCL	7.125		95% KM (Chebyshev) UCL	6.855
	95% Adjusted Gamma UCL	7.212			

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006). For additional insight, the user may want to consult a statistician.

Vanadium

General Statistics			
Number of Valid Data	51	Number of Detected Data	19
Number of Distinct Detected Data	9	Number of Non-Detect Data	32
		Percent Non-Detects	62.75%
Raw Statistics		Log-transformed Statistics	
Minimum Detected	12	Minimum Detected	2.485
Maximum Detected	33	Maximum Detected	3.497
Mean of Detected	19.21	Mean of Detected	2.923
SD of Detected	5.127	SD of Detected	0.261
Minimum Non-Detect	12	Minimum Non-Detect	2.485
Maximum Non-Detect	17	Maximum Non-Detect	2.833

Note: Data have multiple DLs - Use of KM Method is recommended
For all methods (except KM, DL/2, and ROS Methods),
Observations < Largest ND are treated as NDs

Number treated as Non-Detect	36
Number treated as Detected	15
Single DL Non-Detect Percentage	70.59%

UCL Statistics		Lognormal Distribution Test with Detected Values Only	
Normal Distribution Test with Detected Values Only		Shapiro Wilk Test Statistic	0.913
Shapiro Wilk Test Statistic	0.884	5% Shapiro Wilk Critical Value	0.901
5% Shapiro Wilk Critical Value	0.901		
Data not Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	12	Mean	2.364
SD	6.466	SD	0.48
95% DL/2 (t) UCL	13.52	95% H-Stat (DL/2) UCL	13.54
Maximum Likelihood Estimate(MLE) Method		Log ROS Method	
Mean	13.05	Mean in Log Scale	2.483
SD	6.928	SD in Log Scale	0.438

Table B-5. 600 Area Subregion General UCL Statistics for Data Sets with Non-Detects

95% MLE (t) UCL	14.68	Mean in Original Scale	13.17
95% MLE (Tiku) UCL	15.95	SD in Original Scale	5.981
		95% t UCL	14.57
		95% Percentile Bootstrap UCL	14.58
		95% BCA Bootstrap UCL	14.63
Gamma Distribution Test with Detected Values Only		Data Distribution Test with Detected Values Only	
k star (bias corrected)	13.22	Data appear Lognormal at 5% Significance Level	
Theta Star	1.453		
nu star	502.4		
A-D Test Statistic	0.792	Nonparametric Statistics	
5% A-D Critical Value	0.741	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.741	Mean	14.78
5% K-S Critical Value	0.198	SD	4.605
		SE of Mean	0.673
		95% KM (t) UCL	15.91
		95% KM (z) UCL	15.89
		95% KM (jackknife) UCL	15.89
		95% KM (bootstrap t) UCL	16.06
		95% KM (BCA) UCL	16.75
		95% KM (Percentile Bootstrap) UCL	16.53
		95% KM (Chebyshev) UCL	17.71
		97.5% KM (Chebyshev) UCL	18.98
		99% KM (Chebyshev) UCL	21.47
Data not Gamma Distributed at 5% Significance Level			
Assuming Gamma Distribution			
Gamma ROS Statistics using Extrapolated Data			
Minimum	12		
Maximum	33		
Mean	19.23		
Median	19.25		
SD	3.078		
k star	39.27		
Theta star	0.49		
Nu star	4005		
AppChi2	3859		
95% Gamma Approximate UCL	19.96		
95% Adjusted Gamma UCL	19.98		
		Potential UCLs to Use	
		95% KM (t) UCL	15.91
		95% KM (% Bootstrap) UCL	16.53

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006). For additional insight, the user may want to consult a statistician.

Zinc

General Statistics			
Number of Valid Data	51	Number of Detected Data	24
Number of Distinct Detected Data	18	Number of Non-Detect Data	27
		Percent Non-Detects	52.94%
Raw Statistics		Log-transformed Statistics	
Minimum Detected	4	Minimum Detected	1.386
Maximum Detected	71	Maximum Detected	4.263
Mean of Detected	20.88	Mean of Detected	2.552
SD of Detected	21.7	SD of Detected	0.992
Minimum Non-Detect	4	Minimum Non-Detect	1.386
Maximum Non-Detect	6	Maximum Non-Detect	1.792

Note: Data have multiple DLs - Use of KM Method is recommended for all methods (except KM, DL/2, and ROS Methods), Observations < Largest ND are treated as NDs

Number treated as Non-Detect	33
Number treated as Detected	18
Single DL Non-Detect Percentage	64.71%

Table B-5. 600 Area Subregion General UCL Statistics for Data Sets with Non-Detects

		UCL Statistics				
Normal Distribution Test with Detected Values Only				Lognormal Distribution Test with Detected Values Only		
	Shapiro Wilk Test Statistic	0.761			Shapiro Wilk Test Statistic	0.896
	5% Shapiro Wilk Critical Value	0.916			5% Shapiro Wilk Critical Value	0.916
Data not Normal at 5% Significance Level				Data not Lognormal at 5% Significance Level		
Assuming Normal Distribution				Assuming Lognormal Distribution		
	DL/2 Substitution Method				DL/2 Substitution Method	
	Mean	11.12			Mean	1.663
	SD	17.41			SD	1.091
	95% DL/2 (t) UCL	15.2			95% H-Stat (DL/2) UCL	13.87
	Maximum Likelihood Estimate(MLE) Method	N/A			Log ROS Method	
MLE yields a negative mean					Mean in Log Scale	1.193
					SD in Log Scale	1.61
					Mean in Original Scale	10.58
					SD in Original Scale	17.7
					95% t UCL	14.73
					95% Percentile Bootstrap UCL	14.78
					95% BCA Bootstrap UCL	15.31
Gamma Distribution Test with Detected Values Only				Data Distribution Test with Detected Values Only		
	k star (bias corrected)	1.048		Data Follow Appr. Gamma Distribution at 5% Significance Level		
	Theta Star	19.92				
	nu star	50.3				
	A-D Test Statistic	1.248		Nonparametric Statistics		
	5% A-D Critical Value	0.768			Kaplan-Meier (KM) Method	
	K-S Test Statistic	0.768			Mean	11.96
	5% K-S Critical Value	0.182			SD	16.82
Data follow Appr. Gamma Distribution at 5% Significance Level					SE of Mean	2.406
Assuming Gamma Distribution					95% KM (t) UCL	16
	Gamma ROS Statistics using Extrapolated Data				95% KM (z) UCL	15.92
	Minimum	4			95% KM (jackknife) UCL	15.95
	Maximum	71			95% KM (bootstrap t) UCL	17.26
	Mean	20.69			95% KM (BCA) UCL	16.33
	Median	18.99			95% KM (Percentile Bootstrap) UCL	16.35
	SD	14.82			95% KM (Chebyshev) UCL	22.45
	k star	2.179			97.5% KM (Chebyshev) UCL	26.99
	Theta star	9.493			99% KM (Chebyshev) UCL	35.9
	Nu star	222.3		Potential UCLs to Use		
	AppChi2	188.8			95% KM (t) UCL	16
	95% Gamma Approximate UCL	24.36				
	95% Adjusted Gamma UCL	24.48				

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006). For additional insight, the user may want to consult a statistician.

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Native American Risk Assessment for the 300 Area Subregion of the 300-FF-5 Groundwater Operable Unit

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

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Native American Risk Assessment for the 300 Area Subregion of the 300-FF-5 Groundwater Operable Unit

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Assistant Secretary for Environmental Management

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**P.O. Box 1600
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Release Approval

Date

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Draft A

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Terms

ATSDR	Agency for Toxic Substances and Disease Registry
CalEPA	California Environmental Protection Agency
CDI	chronic daily intake
COPC	contaminant of potential concern
CTUIR	Confederated Tribes of the Umatilla Indian Reservation
DA _{event}	Dermally absorbed dose per event
DOE	U.S. Department of Energy
ECF	Environmental Calculation File
ELCR	excess lifetime cancer risk
EPA	Environmental Protection Agency
EPC	exposure point concentration
GIABS	gastrointestinal absorption factor
HEAST	Health Effects Assessment Summary Tables
HEIS	Hanford Environmental Information System
HI	hazard index
HQ	hazard quotient
IRIS	Integrated Risk Information System
IUR	inhalation unit risk
MCL	maximum contaminant level
MRL	minimal risk level
NCEA	National Center for Environmental Assessment
NJDEP	New Jersey Department of Environmental Protection
OEHHA	Office of Environmental Health Hazard Assessment (CalEPA)
ORIA	Office of Radiation and Indoor Air
ORNL	Oak Ridge National Laboratory
OSWER	Office of Solid Waste and Emergency Response (EPA)
OU	Operable Unit
pCi	picocurie

PPRTV	Provisional Peer Reviewed Toxicity Values
RAGS	Risk Assessment Guidance for Superfund
RAIS	Risk Assessment Information System
RfC	reference concentration
RfD	reference dose
RME	reasonable maximum exposure
MRL	Minimal Risk Levels
STSC	superfund health risk technical support center
SF	slope factor
VF	volatilization factor

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1 Purpose

The purpose of this environmental calculation is to document the calculation of potential human health risks and hazards associated with exposure to contaminants in the 300 Area subregion of the 300-FF-5 Groundwater Operable Unit (OU) (hereafter referred to simply as the 300 Area subregion) for two Native American exposure scenarios. Exposure is evaluated assuming a hypothetical failure of current administrative controls, such that tribal use of groundwater from the 300 Area subregion becomes possible. Cancer risks and non-cancer hazards are calculated based on current groundwater conditions for both radioactive and nonradioactive contaminants of potential concern (COPCs). For purposes of this calculation, any analyte detected at least once in groundwater at the 300 Area subregion is included in the exposure and risk calculations as a COPC. Potential health risks are calculated for ingestion, inhalation, and dermal exposure routes from use of groundwater as a domestic drinking water source and from use as a source of steam in a sweat lodge. The results of all exposure routes are summed to calculate total excess lifetime cancer risk (ELCR) and hazard index (HI). This evaluation supports DOE/RL-2010-99, *Remedial Investigation/Feasibility Study for the 300-FF-1, 300-FF-2, and 300-FF-5 Operable Units*.

2 Background

Several local and regional tribes have ancestral ties to the Hanford Reach of the Columbia River, and the U.S. Department of Energy (DOE) has requested that each tribe provide an exposure scenario that reflects their traditional activities. The Confederated Tribes of the Umatilla Indian Reservation (CTUIR) and the Yakama Nation have provided scenarios.

For purposes of this environmental calculation, adult and child members of the CTUIR and the Yakama Nation are assumed to use groundwater from the 300 Area subregion as a drinking water source (i.e., domestic supply) and to make steam in a sweat lodge (adult tribal members only) as a part of their traditional lifeways.

Use of groundwater to irrigate crops and water livestock is not evaluated because those exposure pathways, although potentially complete, are considered insignificant and secondary to the drinking water and sweat lodge exposure pathways. Such food-chain and leaching exposure pathways are evaluated separately in the preliminary remediation goal (PRG) calculations provided in DOE/RL-2010-99, because the RESRAD model (ANL 2009, *RESRAD*, Version 6.5) used to estimate exposures considers these pathways. Contact with contaminated drill cuttings is not addressed; only the drinking water and sweat lodge exposure pathways are relevant to the Native American exposure scenarios.

2.1 Carcinogenic Effects

The potential for carcinogenic effects is evaluated by estimating the incremental increase in the probability of developing cancer over a lifetime (excess lifetime cancer risk [ELCR]), above the background probability of developing cancer (that is, if no exposure to site contaminants occurs). Cancer slope factors developed by the EPA are considered to be plausible upper bound estimates of the cancer potencies of contaminants. Using these cancer slope factors in calculating risks results in plausible, upper-bound estimates of risk; there is reasonable confidence that the actual cancer risks will not exceed the estimated risks and may actually be lower (EPA/540/1-89/002, *Risk Assessment Guidance for Superfund Volume I Human Health Evaluation Manual (Part A): Interim Final*). The following equations are used to estimate cancer risk for non-radionuclides and radionuclides:

For nonradionuclides:

$$Risk = CDI \times SF \quad (1)$$

where:

Risk	=	Excess lifetime cancer risk (unitless probability)
CDI	=	Chronic daily intake, averaged over a lifetime (mg/kg-day)
SF	=	Cancer slope factor (mg/kg-day) ⁻¹

For radionuclides:

$$Risk = Intake \times SF \quad (2)$$

where:

Risk	=	Excess lifetime cancer risk (unitless probability)
Intake	=	Activity (pCi)
SF	=	Cancer slope factor (pCi) ⁻¹

For cases with high ELCR values, defined as an ELCR greater than 0.01, the following “one-hit” cancer risk equation from EPA RAGS Part A guidance (EPA/540/1-89/002) is used.

$$Risk = 1 - \exp(- CDI \times SF) \quad (3)$$

where:

Risk	=	Excess lifetime cancer risk (unitless probability)
CDI	=	Chronic daily intake, averaged over a lifetime (mg/kg-day) or (pCi)
SF	=	Cancer slope factor (mg/kg-day) ⁻¹ or (pCi) ⁻¹

Although synergistic or antagonistic interactions might occur between cancer-causing contaminants and other contaminants, information is generally lacking in the toxicological literature to predict quantitatively the effects of these potential interactions. Therefore, in this evaluation, cancer risks are treated as independent, and additive within an exposure route. This is consistent with the EPA guidelines on chemical mixtures presented in EPA/630/P-03/001F, *Guidelines for Carcinogen Risk Assessment*.

EPA considers external radiation to be a significant exposure route for radionuclides only in soil (EPA/540/1-89/002); external radiation from radionuclides in water is considered insignificant, due to the radiation shielding effect of the water. Therefore, EPA does not publish radionuclide cancer slope factors to quantify cancer risk from external or dermal exposure to radionuclides in water. Because this evaluation assesses risks associated with radionuclides only in water, radionuclide cancer risk is calculated only for the ingestion and inhalation exposure routes.

2.2 Noncarcinogenic Effects

For noncancer effects, the likelihood that a receptor will develop an adverse effect is estimated by comparing the predicted level of exposure for a particular contaminant with the highest level of exposure that is considered protective (that is, its reference dose [RfD]). The ratio of the chronic daily intake (CDI) divided by the RfD is termed the hazard quotient (HQ):

$$HQ = \frac{\text{Chemical Intake (mg/kg - day)}}{\text{RfD (mg/kg - day)}} \quad (4)$$

When the HQ for a contaminant exceeds 1 (that is, exposure exceeds the RfD), there is a concern for potential noncancer health effects. To assess the potential for noncancer effects posed by exposure to multiple contaminants, a hazard index (HI) approach is used, in accordance with EPA guidance (EPA/540/1-89/002). This approach assumes that the noncancer hazards associated with exposure to multiple contaminants are simply additive; synergistic or antagonistic interactions between contaminants, which are largely unknown, are not accounted for.

2.3 Exposure Routes

Potentially complete exposure routes for adult and child tribal members associated with using groundwater as a domestic drinking water supply are:

- Ingestion of drinking water,
- Inhalation of volatiles when showering and using drinking water for other domestic purposes, and
- Dermal exposure from showering and using drinking water for other domestic purposes (e.g., washing dishes).

Potentially complete exposure routes for adult tribal members associated with using groundwater in a sweat lodge are:

- Inhalation of volatiles, semi-volatiles, and aerosolized non-volatiles, while spending time in a sweat lodge, and
- Dermal contact with vapors and condensed liquid, while spending time in a sweat lodge.

2.4 References

For the drinking water exposure pathway, contaminant intake is quantified using standard EPA equations and procedures, as specified in the following references:

- EPA/540/1-89/002, *Risk Assessment Guidance for Superfund: Volume 1—Human Health Evaluation Manual, Part A, Interim Final*;
- EPA/540/R-92/003, *Risk Assessment Guidance for Superfund: Volume I – Human Health Evaluation Manual (Part B, Development of Risk-based Preliminary Remediation Goals): Interim*;
- EPA/540/R/99/005, *Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment), Final*;
- EPA-540-R-070-002, *Risk Assessment Guidance for Superfund: Volume 1: Human Health Evaluation Manual (Part F, Supplemental Guidance for Inhalation Risk Assessment), Final*.
- ORNL, 2010, The Risk Assessment Information System (RAIS) (<http://rais.ornl.gov/>)
 - RAIS Risk Exposure Models for Chemicals User's Guide (http://rais.ornl.gov/tools/rais_chemical_risk_guide.html)

- RAIS Risk Exposure Models for Radionuclides User's Guide (http://rais.ornl.gov/tools/rais_rad_risk_guide.html)

For the sweat lodge exposure pathway, contaminant intake is quantified based on standard EPA methods, coupled with the sweat lodge steam model provided in:

- Harris and Harper, 2004, *Exposure Scenario for CTUIR Traditional Subsistence Lifeways*.

The CTUIR and Yakama Nation provided many of the exposure factors necessary to quantify contaminant intake in the following references. Those values are used preferentially, rather than EPA residential default values. Where tribal-specific factors are not provided, EPA defaults are used (EPA/540/R-92/003).

- Harris and Harper, 2004, *Exposure Scenario for CTUIR Traditional Subsistence Lifeways*;
- Harris, 2008, *Application of the CTUIR Traditional Lifeways Exposure Scenario in Hanford Risk Assessments*; and
- Ridolfi, 2007, *Yakama Nation Exposure Scenario for Hanford Site Risk Assessment*.

3 Methodology

This section provides the equations (and their bases) used to calculate the cancer risks and noncancer hazards associated with exposure to the 300 Area subregion COPCs via the exposure routes associated with the drinking water and sweat lodge exposure pathways.

3.1 Drinking Water Exposure Pathway

Definitions of the variables and input values for the drinking water exposure pathway equations are provided in Table 3-1 for the CTUIR exposure scenario, and in Table 3-2 for the Yakama Nation exposure scenario.

3.1.1 Intake and Risk Equations for Drinking Water Ingestion

The bases for the equations used to calculate intake, risk, and hazard associated with the drinking water ingestion exposure route are summarized in Table 3-3. Equations are provided in the following subsections.

Table 3-3. Calculated Values and Reference Bases Used for the Drinking Water Ingestion Exposure Route

Effect	Symbol for Calculated Value	Reference
Carcinogenic	CDI IRW _{adj}	RAIS Risk Exposure Models for Chemicals User's Guide (ORNL, 2010)
	Risk	EPA/540/R-92/003
Noncarcinogenic	CDI	RAIS Risk Exposure Models for Chemicals User's Guide (ORNL, 2010)
	HQ	EPA/540/R-92/003
Radionuclide	CDI IRW_RAD _{adj}	RAIS Risk Exposure Models for Radionuclides User's Guide (ORNL, 2010)
	Risk	EPA/540/R-92/003

Table 3-3. Calculated Values and Reference Bases Used for the Drinking Water Ingestion Exposure Route

Effect	Symbol for Calculated Value	Reference
<p>Notes:</p> <p>CDI= chronic daily intake</p> <p>HQ= hazard quotient</p> <p>IRW_{adj} = age-adjusted water ingestion rate.</p> <p>IRW_RAD_{adj} = age-adjusted water ingestion rate for radionuclides.</p> <p>EPA/540/R-92/003, <i>Risk Assessment Guidance for Superfund: Volume I – Human Health Evaluation Manual (Part B, Development of Risk-based Preliminary Remediation Goals): Interim.</i></p> <p>ORNL, 2010, The Risk Assessment Information System (RAIS).</p>		

Table 3-1. Summary of Exposure Assumptions for the Drinking Water Exposure Pathway for the CTUIR Exposure Scenario in the 300 Area Subregion of the 300-FF-5 Groundwater Operable Unit. (3 Pages)

Exposure Factor	Symbol	Value	Units	Source
Averaging Time – carcinogens and noncarcinogens	AT	70	years	Harris, 2008
Partitioning Constant Derived by Bunge Model	B	COPC-specific	unitless	See Table 4-2
Body Weight - adult	BW _a	70	kg	Harris and Harper, 2004
Body Weight - child	BW _c	15	kg	Harris and Harper, 2004
Conversion Factor	CF1	365	days/year	1 year = 365 days
Conversion Factor	CF2	1/24	days/ hour	1 day = 24 hours
Conversion Factor	CF3	0.001	L/cm ³	1 L = 1,000 cm ³
Cancer Slope Factor - oral	CSF _o	COPC-specific	(mg/kg-day) ⁻¹	See Table 4-2
Chronic Daily Intake – carcinogenic ingestion	CDI	Calculated value	mg/kg-day	Equation 5
Chronic Daily Intake – noncarcinogenic ingestion	CDI	Calculated value	mg/kg-day	Equation 8
Chronic Daily Intake – radiological ingestion	CDI	Calculated value	pCi	Equation 10
Chronic Daily Intake – carcinogen inhalation	CDI	Calculated value	µg/m ³	Equation 13
Chronic Daily Intake – noncarcinogenic inhalation	CDI	Calculated value	mg/m ³	Equation 15
Chronic Daily Intake – radiological inhalation	CDI	Calculated value	pCi	Equation 17
Chronic Daily Intake – carcinogenic dermal	CDI	Calculated value	mg/kg-day	Equation 21
Chronic Daily Intake – noncarcinogenic dermal	CDI	Calculated value	mg/kg-day	Equation 24
Contaminant concentration in groundwater	C _w	COPC-specific	mg/L or pCi/L	ECF-300FF5-11-0130
Absorbed dose per event	DA _{event}	Calculated value	mg/cm ² -event	Equation 27, 28, and 29
Exposure Duration - adult	ED _a	70	Years	Harris and Harper, 2004
Exposure Duration - child	ED _c	6	Years	Harris, 2008
Exposure Frequency	EF	365	days/year	Harris and Harper, 2004

Table 3-1. Summary of Exposure Assumptions for the Drinking Water Exposure Pathway for the CTUIR Exposure Scenario in the 300 Area Subregion of the 300-FF-5 Groundwater Operable Unit. (3 Pages)

Exposure Factor	Symbol	Value	Units	Source
Exposure Time - adult	ET _a	0.58	hours/day or hours/event	EPA/540/R/99/005
Exposure Time - child	ET _c	1	hours/day or hours/event	EPA/540/R/99/005
Age-Adjusted Exposure Time	ET _{adj}	0.616	hours/day	Equation 19
			hours/event	Equation 26
Event Frequency - adult	EV _a	1	event/day	EPA/540/R/99/005
Event Frequency - child	EV _c	1	event/day	EPA/540/R/99/005
Fraction of absorbed water	FA	COPC-specific	unitless	See Table 4-2
Gastrointestinal Absorption Factor	GIABS	COPC-specific	unitless	See Table 4-2
Inhalation Rate - adult	INH _a	25	m ³ /day	Harris, 2008
Inhalation Rate - child	INH _c	15	m ³ /day	Harris, 2008
Age-Adjusted Inhalation Rate - radiological	INH_RAD _{adj}	1,690	m ³ -year/day	Equation 18
Water Ingestion Rate - adult	IRW _a	4	L/day	Harris, 2008
Water Ingestion Rate - child	IRW _c	1	L/day	Harris and Harper, 2004
Age-adjusted Water Ingestion Rate – nonradiological	IRW _{adj}	4.057	L-year/kg-day	Equation 6
Age-adjusted Water Ingestion Rate – radiological	IRW_RAD _{adj}	262	L-year/day	Equation 11
Inhalation Unit Risk	IUR	COPC-specific	(µg/m ³) ⁻¹	See Table 4-2
Dermal permeability coefficient	K _p	COPC-specific	cm/hour	See Table 4-2
The constant pi	π	3.14159	unitless	--
Reference Concentration	RFC	COPC-specific	mg/m ³	See Table 4-2
Reference Dose - oral	RFD _o	COPC-specific	mg/kg-day	See Table 4-2

Table 3-1. Summary of Exposure Assumptions for the Drinking Water Exposure Pathway for the CTUIR Exposure Scenario in the 300 Area Subregion of the 300-FF-5 Groundwater Operable Unit. (3 Pages)

Exposure Factor	Symbol	Value	Units	Source
Age-adjusted skin surface area	SA _{adj}	19,097	cm ² -year/kg-day	Equation 22
Skin Surface Area - adult	SA _a	18,000	cm ²	EPA/540/R/99/005
Skin Surface Area - child	SA _c	6,600	cm ²	EPA/540/R/99/005
Slope Factor - inhalation	SF _i	COPC-specific	Risk/pCi	See Table 4-2
Slope Factor - oral	SF _o	COPC-specific	Risk/pCi	See Table 4-2
Time to reach steady state conditions	t*	COPC-specific	Hours	See Table 4-2
Lag time	τ	COPC-specific	hours/event	See Table 4-2
Volatilization Factor	VF	0.5	L/m ³	EPA/540/R-92/003

Notes:

ECF-300FF5-11-0130, *Calculation of Exposure Point Concentrations for the 300 Area Subregion of the 300-FF-5 Groundwater Operable Unit.*

EPA/540/R-92/003, *Risk Assessment Guidance for Superfund: Volume I - Human Health Evaluation Manual (Part B, Development of Risk-based Preliminary Remediation Goals): Interim.*

EPA/540/R/99/005, *Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment).*

Harris and Harper, 2004, *Exposure Scenario for CTUIR Traditional Subsistence Lifeways.*

Harris, 2008, *Application of the CTUIR Traditional Lifeways Exposure Scenario in Hanford Risk Assessments.*

Table 3-2. Summary of Exposure Assumptions Used for the Drinking Water Exposure Pathway for the Yakama Nation Exposure Scenario in the 300 Area Subregion of the 300-FF-5 Groundwater Operable Unit. (3 Pages)

Exposure Factor	Symbol	Value	Units	Source
Averaging Time – carcinogens and noncarcinogens	AT	70	Year	Ridolfi, 2007
Partitioning constant Derived by Bunge Model	B	COPC-specific	unitless	See Table 4-2
Body Weight - adult	BW _a	70	Kg	Ridolfi, 2007
Body Weight - child	BW _c	16	Kg	Ridolfi, 2007
Conversion Factor	CF1	365	days/year	1 year = 365 days
Conversion Factor	CF2	1/24	days/hour	1 day = 24 hours
Conversion Factor	CF3	0.001	L/cm ³	1 L = 1,000 cm ³
Cancer Slope Factor - oral	CSF _o	COPC-specific	(mg/kg-day) ⁻¹	See Table 4-2
Chronic Daily Intake – carcinogenic ingestion	CDI	Calculated value	mg/kg-day	Equation 5
Chronic Daily Intake – noncarcinogenic ingestion	CDI	Calculated value	mg/kg-day	Equation 8
Chronic Daily Intake – radiological ingestion	CDI	Calculated value	pCi	Equation 10
Chronic Daily Intake – carcinogenic inhalation	CDI	Calculated value	µg/m ³	Equation 13
Chronic Daily Intake – noncarcinogenic inhalation	CDI	Calculated value	mg/m ³	Equation 15
Chronic Daily Intake – radiological inhalation	CDI	Calculated value	pCi	Equation 17
Chronic Daily Intake – carcinogenic dermal	CDI	Calculated value	mg/kg-day	Equation 21
Chronic Daily Intake – noncarcinogenic dermal	CDI	Calculated value	mg/kg-day	Equation 24
Contaminant concentration in groundwater	C _w	COPC-specific	mg/L or pCi/L	ECF-300FF5-11-0130
Absorbed Dose per Event	DA _{event}	Calculated value	mg/cm ² -event	Equations 27, 28, and 29
Exposure Duration - adult	ED _a	70	Year	Ridolfi, 2007
Exposure Duration - child	ED _c	6	Year	Ridolfi, 2007
Exposure Frequency	EF	365	days/year	Ridolfi, 2007

Table 3-2. Summary of Exposure Assumptions Used for the Drinking Water Exposure Pathway for the Yakama Nation Exposure Scenario in the 300 Area Subregion of the 300-FF-5 Groundwater Operable Unit. (3 Pages)

Exposure Factor	Symbol	Value	Units	Source
Exposure Time - adult	ET _a	0.58	hours/day or hours/event	EPA/540/R/99/005
Exposure Time - child	ET _c	1	hours/day or hours/event	EPA/540/R/99/005
Age-Adjusted Exposure Time	ET _{adj}	0.616	hours/day	Equation 19
			hours/event	Equation 26
Event Frequency - adult	EV _a	1	event/day	EPA/540/R/99/005
Event Frequency - child	EV _c	1	event/day	EPA/540/R/99/005
Fraction of absorbed water	FA	COPC-specific	unitless	See Table 4-2
Gastrointestinal Absorption Factor	GIABS	COPC-specific	unitless	See Table 4-2
Age-Adjusted Inhalation Rate - radiological	INH_RAD _{adj}	1,760	m ³ -year/day	Equation 18
Inhalation Rate - adult	INH _a	26	m ³ /day	Ridolfi, 2007
Inhalation Rate - child	INH _c	16	m ³ /day	Ridolfi, 2007
Water Ingestion Rate - adult	IRW _a	4	L/day	Ridolfi, 2007
Water Ingestion Rate - child	IRW _c	2	L/day	Ridolfi, 2007
Age-adjusted Water Ingestion Rate – nonradiological	IRW _{adj}	4.407	L-year/kg-day	Equation 6
Age-adjusted Water Ingestion Rate – radiological	IRW_RAD _{adj}	262	L-year/day	Equation 11
Inhalation Unit Risk	IUR	COPC-specific	(µg/m ³) ⁻¹	See Table 4-2
Dermal permeability coefficient	K _p	COPC-specific	cm/hour	See Table 4-2
The constant pi	π	3.14159	unitless	--
Reference Concentration	RFC	COPC-specific	mg/m ³	See Table 4-2
Reference Dose - oral	RFD _o	COPC-specific	mg/kg-day	See Table 4-2

Table 3-2. Summary of Exposure Assumptions Used for the Drinking Water Exposure Pathway for the Yakama Nation Exposure Scenario in the 300 Area Subregion of the 300-FF-5 Groundwater Operable Unit. (3 Pages)

Exposure Factor	Symbol	Value	Units	Source
Age-adjusted skin surface area	SA _{adj}	18,932	cm ² -year/kg-day	Equation 22
Skin Surface Area - adult	SA _a	18,000	cm ²	EPA/540/R/99/005
Skin Surface Area - child	SA _c	6,600	cm ²	EPA/540/R/99/005
Slope Factor - inhalation	SF _i	COPC-specific	Risk/pCi	See Table 4-2
Slope Factor - oral	SF _o	COPC-specific	Risk/pCi	See Table 4-2
Time to reach steady state conditions	t*	COPC-specific	Hours	See Table 4-2
Lag time	τ	COPC-specific	hours/event	See Table 4-2
Volatilization Factor	VF	0.5	L/m ³	EPA/540/R-92/003

Notes:

ECF-300FF5-11-0130, *Calculation of Exposure Point Concentrations for the 300 Area Subregion of the 300-FF-5 Groundwater Operable Unit.*

EPA/540/R-92/003, *Risk Assessment Guidance for Superfund: Volume I - Human Health Evaluation Manual (Part B, Development of Risk-based Preliminary Remediation Goals): Interim.*

EPA/540/R/99/005, *Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment).*

Ridolfi, 2007, *Yakama Nation Exposure Scenario for Hanford Site Risk Assessment.*

3.1.1.1 Drinking Water Ingestion—Carcinogenic Effects

For ingestion of carcinogens, the chronic daily intake (CDI) is calculated using the following equations:

$$CDI = \frac{C_w \times IRW_{adj} \times EF}{AT \times CF1} \quad (5)$$

where:

$$IRW_{adj} = \frac{ED_c \times IRW_c}{BW_c} + \frac{(ED_a - ED_c) \times IRW_a}{BW_a} \quad (6)$$

Cancer risk is calculated using the following equation:

$$RISK = CDI \times CSF_o \quad (7)$$

3.1.1.2 Drinking Water Ingestion—Noncarcinogenic Effects

For ingestion of noncarcinogens, the CDI is calculated using the following equation:

$$CDI = \frac{C_w \times IRW_a \times EF \times ED_a}{BW_a \times AT \times CF1} \quad (8)$$

Noncancer hazard is calculated using the following equation:

$$HQ = \frac{CDI}{RfD_o} \quad (9)$$

3.1.1.3 Drinking Water Ingestion—Radionuclides

For ingestion of radionuclides, the CDI is calculated using the following equations:

$$CDI = C_w \times IRW_{RAD_{adj}} \times EF \quad (10)$$

where:

$$IRW_{RAD_{adj}} = (ED_c \times IRW_c) + ([ED_a - ED_c] \times IRW_a) \quad (11)$$

Radiological cancer risk is calculated using the following equation:

$$RISK = CDI \times SF_o \quad (12)$$

3.1.2 Intake and Risk Equations for Drinking Water Inhalation (Volatiles Only)

The bases for the equations used to calculate intake, risk, and hazard associated with inhalation of volatiles in drinking water are summarized in Table 3-4. Equations are provided in the following subsections.

Table 3-4. Calculated Values and Reference Bases Used for the Drinking Water Inhalation of Volatiles Exposure Route

Effect	Symbol for Calculated Value	Reference
Carcinogenic	CDI	RAIS Risk Exposure Models for Chemicals User's Guide (ORNL, 2010)
	Risk	EPA-540-R-070-002
Noncarcinogenic	CDI	RAIS Risk Exposure Models for Chemicals User's Guide (ORNL, 2010)
	HQ	EPA-540-R-070-002
Radionuclide	CDI INH_RAD _{adj}	RAIS Risk Exposure Models for Radionuclides User's Guide (ORNL, 2010)
	ET _{adj}	EPA-540-R-070-002 and EPA/540/R/99/005
	Risk	EPA/540/R-92/003

Notes:

CDI= chronic daily intake.

ET_{adj} = age-adjusted exposure time.

HQ = hazard quotient.

INH_RAD_{adj} = age-adjusted radionuclide inhalation rate.EPA-540-R-070-002, *Risk Assessment Guidance for Superfund: Volume 1—Human Health Evaluation Manual (Part F, Supplemental Guidance for Inhalation Risk Assessment)*.EPA/540/R-92/003, *Risk Assessment Guidance for Superfund: Volume I – Human Health Evaluation Manual (Part B, Development of Risk-based Preliminary Remediation Goals): Interim*.EPA/540/R/99/005, *Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment): Final*.

ORNL, 2010, The Risk Assessment Information System (RAIS).

3.1.2.1 Drinking Water Inhalation of Volatiles—Carcinogenic Effects

For inhalation of carcinogens, the CDI is calculated using the following equation:

$$CDI = \frac{C_w \times ED_a \times EF \times ET_a \times CF_2 \times VF \times \left(1000 \frac{\mu g}{mg}\right)}{AT \times CF_1} \quad (13)$$

Cancer risk is calculated using the following equation:

$$RISK = CDI \times IUR \quad (14)$$

3.1.2.2 Drinking Water Inhalation of Volatiles—Noncarcinogenic Effects

For inhalation of noncarcinogens, the CDI is calculated using the following equation:

$$CDI = \frac{C_w \times ED_a \times EF \times ET_a \times CF_2 \times VF}{AT \times CF_1} \quad (15)$$

Noncancer hazard is calculated using the following equation:

$$HQ = \frac{CDI}{RfC} \quad (16)$$

3.1.2.3 Drinking Water Inhalation of Volatiles—Radionuclides

For inhalation of radionuclides, the CDI is calculated using the following equations:

$$CDI = C_w \times INH_RAD_{adj} \times VF \times EF \times ET_{adj} \times CF_2 \quad (17)$$

where:

$$INH_RAD_{adj} = (ED_c \times INH_c) + ((ED_a - ED_c) \times INH_a) \quad (18)$$

and:

$$ET_{adj} = \frac{(ET_c \times ED_c) + ((ED_a - ED_c) \times ET_a)}{ED_a} \quad (19)$$

Radiological cancer risk is calculated using the following equation:

$$RISK = CDI \times SF_i \quad (20)$$

3.1.3 Intake and Risk Equations for Drinking Water Dermal Absorption

The bases for the equations used to calculate intake, risk, and hazard associated with the drinking water dermal absorption exposure route are provided in Table 3-5. The equations are presented in the following subsections.

Table 3-5. Calculated Values and Reference Bases Used for the Drinking Water Dermal Exposure Route

Effect	Symbol for Calculated Value	Reference
Carcinogenic	CDI	EPA/540/R/99/005
	SA _{adj}	EPA/540/R/99/005
	ET _{adj}	EPA/540/R/99/005
	DA _{event}	EPA/540/R/99/005
	Risk	EPA/540/R/99/005
Noncarcinogenic	CDI	EPA/540/R/99/005
	DA _{event}	EPA/540/R/99/005
	HQ	EPA/540/R/99/005
Radionuclide	Not applicable	

Table 3-5. Calculated Values and Reference Bases Used for the Drinking Water Dermal Exposure Route

Effect	Symbol for Calculated Value	Reference
Notes:		
CDI= chronic daily intake.		
DA _{event} = absorbed dose per event.		
ET _{adj} = age-adjusted exposure time.		
HQ = hazard quotient.		
SA _{adj} = age-adjusted skin surface area.		
EPA/540/R/99/005, <i>Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual Part E, Supplemental Guidance for Dermal Risk Assessment</i>): Final.		

3.1.3.1 Drinking Water Dermal Absorption— Carcinogenic Effects

For dermal exposure to carcinogens, the CDI is calculated using the following equations:

$$CDI = \frac{DA_{event} \times SA_{adj} \times EF}{AT \times CF1} \quad (21)$$

where:

$$SA_{adj} = \frac{ED_c \times SA_c \times EV_c}{BW_c} + \frac{(ED_a - ED_c) \times SA_a \times EV_a}{BW_a} \quad (22)$$

Cancer risk is calculated using the following equation:

$$RISK = CDI \times \frac{CSF_o}{GIABS} \quad (23)$$

3.1.3.2 Drinking Water Dermal Absorption— Noncarcinogenic Effects

For dermal exposure to noncarcinogens, the CDI is calculated using the following equation:

$$CDI = \frac{DA_{event} \times SA_a \times EF \times ED_a \times EV}{BW_a \times AT \times CF1} \quad (24)$$

Noncancer hazard is calculated using the following equation:

$$HQ = \frac{CDI}{RfD_o \times GIABS} \quad (25)$$

3.1.3.3 Drinking Water Dermal Absorption— Event Time (Carcinogenic Effects and Noncarcinogenic Effects)

The event time used in the risk calculations is health effect-dependent. For noncarcinogens, the event time is not age-adjusted ($ET = ET_a$). For carcinogens, an age-adjusted event time is calculated using the following equation:

$$ET_{adj} = \frac{(ET_c \times ED_c) + ((ED_a - ED_c) \times ET_a)}{ED_a} \quad (26)$$

3.1.3.4 Drinking Water Dermal Absorption— Dermally Absorbed Dose (Carcinogenic Effects and Noncarcinogenic Effects)

For organics, the following equations are used to calculate the dermally absorbed dose per event (DA_{event}), using the adult exposure time for noncarcinogenic effects and the age-adjusted exposure time (as calculated above) for carcinogenic effects and:

If $ET \leq t^*$, then the following nonsteady-state equation is used:

$$DA_{event} = 2 \times FA \times K_p \times C_w \times CF3 \times \sqrt{\frac{6 \times \tau \times ET}{\pi}} \quad (27)$$

If $ET > t^*$, then the following pseudosteady-state equation is used:

$$DA_{event} = FA \times K_p \times C_w \times CF3 \times \left[\frac{ET}{1+B} + 2 \times \tau \times \left(\frac{1+3B+3B^2}{(1+B)^2} \right) \right] \quad (28)$$

Where $ET = ET_a$ or ET_{adj} , for noncarcinogenic and carcinogenic effects, respectively.

For inorganics, the following steady-state equation is used to estimate DA_{event} :

$$DA_{event} = K_p \times C_w \times ET \times CF3 \quad (29)$$

Where $ET = ET_a$ or ET_{adj} , for noncarcinogenic and carcinogenic effects, respectively.

3.1.3.5 Drinking Water Dermal Absorption— Radionuclides

Dermal exposure to radionuclides in drinking water is not evaluated. As noted, EPA does not publish radionuclide cancer slope factors to calculate cancer risk from external or dermal exposure to radioactive contaminants in water, due to the shielding effects of water.

3.2 Sweat Lodge Exposure Pathway

Exposure factors used to quantify contaminant intake from sweat lodge exposure are provided in Table 3-6 for the CTUIR exposure scenario and in Table 3-7 for the Yakama Nation exposure scenario. Sweat lodge exposure is evaluated for both the CTUIR and Yakama Nation scenarios (for adults only) based on an exposure frequency of 365 days/yr over a 68-year exposure duration (first 2 years of life excluded)¹. (Although the provided exposure scenarios indicate that childhood sweats occur, exposure assumptions are made for adults only.)

¹ Child exposure assumptions were not provided for the purpose of evaluating exposure through sweat lodge use; therefore, an adult exposure duration was assumed to be 68 years.

Table 3-6. Summary of Exposure Assumptions Used for the Sweat Lodge Exposure Pathway for CTUIR Exposure Scenario in the 300 Area Subregion of the 300-FF-5 Groundwater Operable Unit. (3 Pages)

Exposure Factor	Symbol	Value	Units	Source
Averaging Time – carcinogens ^a	AT	70	year	Harris and Harper, 2004
Averaging Time –noncarcinogens ^a	AT	68	year	Harris and Harper, 2004
Average Body Weight – adult	BW	70	kg	Harris and Harper, 2004
Conversion Factor	CF1	365	days/year	1 year = 365 days
Conversion Factor	CF2	0.01	m/cm	1 meter = 100 cm
Conversion Factor	CF3	10	L/m ² -cm	1 L = 0.01 m ² x 10 cm
Groundwater Concentration ^b	C _{dw}	COPC-specific	mg/L or pCi/L	ECF-300FF5-11-0130
Cancer Slope Factor - oral	CSF _o	COPC-specific	(mg/kg-day) ⁻¹	See Table 4-2
Cancer Slope Factor - inhalation	CSF _i	COPC-specific	(mg/kg-day) ⁻¹	See Table 4-2
Exposure Duration or Number of Years a Person Sweats in a Lifetime - adult	ED	68	year	Harris and Harper, 2004
Exposure Frequency or Number of Sweats per Year	EF	365	events/year	Harris and Harper, 2004
Length of Sweat Event – adult ^c	ET	1/24	days/event	Harris and Harper, 2004
Gastrointestinal Absorption Factor	GIABS	COPC-specific	unitless	See Table 4-2
Inhalation Intake of COPCs in Sweat Lodge— volatile and semi-volatile nonradionuclides	I _{inh}	Calculated value	mg/kg-day	Equation 30
Inhalation Intake of COPCs in Sweat Lodge— volatile and semi-volatile radionuclides	I _{inh}	Calculated value	pCi	Equation 33
Inhalation Intake of COPCs in Sweat Lodge— nonvolatile nonradionuclides	I _{inh}	Calculated value	mg/kg-day	Equation 35
Inhalation Intake of COPCs in Sweat Lodge— nonvolatile radionuclides	I _{inh}	Calculated value	pCi	Equation 38
Dermal Intake of COPCs in Sweat Lodge— volatile and semi-volatile vapor	I _{d,v} = I _{d,total}	Calculated value	mg/kg-day	Equation 40

Table 3-6. Summary of Exposure Assumptions Used for the Sweat Lodge Exposure Pathway for CTUIR Exposure Scenario in the 300 Area Subregion of the 300-FF-5 Groundwater Operable Unit. (3 Pages)

Exposure Factor	Symbol	Value	Units	Source
Dermal Intake of COPCs in Sweat Lodge— nonvolatile condensed liquid	$I_{d,l}$	Calculated value	mg/kg-day	Equation 43
Dermal Intake of COPCs in Sweat Lodge— nonvolatile vapor	$I_{d,v}$	Calculated value	mg/kg-day	Equation 44
Inhalation Rate - adult	IR	25	m ³ /day	Harris, 2008
Inhalation Unit Risk	IUR	COPC-specific	($\mu\text{g}/\text{m}^3$) ⁻¹	See Table 4-2
COPC-specific Permeability Coefficient	K_p	COPC-specific	cm/hour	See Table 4-2
Molecular Weight of Water	MW_w	18	g/gmole	Harris and Harper, 2004
Density of Liquid Water	ρ_w	1,000	g/L	Harris and Harper, 2004
The Constant pi	π	3.14159	unitless	--
Radius of Sweat Lodge	r	1	m	Harris and Harper, 2004
Ideal Gas Law Constant	R	0.06237	mmHg-m ³ /mole-K	Harris and Harper, 2004
Ideal Gas Law Constant ^d	R	62.37	mmHg-L/mole-K	Harris and Harper, 2004
Reference Concentration	RfC	COPC-specific	mg/m ³	See Table 4-2
Reference Dose - inhalation	RfD _i	COPC-specific	mg/kg-day	See Table 4-2
Reference Dose - oral	RfD _o	COPC-specific	mg/kg-day	See Table 4-2
Skin Surface Area - adult	SA	18,000	cm ²	Harris and Harper, 2004
Slope Factor - inhalation	SF _i	COPC-specific	Risk/pCi	See Table 4-2
Temperature of the Sweat Lodge ^e	T	340	K	Harris and Harper, 2004
Cumulative Volume of Water Used in Sweat	$V_{w,total}$	4	Liters	Harris and Harper, 2004

Table 3-6. Summary of Exposure Assumptions Used for the Sweat Lodge Exposure Pathway for CTUIR Exposure Scenario in the 300 Area Subregion of the 300-FF-5 Groundwater Operable Unit. (3 Pages)

Exposure Factor	Symbol	Value	Units	Source
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Notes:

- a. Averaging time of 1 year provided in Harris and Harper, 2004 was replaced with 70 years for carcinogens and 68 years for noncarcinogens to account for lifetime intake rather than annual intake.
- b. Harris and Harper (2004, Appendix 4) indicates water concentration (C_{dw}) is "dissolved surface water concentration of the COPC (mg/L); calculated according to EPA 1998a, Appendix B." However, for this evaluation COPC exposure point concentrations reflect total concentrations in groundwater.
- c. For sweat lodge inhalation exposure, exposure time of 1 hour provided in Harris and Harper, 2004 was replaced with 1/24 days/event so that intake values have appropriate units (mg/kg-day or pCi) when calculated using the inhalation equations provided in Harris and Harper (2004, Equations 7 and 15).
- d. For sweat lodge dermal exposure, the ideal gas law constant of 0.06237 mmHg-m³/gmole-K provided in Harris and Harper, 2004 was replaced with 62.37 mmHg-L/gmole-K so that intake values have appropriate units (mg/kg-day) when calculated using the equations provided in Harris and Harper (2004, Equations 15 and 20).
- e. Temperature of 389 K provided in Harris and Harper, 2004 was replaced with 340 K (150 °F) for consistency with stated assumption in Harris and Harper, 2004 that sweat lodge internal temperature is maintained at 150 °F.

CTUIR = Confederated Tribes of the Umatilla Indian Reservation

ECF-300FF5-11-0130, *Calculation of Exposure Point Concentrations for the 300 Area Subregion of the 300-FF-5 Groundwater Operable Unit.*

Harris and Harper, 2004, *Exposure Scenario for CTUIR Traditional Subsistence Lifeways.*

Harris, 2008, *Application of the CTUIR Traditional Lifeways Exposure Scenario in Hanford Risk Assessments.*

Table 3-7. Summary of Exposure Assumptions Used for the Sweat Lodge Exposure Pathway for Yakama Nation Exposure Scenario in the 300 Area Subregion of the 300-FF-5 Groundwater Operable Unit. (3 Pages)

Exposure Factor	Symbol	Value	Units	Source
Averaging Time – carcinogens ^a	AT	70	year	Harris and Harper, 2004
Averaging Time –noncarcinogens ^a	AT	68	year	Harris and Harper, 2004
Average Body Weight - adult	BW	70	kg	Harris and Harper, 2004
Conversion Factor	CF1	365	days/year	1 year = 365 days/year
Conversion Factor	CF2	0.01	m/cm	1 meter = 100 cm
Conversion Factor	CF3	10	L/m ² -cm	1 L = 0.01 m ² x 10 cm
Groundwater Concentration ^b	C _{dw}	COPC-specific	mg/L or pCi/L	ECF-300FF5-11-0130
Cancer Slope Factor - oral	CSF _o	COPC-specific	(mg/kg-day) ⁻¹	See Table 4-2
Cancer Slope Factor - inhalation	CSF _i	COPC-specific	(mg/kg-day) ⁻¹	See Table 4-2
Exposure Duration or Number of Years a Person Sweats in a Lifetime - adult	ED	68	year	Harris and Harper, 2004
Exposure Frequency or Number of Sweats per Year	EF	365	events/year	Harris and Harper, 2004
Length of Sweat Event – adult ^c	ET	2/24	days/event	Ridolfi, 2007
Gastrointestinal Absorption Factor	GIABS	COPC-specific	unitless	See Table 4-2
Inhalation Intake of COPCs in Sweat Lodge— volatile and semi-volatile nonradionuclides	I _{inh}	Calculated value	mg/kg-day	Equation 30
Inhalation Intake of COPCs in Sweat Lodge— volatile and semi-volatile radionuclides	I _{inh}	Calculated value	pCi	Equation 33
Inhalation Intake of COPCs in Sweat Lodge— nonvolatile nonradionuclides	I _{inh}	Calculated value	mg/kg-day	Equation 35
Inhalation Intake of COPCs in Sweat Lodge— nonvolatile radionuclides	I _{inh}	Calculated value	pCi	Equation 38
Dermal Intake of COPCs in Sweat Lodge— volatile and semi-volatile vapor	I _{d,total} = I _{d,v}	Calculated value	mg/kg-day	Equation 40

Table 3-7. Summary of Exposure Assumptions Used for the Sweat Lodge Exposure Pathway for Yakama Nation Exposure Scenario in the 300 Area Subregion of the 300-FF-5 Groundwater Operable Unit. (3 Pages)

Exposure Factor	Symbol	Value	Units	Source
Dermal Intake of COPCs in Sweat Lodge— nonvolatile condensed liquid	$I_{d,l}$	Calculated value	mg/kg-day	Equation 43
Dermal Intake of COPCs in Sweat Lodge— nonvolatile vapor	$I_{d,v}$	Calculated value	mg/kg-day	Equation 44
Inhalation Rate - adult	IR	26	m ³ /day	Ridolfi, 2007
Inhalation Unit Risk	IUR	COPC-specific	($\mu\text{g}/\text{m}^3$) ⁻¹	See Table 4-2
COPC-specific Permeability Coefficient	K_p	COPC-specific	cm/hour	See Table 4-2
Molecular Weight of Water	MW_w	18	g/gmole	Harris and Harper, 2004
Density of Liquid Water	ρ_w	1,000	g/L	Harris and Harper, 2004
The Constant pi	π	3.14159	unitless	--
Radius of Sweat Lodge	r	1	m	Harris and Harper, 2004
Ideal Gas Law Constant	R	0.06237	mmHg-m ³ /mole-K	Harris and Harper, 2004
Ideal Gas Law Constant ^d	R	62.37	mmHg-L/mole-K	Harris and Harper, 2004
Reference Concentration	RfC	COPC-specific	mg/m ³	See Table 4-2
Reference Dose - inhalation	RfD _i	COPC-specific	mg/kg-day	See Table 4-2
Reference Dose - oral	RfD _o	COPC-specific	mg/kg-day	See Table 4-2
Skin Surface Area - adult	SA	18,000	cm ²	Harris and Harper, 2004
Slope Factor - inhalation	SF _i	COPC-specific	Risk/pCi	See Table 4-2
Temperature Inside the Sweat Lodge ^e	T	340	K	Harris and Harper, 2004
Cumulative Volume of Water Used in Sweat	$V_{w,total}$	4	Liters	Harris and Harper, 2004

Notes:

a. Averaging time of 1 year provided in Harris and Harper, 2004 was replaced with 70 years for carcinogens and 68 years for noncarcinogens to

Table 3-7. Summary of Exposure Assumptions Used for the Sweat Lodge Exposure Pathway for Yakama Nation Exposure Scenario in the 300 Area Subregion of the 300-FF-5 Groundwater Operable Unit. (3 Pages)

Exposure Factor	Symbol	Value	Units	Source
				account for lifetime intake rather than annual intake.
b.				Harris and Harper (2004, Appendix 4) indicates water concentration (C_{dw}) is “dissolved surface water concentration of the COPC (mg/L); calculated according to EPA 1998a, Appendix B.” However, for this evaluation COPC exposure point concentrations reflect total concentrations in groundwater.
c.				Average reported Yakama Nation time spent inside sweathouse is 5 hr per week (Ridolfi, 2007); value used conservatively assumes 2 hr/event, 1 event/day (14 hr/week). For sweat lodge inhalation exposure, exposure time of 2 hr was replaced with 2/24 days/event so that the intake values have appropriate units.(mg/kg-day or pCi) when calculated using the inhalation equations provided in Harris and Harper, (2004, Equations 7 and 15).
d.				For sweat lodge dermal exposure, the ideal gas law constant of 0.06237 mmHg-m ³ /gmole-K provided in Harris and Harper, 2004 was replaced with 62.37 mmHg-L/gmole-K so that intake values have appropriate units (mg/kg-day) when calculated using the equations provided in Harris and Harper (2004, Equations 15 and 20).
e.				Temperature of 389 K provided in Harris and Harper, 2004 was replaced with 340 K (150 °F) for consistency with stated assumption in Harris and Harper, 2004 that sweat lodge internal temperature is maintained at 150 °F.
				ECF-300FF5-11-0130, <i>Calculation of Exposure Point Concentrations for the 300 Area Subregion of the 300-FF-5 Groundwater Operable Unit.</i>
				Harris and Harper, 2004, <i>Exposure Scenario for CTUIR Traditional Subsistence Lifeways.</i>
				Ridolfi, 2007, <i>Yakama Nation Exposure Scenario for Hanford Site Risk Assessment.</i>

3.2.1 Intake and Risk Equations for Sweat Lodge Inhalation of Volatiles and Semi-Volatiles

The bases for the equations used to calculate intake, risk, and hazard associated with the inhalation of volatiles and semi-volatiles during sweat lodge use are summarized in Table 3-8. Equations are provided in the following subsections.

Table 3-8. Calculated Values and Reference Bases Used for the Sweat Lodge Inhalation of Volatiles and Semi-Volatiles Exposure Route

Effect	Symbol for Calculated Value	Reference
Carcinogenic and Noncarcinogenic	I_{inh}	Harris and Harper, 2004
Carcinogenic	Risk	EPA-540-R-070-002
Noncarcinogenic	HQ	EPA-540-R-070-002
Radionuclide	I_{inh}	Harris and Harper, 2004
	Risk	EPA/540/R-92/003

Notes:

I_{inh} = Inhalation intake of COPCs in sweat lodge.

HQ = hazard quotient.

EPA-540-R-070-002, *Risk Assessment Guidance for Superfund: Volume 1—Human Health Evaluation Manual (Part F, Supplemental Guidance for Inhalation Risk Assessment)*.

EPA/540/R-92/003, *Risk Assessment Guidance for Superfund: Volume 1 – Human Health Evaluation Manual (Part B, Development of Risk-based Preliminary Remediation Goals): Interim*.

Harris and Harper, 2004, *Exposure Scenario for CTUIR Traditional Subsistence Lifeways*.

3.2.1.1 Sweat Lodge Inhalation of Volatiles and Semi-Volatiles—Intake (Carcinogenic Effects and Noncarcinogenic Effects)

Inhalation intake of volatiles and semi-volatiles in sweat lodge vapor is calculated with the following equation (Harris and Harper 2004, Appendix 4, Equation 7):

$$I_{inh} = \frac{C_{dw} \times \left(\frac{V_{w,total}}{2} \right) \times \left(\frac{1}{\frac{2}{3} \cdot \pi \cdot r^3} \right) \times IR \times ET \times EF \times ED}{BW \times AT \times CF1} \quad (30)$$

3.2.1.2 Sweat Lodge Inhalation of Volatiles and Semi-Volatiles—Carcinogenic Effects

For carcinogens, the cancer risk is calculated using the following equation:

$$RISK = CSF_i \times I_{inh} \quad (31)$$

3.2.1.3 Sweat Lodge Inhalation of Volatiles and Semi-Volatiles—Noncarcinogenic Effects

For noncarcinogens, the noncancer hazard is calculated using the following equation:

$$HQ = \frac{1}{RfD_i} \times I_{inh} \quad (32)$$

3.2.1.4 Sweat Lodge Inhalation of Volatiles and Semi-Volatiles—Radionuclides

Inhalation intake of volatile and semi-volatile radionuclides in sweat lodge vapor is calculated with the following equation (modified for pCi/L groundwater concentration units and inhalation slope factors from Harris and Harper, 2004, Appendix 4, Equation 7):

$$I_{inh} = C_{dw} \times \left(\frac{V_{w,total}}{2} \right) \times \left(\frac{1}{\frac{2}{3} \cdot \pi \cdot r^3} \right) \times IR \times ET \times EF \times ED \quad (33)$$

Radiological cancer risk is calculated using the following equation:

$$RISK_{rad} = SF_i \times I_{inh} \quad (34)$$

3.2.2 Intake and Risk Equations for Sweat Lodge Inhalation of Nonvolatiles

The bases for the equations used to calculate intake, risk, and hazard associated with the inhalation of nonvolatiles exposure route during sweat lodge use are summarized in Table 3-9. Equations are provided in the following subsections.

Table 3-9. Calculated Values and Reference Bases Used for the Sweat Lodge Inhalation of Nonvolatiles Exposure Route

Effect	Symbol for Calculated Value	Reference
Carcinogenic and Noncarcinogenic	I_{inh}	Harris and Harper, 2004
Carcinogenic	Risk	EPA-540-R-070-002
Noncarcinogenic	HQ	EPA-540-R-070-002
Radionuclide	I_{inh}	Harris and Harper, 2004
	Risk	EPA/540/R-92/003

Notes:

I_{inh} = Inhalation intake of COPCs in sweat lodge.

HQ = hazard quotient.

EPA-540-R-070-002, *Risk Assessment Guidance for Superfund: Volume 1—Human Health Evaluation Manual (Part F, Supplemental Guidance for Inhalation Risk Assessment)*.

EPA/540/R-92/003, *Risk Assessment Guidance for Superfund: Volume 1 – Human Health Evaluation Manual (Part B, Development of Risk-based Preliminary Remediation Goals): Interim*.

Harris and Harper, 2004, *Exposure Scenario for CTUIR Traditional Subsistence Lifeways*.

3.2.2.1 Sweat Lodge Inhalation of Nonvolatiles—Intake (Carcinogenic Effects and Noncarcinogenic Effects)

Inhalation intake of aerosolized nonvolatile contaminants in a sweat lodge is calculated using the following equation (Harris and Harper 2004, Appendix 4, Equation 15):

$$I_{inh} = \left(\frac{IR \cdot ET \cdot EF \cdot ED}{BW \cdot AT \cdot CF1} \right) \times C_{dw} \times \left(\frac{MW_w}{R \cdot T \cdot \rho_w} \right) \times EXP \left(18.3036 - \frac{3816.44}{T - 46.13} \right) \quad (35)$$

3.2.2.2 Sweat Lodge Inhalation of Nonvolatiles—Carcinogenic Effects

For carcinogens, the cancer risk is calculated using the following equation:

$$RISK = CSF_i \times I_{inh} \quad (36)$$

3.2.2.3 Sweat Lodge Inhalation of Nonvolatiles—Noncarcinogenic Effects

For noncarcinogens, the noncancer hazard is calculated using the following equation:

$$HQ = \frac{1}{RfD_i} \times I_{inh} \quad (37)$$

3.2.2.4 Sweat Lodge Inhalation of Nonvolatiles—Radionuclides

Inhalation intake of aerosolized nonvolatile radionuclides in a sweat lodge is calculated with the following equation (modified for pCi/L groundwater concentration units and inhalation slope factors from Harris and Harper, 2004, Appendix 4, Equation 15):

$$I_{inh} = (IR \times ET \times EF \times ED) \times C_{dw} \times \left(\frac{MW_w}{R \cdot T \cdot \rho_w} \right) \times EXP \left(18.3036 - \frac{3816.44}{T - 46.13} \right) \quad (38)$$

Radiological cancer risk is calculated using the following equation:

$$RISK_{rad} = SF_i \times I_{inh} \quad (39)$$

3.2.3 Intake and Risk Equations for Sweat Lodge Dermal Exposure to Volatiles and Semi-Volatiles

The bases for the equations used to calculate intake, risk, and hazard associated with the dermal exposure route for volatiles and semi-volatiles during sweat lodge use are summarized in Table 3-10. Equations are provided in the following subsections.

Table 3-10. Calculated Values and Reference Bases Used for the Sweat Lodge Dermal Exposure to Volatiles and Semi-Volatiles Exposure Route

Effect	Symbol for Calculated Value	Reference
Carcinogenic and Noncarcinogenic	$I_{d,v} = I_{d,total}$	Harris and Harper, 2004
Carcinogenic	Risk	EPA/540/R/99/005
Noncarcinogenic	HQ	EPA/540/R/99/005

Notes:

$I_{d,v}$ = Dermal intake of volatile and semi-volatile COPCs in vapor in sweat lodge.

$I_{d,total}$ = Total dermal intake of volatile and semi-volatile COPCs in sweat lodge.

HQ = hazard quotient.

EPA/540/R/99/005, *Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual Part E, Supplemental Guidance for Dermal Risk Assessment*): Final.

Harris and Harper, 2004, *Exposure Scenario for CTUIR Traditional Subsistence Lifeways*.

Table 3-10. Calculated Values and Reference Bases Used for the Sweat Lodge Dermal Exposure to Volatiles and Semi-Volatiles Exposure Route

Effect	Symbol for Calculated Value	Reference
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3.2.3.1 Sweat Lodge Dermal Exposure to Volatiles and Semi-Volatiles—Intake (Carcinogenic Effects and Noncarcinogenic Effects)

For volatile and semi-volatile compounds, the Harris and Harper model assumes 100% volatilization within the sweat lodge. Vapor exposure is the primary exposure pathway, and exposure from condensed water is considered incomplete. Therefore, $I_{d,total}$ is equal to $I_{d,v}$.

Exposure from dermal contact with volatile and semi-volatile contaminants in sweat lodge vapor is calculated with the following equation (Harris and Harper 2004, Appendix 4, Equation 18):

$$I_{d,total} = I_{d,v} = \frac{C_{dw} \times \left(\frac{V_{w,total}}{2} \right) \times \left(\frac{1}{\frac{2}{3} \cdot \pi \cdot r^3} \right) \times SA \times Kp \times ET \times EF \times ED \times CF2}{BW \times AT \times CF1} \quad (40)$$

3.2.3.2 Sweat Lodge Dermal Exposure to Volatiles and Semi-Volatiles—Carcinogenic Effects

For carcinogens, the cancer risk is calculated using the following equation:

$$RISK = \frac{CSF_o}{GIABS} \times I_{d,total} \quad (41)$$

3.2.3.3 Sweat Lodge Dermal Exposure to Volatiles and Semi-Volatiles—Noncarcinogenic Effects

For noncarcinogens, the noncancer hazard is calculated using the following equation:

$$HQ = \frac{1}{RfD_o \times GIABS} \times I_{d,total} \quad (42)$$

3.2.3.4 Sweat Lodge Dermal Exposure to Volatiles and Semi-Volatiles—Radionuclides

Dermal exposure to volatile and semi-volatile radionuclides in a sweat lodge is not evaluated because radionuclide cancer slope factors are not published for cancer risk from external or dermal exposure to radioactive contaminants in water.

3.2.4 Intake and Risk Equations for Sweat Lodge Dermal Exposure to Nonvolatiles

The bases for the equations used to calculate intake, risk, and hazard associated with the dermal exposure route for nonvolatiles during sweat lodge use are summarized in Table 3-11. Equations are provided in the following subsections.

Table 3-11. Calculated Values and Reference Bases Used for the Sweat Lodge Dermal Exposure to Nonvolatiles Exposure Route

Effect	Symbol for Calculated Value	Reference
Carcinogenic and Noncarcinogenic	$I_{d,l}$	Harris and Harper, 2004
Carcinogenic and Noncarcinogenic	$I_{d,v}$	Harris and Harper, 2004
Carcinogenic and Noncarcinogenic	$I_{d,total}$	Harris and Harper, 2004
Carcinogenic	Risk	EPA/540/R/99/005
Noncarcinogenic	HQ	EPA/540/R/99/005

Notes:

 $I_{d,l}$ = Dermal intake of nonvolatiles COPCs in condensed liquid in sweat lodge. $I_{d,v}$ = Dermal intake of nonvolatile COPCs in vapor in sweat lodge. $I_{d,total}$ = Total dermal intake of nonvolatile COPCs in sweat lodge.

HQ = hazard quotient.

EPA/540/R/99/005, *Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment): Final.*Harris and Harper, 2004, *Exposure Scenario for CTUIR Traditional Subsistence Lifeways.*

3.2.4.1 Sweat Lodge Dermal Exposure to Nonvolatiles in Condensed Liquid—Intake (Carcinogenic Effects and Noncarcinogenic Effects)

In the Harris and Harper model, total dermal intake of nonvolatile contaminants is calculated as the sum of intakes from dermal exposure to vapors and to aqueous condensate. For condensed liquid, the model assumes nonvolatile contaminant concentrations in the condensed water are equal to that of the water added to the heated rocks. Intake from dermal contact with nonvolatile compounds in sweat lodge condensed liquid is calculated with the following equation (Harris and Harper 2004, Appendix 4, Equation 19):

$$I_{d,l} = \frac{C_{dw} \times SA \times K_p \times ET \times EF \times ED \times CF_3}{BW \times AT \times CF_1} \quad (43)$$

3.2.4.2 Sweat Lodge Dermal Exposure to Nonvolatiles in Vapor—Intake (Carcinogenic Effects and Noncarcinogenic Effects)

Intake from dermal contact with nonvolatile compounds in sweat lodge vapor is calculated with the following equation (Harris and Harper 2004, Appendix 4, Equation 20):

$$I_{d,v} = \left(\frac{SA \times K_p \times ET \times EF \times ED \times CF_3}{BW \times AT \times CF_1} \right) \times C_{dw} \times \left(\frac{MW_w}{R \times T \times \rho_w} \right) \times \dots \quad (44)$$

$$\dots EXP \left(18.3036 - \frac{3816.44}{T - 46.13} \right)$$

3.2.4.3 Sweat Lodge Dermal Exposure to Nonvolatiles in Vapor—Total Intake (Carcinogenic Effects and Noncarcinogenic Effects)

The total dermal exposure for nonvolatile compounds in a sweat lodge is calculated using the following equation (Harris and Harper 2004, Appendix 4, Equation 21):

$$I_{d,total} = I_{d,v} + I_{d,l} \quad (45)$$

3.2.4.4 Sweat Lodge Dermal Exposure to Nonvolatiles—Carcinogenic Effects

For carcinogens, the cancer risk is calculated using the following equation:

$$RISK = \frac{CSF_o}{GIABS} \times I_{d,total} \quad (46)$$

3.2.4.5 Sweat Lodge Dermal Exposure to Nonvolatiles—Noncarcinogenic Effects

For noncarcinogens, the noncancer hazard is calculated using the following equation:

$$HQ = \frac{1}{RfD_o \times GIABS} \times I_{d,total} \quad (47)$$

3.2.4.6 Sweat Lodge Dermal Exposure to Nonvolatiles—Radionuclides

Dermal exposure to radionuclides in a sweat lodge is not evaluated because radionuclide cancer slope factors are not published for calculating cancer risk from external or dermal exposure to radioactive contaminants in water.

3.3 Cumulative Risk—Cancer

For estimating the cancer risks from exposure to multiple carcinogens from a single exposure route, the following equation is used. The basis for the equation is provided in EPA/540/1-89/002.

$$Risk_T = \sum_1^N Risk_i \quad (48)$$

where:

Risk _T	=	Total cancer risk from route of exposure
Risk _i	=	Cancer risk for the i th chemical
N	=	Number of chemicals

3.4 Hazard Index—Noncancer

The HI is calculated with the following equation. The basis for the equation is provided in EPA/540/1-89/002.

$$HI = \frac{\sum_1^N CDI_i}{RfD_i} \quad (49)$$

where:

HI	=	hazard index
CDI _i	=	chronic daily intake of the i th chemical (mg/kg-day)
RfD _i	=	reference dose of the i th chemical (mg/kg-day)
N	=	number of chemicals

4 Assumptions and Inputs

Assumptions and inputs associated with the exposure scenarios and human health toxicity values, along with the groundwater COPCs and associated exposure point concentrations (EPCs), used in the CTUIR and Yakama Nation human health risk calculations, are described below.

4.1 Exposure Inputs and Assumptions

- Exposure inputs used to quantify intake from the drinking water exposure pathway are provided in Tables 3-1 and 3-2 for the CTUIR and Yakama Nation exposure scenarios, respectively. Exposure inputs used to quantify intake from the sweat lodge exposure pathway are provided in Tables 3-6 and 3-7 for the CTUIR and Yakama Nation exposure scenarios, respectively.
- Exposure routes evaluated for the drinking water exposure pathway for the CTUIR and Yakama Nation exposure scenarios are ingestion, inhalation, and dermal absorption. (Dermal exposure is evaluated for nonradionuclides only.)
- Exposure routes evaluated for the sweat lodge exposure pathway for the CTUIR and Yakama Nation exposure scenarios are inhalation and dermal absorption. (Dermal exposure is evaluated for nonradionuclides only.)
- For domestic use of groundwater as a drinking water supply, EPA considers the inhalation pathway potentially complete only for volatile contaminants because there is no mechanism for release of nonvolatile chemicals into the air in significant concentrations (EPA/540/R-92/003). For the drinking water exposure pathway, inhalation intake is quantified for volatile contaminants as defined by EPA, 2009, *Regional Screening Levels for Chemical Contaminants at Superfund Sites*.
- Exposure times for dermal exposure to drinking water are assumed to be 35 minutes for an adult and 1 hour for a child based on the EPA recommended values for showering/bathing under a reasonable maximum exposure (RME) residential scenario (EPA/540/R/99/005). Exposure times for inhalation of volatiles in drinking water are assumed to be the same as for the dermal exposure route.
- The Yakama Nation exposure scenario (Ridolfi, 2007) did not provide intake equations for exposures related to sweat lodge use; therefore, equations provided by Harris and Harper were used.
- Harris and Harper, 2004, Appendix 4, indicates that the water concentration (C_{dw}) is “dissolved surface water concentration of the COPC (mg/L); calculated according to EPA 1998a, Appendix B.” However, for this evaluation, the EPCs were used for C_{dw} ; the EPCs are calculated based on total concentrations (not dissolved concentrations) in groundwater. (Total concentrations are typically higher than dissolved concentrations.)
- For the sweat lodge scenario, an exposure time of 1 hour/event is used for the CTUIR, based on Harris and Harper, 2004. For the Yakama Nation, an exposure time of 2 hours/event is used. In the Yakama Nation exposure document (Ridolfi, 2007), seven hours/day is the recommended sweat lodge exposure time, based on the maximum value reported in a tribal survey. The average reported Yakama Nation value is 5 hours/week. The maximum exposure time of seven hours for sweat lodge use has the potential to overestimate the time budgeted for this activity and has the potential to underestimate the time budgeted to the remaining lifeway activities described in the Yakama Nation document (Ridolfi, 2007). For purposes of this calculation, a value of 2 hours/event (14 hours/week) is assumed.

- The sweat lodge scenario assumes 4 liters of groundwater are poured over hot rocks to make steam in a hemispherical sweat lodge with a radius of 1 m (Harris and Harper, 2004). The internal temperature of the sweat lodge is assumed to be maintained at a constant 150 degrees Fahrenheit (Harris and Harper, 2004). This scenario creates a unique environment where volatile, semi-volatile, and nonvolatile COPCs could potentially be present in the air and available for inhalation and dermal exposure. Harris and Harper, 2004 describes a method for calculating a vaporization factor for the sweat lodge scenario. The vaporization factor is applied to the groundwater concentration to estimate COPC concentrations in sweat lodge steam. Ridolfi (2007) does not specify a method for estimating COPC concentrations in sweat lodge steam; therefore, the Harris and Harper steam model is used for both the CTUIR and Yakama Nation intake calculations.
- Harris and Harper recommend different methods for calculating vaporization factors for volatile and semi-volatile COPCs, versus nonvolatile COPCs. For volatile and semi-volatile COPCs, the model assumes 100 percent volatilization throughout the sweat; hence, dermal exposure to volatiles and nonvolatiles in condensed water is considered an incomplete pathway. Therefore, volatile and semi-volatile COPCs (including tritium) are evaluated for intake via inhalation and dermal absorption only from the vapor phase.
- For nonvolatile COPCs, the model assumes that the COPCs become airborne as an aerosol and that, once airborne, the COPCs can deposit onto the skin surface as aqueous condensate. Nonvolatile COPC intake is assumed to occur via inhalation from the vapor phase and dermal absorption from both the vapor and liquid phases. The Harris and Harper model assumes the concentration of nonvolatiles in condensed water is equal to the concentration in the water used to create the steam.

4.2 Groundwater Contaminants of Potential Concern and Exposure Point Concentrations

The COPCs assessed in this environmental calculation were identified from the 300 Area subregion analytical data set in the Hanford Environmental Information System (HEIS) database. The data set was first processed as described in ECF-300FF5-11-0128, *Identification of Contaminants of Potential Concern for Groundwater Risk Assessment at the 300 Area Subregion of the 300-FF-5 Groundwater Operable Unit*, to exclude analytes classed as essential nutrients (minerals), analytes without known toxicity information, and nondetected analytes.

The COPC identification methodology presented in ECF-300FF5-11-0128 applies a multi-step screening process that includes among its several steps a comparison of maximum detected groundwater concentrations to chemical-specific action levels for protection of human health and aquatic receptors. For this evaluation, comparisons to action levels were not made; with the exception of acrolein and cis-1,2-dichloroethylene any analyte in the (processed) 300 Area subregion data set with at least one reported detection was identified as a COPC and assessed in the Native American risk calculations. Acrolein was determined to be a laboratory contaminant, and is therefore not considered a COPC for this evaluation. Both cis-1,2-dichloroethylene and 1,2-dichloroethene (total) are reported in the 300 Area subregion data set with an associated exposure point concentration of 0.22 µg/L. Because the 1,2-dichloroethene (total) represents the total concentration of all isomers of 1,2-dichloroethene it is used as the sole analytical representative for all isomers of 1,2-dichloroethene for this evaluation. Furthermore, the oral reference dose for 1,2-dichloroethene (total) (0.009 mg/kg-day) is more conservative than the oral reference dose for cis-1,2-dichloroethylene (0.01 mg/kg-day), which would result in a more conservative estimation on noncancer hazard from exposure to 1,2-dichloroethene.

The EPCs used for the Native American risk calculations are the analyte-specific 90th percentile groundwater concentration values calculated from the (processed) 300 Area subregion analytical data set, as described in ECF-300FF5-11-0130, *Calculation of Exposure Point Concentrations for the 300 Area*

Subregion of the 300-FF-5 Groundwater Operable Unit. The identified COPCs and their associated 90th percentile values are presented in Table 4-1.

Table 4-1. Contaminants of Potential Concern and Exposure Point Concentrations (90th Percentile Groundwater Concentrations) Used for the Native American Supplemental Risk Evaluation at the 300 Area Subregion of the 300-FF-5 Groundwater Operable Unit

Contaminant of Potential Concern	Exposure Point Concentration (µg/L or pCi/L) ^a	Contaminant of Potential Concern	Exposure Point Concentration (µg/L or pCi/L) ^a
1,2-Dichloroethene (Total)	0.22	Iron	106
Acetone	1.0	Lead	0.2
Aluminum	10	Lithium	25
Arsenic	5.2	Manganese	6.0
Barium	71	Molybdenum	5.7
Boron	45	Nickel	6.0
Bromodichloromethane	0.088	Nitrate	31,250
Bromomethane	0.25	Selenium	3.7
Carbon disulfide	0.054	Silver	0.20
Carbon tetrachloride	0.12	Strontium	248
Chloride	25,950	Sulfate	58,500
Chloroform	0.47	Tetrachloroethene	0.18
Chromium	7.1	Thallium	0.10
Cobalt	0.12	Tin	0.10
Copper	1.4	Trichloroethene	2.2
Cyanide	4.0	Tritium	6,150
Fluoride	280	Uranium	114
Gross alpha	71	Vanadium	21
Gross beta	42	Zinc	42

Notes:

- a. 90th percentile groundwater concentration calculated as described in ECF-300FF5-11-0130.

4.3 Toxicity Values

The toxicity criteria used for the Native American human health risk calculations are provided in Table 4-2. The sources for these criteria are discussed below.

4.3.1 Toxicity Values for Nonradionuclides

For nonradionuclides, the COPC-specific toxicity values shown in Table 4-2 are determined using the recommended reference hierarchy as described in Cook, 2003, “*Human Health Toxicity Values in Superfund Risk Assessments*.” The hierarchy is summarized below.

- Tier 1 – The EPA Integrated Risk Information System (IRIS)
- Tier 2 – The EPA Provisional Peer Reviewed Toxicity Values (PPRTVs)
- Tier 3 – Other Toxicity Values

Tier 1 – IRIS

The preferred source of toxicity data is the EPA IRIS database (<http://www.epa.gov/iris/index.html>). EPA toxicologists derived the values in this database. The values have undergone thorough review and validation, both within and outside EPA. If a toxicity value is available in IRIS, that value is used in preference to any other value.

Tier 2 – PPRTVs

If a toxicity value is not available in IRIS, the next source is the EPA PPRTVs. This source includes toxicity values that have been developed by the Office of Research and Development/National Center for Environmental Assessment/Superfund Health Risk Technical Support Center. This database is not available to the general public, but is accessible to EPA risk assessors via the EPA intranet. These values are also published at the EPA Regional Screening Levels website (EPA, 2009).

Tier 3 – Other Toxicity Values

If neither a Tier 1 or Tier 2 value is available for a COPC, a Tier 3 value is sought. Tier 3 includes additional EPA and non-EPA sources of toxicity information, including:

- The California EPA’s (CalEPA’s) Toxicity Criteria Database. This database contains both cancer and non-cancer effects toxicity values that have been peer reviewed.
- The Agency for Toxic Substances and Disease Registry (ATSDR)’s Minimal Risk Levels (MRLs) for Hazard Substances. These levels are peer-reviewed estimates of permissible daily human exposure to hazardous substances that are likely to be without appreciable risk of adverse non-cancer health effects over a specified duration of exposure.
- Toxicity values in EPA 540/R-97-036, *Health Effects Assessment Summary Tables (HEAST)*.

When Tier 1, Tier 2, and Tier 3 toxicity values are not available for a COPC, the toxicity values from the National Center for Environmental Assessment (NCEA) are used. NCEA values can be found in the Risk Assessment Information System (RAIS, ORNL, 2010).

For this environmental calculation, one toxicity value required conversion to a different concentration basis: nitrate.

- **Nitrate.** A derived RfD for nitrate (NO_3^-) was calculated from the RfD reported in IRIS, which is given as 1.6 mg/kg-day for *nitrate as nitrogen* (NO_3^- as N). Conversion from *nitrate as nitrogen* to *nitrate* was made using the mass fraction of nitrogen in nitrate. The mass fraction of nitrogen in nitrate = mol wt N/mol wt NO_3^- = (14 g/mol)/(62 g/mol) = 0.226. The derived RfD for *nitrate* = (1.6 mg NO_3^- as N/kg-day) x (1 mg NO_3^- /0.226 mg NO_3^- as N) = 7.1 mg NO_3^- /kg-day.

For several nonradionuclide COPCs, the toxicity value used was obtained from a different source than recommended by the EPA Superfund hierarchy (Cook 2003). The differences in toxicity values are summarized below.

- For fluoride, the oral reference dose of 0.06 mg/kg-day published on IRIS is used for this evaluation. The value reported on IRIS has not been updated since 1989 and does not reflect the most current source of information. The oral reference dose currently implemented by EPA in the Regional Screening Levels is established by the CalEPA Office of Environmental Health Hazard Assessment (OEHHA). The oral reference dose derived by OEHHA is 0.04 mg/kg-day as documented in OEHHA, 2003, *Chronic Toxicity Summary: Fluorides including Hydrogen Fluoride*. Use of the IRIS value in this evaluation has the potential to under-estimate noncancer hazards.
- For trichloroethene, the oral cancer slope factor of $0.089 \text{ (mg/kg-day)}^{-1}$ and inhalation unit risk of $2.5\text{E-}05 \text{ (}\mu\text{g/m}^3\text{)}^{-1}$ published in HEAST are used for this . HEAST has not been updated since 1997 and does not reflect the most current source of information. The oral cancer slope factor and inhalation unit risk currently implemented by EPA in the Regional Screening Levels (EPA, 2009) are established by the CalEPA OEHHA. The oral slope factor of $0.0059 \text{ (mg/kg-day)}^{-1}$ and the Inhalation Unit Risk of $2.0\text{E-}06 \text{ (}\mu\text{g/m}^3\text{)}^{-1}$ derived by OEHHA are presented in OEHHA, 2009, *Public Health Goal for Chemicals In Drinking Water Trichloroethylene*. Use of the HEAST values in this evaluation has the potential to over-estimate cancer risk.
- For consistency with previous Hanford analyses of carbon tetrachloride, the toxicity evaluation uses an oral cancer slope factor of $0.13 \text{ (mg/kg-day)}^{-1}$, an oral reference dose of 0.0007 (mg/kg-day), and an inhalation unit risk factor of $1.5\text{E-}05 \text{ (}\mu\text{g/m}^3\text{)}^{-1}$ previously published in IRIS, as well as the inhalation reference concentration of $0.19 \text{ (mg/m}^3\text{)}$ published by ATSDR. These values do not reflect the most current toxicity values published for carbon tetrachloride. The oral cancer slope factor of $0.07 \text{ (mg/kg-day)}^{-1}$, oral reference dose of 0.004 (mg/kg-day), inhalation unit risk of $6\text{E-}06 \text{ (}\mu\text{g/m}^3\text{)}^{-1}$, and inhalation reference concentration of $0.1 \text{ (mg/m}^3\text{)}$ for carbon tetrachloride is currently implemented by EPA in the Regional Screening Levels (EPA, 2009) and are established by IRIS. Use of the previous IRIS values in this evaluation has the potential to over-estimate both cancer risks and noncancer hazards.

4.3.2 Toxicity Values for Radionuclides

The cancer slope factors for radionuclides in Table 4-2 were obtained from EPA, 2001, “*Health Effects Assessment Summary Tables database*” / “April 16, 2001 Update: Radionuclide Toxicity,” / “Radionuclide Table: Radionuclide Carcinogenicity – Slope Factors.”

4.3.3 Toxicity Values for Sweat Lodge Equations

EPA has recently published guidance to address chemical inhalation exposures in EPA-540-R-070-002. A methodology is provided to use the toxicity values that are currently provided in IRIS as concentrations (reference concentrations [RfC] for non-cancer effects and inhalation unit risk values [IUR] for cancer endpoints). These values now supersede the intake-based approach specified in EPA/540/1-89/002.

The method described in Harris and Harper, 2004 for inhalation of nonradionuclide COPCs in sweat lodge vapor follows the former EPA/540/1-89/002 approach of quantifying intake. Therefore, in the sweat lodge exposure pathway calculations, the IUR and RfC values from the EPA toxicity tables (EPA, 2009) were converted to CSF_i and RfD_i values, following the protocol given in EPA/540/1-89/002. The following equations were used, based on an assumed breathing rate of $20 \text{ m}^3\text{/day}$ and an assumed body weight of 70 kg.

$$\text{CSF}_i \text{ (kg-day/mg)} = \text{IUR (m}^3\text{/}\mu\text{g)} \times 1/[20 \text{ (m}^3\text{/day)}] \times 70 \text{ (kg)} \times 1000 \text{ (}\mu\text{g/mg)} \quad (50)$$

$$\text{RfD}_i \text{ (mg/kg-day)} = \text{RfC (mg/m}^3\text{)} \times 20 \text{ (m}^3\text{/day)} \times 1/70 \text{ (kg)} \quad (51)$$

The CSF_i and RfD_i values are used to calculate inhalation cancer risks and inhalation non-cancer hazards, respectively. For inhalation of radionuclides in sweat lodge vapor, no toxicity factor conversions are

necessary. Sweat lodge radiological risk is calculated by quantifying inhalation intake (pCi) and then multiplying by the EPA inhalation slope factor (risk/pCi).

Table 4-2. Toxicity Criteria for 300 Area Subregion Contaminants of Potential Concern

COPC ^a	Oral Reference Dose (RfD _o) ^b (mg/kg-day)	Key	Inhalation Reference Concentration (RfC) ^b (mg/m ³)	Key	Inhalation Reference Dose (RfD _i) ^e (mg/kg-day)	Oral Cancer Slope Factor (CSF _o) ^b (mg/kg-day) ⁻¹ or Oral Slope Factor (SF _o) ^c (Risk/pCi)	Key	Inhalation Unit Risk (IUR) ^b (μg/m ³) ⁻¹	Key	Inhalation Cancer Slope Factor (CSF _i) ^d (kg-day/mg) or Inhalation Slope Factor (SF _i) ^c (Risk/pCi)	Volatile Nonradionuclides ^b	GIABS Nonradionuclides ^b	K _p ^f (cm/hour)	B ^f	τ ^f (hours/e vent)	t ^{*f} (hours)	FA ^f
1,2-Dichloroethene (Total)	9.00E-03	H	--	--	--	--	--	--	--	--	V	1.00E+00	7.70E-03	0.00E+00	3.70E-01	8.90E-01	1
Acetone	9.00E-01	I	3.10E+01	A	8.86E+00	--	--	--	--	--	V	1.00E+00	5.12E-04e	--	--	--	--
Aluminum	1.00E+00	P	5.00E-03	P	1.43E-03	--	--	--	--	--	--	1.00E+00	1.00E-03	--	--	--	--
Arsenic	3.00E-04	I	1.50E-05	C	4.29E-06	1.50E+00	I	4.30E-03	I	1.51E+01	--	1.00E+00	1.00E-03	--	--	--	--
Barium	2.00E-01	I	5.00E-04	H	1.43E-04	--	--	--	--	--	--	7.00E-02	1.00E-03	--	--	--	--
Boron	2.00E-01	I	2.00E-02	H	5.71E-03	--	--	--	--	--	--	1.00E+00	1.00E-03	--	--	--	--
Bromodichloromethane	2.00E-02	I	--	--	--	6.20E-02	I	3.70E-05	C	1.30E-01	V	1.00E+00	4.60E-03	0.00E+00	8.80E-01	2.12E+00	1
Bromomethane	1.40E-03	I	5.00E-03	I	1.43E-03	--	--	--	--	--	V	1.00E+00	2.80E-03	0.00E+00	3.60E-01	8.70E-01	1
Carbon disulfide	1.00E-01	I	7.00E-01	I	2.00E-01	--	--	--	--	--	V	1.00E+00	1.70E-02	1.00E-01	3.00E-01	7.20E-01	1
Carbon tetrachloride	7.00E-04	I	1.90E-01	A	5.43E-02	1.30E-01	I	1.50E-05	I	5.25E-02	V	1.00E+00	1.60E-02	1.00E-01	7.80E-01	1.86E+00	1
Chloride	--	--	--	--	--	--	--	--	--	--	--	1.00E+00	1.00E-03	--	--	--	--
Chloroform	1.00E-02	I	9.80E-02	A	2.80E-02	3.10E-02	C	2.30E-05	I	8.05E-02	V	1.00E+00	6.80E-03	0.00E+00	5.00E-01	1.19E+00	1
Chromium	1.50E+00	I	--	--	--	--	--	--	--	--	--	1.30E-02	1.00E-03	--	--	--	--
Cobalt	3.00E-04	P	6.00E-06	P	1.71E-06	--	--	9.00E-03	P	3.15E+01	--	1.00E+00	4.00E-04	--	--	--	--
Copper	4.00E-02	H	--	--	--	--	--	--	--	--	--	1.00E+00	1.00E-03	--	--	--	--
Cyanide	2.00E-02	I	--	--	--	--	--	--	--	--	V	1.00E+00	1.00E-03	--	--	--	--
Fluoride	6.00E-02	I	1.30E-02	C	3.71E-03	--	--	--	--	--	--	1.00E+00	1.00E-03	--	--	--	--
Gross alpha	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Gross beta	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Iron	7.00E-01	P	--	--	--	--	--	--	--	--	--	1.00E+00	1.00E-03	--	--	--	--
Lead	--	--	--	--	--	--	--	--	--	--	--	1.00E+00	1.00E-04	--	--	--	--
Lithium	2.00E-03	P	--	--	--	--	--	--	--	--	--	1.00E+00	1.00E-03	--	--	--	--
Manganese	2.40E-02	S	5.00E-05	I	1.43E-05	--	--	--	--	--	--	4.00E-02	1.00E-03	--	--	--	--
Molybdenum	5.00E-03	I	--	--	--	--	--	--	--	--	--	1.00E+00	1.00E-03	--	--	--	--

Table 4-2. Toxicity Criteria for 300 Area Subregion Contaminants of Potential Concern

COPC ^a	Oral Reference Dose (RfD _o) ^b (mg/kg-day)	Key	Inhalation Reference Concentration (RfC) ^b (mg/m ³)	Key	Inhalation Reference Dose (RfD _i) ^e (mg/kg-day)	Oral Cancer Slope Factor (CSF _o) ^b (mg/kg-day) ⁻¹ or Oral Slope Factor (SF _o) ^c (Risk/pCi)	Key	Inhalation Unit Risk (IUR) ^b (μg/m ³) ⁻¹	Key	Inhalation Cancer Slope Factor (CSF _i) ^d (kg-day/mg) or Inhalation Slope Factor (SF _i) ^c (Risk/pCi)	Volatile Nonradionuclides ^b	GIABS Nonradionuclides ^b	Radionuclides ^c	K _p ^f (cm/hour)	B ^f	τ ^f (hours/e vent)	t ^{*f} (hours)	FA ^f
Nickel	2.00E-02	I	9.00E-05	A	2.57E-05	--	--	2.60E-04	C	9.10E-01	--	4.00E-02	2.00E-04	--	--	--	--	--
Nitrate	7.10E+00	I	--	--	--	--	--	--	--	--	--	1.00E+00	1.00E-03	--	--	--	--	--
Selenium	5.00E-03	I	2.00E-02	C	5.71E-03	--	--	--	--	--	--	1.00E+00	1.00E-03	--	--	--	--	--
Silver	5.00E-03	I	--	--	--	--	--	--	--	--	--	4.00E-02	6.00E-04	--	--	--	--	--
Strontium	6.00E-01	I	--	--	--	--	--	--	--	--	--	1.00E+00	1.00E-03	--	--	--	--	--
Sulfate	--	--	--	--	--	--	--	--	--	--	--	--	1.00E-03	--	--	--	--	--
Tetrachloroethene	1.00E-02	I	2.70E-01	A	7.71E-02	5.40E-01	C	5.90E-06	C	2.07E-02	V	1.00E+00	3.30E-02	2.00E-01	9.10E-01	2.18E+00	1	
Thallium	--	--	--	--	--	--	--	--	--	--	--	1.00E+00	1.00E-03	--	--	--	--	--
Tin	6.00E-01	H	--	--	--	--	--	--	--	--	--	1.00E+00	1.00E-03	--	--	--	--	--
Trichloroethene	--	--	3.50E-02	H	1.00E-02	8.90E-02	H	2.50E-05	H	8.75E-02	V	1.00E+00	1.20E-02	1.00E-01	5.80E-01	1.39E+00	1	
Tritium	--	--	--	--	--	5.07E-14	H	--	--	5.62E-14	V	--	--	--	--	--	--	--
Uranium	3.00E-03	I	3.00E-04	A	8.57E-05	--	--	--	--	--	--	1.00E+00	1.00E-03	--	--	--	--	--
Vanadium	5.00E-03	S	--	--	--	--	--	--	--	--	--	1.00E+00	1.00E-03	--	--	--	--	--
Zinc	3.00E-01	I	--	--	--	--	--	--	--	--	--	1.00E+00	6.00E-04	--	--	--	--	--

Table 4-2. Toxicity Criteria for 300 Area Subregion Contaminants of Potential Concern

COPC ^a	Oral Reference Dose (RfD _o) ^b (mg/kg-day)	Key	Inhalation Reference Concentration (RfC) ^b (mg/m ³)	Key	Inhalation Reference Dose (RfD _i) ^e (mg/kg-day)	Oral Cancer Slope Factor (CSF _o) ^b (mg/kg-day) ⁻¹ or Oral Slope Factor (SF _o) ^c (Risk/pCi)	Key	Inhalation Unit Risk (IUR) ^b (μg/m ³) ⁻¹	Key	Inhalation Cancer Slope Factor (CSF _i) ^d (kg-day/mg) or Inhalation Slope Factor (SF _i) ^c (Risk/pCi)	Volatile Nonradionuclides ^b	GIABS Nonradionuclides ^b	Radionuclides ^c	K _p ^f (cm/hour)	B ^f	τ ^f (hours/e vent)	t* ^f (hours)	FA ^f
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Notes:

- a. Source = ECF-300FF5-11-0130.
- b. Source = EPA, 2009.
- c. Source = EPA, 2001.
- d. CSF_i (kg-day/mg) = IUR (m³/μg) x 1/20 (m³/day) x 70 (kg) x 1000 (μg/mg)
- e. RfD_i (mg/kg-day) = RfC (mg/m³) x 20 (m³/day) x 1/70 (kg)
- f. Source = EPA/540/R/99/005, Exhibits 3-1 (inorganic COPCs) and B-3 (organic COPCs).
- g. Source = ORNL, 2010.

-- = indicates toxicity value not available for this contaminant and exposure route.

A = ATSDR

B = partitioning constant.

C = Cal EPA

COPC = contaminant of potential concern.

FA = fraction absorbed.

GIABS = gastrointestinal absorption factor.

H = HEAST

I = IRIS

K_p = dermal permeability constant.

P = PPRTV

t* = time to reach steady-state.

τ = lag time

V = volatile

SV= Semivolatile

ECF- ECF-300FF5-11-0130, *Calculation of Exposure Point Concentrations for the 300 Area Subregion of the 300-FF-5 Groundwater Operable Unit*

EPA/540/R/99/005, *Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment): Final.*

EPA, 2001, *Health Effects Assessment Summary Tables* database, "April 16, 2001 Update: Radionuclide Toxicity," "Radionuclide Table: Radionuclide Carcinogenicity – Slope Factors."

EPA, 2009, "Regional Screening Levels for Chemical Contaminants at Superfund Sites."

ORNL, 2010, *The Risk Assessment Information System (RAIS).*

5 Software Applications

All calculations for this Environmental Calculation were performed on electronic spreadsheets using Microsoft Excel®. These spreadsheets are provided as electronic attachments to this environmental calculation.

6 Calculation

Potential human health risks to members of the CTUIR and the Yakama Nation are calculated using the methodology, COPCs, EPCs, and toxicity factors documented in Sections 3 and 4 of this environmental calculation. The calculation spreadsheets were validated by comparison with the hand calculations presented in Figure 6-1, and are provided as electronic attachments (formatted for on-screen viewing).

6.1 Drinking Water Exposure Pathway Worksheets

The drinking water exposure pathway calculations for the CTUIR exposure scenario are contained in the Excel workbook “300 Area Subregion Native Am Risk Env Calc - Attach A - Drinking Water CTUIR.xlsx”. The worksheets in this workbook are listed in Table 6-1.

The drinking water exposure pathway calculations for the Yakama Nation exposure scenario are contained in the Excel workbook “300 Area Subregion Native Am Risk Env Calc - Attach B - Drinking Water YN.xlsx”. The worksheets in this workbook are listed in Table 6-2.

Table 6-1. Worksheets for the CTUIR Drinking Water Exposure Pathway Calculations

300 Area Subregion
A-1: Results Summary
A-2: Ingestion of Nonradioactive COPCs in Drinking Water
A-3: Inhalation of Volatile Nonradioactive COPCs in Drinking Water
A-4: Dermal Absorption of Nonradioactive COPCs in Drinking Water
A-5: Inhalation of Volatile Radioactive COPCs in Drinking Water
A-6: Ingestion of Radioactive COPCs in Drinking Water

Notes:

COPC = contaminant of potential concern

® Microsoft Excel is a registered product of the Microsoft Corporation.

Table 6-2. Worksheets for the Yakama Nation Drinking Water Exposure Pathway Calculations

300 Area Subregion
B-1: Results Summary
B-2: Ingestion of Nonradioactive COPCs in Drinking Water
B-3: Inhalation of Volatile Nonradioactive COPCs in Drinking Water
B-4: Dermal Absorption of Nonradioactive COPCs in Drinking Water
B-5: Inhalation of Volatile Radioactive COPCs in Drinking Water
B-6: Ingestion of Radioactive COPCs in Drinking Water

Notes:

COPC = contaminant of potential concern

6.2 Sweat Lodge Exposure Pathway Worksheets

The sweat lodge exposure pathway calculations for the CTUIR exposure scenario are contained in the Excel workbook “300 Area Subregion Native Am Risk Env Calc - Attach C - Sweatlodge CTUIR.xlsx”. The worksheets in this workbook are listed in Table 6-3.

The sweat lodge exposure pathway calculations for the Yakama Nation exposure scenario are contained in the Excel workbook “300 Area Subregion Native Am Risk Env Calc - Attach D - Sweatlodge YN.xlsx”. The worksheets in this workbook are listed in Table 6-4.

Table 6-3. Worksheets for the CTUIR Sweat Lodge Exposure Pathway Calculations

300 Area Subregion
C-1: Results Summary
C-2: Inhalation of Volatile and Semi-Volatile COPCs in Vapor
C-3: Inhalation of Nonvolatile COPCs in Vapor
C-4: Dermal Exposure to Volatile and Semi-Volatile COPCs in Vapor
C-5: Dermal Exposure to Nonvolatile COPCs in Condensed Water

Table 6-3. Worksheets for the CTUIR Sweat Lodge
Exposure Pathway Calculations

300 Area Subregion
C-6: Dermal Exposure to Nonvolatile COPCs in Vapor
C-7: Inhalation of Volatile and Semi-Volatile Radioactive COPCs in Vapor
C-8: Inhalation of Nonvolatile Radioactive COPCs in Vapor

Table 6-4. Worksheets for the Yakama Nation
Sweat Lodge Exposure Pathway Calculations

300 Area Subregion
D-1: Results Summary
D-2: Inhalation of Volatile and Semi-Volatile COPCs in Vapor
D-3: Inhalation of Nonvolatile COPCs in Vapor
D-4: Dermal Exposure to Volatile and Semi-Volatile COPCs in Vapor
D-5: Dermal Exposure to Nonvolatile COPCs in Condensed Water
D-6: Dermal Exposure to Nonvolatile COPCs in Vapor
D-7: Inhalation of Volatile and Semi-Volatile Radioactive COPCs in Vapor
D-8: Inhalation of Nonvolatile Radioactive COPCs in Vapor

6.3 Hand Calculations

The electronic spreadsheet calculations are validated by comparison with hand calculations. The hand calculations are presented in Figure 6-1. The hand calculations were performed to validate the formulas used in the spreadsheets.

7 Results/Conclusions

Results of the CTUIR and Yakama Nation human health risk calculations are summarized and discussed in the sections below.

7.1 Summary of the CTUIR Supplemental Risk Evaluation

This section summarizes the supplemental risk evaluation results for use of groundwater as a drinking water source and use of groundwater to make steam in a sweat lodge, where the groundwater source is the 300 Area subregion.

7.1.1 Use of Groundwater as a Potential Drinking Water Source

Potential exposure to groundwater as a drinking water source is evaluated under this scenario. Potential routes of exposure to groundwater include ingestion, dermal contact (nonradionuclides only), and inhalation of volatiles during household activities. Table 7-1 provides a summary of the risk estimates, by exposure route. Additional detail, including COPC-specific risk contributions, is provided in the electronic spreadsheet attachments.

Table 7-1. CTUIR Exposure Scenario—Summary of Risk Estimates from Use of Groundwater as a Potential Drinking Water Source

Exposure Route	300 Area Subregion	
	ELCR	HI
Nonradionuclide COPCs		
Ingestion	4.7E-04	4.9
Dermal	4.4E-06	0.02
Inhalation	8.7E-07	<0.01
Total	4.8E-04	4.9
Radionuclide COPCs		
Ingestion	3.0E-05	--
Inhalation	2.7E-06	--
Total	3.3E-05	--
Total ELCR ^a	5.1E-04	--

Notes:

a. Total ELCR represents the sum of the total nonradionuclide ELCR and the total radionuclide ELCR.

COPC = contaminant of potential concern.

ELCR = excess lifetime cancer risk.

HI = hazard index.

-- = Indicates HI not applicable.

The cumulative ELCR for the 300 Area subregion is 4.8×10^{-4} for nonradiological COPCs and 3.3×10^{-5} for radiological COPCs. The nonradiological ELCR is greater than the EPA upper target risk threshold of 1×10^{-4} and the radiological ELCR is within the EPA range of 1×10^{-4} to 1×10^{-6} . Individual ELCR values for carbon tetrachloride, chloroform, tetrachloroethene, trichloroethene, and tritium are within the EPA range of 1×10^{-4} to 1×10^{-6} . The HI for the 300 Area subregion is 4.9, which is greater than the EPA target HI of 1.0. The primary contributor to the noncancer HI is uranium, with a HQ of 2.2.

Although the individual ELCR value associated with arsenic is greater than EPA's regulatory target risk threshold of 1×10^{-4} , the 90th percentile value of 5.2 $\mu\text{g/L}$ is considered to be within the range of naturally occurring concentrations of arsenic. Therefore, arsenic is not considered a contributor to risk or hazard.

7.1.2 Use of Groundwater as a Source of Steam for Sweat Lodge Use

Potential exposure to groundwater as a source of steam in a sweat lodge is evaluated under this scenario. Potential routes of exposure to steam generated from groundwater while spending time in a sweat lodge include 1) inhalation of vaporized volatiles and semi-volatiles and aerosolized nonvolatiles, and 2) dermal contact with vaporized volatiles and semi-volatiles, aerosolized nonvolatiles, and condensed liquid. Table 7-2 provides a summary of the risk estimates by exposure route. Additional detail including COPC-specific risk contributions is provided in the electronic spreadsheet attachments.

Table 7-2. CTUIR Exposure Scenario—Summary of Risk Estimates from Use of Groundwater in a Sweat Lodge

Exposure Route	300 Area Subregion	
	ELCR	HI
Nonradionuclide COPCs		
Inhalation in Sweat Lodge		
Volatile and Semi-Volatiles (vapor)	3.5E-06	<0.01
Nonvolatile (aerosol)	2.1E-04	9.4
Total	2.1E-04	9.4
Dermal Exposure in Sweat Lodge		
Volatile and Semi-Volatiles (vapor only)	1.4E-09	<0.01
Nonvolatile (vapor and aqueous condensate)	2.0E-06	0.03
Total	2.0E-06	0.03
Total Nonradionuclide	2.1E-04	9.4
Radionuclide COPCs		
Inhalation in Sweat Lodge		
Volatile and Semi-Volatiles (vapor)	8.5E-06	--
Nonvolatile (aerosol)	--	--
Total Radionuclide	8.5E-06	--
Total ELCR ^a	2.2E-04	--

Table 7-2. CTUIR Exposure Scenario—Summary of Risk Estimates from Use of Groundwater in a Sweat Lodge

Exposure Route	300 Area Subregion	
	ELCR	HI

Notes:

a. Total ELCR represents the sum of the total nonradionuclide ELCR and the total radionuclide ELCR.

-- = Indicates HI or ELCR is not applicable.

COPC = contaminant of potential concern.

CTUIR = Confederated Tribes of the Umatilla Indian Reservation.

HI = hazard index.

ELCR = excess lifetime cancer risk.

The cumulative ELCR for the 300 Area subregion is 2.1×10^{-4} for nonradiological COPCs and 8.5×10^{-6} for radiological COPCs. The nonradiological ELCR is greater than the EPA upper target risk threshold of 1×10^{-4} and the radiological ELCR is within the EPA range of 1×10^{-4} to 1×10^{-6} . The individual ELCR values for trichloroethene and tritium are within the EPA range of 1×10^{-4} to 1×10^{-6} . The HI for the 300 Area subregion is 9.4, which is greater than the EPA target HI of 1.0. The primary contributor to the noncancer HI is uranium, with a HQ of 3.3.

Although the individual ELCR value for arsenic is greater than EPA's regulatory target risk threshold of 1×10^{-4} and the HQ is greater than 1.0, the 90th percentile value of 5.2 $\mu\text{g/L}$ is within the range of naturally occurring concentrations of arsenic. Therefore, arsenic is not considered a contributor to risk or hazard.

Although the individual ELCR associated with cobalt is within the EPA range of 1×10^{-4} to 1×10^{-6} , the 90th percentile value of 0.12 $\mu\text{g/L}$ is considered to be within the range of naturally occurring concentrations of cobalt. Therefore, cobalt is not considered a contributor the ELCR.

Although the individual ELCR associated with nickel is within the EPA range of 1×10^{-4} to 1×10^{-6} , the 90th percentile value of 6 $\mu\text{g/L}$ is considered to be within the range of naturally occurring concentrations of nickel. Therefore, nickel is not considered a contributor the ELCR.

Although the individual HQ associated with barium is greater than 1.0, the 90th percentile value of 71 $\mu\text{g/L}$ is considered to be within the range of naturally occurring concentrations of barium. Therefore, barium is not considered a contributor to the HI.

Although the individual HQ associated with manganese is greater than 1.0, manganese is not considered to be a contributor to the HI because the 90th percentile value of 6.0 $\mu\text{g/L}$ is below the secondary MCL of 50 $\mu\text{g/L}$ and the secondary MCL is based on aesthetic qualities and is not federally enforceable.

7.2 Summary of the Yakama Nation Supplemental Risk Evaluation

This section summarizes the supplemental risk evaluation results for use of groundwater as a drinking water source and use of groundwater to make steam in a sweat lodge, where the groundwater source is the 300 Area subregion.

7.2.1 Use of Groundwater as a Potential Drinking Water Source

Potential exposure to groundwater as a drinking water source is evaluated under this scenario. Potential routes of exposure to groundwater include ingestion, dermal contact (nonradionuclides only), and inhalation of volatiles during household activities. Table 7-3 provides a summary of the risk estimates, by exposure route. Additional detail, including COPC-specific risk contributions, is provided in the electronic spreadsheet attachments.

Table 7-3. Yakama Nation Exposure Scenario—
Summary of Risk Estimates from Use of
Groundwater as a Potential Drinking Water Source

Exposure Route	300 Area Subregion	
	ELCR	HI
Nonradionuclide COPCs		
Ingestion	5.1E-04	4.9
Dermal	4.3E-06	0.02
Inhalation	8.7E-07	<0.01
Total	5.2E-04	4.9
Radionuclide COPCs		
Ingestion	3.1E-05	--
Inhalation	2.9E-06	--
Total	3.3E-05	--
Total ELCR ^a	5.5E-04	--

Notes:

a. Total ELCR represents the sum of the total nonradionuclide ELCR and the total radionuclide ELCR.

COPC = contaminant of potential concern.

ELCR = excess lifetime cancer risk.

HI = hazard index.

-- = Indicates HI not applicable.

The cumulative ELCR for the 300 Area subregion is 5.2×10^{-4} for nonradiological COPCs and 3.3×10^{-5} for radiological COPCs. The nonradiological ELCR is greater than the EPA upper target risk threshold of 1×10^{-4} and the radiological ELCR is within the EPA range of 1×10^{-4} to 1×10^{-6} . Individual ELCR values for carbon tetrachloride, chloroform, tetrachloroethene, trichloroethene, and tritium are within the EPA range of 1×10^{-4} to 1×10^{-6} . The HI for the 300 Area subregion is 4.9, which is greater than the EPA target HI of 1.0. The primary contributor to the noncancer HI is uranium, with a HQ of 2.2.

Although the individual ELCR value associated with arsenic is greater than EPA's regulatory target risk threshold of 1×10^{-4} , the 90th percentile value of 5.2 µg/L is considered to be within the range of naturally occurring concentrations of arsenic. Therefore, arsenic is not considered a contributor to risk or hazard.

7.2.2 Use of Groundwater as a Source of Steam for Sweat Lodge Use

Potential exposure to groundwater as a source of steam in a sweat lodge is evaluated under this scenario. Potential routes of exposure to steam generated from groundwater while spending time in a sweat lodge include 1) inhalation of vaporized volatiles and semi-volatiles and aerosolized nonvolatiles, and 2) dermal contact with vaporized volatiles and semi-volatiles, aerosolized nonvolatiles, and condensed liquid. Table 7-4 provides a summary of the risk estimates by exposure route. Additional detail including COPC-specific risk contributions is provided in the electronic spreadsheet attachments.

Table 7-4. Yakama Nation Exposure Scenario—Summary of Risk Estimates from Use of Groundwater in a Sweat Lodge

Exposure Route	300 Area Subregion	
	ELCR	HI
Nonradionuclide COPCs		
Inhalation in Sweat Lodge		
Volatile and Semi-Volatiles (vapor)	7.2E-06	0.01
Nonvolatile (aerosol)	4.3E-04	20
Total	4.3E-04	20
Dermal Exposure in Sweat Lodge		
Volatile and Semi-Volatiles (vapor only)	2.8E-09	<0.01
Nonvolatile (vapor and aqueous condensate)	3.9E-06	0.05
Total	3.9E-06	0.05
Total Nonradionuclide	4.4E-04	20
Radionuclide COPCs		
Inhalation in Sweat Lodge		
Volatile and Semi-Volatiles (vapor)	1.8E-05	--
Nonvolatile (aerosol)	--	--
Total Radionuclide	1.8E-05	--
Total ELCR ^a	4.6E-04	--
Notes:		
a. Total ELCR represents the sum of the total nonradionuclide ELCR and the total radionuclide ELCR.		
-- = Indicates HI or ELCR not applicable.		
COPC = contaminant of potential concern.		
HI = hazard index.		
ELCR = excess lifetime cancer risk.		

The cumulative ELCR for the 300 Area subregion is 4.4×10^{-4} for nonradiological COPCs and 1.8×10^{-5} for radiological COPCs. The nonradiological ELCR is greater than the EPA upper target risk threshold of 1×10^{-4} and the radiological ELCR is within the EPA range of 1×10^{-4} to 1×10^{-6} . The individual ELCR

values for chloroform, trichloroethene and tritium are within the EPA range of 1×10^{-4} to 1×10^{-6} . The HI for the 300 Area subregion is 20, which is greater than the EPA target HI of 1.0. The primary contributor to the noncancer HI is uranium with a HQ of 6.8.

Although the individual ELCR value for arsenic is greater than EPA's regulatory target risk threshold of 1×10^{-4} and the HQ is greater than 1.0, the 90th percentile value of 5.2 $\mu\text{g/L}$ is within the range of naturally occurring concentrations of arsenic. Therefore, arsenic is not considered a contributor to risk or hazard.

Although the individual ELCR associated with cobalt is within the EPA range of 1×10^{-4} to 1×10^{-6} , the 90th percentile value of 0.12 $\mu\text{g/L}$ is considered to be within the range of naturally occurring concentrations of cobalt. Therefore, cobalt is not considered a contributor the ELCR.

Although the individual ELCR value for nickel is within the EPA range of 1×10^{-4} to 1×10^{-6} and the HQ is greater than 1.0, the 90th percentile value of 6 $\mu\text{g/L}$ is within the range of naturally occurring concentrations of nickel. Therefore, nickel is not considered a contributor to risk or hazard.

Although the individual HQ associated with barium is greater than 1.0, the 90th percentile value of 71 $\mu\text{g/L}$ is considered to be within the range of naturally occurring concentrations of barium. Therefore, barium is not considered a contributor to the HI.

Although the individual HQ associated with manganese is greater than 1.0, manganese is not considered to be a contributor to the HI because the 90th percentile value of 6.0 $\mu\text{g/L}$ is below the secondary MCL of 50 $\mu\text{g/L}$ and the secondary MCL is based on aesthetic qualities and is not federally enforceable.

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Figure 6-1
HAND CALCULATIONS
(9 Sheets)

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pg 1

Drinking Water Ingestion

Carcinogen

$$CDI = \frac{C_w * IRW_{adj} * EF}{AT * CF_i}$$

$$IRW_{adj} = \frac{ED * IRW_c}{BW_c} + \frac{[ED_a - ED_c] * IRW_a}{BW_a}$$

$$Risk = CDI * CSF_o$$

→ Arsenic

$$IRW_{adj} = \frac{6yr * 1 \frac{L}{d}}{15kg} + \frac{[70yr - 6yr] * 4 \frac{L}{d}}{70kg} = 4.057 \frac{L-yr}{kg-d}$$

$$CDI = \frac{5.215e-3 \frac{mg}{L} * 4.057 \frac{L-yr}{kg-d} * 365 \frac{d}{yr}}{70yr * 365 \frac{d}{yr}} = 3.02e-4 \frac{mg}{kg-d}$$

$$Risk = 3.02e-4 \frac{mg}{kg-d} * 1.5 \frac{kg-d}{mg} = 4.53e-4$$

Noncarcinogen

$$CDI = \frac{C_w * IRW_a * EF * ED_a}{BW_a * AT * CF_i}$$

$$HQ = \frac{CDI}{RfD_o}$$

→ Arsenic

$$CDI = \frac{5.215e-3 \frac{mg}{L} * 4 \frac{L}{d} * 365 \frac{d}{yr} * 70yr}{70kg * 70yr * 365 \frac{d}{yr}} = 2.98e-4 \frac{mg}{kg-d}$$

$$HQ = \frac{2.98e-4 \frac{mg}{kg-d}}{3.00e-4 \frac{mg}{kg-d}} = 0.99$$

Drinking Water Ingestion - Radionuclides

$$CDI = C_w * IRW_{adj} * EF$$

$$IRW_{RADadj} = [ED_c * IRW_c] + [(ED_a - ED_c) * IRW_a]$$

$$Risk = CDI * SF_o$$

→ Tritium

$$IRW_{RADadj} = [6yr * 1 \frac{L}{d}] + [(70yr - 6yr) * 4 \frac{L}{d}] = 262 \frac{L-yr}{d}$$

$$CDI = 1650 \frac{pCi}{L} * 262 \frac{L-yr}{d} * 365 \frac{d}{yr} = 5.88e8 pCi$$

$$Risk = 5.88e8 pCi * 5.07e-14 \frac{risk}{pCi} = 2.98e-5$$

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Drinking Water Inhalation of Volatiles - Nonradionuclides

Carcinogen

$$CDI = \frac{C_w \times ED_a \times EF \times ET_a \times CF_2 \times VF \times 1000 \frac{\mu g}{mg}}{AT \times CF_1}$$

$$Risk = CDI \times IUR$$

→ Chloroform

$$CDI = \frac{4.7E-4 \frac{mg}{L} \times 70yr \times 365 \frac{d}{yr} \times 0.58 \frac{hr}{d} \times \frac{1d}{24hr} \times 0.5 \frac{L}{m^3} \times 1000 \frac{\mu g}{mg}}{70yr \times 365 \frac{d}{yr}}$$

$$= 5.68E-5 \frac{\mu g}{m^3}$$

$$Risk = 5.68E-5 \frac{\mu g}{m^3} \times 2.30E-5 \frac{m^3}{\mu g} = 1.31E-7 \quad \checkmark$$

Noncarcinogen

$$CDI = \frac{C_w \times ED_a \times EF \times ET_a \times CF_2 \times VF}{AT \times CF_1}$$

$$HQ = CDI / RfC$$

→ Chloroform

$$CDI = \frac{4.7E-4 \frac{mg}{L} \times 70yr \times 365 \frac{d}{yr} \times 0.58 \frac{hr}{d} \times \frac{1d}{24hr} \times 0.5 \frac{L}{m^3}}{70yr \times 365 \frac{d}{yr}}$$

$$= 5.68E-6 \frac{mg}{m^3}$$

$$HQ = 5.68E-6 \frac{mg}{m^3} / 9.80E-2 = 5.8E-5 \quad \checkmark$$

Drinking Water Inhalation of Volatiles - Radionuclides

$$CDI = C_w \times INH_RAD_{adj} \times VF \times EF \times ET_{adj} \times CF_2$$

$$INH_RAD_{adj} = (ED_c \times INH_c) + ([ED_a - ED_c] \times INH_a)$$

$$ET_{adj} = \frac{(ET_c \times ED_c) + ([ED_a - ED_c] \times ET_a)}{ED_a}$$

$$Risk = CDI \times SF_i$$

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→ Tritium

$$ET_{adj} = \frac{\left(1 \frac{hr}{d} \times 6yr\right) + \left(\left[70yr - 6yr\right] \times 0.58 \frac{hr}{d}\right)}{70 yr} = 0.616 \frac{hr}{d}$$

$$INH-RAD_{adj} = \left(6yr \times 15 \frac{m^3}{d}\right) + \left(\left[70yr - 6yr\right] \times 0.58 \frac{hr}{d}\right) = 1690 \frac{m^3 \cdot yr}{d}$$

$$CDI = 6150 \frac{pci}{L} \times 1690 \frac{m^3 \cdot yr}{d} \times 0.5 \frac{L}{m^3} \times 365 \frac{d}{yr} \times 0.616 \frac{hr}{d} \times \frac{1d}{24hr}$$

$$= 4.87 E^{+7} pci$$

$$Risk = 4.87 E^{+7} pci \times 5.62 E^{-14} \frac{risk}{pci}$$

$$= 2.74 E^{-6} \checkmark$$

Drinking Water Dermal Absorption - Nonradionuclide
Carcinogen

$$CDI = DA_{event} \times SA_{adj} \times EF$$

$$SA_{adj} = \frac{ED_c \times SA_c \times EV_c}{BW_c} + \frac{[ED_a - ED_c] \times SA_a \times EV_a}{BW_a}$$

$$ET_{adj} = \frac{(ET_c \times ED_c) + ([ED_a - ED_c] \times ET_a)}{ED_a}$$

$$Risk = CDI \times \frac{CSF_0}{GIABS}$$

DA_{event}IF $ET_{adj} \leq t^*$

$$DA_{event} = 2 \times FA \times Kp \times C_w \times CF_3 \times \sqrt{\frac{6 \times t \times ET_{adj}}{r}}$$

IF $ET_{adj} > t^*$

$$DA_{event} = FA \times Kp \times C_w \times CF_3 \times \left(\left[\frac{ET_{adj}}{1+B} \right] + 2 + t \times \left[\frac{1+3B+3B^2}{(1+B)^2} \right] \right)$$

Inorganic

$$DA_{event} = Kp \times C_w \times ET_{adj} \times CF_3$$

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→ Chloroform

$$ET_{adj} = \frac{\left(1 \frac{hr}{d} \times 60yr\right) + \left(\left[70yr - 60yr\right] \times 0.58 \frac{hr}{d}\right)}{70yr} = 0.666 \frac{hr}{d}$$

$$SA_{adj} = \frac{60yr \times 6600 \text{ cm}^2 \times 1 \frac{\text{event}}{d}}{15 \text{ Kg}} + \frac{\left[70yr - 60yr\right] \times 18000 \text{ cm}^2 \times 1 \frac{\text{event}}{d}}{70 \text{ Kg}}$$

$$= 19097 \frac{\text{cm}^2 \cdot \text{yr} \cdot \text{event}}{\text{Kg} \cdot \text{d}}$$

$$DA_{\text{event}} = 2 \times 1 \times 6.80 \times 10^{-3} \frac{\text{cm}}{\text{hr}} \times 4.7 \times 10^{-4} \frac{\text{mg}}{\text{L}} \times 0.001 \frac{\text{L}}{\text{cm}^3} \times \sqrt{\frac{6 \times 0.5 \frac{hr}{\text{event}} \times 0.666 \frac{hr}{\text{event}}}{\text{hr}}}$$

$$= 4.90 \times 10^{-9} \frac{\text{mg}}{\text{cm}^2 \cdot \text{event}}$$

$$CDI = \frac{4.90 \times 10^{-9} \frac{\text{mg}}{\text{cm}^2 \cdot \text{event}} \times 19097 \frac{\text{cm}^2 \cdot \text{yr} \cdot \text{event}}{\text{Kg} \cdot \text{d}} \times 365 \text{ d/yr}}{70 \text{ yr} \times 365 \text{ d/yr}}$$

$$= 1.34 \times 10^{-6} \frac{\text{mg}}{\text{Kg} \cdot \text{d}}$$

$$\text{Risk} = 1.34 \times 10^{-6} \frac{\text{mg}}{\text{Kg} \cdot \text{d}} \times \frac{3.10 \times 10^{-2} \frac{\text{Kg} \cdot \text{d}}{\text{mg}}}{1} = 4.15 \times 10^{-8}$$

→ Arsenic

$$DA_{\text{event}} = 0.001 \frac{\text{cm}}{\text{hr}} \times 5.215 \times 10^{-3} \frac{\text{mg}}{\text{L}} \times 0.666 \frac{\text{hr}}{\text{event}} \times 0.001 \frac{\text{L}}{\text{cm}^3} = 3.21 \times 10^{-9} \frac{\text{mg}}{\text{cm}^2 \cdot \text{event}}$$

$$CDI = \frac{3.21 \times 10^{-9} \frac{\text{mg}}{\text{cm}^2 \cdot \text{event}} \times 19097 \frac{\text{cm}^2 \cdot \text{yr} \cdot \text{event}}{\text{Kg} \cdot \text{d}} \times 365 \text{ d/yr}}{70 \text{ yr} \times 365 \text{ d/yr}} = 8.76 \times 10^{-7} \frac{\text{mg}}{\text{Kg} \cdot \text{d}}$$

$$\text{Risk} = 8.76 \times 10^{-7} \frac{\text{mg}}{\text{Kg} \cdot \text{d}} \times \frac{1.5 \frac{\text{Kg} \cdot \text{d}}{\text{mg}}}{1} = 1.31 \times 10^{-6}$$

Noncarcinogen

$$CDI = \frac{DA_{\text{event}} \times SA_a \times EF \times ED_a \times EV}{BWA \times AT \times CF}$$

$$HQ = \frac{CDI}{RFD_0 \times GIABS}$$

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DA_{event}IF $ET \leq L^*$,

$$DA_{event} = 2 * FA * Kp * Cw * CF3 * \sqrt{\frac{6 * L * ET}{\pi}}$$

IF $ET > L^*$,

$$DA_{event} = FA * Kp * Cw * CF3 * \left(\left[\frac{ET}{1+B} \right] + 2 + L * \left[\frac{1+3B+3B^2}{(1+B)^2} \right] \right)$$

Inorganic,

$$DA_{event} = Kp * Cw * ET * CF3$$

→ Chloroform

$$DA_{event} = 2 * 1 * 6.80E-3 \frac{cm}{hr} * 4.7E-4 \frac{mg}{L} * 0.001 \frac{L}{cm^3} * \sqrt{\frac{6 * 0.5 \frac{hr}{event} * 0.58 \frac{hr}{event}}{\pi}}$$

$$= 4.76E-9 \frac{mg}{cm^2 \cdot event}$$

$$CDI = \frac{4.76E-9 \frac{mg}{cm^2 \cdot event} * 18000 cm^2 * 365 d/yr * 70 yr * 1 \frac{event}{d}}{70 kg * 70 yr * 365 d/yr}$$

$$= 1.22E-6 \frac{mg}{kg \cdot d}$$

$$HQ = \frac{1.22E-6 \frac{mg}{kg \cdot d}}{0.01 \frac{mg}{kg \cdot d} * 1} = 1.22E-4$$

→ Arsenic

$$DA_{event} = 0.001 \frac{cm}{hr} * 5.215E-3 \frac{mg}{L} * 0.58 \frac{hr}{event} * 0.001 \frac{L}{cm^3} = 3.02E-9 \frac{mg}{cm^2 \cdot event}$$

$$CDI = \frac{3.02E-9 \frac{mg}{cm^2 \cdot event} * 18000 cm^2 * 365 d/yr * 70 yr * 1 \frac{event}{d}}{70 kg * 70 yr * 365 d/yr} = 7.78E-7 \frac{mg}{kg \cdot d}$$

$$HQ = \frac{7.78E-7 \frac{mg}{kg \cdot d}}{3.00E-4 \frac{mg}{kg \cdot d} * 1} = 2.59E-3$$

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pg 1

Sweatlodge - Inhalation of Volatiles & Semi volatiles
Nonradionuclides

$$I_{inh} = \frac{C_{dw} \times \left[\frac{V_{w, total}}{2} \right] \times \left[\frac{1}{2/3 \times \pi \times r^3} \right] \times IR \times ET \times EF \times ED}{BW \times AT \times CF_i}$$

Carcinogen

$$Risk = CSF_i \times I_{inh}$$

noncarcinogen

$$HQ = \frac{1}{RFD_i} \times I_{inh}$$

→ Chloroform - Carcinogen

$$I_{inh} = \frac{4.7 \times 10^{-4} \frac{mg}{L} \times \left[\frac{4L}{2} \right] \times \left[\frac{1}{2/3 \times \pi \times (1m)^3} \right] \times 25 \frac{m^3}{d} \times \frac{1 d}{24 hr} \times 365 \frac{event}{yr} \times 68 yr}{70 kg \times 70 yr \times 365 d/yr}$$

$$= 6.49 \times 10^{-6} \frac{mg}{kg \cdot d}$$

$$Risk = 8.05 \times 10^{-2} \frac{kg \cdot d}{mg} \times 6.49 \times 10^{-6} \frac{mg}{kg \cdot d} = 5.22 \times 10^{-7}$$

→ Chloroform - Noncarcinogen

$$I_{inh} = \frac{4.7 \times 10^{-4} \frac{mg}{L} \times \left[\frac{4L}{2} \right] \times \left[\frac{1}{2/3 \times \pi \times (1m)^3} \right] \times 25 \frac{m^3}{d} \times \frac{1 d}{24 event} \times 365 \frac{event}{yr} \times 68 yr}{70 kg \times 68 yr \times 365 d/yr}$$

$$= 6.68 \times 10^{-6} \frac{mg}{kg \cdot d}$$

$$HQ = \frac{1}{2.8 \times 10^{-2} \frac{mg}{kg \cdot d}} \times 6.68 \times 10^{-6} \frac{mg}{kg \cdot d} = 2.39 \times 10^{-4}$$

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CTVIR
Sweatlodge - Inhalation of Volatile Radionuclides

pg 2

$$I_{inh} = C_{dw} * \left[\frac{V_{w, total}}{2} \right] * \left[\frac{1}{2/3 * \pi * r^3} \right] * IR * ET * EF * ED$$

$$Risk = SF_i * I_{inh}$$

→ Tritium

$$I_{inh} = 650 \text{ pCi/L} * \left[\frac{4L}{2} \right] * \left[\frac{1}{2/3 * \pi * (m)^3} \right] * 25 \frac{m^3}{d} * \frac{1d}{24 \text{ event}} * 365 \frac{\text{event}}{\text{yr}} * 68 \text{ yr}$$

$$= 1.52E+8 \text{ pCi}$$

$$Risk = 1.52E+8 \text{ pCi} * 5.62E-14 \frac{\text{risk}}{\text{pCi}} = 8.53E-6$$

Sweatlodge - Inhalation of Nonvolatiles

$$I_{inh} = \left[\frac{IR * ET * EF * ED}{BW * AT * CF} \right] * C_{dw} * \left[\frac{MW_w}{R * T * P_w} \right] * \exp \left[18.3036 - \frac{3816.44}{T - 46.13} \right]$$

$$Risk = CSF_i * I_{inh}$$

$$HQ = \frac{1}{RFD_i} * I_{inh}$$

→ Arsenic - Carcinogen

$$I_{inh} = \frac{25 \frac{m^3}{d} * \frac{1d}{24 \text{ event}} * 365 \frac{\text{event}}{\text{yr}} * 68 \text{ yr}}{70 \text{ kg} * 70 \text{ yr} * 365 \text{ d/yr}} * 5.215E-3 \frac{\text{mg}}{\text{L}} * \left[\frac{18 \frac{\text{g}}{\text{mol}}}{0.06237 \frac{\text{mmHg} * m^3}{\text{g} * \text{mol} * K} * 338.7K * 1000\%} \right] * \exp \left[18.3036 - \frac{3816.44}{338.7K - 46.13} \right]$$

$$= (1.446E-2 * 5.215E-3 * 8.52E-4 * 192.3) \frac{\text{mg}}{\text{kg} * \text{d}} = 1.24E-5 \frac{\text{mg}}{\text{kg} * \text{d}}$$

$$Risk = 1.24E-5 \frac{\text{mg}}{\text{kg} * \text{d}} * 15.1 \frac{\text{kg} * \text{d}}{\text{mg}} = 1.87E-4 \quad \checkmark \text{ rounding}$$

→ Arsenic - Noncarcinogen

$$I_{inh} = \left[\frac{25 \frac{m^3}{d} * \frac{1d}{24 \text{ event}} * 365 \frac{\text{event}}{\text{yr}} * 68 \text{ yr}}{70 \text{ kg} * 68 \text{ yr} * 365 \text{ d/yr}} \right] * 5.215E-3 \frac{\text{mg}}{\text{L}} * \left[\frac{18 \frac{\text{g}}{\text{mol}}}{0.06237 \frac{\text{mmHg} * m^3}{\text{g} * \text{mol} * K} * 338.7K * 1000\%} \right] * \exp \left[18.3036 - \frac{3816.44}{338.7K - 46.13} \right]$$

$$= (1.498E-2 * 5.215E-3 * 8.52E-4 * 192.3) \frac{\text{mg}}{\text{kg} * \text{d}} = 1.27E-5 \frac{\text{mg}}{\text{kg} * \text{d}}$$

$$HQ = 1.27E-5 \frac{\text{mg}}{\text{kg} * \text{d}} * \frac{1}{4.29E-6 \frac{\text{mg}}{\text{kg} * \text{d}}} = 2.96 \quad \checkmark \text{ rounding}$$

Sweatlodge - Dermal Absorption Volatiles

$$I_{d,total} = I_{d,v} = \frac{C_{d,w} * \left[\frac{V_{w,total}}{2} \right] * \left[\frac{1}{2r^3 * \pi * r^3} \right] * SA * K_p * ET * EF * ED * CF_R}{BW * AT * CF_I}$$

$$Risk = \frac{CSF_c}{GIABS} * I_{d,total}$$

$$HQ = \frac{1}{RFD_0 * GIABS} * I_{d,total}$$

Chloroform - Carcinogen

$$I_{d,v} = \frac{4.7E-4 \frac{mg}{L} * \left[\frac{4L}{2} \right] * \left[\frac{1}{2r^3 * \pi * (1m)^3} \right] * 1.8m^2 * 6.8E-3 \frac{cm}{hr} * 1 \frac{hr}{event} * 365 \frac{event}{yr} * 68yr * 0.01 \frac{m}{cm}}{70kg * 70yr * 365 \frac{d}{yr}}$$

$$= 7.62E-10 \frac{mg}{kg-d}$$

$$Risk = 7.62E-10 \frac{mg}{kg-d} * \frac{3.10E-2 \frac{kg-d}{mg}}{1} = 2.36E-11 \checkmark$$

Chloroform - Noncarcinogen

$$I_{d,v} = \frac{4.7E-4 \frac{mg}{L} * \left[\frac{4L}{2} \right] * \left[\frac{1}{2r^3 * \pi * (1m)^3} \right] * 1.8m^2 * 6.8E-3 \frac{cm}{hr} * 1 \frac{hr}{event} * 365 \frac{event}{yr} * 68yr * 0.01 \frac{m}{cm}}{70kg * 68yr * 365 \frac{d}{yr}}$$

$$= 7.85E-10 \frac{mg}{kg-d}$$

$$HQ = \frac{7.85E-10 \frac{mg}{kg-d}}{0.01 \frac{mg}{kg-d} * 1} = 7.85E-8 \checkmark$$

Sweatlodge Dermal Absorption - Nonvolatile Condensed Liquid

$$I_{d,l} = \frac{C_{d,w} * SA * K_p * ET * EF * ED * CF_3}{BW * AT * CF_I}$$

$$Risk = \frac{CSF_c}{GIABS} * I_{d,l}$$

$$HQ = \frac{1}{RFD_0 * GIABS}$$

Arsenic - Carcinogen

$$I_{d,l} = \frac{5.215E-3 \frac{mg}{L} * 1.8m^2 * 0.001 \frac{cm}{hr} * 1 \frac{hr}{event} * 365 \frac{event}{yr} * 68yr * 10 \frac{m^2-cm}{m^2-cm}}{70kg * 70yr * 365 \frac{d}{yr}}$$

$$= 1.30E-6 \frac{mg}{kg-d}$$

$$Risk = 1.30E-6 \frac{mg}{kg-d} * \frac{1.5 \frac{kg-d}{mg}}{1} = 1.95E-6$$

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pg 4

→ Arsenic - Noncarcinogen

$$I_{d1} = \frac{5.215 \times 10^{-3} \frac{\text{mg}}{\text{L}} \times 1.8 \text{ m}^2 \times 0.001 \frac{\text{cm}}{\text{hr}} \times 1 \frac{\text{hr}}{\text{event}} \times 365 \frac{\text{event}}{\text{yr}} \times 68 \text{ yr} \times 10 \frac{\text{L}}{\text{m}^2 \cdot \text{cm}}}{70 \text{ kg} \times 68 \text{ yr} \times 365 \frac{\text{d}}{\text{yr}}} = 1.34 \times 10^{-6} \frac{\text{mg}}{\text{kg} \cdot \text{d}}$$

$$HQ = \frac{1}{3.00 \times 10^{-4} \frac{\text{kg} \cdot \text{d}}{\text{mg}}} \times 1.34 \times 10^{-6} \frac{\text{mg}}{\text{kg} \cdot \text{d}} = 4.47 \times 10^{-3} \quad \checkmark$$

Sweatlodge Dermal Absorption - Nonvolatile in vapor

$$I_{d,v} = \left[\frac{SA \cdot K_p \cdot ET \cdot EF \cdot ED \cdot CF_2}{BW \cdot AT \cdot CF_1} \right] \times C_{d,w} \times \left[\frac{MW_w}{R \cdot T \cdot P_w} \right] \times \text{Exp} \left[18.3036 - \frac{3816.44}{T - 46.13} \right]$$

→ Arsenic - carcinogen

$$I_{d,v} = \left[\frac{1.8 \text{ m}^2 \times 0.001 \frac{\text{cm}}{\text{hr}} \times 1 \frac{\text{hr}}{\text{event}} \times 365 \frac{\text{event}}{\text{yr}} \times 68 \text{ yr} \times 10 \frac{\text{L}}{\text{m}^2 \cdot \text{cm}}}{70 \text{ kg} \times 70 \text{ yr} \times 365 \frac{\text{d}}{\text{yr}}} \right] \times 5.215 \times 10^{-3} \frac{\text{mg}}{\text{L}} \times \left[\frac{18 \frac{\text{g}}{\text{mol}}}{(62.37 \frac{\text{mmHg} \cdot \text{L}}{\text{g} \cdot \text{mol} \cdot \text{K}} \times 338.7 \text{ K} \times 1000 \frac{\text{g}}{\text{L}})} \right] \times \text{Exp} \left[18.3036 - \frac{3816.44}{338.7 \text{ K} - 46.13} \right]$$

$$= (2.50 \times 10^{-4} \times 5.215 \times 10^{-3} \times 8.52 \times 10^{-7} \times 192.3) \frac{\text{mg}}{\text{kg} \cdot \text{d}} = 2.14 \times 10^{-10} \frac{\text{mg}}{\text{kg} \cdot \text{d}} \quad \checkmark \text{ rounday}$$

$$\text{Risk} = 2.14 \times 10^{-10} \frac{\text{mg}}{\text{kg} \cdot \text{d}} \times \frac{1.50 \frac{\text{kg} \cdot \text{d}}{\text{mg}}}{1} = 3.20 \times 10^{-10} \quad \checkmark$$

→ Arsenic - Noncarcinogen

$$I_{d,v} = \left[\frac{1.8 \text{ m}^2 \times 0.001 \frac{\text{cm}}{\text{hr}} \times 1 \frac{\text{hr}}{\text{event}} \times 365 \frac{\text{event}}{\text{yr}} \times 68 \text{ yr} \times 10 \frac{\text{L}}{\text{m}^2 \cdot \text{cm}}}{70 \text{ kg} \times 68 \text{ yr} \times 365 \frac{\text{d}}{\text{yr}}} \right] \times 5.215 \times 10^{-3} \frac{\text{mg}}{\text{L}} \times \left[\frac{18 \frac{\text{g}}{\text{mol}}}{(62.37 \frac{\text{mmHg} \cdot \text{L}}{\text{g} \cdot \text{mol} \cdot \text{K}} \times 338.7 \text{ K} \times 1000 \frac{\text{g}}{\text{L}})} \right] \times \text{Exp} \left[18.3036 - \frac{3816.44}{338.7 \text{ K} - 46.13} \right]$$

$$= (2.57 \times 10^{-4} \times 5.215 \times 10^{-3} \times 8.52 \times 10^{-7} \times 192.3) \frac{\text{mg}}{\text{kg} \cdot \text{d}}$$

$$HQ = 2.20 \times 10^{-10} \frac{\text{mg}}{\text{kg} \cdot \text{d}} \times \frac{1}{3.00 \times 10^{-4} \frac{\text{kg} \cdot \text{d}}{\text{mg}}} = 7.32 \times 10^{-7} \quad \checkmark$$

300 Area Subregion Native American Risk Assessment--Summary of CTUIR Drinking Water Exposure Scenario Noncancer Hazard Results for Nonradioactive COPCs in Groundwater.								
COPC	Contaminant Concentration in Groundwater		Volatile ^a	HQ (Inhalation) (unitless)	HQ (Ingestion) (unitless)	HQ (Dermal) (unitless)	Total HQ (unitless)	% Contribution
	C _w (mg/L)							
1,2-Dichloroethene (Total)	0.00022		Yes	--	1.40E-03	6.20E-05	1.46E-03	0.030
Acetone	0.001045		Yes	4.07E-07	6.63E-05	--	6.68E-05	0.0014
Aluminum	0.01		--	--(b)	5.71E-04	1.49E-06	5.73E-04	0.012
Arsenic	0.005215		--	--(b)	9.93E-01	2.59E-03	9.96E-01	20
Barium	0.07145		--	--(b)	2.04E-02	7.61E-04	2.12E-02	0.43
Boron	0.0445		--	--(b)	1.27E-02	3.32E-05	1.27E-02	0.26
Bromodichloromethane	0.000088		Yes	--	2.51E-04	1.03E-05	2.62E-04	0.0053
Bromomethane	0.00025		Yes	--	1.02E-02	1.62E-04	1.04E-02	0.21
Carbon disulfide	0.0000535		Yes	--	3.06E-05	2.70E-06	3.33E-05	6.77E-04
Carbon tetrachloride	0.00012		Yes	7.63E-06	9.80E-03	1.31E-03	1.11E-02	0.23
Chloride	25.95		--	--(b)	--	--	--	--
Chloroform	0.00047		Yes	5.80E-05	2.69E-03	1.22E-04	2.87E-03	0.058
Chromium	0.007125		--	--(b)	2.71E-04	5.45E-05	3.26E-04	0.0066
Cobalt	0.000118		--	--(b)	2.25E-02	2.35E-05	2.25E-02	0.46
Copper	0.001355		--	--(b)	1.94E-03	5.05E-06	1.94E-03	0.040
Cyanide	0.004		Yes	--	1.14E-02	2.98E-05	1.15E-02	0.23
Fluoride	0.28		--	--(b)	2.67E-01	6.96E-04	2.67E-01	5.4
Iron	0.1055		--	--(b)	8.61E-03	2.25E-05	8.63E-03	0.18
Lead	0.0002		--	--(b)	--	--	--	--
Lithium	0.0245		--	--(b)	7.00E-01	1.83E-03	7.02E-01	14
Manganese	0.006		--	--(b)	1.43E-02	9.32E-04	1.52E-02	0.31
Molybdenum	0.00565		--	--(b)	6.46E-02	1.69E-04	6.47E-02	1.3
Nickel	0.006		--	--(b)	1.71E-02	2.24E-04	1.74E-02	0.35
Nitrate	31.25		--	--(b)	2.52E-01	6.56E-04	2.52E-01	5.1
Selenium	0.00372		--	--(b)	4.25E-02	1.11E-04	4.26E-02	0.87
Silver	0.0002		--	--(b)	2.29E-03	8.95E-05	2.38E-03	0.048
Strontium	0.248		--	--(b)	2.36E-02	6.16E-05	2.37E-02	0.48
Sulfate	58.5		--	--(b)	--	--	--	--
Tetrachloroethene	0.00018		Yes	--	1.03E-03	3.07E-04	1.34E-03	0.027
Thallium	0.0001		--	--(b)	--	--	--	--
Tin	0.0001		--	--(b)	9.52E-06	2.49E-08	9.55E-06	1.94E-04
Trichloroethene	0.0022		Yes	7.60E-04	--	--	7.60E-04	0.015
Uranium	0.114		--	--(b)	2.17E+00	5.67E-03	2.18E+00	44
Vanadium	0.0205		--	--(b)	2.34E-01	6.11E-04	2.35E-01	4.8
Zinc	0.0415		--	--(b)	7.90E-03	1.24E-05	7.92E-03	0.16
Total HI				8.26E-04	4.89E+00	1.66E-02	4.91E+00	100

^aVolatile contaminants as defined by EPA, 2009, "Regional Screening Levels for Chemical Contaminants at Superfund Sites."

^bNonvolatile constituents are not considered in the inhalation exposure route

-- = Indicates toxicity criteria not available to quantify contaminant's noncancer hazard via this exposure route.

COPC = contaminant of potential concern.

CTUIR = Confederated Tribes of the Umatilla Indian Reservation.

HI = hazard index.

HQ = hazard quotient.

300 Area Subregion Native American Risk Assessment--Summary of CTUIR Drinking Water Exposure Scenario Cancer Risk Results for Nonradioactive COPCs in Groundwater.								
COPC	Contaminant Concentration in Groundwater		Volatile ^a	Risk (Inhalation) (unitless)	Risk (Ingestion) (unitless)	Risk (Dermal) (unitless)	Total Risk (unitless)	% Contribution
	C _w (mg/L)							
1,2-Dichloroethene (Total)	0.00022		Yes	--	--	--	--	--
Acetone	0.001045		Yes	--	--	--	--	--
Aluminum	0.01		--	--(b)	--	--	--	--
Arsenic	0.005215		--	--(b)	4.53E-04	1.31E-06	4.55E-04	95
Barium	0.07145		--	--(b)	--	--	--	--
Boron	0.0445		--	--(b)	--	--	--	--
Bromodichloromethane	0.000088		Yes	3.93E-08	3.16E-07	1.39E-08	3.70E-07	0.077
Bromomethane	0.00025		Yes	--	--	--	--	--
Carbon disulfide	0.0000535		Yes	--	--	--	--	--
Carbon tetrachloride	0.00012		Yes	2.18E-08	9.04E-07	1.30E-07	1.06E-06	0.22
Chloride	25.95		--	--(b)	--	--	--	--
Chloroform	0.00047		Yes	1.31E-07	8.44E-07	4.15E-08	1.02E-06	0.21
Chromium	0.007125		--	--(b)	--	--	--	--
Cobalt	0.000118		--	--(b)	--	--	--	--
Copper	0.001355		--	--(b)	--	--	--	--
Cyanide	0.004		Yes	--	--	--	--	--
Fluoride	0.28		--	--(b)	--	--	--	--
Iron	0.1055		--	--(b)	--	--	--	--
Lead	0.0002		--	--(b)	--	--	--	--
Lithium	0.0245		--	--(b)	--	--	--	--
Manganese	0.006		--	--(b)	--	--	--	--
Molybdenum	0.00565		--	--(b)	--	--	--	--
Nickel	0.006		--	--(b)	--	--	--	--
Nitrate	31.25		--	--(b)	--	--	--	--
Selenium	0.00372		--	--(b)	--	--	--	--
Silver	0.0002		--	--(b)	--	--	--	--
Strontium	0.248		--	--(b)	--	--	--	--
Sulfate	58.5		--	--(b)	--	--	--	--
Tetrachloroethene	0.00018		Yes	1.28E-08	5.63E-06	1.81E-06	7.46E-06	1.6
Thallium	0.0001		--	--(b)	--	--	--	--
Tin	0.0001		--	--(b)	--	--	--	--
Trichloroethene	0.0022		Yes	6.65E-07	1.13E-05	1.06E-06	1.31E-05	2.7
Uranium	0.114		--	--(b)	--	--	--	--
Vanadium	0.0205		--	--(b)	--	--	--	--
Zinc	0.0415		--	--(b)	--	--	--	--
Total Nonradionuclide ELCR				8.69E-07	4.72E-04	4.37E-06	4.78E-04	100

^aVolatile contaminants as defined by EPA, 2009, "Regional Screening Levels for Chemical Contaminants at Superfund Sites."

^bNonvolatile constituents are not considered in the inhalation exposure route

-- = Indicates toxicity criteria not available to quantify contaminant's cancer risk via this exposure route.

COPC = contaminant of potential concern.

CTUIR = Confederated Tribes of the Umatilla Indian Reservation.

ELCR = excess lifetime cancer risk.

300 Area Subregion Native American Risk Assessment--Summary of CTUIR Drinking Water Exposure Scenario Cancer Risk Results for Radioactive COPCs in Groundwater.							
COPC	Contaminant Concentration in Groundwater		Volatile ^a	Risk (Inhalation) (unitless)	Risk (Ingestion) (unitless)	Total Risk (unitless)	% Contribution
	C _w (pCi/L)						
Gross alpha	71		--	--(b)	--	--	--
Gross beta	41.5		--	--(b)	--	--	--
Tritium	6150		Yes	2.74E-06	2.98E-05	3.26E-05	100.00
Total Radionuclide ELCR				2.74E-06	2.98E-05	3.26E-05	100

^aVolatile radioactive contaminants as defined by EPA, 2001, *Health Effects Assessment Summary Tables* database, "April 16, 2001 Update: Radionuclide Toxicity," "Radionuclide Table: Radionuclide Carcinogenicity - Slope Factors."

^bNonvolatile constituents are not considered in the inhalation exposure route

-- = Indicates radionuclide toxicity criteria not available to quantify contaminant's cancer risk via this exposure route.

COPC = contaminant of potential concern.

CTUIR = Confederated Tribes of the Umatilla Indian Reservation.

ELCR = excess lifetime cancer risk.

300 Area Subregion Native American Risk Assessment
CTUIR

Ingestion of Nonradioactive COPCs in Drinking Water - CTUIR

Intake Parameter Values				
Parameter	Symbol	Value	Unit	Source
Chronic Daily Intake - nonradiological ingestion	CDI	Calculated Value	mg/kg-day	Equations 5 and 8
Contaminant concentration in groundwater	C _w	COPC-specific	mg/L	ECF-300FF5-11-0130
Body Weight - adult	BW _a	70	kg	Harris and Harper, 2004
Body Weight - child	BW _c	15	kg	Harris and Harper, 2004
Water Ingestion Rate - adult	IRW _a	4	L/day	Harris, 2008
Water Ingestion Rate - child	IRW _c	1	L/day	Harris and Harper, 2004
Age-Adjusted Water Ingestion Rate - nonradiological	IRW _{adj}	4.057	L-year/kg-day	Equation 6
Exposure Frequency	EF	365	days/year	Harris and Harper, 2004
Exposure Duration - adult	ED _a	70	years	Harris and Harper, 2004
Exposure Duration - child	ED _c	6	years	Harris, 2008
Averaging time - carcinogens and noncarcinogens	AT	70	years	Harris, 2008
Reference Dose - Oral	RfD _o	COPC-specific	mg/kg-day	EPA, 2009
Cancer Slope Factor - Oral	CSF _o	COPC-specific	(mg/kg-day) ⁻¹	EPA, 2009
Conversion Factor	CF1	365	days/year	1 year = 365 days

ECF-300FF5-11-0130, Calculation of Exposure Point Concentrations for the 300-FF-5 Groundwater Operable Unit.

EPA, 2009, "Regional Screening Levels for Chemical Contaminants at Superfund Sites."

Harris, S., and Harper, B., 2004, Exposure Scenario for CTUIR Traditional Subsistence Lifeways.

Harris, S., 2008, Application of the CTUIR Traditional Lifeways Exposure Scenario in Hanford Risk Assessments.

Non-cancer HQ calculation

300 Area Subregion Nonradioactive COPC	CAS #	C _w (mg/L)	CDI (noncarcinogen) (mg/kg-day)	RfD _o ^a (mg/kg-day)	HQ (unitless)	% Contribution
1,2-Dichloroethene (Total)	540-59-0	0.00022	1.26E-05	9.00E-03	1.40E-03	0.029
Acetone	67-64-1	0.001045	5.97E-05	9.00E-01	6.63E-05	0.0014
Aluminum	7429-90-5	0.01	5.71E-04	1.00E+00	5.71E-04	0.012
Arsenic	7440-38-2	0.005215	2.98E-04	3.00E-04	9.93E-01	20
Barium	7440-39-3	0.07145	4.08E-03	2.00E-01	2.04E-02	0.42
Boron	7440-42-8	0.0445	2.54E-03	2.00E-01	1.27E-02	0.26
Bromodichloromethane	75-27-4	0.000088	5.03E-06	2.00E-02	2.51E-04	0.0051
Bromomethane	74-83-9	0.00025	1.43E-05	1.40E-03	1.02E-02	0.21
Carbon disulfide	75-15-0	0.0000535	3.06E-06	1.00E-01	3.06E-05	6.25E-04
Carbon tetrachloride	56-23-5	0.00012	6.86E-06	7.00E-04	9.80E-03	0.20
Chloride	16887-00-6	25.95	1.48E+00	--	--	--
Chloroform	67-66-3	0.00047	2.69E-05	1.00E-02	2.69E-03	0.055
Chromium	7440-47-3	0.007125	4.07E-04	1.50E+00	2.71E-04	0.0055
Cobalt	7440-48-4	0.000118	6.74E-06	3.00E-04	2.25E-02	0.46
Copper	7440-50-8	0.001355	7.74E-05	4.00E-02	1.94E-03	0.040
Cyanide	57-12-5	0.004	2.29E-04	2.00E-02	1.14E-02	0.23
Fluoride	16984-48-8	0.28	1.60E-02	6.00E-02	2.67E-01	5.4
Iron	7439-89-6	0.1055	6.03E-03	7.00E-01	8.61E-03	0.18
Lead	7439-92-1	0.0002	1.14E-05	--	--	--
Lithium	7439-93-2	0.0245	1.40E-03	2.00E-03	7.00E-01	14
Manganese	7439-96-5	0.006	3.43E-04	2.40E-02	1.43E-02	0.29
Molybdenum	7439-98-7	0.00565	3.23E-04	5.00E-03	6.46E-02	1.3
Nickel	7440-02-0	0.006	3.43E-04	2.00E-02	1.71E-02	0.35
Nitrate	14797-55-8	31.25	1.79E+00	7.10E+00	2.52E-01	5.1
Selenium	7782-49-2	0.00372	2.13E-04	5.00E-03	4.25E-02	0.87
Silver	7440-22-4	0.0002	1.14E-05	5.00E-03	2.29E-03	0.047
Strontium	7440-24-6	0.248	1.42E-02	6.00E-01	2.36E-02	0.48
Sulfate	14808-79-8	58.5	3.34E+00	--	--	--
Tetrachloroethene	127-18-4	0.00018	1.03E-05	1.00E-02	1.03E-03	0.021
Thallium	7440-28-0	0.0001	5.71E-06	--	--	--
Tin	7440-31-5	0.0001	5.71E-06	6.00E-01	9.52E-06	1.95E-04
Trichloroethene	79-01-6	0.0022	1.26E-04	--	--	--
Uranium	7440-61-1	0.114	6.51E-03	3.00E-03	2.17E+00	44
Vanadium	7440-62-2	0.0205	1.17E-03	5.00E-03	2.34E-01	4.8
Zinc	7440-66-6	0.0415	2.37E-03	3.00E-01	7.90E-03	0.16
Total HI					4.89E+00	100

^aEPA, 2009, "Regional Screening Levels for Chemical Contaminants at Superfund Sites."

-- = Indicates toxicity criteria not available to quantify contaminant's noncancer hazard via this exposure route.

COPC = contaminant of potential concern.

HI = hazard index.

HQ = hazard quotient.

EPA/540/1-89/002, Risk Assessment Guidance for Superfund Volume I Human Health Evaluation Manual (Part A): Interim Final.

Cancer risk calculation

300 Area Subregion Nonradioactive COPC	CAS #	C _w (mg/L)	CDI (carcinogen) (mg/kg-day)	CSF _o ^a (mg/kg-day) ⁻¹	Risk (unitless)	% Contribution
1,2-Dichloroethene (Total)	540-59-0	0.00022	1.28E-05	--	--	--
Acetone	67-64-1	0.001045	6.06E-05	--	--	--
Aluminum	7429-90-5	0.01	5.80E-04	--	--	--
Arsenic	7440-38-2	0.005215	3.02E-04	1.50E+00	4.53E-04	95.97
Barium	7440-39-3	0.07145	4.14E-03	--	--	--
Boron	7440-42-8	0.0445	2.58E-03	--	--	--
Bromodichloromethane	75-27-4	0.000088	5.10E-06	6.20E-02	3.16E-07	0.07
Bromomethane	74-83-9	0.00025	1.45E-05	--	--	--
Carbon disulfide	75-15-0	0.0000535	3.10E-06	--	--	--
Carbon tetrachloride	56-23-5	0.00012	6.96E-06	1.30E-01	9.04E-07	0.19
Chloride	16887-00-6	25.95	1.50E+00	--	--	--
Chloroform	67-66-3	0.00047	2.72E-05	3.10E-02	8.44E-07	0.18
Chromium	7440-47-3	0.007125	4.13E-04	--	--	--
Cobalt	7440-48-4	0.000118	6.84E-06	--	--	--
Copper	7440-50-8	0.001355	7.85E-05	--	--	--
Cyanide	57-12-5	0.004	2.32E-04	--	--	--
Fluoride	16984-48-8	0.28	1.62E-02	--	--	--
Iron	7439-89-6	0.1055	6.11E-03	--	--	--
Lead	7439-92-1	0.0002	1.16E-05	--	--	--
Lithium	7439-93-2	0.0245	1.42E-03	--	--	--
Manganese	7439-96-5	0.006	3.48E-04	--	--	--
Molybdenum	7439-98-7	0.00565	3.27E-04	--	--	--
Nickel	7440-02-0	0.006	3.48E-04	--	--	--
Nitrate	14797-55-8	31.25	1.81E+00	--	--	--
Selenium	7782-49-2	0.00372	2.16E-04	--	--	--
Silver	7440-22-4	0.0002	1.16E-05	--	--	--
Strontium	7440-24-6	0.248	1.44E-02	--	--	--
Sulfate	14808-79-8	58.5	3.39E+00	--	--	--
Tetrachloroethene	127-18-4	0.00018	1.04E-05	5.40E-01	5.63E-06	1.19
Thallium	7440-28-0	0.0001	5.80E-06	--	--	--
Tin	7440-31-5	0.0001	5.80E-06	--	--	--
Trichloroethene	79-01-6	0.0022	1.28E-04	8.90E-02	1.13E-05	2.40
Uranium	7440-61-1	0.114	6.61E-03	--	--	--
Vanadium	7440-62-2	0.0205	1.19E-03	--	--	--
Zinc	7440-66-6	0.0415	2.41E-03	--	--	--
Total Nonradionuclide ELCR					4.72E-04	100

^aEPA, 2009, "Regional Screening Levels for Chemical Contaminants at Superfund Sites."

-- = Indicates toxicity criteria not available to quantify contaminant's cancer risk via this exposure route.

COPC = contaminant of potential concern.

ELCR = excess lifetime cancer risk.

EPA/540/1-89/002, Risk Assessment Guidance for Superfund Volume I Human Health Evaluation Manual (Part A): Interim Final.

300 Area Subregion Native American Risk Assessment
CTUIR

Inhalation of Volatile Nonradioactive COPCs in Drinking Water - CTUIR

Intake Parameter Values				
Parameter	Symbol	Value	Unit	Source
Chronic Daily Intake - nonradiological inhalation	CDI	Calculated Value	mg/m ³ for noncarcinogens, µg/m ³ for carcinogens	Equations 13 and 15
Contaminant concentration in groundwater	C _w	COPC-specific	mg/L	ECF-300FF5-11-0130
Exposure Time- adult	ET _a	0.58	hours/day	EPA/540/R/99/005
Exposure Frequency	EF	365	days/year	Harris and Harper, 2004
Exposure Duration - adult	ED _a	70	years	Harris and Harper, 2004
Averaging time - carcinogens and noncarcinogens	AT	70	years	Harris, 2008
Volatilization Factor	VF	0.5	L/m ³	EPA/540/R-92/003
Reference Concentration	RF _C	COPC-specific	mg/m ³	EPA, 2009
Inhalation Unit Risk	IUR	COPC-specific	(µg/m ³) ⁻¹	EPA, 2009
Conversion Factor	CF1	365	days/year	1 year = 365 days
Conversion Factor	CF2	1/24	days/hour	1 day = 24 hours

ECF-300FF5-11-0130, Calculation of Exposure Point Concentrations for the 300-FF-5 Groundwater Operable Unit.

EPA/540/R-92/003, Risk Assessment Guidance for Superfund: Volume I - Human Health Evaluation Manual (Part B, Development of Risk-based Preliminary Remediation Goals): Interim.

EPA/540/R/99/005, Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment): Final.

EPA, 2009, "Regional Screening Levels for Chemical Contaminants at Superfund Sites."

Harris, S., and Harper, B., 2004, Exposure Scenario for CTUIR Traditional Subsistence Lifeways.

Harris, S., 2008, Application of the CTUIR Traditional Lifeways Exposure Scenario in Hanford Risk Assessments.

Non-cancer HQ calculation

300 Area Subregion Nonradioactive COPC	CAS #	Volatile ^a	C _w (mg/L)	CDI (noncarcinogen) (mg/m ³)	RF _C ^b (mg/m ³) ⁻¹	HQ (unitless)	% Contribution
1,2-Dichloroethene (Total)	540-59-0	Yes	0.00022	2.66E-06	--	--	
Acetone	67-64-1	Yes	0.001045	1.26E-05	3.10E+01	4.07E-07	0.049
Aluminum	7429-90-5	--	0.01	--(b)	5.00E-03	--(b)	
Arsenic	7440-38-2	--	0.005215	--(b)	1.50E-05	--(b)	
Barium	7440-39-3	--	0.07145	--(b)	5.00E-04	--(b)	
Boron	7440-42-8	--	0.0445	--(b)	2.00E-02	--(b)	
Bromodichloromethane	75-27-4	Yes	0.000088	1.06E-06	--	--	
Bromomethane	74-83-9	Yes	0.00025	3.02E-06	5.00E-03	--	
Carbon disulfide	75-15-0	Yes	0.0000535	6.46E-07	7.00E-01	--	
Carbon tetrachloride	56-23-5	Yes	0.00012	1.45E-06	1.90E-01	7.63E-06	0.92
Chloride	16887-00-6	--	25.95	--(b)	--	--(b)	
Chloroform	67-66-3	Yes	0.00047	5.68E-06	9.80E-02	5.80E-05	7.0
Chromium	7440-47-3	--	0.007125	--(b)	--	--(b)	
Cobalt	7440-48-4	--	0.000118	--(b)	6.00E-06	--(b)	
Copper	7440-50-8	--	0.001355	--(b)	--	--(b)	
Cyanide	57-12-5	Yes	0.004	4.83E-05	--	--	
Fluoride	16984-48-8	--	0.28	--(b)	1.30E-02	--(b)	
Iron	7439-89-6	--	0.1055	--(b)	--	--(b)	
Lead	7439-92-1	--	0.0002	--(b)	--	--(b)	
Lithium	7439-93-2	--	0.0245	--(b)	--	--(b)	
Manganese	7439-96-5	--	0.006	--(b)	5.00E-05	--(b)	
Molybdenum	7439-98-7	--	0.00565	--(b)	--	--(b)	
Nickel	7440-02-0	--	0.006	--(b)	9.00E-05	--(b)	
Nitrate	14797-55-8	--	31.25	--(b)	--	--(b)	
Selenium	7782-49-2	--	0.00372	--(b)	2.00E-02	--(b)	
Silver	7440-22-4	--	0.0002	--(b)	--	--(b)	
Strontium	7440-24-6	--	0.248	--(b)	--	--(b)	
Sulfate	14808-79-8	--	58.5	--(b)	--	--(b)	
Tetrachloroethene	127-18-4	Yes	0.00018	2.18E-06	2.70E-01	--	
Thallium	7440-28-0	--	0.0001	--(b)	--	--(b)	
Tin	7440-31-5	--	0.0001	--(b)	--	--(b)	
Trichloroethene	79-01-6	Yes	0.0022	2.66E-05	3.50E-02	7.60E-04	92
Uranium	7440-61-1	--	0.114	--(b)	3.00E-04	--(b)	
Vanadium	7440-62-2	--	0.0205	--(b)	--	--(b)	
Zinc	7440-66-6	--	0.0415	--(b)	--	--(b)	
Total HI						8.26E-04	100

^aEPA, 2009, "Regional Screening Levels for Chemical Contaminants at Superfund Sites."

^bNonvolatile constituents are not considered in the inhalation exposure route

-- = Indicates toxicity criteria not available to quantify contaminant's noncancer hazard via this exposure route.

COPC = contaminant of potential concern.

HI = hazard index.

HQ = hazard quotient.

EPA-540-R-070-002, Risk Assessment Guidance for Superfund: Volume 1—Human Health Evaluation Manual (Part F, Supplemental Guidance for Inhalation Risk Assessment).

Cancer risk calculation

300 Area Subregion Nonradioactive COPC	CAS #	Volatile ^a	C _w (mg/L)	CDI (cancer) (µg/m ³)	IUR ^b (µg/m ³) ⁻¹	Risk (unitless)	% Contribution
1,2-Dichloroethene (Total)	540-59-0	Yes	0.00022	2.66E-03	--	--	
Acetone	67-64-1	Yes	0.001045	1.26E-02	--	--	
Aluminum	7429-90-5	--	0.01	--(b)	--	--(b)	
Arsenic	7440-38-2	--	0.005215	--(b)	4.30E-03	--(b)	
Barium	7440-39-3	--	0.07145	--(b)	--	--(b)	
Boron	7440-42-8	--	0.0445	--(b)	--	--(b)	
Bromodichloromethane	75-27-4	Yes	0.000088	1.06E-03	3.70E-05	3.93E-08	4.5
Bromomethane	74-83-9	Yes	0.00025	3.02E-03	--	--	
Carbon disulfide	75-15-0	Yes	0.0000535	6.46E-04	--	--	
Carbon tetrachloride	56-23-5	Yes	0.00012	1.45E-03	1.50E-05	2.18E-08	2.5
Chloride	16887-00-6	--	25.95	--(b)	--	--(b)	
Chloroform	67-66-3	Yes	0.00047	5.68E-03	2.30E-05	1.31E-07	15
Chromium	7440-47-3	--	0.007125	--(b)	--	--(b)	
Cobalt	7440-48-4	--	0.000118	--(b)	9.00E-03	--(b)	
Copper	7440-50-8	--	0.001355	--(b)	--	--(b)	
Cyanide	57-12-5	Yes	0.004	4.83E-02	--	--	
Fluoride	16984-48-8	--	0.28	--(b)	--	--(b)	
Iron	7439-89-6	--	0.1055	--(b)	--	--(b)	
Lead	7439-92-1	--	0.0002	--(b)	--	--(b)	
Lithium	7439-93-2	--	0.0245	--(b)	--	--(b)	
Manganese	7439-96-5	--	0.006	--(b)	--	--(b)	
Molybdenum	7439-98-7	--	0.00565	--(b)	--	--(b)	
Nickel	7440-02-0	--	0.006	--(b)	2.60E-04	--(b)	
Nitrate	14797-55-8	--	31.25	--(b)	--	--(b)	
Selenium	7782-49-2	--	0.00372	--(b)	--	--(b)	
Silver	7440-22-4	--	0.0002	--(b)	--	--(b)	
Strontium	7440-24-6	--	0.248	--(b)	--	--(b)	
Sulfate	14808-79-8	--	58.5	--(b)	--	--(b)	
Tetrachloroethene	127-18-4	Yes	0.00018	2.18E-03	5.90E-06	1.28E-08	1.5
Thallium	7440-28-0	--	0.0001	--(b)	--	--(b)	
Tin	7440-31-5	--	0.0001	--(b)	--	--(b)	
Trichloroethene	79-01-6	Yes	0.0022	2.66E-02	2.50E-05	6.65E-07	76
Uranium	7440-61-1	--	0.114	--(b)	--	--(b)	
Vanadium	7440-62-2	--	0.0205	--(b)	--	--(b)	
Zinc	7440-66-6	--	0.0415	--(b)	--	--(b)	
Total Nonradionuclide ELCR						8.69E-07	100

^aEPA, 2009, "Regional Screening Levels for Chemical Contaminants at Superfund Sites."

^bNonvolatile constituents are not considered in the inhalation exposure route

-- = Indicates toxicity criteria not available to quantify contaminant's cancer risk via this exposure route.

COPC = contaminant of potential concern.

ELCR = excess lifetime cancer risk.

EPA-540-R-070-002, Risk Assessment Guidance for Superfund: Volume 1—Human Health Evaluation Manual (Part F, Supplemental Guidance for Inhalation Risk Assessment).

300 Area Subregion Native American Risk Assessment
CTUIR

Dermal Absorption of Nonradioactive COPCs in Drinking Water - CTUIR

Intake Parameter Values				
Parameter	Symbol	Value	Unit	Source
Chronic Daily Intake - Dermal	CDI	calculated	mg/kg-day	Equations 21 and 24
Contaminant concentration in groundwater	C _w	COPC-specific	mg/L	EPA-300FF5-11-0130
Body Weight - adult	BW _a	70	kg	Harris and Harper, 2004
Body Weight - child	BW _c	15	kg	Harris and Harper, 2004
Exposure Time - adult	ET _a	0.58	hours/event	EPA/540/R/99/005
Exposure Time - child	ET _c	1	hours/event	EPA/540/R/99/005
Age-Adjusted Exposure Time	ET _{adj}	0.616	hours/event	Equation 26
Skin Surface Area - adult	SA _a	18,000	cm ²	EPA/540/R/99/005
Skin Surface Area - child	SA _c	6,600	cm ²	EPA/540/R/99/005
Age-Adjusted Skin Surface Area	SA _{adj}	19,097	(cm ² -year-event)/(kg-day)	Equation 22
Event Frequency - adult	EV _a	1	event/day	EPA/540/R/99/005
Event Frequency - child	EV _c	1	event/day	EPA/540/R/99/005
Exposure Frequency	EF	365	days/year	Harris and Harper, 2004
Exposure Duration - adult	ED _a	70	years	Harris and Harper, 2004
Exposure Duration - child	ED _c	6	years	Harris, 2008
Averaging Time - carcinogens and noncarcinogens	AT	70	years	Harris, 2008
Reference Dose - Oral	RfD _o	COPC-specific	mg/kg-day	EPA, 2009
Cancer Slope Factor - Oral	CSF _o	COPC-specific	(mg/kg-day) ⁻¹	EPA, 2009
Gastrointestinal Absorption Factor	GIABS	COPC-specific	unitless	EPA, 2009
Conversion Factor	CF1	365	days/year	1 year = 365 days
Conversion Factor	CF3	0.001	L/cm ³	1 L = 1000 cm ³
The constant pi	π	3.14159	unitless	--
Time to reach steady state conditions	t*	COPC-specific	hours	EPA/540/R/99/005
Partitioning Constant derived by Bunge Model	B	COPC-specific	unitless	EPA/540/R/99/005
Absorbed Dose per Event	DA _{event}	calculated	mg/cm ² -event	Equations 27, 28, and 29
Dermal Permeability Coefficient	K _p	COPC-specific	cm/hour	EPA/540/R/99/005
Fraction of absorbed water	FA	COPC-specific	unitless	EPA/540/R/99/005
Lag Time	t	COPC-specific	hours/event	EPA/540/R/99/005

EPA-300FF5-11-0130, Calculation of Exposure Point Concentrations for the 300-FF-5 Groundwater Operable Unit.

EPA/540/R/92/003, Risk Assessment Guidance for Superfund: Volume I - Human Health Evaluation Manual (Part B, Development of Risk-based Preliminary Remediation Goals): Interim.

EPA/540/R/99/005, Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment): Final.

EPA, 2009, "Regional Screening Levels for Chemical Contaminants at Superfund Sites."

Harris, S., and Harper, B., 2004, Exposure Scenario for CTUIR Traditional Subsistence Lifeways.

Harris, S., 2008, Application of the CTUIR Traditional Lifeways Exposure Scenario in Hanford Risk Assessments.

Absorbed Dermal Dose Calculation

300 Area Subregion Native American Risk Assessment--Dermal Absorbed Dose Calculations										
300 Area Subregion Nonradioactive COPC	CAS #	C _w (mg/L)	Inorganic/organic ^a	FA ^b (unitless)	K _p ^c (cm/hour)	B ^d (unitless)	t ^e (hours/event)	t ^g (hours)	DA (noncancer) (mg/cm ² -event)	DA (cancer) (mg/cm ² -event)
1,2-Dichloroethene (Total)	540-59-0	0.00022	--	1	7.70E-03	0	0.37	0.89	2.17E-09	2.24E-09
Acetone ^h	67-64-1	0.001045	--	--	5.12E-04	--	--	--	--	--
Aluminum	7429-90-5	0.01	INORGANIC	--	1.00E-03	--	--	--	5.80E-09	6.16E-09
Arsenic	7440-38-2	0.005215	INORGANIC	--	1.00E-03	--	--	--	3.02E-09	3.21E-09
Barium	7440-39-3	0.07145	INORGANIC	--	1.00E-03	--	--	--	4.14E-08	4.40E-08
Boron	7440-42-8	0.0445	INORGANIC	--	1.00E-03	--	--	--	2.58E-08	2.74E-08
Bromodichloromethane	75-27-4	0.000088	--	1	4.60E-03	0	0.88	2.12	7.99E-10	8.24E-10
Bromomethane	74-83-9	0.00025	--	1	2.80E-03	0	0.36	0.87	8.84E-10	9.11E-10
Carbon disulfide	75-15-0	0.0000535	--	1	1.70E-02	0.1	0.72	1.05E-09	1.08E-09	1.08E-09
Carbon tetrachloride	56-23-5	0.00012	--	1	1.60E-02	0.1	0.78	1.86	3.57E-09	3.68E-09
Chloride	16887-00-6	25.95	INORGANIC	--	1.00E-03	--	--	--	1.51E-05	1.60E-05
Chloroform	67-66-3	0.00047	--	1	6.80E-03	0	0.5	1.19	4.76E-09	4.90E-09
Chromium	7440-47-3	0.007125	INORGANIC	--	1.00E-03	--	--	--	4.13E-09	4.39E-09
Cobalt	7440-48-4	0.000118	INORGANIC	--	4.00E-04	--	--	--	2.74E-11	2.91E-11
Copper	7440-50-8	0.001355	INORGANIC	--	1.00E-03	--	--	--	7.86E-10	8.35E-10
Cyanide	57-12-5	0.004	INORGANIC	--	1.00E-03	--	--	--	2.32E-09	2.46E-09
Fluoride	16984-48-8	0.28	INORGANIC	--	1.00E-03	--	--	--	1.62E-07	1.72E-07
Iron	7439-89-6	0.1055	INORGANIC	--	1.00E-03	--	--	--	6.12E-08	6.50E-08
Lead	7439-92-1	0.0002	INORGANIC	--	1.00E-04	--	--	--	1.16E-11	1.23E-11
Lithium	7439-93-2	0.0245	INORGANIC	--	1.00E-03	--	--	--	1.42E-08	1.51E-08
Manganese	7439-96-5	0.006	INORGANIC	--	1.00E-03	--	--	--	3.48E-09	3.70E-09
Molybdenum	7439-98-7	0.00565	INORGANIC	--	1.00E-03	--	--	--	3.28E-09	3.48E-09
Nickel	7440-02-0	0.006	INORGANIC	--	2.00E-04	--	--	--	6.96E-10	7.39E-10
Nitrate	14797-55-8	31.25	INORGANIC	--	1.00E-03	--	--	--	1.81E-05	1.93E-05
Selenium	7782-49-2	0.00372	INORGANIC	--	1.00E-03	--	--	--	2.16E-09	2.29E-09
Silver	7440-22-4	0.0002	INORGANIC	--	6.00E-04	--	--	--	6.96E-11	7.39E-11
Strontium	7440-24-6	0.248	INORGANIC	--	1.00E-03	--	--	--	1.44E-07	1.53E-07
Sulfate	14808-79-8	58.5	INORGANIC	--	1.00E-03	--	--	--	3.39E-05	3.60E-05
Tetrachloroethene	127-18-4	0.00018	--	1	3.30E-02	0.2	0.91	2.18	1.19E-08	1.23E-08
Thallium	7440-28-0	0.0001	INORGANIC	--	1.00E-03	--	--	--	5.80E-11	6.16E-11
Tin	7440-31-5	0.0001	INORGANIC	--	1.00E-03	--	--	--	5.80E-11	6.16E-11
Trichloroethene	79-01-6	0.0022	--	1	1.20E-02	0.1	0.58	1.39	4.23E-08	4.36E-08
Uranium	7440-61-1	0.114	INORGANIC	--	1.00E-03	--	--	--	6.61E-08	7.02E-08
Vanadium	7440-62-2	0.0205	INORGANIC	--	1.00E-03	--	--	--	1.19E-08	1.26E-08
Zinc	7440-66-6	0.0415	INORGANIC	--	6.00E-04	--	--	--	1.44E-08	1.53E-08

^aEPA/540/R/99/005, Exhibit 3-1 (Inorganics) and Exhibit B-3

^bEPA/540/R/99/005, Exhibit B-3

^cThe K_p value was taken from ORNL, 2010, The Risk Assessment Information System (RAIS).

^dEPA/540/R/99/005, Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment): Final.

Non-cancer HQ calculation

300 Area Subregion Nonradioactive COPC	CAS #	C _w (mg/L)	CDI (noncarcinogen) (mg/kg-day)	RfD ^a (mg/kg-day)	GIABS ^b (unitless)	HQ (unitless)	% Contribution
1,2-Dichloroethene (Total)	540-59-0	0.00022	5.58E-07	9.00E-03	1.00E+00	6.20E-05	0.37
Acetone	67-64-1	0.001045	--	9.00E-01	1.00E+00	--	--
Aluminum	7429-90-5	0.01	1.49E-06	1.00E+00	1.00E+00	1.49E-06	0.0090
Arsenic	7440-38-2	0.005215	7.78E-07	3.00E-04	1.00E+00	2.59E-03	16
Barium	7440-39-3	0.07145	1.07E-05	2.00E-01	7.00E-02	7.61E-04	4.6
Boron	7440-42-8	0.0445	6.64E-06	2.00E-01	1.00E+00	3.32E-05	0.20
Bromodichloromethane	75-27-4	0.000088	2.06E-07	2.00E-02	1.00E+00	1.03E-05	0.062
Bromomethane	74-83-9	0.00025	2.27E-07	1.40E-03	1.00E+00	1.62E-04	0.98
Carbon disulfide	75-15-0	0.0000535	2.70E-07	1.00E-01	1.00E+00	2.70E-06	0.016
Carbon tetrachloride	56-23-5	0.00012	9.18E-07	7.00E-04	1.00E+00	1.31E-03	7.9
Chloride	16887-00-6	25.95	3.87E-03	--	1.00E+00	--	--
Chloroform	67-66-3	0.00047	1.22E-06	1.00E-02	1.00E+00	1.22E-04	0.74
Chromium	7440-47-3	0.007125	1.06E-06	1.50E+00	1.30E-02	5.45E-05	0.33
Cobalt	7440-48-4	0.000118	7.04E-09	3.00E-04	1.00E+00	2.35E-05	0.14
Copper	7440-50-8	0.001355	2.02E-07	4.00E-02	1.00E+00	5.05E-06	0.031
Cyanide	57-12-5	0.004	5.97E-07	2.00E-02	1.00E+00	2.98E-05	0.18
Fluoride	16984-48-8	0.28	4.18E-05	6.00E-02	1.00E+00	6.96E-04	4.2
Iron	7439-89-6	0.1055	1.57E-05	7.00E-01	1.00E+00	2.25E-05	0.14
Lead	7439-92-1	0.0002	2.98E-09	--	1.00E+00	--	--
Lithium	7439-93-2	0.0245	3.65E-06	2.00E-03	1.00E+00	1.83E-03	11
Manganese	7439-96-5	0.006	8.95E-07	2.40E-02	4.00E-02	9.32E-04	5.6
Molybdenum	7439-98-7	0.00565	8.43E-07	5.00E-03	1.00E+00	1.69E-04	1.0
Nickel	7440-02-0	0.006	1.79E-07	2.00E-02	4.00E-02	2.24E-04	1.4
Nitrate	14797-55-8	31.25	4.66E-03	7.10E+00	1.00E+00	6.56E-04	4.0
Selenium	7782-49-2	0.00372	5.55E-07	5.00E-03	1.00E+00	1.11E-04	0.67
Silver	7440-22-4	0.0002	1.79E-08	5.00E-03	4.00E-02	8.95E-05	0.54
Strontium	7440-24-6	0.248	3.70E-05	6.00E-01	1.00E+00	6.16E-05	0.37
Sulfate	14808-79-8	58.5	8.72E-03	--	1.00E+00	--	--
Tetrachloroethene	127-18-4	0.00018	3.07E-06	1.00E-02	1.00E+00	3.07E-04	1.9
Thallium	7440-28-0	0.0001	1.49E-08	--	1.00E+00	--	--
Tin	7440-31-5	0.0001	1.49E-08	6.00E-01	1.00E+00	2.49E-08	1.50E-04
Trichloroethene	79-01-6	0.0022	1.09E-05	--	1.00E+00	--	--
Uranium	7440-61-1	0.114	1.70E-05	3.00E-03	1.00E+00	5.67E-03	34
Vanadium	7440-62-2	0.0205	3.06E-06	5.00E-03	1.00E+00	6.11E-04	3.7
Zinc	7440-66-6	0.0415	3.71E-06	3.00E-01	1.00E+00	1.24E-05	0.075
Total HI						1.66E-02	100

^aEPA, 2009, "Regional Screening Levels for Chemical Contaminants at Superfund Sites."

-- Indicates toxicity criteria not available to quantify contaminant's noncancer hazard via this exposure route.

COPC = contaminant of potential concern.

HI = hazard index

HQ = hazard quotient.

EPA/540/R/99/005, Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment): Final.

Cancer risk calculation

300 Area Subregion Nonradioactive COPC	CAS #	C _w (mg/L)	CDI (carcinogen) (mg/kg-day)	CSF ^a (mg/kg-day) ⁻¹	GIABS ^b (unitless)	Risk (unitless)	% Contribution
1,2-Dichloroethene (Total)	540-59-0	0.00022	6.10E-07	--	1.00E+00	--	--
Acetone	67-64-1	0.001045	--	--	1.00E+00	--	--
Aluminum	7429-90-5	0.01	1.68E-06	--	1.00E+00	--	--
Arsenic	7440-38-2	0.005215	8.76E-07	1.50E+00	1.00E+00	1.31E-06	30
Barium	7440-39-3	0.07145	1.20E-05	--	7.00E-02	--	--
Boron	7440-42-8	0.0445	7.48E-06	--	1.00E+00	--	--
Bromodichloromethane	75-27-4	0.000088	2.25E-07	6.20E-02	1.00E+00	1.39E-08	0.32
Bromomethane	74-83-9	0.00025	2.49E-07	--	1.00E+00	--	--
Carbon disulfide	75-15-0	0.0000535	2.95E-07	--	1.00E+00	--	--
Carbon tetrachloride	56-23-5	0.00012	1.00E-06	1.30E-01	1.00E+00	1.30E-07	3.0
Chloride	16887-00-6	25.95	4.36E-03	--	1.00E+00	--	--
Chloroform	67-66-3	0.00047	1.34E-06	3.10E-02	1.00E+00	4.15E-08	0.95
Chromium	7440-47-3	0.007125	1.20E-06	--	1.30E-02	--	--
Cobalt	7440-48-4	0.000118	7.93E-09	--	1.00E+00	--	--
Copper	7440-50-8	0.001355	2.28E-07	--	1.00E+00	--	--
Cyanide	57-12-5	0.004	6.72E-07	--	1.00E+00	--	--
Fluoride	16984-48-8	0.28	4.71E-05	--	1.00E		